3-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: 500 Kbps
- Up to 256 Nodes on a Bus (1/8 Unit Load) at 500 kbps
- 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
- Operation Temperature Range: –40°C to 125°C

Applications

- Motor Drives
- Industrial Control
- Communication Infrastructure

Description

The TPT487 is a series of IEC 61000 ESD-protected, 3-V to 5.5-V powered transceivers that meet the RS-485 and RS-422 standards for balanced communication.

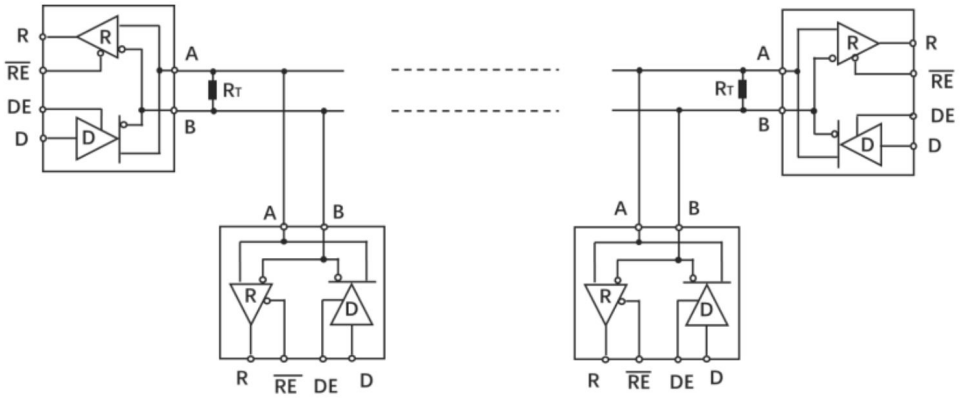
Transmitters in this family deliver exceptional differential output voltages into the RS-485 required 54-Ω load. These 500-kbps devices have very low bus currents, so they present a true "1/8 unit load" to the RS-485 bus. This allows up to 256 transceivers on the network without using repeaters. Receiver (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 TPT487 transceivers are designed for half-duplex RS-485, and support the SOP8, MSOP8, and DFN3X3-8 packages, which are characterized from –40°C to 125°C.

Device Table

Part	Duplex	Enable	Data Rate	Nodes
TPT487	Half	Yes	500 Kbps	256

Typical Application Circuit



TPT487 Network

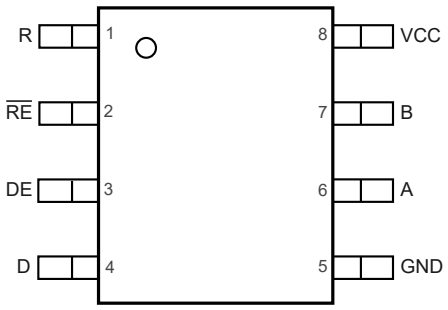
Table of Contents

Revision History

Date	Revision	Notes
2019-01-14	Rev.Pre.0	Initial version.
2019-06-15	Rev.Pre.1	Updated the package information.
2019-09-17	Rev.A.0	Released version.
2020-03-20	Rev.A.1	Updated the Absolute Maximum Ratings.
2023-05-10	Rev.A.2	Added the Thermal Information.
2024-12-24	Rev.A.3	Updated to a new datasheet format. Updated the POD. Added Tape and Reel Information.

Pin Configuration and Functions

TPT487
SOP8/MSOP8
Top View



TPT487
DFN3X3-8
Top View

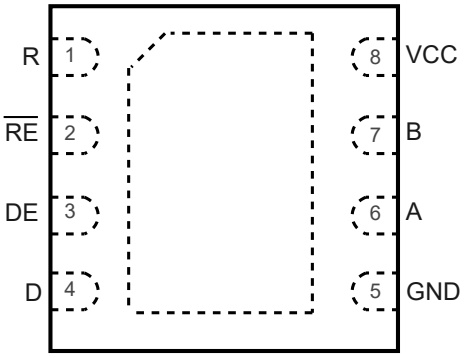


Table 1. Pin Functions

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	V_{CC}	Power	Power supply.

Functional Table

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

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 (2)		−0.3	V_{CC} + 0.3	V
Voltage at Bus Pin: A, B as Receiver and Idle		−15	15	V
Voltage at Bus pin: A, B as Driver		−8	13	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.

