±12-kV ESD Protected, 10-Mbps, Full Fail-Safe, RS-485 Transceivers

Features

- High Data Rates:
  10 Mbps at 5-V Supply
- 35-ns Tx/Rx Propagation Delays
- 10-ns (Typ) Skew
- Full Fail-Safe (Open, Short, and Terminated) Receivers
- Up to 128 Nodes on a Bus (1/4 Unit Load)
- Wide Supply Voltage: 3 V to 5.5 V
- Low Quiescent Supply Current: 3 mA
- Bus-Pin Protection:
  - ±12-kV IEC-ESD Contact
  - ±15-kV IEC-ESD Air-discharge
- Pb-Free

Applications

- PROFIBUS® DP and FMS Networks
- SCSI "Fast 40" Drivers and Receivers
- Motor Controller/Position Encoder Systems
- Factory Automation
- Field Bus Networks
- Industrial/Process Control Networks

Description

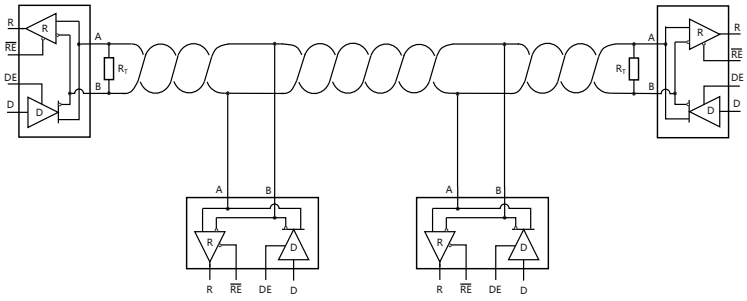
The TPT75176A and TPT75176B are enhanced RS485 transceivers which exceed the standard TIA/EIA-485-A with a ±12-kV ESD protected, 3-V to 5.5-V powered, and single transceiver for balanced communication. These devices also feature larger output voltages and higher data rate (up to 10 Mbps) required by high-speed PROFIBUS applications, and are offered in industrial and extended industrial (−40°C to +125°C) temperature ranges.

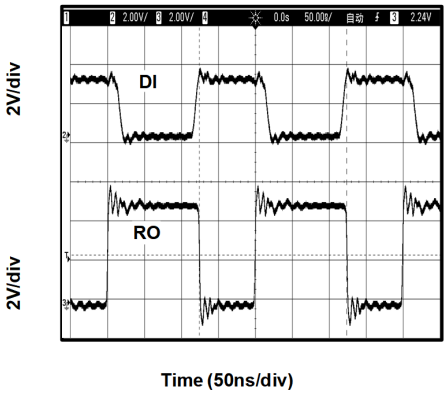
These transceivers require a 3-V to 5.5-V tolerance supply, and deliver at least a 2.1-V differential output voltage on 5-V supply condition. This translates into better noise immunity (data integrity), longer reach, or the ability to drive up to three 120-Ω terminations in "star" or other non-standard bus topologies, at an exceptional 10-Mbps data rate.

Receiver (Rx) inputs feature a "Full Fail-Safe" design, which ensures a logic high Rx output if Rx inputs are floating, shorted, or terminated but undriven. Rx outputs feature high drive levels (typically >25 mA @ V_{OL} = 1 V) to ease the design of optically isolated interfaces.

The TPT75176A and TPT75176B are available in the SOP8, MSOP8, and DFN3X3-8 packages, and are characterized from –40°C to 125°C.

Typical Application Circuit





Loopback Test at 10 Mbps/5 V

Table of Contents

Product Family Table

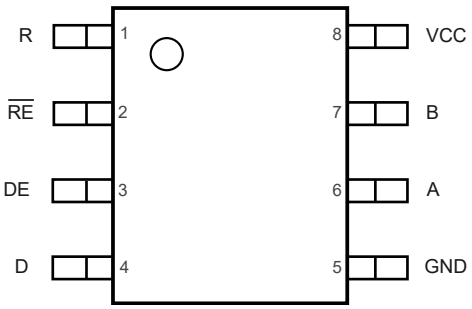
Part Number	Duplex	Data rate	HBM ESD	IEC-ESD	Package
TPT75176A	Half	10 Mbps	±12 kV	±8 kV	SOP8, MSOP8, DFN3x3-8
TPT75176B	Half	10 Mbps	±12 kV	±12 kV	SOP8, MSOP8, DFN3x3-8

