# AiP485A
# Low-Power 10Mbps Full Fail-Safe RS-485 Transceiver

# Product Specification

**Specification Revision History：**

| Version | Date | Description |
|---|---|---|
| 2021-05-A1 | 2021-05 | New |
| | | |
| | | |
| | | |

## 1、General Description

The AiP485A is 3V~5.5V powered transceiver that meets the RS-485 standards for balanced communication. It features the larger output voltage and higher data rate up to 10Mbps required by high speed PROFIBUS applications.

This transceiver delivers at least a 2.1V differential output voltage on 5V supply condition, into the RS-485 required 54Ω load, for better noise immunity, or to allow up to three 120Ω terminations in "star" topologies, at the exceptional 10Mbps data rate. This device has very low bus currents so that presents a true "1/8 unit load" to the RS-485 bus. This allows up to 256 transceivers on the network without using repeaters.

Receiver (Rx) inputs feature a "Full Fail-Safe" design, which ensures a logic high Rx output if Rx inputs are floating, shorted, or on a terminated but undriven bus.

**Features:**

- Wide supply voltage 3V to 5.5V
- Hot plug circuitry-Tx and Rx outputs remain three-state during power-up/power-down
- High Data Rate: 10Mbps At 5V Supply
- Full fail-safe (open, short, terminated) receivers
- Up to 256 nodes on a bus (1/8 unit load)
- Bus-Pin Protection: ±15kV HBM protection
- Specified from -40℃ to +85℃
- Packaging information: SOP8/MSOP8/DFN8

**Ordering Information:**

**Tube packing specifications:**

| Part number | Packaging form | Marking code | Tube quantity | Boxed tube quantity | Boxed quantity | Notes |
|---|---|---|---|---|---|---|
| AiP485ASA8.TB | SOP8 | AiP485A | 100 PCS/tube | 100 tube/box | 10000 PCS/box | Dimensions of plastic enclosure: 4.9mm×3.9mm Pin spacing: 1.27mm |
| AiP485AMA8.TB | MSOP8 | AiP485A | 100 PCS/tube | 120 tube/box | 12000 PCS/box | Dimensions of plastic enclosure: 3.0mm×3.0mm Pin spacing: 0.65mm |
| AiP485AXA8.TB | DFN8 | AiP485A | 490 PCS/plate | 10 plate/box | 4900 PCS/box | Dimensions of plastic enclosure: 3.0mm×3.0mm Pin spacing: 0.65mm |

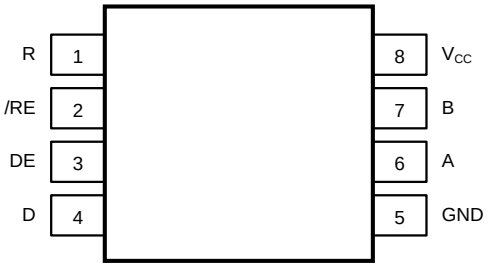
**Reel packing specifications:**

| Part number | Packaging form | Marking code | Reel quantity | Boxed reel quantity | Notes |
|---|---|---|---|---|---|
| AiP485ASA8.TR | SOP8 | AiP485A | 4000PCS/reel | 8000PCS/box | Dimensions of plastic enclosure: 4.9mm×3.9mm Pin spacing:1.27mm |
| AiP485AMA8.TR | MSOP8 | AiP485A | 5000PCS/reel | 10000PCS/box | Dimensions of plastic enclosure: 3.0mm×3.0mm Pin spacing:0.65mm |

Note: If the physical information is inconsistent with the ordering information, please refer to the actual product.

## 2、Block Diagram And Pin Description

### 2.1、Pin Configurations




### 2.2、Pin Description

| Pin No. | Pin Name | I/O | Description |
|---|---|---|---|
| 1 | R | digital output | receiver output |
| 2 | /RE | digital input | receiver output enable |
| 3 | DE | digital input | driver output enable |
| 4 | D | digital input | driver input |
| 5 | GND | ground | ground |
| 6 | A | bus input/output | noninverting receiver input A and noninverting driver output A |
| 7 | B | bus input/output | inverting receiver input A and inverting driver output A |
| 8 | $V_{CC}$ | power | power supply |

### 2.3、Function Table

#### 2.3.1、Driver Function Table

| Input | Enable | Outputs | | Description |
|---|---|---|---|---|
| **D** | **DE** | **A** | **B** | |
| **Normal Mode** | | | | |
| H | H | H | L | actively drives bus High |
| L | H | L | H | actively drives bus Low |
| X | L | Z | Z | driver disabled |
| X | open | Z | Z | driver disabled by default |
| open | H | H | L | actively drives bus High by default |

#### 2.3.2、Receiver Function Table

| Differential Input | Enable | Outputs | Description |
|---|---|---|---|
| **$V_{ID}$=VA-VB** | **/RE** | **R** | |
| **Normal Mode** | | | |
| $V_{IT+}<V_{ID}$ | L | H | receive valid bus High |
| $V_{IT-}<V_{ID}<V_{IT+}$ | L | - | indeterminate bus state |
| $V_{ID}<V_{IT-}$ | L | L | receive valid bus Low |
| X | H | Z | receiver disabled |
| X | open | Z | receiver disabled by default |
| open, short, idle bus | L | H | fail-safe high output |

