

3.0-V to 5.5-V RS-485 Transceivers

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 20 Mbps
- Full Fail-Safe Receiver (Open, Short, and Terminated)
- Wide Supply Voltage 3 V to 5.5 V
- Bus-Pin Protection:
 - ±18-kV HBM ESD
 - ±15-kV IEC61000-4-2 Contact Discharge
 - ±15-kV IEC61000-4-2 Air Discharge
- Operating Temperature Range: -40°C to 125°C

Applications

- Motor Drives
- Industrial Control
- Communication Infrastructure

Description

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

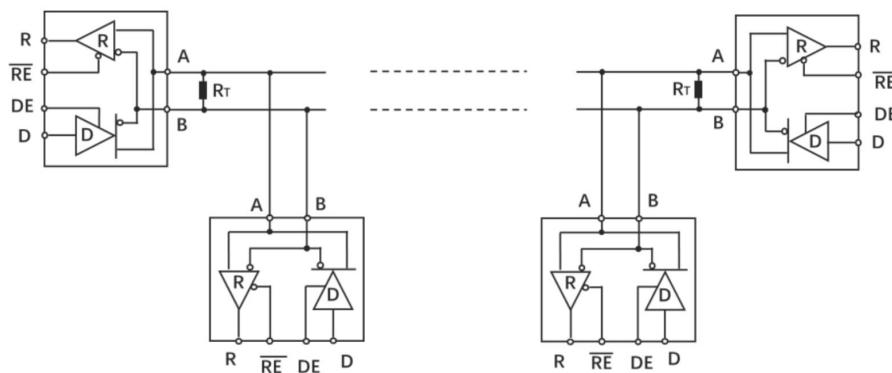
Transmitters in this family deliver exceptional differential output voltages into the RS-485 required 54-Ω load. These 20-Mbps devices have very low bus currents, so they present a true "1/8 unit load" to the RS-485 bus. This allows up to 256 transceivers on the network without using repeaters. Receiver (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.

The TPT481 is designed for half-duplex RS485, and supports SOP8, MSOP8, and DFN3X3-8 packages, which are characterized from -40°C to 125°C.

Device Table

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

Typical Application Circuit



TPT481 Network

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Revision History

Date	Revision	Notes
2019-04-08	Rev.Pre.0	Initial version.
2020-03-24	Rev.A	Released version. Updated the A/B pin Absolute Maximum Ratings, VID and VI recommended value.
2020-08-12	Rev.B Rev.C	Updated HBM level to 18 kV. Added note (1) in the Absolute Maximum Ratings.
2021-05-26	Rev.D	Added Tape and Reel Information.
2021-10-28	Rev.E	Added Power Consumption data.
2023-04-18	Rev.E.2	Updated $V_{OH} = 4$ V as min value @ 5-V voltage.
2024-12-24	Rev.E.3	Updated to a new datasheet format. Updated the POD. Updated Tape and Reel Information.

Pin Configuration and Functions

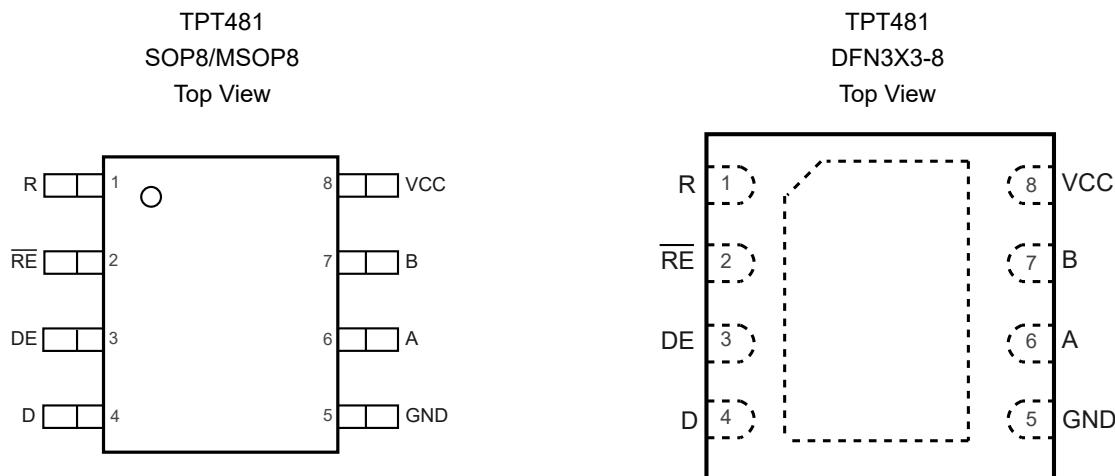


Table 1. Pin Functions

Pin No.	Name	I/O	Description
1	R	Digital Output	Receiver output.
2	\overline{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	Non-inverting receiver input A and non-inverting driver output A.
7	B	Bus Input/Output	Inverting receiver input B and inverted driver output B.
8	Vcc	Power	Power supply.