Revision History

Date	Revision	Notes
2019-04-23	Rev.Pre.0	Definition version
2019-07-29	Rev.Pre.1	Updated ESD level
2019-10-22	Rev. 0	Initial release
2024-09-19	Rev. A.0	• Updated to new datasheet format • Added Typical Application Circuit, Product Family Table, Tape and Reel information • Updated Pin Configuration and Functions, ESD, Thermal Information, and Order Information

Pin Configuration and Functions

TPT75176A, TPT75176B
SOP8/MSOP8
Top View



TPT75176A, TPT75176B
DFN3X3-8
Top View

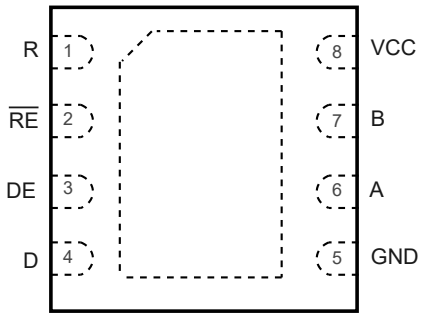


Table 1. Pin Functions: TPT75176A, TPT75176B

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	Noninverting Receiver Input A and Noninverting Driver Output A.
7	B	Bus input/output	Inverting Receiver Input B and Inverting Driver Output B.
8	VCC	Power	Power Supply.

Specifications

Absolute Maximum Ratings (1)

Parameter	Min	Max	Unit
V_{DD} to GND	−0.3	7	V
Input Voltages DI, DE, $\overline{RE}$	−0.3	V_{CC} + 0.3	V
Input/Output Voltages A, B	−9	14	V
A, B (Transient Pulse through 100 Ω)	−100	100	V
Ro	−0.3	V_{CC} + 0.3	V
Short Circuit Duration A, B		Continuous	

(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

Parameter		Condition	Minimum Level	Unit
HBM	Human Body Model, per ANSI/ESDA/ JEDEC JS-001/ANSI/ESD STM5.5.1	RS-485 pins (A, B)	±12	kV
		All other pins	±4	kV
CDM	CDM, per ANSI/ESDA/JEDEC JS-002	RS-485	±1.5	kV

Recommended Operating Conditions

Parameter		Min	Max	Unit
	Supply Voltage	3	5.5	V
T_A	Operating Temperature Range	−40	125	°C
	Bus Pin Common-Mode Voltage Range	−7	12	V
T_J	Maximum Junction Temperature (Plastic Package)		150	°C
T_{STG}	Maximum Storage Temperature Range	−65	150	°C

Thermal Information

Package Type	θ_{JA}	θ_{JB}	θ_{JC}	Unit
SOP8	112.2	90.6	45.8	°C/W
MSOP8	146.2	109.6	45.5	°C/W
DFN3x3-8	48.7	17.3	49.1	°C/W

Electrical Characteristics

All test conditions: V_{CC} = 5 V, T_A = 25°C, unless otherwise noted.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$\|V_{OD}\|$	Driver Differential-Output Voltage Magnitude	R_L= 54 Ω V_{CC} = 5 V	See Figure 1A	2.3	2.5		V
		R_L = 54 Ω with V_A or V_B from –7 to +12 V, V_{CC} = 5 V (RS-485)		2.2	2.4		
		R_L = 54 Ω with V_A or V_B from –7 to +12 V, V_{CC} = 3 V (RS-485)		1.2	1.5		
$\Delta\|V_{OD}\|$	Change in Magnitude of Driver Differential-Output Voltage	R_L = 54 Ω, C_L = 50 pF, V_{CC} = 5 V	See Figure 1A	−0.2	-0.002	0.2	V
$V_{OC(SS)}$	Steady-Stage Common-Mode Output Voltage	Center of two 27-Ω load resistors	See Figure 1A		V_{CC}/2		V
ΔV_{OC}	Change in Differential Driver Common-Mode Output Voltage				0.05		V
$V_{OC(PP)}$	Peak-to-Peak Driver Common-Mode Output Voltage				0.5		
C_{OD}	Differential Output Capacitance				8		pF
V_{IT+}	Positive-Going Receiver Differential-Input Voltage Threshold	V_A or V_B from –5 V to +7 V			−50	−10	mV
V_{IT-}	Negative-Going Receiver Differential-Input Voltage Threshold	V_A or V_B from –5 V to +7 V		−200	−130		mV
V_{HYS}	Receiver Differential-Input Voltage Threshold Hysteresis (V_{IT+} – V_{IT-})				75		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
V_{OL}	Receiver Low-Level Output Voltage	I_{OL} = 8 mA				0.4	V
I_I	Driver Input, Driver Enable and Receiver Enable Input Current	DI, DE, $\overline{RE}$		−2		2	μA

