

Features

- Exceeds Requirements of EIA-485 Standard
- Hot Plug Circuitry - Tx and Rx Outputs Remain Three-State During Power-up/Power-down
- Data Rate: 20 Mbps
- Up to 256 Nodes on a Bus (1/8 unit load) at 20Mbps
- Full Fail-safe Receiver (Open, Short, Terminated)
- Wide Supply Voltage 3V to 5.5V
- Bus-Pin Protection:
 - ±18 kV HBM ESD
 - ±15 kV IEC61000-4-2 Contact Discharge
 - ±15 kV IEC61000-4-2 Air Discharge
- -40°C to 125°C Operation Temperature Range

Description

The TPT481 are IEC61000 ESD protected, 3.0V to 5.5V powered transceivers that meet the RS-485 and RS-422 standards for balanced communication.

Transmitters in this family deliver exceptional differential output voltages into the RS-485 required 54Ω load. These 20Mbps devices have very low bus currents so they present 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.

TPT481 is designed for half-duplex RS485, and support SOP8, MSOP8 and DFN3X3-8L package, which is characterized from -40°C to 125°C.

Applications

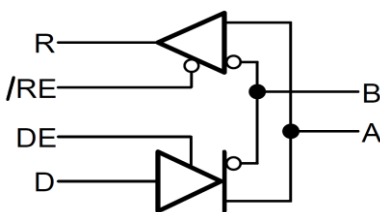
- Motor Drives
- Industrial Control
- Communication Infrastructure

Device Table

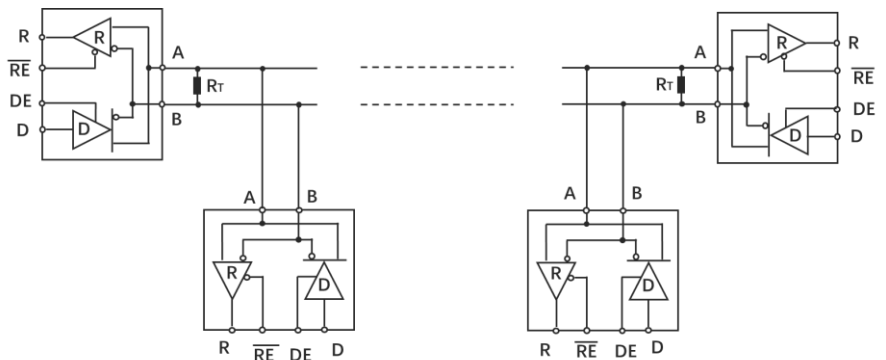
| Part | Duplex | Enable | Data Rate | Nodes |
|--------|--------|--------|-----------|-------|
| TPT481 | Half | Yes | 20Mbps | 256 |

