Features

- Exceeds Requirements of Full Duplex EIA-485 Standard
- Hot Plug Circuitry - Tx and Rx Outputs Remain Three-State During Power-up/Power-down
- Supply voltage: 3.0V ~ 5.5V
- Input Common-mode Range: -7V ~ +12 V
- Data Rate: 500 Kbps
- Up to 256 Nodes on a Bus (1/8 unit load)
- Full Fail-safe Receiver (Open, Short, Terminated)
- Bus-Pin Protection:
  - ±20 kV HBM ESD
  - ±12 kV IEC61000-4-2 Contact Discharge
  - ±15 kV IEC61000-4-2 Air Discharge
- –40°C to 125°C Operation Temperature Range

Applications

- Home Appliance
- Motor Drives
- Industrial Control
- Grid Infrastructure
- Video Surveillance
- Communication Infrastructure

Description

The TPT486/488 is IEC61000 ESD protected, which support ±12 kV IEC contact and ±15 kV IEC air discharge. 3.0V ~ 5.5V transceivers that meet the RS-485 and RS-422 standards for Full Duplex communication.

Transmitters in this family deliver exceptional differential output voltages into the RS-485 required 54Ω load. The 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.

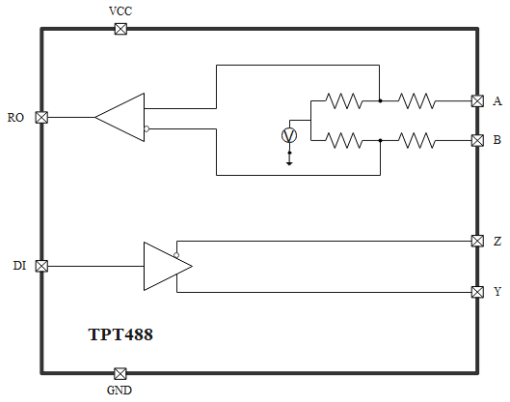
Receiver (Rx) inputs feature a “Full Fail-Safe” design, which ensures a logic high Rx output if Rx inputs are floating, shorted, or on a terminated but undriven bus.

The TPT486/488 is designed for full-duplex RS485, and support SOP14, SOP8 and DFN3X3-8 package, which is characterized from –40°C to 125°C.

Device Table

Part	Duplex	Enable	Data Rate	Package
TPT486	Full	Yes	500 Kbps	SOP14
TPT488	Full	Yes	500 Kbps	SOP8, DFN3X3-8

Simplified Schematic



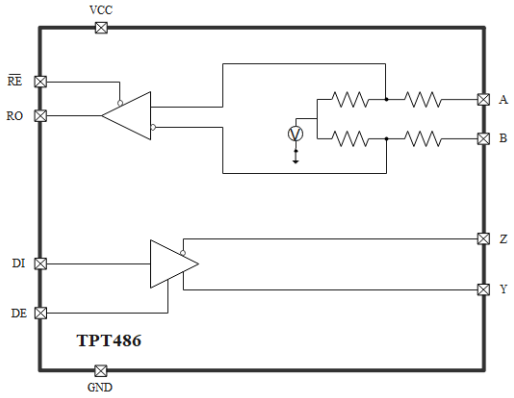
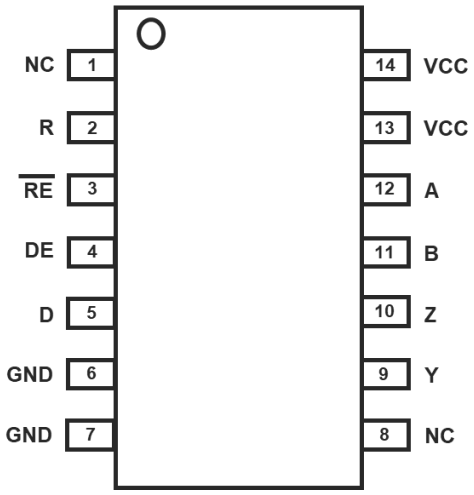


Table of Contents

Revision History

Date	Revision	Notes
2020/12/18	Rev. Pre.0	Definition version Pre.0
2022/02/11	Rev. Pre.1	Add electrical data
2022/06/18	Rev. Pre.2	Update ESD data
2023/01/30	Rev. A.0	Released version

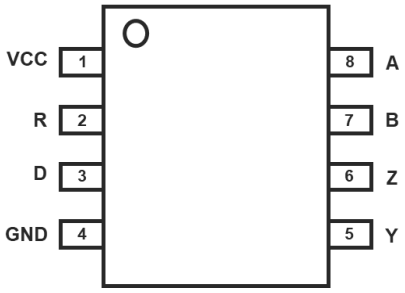
Pin Configuration and Functions – TPT486