# 3、Electrical Parameter

## 3.1、Absolute Maximum Ratings

($T_{amb}$=25℃, all voltage referenced to GND, unless otherwise specified)

| Characteristic | Symbol | Conditions | Value | Unit |
|---|---|---|---|---|
| supply voltage | $V_{CC}$ | - | -0.3 to +7 | V |
| input voltage | $V_I$ | D, DE, /RE | -0.3 to $V_{CC}$+0.3 | V |
| Input/output voltage | $V_{I/O}$ | A, B | -15 to +15 | V |
| | | A, B (transient pulse through 100Ω) | ±100 | V |
| | | R | -0.3 to $V_{CC}$+0.3 | V |
| short circuit duration | - | A, B | continuous | - |

## 3.2、Recommended Operating Conditions

| Characteristic | Symbol | Conditions | Value | Unit |
|---|---|---|---|---|
| supply voltage | $V_{CC}$ | - | 3 to 5.5 | V |
| bus pin common mode voltage | $V_{CM}$ | - | -7 to 12 | V |
| High-level input voltage | $V_{IH}$ | driver, driver enable, and receiver enable inputs | 2 to $V_{CC}$ | V |
| Low-level input voltage | $V_{IL}$ | driver, driver enable, and receiver enable inputs | 0 to 0.8 | V |
| differential input voltage | $V_{ID}$ | - | -7 to 12 | V |
| differential load resistance | $R_L$ | - | >54 | Ω |
| operating temperature | $T_{amb}$ | - | -40 to 85 | ℃ |
| storage temperature | $T_{stg}$ | - | -65 to 150 | ℃ |

## 3.3、ESD Rating

| HBM Model | Value | Unit |
|---|---|---|
| bus pins(A,B) | ±15 | kV |
| all other pins | ±15 | kV |

### 3.4、Electrical Characteristics

#### 3.4.1、DC Characteristics

($T_{amb}$=-40 to 85℃, $V_{CC}$=5V, unless otherwise specified)

| Parameter | Symbol | Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| driver differential-output voltage magnitude | $\|V_{OD}\|$ | $R_L$=60Ω@VA&VB(-7~12V) $V_{CC}$=4.5 to 5.5V | Figure 1B | 2.1 | 3.5 | - | V |
| | | $R_L$=60Ω@VA&VB(-7~12V) $V_{CC}$=3.0 to 3.6V | | 1.5 | 2.2 | - | V |
| | | $R_L$=54Ω, $V_{CC}$=5V | Figure 1A | 2 | 3.6 | - | V |
| | | $R_L$=54Ω, $V_{CC}$=3V | | 1.5 | 1.9 | - | V |
| | | $R_L$=100Ω, $V_{CC}$=5V | | 2.7 | 4.0 | - | V |
| | | $R_L$=100Ω, $V_{CC}$=3V | | 2 | 2.3 | - | V |
| change in magnitude of driver differential-output voltage | $\Delta\|V_{OD}\|$ | $R_L$=54Ω, $V_{CC}$=5V, $C_L$=50pF | Figure 1A | -50 | 2 | 50 | mV |
| steady-stage common-mode output voltage | $V_{OC(SS)}$ | center of two 27Ω load resistors | Figure 1A | 1 | $V_{CC}$/2 | 3 | V |
| change in differential driver common-mode output voltage | $\Delta V_{OC}$ | | | - | 50 | - | mV |
| peak-to-peak driver common-mode output voltage | $V_{OC(PP)}$ | | | - | 500 | - | mV |
| differential output capacitance | $C_{OD}$ | - | | - | 8 | - | pF |
| positive-going receiver differential-input voltage threshold | $V_{IT+}$ | VA/VB: from -7~12V | | - | -120 | -40 | mV |
| negative-going receiver differential-input voltage threshold | $V_{IT-}$ | VA/VB: from -7~12V | | -220 | -170 | - | mV |
| receiver differential-input voltage threshold hysteresis ($V_{IT+}$-$V_{IT-}$) | $V_{HYS}$ | - | | - | 50 | - | mV |
| logic Input High Voltage | $V_{IH}$ | DI, DE, /RE | | 2 | - | - | V |
| logic Input Low Voltage | $V_{IL}$ | DI, DE, /RE | | - | - | 0.8 | V |
| receiver high-level output voltage | $V_{OH}$ | $I_{OH}$=-8mA | | 3 | 4.6 | - | V |
| receiver low-level output voltage | $V_{OL}$ | $I_{OL}$=8mA | | - | - | 0.4 | V |
| driver input, driver enable | $I_i$ | DI, DE, /RE | | -5 | - | 5 | uA |
| receiver high-Z output current | $I_{OZ}$ | $V_O$=0/$V_{CC}$, /RE=$V_{CC}$ | | -1 | - | 1 | uA |
| driver short-circuit output current | $\|I_{OS}\|$ | $\|I_{OS}\|$ with VA/VB from -7 to 12V | | -250 | 110 | 250 | mA |
| | | bus pin A,B short current | | - | - | 150 | mA |
| bus input current(driver disabled) | $I_{IN}$ | $V_{CC}$=4.5 to 5.5 or $V_{CC}$=0, DE at 0V | $V_I$=12V | - | - | 120 | uA |
| | | | $V_I$=-7V | -110 | - | - | uA |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| bus input impedance | $R_A/R_B$ | VA=-7V, VB=12V and VA=12V, VB=-7V | | 96 | - | - | KΩ |
| supply current (quiescent) | $I_{CC}$ | TX、RX enable | DE=$V_{CC}$, /RE=GND, no load; | - | 1.9 | 2.2 | mA |
| | | TX enable, RX disable | DE=$V_{CC}$, /RE=$V_{CC}$, no load; | - | 0.47 | 0.6 | |
| | | TX disable, RX enable | DE=GND, /RE=GND, no load; | - | 1.7 | 2.0 | |
| | | TX disable, RX disable | DE=GND, /RE=$V_{CC}$, no load; | - | - | <0.001 | |