Simplified Schematic

TPT481 Block Diagram



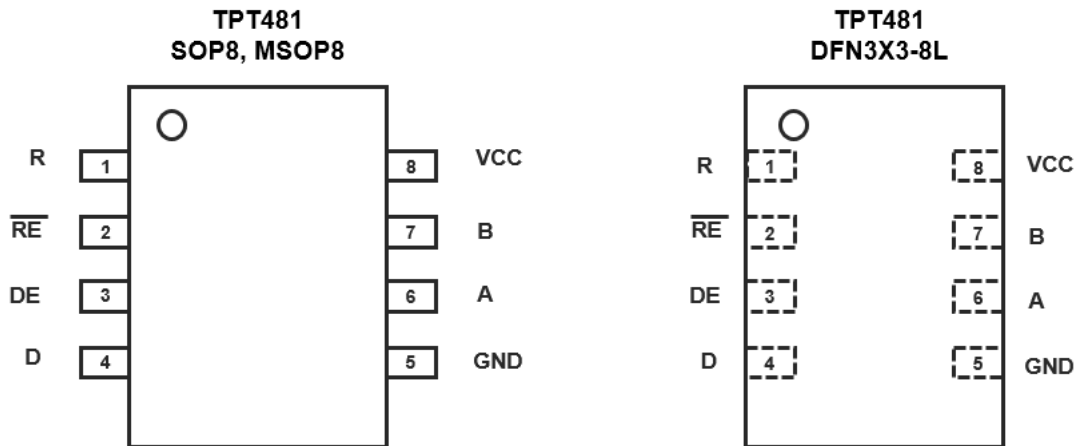
TPT481 Network



Revision History

| Date | Revision | Notes |
|------------|--------------|--|
| 2019/4/8 | Rev. Pre 0.1 | Definition Version |
| 2019/8/6 | Rev. Pre 0.2 | Update ESD data |
| 2019/9/3 | Rev. Pre 0.3 | Update Electrical data |
| 2019/9/26 | Rev. 0 | Final version |
| 2020/3/24 | Rev. A | Update A/B pin absolute maximum rating, VID and VI recommended value |
| 2020/5/16 | Rev. B | Update HBM level to 18kV |
| 2020/8/12 | Rev. C | Add note (1) in absolute maximum rating |
| 2021/5/26 | Rev. D | Add tape reel information |
| 2021/10/28 | Rev. E | Add Power Consumption data |

Pin Configuration and Functions



Pin Table

| Pin No. | Pin Name | I/O | Description |
|---------|------------------------|------------------|---|
| 1 | R | Digital output | Receiver Output. |
| 2 | $\overline{\text{RE}}$ | 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 B and Inverted Driver Output B. |
| 8 | V _{CC} | Power | Power Supply. |

Functional Table

Driver Function Table

| Input | Enable | Outputs | Outputs | Description |
|-------|--------|---------|---------|-------------------------------------|
| D | DE | A | B | |
| 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 |

X = don't care

Z = high impedance

Receiver Function Table

| Input A-B | Input /RE | Output R | Description |
|--------------------|--------------|-------------|------------------------------|
| >-50mV | L | H | |
| -200mV<Input<-50mV | L | ? | Indeterminate bus state |
| <-200mV | L | L | Receive valid bus Low |
| X | H | Z | Receiver disabled |
| X | Open | Z | Receiver disabled in default |
| Open | L | H | Fail-safe high output |
| Short | L | H | Fail-safe high output |
| Idle(Terminated) | L | H | Fail-safe high output |

X = don't care

Z = high impedance

Order Information

| Model Name | Order Number | Package | MSL Level | Transport Media, Quantity | Marking Information |
|------------|---------------|--------------|-----------|---------------------------|---------------------|
| TPT481 | TPT481L1-SO1R | 8-Pin SOP | MSL1 | Tape and Reel 4,000 | T481 |
| TPT481 | TPT481-VS1R | 8-Pin MSOP | MSL3 | Tape and Reel 3,000 | T481 |
| TPT481 | TPT481L1-DF6R | 8-Pin DFN3X3 | MSL1 | Tape and Reel 4,000 | T481 |

Absolute Maximum Ratings

| Parameters | Rating |
|---|---------------------------------|
| V _{CC} to GND | -0.3V to +7V |
| Voltage at Logic pin: D, DE, /RE, R | -0.3V to V _{CC} + 0.3V |
| Voltage at Bus pin: A, B ⁽¹⁾ | -15V to +15V |
| Operating Temperature Range | -40°C to 125°C |
| Storage Temperature Range | -65°C to 150°C |
| Maximum Junction Temperature | 150°C |
| Lead Temperature (Soldering, 10 sec) | 260°C |

(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

Over operating free-air temperature range (unless otherwise noted)

| | | MIN | NOM | MAX | UNIT |
|-----------------|--|-----|-----|-----------------|------|
| V _{CC} | Supply voltage | 3.0 | | 5.5 | V |
| V _I | Input voltage at any bus terminal ⁽¹⁾ | -7 | | 12 | V |
| V _{IH} | High-level input voltage (driver, driver enable, and receiver enable inputs) | 2 | | V _{CC} | V |
| V _{IL} | Low-level input voltage (driver, driver enable, and receiver enable inputs) | 0 | | 0.8 | V |
| V _{ID} | Differential input voltage | -7 | | 12 | V |
| R _L | Differential load resistance | 54 | | | Ω |
| T _A | Operating ambient temperature | -40 | | 125 | °C |
| T _J | Junction temperature | -40 | | 150 | °C |

(1) The algebraic convention, in which the least positive (most negative) limit is designated as minimum is used in this data sheet.