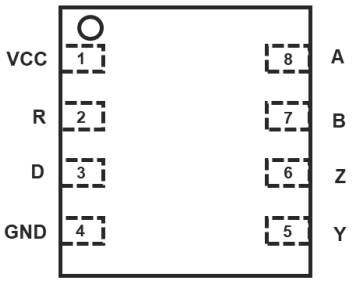
Pin No.	Pin Name	I/O	Description
1	NC		
2	R	Digital output	Receiver Output
3	/RE	Digital input	Receiver Output Enable
4	DE	Digital input	Driver Output Enable
5	D	Digital input	Driver Input
6	GND	Ground	Ground
7	GND	Ground	Ground
8	NC		
9	Y	Bus output	Noninverting Driver Output
10	Z	Bus output	Inverting Driver Output
11	B	Bus input	Inverting Receiver Input
12	A	Bus input	Noninverting Receiver Input
13	VCC	Power	Power Supply
14	VCC	Power	Power Supply

Pin Configuration and Functions – TPT488

SOP8



DFN3X3-8L



Pin No.	Pin Name	I/O	Description
1	VCC	Power	Power Supply
2	R	Digital output	Receiver Output
3	D	Digital input	Driver Input
4	GND	Ground	Ground
5	Y	Bus output	Noninverting Driver Output
6	Z	Bus output	Inverting Driver Output
7	B	Bus input	Inverting Receiver Input
8	A	Bus input	Noninverting Receiver Input

Functional Table

Driver Function Table

Input	Enable	Output	Output	Description
D	DE	Y	Z	
H	H	H	L	Actively drives bus High
L	H	L	H	Actively drives bus Low
X	L	Z	Z	Driver disabled
Open	H	H	L	Actively drives bus High by default

X = don't care

Z = high impedance

Receiver Function Table

Input	Input	Output	Description
A-B	/RE	R	
>-50mV	L	H	Receive valid bus High
-200mV<Input<-50mV	L	?	Indeterminate bus state
<-200mV	L	L	Receive valid bus Low
X	H	Z	Receiver disabled
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

Absolute Maximum Ratings

Parameters	Rating
VCC to GND	-0.3V to +7V
Voltage at Logic pin: D, DE, /RE, R	-0.3V to VCC + 0.3V
Voltage at Bus pin: A, B, Y, Z (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
VCC	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	VCC	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	±12	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	±20	kV
	All Pin Except Bus Pin	±4	kV
CDM, per ANSI/ESDA/JEDEC JS-002	All Pin	±1.5	kV

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
14-Pin SOIC	120	36	°C/W
8-Pin SOP	120	64	°C/W
8-Pin DFN	65	9	°C/W

Electrical Characteristics

All test condition is VCC = 3.3V~5.0V, T_A = -40 ~ +125°C, unless otherwise noted.

Symbol	Parameter	Test Conditions		Min		MAX	Unit
$\|V_{OD}\|$	Driver differential output voltage magnitude	R_L = 54 Ω , VCC=3.3V		1.5	2.2		V
		R_L = 54 Ω , VCC=5.0V		2.0	3.3		V
		R_L = 100 Ω, VCC = 3.3V		1.5	2.6		V
		R_L = 100 Ω, VCC = 5.0V		3.0	3.9		V
$\Delta\|V_{OD}\|$	Change in magnitude of driver	R_L = 54 Ω, C_L = 50 pF，375 Ω on A/B: –7 V to 12V, VCC=3.3V		–50		50	mV
$V_{OC(SS)}$	Steady-state common-mode output	Center of two 27-Ω load resistors		1	VCC/2	3	V
ΔV_{OC}	Change in differential driver output			–200		200	mV
C_{OD}	Differential output capacitance [1]				15		pF
V_{IT+}	Positive-going receiver differential				-110	–50	mV
$V_{IT–}$	Negative-going receiver differential			–200	–130		mV
V_{HYS}	Receiver differential input voltage threshold hysteresis (V_{IT+} – $V_{IT–}$) [1]				50		mV
V_{OH}	Receiver high-level output voltage	VCC = 3.3 V, I_{OH} = -8 mA		2.6	3.0		V
		VCC = 5 V, I_{OH} = -8 mA		4.1	4.8		
V_{OL}	Receiver low-level output voltage	VCC = 3.3 V, I_{OH} = -8 mA			0.19	0.4	V
		VCC = 5 V, I_{OH} = -8 mA			0.02	0.4	
V_{IH}	Input High Logic Leve	D, DE, /RE		2.0			V
V_{IL}	Input Low Logic Leve	D, DE, /RE				0.8	V
I_{IN}	Driver input, driver enable, and	D, DE, /RE		–5		5	μA
I_{OZ}	Driver output high-Z current	V_O = -7V		–100		0	μA
		V_O = 12V		0		125	
I_{OZ}	Receiver high-Z current	V_O = 0 V or VCC		–1		1	μA
I_{OS}	Driver short-circuit output current	VY, VZ= -7V ~ 12V		–250		250	mA
		VY, VZ =0V or VCC		-180		180	mA
$I_{IA/B}$	Bus input current (disabled driver)	DE = 0 V, RE=VCC	V_I = 12 V,		55	125	μA
			V_I = –7 V,	-100	-50		μA
I_{CC}	Supply current (quiescent), 500Kbps	Driver and Receiver enabled	DE=VCC, RE = GND, No load			1000	μA
		Driver enabled, receiver disabled	DE=VCC, RE = VCC, No load		400	1000	μA
		Driver disabled, receiver enabled	DE=GND, RE = GND, No load		400	1000	μA
		Driver and receiver disabled	DE=GND, RE = VCC, No load	-5		5	μA