### 3.4.2、AC Characteristics

| Parameter | Symbol | Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| **Driver** | | | | | | | |
| maximum data rate | $f_{MAX}$ | $V_{OD}$≥±1.5V, $R_L$=54Ω, $C_L$=100pF; (Figure 4) | | - | - | 10 | Mbps |
| driver differential-output rise and fall times | $t_r$, $t_f$ | $R_L$=54Ω, $C_L$=50pF | Figure 2 | - | 5 | - | ns |
| driver propagation delay | $t_{PHL}$, $t_{PLH}$ | | | - | 15 | 30 | ns |
| $\|t_{PHL}- t_{PLH}\|$ | $t_{SK(P)}$ | | | - | - | 20 | ns |
| driver disable time | $t_{PHZ}$ | $C_L$=15pF | Figure 3 | - | 17 | 50 | ns |
| | $t_{PLZ}$ | | | - | 20 | 50 | ns |
| driver enable time | $t_{PZH}$ | RX enable | | - | 36 | 45 | ns |
| | | RX disable | | - | 2400 | 3200 | ns |
| | $t_{PZL}$ | RX enable | | - | 21 | 45 | ns |
| | | RX disable | | - | 2400 | 3200 | ns |
| **Receiver** | | | | | | | |
| receiver output rise and fall times | $t_r$, $t_f$ | $C_L$=15pF | Figure 5 | - | 9 | - | ns |
| receiver propagation delay time | $t_{PHL}$, $t_{PLH}$ | | | - | 28 | 50 | ns |
| receiver pulse skew, $\|t_{PHL}-t_{PLH}\|$ | $t_{SK(P)}$ | | | - | - | 15 | ns |
| receiver disable time | $t_{PHZ}$ | - | | - | 30 | 60 | ns |
| | $t_{PLZ}$ | | | - | 27 | 60 | |
| receiver enable time | $t_{PZH}$ | TX enable | | - | 67 | - | ns |
| | | TX disable | | - | 2500 | 3200 | ns |
| | $t_{PZL}$ | TX enable | | - | 24 | 35 | ns |
| | | TX disable | | - | 2400 | 3200 | ns |

# 4、Testing Circuit

## 4.1、DC Testing Circuit

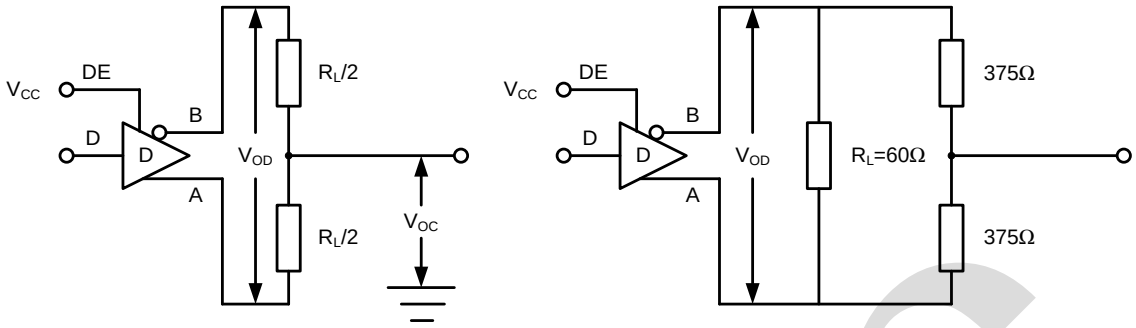



Figure 1A. $V_{OD}$ and $V_{OC}$ Figure 1B. $V_{OD}$ with common mode load

Figure 1. DC driver test circuits

## 4.2、AC Testing Circuit

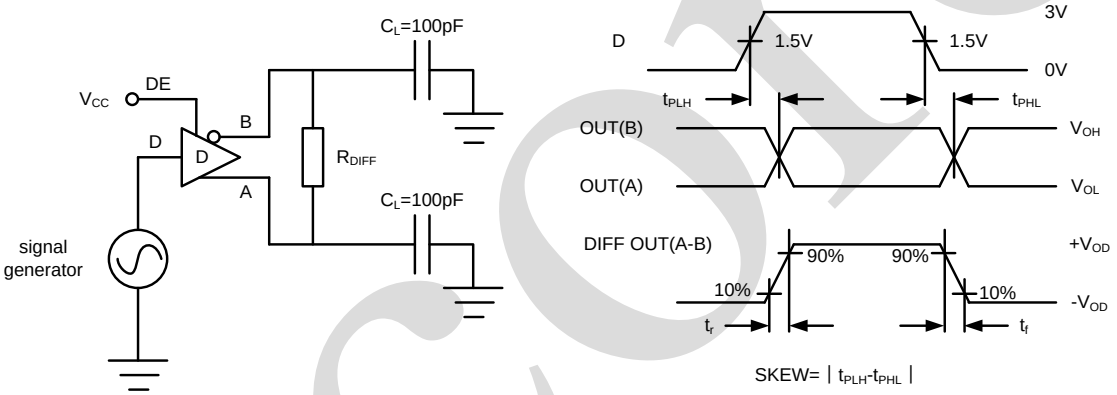
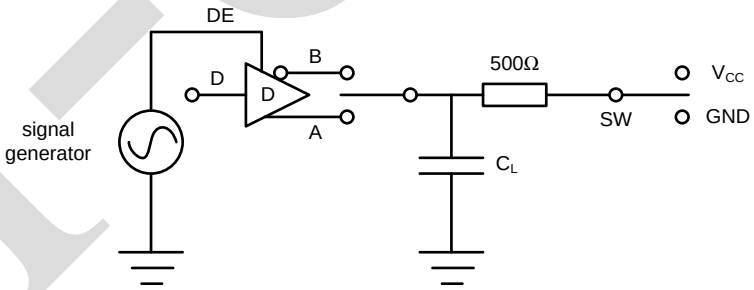