ESD Rating

| | | Value | Unit |
|---|------------------------|-------|------|
| IEC-61000-4-2, Contact Discharge | Bus Pin | 15 | kV |
| IEC-61000-4-2, Air-Gap Discharge | Bus Pin | 15 | kV |
| HBM, per ANSI/ESDA/JEDEC JS-001 / ANSI/ESD STM5.5.1 | Bus Pin | 18 | kV |
| | All Pin Except Bus Pin | 4 | kV |
| CDM, per ANSI/ESDA/JEDEC JS-002 | All Pin | 1.5 | kV |

Power Consumption

| Parameter | Description | Test Condition | Value | Unit |
|-----------|---|--------------------------|-------|------|
| Pcon | Driver and receiver enabled, VCC = 5.5 V, Ta = 125 0C, 50% duty cycle square wave at maximum signaling rate, CL = 50 pF | Unterminated: RL = 300 Ω | 390 | mW |
| | | RS-422 load: RL = 100 Ω | 470 | mW |
| | | RS-485 load: RL = 54 Ω | 550 | mW |

Note: value based on lab test

Electrical Characteristics

Test Conditions: 5V with temperature range

| Parameter | | Conditions | | Min | Typ | Max | Units |
|---------------------|---|---|--|------|----------------------|------|-------|
| V _{OD} | Driver differential-output voltage magnitude | RL = 60 Ω with V _A or V _B from -7 to +12 V, V _{CC} = 4.5V~5.5V | See Figure 1B | 2.1 | 2.7 | | V |
| | | RL = 60 Ω with V _A or V _B from -7 to +12 V, V _{CC} = 3.0~3.6V | See Figure 1B | 1.5 | 2.3 | | |
| | | RL = 54 Ω, V _{CC} = 5V | See Figure 1A | 2.1 | 2.7 | | |
| | | RL = 54 Ω, V _{CC} = 3V | | 1.5 | 2.3 | | |
| | | RL = 100 Ω, V _{CC} = 5V | | 2.1 | 2.7 | | |
| | | RL = 100 Ω, V _{CC} = 3V | | 1.5 | 2.3 | | |
| Δ V _{OD} | Change in magnitude of driver differential-output voltage | RL = 54 Ω, CL=50 pF, V _{CC} = 5V | See Figure 1A | -50 | | 50 | mV |
| V _{OC(SS)} | Steady-stage common-mode output voltage | Center of two 27 Ω load resistors | See Figure 1A | 1 | V _{CC} /2 | 3 | V |
| ΔV _{OC} | Change in differential driver common-mode output voltage | | | -50 | | 50 | mV |
| V _{OC(PP)} | Peak-to-peak driver common-mode output voltage | | | | 0.5 | | V |
| C _{OD} | Differential output capacitance | | | | 8 | | pF |
| V _{IT+} | Positive-going receiver differential-input voltage threshold | | | | | -20 | mV |
| V _{IT-} | Negative-going receiver differential-input voltage threshold | | | -220 | | | mV |
| V _{HYS} | Receiver differential-input voltage threshold hysteresis (V _{IT+} - V _{IT-}) | | | | 60 | | 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 | | 2.4 | V _{CC} -0.3 | | V |
| V _{OL} | Receiver low-level output voltage | I _{OL} = 8 mA | | | | 0.4 | V |
| R _{in} | BUS pin input resistance | -7V ≤ V _{CM} ≤ +12V | | 96 | 140 | | kΩ |
| I _I | Driver input, driver enable and receiver enable input current | | | -5 | | 5 | μA |
| I _{OZ} | Receiver high-impedance output current | V _O = 0 V or V _{CC} , /RE at V _{CC} | | -1 | | 1 | μA |
| I _{OS} | Driver short-circuit output current | I _{OS} with V _A or V _B from -7 to +12 V | | -250 | | 250 | mA |
| | | Bus pin A,B short current | | | | 150 | mA |
| I _I | Bus input current(driver disabled) | V _{CC} = 4.5 to 5.5 V or V _{CC} = 0 V, DE at 0 V | V _I = 12 V | | 100 | 150 | μA |
| | | | V _I = -7 V | -120 | -60 | | |
| I _{CC} | Supply current(quiescent) | Driver and receiver enabled | DE = V _{CC} , /RE = GND, No LOAD | | 1800 | 2700 | μA |
| | | Driver enabled, receiver disabled | DE = V _{CC} , /RE = V _{CC} , No LOAD | | 500 | 800 | |

