3.0-V to 5.5-V RS-485 Transceivers with 1.8-V I/O

Features

- Exceeds Requirements of EIA-485 Standard
- Data Rate: 20 Mbps or 500 Kbps
- Up to 256 Nodes on a Bus (1/8 Unit Load)
- Full Fail-Safe Receiver (Open, Short, and Terminated)
- Wide Supply Voltage Range: 3 V to 5.5 V
- 1.65 V to V_{CC} Supply for Digital IOs
- Bus-Pin Protection:
  - ±18-kV HBM ESD
  - ±15-kV IEC61000-4-2 Contact Discharge
  - ±15-kV IEC61000-4-2 Air Discharge

Applications

- Factory Automation
- Field Bus Networks
- Industrial/Process Control Networks
- Communication Infrastructure

Description

The TPT4181V/H is a 3.0-V to 5.5-V, IEC electrostatic discharge (ESD) protected RS-485 transceiver. The device supports ±15-kV Contact Discharge on the transceiver bus pins without damage. The TPT4181V/H features a VIO logic supply pin allowing a flexible digital interface capable of operating as low as 1.65 V.

Transmitters in this family deliver exceptional differential output voltages into the RS-485 required 54-Ω loads. 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. The TPT4181V/H is available in the SOP8 package and is characterized from –40°C to 125°C.

Typical RS-485 Network

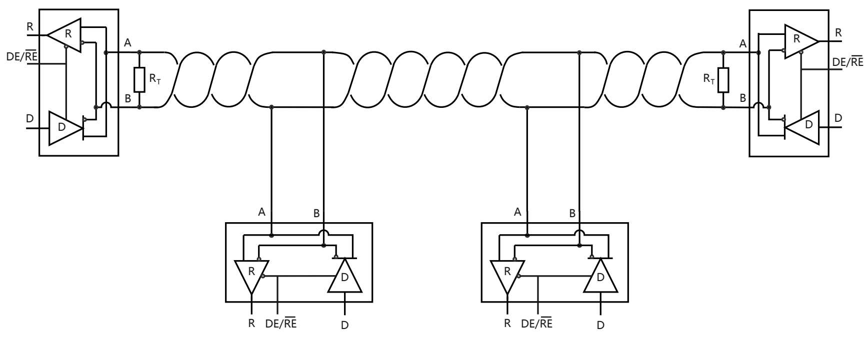


Table of Contents

Product Family Table

Device	Data Rate	Package
TPT4181V	500K bps	SOP8
TPT4181H	20M bps	SOP8

Revision History

Date	Revision	Notes
2024-12-19	Rev.A.0	Released version

Pin Configuration and Functions

TPT4181V/H-S
SOP8
Top View

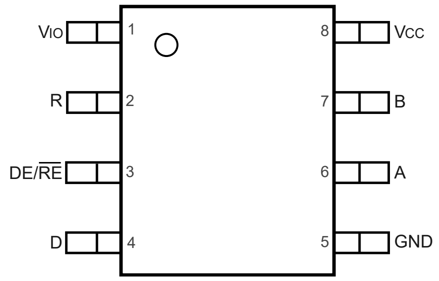


Table 1. Pin Functions

Pin No.	Name	I/O	Description
1	V_{IO}	Logic Supply	1.65-V to V_{CC} supply for logic I/O signals R, D, DE/$\overline{RE}$.
2	R	Digital Output	Receive data output.
3	DE/$\overline{RE}$	Digital Input	Driver/Receiver enable input. Driver enable (Active high), Receiver enable (Active Low).
4	D	Digital Input	Transmission data input
5	GND	Reference Potential	Local device ground.
6	A	Bus I/O	Digital bus I/O, A.
7	B	Bus I/O	Digital bus I/O, B.
8	V_{CC}	Bus Supply	3-V to 5.5-V supply for A and B bus lines.

