

### Features

- **High Data Rates: 10Mbps At 5V Supply**
- **30/50ns (Max) Tx/Rx Propagation Delays; 6ns (Max) Skew**
- **Full Fail-safe (Open, Short, Terminated) Receivers**
- **Up to 256 Nodes on a Bus (1/8 unit load)**
- **Wide Supply Voltage 3V to 5.5V**
- **Low Quiescent Supply Current: 1.65 mA**
- **Bus-Pin Protection:**
  - ±15 kV HBM protection
  - ±15 kV IEC-ESD
- **Pb-Free**

### Applications

- PROFIBUS® DP and FMS Networks
- SCSI “Fast 40” Drivers and Receivers
- Motor Controller/Position Encoder Systems
- Factory Automation
- Field Bus Networks
- Industrial/Process Control Networks

### Description

3PEAK's TPT75176H is enhanced RS485 which exceeds standard TIA/EIA-485-A with ±15kV IEC-ESD Protected, 3V~5.5V powered, single transceiver for balanced communication. It also features the larger output voltage and higher data rate - up to 10Mbps - required by high speed PROFIBUS applications, and is offered in Industrial and Extended Industrial (-40°C to +125°C) temperature ranges.

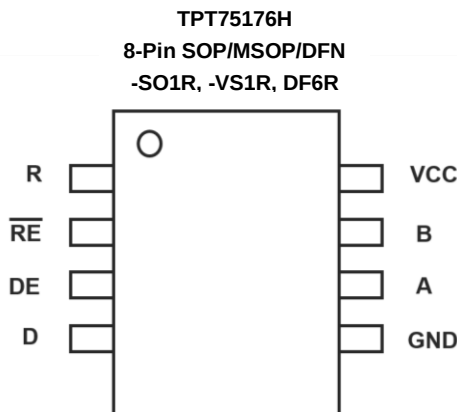
This transceiver requires a 3V~5.5V tolerance supply, and delivers at least a 2.1V differential output voltage on 5V supply condition. This translates into better noise immunity (data integrity), longer reach, or the ability to drive up to three 120Ω terminations in “star” or other non-standard bus topologies, at the exceptional 10Mbps data rate.

Receiver (Rx) inputs feature a “Full Fail-Safe” design, which ensures a logic high Rx output if Rx inputs are floating, shorted, or terminated but undriven. Rx outputs feature high drive levels (typically >25mA @ V<sub>OL</sub> = 1V) to ease the design of optically isolated interfaces.

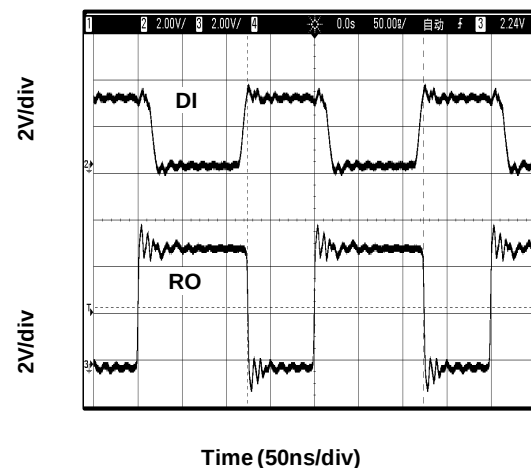
The TPT75176H is available in an SOP8, MSOP8 and DFN3X3-8L package, and is characterized from -40°C to 125°C.

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### Pin Configuration (Top View)



### Loopback Test At 10Mbps/5V



## Revision History

| Date       | Revision     | Notes                                                                         |
|------------|--------------|-------------------------------------------------------------------------------|
| 2019/2/22  | Rev. Pre 0.1 | Definition Version 0                                                          |
| 2019/3/25  | Rev. Pre 0.2 | Update package information                                                    |
| 2019/4/19  | Rev. Pre 0.3 | Update tape and reel information                                              |
| 2019/7/29  | Rev. Pre 0.4 | Update ESD level                                                              |
| 2019/9/20  | Rev. 0       | Final version, update full temp data                                          |
| 2020/3/18  | Rev. A       | Update Receiver rise/fall time and add the note1 for Absolute Maximum Ratings |
| 2020/10/31 | Rev. B       | Update VOH/VOL, VIH/VIL at 3.3V                                               |
| 2021/6/10  | Rev. C       | Add tape reel information                                                     |

## Order Information

| Model Name | Order Number     | Package    | Transport Media, Quantity | Marking Information |
|------------|------------------|------------|---------------------------|---------------------|
| TPT75176H  | TPT75176HL1-SO1R | 8-Pin SOP  | Tape and Reel, 4,000      | T176H               |
| TPT75176H  | TPT75176H-VS1R   | 8-Pin MSOP | Tape and Reel, 3,000      | 176H                |
| TPT75176H  | TPT75176HL1-DF6R | 8-Pin DFN  | Tape and Reel, 4,000      | 176H                |