Note:

[1]. The parameters are provided by lab bench test and design simulation

Switching Characteristics, VCC= 5.0V

Parameter		Conditions		Min	Typ	Max	Units
Driver							
t_r, t_f	Driver differential-output rise and fall times [1]	RL = 54 Ω, CL=50pF	See Figure 2		470		ns
t_{PHL}, t_{PLH}	Driver propagation delay				450	600	
$t_{SK(P)}$	Driver pulse skew, $\|t_{PHL} - t_{PLH}\|$ [1]				6		
t_{PHZ}, t_{PLZ}	Driver disable time	/RE=0 or VCC	See Figure 3		61	100	ns
t_{PZH}, t_{PZL}	Driver enable time	Receiver enabled			216	500	ns
		Receiver disabled			1960	4000	
Receiver							
t_r, t_f	Driver differential-output rise and fall times [1]				15		ns
t_{PHL}, t_{PLH}	Receiver propagation delay time				100	150	ns
$t_{SK(P)}$	Receiver pulse skew, $\|t_{PHL} - t_{PLH}\|$ [1]				5		
t_{PHZ}, t_{PLZ}	Receiver disable time	DE=0 or VCC	See Figure 6		20	50	ns
t_{PZL}, t_{PZH}	Receiver enable time	Driver enabled			25	50	ns
		Driver disabled			1760	4000	

Note:

[1]. The parameters are provided by lab bench test and design simulation

Switching Characteristics, VCC=3.3V

Parameter		Conditions		Min	Typ	Max	Units
Driver							
t_r, t_f	Driver differential-output rise and fall times [1]	RL = 54 Ω, CL=50pF	See Figure 2		460		ns
t_{PHL}, t_{PLH}	Driver propagation delay				460	700	
$t_{SK(P)}$	Driver pulse skew, $\|t_{PHL} - t_{PLH}\|$ [1]				4		
t_{PHZ}, t_{PLZ}	Driver disable time	/RE=0 or VCC	See Figure 3		67	200	ns
t_{PZH}, t_{PZL}	Driver enable time	Receiver enabled			350	1000	ns
		Receiver disabled			2870	4000	

Parameter		Conditions		Min	Typ	Max	Units
Receiver							
t_r, t_f	Driver differential-output rise and fall times [1]				20		ns
t_{PHL}, t_{PLH}	Receiver propagation delay time				115	200	ns
$t_{SK(P)}$	Receiver pulse skew, $\|t_{PHL} - t_{PLH}\|$ [1]				8		
t_{PHZ}, t_{PLZ}	Receiver disable time	DE=0 or VCC	See Figure 6		21	40	ns
t_{PZL}, t_{PZH}	Receiver enable time	Driver enabled			33	50	ns
		Driver disabled			2560	4000	

Note:

[1]. The parameters are provided by lab bench test and design simulation

Test Circuits and Waveforms

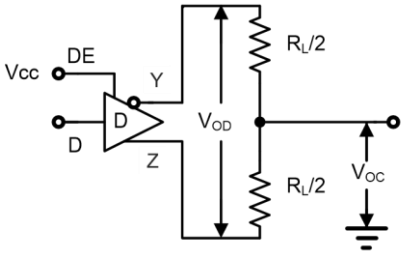


Figure 1A. VOD and VOC

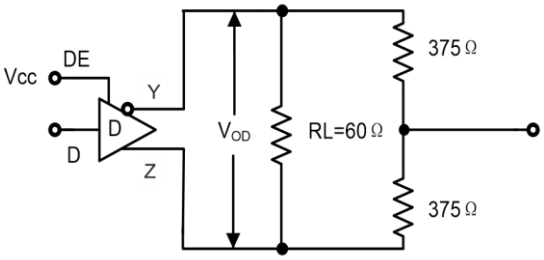


Figure 1B. VOD with Common Mode Load

Figure 1. DC Driver Test Circuits

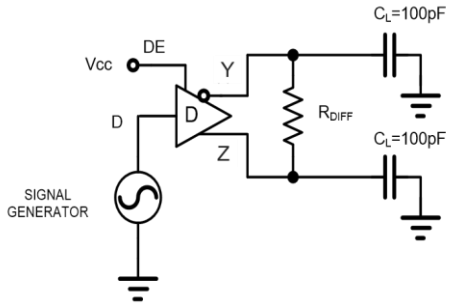


Figure 2A. Test Circuit

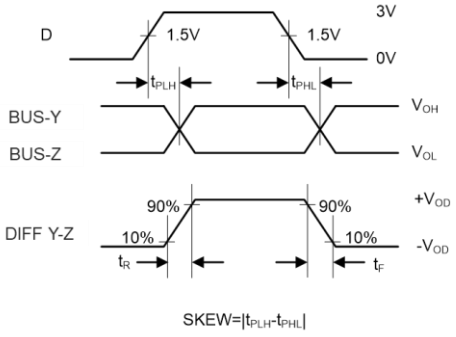


Figure 2B. Measurement Points

Figure 2. Driver Propagation Delay and Differential Transition Times

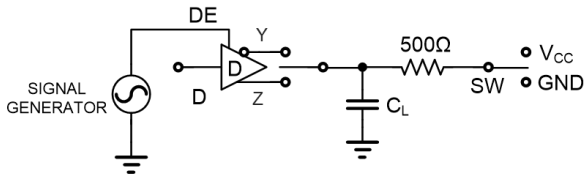


Figure 3A. Test Circuit

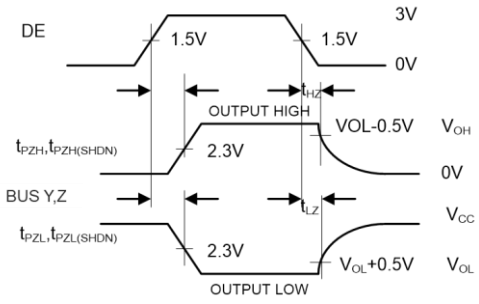


Figure 3B. Measurement Points

PARAMETER	OUTPUT	RE	DI	SW	CL (pF)
tPHZ	Y/Z	X	1/0	GND	15
tPLZ	Y/Z	X	0/1	VCC	15
tPZH	Y/Z	0	1/0	GND	100
tPZL	Y/Z	0	0/1	VCC	100
tPZH(SHDN)	Y/Z	1	1/0	GND	100
tPZL(SHDN)	Y/Z	1	0/1	VCC	100

Figure 3. Driver Enable and Disable Times

Test Circuits and Waveforms (continue)

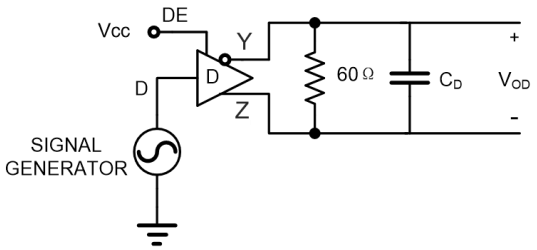


Figure 4A. Test Circuit

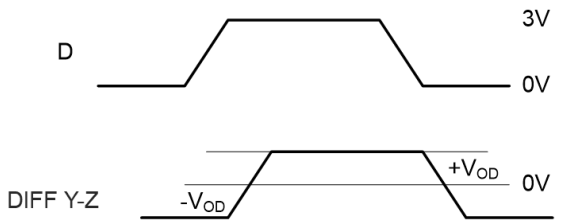


Figure 4B. Measurement Points

Figure 4. Driver Data rate

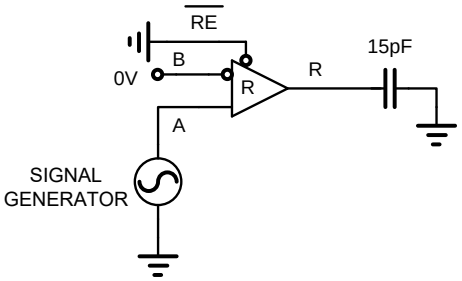


Figure 5A. Test Circuit

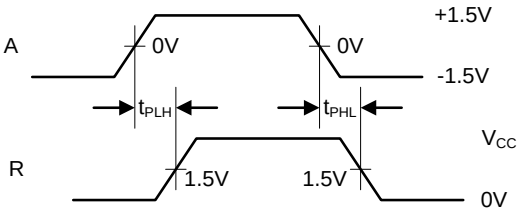
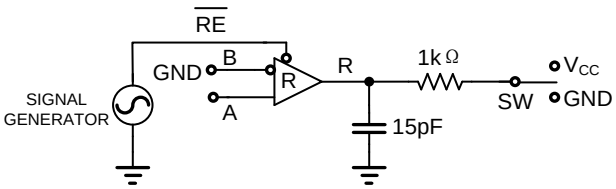