| Parameter | | Conditions | | Min | Typ | Max | Units |
|-----------|--|--------------------------------------|--|-----|------|------|-------|
| | | Driver disabled, receiver enabled | DE = GND, /RE = GND, No LOAD | | 1600 | 2100 | |
| | | Driver and receiver disabled | DE = GND, /RE = V _{CC} , D= V _{CC} No LOAD | | 5 | 10 | |

Switching Characteristics

| Parameter | | Conditions | | Min | Typ | Max | Units |
|-------------------------------------|---|--------------------|--------------|-----|------|------|-------|
| Driver | | | | | | | |
| t _r , t _f | Driver differential-output rise and fall times | RL = 54 Ω, CL=50pF | See Figure 2 | | 30 | | ns |
| t _{PHL} , t _{PLH} | Driver propagation delay | | | | 20 | 30 | |
| t _{SK(P)} | Driver pulse skew, t _{PHL} – t _{PLH} | | | | 2 | 7 | |
| t _{PHZ} , t _{PLZ} | Driver disable time | Receiver enabled | See Figure 3 | | 28 | 55 | ns |
| | | Receiver disabled | | | 30 | 55 | |
| t _{PZH} , t _{PZL} | Driver enable time | Receiver enabled | | | 24 | 40 | ns |
| | | Receiver disabled | | | 2300 | 3000 | |
| Receiver | | | | | | | |
| t _r , t _f | Receiver output rise and fall times | CL=15 pF | See Figure 5 | | 11 | | ns |
| t _{PHL} , t _{PLH} | Receiver propagation delay time | | | | 33 | 45 | |
| t _{SK(P)} | Receiver pulse skew, t _{PHL} – t _{PLH} | | | | 2.1 | 7 | |
| t _{PHZ} , t _{PLZ} | Receiver disable time | Driver enabled | See Figure 6 | | 30 | 55 | ns |
| | | Driver disabled | | | 30 | 55 | |
| t _{PZL} , t _{PZH} | Receiver enable time | Driver enabled | | | 75 | 120 | ns |
| | | Driver disabled | | | 2350 | 3000 | |