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		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.

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	18	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.

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
SOP8	120	64	°C/W
MSOP8	135	68	°C/W
DFN3X3-8	65	23	°C/W

Electrical Characteristics

All test conditions: V_{CC} = 5 V, over operating free-air temperature range, unless otherwise noted.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Driver							
$\|V_{OD}\|$	Driver Differential-Output Voltage Magnitude, V_{CC} = 3.3 V	R_L = 60 Ω, −7 V ≤ V_{test} ≤ +12 V	See Figure 1B	1.5	2.3		V
		R_L = 54 Ω (RS-485)	See Figure 1A	1.5	2.2		
		R_L = 100 Ω (RS-485)		2.0	2.6		
	Driver Differential-Output Voltage Magnitude, V_{CC} = 5.0 V	R_L = 60 Ω, −7 V ≤ V_{test} ≤ +12 V	See Figure 1B	2.0	3.5		
		R_L = 54 Ω (RS-485)	See Figure 1A	2.0	3.4		
		R_L = 100 Ω (RS-485)		2.7	3.9		
$\Delta\|V_{OD}\|$	Change in Magnitude of Driver Differential-Output Voltage	R_L = 54 Ω, C_L = 50 pF	See Figure 1A	–50		50	mV
		R_L = 100 Ω, C_L = 50 pF	See Figure 1A	–50		50	
$V_{OC\ (SS)}$	Steady-State 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			–65		65	mV
$V_{OC\ (PP)}$	Peak-to-Peak Driver Common-Mode Output Voltage				600		
$\|I_{OS}\|$	Driver Short-Circuit Output Current	$\|I_{OS}\|$ with A shorted to B			86	110	mA
		$\|I_{OS}\|$ with −7 V to +12 V		−220		220	
Receiver							
V_{IT+}	Positive-Going Receiver Differential-Input Voltage Threshold				−100	–15	mV
V_{IT-}	Negative-Going Receiver Differential-Input Voltage Threshold			–240	−150		mV
V_{HYS} (1)	Receiver Differential-Input Voltage Threshold Hysteresis (V_{it+} – V_{it-})				60		mV
V_{IH}	Logic Input High Voltage	DI, DE, $\overline{RE}$		2			V
V_{IL}	Logic Input Low Voltage	DI, DE, $\overline{RE}$				0.8	V
V_{OH}	Receiver High-Level Output Voltage	I_{OH} = −8 mA		4	V_{CC} − 0.3		V
V_{OL}	Receiver Low-Level Output Voltage	I_{OL} = 8 mA			0.2	0.4	V

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
I_{in}	DE = 0, V_{CC} = 0 or V_{CC} = 5.5 V (A, B)	V_I = 12 V			30	120	μA
		V_I = −7 V		−100	−50		μA
RA, RB	Bus Input Impedance	V_A = −7 V, V_B = 12 V or V_A = 12 V, V_B = −7 V		96			kΩ
I_{OZ}	Receiver High-Impedance Output Current	V_O = 0 V or V_{CC}, $\overline{RE}$ at V_{CC}		–1		1	μA
I_{OSR}	Receiver Output Short to Ground Current	REN = 0, DE = V_{CC}			78	95	mA
Logic							
Iin	Input current ($\overline{RE}$, DE, D)	4.5 V < V_{CC} < 5.5 V		−5		5	μA
Supply							
I_{CC}	Supply Current (Quiescent)	Driver and receiver enabled	DE = V_{CC}, $\overline{RE}$ = GND, no load		650	750	μA
		Driver enabled, receiver disabled	DE = $\overline{RE}$ = V_{CC}, no load		450	600	
		Driver disabled, receiver enabled	DE = GND, $\overline{RE}$ = V_{CC}, no load		450	600	
		Driver and receiver disabled	DE = GND, $\overline{RE}$ = D = V_{CC}, no load		0.5	2	