Figure 5B. Measurement Points

Figure 5. Receiver Propagation Delay and Data rate



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 6A. Test Circuit

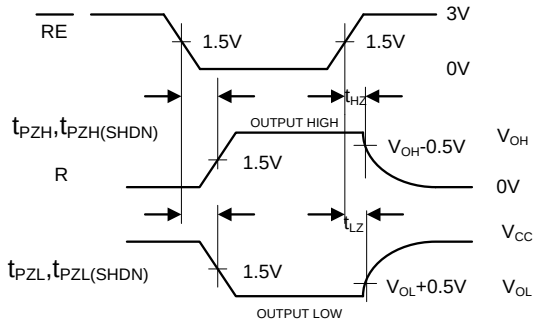
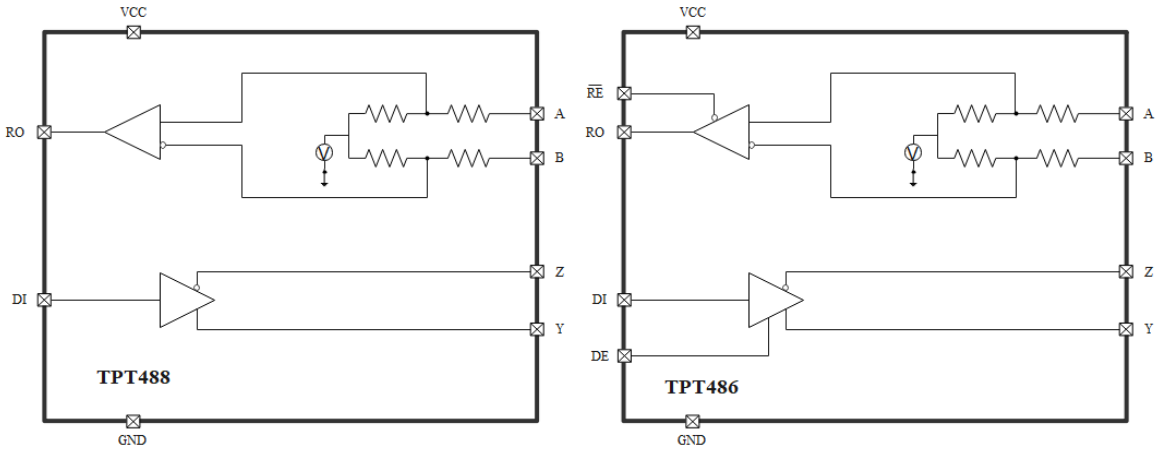


Figure 6B. Measurement Points

Figure 6. Receiver Enable and Disable Times

Function Block diagram:



Theory of Operation

General description

The TPT486/488 is a Full-Duplex RS-485/RS-422 transceivers with robust HBM and IEC 61000 ESD protection. The device build in fail-safe circuit, when the receiver input is open or shorted, or idle mode, it will generate a logic-high receiver output. The TPT486/488 supports hot-swap function allowing line insertion to avoid wrong data transmission, and optimizes the drivers slew-rate to minimize EMI and reduce reflections caused by different terminated cables, then TPT486/488 can support the high communication speed up to 500 Kbps.

The TPT486/488 operates from a single +3.3V to 5.0V power supply, the driver is designed with output short-circuit current limitation, together with thermal-shutdown circuitry to protect drivers in the status of excessive power dissipation. In active mode, the thermal-shutdown circuitry places the driver outputs into a high-impedance state.

In the typical RS485 communication, twisted-pair lines are connected backward in the network.