Figure 2A. test circuit Figure 2B. measurement points

Figure 2. driver propagation delay and differential transition times




| Parameter | Output | /RE | D | SW | $C_L$(pF) |
|---|---|---|---|---|---|
| $t_{PHZ}$ | A/B | X | 1/0 | GND | 15 |
| $t_{PLZ}$ | A/B | X | 0/1 | $V_{CC}$ | 15 |
| $t_{PZH}$ | A/B | 0 | 1/0 | GND | 100 |
| $t_{PZL}$ | A/B | 0 | 0/1 | $V_{CC}$ | 100 |
| $t_{PZH(SHDN)}$ | A/B | 1 | 1/0 | GND | 100 |
| $t_{PZL(SHDN)}$ | A/B | 1 | 0/1 | $V_{CC}$ | 100 |

Figure 3A. test circuit

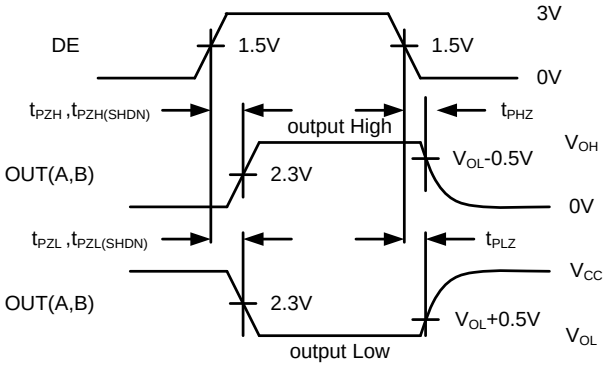



Figure 3B. measurement points

Figure 3. driver enable and disable times

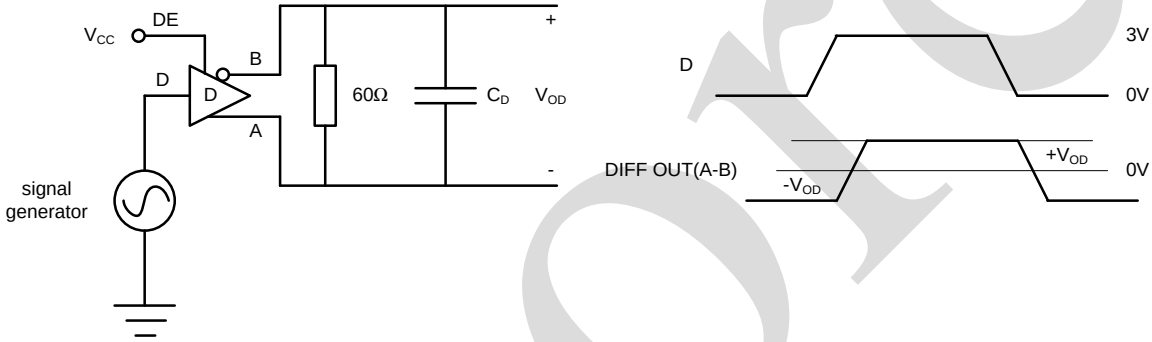



Figure 4A. test circuit

Figure 4B. measurement points

Figure 4. driver data rate

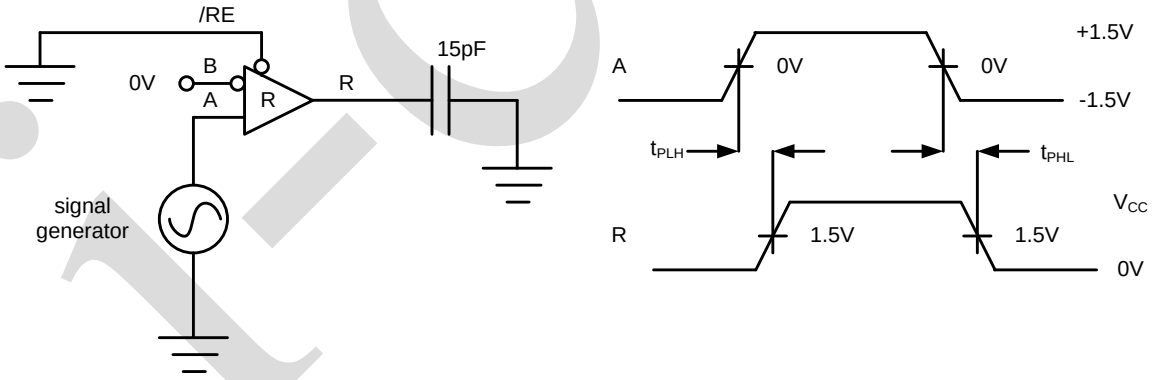
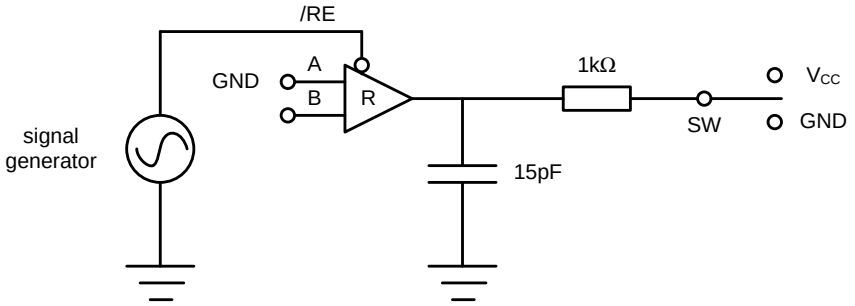



