

## Features

- Exceeds Requirements of EIA-485 Standard
- Data Rate: 20Mbps or 500Kbps
- Up to 256 Nodes on a Bus (1/8 unit load)
- Full Fail-safe Receiver (Open, Short, Terminated)
- Wide Supply Voltage 3V to 5.5V
- 1.65V to Vcc 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

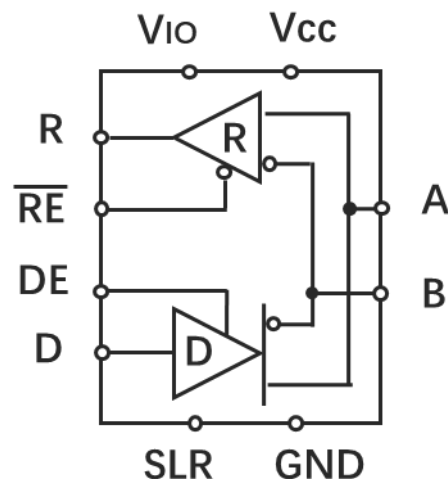
- Factory Automation
- Field Bus Networks
- Industrial/Process Control Networks
- Communication Infrastructure

## Description

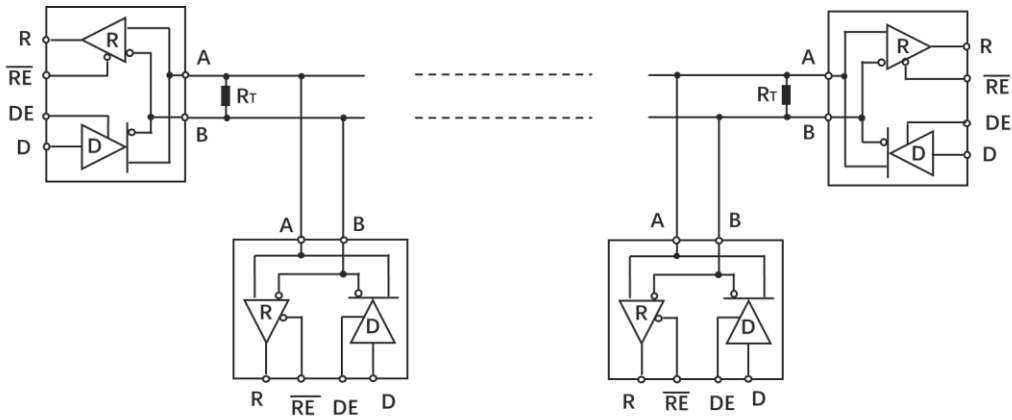
The TPT4181 is a 3.0 V to 5.5 V, IEC electrostatic discharge (ESD) protected RS-485 transceiver, and the device can support ±15 kV Contact Discharge on the transceiver bus pins without damage. The TPT4181 features a VIO logic supply pin allowing a flexible digital interface capable of operating as low as 1.65 V.

Transmitters in this family deliver exceptional differential output voltages into the RS-485 required 54Ω load. 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 TPT4181 is available in an DFN3X3-10L package, and is characterized from –40°C to 125°C.

## Simplified Schematic



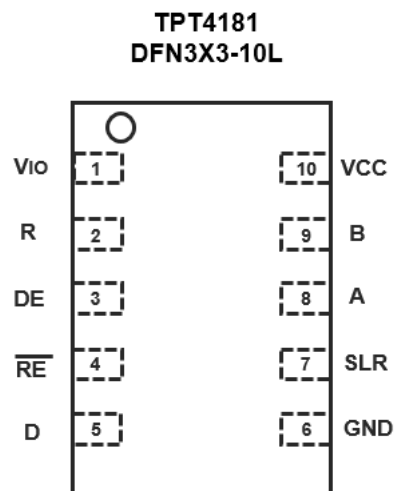
### Typical RS-485 Network



### Revision History

Date	Revision	Notes
2018/12/20	Rev. Pre 0	Initial Definition
2019/04/08	Rev. Pre 0.1	Add package information
2019/08/06	Rev. Pre 0.2	Update ESD data
2019/09/03	Rev. Pre 0.3	Update Electrical data
2019/09/27	Rev. Pre 0.4	Update thermal data
2019/09/30	Rev. 0	Final datasheet Rev. 0
2019/12/30	Rev. A	Production update $t_{sk}$ spec
2020/3/24	Rev. B	Update ESD data, absolute rating for A/B bus pin