Application Information

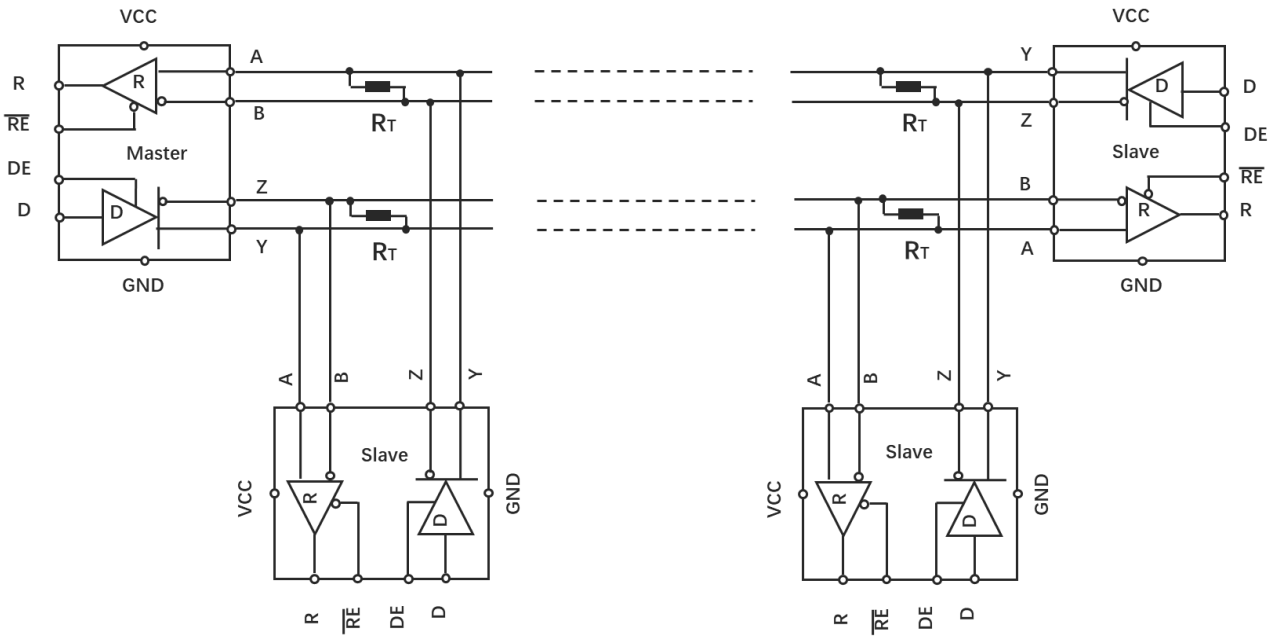
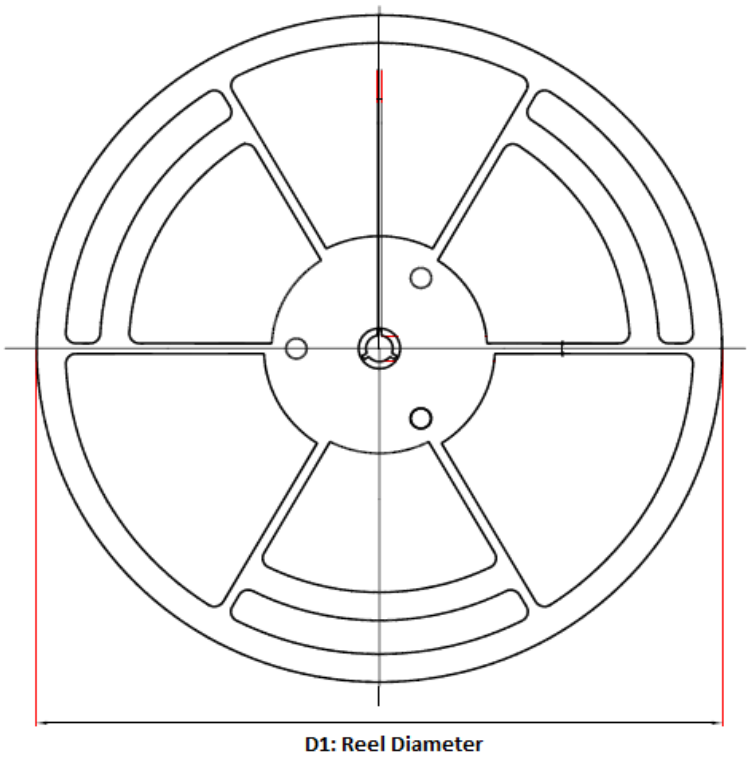
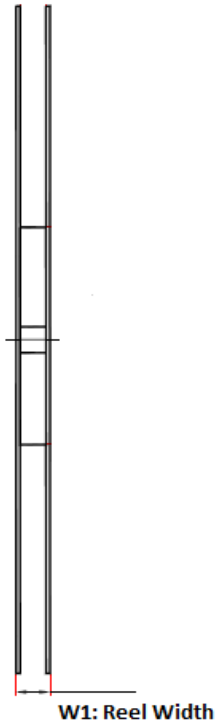


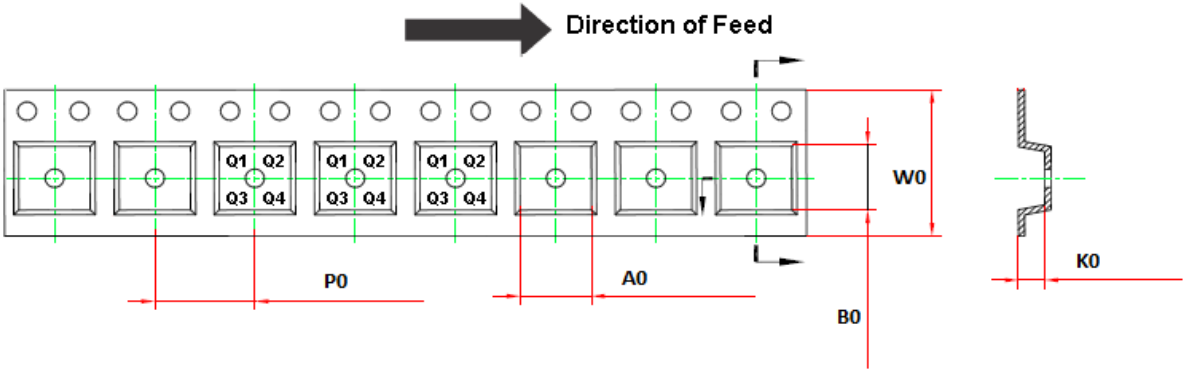
Figure 7. Typical RS485 communication network with enable function

The TPT486/488 transceiver is designed for bidirectional RS485/422 data communications on multipoint bus transmission lines. Figures 7 shows typical network applications circuit to support up to 256 nodes. To minimize line reflections, terminate the line at both ends in its characteristic impedance, one 120ohm load in master side, and another 120ohm load in the end of slave side, and limit stub lengths off the main line as short as possible.