Specifications

Absolute Maximum Ratings (1)

Parameter		Min	Max	Unit
V_{IO} to GND		−0.3	7	V
V_{CC} to GND		−0.3	7	V
Voltage at Logic Pin: DI, DE, $\overline{RE}$, RO		−0.3	V_{CC} + 0.3	V
Voltage at Bus Pin: A, B		−15	+15	V
T_A	Operating Temperature Range	−40	125	°C
T_{STG}	Storage Temperature Range	−65	150	°C
T_J	Maximum Junction Temperature		150	°C
T_L	Lead Temperature (Soldering, 10 sec)		260	°C

(1) 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*.

ESD, Electrostatic Discharge Protection

Symbol	Parameter	Condition	Minimum Level	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	kV

Recommended Operating Conditions

Parameter	Min	Typ	Max	Unit
V_{IO}	1.65		V_{CC}	V
V_{CC}	3		5.5	V
Voltage at Logic Pin: DI, DE/ $\overline{RE}$, RO			V_{IO}	V
Voltage at Bus Pin: A, B	−7		+12	V
Operating Temperature Range	−40		125	°C

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
SOP8	120	60	°C/W

Electrical Characteristics

All test conditions: V_{CC} = 3.3 V to 5.0 V, T_A = −40°C to +125°C, unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$\lvert V_{OD}\rvert$	Driver Differential Output Voltage Magnitude	R_L = 60 Ω, 375 Ω on A/B: –7 V to 12V, V_{CC} = 3.3 V	1.5	1.9		V
		R_L = 60 Ω, 375 Ω on A/B: –7 V to 12 V, V_{CC} = 5 V	2.0	3.0		V
		R_L = 54 Ω, V_{CC} = 3.3 V	1.5	2.0		V
		R_L = 54 Ω, V_{CC} = 5.0 V	2.0	3.0		
		R_L = 100 Ω, V_{CC} = 3.3 V	1.5	2.3		
		R_L = 100 Ω, V_{CC} = 5.0 V	2.0	3.5		V
$\Delta\lvert V_{OD}\rvert$	Change in Magnitude of Driver Differential Output Voltage	R_L = 54 Ω, C_L = 50 pF, 375 Ω on A/B: –7 V to 12 V, V_{CC} = 3.3 V	–50		50	mV
$V_{OC(SS)}$	Steady-State Common-Mode Output Voltage	Center of two 27-Ω load resistors	1	V_{CC} / 2	3	V
ΔV_{OC}	Change in Differential Driver Output Common-Mode Voltage		–50		50	mV
$V_{OC(PP)}$	Peak-to-Peak Driver Common-Mode Output Voltage (1)			500		mV
C_{OD}	Differential Output Capacitance (1)			15		pF
V_{IT+}	Positive-Going Receiver Differential Input Voltage Threshold			−100	–20	mV
V_{IT-}	Negative-Going Receiver Differential Input Voltage Threshold		–220	–150		mV
V_{HYS}	Receiver Differential Input Voltage Threshold Hysteresis (V_{it+} – V_{it-}) (1)			50		mV
V_{OH}	Receiver High-Level Output Voltage	V_{IO} = 1.65 V, I_{OH} = −2 mA	1.3	1.5		V
		V_{IO} = 3 V, I_{OH} = −2 mA	2.8	2.9		
V_{OL}	Receiver Low-Level Output Voltage	V_{IO} = 1.65 V, I_{OL} = 2 mA		0.13	0.35	V
		V_{IO} = 3 V, I_{OL} = 2 mA		0.07	0.2	
V_{IH}	Input High Logic Level	D, DE/$\overline{RE}$	2/3 V_{IO}			V
V_{IL}	Input Low Logic Level	D, DE/$\overline{RE}$			1/3 V_{IO}	V
I_{IN}	Driver Input, Driver Enable, and Receiver Enable Input Current	D, DE/$\overline{RE}$	–5		5	μA
I_{OZ}	Receiver Output High-Z Current	V_O = 0 V or V_{IO}, RE at V_{IO}	–1		1	μA