## Pin Configuration and Functions



Pin No.	Pin Name	I/O	Description
1	VIO	Logic Supply	1.65 V to Vcc supply for logic I/O signals R, RE, D, DE, and SLR)
2	R	Digital Output	Receive data output
3	DE	Digital Input	Driver enable input
4	/RE	Digital Input	Receiver enable input
5	D	Digital Input	Transmission data input
6	GND	Reference Potential	Local device ground
7	SLR	Digital Input	Slew rate select: Low = 20 Mbps, High = 500 kbps. Default output is 20 Mbps if SLR is floated
8	A	Bus I/O	Digital bus I/O, A
9	B	Bus I/O	Digital bus I/O, B
10	VCC	Bus Supply	3 V to 5.5 V supply for A and B bus lines

## Order Information

Model Name	Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity
TPT4181	TPT4181L1-DF8R	-40 to 125°C	10-Pin DFN3X3	T4181	MSL1	Tape and Reel, 4000

## Absolute Maximum Ratings

Parameters	Rating
$V_{IO}$ to GND	-0.3V to +7V
$V_{CC}$ to GND	-0.3V to +7V
Voltage at Logic pin: DI, DE, /RE, RO	-0.3V to $V_{CC} + 0.3V$
Voltage at Bus pin: A, B	-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) 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 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	kV

## Recommended Operating Conditions

Parameters	Spec
$V_{IO}$	1.65V to VCC
$V_{CC}$	3V to 5.5V
Voltage at Logic pin: DI, DE, /RE, RO	= $V_{IO}$
Voltage at Bus pin: A, B	-7V to +12V
Operating Temperature Range	-40°C to 125°C

## Electrical Characteristics

All test condition is  $V_{CC} = 3.3V \sim 5.0V$ ,  $T_A = -40 \sim +125^\circ C$