Functional Table

Table 2. Driver Function Table

Input	Enable	Outputs	Outputs	Description
D	DE	A	B	
H	H	H	L	Actively drive bus High
L	H	L	H	Actively drive bus Low
X	L	Z	Z	Driver disabled
X	OPEN	Z	Z	Driver disabled by default
OPEN	H	H	L	Actively drive bus High by default

(1) X = don't care.

(2) Z = high impedance.

Table 3. Receiver Function Table

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

(1) X = don't care.

(2) Z = high impedance.

Specifications

Absolute Maximum Ratings (1)

Parameter		Min	Max	Unit
V _{CC} to GND		-0.3	7	V
Voltage at Logic Pin: D, DE, \overline{RE} , R		-0.3	$V_{CC} + 0.3$	V
Voltage at Bus Pin: A, B (2)		-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.

(2) Support ±15 V in receiver mode, and -8 V to +13 V in driver mode.

Recommended Operating Conditions

All test conditions: over operating free-air temperature range, unless otherwise noted.

Parameter		Min	Typ	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 the minimum is used in this data sheet.

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ESD, Electrostatic Discharge Protection

Symbol	Parameter	Condition		Minimum Level	Unit
	Contact Discharge	IEC-61000-4-2	Bus Pins	15	kV
	Air-Gap Discharge	IEC-61000-4-2	Bus Pins	15	kV
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001/ ANSI/ESD STM5.5.1	Bus Pins	18	kV
			All Pins except Bus Pins	4	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 ⁽¹⁾	All Pins	1.5	kV

(1) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

Power Consumption

Parameter	Description	Test Condition	Value	Unit
Pcon	Driver and receiver enabled, $V_{CC} = 5.5$ V, $T_A = 125$ °C, 50% duty cycle square wave at maximum signaling rate, $C_L = 50$ pF	Unterminated: $R_L = 300 \Omega$	390	mW
		RS-422 load: $R_L = 100 \Omega$	470	mW
		RS-485 load: $R_L = 54 \Omega$	550	mW

(1) All values are based on lab tests.

3.0-V to 5.5-V RS-485 Transceivers

Electrical Characteristics

All test conditions: $V_{CC} = 4.5\text{ V}$ to 5.5 V , unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
$ V_{OD} $	Driver Differential-Output Voltage Magnitude	$R_L = 60\ \Omega$ with V_A or V_B from -7 V to $+12\text{ V}$, $V_{CC} = 4.5\text{ V}$ to 5.5 V	See Figure 1B	2.1	2.7	V	
		$R_L = 60\ \Omega$ with V_A or V_B from -7 V to $+12\text{ V}$, $V_{CC} = 3.0\text{ V}$ to 3.6 V	See Figure 1B	1.5	2.3		
		$R_L = 54\ \Omega$, $V_{CC} = 5\text{ V}$	See Figure 1A	2.1	2.7		
		$R_L = 54\ \Omega$, $V_{CC} = 3\text{ V}$		1.5	2.3		
		$R_L = 100\ \Omega$, $V_{CC} = 5\text{ V}$		2.1	2.7		
		$R_L = 100\ \Omega$, $V_{CC} = 3\text{ V}$		1.5	2.3		
$\Delta V_{OD} $	Change in Magnitude of Driver Differential-Output Voltage	$R_L = 54\ \Omega$, $C_L = 50\ \text{pF}$, $V_{CC} = 5\text{ V}$	See Figure 1A	-50	50	mV	
$V_{OC(\text{ss})}$	Steady-State Common-Mode Output Voltage	Center of two $27\text{-}\Omega$ load resistors	See Figure 1A	1	$V_{CC}/2$	3	V
ΔV_{OC}	Change in Differential Driver Common-Mode Output Voltage			-50	50	mV	
$V_{OC(\text{PP})}$	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	$I_{OH} = -8\ \text{mA}$ ⁽¹⁾	4	$V_{CC} - 0.3$		V	
V_{OL}	Receiver Low-Level Output Voltage	$I_{OL} = 8\ \text{mA}$			0.4	V	