Figure 5A. test circuit

Figure 5B. measurement points

Figure 5. receiver propagation delay and data rate




| Parameter | DE | A | SW |
|---|---|---|---|
| $t_{PHZ}$ | 1 | +1.5V | GND |
| $t_{PLZ}$ | 1 | -1.5V | $V_{CC}$ |
| $t_{PZH}$ | 1 | +1.5V | GND |
| $t_{PZL}$ | 1 | -1.5V | $V_{CC}$ |
| $t_{PZH(SHDN)}$ | 0 | +1.5V | GND |
| $t_{PZL(SHDN)}$ | 0 | -1.5V | $V_{CC}$ |

Figure 6A. test circuit

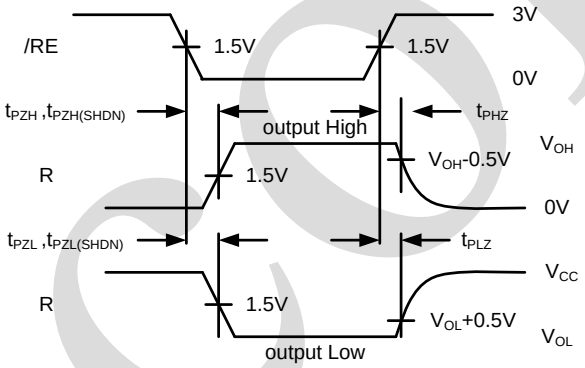



Figure 6B. measurement points

Figure 6. receiver enable and disable times

## 5、Characteristic Curve

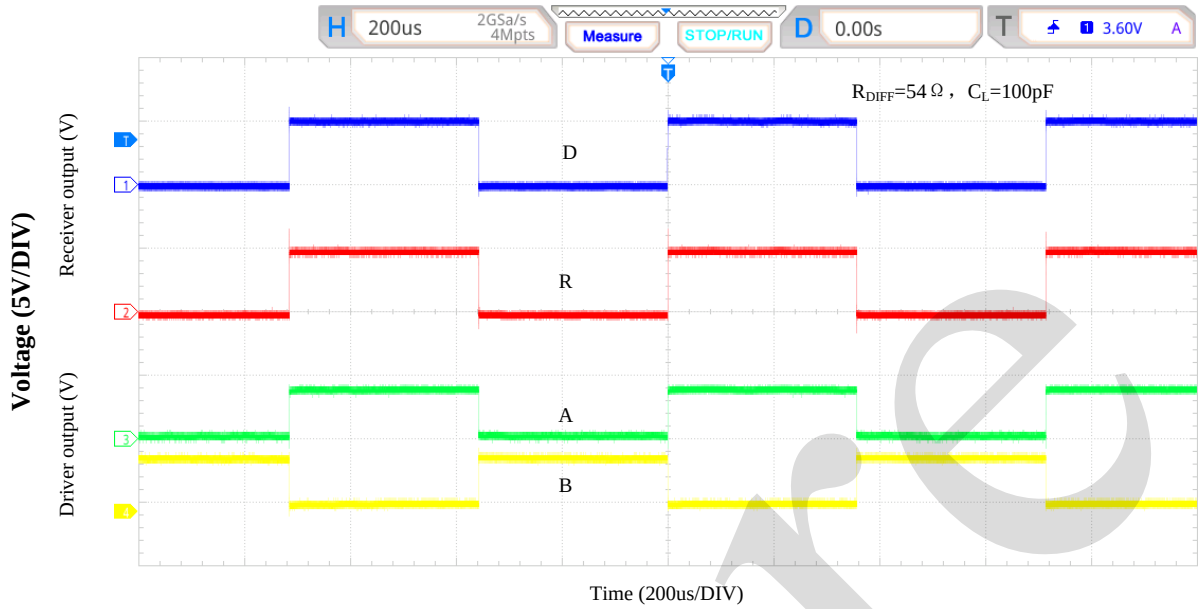



Figure 7. driver and receiver waveforms

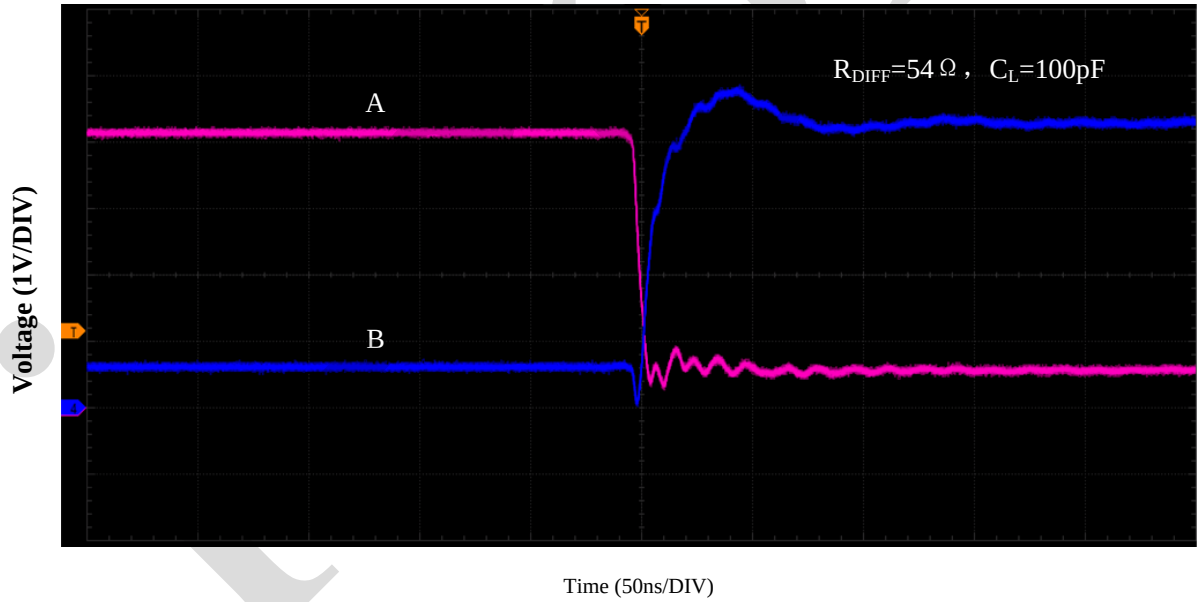



Figure 8. driver waveforms

## 6、Function Description

RS-485 is intended for network lengths up to 4000', but the maximum system data rate decreases as the transmission length increases. Devices operating at 10Mbps are limited to lengths less than 100'.

Twisted pair is the cable of choice for RS-485 networks. Twisted pair cables tend to pick up noise and other electromagnetically induced voltages as common mode signals, which are effectively rejected by the differential receiver in this IC.

Proper termination is imperative to minimize reflections. In point-to-point, or point-to-multipoint (single driver on bus) networks, the main cable should be terminated in its characteristic impedance (typically 120Ω) at the end farthest from the driver. In multi-receiver applications, stubs connecting receivers to the main cable should be kept as short as possible. Multipoint (multi-driver) systems require that the main cable be terminated in its characteristic impedance at both ends. Stubs connecting a transceiver to the main cable should be kept as short as possible.

The AiP485A may also be used at slower data rates over longer cables, but there are some limitations. The Rx is optimized for high speed operation, so its output may glitch if the Rx input differential transition times are too slow. Keeping the transition times below 500ns, which equates to the Tx driving a 1000' (305m) CAT 5 cable, yields excellent performance over the full operating temperature range.

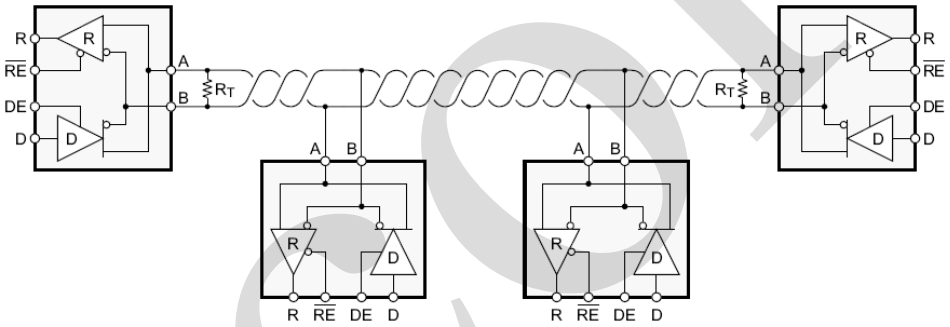



Figure 9. Typical Application