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		300		ns
t_{PHL}, t_{PLH}	Driver Propagation Delay			230	280	410	
$t_{SK(P)}$	Driver Pulse Skew, $\|T_{phl} - T_{plh}\|$					20	
t_{PHZ}, t_{PLZ}	Driver Disable Time	$\overline{RE}$ = 0, $\overline{RE}$ = V_{CC}	See Figure 3		50	90	ns
t_{PZH}, t_{PZL}	Driver Enable Time	$\overline{RE}$ = 0			200	450	ns
		$\overline{RE}$ = V_{CC}			2750	3200	
Receiver							
t_r, t_f	Receiver Rise and Fall Time				28		
t_{PHL}, t_{PLH}	Receiver Propagation Delay Time	C_L = 15 pF	See Figure 5		100	150	ns
$t_{SK\ (P)}$	Receiver Pulse Skew, $\|T_{phl} - T_{plh}\|$					25	
t_{PHZ}, t_{PLZ}	Driver Disable Time	$\overline{RE}$ = 0, $\overline{RE}$ = V_{CC}	See Figure 6		20	65	ns
t_{PZL}	Receiver Enable Time	DE = V_{CC}	See Figure 6		20	50	ns
t_{PZH}	Receiver Enable Time	DE = V_{CC}	See Figure 6		127	200	ns
t_{PZH}, t_{PZL}	Receiver Enable Time	DE = 0	See Figure 6		2600	3200	ns