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Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Rin	BUS Pin Input Resistance	-7 V ≤ V _{CM} ≤ +12 V		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} , \overline{RE} at V _{CC}		-1		1	μA
I _{os}	Driver Short-Circuit Output Current	I _{os} with V _A or V _B from -7 V 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 V to 5.5 V, or V _{CC} = 0 V, DE at 0 V	V _I = 12 V V _I = -7 V		100 -120	150 -60	μA
I _{CC}	Supply Current (Quiescent)	Driver and receiver enabled	DE = V _{CC} , \overline{RE} = GND, no load		1800	2700	μA
		Driver enabled, receiver disabled	DE = V _{CC} , \overline{RE} = V _{CC} , no load		500	800	
		Driver disabled, receiver enabled	DE = GND, \overline{RE} = GND, no load		1600	2100	
		Driver and receiver disabled	DE = GND, \overline{RE} = V _{CC} , D = V _{DD} , no load		5	10	

(1) Test data is based on 5-V voltage, and V_{OH} = 2.4 V (min) @ 3.3-V voltage.

Switching Characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Units
Driver							
t _r , t _f	Driver Differential-Output Rise and Fall Time	R _L = 54 Ω, C _L = 50 pF	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 Time	C _L = 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 _{PZH} , t _{PZL}	Receiver Enable Time	Driver enabled			75	120	ns
		Driver disabled			2350	3000	

Test Circuits and Waveforms

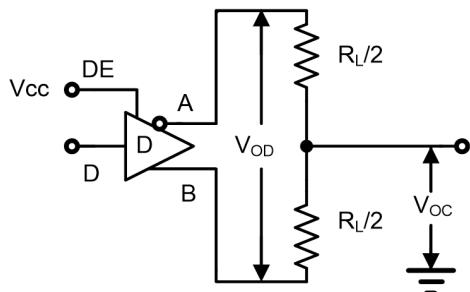


Figure 1A. V_{OD} and V_{OC}

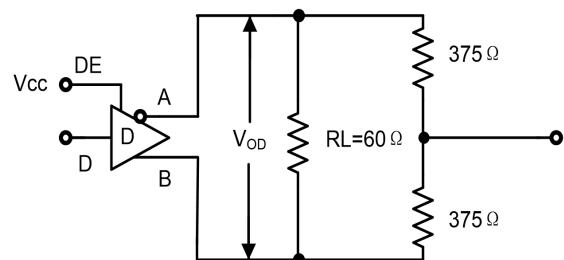


Figure 1B. V_{OD} with Common-Mode Load

Figure 1. DC Driver Test Circuits

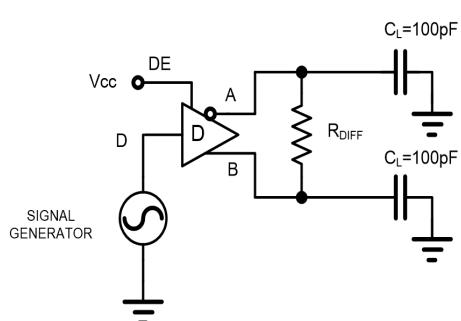


Figure 2A. Test Circuit

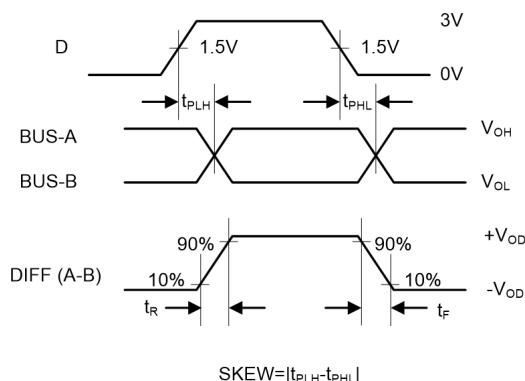
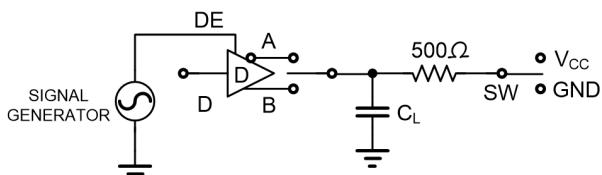