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
I_{OZ}	Receiver High-Impedance Output Current	V_O = 0 V or V_{CC}, $\overline{RE}$ at V_{CC}		−2		2	μA
$\|I_{OS}\|$	Driver Short-Circuit Output Current	$\|I_{OS}\|$ with V_A or V_B from –7 V to +12 V			120	300	mA
I_{IN}	Bus Input Current (Driver Disabled)	V_{CC} = 4.5 V to 5.5 V or V_{CC} = 0 V, DE at 0 V	VI = 12 V			1	mA
			VI = −7 V	−0.8			
I_{CC}	Supply Current (Quiescent)	Driver and receiver enabled	DE = V_{CC}, $\overline{RE}$ = GND, no load		2.2	5	mA
		Driver enabled, receiver disabled	DE = V_{CC}, $\overline{RE}$ = V_{CC}, no load		1.5	3	
		Driver disabled, receiver enabled	DE = GND, $\overline{RE}$ = GND, no load		0.5	1	
		Driver and receiver disabled	DE = GND, $\overline{RE}$ = V_{CC}, D = V_{CC}, no load		0.1	0.5	

Switching Characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Driver							
f_{MAX}	Maximum Data Rate	V_{OD} ≥ ±1.5 V, R_L = 54 Ω, C_L = 100 pF (Figure 4)				10	Mbps
t_r, t_f	Driver Differential-Output Rise and Fall Times	R_L = 54 Ω, C_L= 50 pF	See Figure 2		36		ns
t_{PHL}, t_{PLH}	Driver Propagation Delay				35	45	
$t_{SK(P)}$	Driver Pulse Skew, $\|T_{PHL} - T_{PLH}\|$				5	10	
t_{PHZ}, t_{PLZ}	Driver Disable Time		See Figure 3		70	90	ns
t_{PHZ}, t_{PLZ}	Driver Enable Time	Receiver enabled			70	90	
		Receiver disabled			90	120	ns
Receiver							
t_r, t_f	Receiver Output Rise and Fall Times (1)	C_L = 15 pF	see Figure 5		20		ns
t_{PHL}, t_{PLH}	Receiver Propagation Delay Time				35	50	
$t_{SK(P)}$	Receiver Pulse Skew, $\|T_{PHL} - T_{PLH}\|$				10	15	
t_{PHZ}, t_{PLZ}	Receiver Disable Time				45	60	ns
t_{PZL}, t_{PZH}	Receiver Enable Time	Driver enabled	see Figure 6		50	70	ns
	Receiver Enable Time	Driver disabled			70	90	ns