Test Circuits and Waveforms

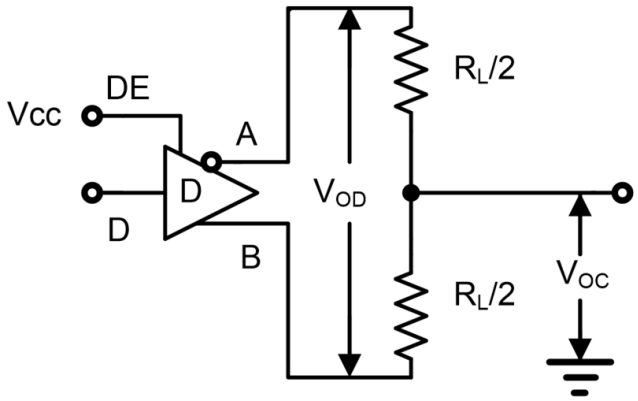


Figure 1A. V_{OD} and V_{OC}

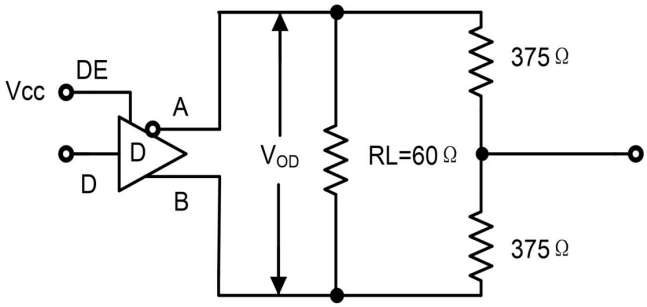


Figure 1B. V_{OD} with Common-Mode Load

Figure 1. DC Driver Test Circuits

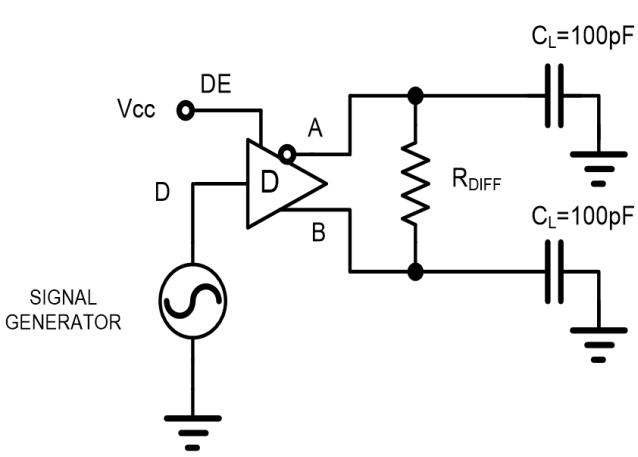


Figure 2A. Test Circuit

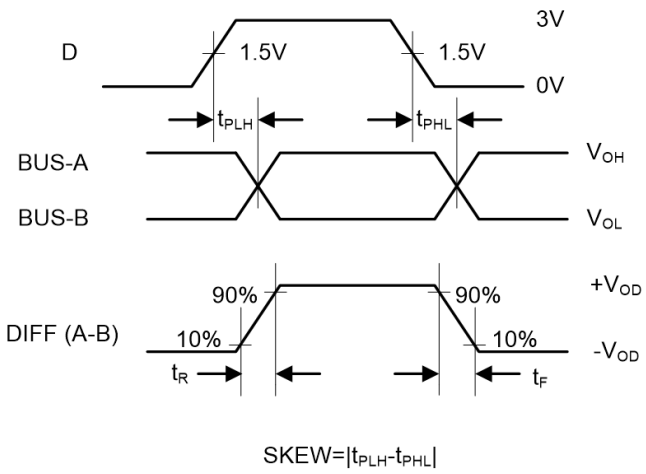
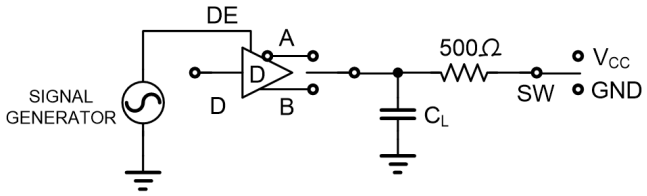