Figure 2B. Measurement Points

Figure 2. Driver Propagation Delay and Differential Transition Times



PARAMETER	OUTPUT	RE	DI	SW	C_L (pF)
tPHZ	A/B	X	1/0	GND	15
tPLZ	A/B	X	0/1	V_{CC}	15
tPZH	A/B	0	1/0	GND	100
tPZL	A/B	0	0/1	V_{CC}	100
tPZH(SHDN)	A/B	1	1/0	GND	100
tPZL(SHDN)	A/B	1	0/1	V_{CC}	100

Figure 3A. Test Circuit

Figure 3. Driver Enable and Disable Times

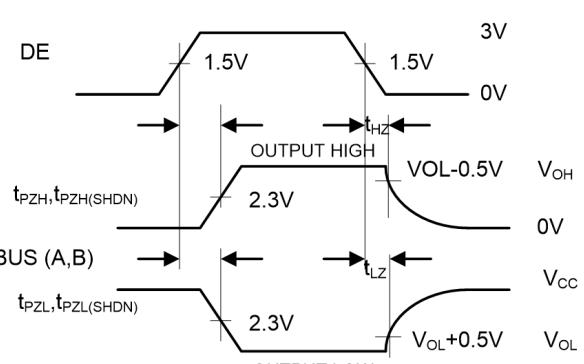
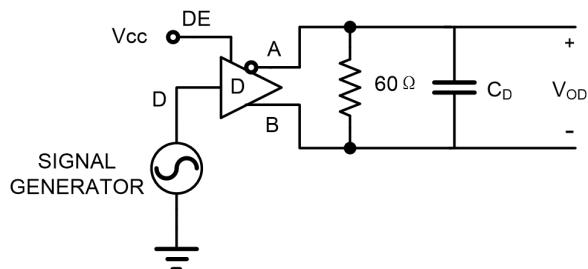
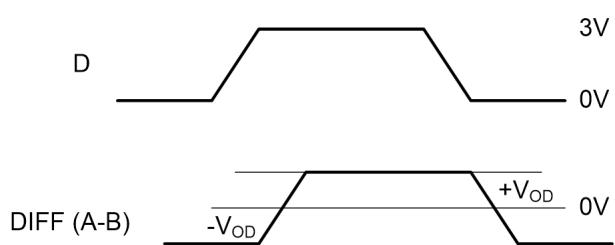
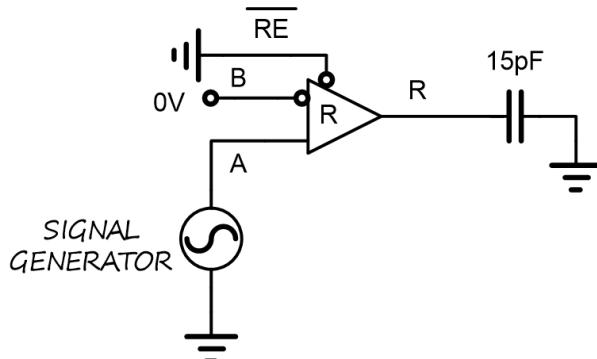
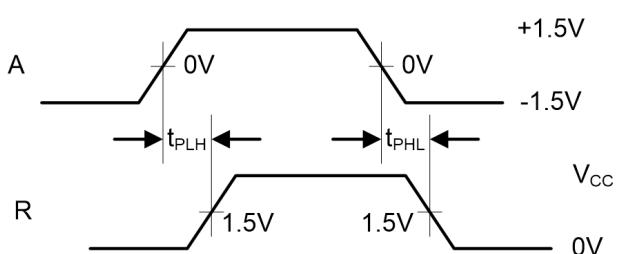
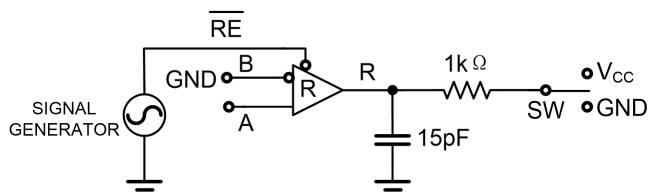
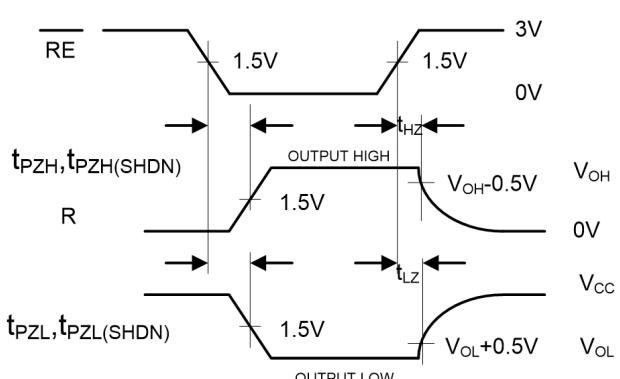