### 6.1、Receiver (Rx) Features

AiP485A utilize a differential input receiver for maximum noise immunity and common mode rejection. Input sensitivity is better than ±200mV, as required by the RS-485 specifications. Rx outputs feature high drive levels to ease the design of optically coupled isolated interfaces.

Receiver input resistance of 100kΩ is eight times the RS-485 “Unit Load (UL)” requirement of 12kΩ minimum. Thus, these products are known as UL/8 transceivers, and there can be up to 256 of these devices on a network while still complying with the RS-485 loading specification. Rx inputs function with common mode voltages as great as ±7V outside the power supplies (i.e., +12V and -7V), making them ideal for long networks where induced voltages are a realistic concern.

### 6.2、Driver (Tx) Features

AiP485A driver is a differential output device that delivers at least 2.1V across a 54Ω load (RS-485). The drivers feature low propagation delay skew to maximize bit width, and to minimize EMI, and all drivers are three-stable via the active high DE input.

### 6.3、Full Fail-Safe

The receiver includes a “full fail-safe” function that guarantees a high level receiver output if the receiver inputs are unconnected (floating), shorted together, or connected to a terminated bus with all the transmitters disabled. The receiver easily meets the data rates supported by the corresponding driver, and the receiver output is three-stable via the active low /RE input.

### 6.4、Hot Plug Function

When a piece of equipment powers up, there is a period of time where the processor or ASIC driving the RS-485 control lines (DE, /RE) is unable to ensure that the RS-485 Tx and Rx outputs are kept disabled. If the equipment is connected to the bus, a driver activating prematurely during power-up may crash the bus. To avoid this scenario, the AiP485A devices incorporate a “Hot Plug” function. Circuitry monitoring $V_{CC}$ ensures that, during power-up and power-down, the Tx and Rx outputs remain disabled, regardless of the state of DE and /RE, if $V_{CC}$ is less than ~2.5V. This gives the processor/ASIC a chance to stabilize and drive the RS-485 control lines to the proper states.

### 6.5、Detailed Design Procedure

In order to protect bus nodes against high-energy transients, the implementation of external transient protection devices is necessary.