Figure 2B. Measurement Points

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

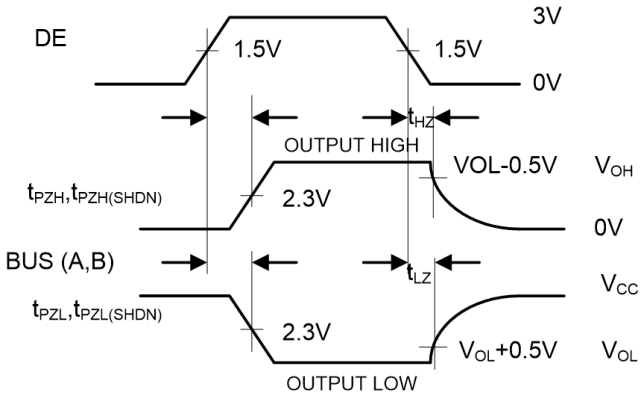


Figure 3B. Measurement Points

Figure 3. Driver Enable and Disable Times

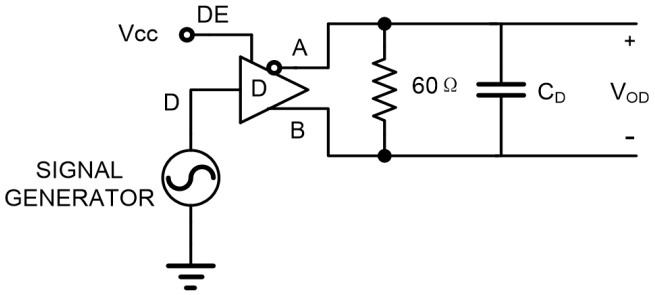


Figure 4A. Test Circuit

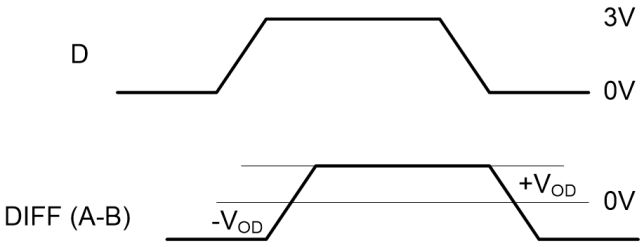


Figure 4B. Measurement Points

Figure 4. Driver Data Rate

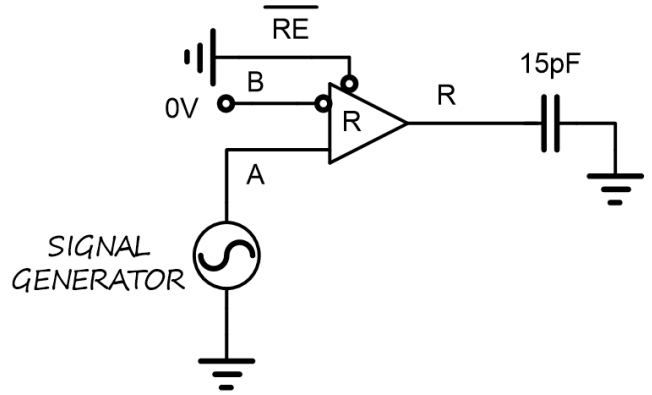


Figure 5A. Test Circuit

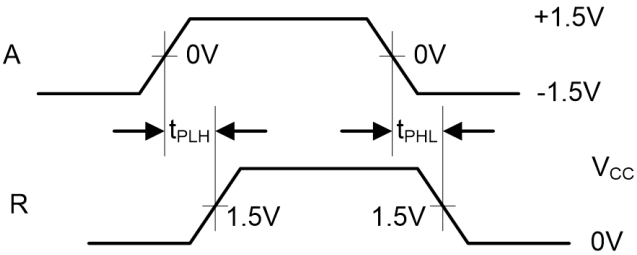
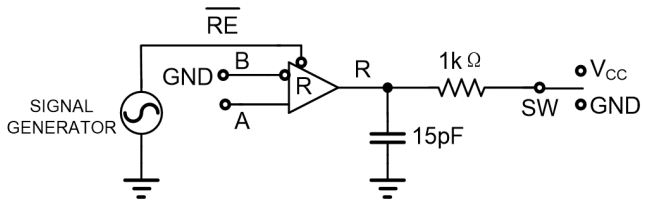


Figure 5B. Measurement Points

Figure 5. Receiver Propagation Delay and Data Rate



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

Figure 6A. Test Circuit

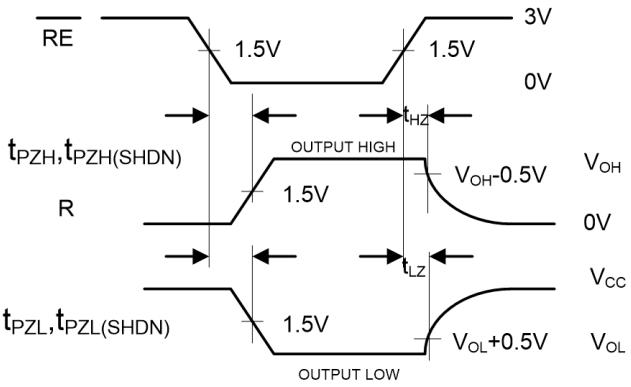
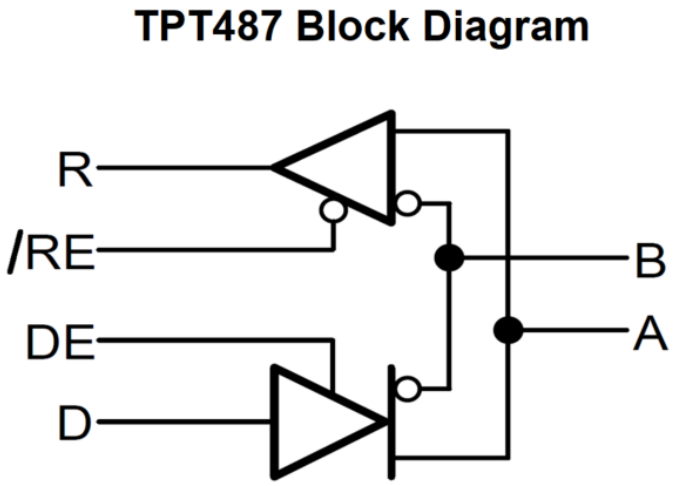


Figure 6B. Measurement Points

Figure 6. Receiver Enable and Disable Times

Detailed Description

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 7 shows the typical application schematic.