Test Circuits and Waveforms

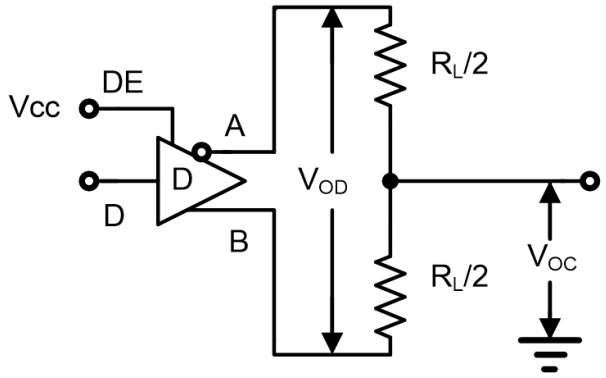


Figure 1A. V_{OD} and V_{OC}

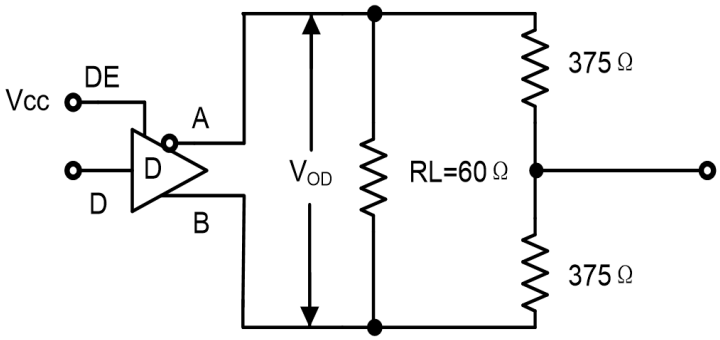


Figure 1B. V_{OD} with Common-Mode Load

Figure 1. DC Driver Test Circuits

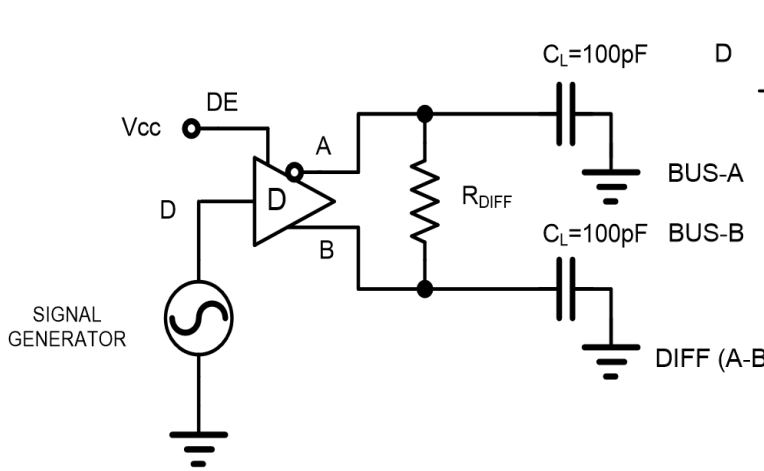


Figure 2A. Test Circuit

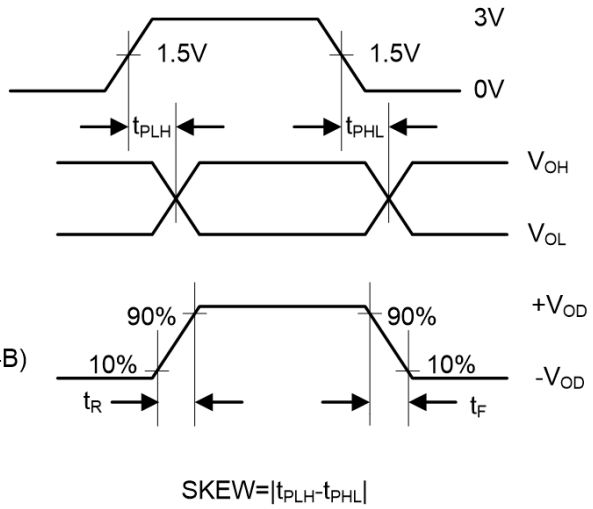
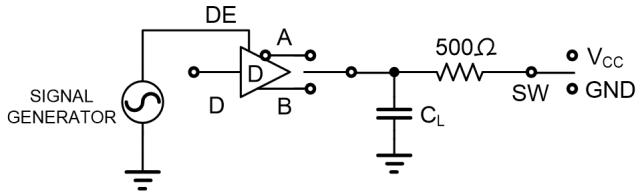


Figure 2B. Measurement Points

Figure 2. Driver Propagation Delay and Differential Transition Times



PARAMETER	OUTPUT	RE	DI	SW	CL (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