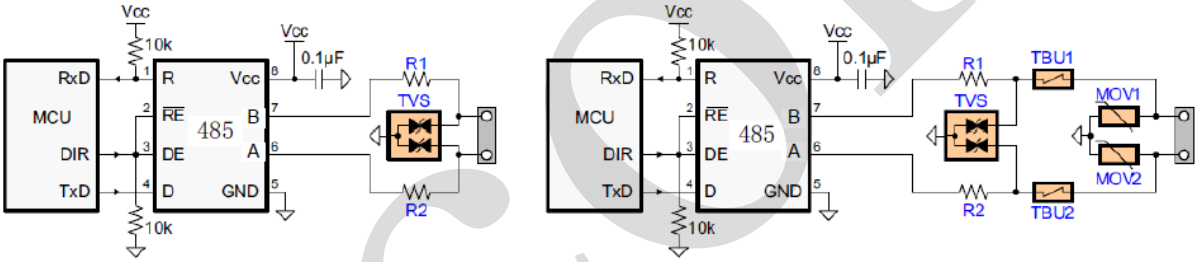



Figure 10. Transient Protections Against ESD, EFT, and Surge Transients

The left circuit shown in Figure 10 provides surge protection of ≥500V transients, while the right protection circuits can withstand surge transients of 5KV. Table 1 shows the associated Bill of Materials.

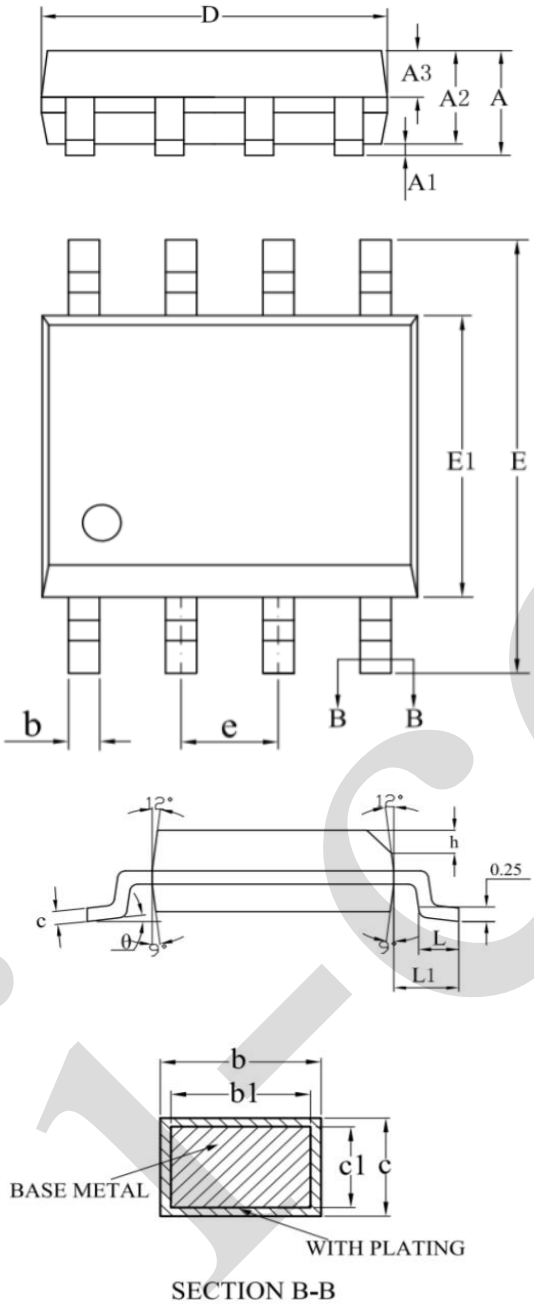
Table 1. Bill of Materials

| Device | Function | Order Number | Manufacturer |
|---|---|---|---|
| 485 | 5-V, 10Mbps RS-485 Transceiver | AiP485A | i-core |
| R1,R2 | 10-Ω, Pulse-Proof Thick-Film Resistor | CRCW0603010RJNEAHP | Vishay |
| TVS | Bidirectional 400-W Transient Suppressor | CDSOT23-SM712 | Bourns |
| TBU1,TBU2 | Bidirectional | TBU-CA-065-200-WH | Bourns |
| MOV1,MOV2 | 200mA Transient Blocking Unit 200-V, Metal- Oxide Varistor | MOV-10D201K | Bourns |

## 7、Package Information

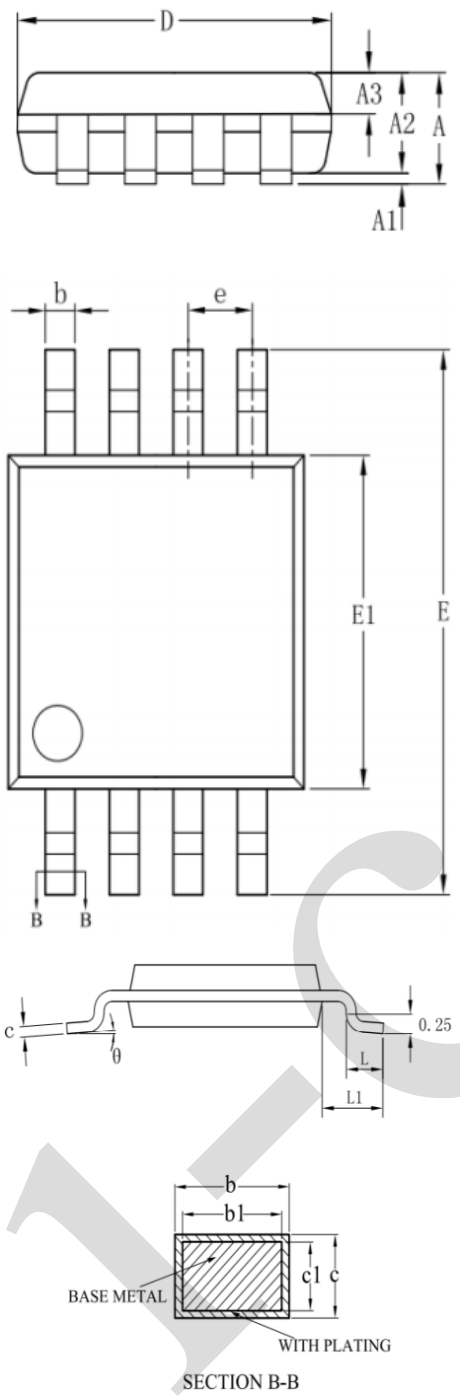
### 7.1、SOP8

SOP8(SO1R)