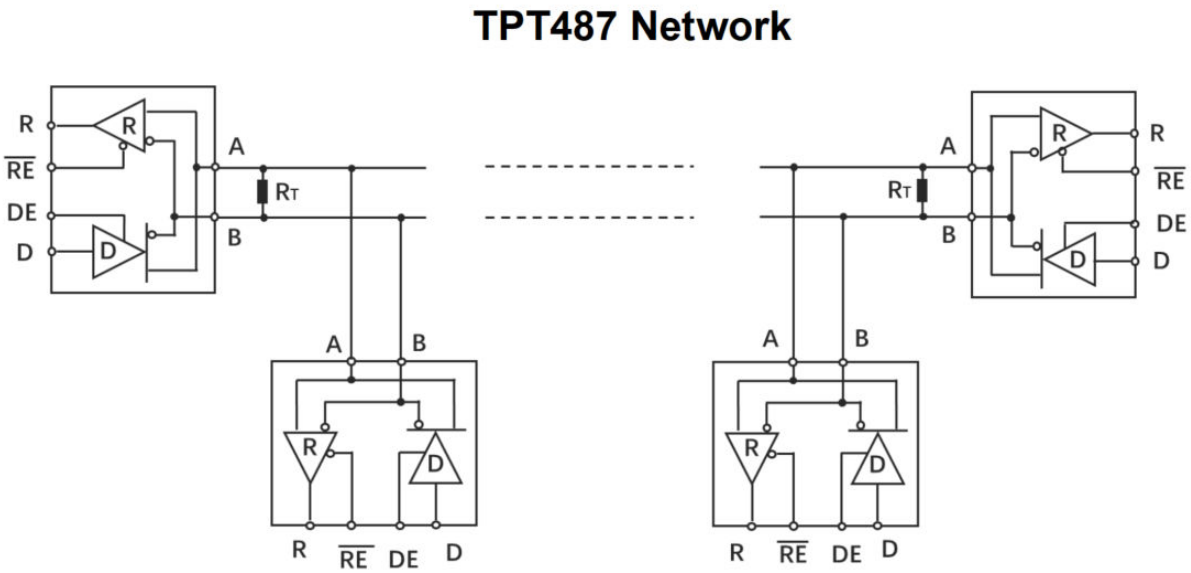
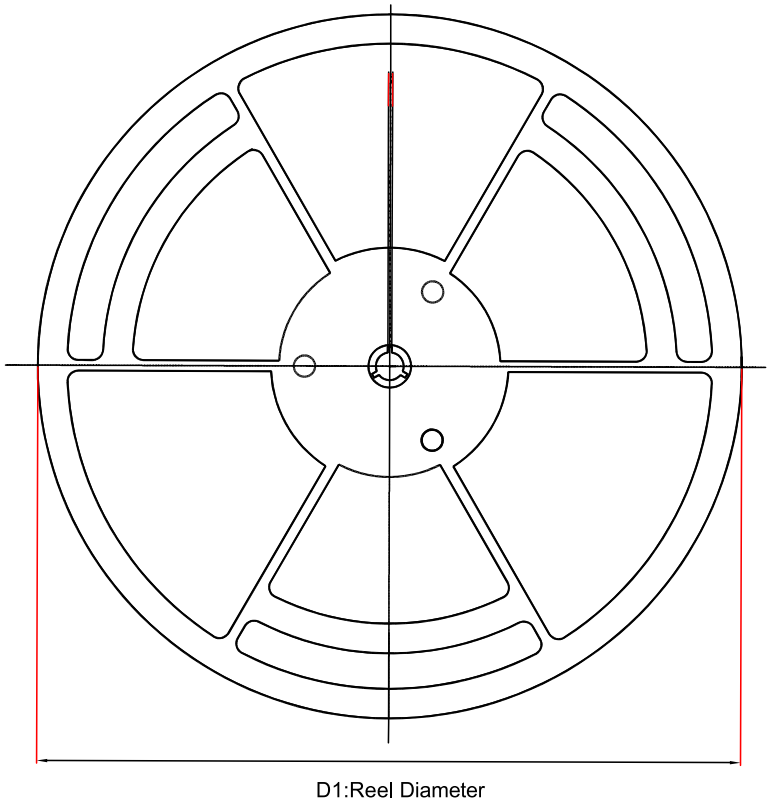
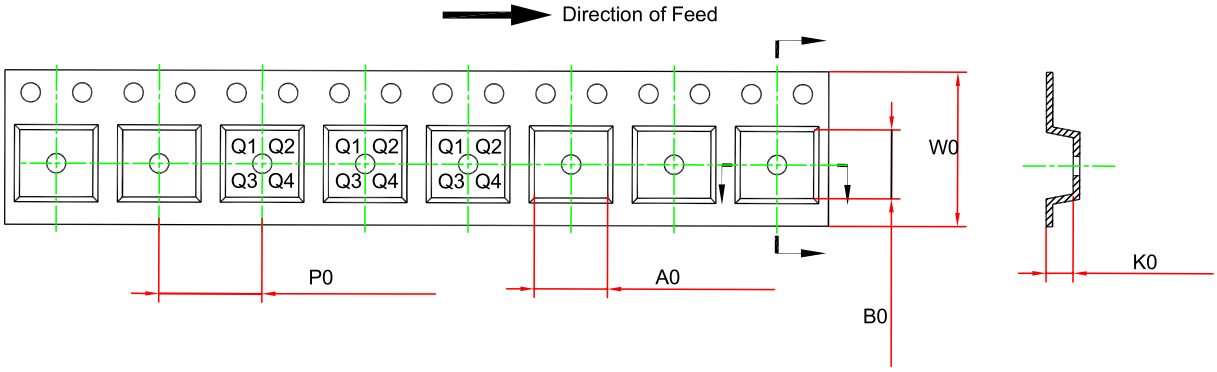