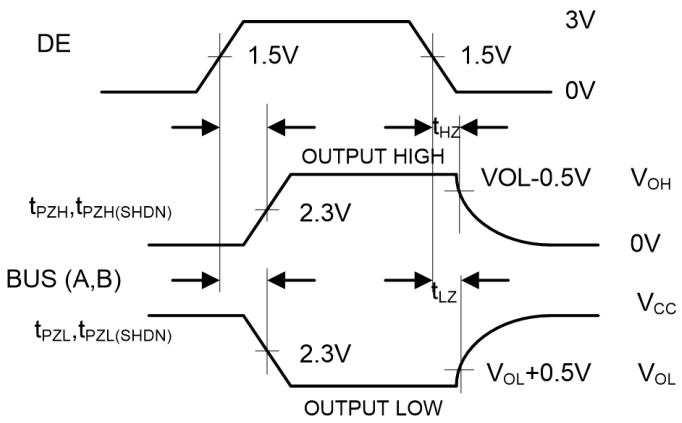


Figure 3B. Measurement Points

Figure 3. Driver Enable and Disable Times

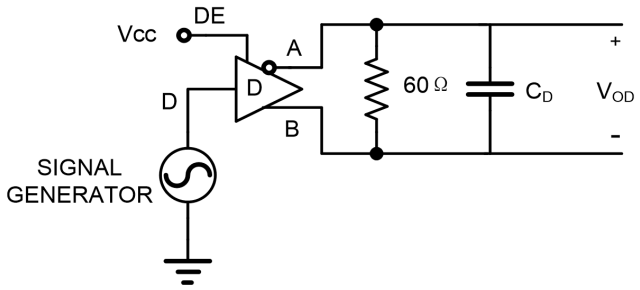


Figure 4A. Test Circuit

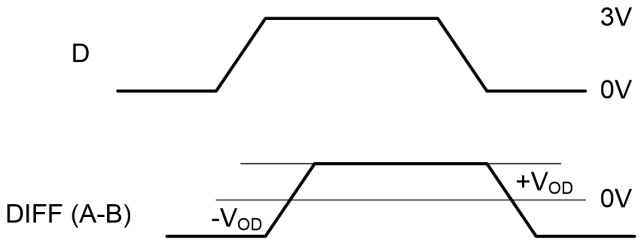


Figure 4B. Measurement Points

Figure 4. Driver Data Rate

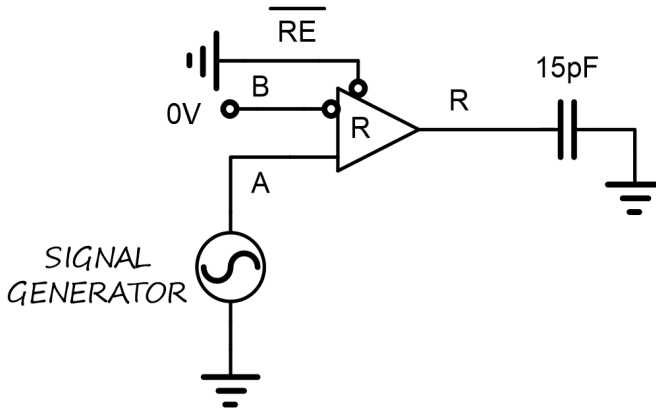


Figure 5A. Test Circuit

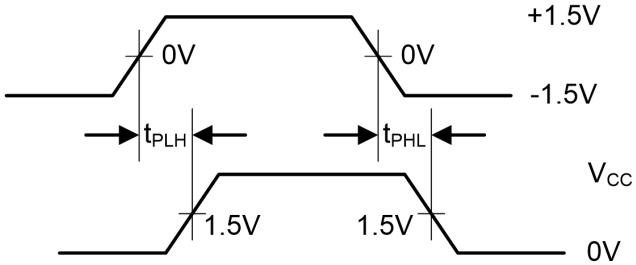
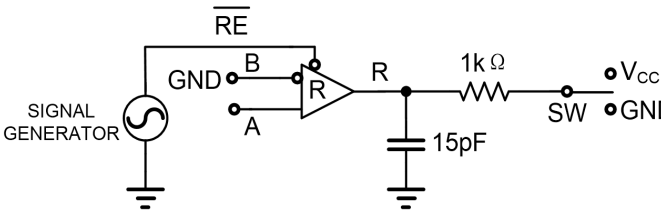


Figure 5B. Measurement Points

Figure 5. Receiver Propagation Delay and Data Rate



PARAMETER	DE	A	SW
tPHZ	1	+1.5 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