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
I_{OS}	Driver Short-Circuit Output Current	V_A, V_B = −7 V to 12 V		–250		250	mA
		A, B short		−120		120	mA
$I_{IA/B}$	Bus Input Current (Disabled Driver)	V_{IO} = 1.8 V, DE at 0 V V_{CC} = 5.0 V, or V_{CC} = 0 V	V_I = 12 V		100	150	µA
			V_I = –7 V	−100	−50		µA
I_{CC}	Supply Current (Quiescent), TPT4181H	Driver enabled, receiver disabled	DE/$\overline{RE}$ = V_{CC}, no load		450	560	µA
		Driver disabled, receiver enabled	DE/$\overline{RE}$ = GND, no load		1600	2000	µA
I_{CC}	Supply Current (Quiescent), TPT4181V	Driver enabled, receiver disabled	DE/$\overline{RE}$ = V_{CC}, no load		400	600	µA
		Driver disabled, receiver enabled	DE/$\overline{RE}$ = GND, no load		400	600	µA

(1) Parameters are provided by lab bench test and design simulation. NOT test in production.

Switching Characteristics, V_{CC} = V_{IO} = 3.0 V （TPT4181H 20-Mbps）

Parameter		Conditions		Min	Typ	Max	Units
Driver							
t_r, t_f	Driver Differential-Output Rise and Fall Times (1)	R_L = 54 Ω, C_L = 50 pF	See Figure 2		10		ns
t_{PHL}, t_{PLH}	Driver Propagation Delay				22	40	
$t_{SK(P)}$	Driver Pulse Skew, $\|T_{phl} – T_{plh}\|$				3	10	
t_{PHZ}	Driver Disable Time		See Figure 3		26	50	ns
t_{PLZ}					18	50	ns
t_{PZH}	Driver Enable Time				30	50	ns
t_{PZL}					26	50	ns
Receiver							
t_{PHL}, t_{PLH}	Receiver Propagation Delay Time				40	80	ns
$t_{SK(P)}$	Receiver Pulse Skew, $\|T_{phl} – T_{plh}\|$				7	15	
t_{PHZ}	Receiver Disable Time		See Figure 6		16	50	ns
t_{PLZ}					16	50	ns
t_{PZH}	Receiver Enable Time				80	125	ns
t_{PZL}					10	50	ns

(1) Parameters are provided by lab bench test and design simulation. NOT test in production.

Switching Characteristics, V_{CC} = V_{IO} = 3.0 V （TPT4181V 500-Kbps）

Parameter		Conditions		Min	Typ	Max	Units
Driver							
t_r, t_f	Driver Differential-Output Rise and Fall Times [1]	R_L = 54 Ω, C_L = 50 pF	See Figure 2		400		ns
t_{PHL}, t_{PLH}	Driver Propagation Delay				280	400	
$t_{SK(P)}$	Driver Pulse Skew, $\|T_{phl} – T_{plh}\|$				5	20	
t_{PHZ}	Driver Disable Time		See Figure 3		48	90	ns
t_{PLZ}					48	90	ns
t_{PZH}	Driver Enable Time				300	500	ns
t_{PZL}					240	500	ns
Receiver							
t_{PHL}, t_{PLH}	Receiver Propagation Delay Time				110	200	ns
$t_{SK(P)}$	Receiver Pulse Skew, $\|T_{phl} – T_{plh}\|$				15	28	
t_{PHZ}	Receiver Disable Time		See Figure 6		16	50	ns
t_{PLZ}					16	50	ns
t_{PZH}	Receiver Enable Time				135	180	ns
t_{PZL}					20	50	ns

(1) Parameters are provided by lab bench test and design simulation. NOT test in production.