Symbol	PARAMETER	TEST CONDITIONS	Min	MAX	UNIT		
V <sub>OD</sub>	Driver differential output voltage magnitude	R <sub>L</sub> = 60 Ω, 375 Ω on A/B: -7 V to 12V, V <sub>CC</sub> =3.3V	1.5	1.9	V		
		R <sub>L</sub> = 60 Ω, 375 Ω on A/B: -7 V to 12V, V <sub>CC</sub> =5V	2.0	3.0	V		
		R <sub>L</sub> = 54 Ω, V <sub>CC</sub> =3.3V	1.5	2.0	V		
		R <sub>L</sub> = 54 Ω, V <sub>CC</sub> =5.0V	2.0	3.0			
		R <sub>L</sub> = 100 Ω, V <sub>CC</sub> = 3.3V	1.5	2.3			
		R <sub>L</sub> = 100 Ω, V <sub>CC</sub> = 5.0V	2.0	3.5	V		
Δ V <sub>OD</sub>	Change in magnitude of driver differential output voltage	R <sub>L</sub> = 54 Ω, C <sub>L</sub> = 50 pF, 375 Ω on A/B: -7 V to 12V, V <sub>CC</sub> =3.3V	-50	50	mV		
V <sub>OC(SS)</sub>	Steady-state common-mode output voltage	Center of two 27-Ω load resistors	1	V <sub>CC</sub> /2	3	V	
ΔV <sub>OC</sub>	Change in differential driver output common-mode voltage		-50	50	mV		
V <sub>OC(PP)</sub>	Peak-to-peak driver common-mode output voltage		500		mV		
C <sub>OD</sub>	Differential output capacitance		15		pF		
V <sub>IT+</sub>	Positive-going receiver differential input voltage threshold		-100	-20	mV		
V <sub>IT-</sub>	Negative-going receiver differential input voltage threshold		-220	-150	mV		
V <sub>HYS</sub>	Receiver differential input voltage threshold hysteresis (V <sub>IT+</sub> - V <sub>IT-</sub> )		50		mV		
V <sub>OH</sub>	Receiver high-level output voltage	V <sub>L</sub> = 1.65 V, I <sub>OH</sub> = -2 mA	1.3	1.5	V		
		V <sub>L</sub> = 3 V, I <sub>OH</sub> = -2 mA	2.8	2.9			
V <sub>OL</sub>	Receiver low-level output voltage	V <sub>L</sub> = 1.65 V, I <sub>OL</sub> = 2 mA	0.13	0.35	V		
		V <sub>L</sub> = 3 V, I <sub>OL</sub> = 2 mA	0.07	0.2			
V <sub>IH</sub>	Input High Logic Level	D, DE, /RE	2/3 V <sub>L</sub>		V		
V <sub>IL</sub>	Input Low Logic Level	D, DE, /RE	1/3 V <sub>L</sub>		V		
I <sub>IN</sub>	Driver input, driver enable, and receiver enable input current	D, DE, /RE	-5	5	μA		
I <sub>OZ</sub>	Receiver output high-Z current	V <sub>O</sub> = 0 V or V <sub>L</sub> , RE at V <sub>L</sub>	-1	1	μA		
I <sub>OS</sub>	Driver short-circuit output current	V <sub>A</sub> V <sub>B</sub> = -7V ~ 12V	-250	250	mA		
		A, B short	-120	120			
I <sub>IAB</sub>	Bus input current (disabled driver)	V <sub>L</sub> = 1.8 V, DE at 0 V	V <sub>I</sub> = 12 V,		100	150	μA
		V <sub>CC</sub> = 5.0 V, or V <sub>CC</sub> = 0 V	V <sub>I</sub> = -7 V,		-100	-50	
I <sub>CC</sub>	Supply current (quiescent), 20Mbps	Driver and Receiver enabled	DE=V <sub>L</sub> , RE = GND, No load		2200	μA	
		Driver enabled, receiver disabled	DE=V <sub>CC</sub> , RE = V <sub>L</sub> , No load		350	560	μA
		Driver disabled, receiver enabled	DE=GND, RE = GND, No load		1000	2000	μA
		Driver and receiver disabled	DE=GND, RE = V <sub>L</sub> , No load		-2	2	μA

I <sub>CC</sub>	Supply current (quiescent), 500Kbps	Driver and Receiver enabled	DE=V <sub>L</sub> , RE = GND, No load	850	μA
		Driver enabled, receiver disabled	DE=V <sub>CC</sub> , RE = V <sub>L</sub> , No load	400 600	μA
		Driver disabled, receiver enabled	DE=GND, RE = GND, No load	400 600	μA
		Driver and receiver disabled	DE=GND, RE = V <sub>L</sub> , No load	-2 2	μA