## Functional Table

## DRIVER PIN FUNCTIONS

| 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   |

## RECEIVER PIN FUNCTIONS

| DIFFERENTIAL INPUT           | ENABLE | OUTPUT | DESCRIPTION             |
|------------------------------|--------|--------|-------------------------|
| $V_{ID} = V_A - V_B$         | /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       |
| Open, short, idle Bus        | L      | H      | Indeterminate bus state |

## Absolute Maximum Ratings

|                                                  |                         |
|--------------------------------------------------|-------------------------|
| V <sub>DD</sub> to GND.....                      | -0.3V to +7V            |
| Input Voltages D, DE, RE.....                    | -0.3V to (VCC + 0.3V)   |
| Input/Output Voltages A, B.....                  | -15V to +15V            |
| A, B (Transient Pulse Through 100Ω, Note 1)..... | ±100V                   |
| R.....                                           | -0.3V to (VCC + 0.3V)   |
| Short Circuit Duration A, B.....                 | Continuous              |
| ESD Rating.....                                  | See Specification Table |

### Note:

(1) Support ±15V in receiver mode, and -8 ~+13V in driver mode

(2) Stresses beyond the *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*.

## Recommended Operating Conditions

|                                                                     |                 |
|---------------------------------------------------------------------|-----------------|
| Supply Voltage.....                                                 | 3V~5.5V         |
| Temperature Range.....                                              | -40°C to +125°C |
| Bus Pin Common Mode Voltage Range .....                             | -7V to +12V     |
| Thermal Resistance, $\Theta_{JA}$ (Typical) 8-Pin SOP Package ..... | 152°C/W         |
| 8-Pin MSOP Package .....                                            | 200°C/W         |
| Maximum Junction Temperature (Plastic Package) .....                | +150°C          |
| Maximum Storage Temperature Range .....                             | -65°C to +150°C |

### Note:

(1) Tested according to TIA/EIA-485-A, Section 4.2.6 (±100V for 15μs at a 1% duty cycle).

## Electrical Characteristics

Test Conditions:  $V_{CC} = 5V$ ,  $T_a = -45 \sim +125^{\circ}C$  (unless otherwise noted)