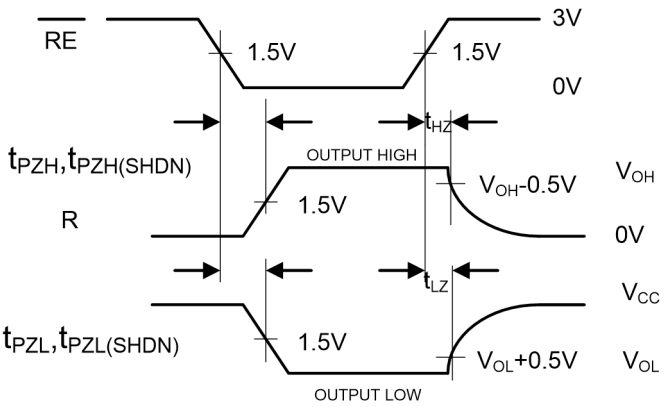


Figure 6B. Measurement Points

Figure 6. Receiver Enable and Disable Times

Functional Table

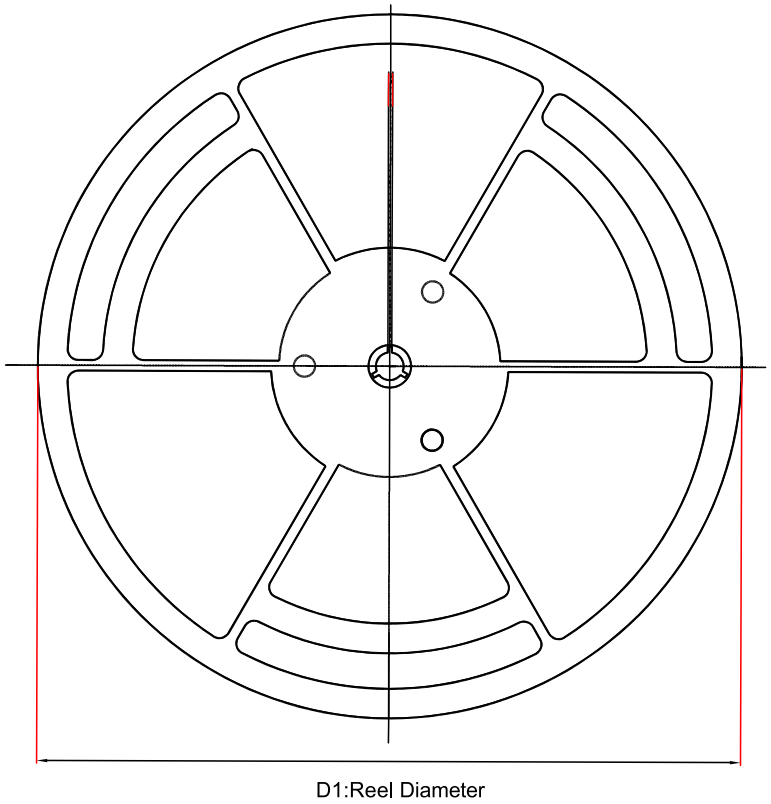
Table 2. Driver Pin Functions

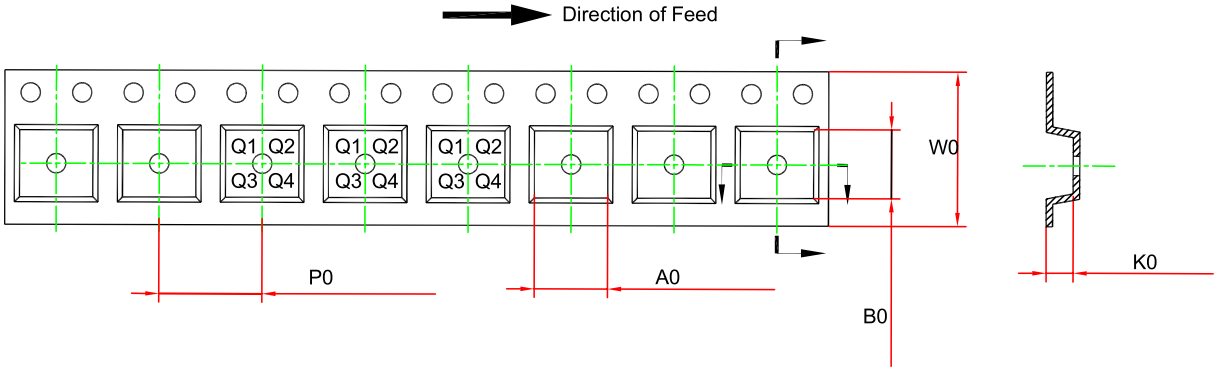
Input	Enable	Outputs		Description
D	DE	A	B	
Normal Mode				
H	H	H	L	Actively drives bus High
L	H	L	H	Actively drives bus Low
X	L	Z	Z	Driver disabled
X	OPEN	Z	Z	Driver disabled by default
OPEN	H	H	L	Actively drives bus High

Table 3. Receiver Pin Functions

Differential Input	Enable	Output	Description
$V_{ID} = V_A – V_B$	$\overline{RE}$	R	
Normal Mode			
$V_{IT+} < V_{ID}$	L	H	Receive valid bus High
$V_{IT–} < V_{ID} < V_{IT+}$	L	?	Indeterminate bus state
$V_{ID} < V_{IT–}$	L	L	Receive valid bus Low
X	H	Z	Receiver disabled
X	OPEN	Z	Receiver disabled
Open, short, idle Bus	L	H	Indeterminate bus state