Tape and Reel Information





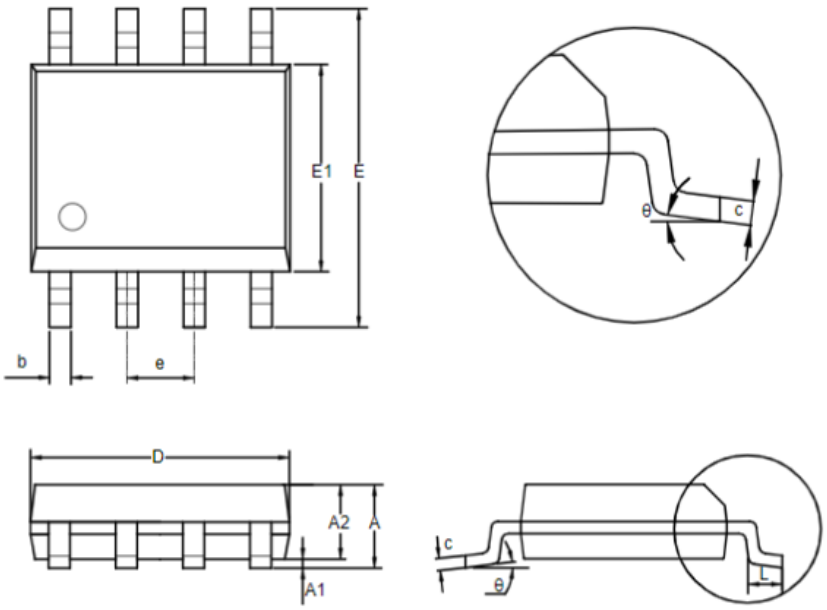


Order Number	Package	D1	W1	A0	B0	K0	P0	W0	Pin1 Quadrant
TPT486-SO2R	14-Pin SOP	330.0	21.6	6.5	9.0	2.1	8.0	16.0	Q1
TPT488L1-SO1R	8-Pin SOP	330.0	17.6	6.4	5.4	2.1	8.0	12.0	Q1
TPT488-DF6R	DFN3X3-8L	330.0	17.6	3.3	3.3	1.1	8.0	12.0	Q1

Package Outline Dimensions

SO1R (SOP8)

Package Outline Dimensions SO1(SOP-8-A)



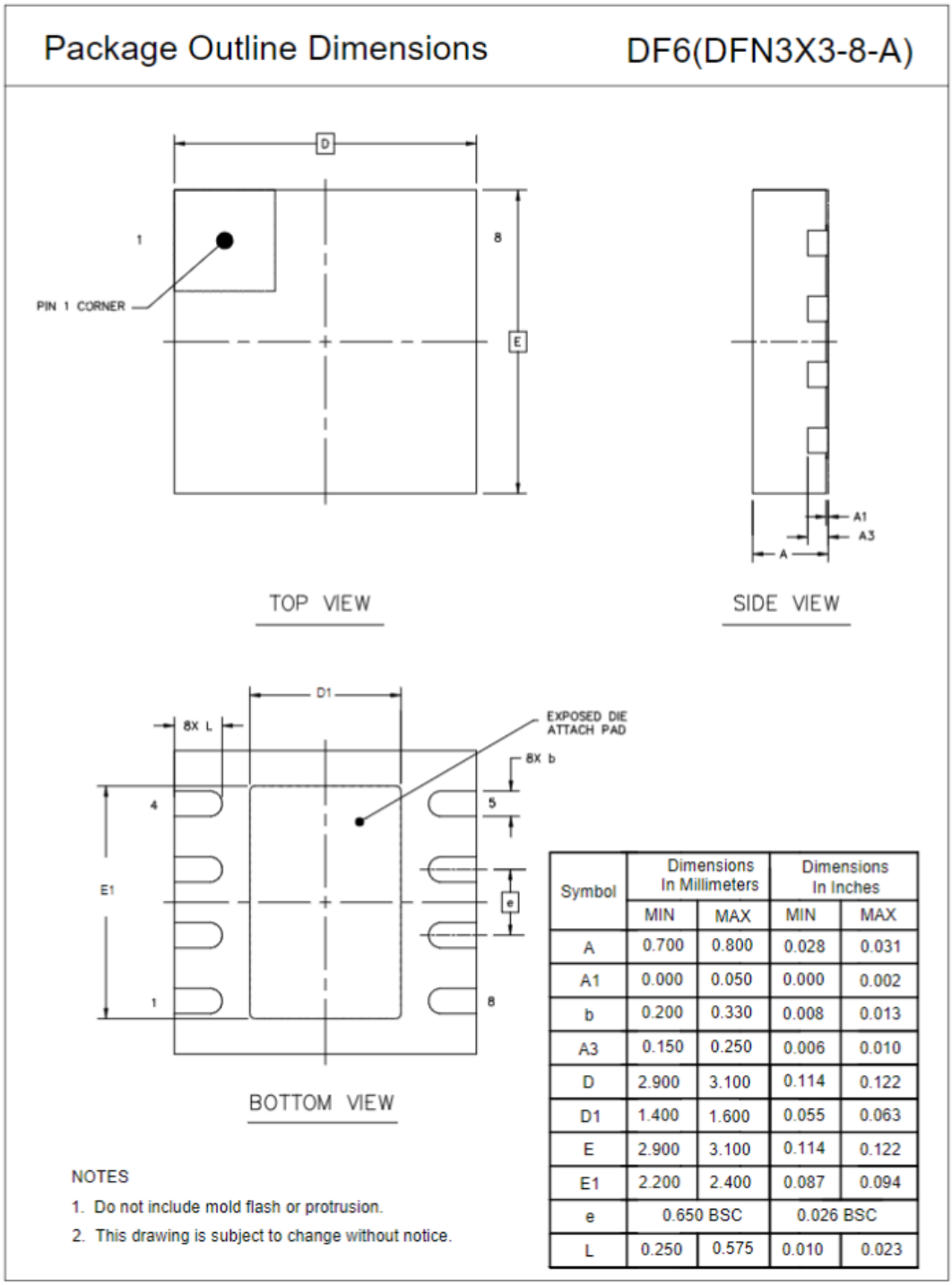
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.550	0.049	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050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