Test Circuits and Waveforms

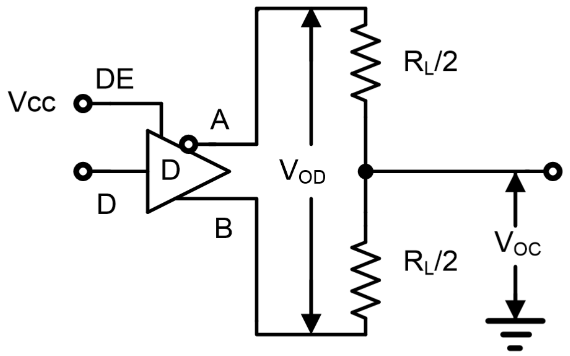


Figure 1A. V_{OD} and V_{OC}

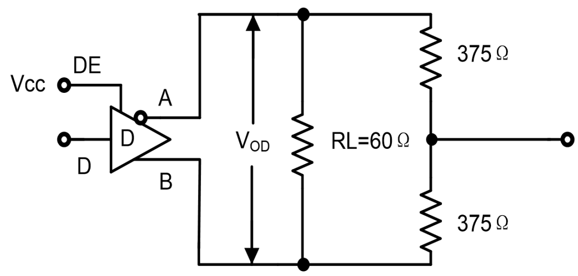


Figure 1B. V_{OD} with Common Mode Load

Figure 1. DC Driver Test Circuits

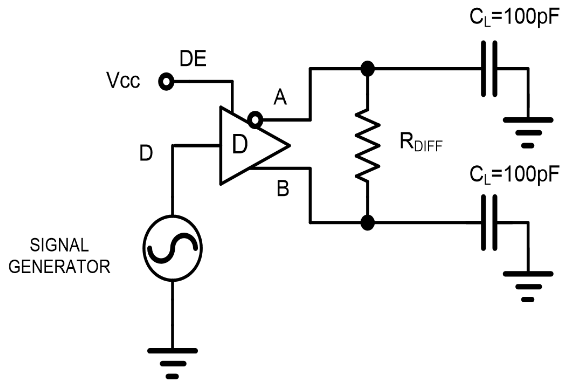


Figure 2A. Test Circuit

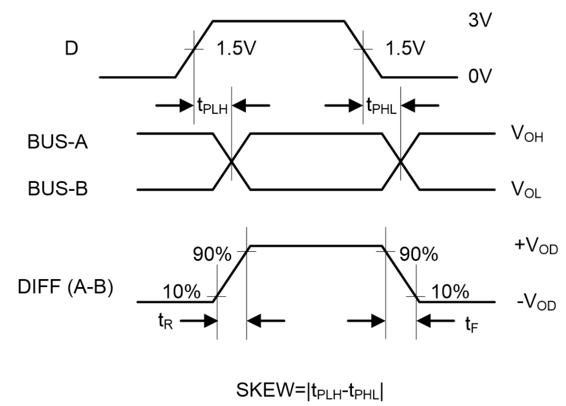


Figure 2B. Measurement Points

Figure 2. Driver Propagation Delay and Differential Transition Times

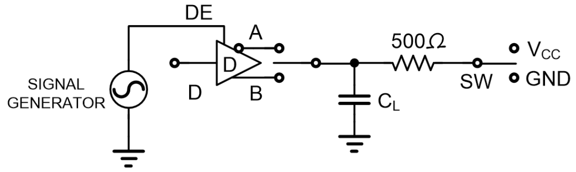


Figure 3A. Test Circuit

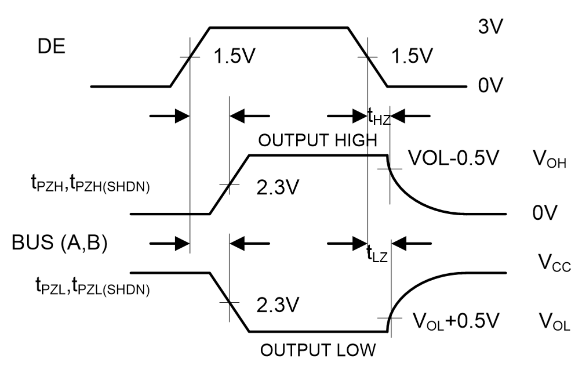


Figure 3B. Measurement Points

Parameter	Output	RE	DI	SW	CL (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 3. Driver Enable and Disable Times