| Parameter        |                                                                                                 | Conditions                                                       |                                                | Min  | Typ        | Max | Units   |
|------------------|-------------------------------------------------------------------------------------------------|------------------------------------------------------------------|------------------------------------------------|------|------------|-----|---------|
| $ V_{OD} $       | Driver differential-output voltage magnitude                                                    | RL = 60 $\Omega$ with VA or VB from -7 to +12 V, VCC = 4.5V~5.5V | See Figure 1B                                  | 2.1  | 2.8        |     | V       |
|                  |                                                                                                 | RL = 60 $\Omega$ with VA or VB from -7 to +12 V, VCC = 3.0~3.6V  |                                                | 1.5  | 2.0        |     |         |
|                  |                                                                                                 | RL = 54 $\Omega$ , VCC = 5V                                      | See Figure 1A                                  | 2.1  | 2.8        |     | V       |
|                  |                                                                                                 | RL = 54 $\Omega$ , VCC = 3V                                      |                                                | 1.5  | 1.9        |     |         |
|                  |                                                                                                 | RL = 100 $\Omega$ , VCC = 5V                                     |                                                | 2.1  | 3.5        |     |         |
|                  |                                                                                                 | RL = 100 $\Omega$ , VCC = 3V                                     |                                                | 1.5  | 2.3        |     |         |
| $\Delta V_{OD} $ | Change in magnitude of driver differential-output voltage                                       | RL = 54 $\Omega$ , CL=50 pF, VCC = 5V                            | See Figure 1A                                  | -50  | 1          | 50  | mV      |
| $V_{OC(SS)}$     | Steady-stage common-mode output voltage                                                         | Center of two 27 $\Omega$ load resistors                         | See Figure 1A                                  | 1    | $V_{CC}/2$ | 3   | V       |
| $\Delta V_{OC}$  | Change in differential driver common-mode output voltage <sup>[1]</sup>                         |                                                                  |                                                |      | 50         |     | mV      |
| $V_{OC(PP)}$     | Peak-to-peak driver common-mode output voltage <sup>[1]</sup>                                   |                                                                  |                                                |      | 500        |     |         |
| $C_{OD}$         | Differential output capacitance <sup>[1]</sup>                                                  |                                                                  |                                                |      | 8          |     | pF      |
| $V_{IT+}$        | Positive-going receiver differential-input voltage threshold                                    | $V_A$ or $V_B$ from -7 to +12 V                                  |                                                |      | -90        | -40 | mV      |
| $V_{IT-}$        | Negative-going receiver differential-input voltage threshold                                    | $V_A$ or $V_B$ from -7 to +12 V                                  |                                                | -220 | -155       |     | mV      |
| $V_{HYS}$        | Receiver differential-input voltage threshold hysteresis ( $V_{IT+} - V_{IT-}$ ) <sup>[1]</sup> |                                                                  |                                                |      | 70         |     | mV      |
| $V_{IH}$         | Logic Input High Voltage                                                                        | D, DE, $\overline{RE}$                                           |                                                | 2    |            |     | V       |
| $V_{IL}$         | Logic Input Low Voltage                                                                         | D, DE, $\overline{RE}$                                           |                                                |      |            | 0.8 | V       |
| $V_{OH}$         | Receiver high-level output voltage                                                              | $I_{OH} = -8$ mA, Vcc = 4.5V to 5.5V                             |                                                | 3    | 4.5        |     | V       |
|                  |                                                                                                 | $I_{OH} = -8$ mA, Vcc = 3.0V to 3.6V                             |                                                | 2.45 | 2.65       |     | V       |
| $V_{OL}$         | Receiver low-level output voltage                                                               | $I_{OL} = 8$ mA, Vcc = 4.5V to 5.5V                              |                                                |      |            | 0.4 | V       |
|                  |                                                                                                 | $I_{OL} = 8$ mA, Vcc = 3.0V to 3.6V                              |                                                |      |            | 0.5 | V       |
| $I_I$            | Driver input, driver enable and                                                                 | D, DE, $\overline{RE}$                                           |                                                | -5   |            | 5   | $\mu A$ |
| $I_{OZ}$         | Receiver high-Z output current                                                                  | $V_O = 0$ V or $V_{CC}$ , /RE at $V_{CC}$                        |                                                | -1   |            | 1   | $\mu A$ |
| $ I_{OS} $       | Driver short-circuit output current                                                             | $ I_{OS} $ with $V_A$ or $V_B$ from -7 to +12 V                  |                                                | -250 | 120        | 250 | mA      |
|                  |                                                                                                 | Bus pin A,B short current                                        |                                                |      |            | 150 | mA      |
| $I_{IN}$         | Bus input current(driver disabled)                                                              | $V_{CC} = 4.5$ to $5.5$ V or $V_{CC} = 0$ V, DE at 0 V           | VI= 12 V                                       |      |            | 120 | $\mu A$ |
|                  |                                                                                                 |                                                                  | VI= -7 V                                       | -110 |            |     |         |
| $I_{CC}$         | Supply current(quiescent)                                                                       | Driver and receiver enabled                                      | DE = $V_{CC}$ , /RE = GND, No LOAD             |      | 1.9        | 2.2 | mA      |
|                  |                                                                                                 | Driver enabled, receiver disabled                                | DE = $V_{CC}$ , /RE = $V_{CC}$ , No LOAD       |      | 1.8        | 2.2 |         |
|                  |                                                                                                 | Driver disabled, receiver enabled                                | DE = GND, /RE = GND, No LOAD                   |      | 1.7        | 2.0 |         |
|                  |                                                                                                 | Driver and receiver disabled                                     | DE = GND, /RE = $V_{CC}$ , D= $V_{CC}$ No LOAD |      | 1.65       | 2.0 |         |