Figure 3B. Measurement Points

3.0-V to 5.5-V RS-485 Transceivers

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
tPHZ	1	+1.5 V	GND
tPLZ	1	-1.5 V	V_{CC}
tPZH	1	+1.5 V	GND
tPZL	1	-1.5 V	V_{CC}
tPZH(SHDN)	0	+1.5 V	GND
tPZL(SHDN)	0	-1.5 V	V_{CC}

Figure 6A. Test Circuit

Figure 6B. Measurement Points
Figure 6. Receiver Enable and Disable Times

Detailed Description

Functional Block Diagram

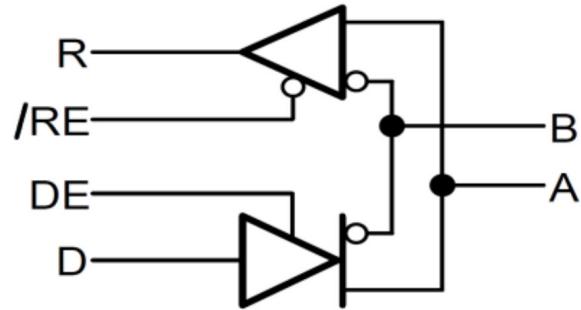


Figure 7. Functional Block Diagram

Application and Implementation

Note

Information in the following application sections is not part of the 3PEAK's component specification and 3PEAK does not warrant its accuracy or completeness. 3PEAK's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

Typical Application

Figure 8 shows the typical application schematic.