Test Circuits and Waveforms

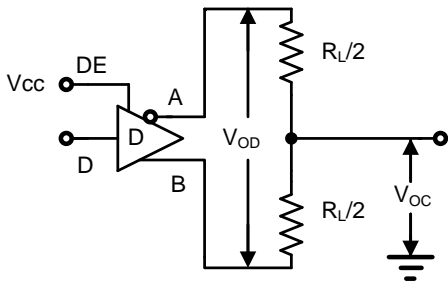


Figure 1A. VOD and VOC

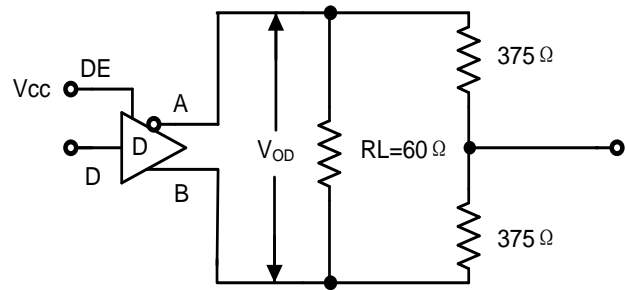


Figure 1B. VOD with Common Mode Load

FIGURE 1. DC Driver Test Circuits

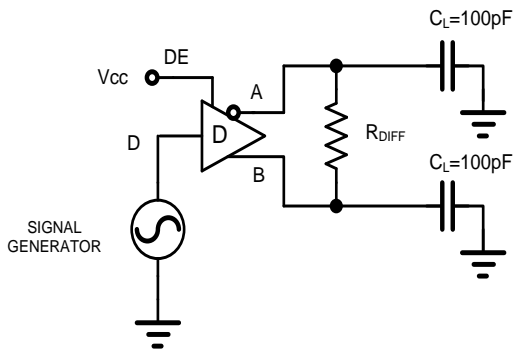


Figure 2A. Test Circuit

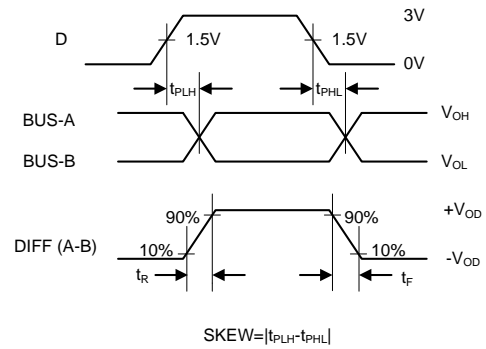


Figure 2B. Measurement Points

Figure 2. Driver Propagation Delay and Differential Transition Times

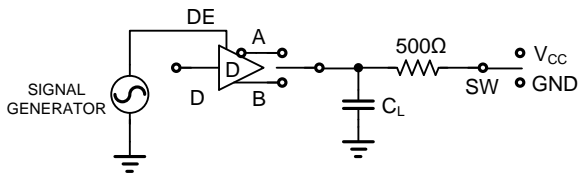


Figure 3A. Test Circuit

| 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 |

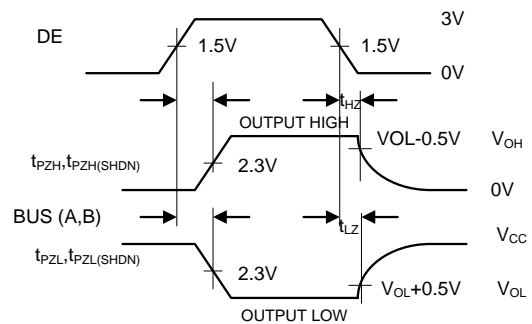


Figure 3B. Measurement Points

Figure 3. Driver Enable and Disable Times

Test Circuits and Waveforms (continue)