## Switching Characteristics

| PARAMETER                                                        |                                                               | CONDITIONS                                                                       |              | MIN  | TYP | MAX | UNITS |
|------------------------------------------------------------------|---------------------------------------------------------------|----------------------------------------------------------------------------------|--------------|------|-----|-----|-------|
| DRIVER                                                           |                                                               |                                                                                  |              |      |     |     |       |
| f <sub>MAX</sub>                                                 | Maximum Data Rate <sup>[1]</sup>                              | V <sub>OD</sub> ≥ ±1.5V, R <sub>L</sub> = 54Ω, C <sub>L</sub> = 100pF (Figure 4) |              |      |     | 10  | Mbps  |
| t <sub>r</sub> , t <sub>f</sub>                                  | Driver differential-output rise and fall times <sup>[1]</sup> | R <sub>L</sub> = 54 Ω, C <sub>L</sub> =50pF                                      | See Figure 2 |      | 8   |     | ns    |
| t <sub>PHL</sub> , t <sub>PLH</sub>                              | Driver propagation delay                                      |                                                                                  |              |      | 21  | 30  |       |
| t <sub>SK</sub> (P)                                              | Driver pulse skew,  t <sub>PHL</sub> – t <sub>PLH</sub>       |                                                                                  |              |      | 3   | 6   |       |
| t <sub>PHZ</sub> , t <sub>PLZ</sub>                              | Driver disable time                                           |                                                                                  | See Figure 3 |      | 30  | 50  | ns    |
| t <sub>PZH</sub> , t <sub>PZL</sub>                              | Driver enable time                                            | Receiver enabled                                                                 |              |      | 20  | 45  |       |
|                                                                  | Driver enable time                                            | Receiver disabled                                                                |              |      | 30  | 50  | ns    |
| RECEIVER                                                         |                                                               |                                                                                  |              |      |     |     |       |
| t <sub>r</sub> , t <sub>f</sub>                                  | Receiver output rise and fall times <sup>[1]</sup>            | C <sub>L</sub> =15 pF                                                            | See Figure 5 |      | 14  |     | ns    |
| t <sub>PHL</sub> , t <sub>PLH</sub>                              | Receiver propagation delay time                               |                                                                                  |              |      | 35  | 50  |       |
| t <sub>SK</sub> (P)                                              | Receiver pulse skew,  t <sub>PHL</sub> – t <sub>PLH</sub>     |                                                                                  |              |      | 10  | 15  |       |
| t <sub>PHZ</sub> , t <sub>PLZ</sub>                              | Receiver disable time                                         |                                                                                  |              |      | 30  | 60  | ns    |
| t <sub>PZH</sub> , t <sub>PZL</sub>                              | Receiver enable time                                          | Driver enabled                                                                   |              |      | 20  | 30  | ns    |
|                                                                  | Receiver enable time                                          | Driver disabled                                                                  |              |      | 25  | 40  | ns    |
| ESD                                                              |                                                               |                                                                                  |              |      |     |     |       |
| Human Body Model, per ANSI/ESDA/JEDEC JS-001 / ANSI/ESD STM5.5.1 |                                                               | RS-485 Pins (A, B)                                                               |              | ±15  |     | kV  |       |
|                                                                  |                                                               | All Other Pins                                                                   |              | ±4   |     | kV  |       |
| CDM, per ANSI/ESDA/JEDEC JS-002                                  |                                                               | RS-485                                                                           |              | ±1.5 |     | kV  |       |
| IEC-61000-4-2, IEC-Contact ESD, Bus Pins                         |                                                               | RS-485 Pins (A, B)                                                               |              | ±15  |     | kV  |       |