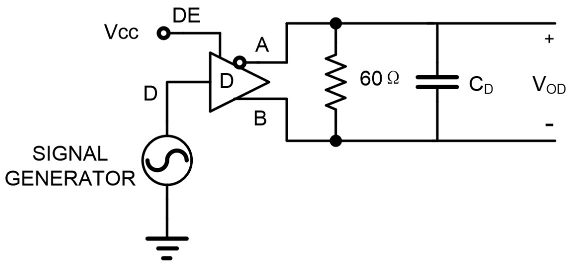


Figure 4A. Test Circuit

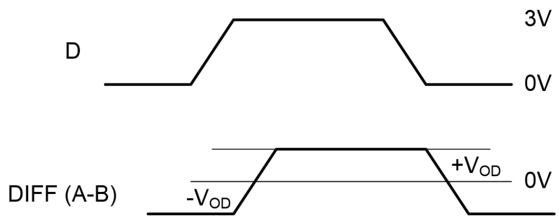


Figure 4B. Measurement Points

Figure 4. Driver Data Rate

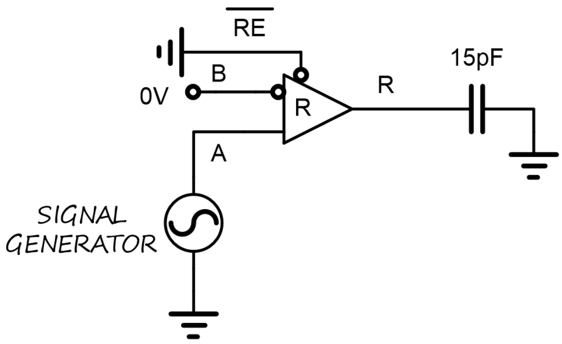


Figure 5A. Test Circuit