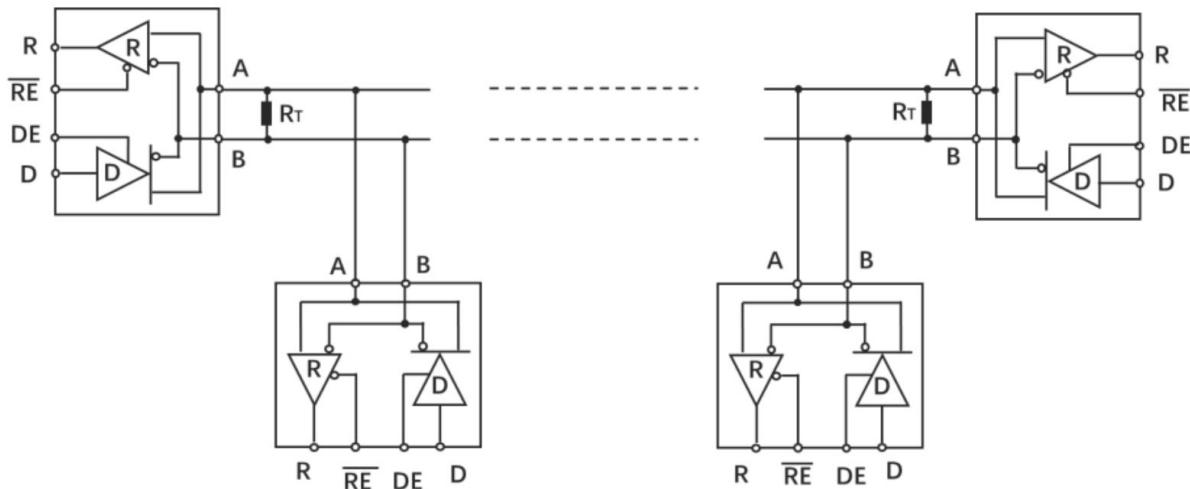
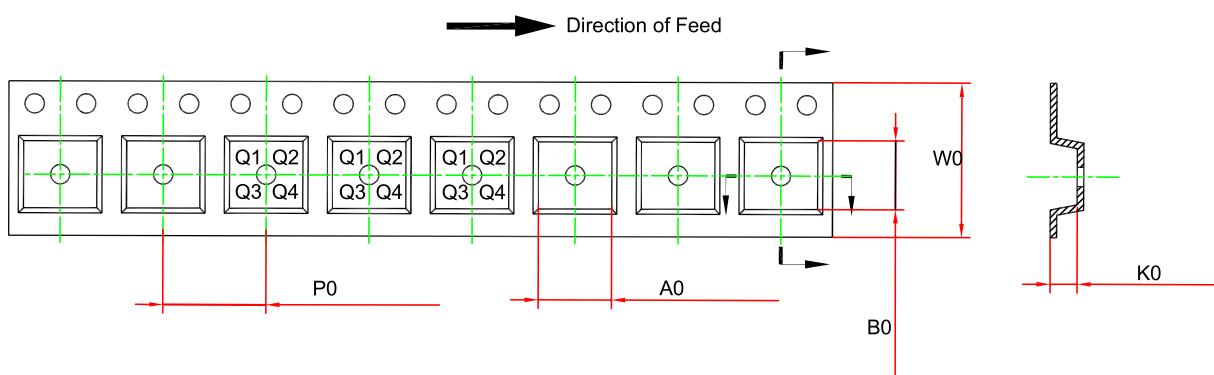
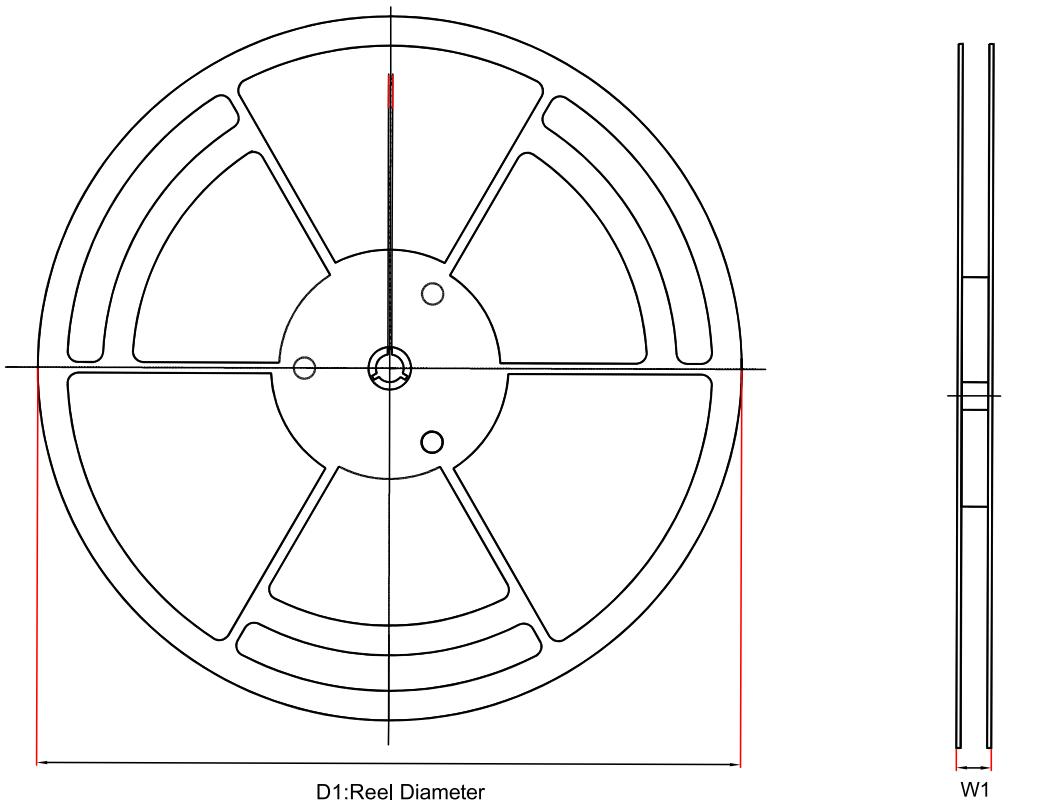


Figure 8. Typical Application Circuit

Tape and Reel Information



Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)⁽¹⁾	B0 (mm)⁽¹⁾	K0 (mm)⁽¹⁾	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPT481L1-SO1R	SOP8	330.0	17.6	6.5	5.4	2.0	8.0	12.0	Q1
TPT481-VS1R	MSOP8	330.0	17.6	5.3	3.4	1.3	8.0	12.0	Q1
TPT481L1-DF6R	DFN3X3-8	330.0	17.6	3.3	3.3	1.1	8.0	12.0	Q1

(1) The value is for reference only. Contact the 3PEAK factory for more information.