Note

[1] Parameter is provided by lab bench test and design simulation

## Test Circuits and Waveforms

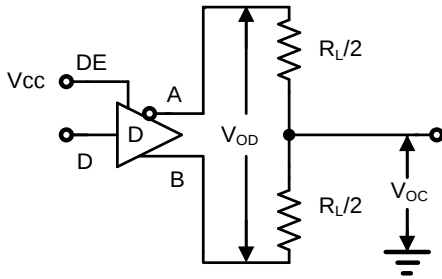


Figure 1A. VOD and VOC

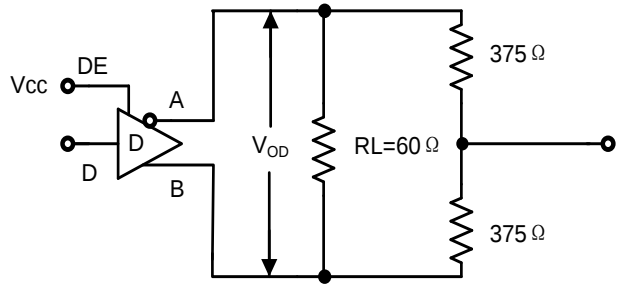


Figure 1B. VOD with Common Mode Load

Figure 1. DC Driver Test Circuits

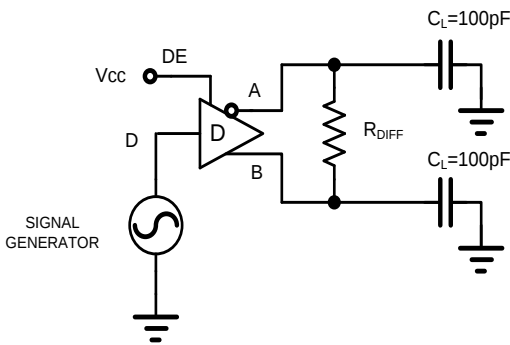


Figure 2A. Test Circuit

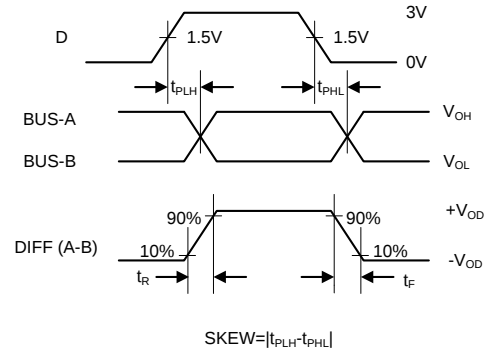


Figure 2B. Measurement Points

Figure 2. Driver Propagation Delay and Differential Transition Times

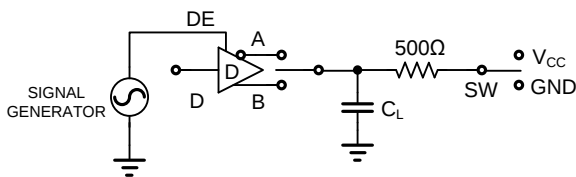


Figure 3A. Test Circuit

| PARAMETER  | OUTPUT | RE | DI  | SW  | CL (pF) |
|------------|--------|----|-----|-----|---------|
| tPHZ       | A/B    | X  | 1/0 | GND | 15      |
| tPLZ       | A/B    | X  | 0/1 | VCC | 15      |
| tPZH       | A/B    | 0  | 1/0 | GND | 100     |
| tPZL       | A/B    | 0  | 0/1 | VCC | 100     |
| tPZH(SHDN) | A/B    | 1  | 1/0 | GND | 100     |
| tPZL(SHDN) | A/B    | 1  | 0/1 | VCC | 100     |

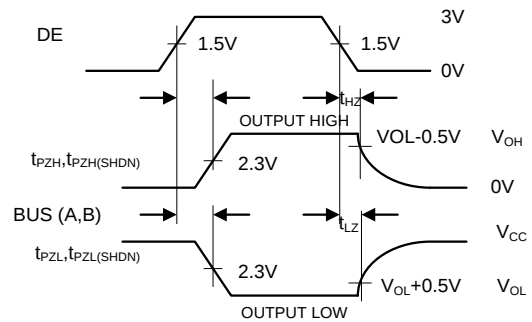


Figure 3B. Measurement Points

Figure 3. Driver Enable and Disable Times

## Test Circuits and Waveforms (continue)

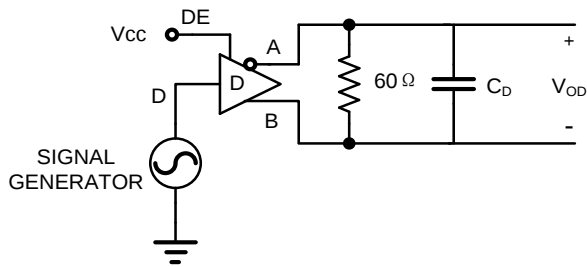


Figure 4A. Test Circuit

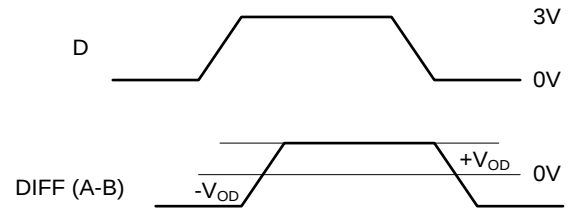


Figure 4B. Measurement Points

Figure 4. Driver Data rate

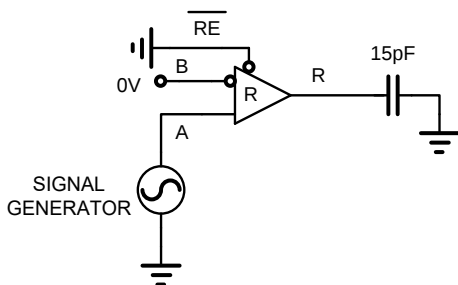


Figure 5A. Test Circuit

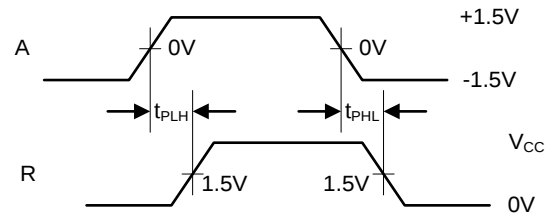


Figure 5B. Measurement Points

Figure 5. Receiver Propagation Delay and Data rate

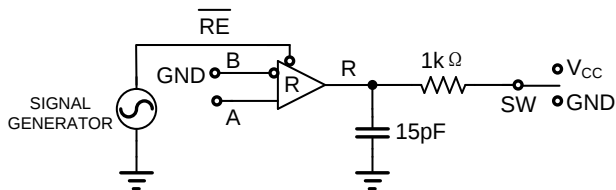


Figure 6A. Test Circuit

| PARAMETER  | DE | A     | SW  |
|------------|----|-------|-----|
| tPHZ       | 1  | +1.5V | GND |
| tPLZ       | 1  | -1.5V | VCC |
| tPZH       | 1  | +1.5V | GND |
| tPZL       | 1  | -1.5V | VCC |
| tPZH(SHDN) | 0  | +1.5V | GND |
| tPZL(SHDN) | 0  | -1.5V | VCC |