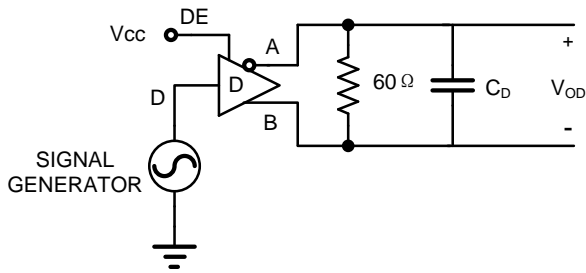


Figure 4A. Test Circuit

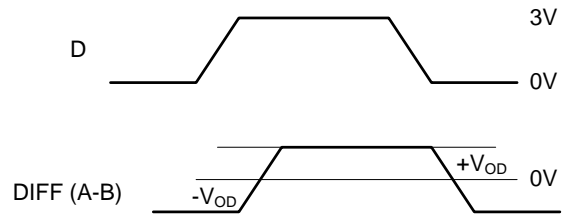


Figure 4B. Measurement Points

Figure 4. Driver Data rate

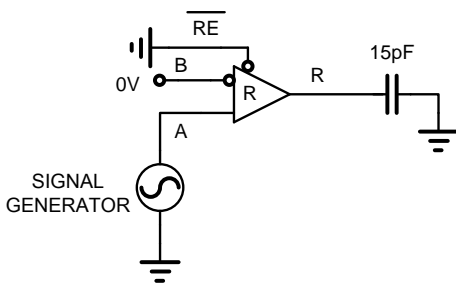


Figure 5A. Test Circuit

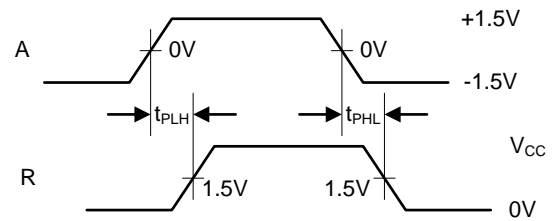


Figure 5B. Measurement Points

Figure 5. Receiver Propagation Delay and Data rate

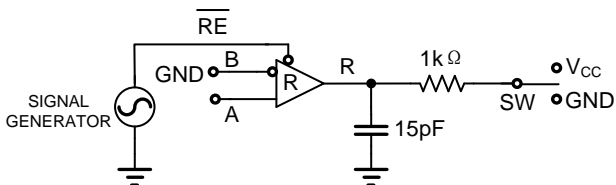


Figure 6A. Test Circuit

| 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 |

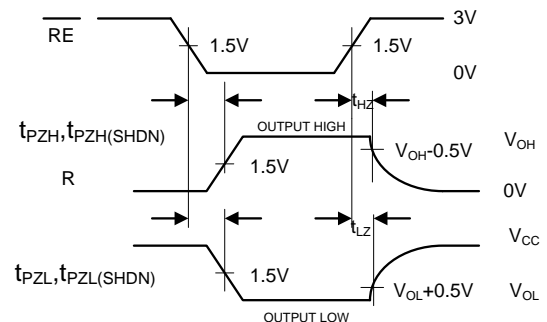
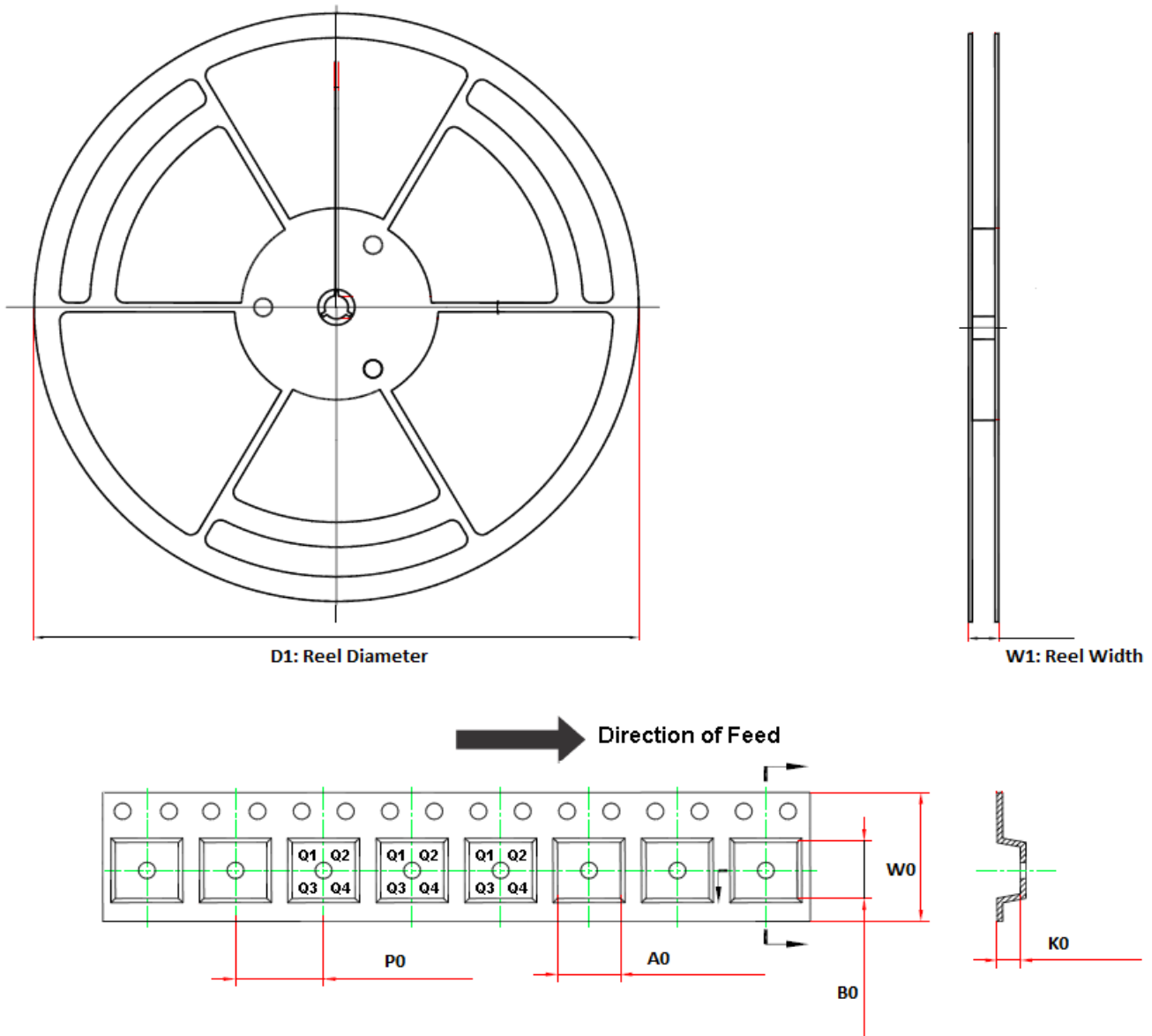