Tape and Reel Information



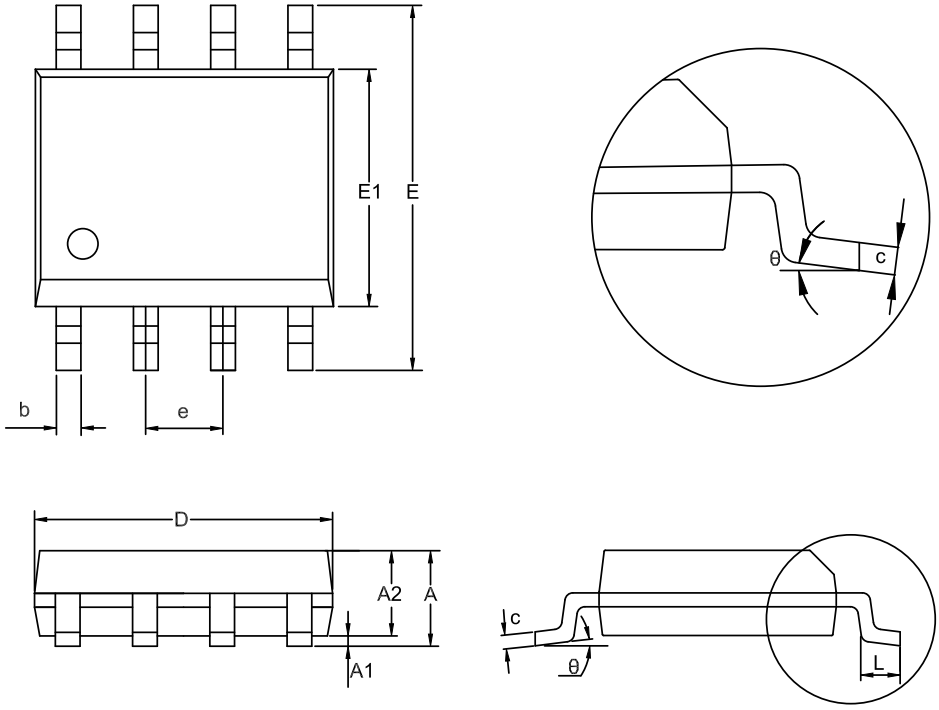


Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPT75176A-SO1R	SOP8	330	17.6	6.5	5.4	2	8	12	Q1
TPT75176A-VS1R	MSOP8	330	17.6	5.3	3.4	1.3	8	12	Q1
TPT75176A-DF6R	DFN3X3-8	330	17.6	3.3	3.3	1.1	8	12	Q1
TPT75176B-SO1R	SOP8	330	17.6	6.5	5.4	2	8	12	Q1
TPT75176B-VS1R	MSOP8	330	17.6	5.3	3.4	1.3	8	12	Q1
TPT75176B-DF6R	DFN3X3-8	330	17.6	3.3	3.3	1.1	8	12	Q1

Package Outline Dimensions

SOP8-A

Package Outline Dimensions SO1(SOP-8-A)



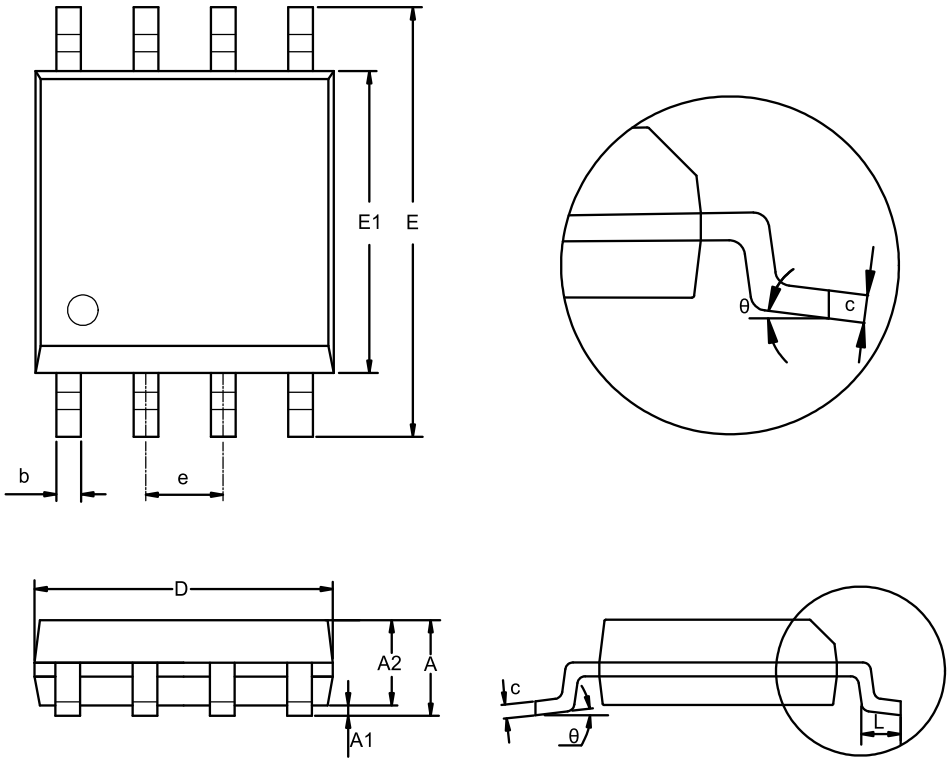
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.550	0.049	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050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