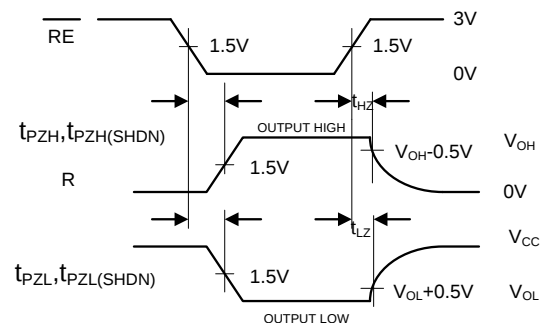


Figure 6B. Measurement Points

Figure 6. Receiver Enable and Disable Times

## Detailed Description

### High Data Rate

RS-485/RS-422 are 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/RS-422 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 TPT75176H 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. For below test waveform, the transmitter was driven at 10Mbps and/or with 100' (31m) CAT 5 cable, the transmitters were loaded with an RS-485 receiver in parallel with 54Ω.

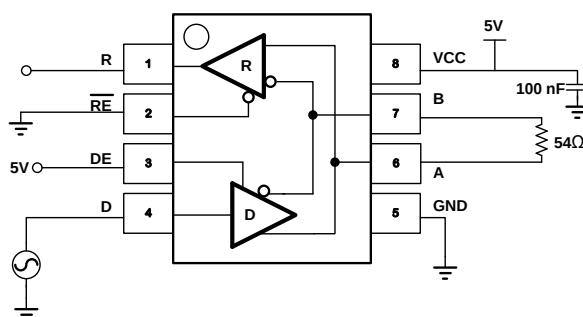


Figure 7. Loopback Test Circuit

### Full Fail-Safe

All the receivers include 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. Receivers easily meet the data rates supported by the corresponding driver, and all receiver outputs are three-stable via the active low RE input.

### 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 TPT75176H devices incorporate a “Hot Plug” function. Circuitry monitoring VCC ensures that, during power-up and power-down, the Tx and Rx outputs remain disabled, regardless of the state of DE and RE, if VCC 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.