Figure 6B. Measurement Points

Figure 6. Receiver Enable and Disable Times

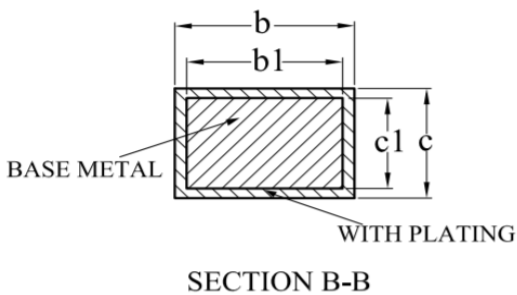
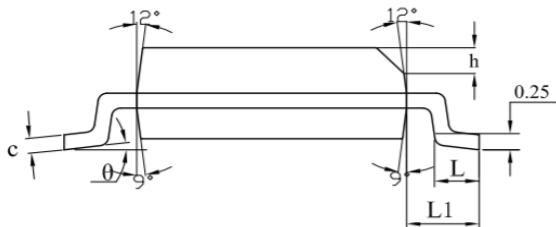
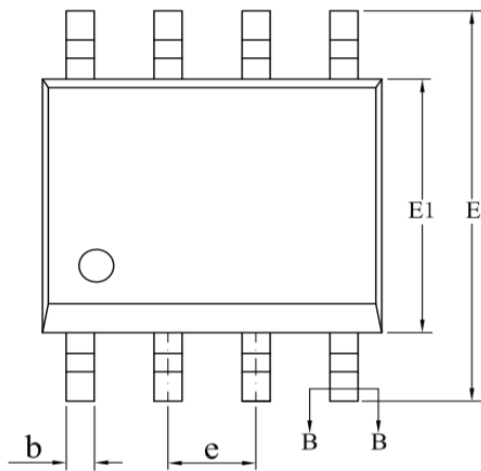
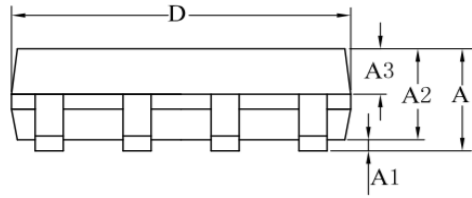
Tape and Reel Information



| Order Number | Package | D1 | W1 | A0 | B0 | K0 | P0 | W0 | Pin1 Quadrant |
|---------------|------------|-------|------|-----|-----|-----|-----|------|---------------|
| TPT481L1-SO1R | 8-Pin SOIC | 330.0 | 17.6 | 6.4 | 5.4 | 2.1 | 8.0 | 12.0 | Q1 |
| TPT481-VS1R | 8-Pin MSOP | 330.0 | 17.6 | 6.4 | 5.4 | 2.1 | 8.0 | 12.0 | Q1 |
| TPT481L1-DF6R | DFN3X3-8L | 330.0 | 17.6 | 3.4 | 3.4 | 1.1 | 8.0 | 12.0 | Q2 |