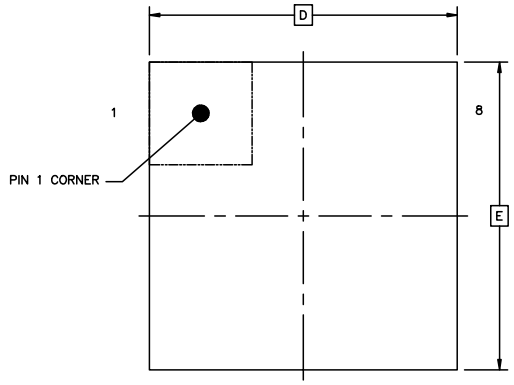
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.800	1.100	0.031	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	4.700	5.100	0.185	0.201
E1	2.900	3.100	0.114	0.122
e	0.650 BSC		0.026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

NOTES

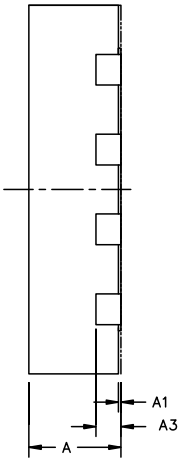
1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

DFN3X3-8

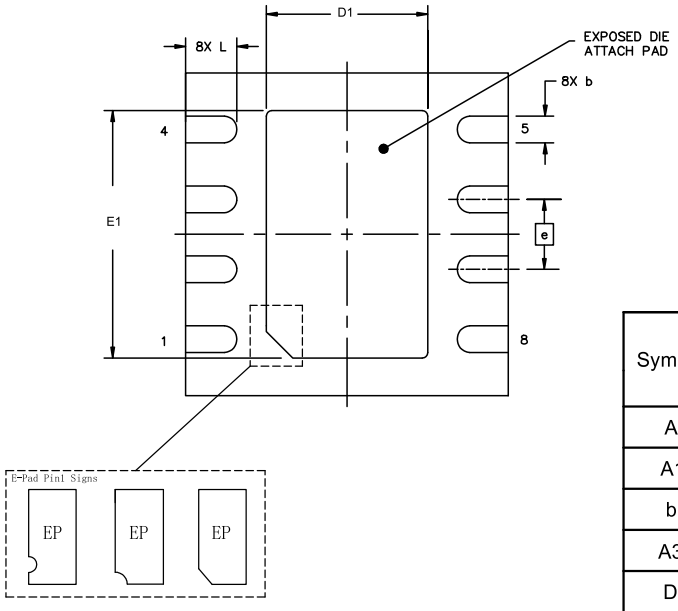
Package Outline Dimensions DF6(DFN3X3-8-A)



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
TPT75176A-SO1R	−40 to 125°C	SOP8	T176A	3	Tape and Reel, 4,000	Green
TPT75176A-VS1R	−40 to 125°C	MSOP8	176A	3	Tape and Reel, 3,000	Green
TPT75176A-DF6R	−40 to 125°C	DFN3x3-8	176A	3	Tape and Reel, 4,000	Green
TPT75176B-SO1R	−40 to 125°C	SOP8	T176B	3	Tape and Reel, 4,000	Green
TPT75176B-VS1R	−40 to 125°C	MSOP8	176B	3	Tape and Reel, 3,000	Green
TPT75176B-DF6R	−40 to 125°C	DFN3x3-8	176B	3	Tape and Reel, 4,000	Green

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

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