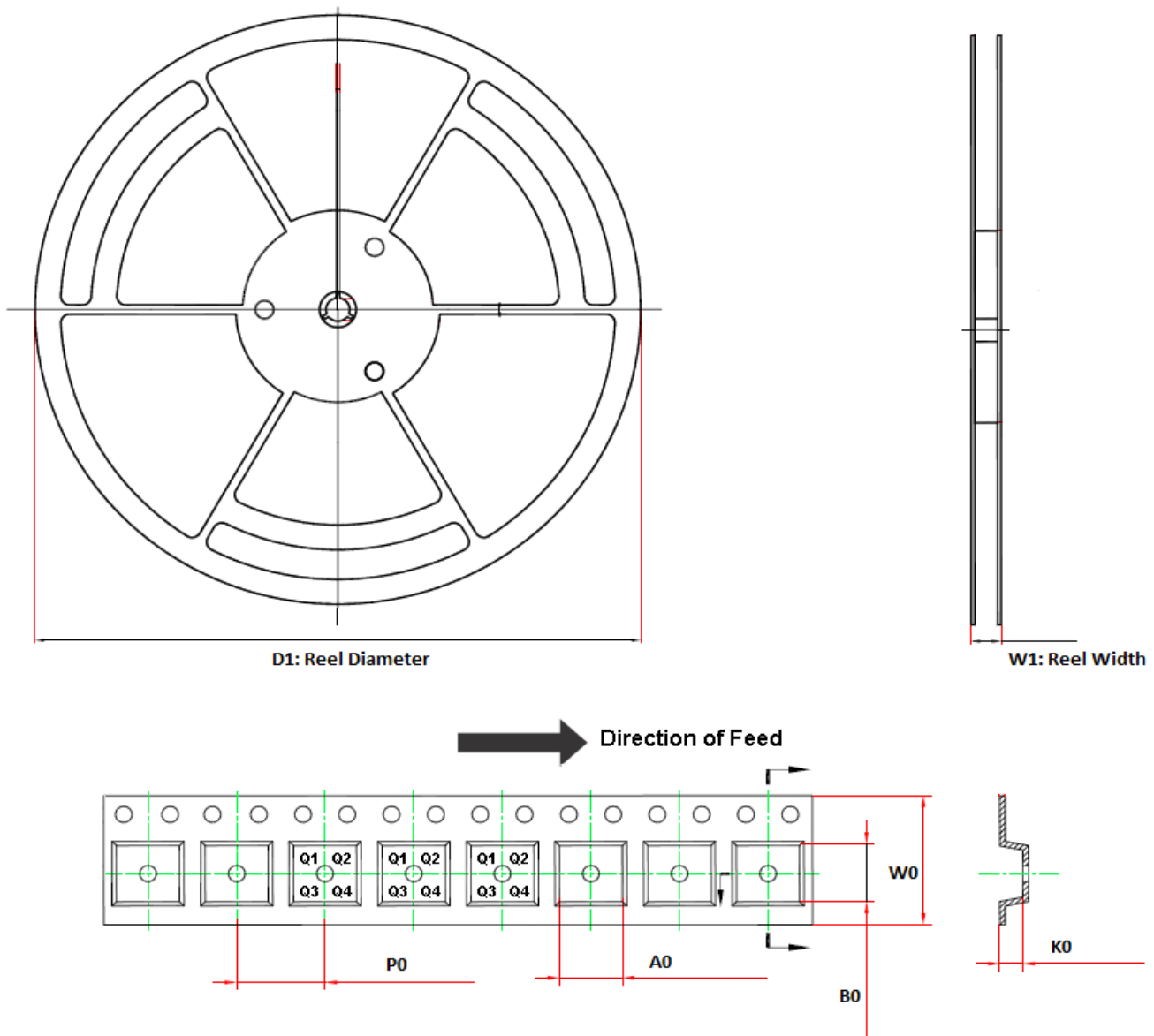
### Transient Protection

The bus terminals of the TPT75176H transceiver family possess on-chip ESD protection against ±15 kV HBM. The International

Electrotechnical Commission (IEC) ESD test is far more severe than the HBM ESD test. The 50% higher charge capacitance, CS, and 78% lower discharge resistance, RD of the IEC model produce significantly higher discharge currents than the HBM model.

As stated in the IEC 61000-4-2 standard, contact discharge is the preferred transient protection test method. Although IEC air-gap testing is less repeatable than contact testing, air discharge protection levels are inferred from the contact discharge test results.

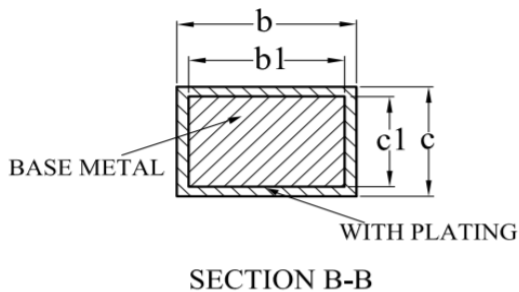
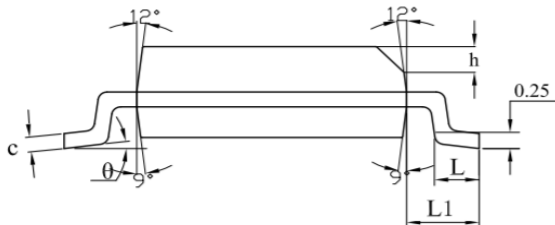
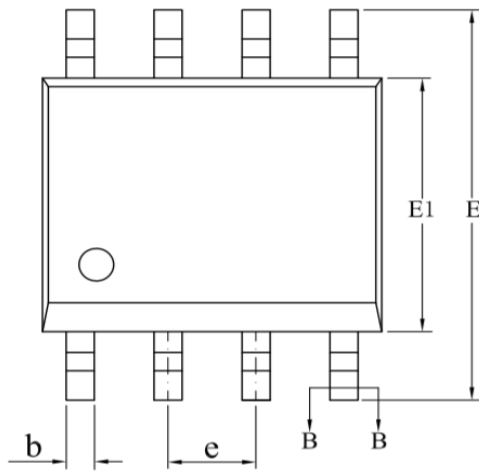
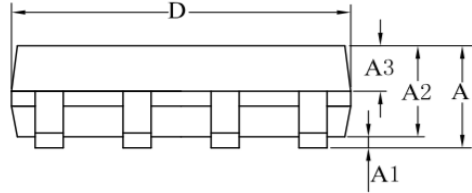
## Tape and Reel Information



| Order Number     | Package      | D1    | W1   | A0  | B0  | K0  | P0  | W0   | Pin1<br>Quadrant |
|------------------|--------------|-------|------|-----|-----|-----|-----|------|------------------|
| TPT75176HL1-SO1R | 8-Pin SOP    | 330.0 | 17.6 | 6.4 | 5.4 | 2.1 | 8.0 | 12.0 | Q1               |
| TPT75176H-VS1R   | 8-Pin MSOP   | 330.0 | 17.6 | 5.2 | 3.3 | 1.5 | 8.0 | 12.0 | Q1               |
| TPT75176HL1-DF6R | 8-Pin DFN3X3 | 330.0 | 17.6 | 3.4 | 3.4 | 1.1 | 8.0 | 12.0 | Q1               |