**Switching Characteristics, V<sub>CC</sub>=V<sub>L</sub>=3.0V (Test in 20Mbps mode)**

Parameter	Conditions	Min	Typ	Max	Units
<b>Driver</b>					
t <sub>r</sub> , t <sub>f</sub>	Driver differential-output rise and fall times	RL = 54 Ω, CL=50pF	See Figure 2	10	ns
t <sub>PHL</sub> , t <sub>PLH</sub>	Driver propagation delay			22 40	
tsk(P)	Driver pulse skew,  t <sub>PHL</sub> – t <sub>PLH</sub>			3 10	
t <sub>PHZ</sub> , t <sub>PLZ</sub>	Driver disable time	Receiver enabled	See Figure 3	26 50	ns
		Receiver disabled		26 50	
t <sub>PZH</sub> , t <sub>PZL</sub>	Driver enable time	Receiver enabled		26 50	ns
		Receiver disabled		2400 3500	
<b>Receiver</b>					
t <sub>PHL</sub> , t <sub>PLH</sub>	Receiver propagation delay time			40 80	ns
tsk(P)	Receiver pulse skew,  t <sub>PHL</sub> – t <sub>PLH</sub>			7 15	
t <sub>PHZ</sub> , t <sub>PLZ</sub>	Receiver disable time	Driver enabled	See Figure 6	25 50	ns
		Driver disabled		25 50	
t <sub>PZH</sub> , t <sub>PZL</sub>	Receiver enable time	Driver enabled		80 125	ns
		Driver disabled		2500 3500	

**Switching Characteristics, Vcc=VL=3.0V (Test in 500Kbps mode)**

Parameter		Conditions	Min	Typ	Max	Units	
<b>Driver</b>							
$t_r, t_f$	Driver differential-output rise and fall times	RL = 54 $\Omega$ , CL=50pF	See Figure 2		400	ns	
$t_{PHL}, t_{PLH}$	Driver propagation delay				280		400
$t_{SK(P)}$	Driver pulse skew,  t <sub>PHL</sub> – t <sub>PLH</sub>				5		20
$t_{PHZ}, t_{PLZ}$	Driver disable time	Receiver enabled	See Figure 3		48	90	ns
		Receiver disabled			48	90	
$t_{PZH}, t_{PZL}$	Driver enable time	Receiver enabled			300	500	ns
		Receiver disabled			2700	3500	
<b>Receiver</b>							
$t_{PHL}, t_{PLH}$	Receiver propagation delay time				110	200	ns
$t_{SK(P)}$	Receiver pulse skew,  t <sub>PHL</sub> – t <sub>PLH</sub>				15	28	
$t_{PHZ}, t_{PLZ}$	Receiver disable time	Driver enabled	See Figure 6		28	50	ns
		Driver disabled			28	50	
$t_{PZL}, t_{PZH}$	Receiver enable time	Driver enabled			135	180	ns
		Driver disabled			2600	3500	