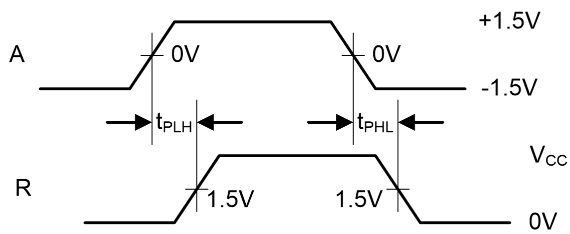


Figure 5B. Measurement Points

Figure 5. Receiver Propagation Delay and Data Rate

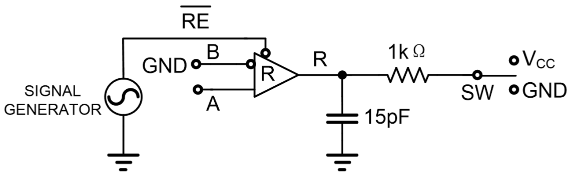


Figure 6A. Test Circuit

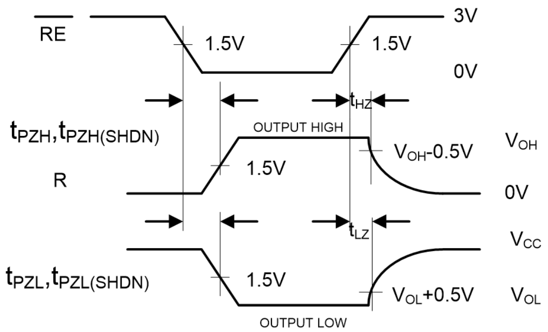
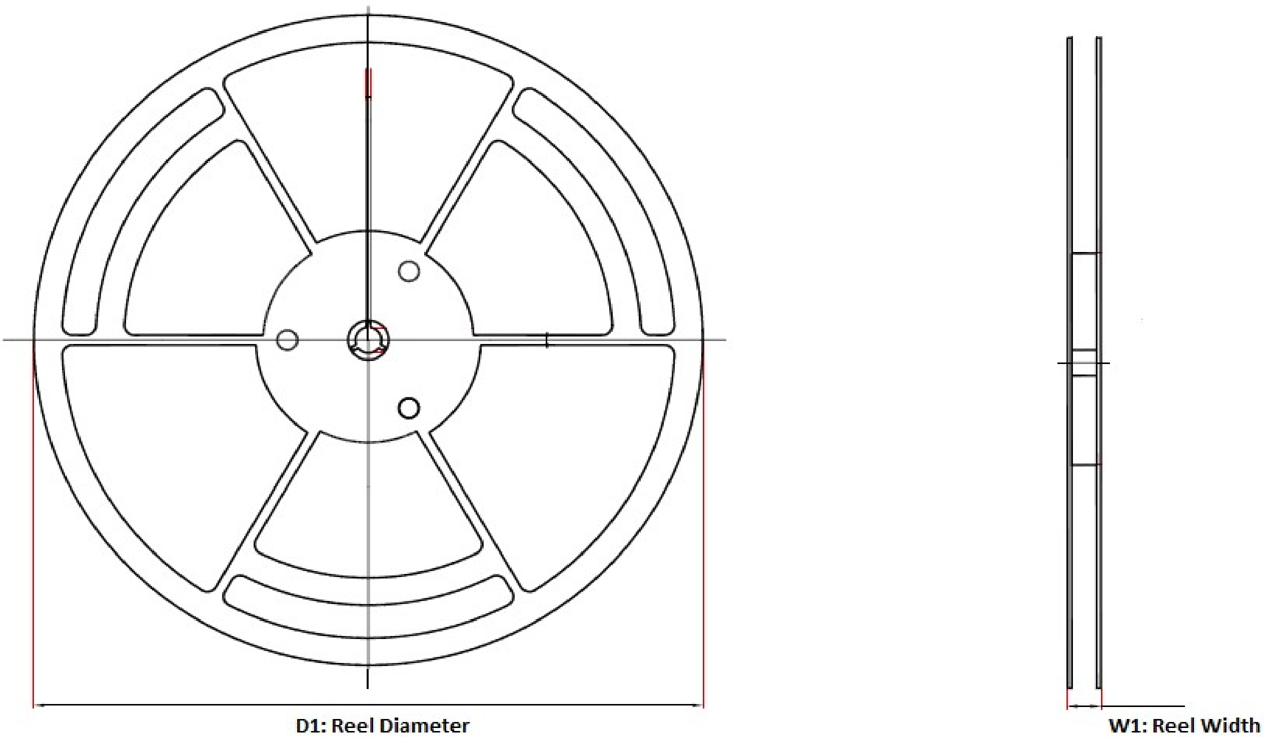