Package Outline Dimensions

DF6R (DFN3x3-8L)

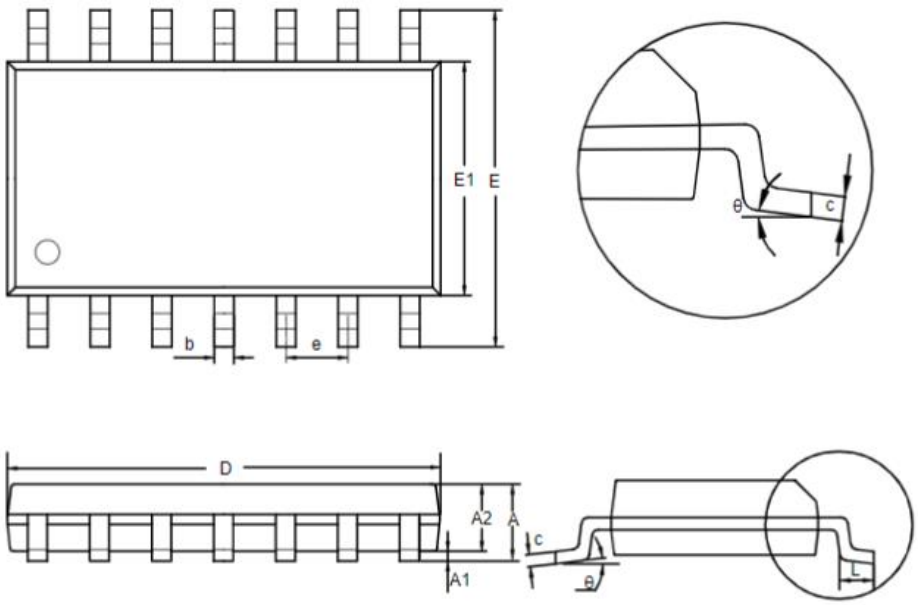


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
b	0.200	0.330	0.008	0.013
A3	0.150	0.250	0.006	0.010
D	2.900	3.100	0.114	0.122
D1	1.400	1.600	0.055	0.063
E	2.900	3.100	0.114	0.122
E1	2.200	2.400	0.087	0.094
e	0.650 BSC		0.026 BSC	
L	0.250	0.575	0.010	0.023

Package Outline Dimensions

SO2R (SOP14)

Package Outline Dimensions SO2(SOP-14-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	1.650	0.049	0.065
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D	8.450	8.850	0.333	0.348
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	1.270	0.016	0.050
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
TPT486-SO2R	-40 to 125°C	14-Pin SOP	T486	MSL3	Tape and Reel, 2,500	Green
TPT488L1-SO1R	-40 to 125°C	8-Pin SOP	T488	MSL1	Tape and Reel, 4000	Green
TPT488-DF6R (1)	-40 to 125°C	8-Pin DFN	T488	MSL3	Tape and Reel, 4000	Green

(1) Future product, contact 3PEAK factory for more information and sample

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

IMPORTANT NOTICE AND DISCLAIMER