Test Circuits and Waveforms

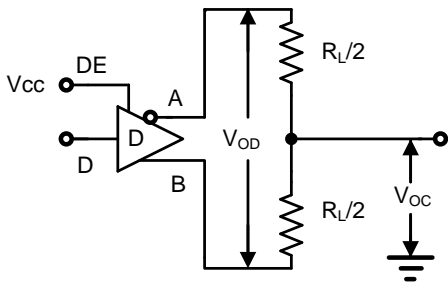


Figure 1A. VOD and VOC

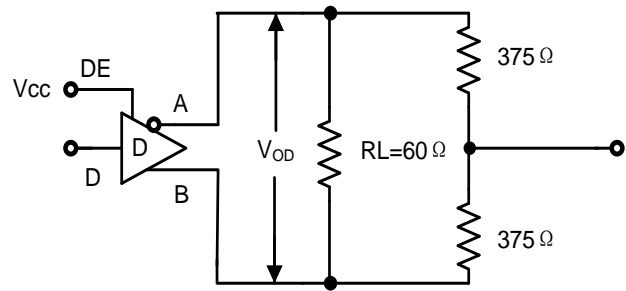


Figure 1B. VOD with Common Mode Load

FIGURE 1. DC Driver Test Circuits

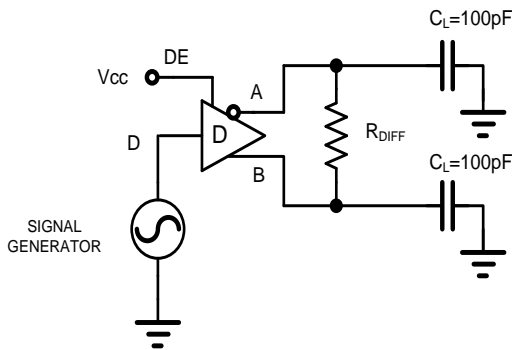


Figure 2A. Test Circuit

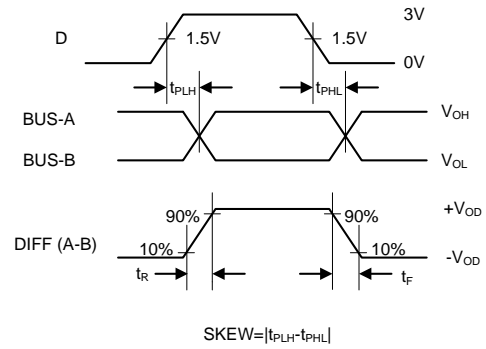


Figure 2B. Measurement Points

Figure 2. Driver Propagation Delay and Differential Transition Times

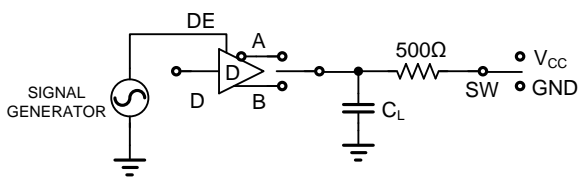


Figure 3A. Test Circuit

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

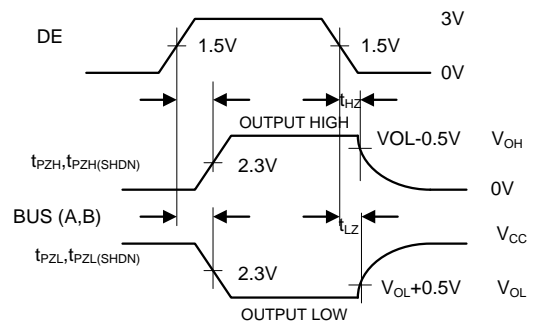


Figure 3B. Measurement Points

Figure 3. Driver Enable and Disable Times



Test Circuits and Waveforms (continue)