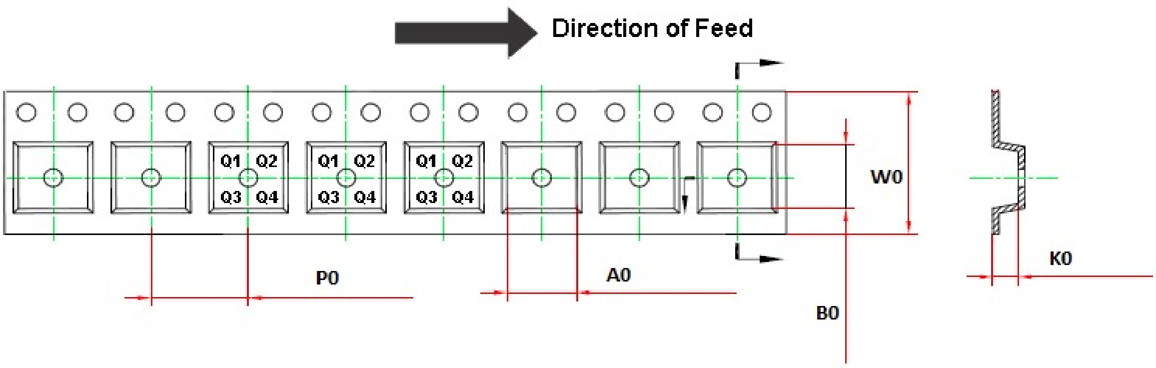
Figure 6B. Measurement Points

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

Figure 6. Receiver Enable and Disable Times

Tape and Reel Information



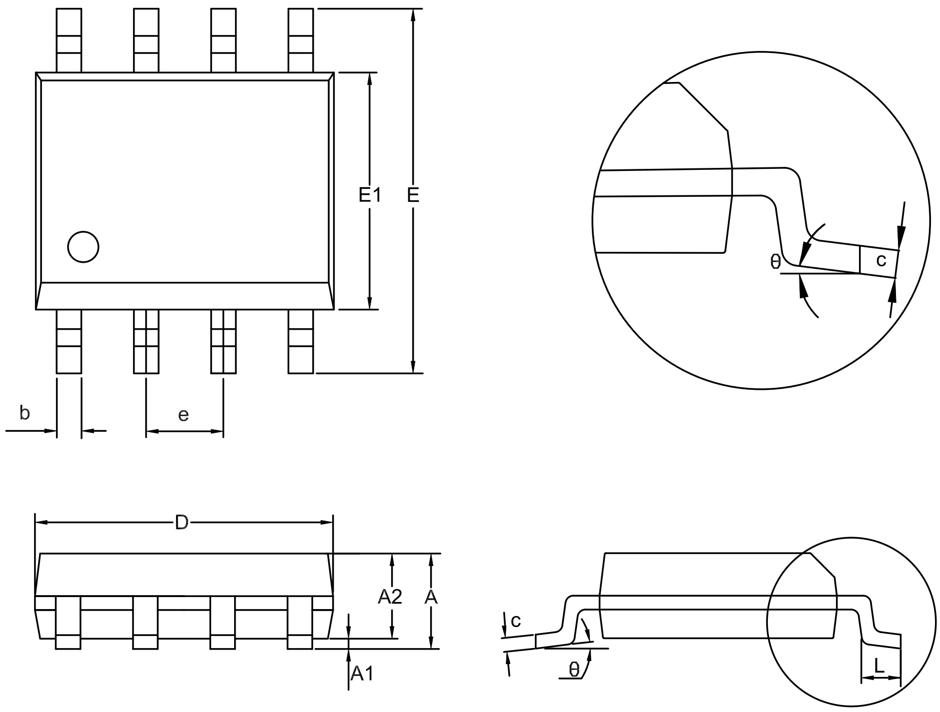


Order Number	Package	D1 (mm)	A0 (mm)	K0 (mm)	W0 (mm)	W1 (mm)	B0 (mm)	P0 (mm)	Pin1 Quadrant
TPT4181V-SO1R-S	SOP8	330.0	6.5	2.0	12.0	17.6	5.4	8.0	Q1
TPT4181H-SO1R-S	SOP8	330.0	6.5	2.0	12.0	17.6	5.4	8.0	Q1

Package Outline Dimensions

SOP8

Package Outline Dimensions SO1(SOP-8-A)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.550	0.049	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050 BSC	
L	0.400	1.000	0.016	0.039
θ	0	8°	0	8°

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPT4181V-SO1R-S	−40 to 125°C	SOP8	4181V	MSL1	Tape and Reel, 4000	Green
TPT4181H-SO1R-S	−40 to 125°C	SOP8	4181H	MSL1	Tape and Reel, 4000	Green

Green: 3PEAK defines "Green" to mean RoHS compatible and free of halogen substances.

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