| SYMBOL | MILLIMETER | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | — | — | 1.75 |
| A1 | 0.10 | — | 0.225 |
| A2 | 1.30 | 1.40 | 1.50 |
| A3 | 0.60 | 0.65 | 0.70 |
| b | 0.39 | — | 0.47 |
| b1 | 0.38 | 0.41 | 0.44 |
| c | 0.20 | — | 0.24 |
| c1 | 0.19 | 0.20 | 0.21 |
| D | 4.80 | 4.90 | 5.00 |
| E | 5.80 | 6.00 | 6.20 |
| E1 | 3.80 | 3.90 | 4.00 |
| e | 1.27BSC | | |
| h | 0.25 | — | 0.50 |
| L | 0.50 | — | 0.80 |
| L1 | 1.05REF | | |
| θ | 0 | — | 8° |

**7.2、MSOP8**

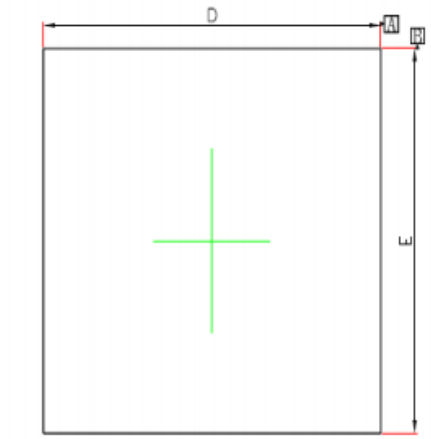



# MSOP8(VS1R)

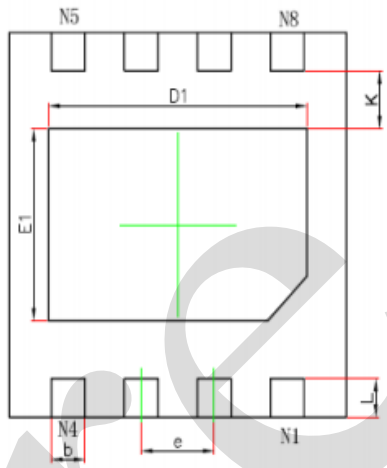
| SYMBOL | MILLIMETER | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | — | — | 1.10 |
| A1 | 0.05 | — | 0.15 |
| A2 | 0.75 | 0.85 | 0.95 |
| A3 | 0.30 | 0.35 | 0.40 |
| b | 0.28 | — | 0.36 |
| b1 | 0.27 | 0.30 | 0.33 |
| c | 0.15 | — | 0.19 |
| c1 | 0.14 | 0.15 | 0.16 |
| D | 2.90 | 3.00 | 3.10 |
| E | 4.70 | 4.90 | 5.10 |
| E1 | 2.90 | 3.00 | 3.10 |
| e | 0.65BSC | | |
| L | 0.40 | — | 0.70 |
| L1 | 0.95REF | | |
| θ | 0 | — | 8° |

**7.3、DFN8**

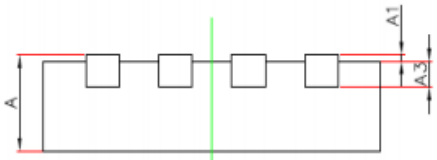
## DFNWB3X3-8L-F(DF6R)




TOP VIEW




BOTTOM VIEW




SIDE VIEW

| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min. | NOM. | Min. | NOM. |
| A | 0.700/0.800 | 0.800/0.900 | 0.028/0.031 | 0.031/0.035 |
| A1 | 0.000 | 0.050 | 0.000 | 0.002 |
| A3 | 0.203REF. | | 0.008REF. | |
| D | 3.000BSC. | | 0.118BSC. | |
| E | 3.000BSC. | | 0.118BSC. | |
| D1 | 2.200 | 2.400 | 0.087 | 0.094 |
| E1 | 1.400 | 1.600 | 0.055 | 0.063 |
| k | 0.250MIN. | | 0.010MIN. | |
| b | 0.250 | 0.350 | 0.010 | 0.014 |
| e | 0.650TYP. | | 0.026TYP. | |
| L | 0.224 | 0.376 | 0.009 | 0.015 |

# 8、Statements And Notes

## 8.1、The name and content of Hazardous substances or Elements in the product

| Part name | Hazardous substances or Elements | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Lead and lead compounds | Mercury and mercury compounds | Cadmium and cadmium compounds | Hexavalent chromium compounds | Polybrominated biphenyls | Polybrominated biphenyl ethers | Dibutyl phthalate | Butylbenzyl phthalate | Di-2-ethylhexyl phthalate | Diisobutyl phthalate |
| Lead frame | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Plastic resin | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Chip | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| The lead | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Plastic sheet installed | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| explanation | ○：Indicates that the content of hazardous substances or elements in the detection limit of the following the SJ/T11363-2006 standard.<br>×：Indicates that the content of hazardous substances or elements exceeding the SJ/T11363-2006 Standard limit requirements. | | | | | | | | | |

## 8.2、Notion

Recommended carefully reading this information before the use of this product；

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