Package Outline Dimensions

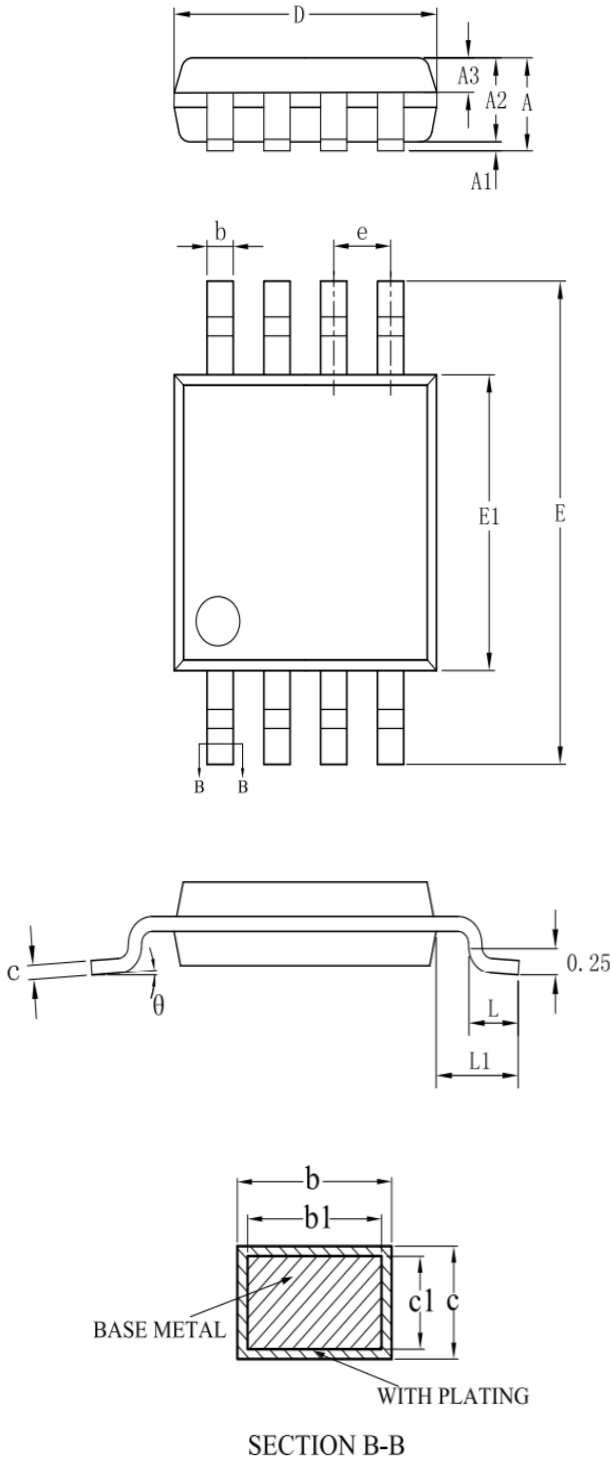
S01R (SOP8)



| 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)

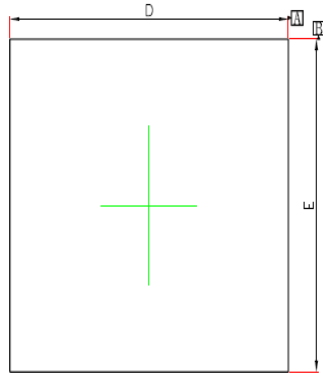


| SYMBOL | MILLIMETER | | |
|--------|------------|------|------|
| | MIN | NOM | MAX |
| A | — | — | 1.10 |
| A1 | 0.05 | — | 0.15 |
| A2 | 0.75 | 0.85 | 0.95 |
| A3 | 0.30 | 0.35 | 0.40 |
| b | 0.28 | — | 0.36 |
| b1 | 0.27 | 0.30 | 0.33 |
| c | 0.15 | — | 0.19 |
| c1 | 0.14 | 0.15 | 0.16 |
| D | 2.90 | 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 | | |
| θ | 0 | — | 8° |

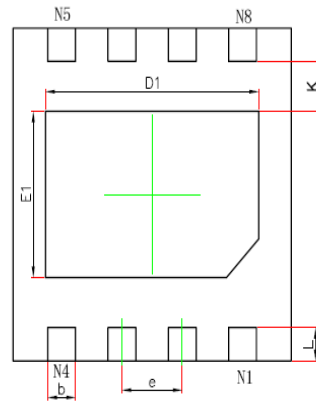
Package Outline Dimensions

DF6R (DFN3X3-8L)

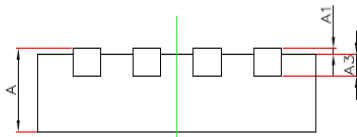
DFNWB3×3-8L-F(P0.65T0.75/0.85) PACKAGE OUTLINE DIMENSIONS



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 |