Figure 7. Typical Application Circuit

Tape and Reel Information





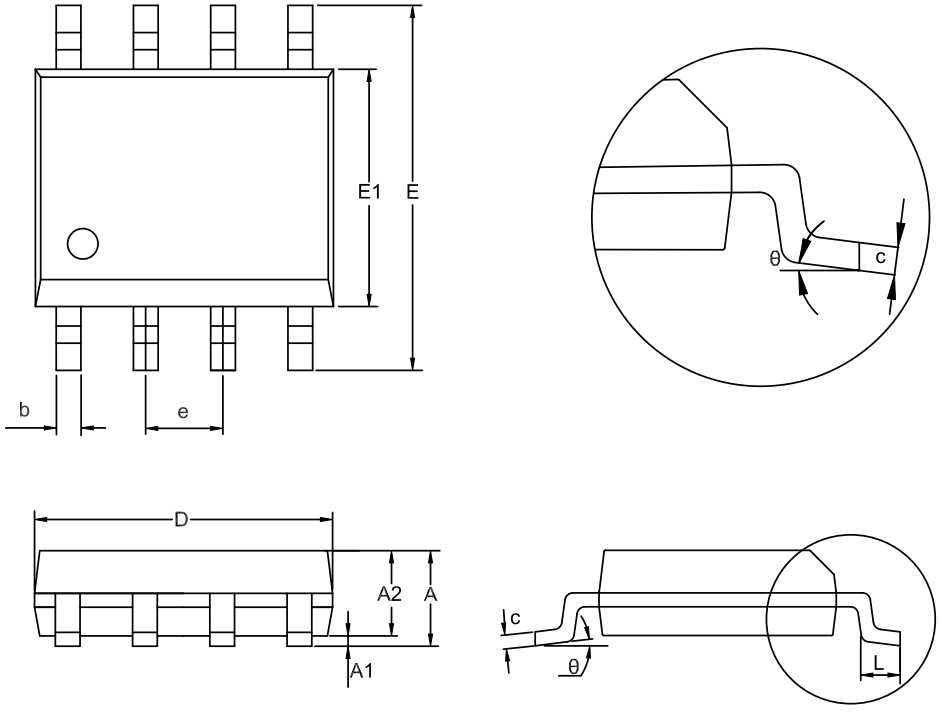
Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) (1)	B0 (mm) (1)	K0 (mm) (1)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPT487L1-SO1R	SOP8	330.0	17.6	6.5	5.4	2.0	8.0	12.0	Q1
TPT487-VS1R	MSOP8	330.0	17.6	5.3	3.4	1.3	8.0	12.0	Q1
TPT487L1-DF6R	DFN3X3-8	330.0	17.6	3.3	3.3	1.1	8.0	12.0	Q1

(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)