## Package Outline Dimensions

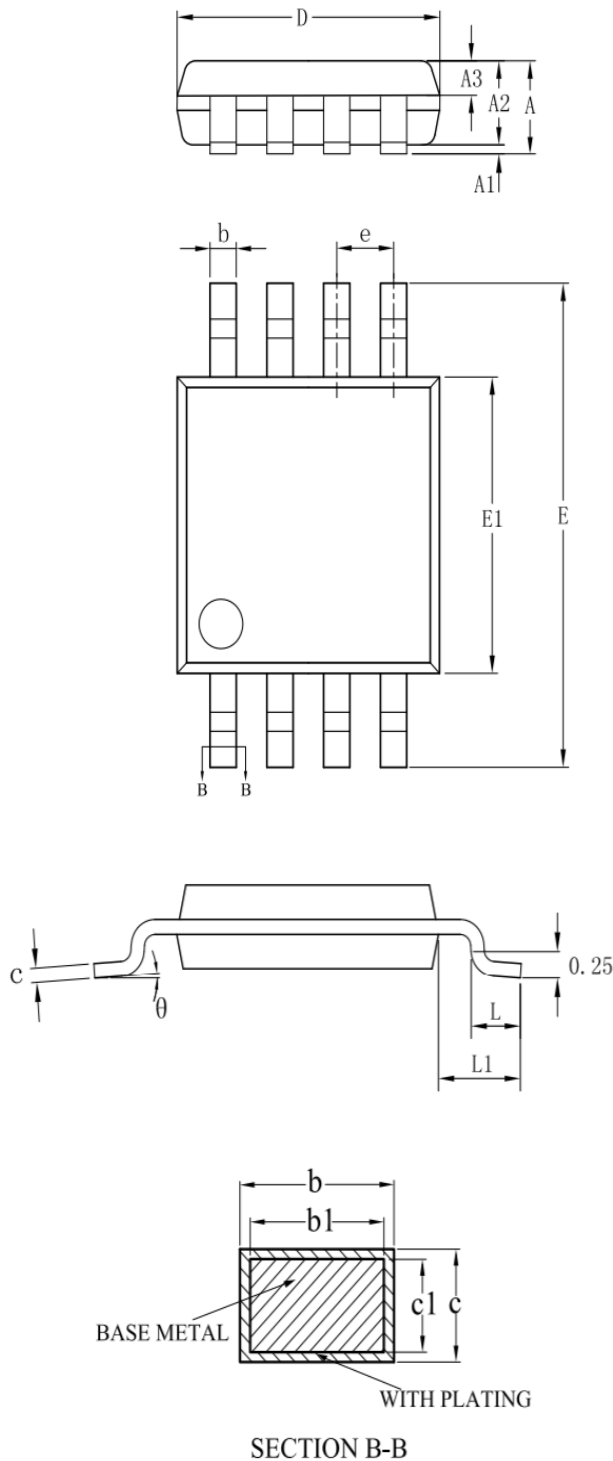
SO1R (SOP8)



| 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°    |

## Package Outline Dimensions

VS1R (MSOP8)

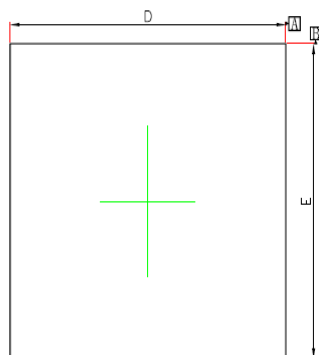


| SYMBOL   | MILLIMETER |      |      |
|----------|------------|------|------|
|          | MIN        | NOM  | MAX  |
| A        | —          | —    | 1.10 |
| A1       | 0.05       | —    | 0.15 |
| A2       | 0.75       | 0.85 | 0.95 |
| A3       | 0.30       | 0.35 | 0.40 |
| b        | 0.28       | —    | 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    |      |      |
| $\theta$ | 0          | —    | 8°   |

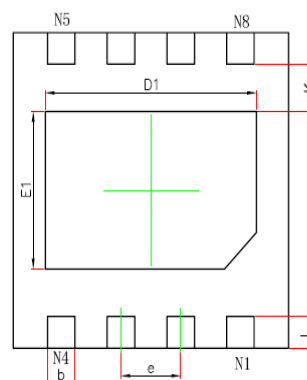
## Package Outline Dimensions

DF6R (DFN3X3-8L)

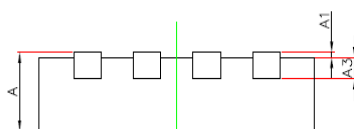
DFNWB3×3-8L-F (P0.65T0.75/0.85) PACKAGE OUTLINE DIMENSIONS



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       |

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