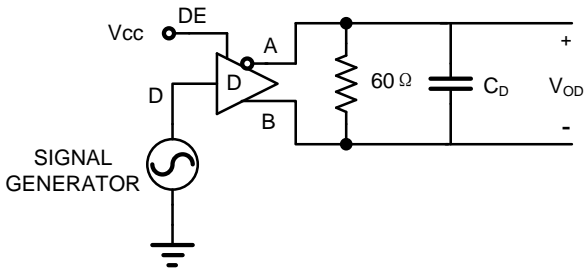


Figure 4A. Test Circuit

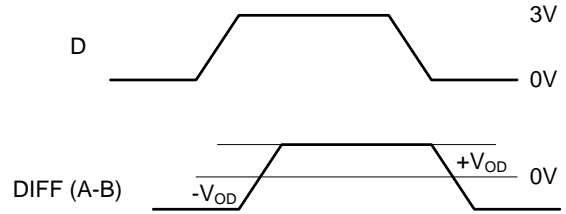


Figure 4B. Measurement Points

Figure 4. Driver Data rate

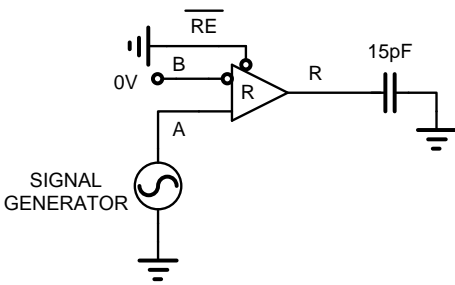


Figure 5A. Test Circuit

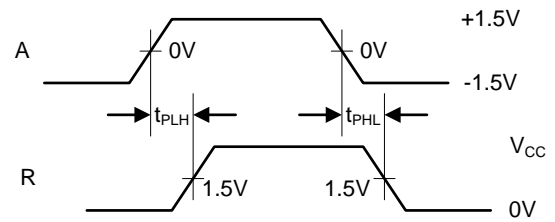


Figure 5B. Measurement Points

Figure 5. Receiver Propagation Delay and Data rate

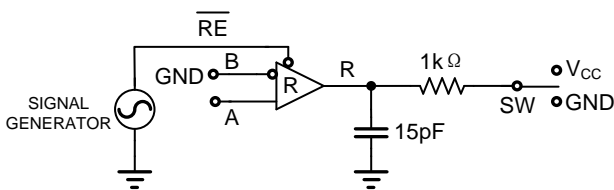


Figure 6A. Test Circuit

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

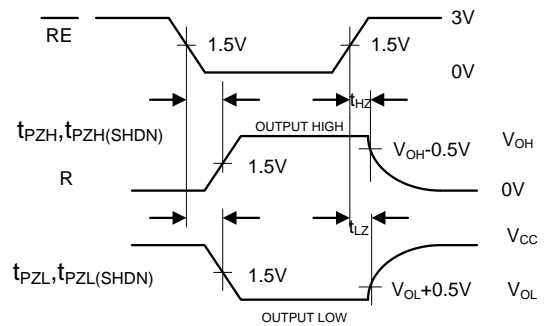
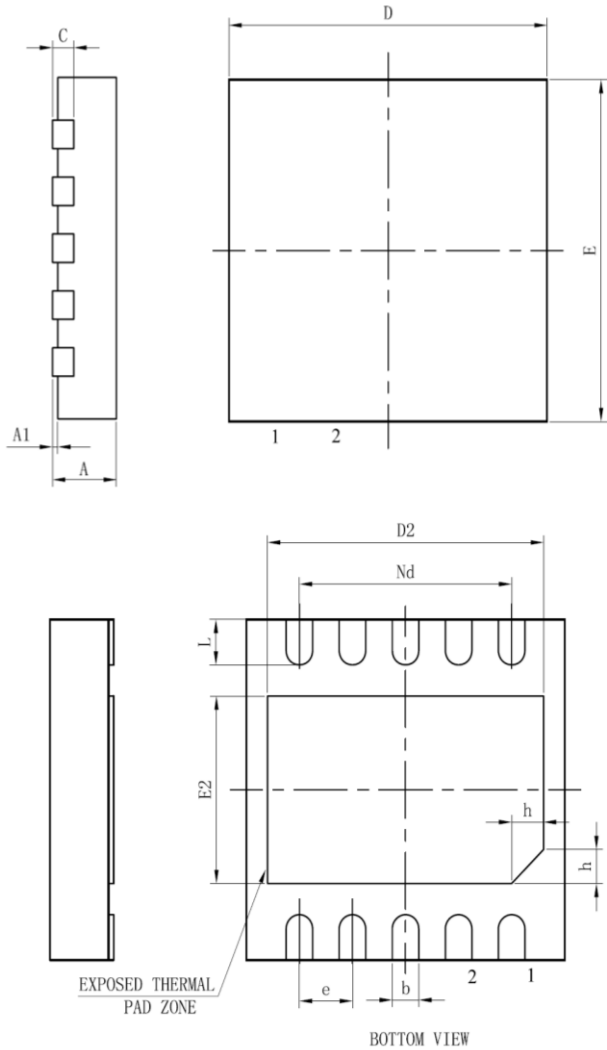


Figure 6B. Measurement Points

Figure 6. Receiver Enable and Disable Times

### Package Outline Dimensions

#### DF8R ( DFN3X3-10L )



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	—	0.02	0.05
b	0.18	0.25	0.30
c	0.18	0.20	0.25
D	2.90	3.00	3.10
D2	2.40	2.50	2.60
e	0.50BSC		
Nd	2.00BSC		
E	2.90	3.00	3.10
E2	1.45	1.55	1.65
L	0.30	0.40	0.50
h	0.20	0.25	0.30
L/F载体尺寸 (mil)	106*75		