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.

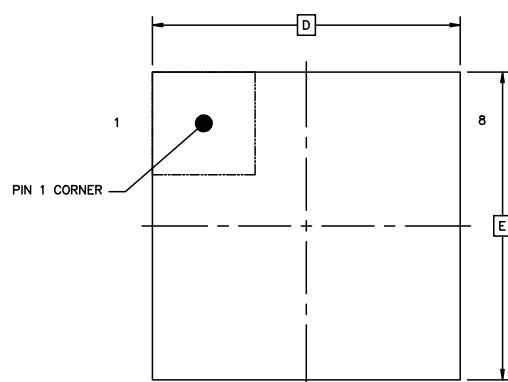
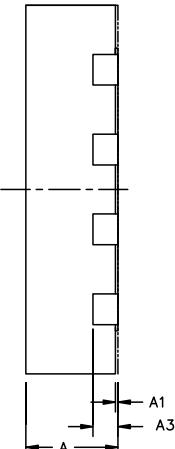
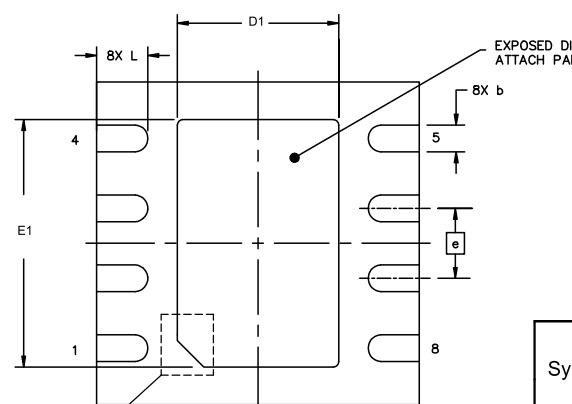
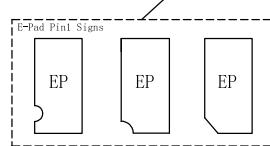
MSOP8

Package Outline Dimensions		VS1(MSOP-8-A)			
Symbol	Dimensions In Millimeters		Dimensions In Inches		
	MIN	MAX	MIN	MAX	
A	0.800	1.100	0.031	0.043	
A1	0.020	0.150	0.001	0.006	
A2	0.750	0.950	0.030	0.037	
b	0.250	0.380	0.010	0.015	
c	0.090	0.230	0.004	0.009	
D	2.900	3.100	0.114	0.122	
E	4.700	5.100	0.185	0.201	
E1	2.900	3.100	0.114	0.122	
e	0.650 BSC		0.026 BSC		
L	0.400	0.800	0.016	0.031	
θ	0	8°	0	8°	

NOTES

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

DFN3X3-8

Package Outline Dimensions		DF6(DFN3X3-8-A)			
TOP VIEW		SIDE VIEW			
					
					
Symbol	Dimensions In Millimeters		Dimensions In Inches		
	MIN	MAX	MIN	MAX	
A	0.700	0.800	0.028	0.031	
A1	0.000	0.050	0.000	0.002	
b	0.200	0.350	0.008	0.014	
A3	0.150	0.250	0.006	0.010	
D	2.900	3.100	0.114	0.122	
D1	1.400	1.600	0.055	0.063	
E	2.900	3.100	0.114	0.122	
E1	2.200	2.400	0.087	0.094	
e	0.650 BSC		0.026 BSC		
L	0.224	0.575	0.009	0.023	

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.
3. The many types of E-pad Pin1 signs may appear in the product.

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPT481L1-SO1R	-40 to 125°C	SOP8	T481	1	Tape and Reel, 4000	Green
TPT481-VS1R	-40 to 125°C	MSOP8	T481	3	Tape and Reel, 3000	Green
TPT481L1-DF6R	-40 to 125°C	DFN3X3-8	T481	1	Tape and Reel, 4000	Green

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

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