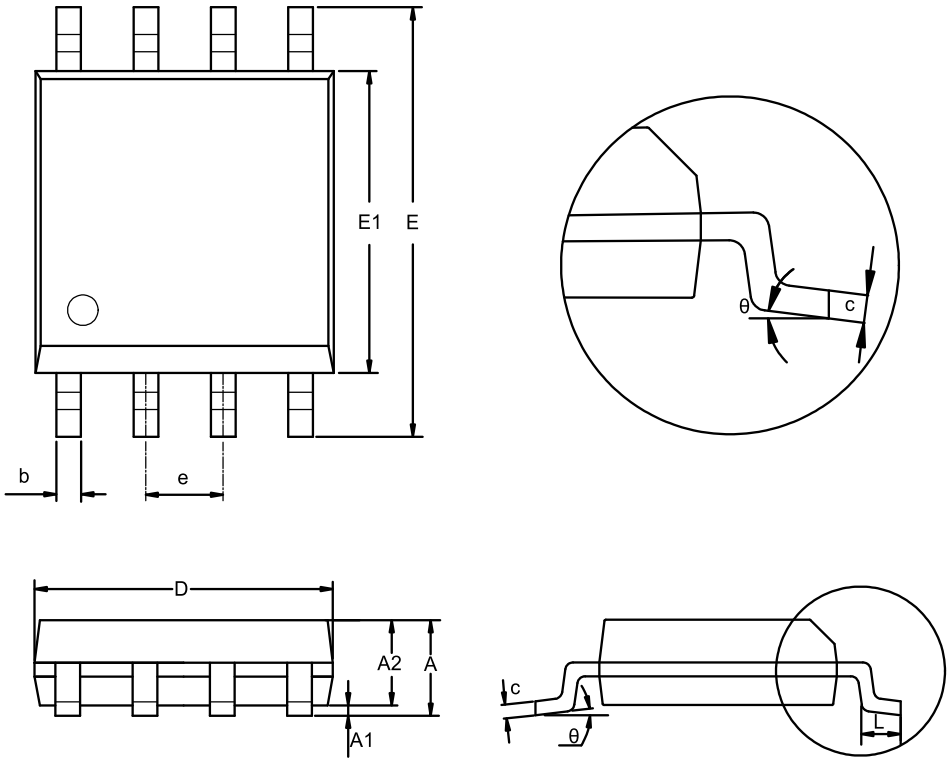
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.550	0.049	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050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



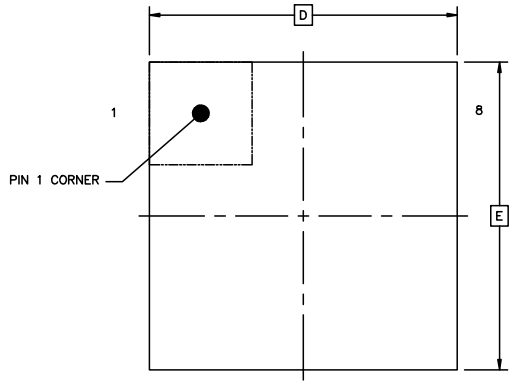
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.800	1.100	0.031	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	4.700	5.100	0.185	0.201
E1	2.900	3.100	0.114	0.122
e	0.650 BSC		0.026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

NOTES

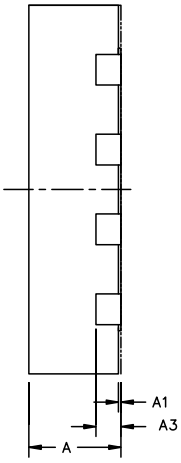
1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

DFN3X3-8

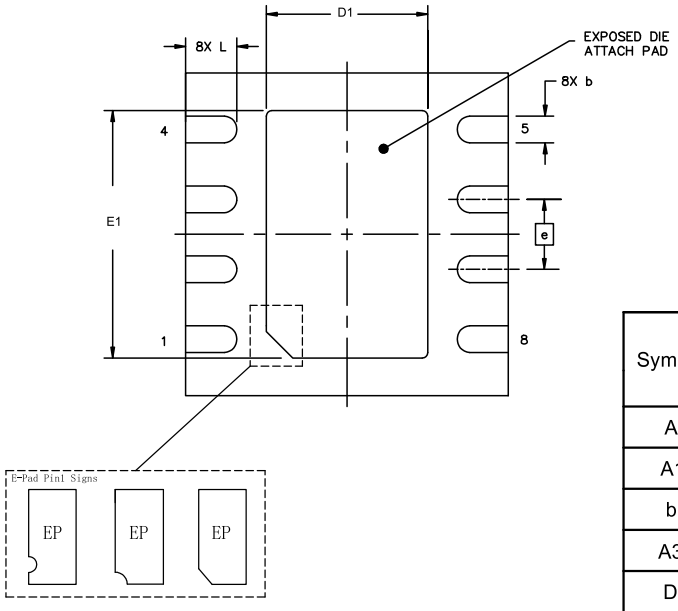
Package Outline Dimensions DF6(DFN3X3-8-A)



TOP VIEW



SIDE VIEW



BOTTOM VIEW

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.

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

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPT487L1-SO1R	−40 to 125°C	SOP8	T487	1	Tape and Reel, 4000	Green
TPT487-VS1R	−40 to 125°C	MSOP8	T487	3	Tape and Reel, 3000	Green
TPT487L1-DF6R	−40 to 125°C	DFN3X3-8	T487	1	Tape and Reel, 4000	Green

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

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