±15kV ESD Protected, 10Mbps, Full Fail-safe, RS-485 Transceivers

Features

- **High Data Rates: 10Mbps At 5V Supply**
- **30/50ns (Max) Tx/Rx Propagation Delays; 6ns (Max) Skew**
- **Full Fail-safe (Open, Short, Terminated) Receivers**
- **Up to 256 Nodes on a Bus (1/8 unit load)**
- **Wide Supply Voltage 3V to 5.5V**
- **Low Quiescent Supply Current: 1.65 mA**
- **Bus-Pin Protection:**
  - **±15 kV HBM protection**
  - **±15 kV IEC-ESD**
- **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

3PEAK’s TPT75176H is enhanced RS485 which exceeds standard TIA/EIA-485-A with ±15kV IEC-ESD Protected, 3V~5.5V powered, single transceiver for balanced communication. It also features the larger output voltage and higher data rate - up to 10Mbps - required by high speed PROFIBUS applications, and is offered in Industrial and Extended Industrial (-40°C to +125°C) temperature ranges.

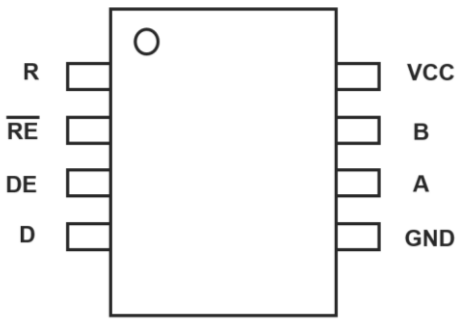
This transceiver requires a 3V~5.5V tolerance supply, and delivers at least a 2.1V differential output voltage on 5V supply condition. This translates into better noise immunity (data integrity), longer reach, or the ability to drive up to three 120Ω terminations in “star” or other non-standard bus topologies, at the exceptional 10Mbps 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 >25mA @ V_{OL} = 1V) to ease the design of optically isolated interfaces.

The TPT75176H is available in an SOP8, MSOP8 and DFN3X3-8L package, and is characterized from –40°C to 125°C.

Pin Configuration (Top View)

TPT75176H
8-Pin SOP/MSOP/DFN
-SO1R, -VS1R, DF6R



Loopback Test At 10Mbps/5V

Revision History

Date	Revision	Notes
2019/2/22	Rev. Pre 0.1	Definition Version 0
2019/3/25	Rev. Pre 0.2	Update package information
2019/4/19	Rev. Pre 0.3	Update tape and reel information
2019/7/29	Rev. Pre 0.4	Update ESD level
2019/9/20	Rev. 0	Final version, update full temp data
2020/3/18	Rev. A	Update Receiver rise/fall time and add the note1 for Absolute Maximum Ratings
2020/10/31	Rev. B	Update VOH/VOL, VIH/VIL at 3.3V
2021/6/10	Rev. C	Add tape reel information

Order Information

Model Name	Order Number	Package	Transport Media, Quantity	Marking Information
TPT75176H	TPT75176HL1-SO1R	8-Pin SOP	Tape and Reel, 4,000	T176H
TPT75176H	TPT75176H-VS1R	8-Pin MSOP	Tape and Reel, 3,000	176H
TPT75176H	TPT75176HL1-DF6R	8-Pin DFN	Tape and Reel, 4,000	176H

Functional Table

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

RECEIVER PIN FUNCTIONS

DIFFERENTIAL INPUT	ENABLE	OUTPUT	DESCRIPTION
$V_{ID} = V_A - V_B$	/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

Absolute Maximum Ratings

V_{DD} to GND.....-0.3V to +7V

Input Voltages D, DE, RE.....-0.3V to (VCC + 0.3V)

Input/Output Voltages A, B..... -15V to +15V

A, B (Transient Pulse Through 100Ω, Note 1)..... ±100V

R..... -0.3V to (VCC +0.3V)

Short Circuit Duration A, B.....Continuous

ESD Rating..... See Specification Table

Note:

(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

Supply Voltage.....3V~5.5V

Temperature Range.....-40°C to +125°C

Bus Pin Common Mode Voltage Range ..... -7V to +12V

Thermal Resistance, Θ_{JA} (Typical) 8-Pin SOP Package .....152°C/W

8-Pin MSOP Package ..... 200°C/W

Maximum Junction Temperature (Plastic Package) .....+150°C

Maximum Storage Temperature Range ..... -65°C to +150°C

Note:

(1) Tested according to TIA/EIA-485-A, Section 4.2.6 (±100V for 15μs at a 1% duty cycle).

Electrical Characteristics

Test Conditions: V_{CC} = 5V, Ta = -45 ~ +125°C (unless otherwise noted)

Parameter		Conditions		Min	Typ	Max	Units
$\|V_{OD}\|$	Driver differential-output voltage magnitude	RL = 60 Ω with VA or VB from –7 to +12 V, VCC = 4.5V~5.5V	See Figure 1B	2.1	2.8		V
		RL = 60 Ω with VA or VB from –7 to +12 V, VCC = 3.0~3.6V		1.5	2.0		
		RL = 54 Ω, VCC = 5V	See Figure 1A	2.1	2.8		V
		RL = 54 Ω, VCC = 3V		1.5	1.9		
		RL = 100 Ω, VCC = 5V		2.1	3.5		
		RL = 100 Ω, VCC = 3V		1.5	2.3		
$\Delta\|V_{OD}\|$	Change in magnitude of driver differential-output voltage	RL = 54 Ω, CL=50 pF, VCC = 5V	See Figure 1A	-50	1	50	mV
$V_{OC(SS)}$	Steady-stage 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 [1]				50		mV
$V_{OC(PP)}$	Peak-to-peak driver common-mode output voltage [1]				500		
C_{OD}	Differential output capacitance [1]				8		pF
V_{IT+}	Positive-going receiver differential-input voltage threshold	V_A or V_B from –7 to +12 V			-90	-40	mV
V_{IT-}	Negative-going receiver differential-input voltage threshold	V_A or V_B from –7 to +12 V		-220	-155		mV
V_{HYS}	Receiver differential-input voltage threshold hysteresis ($V_{IT+} – V_{IT–}$) [1]				70		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 mA, Vcc = 4.5V to 5.5V		3	4.5		V
		I_{OH}= -8 mA, Vcc = 3.0V to 3.6V		2.45	2.65		V
V_{OL}	Receiver low-level output voltage	I_{OL}= 8 mA, Vcc = 4.5V to 5.5V				0.4	V
		I_{OL}= 8 mA, Vcc = 3.0V to 3.6V				0.5	V
I_I	Driver input, driver enable and	D, DE, $\overline{RE}$		-5		5	μA
I_{OZ}	Receiver high-Z output current	V_O = 0 V or V_{CC}, /RE at V_{CC}		-1		1	μA
$\|I_{OS}\|$	Driver short-circuit output current	|IOS| with V_A or V_B from –7 to +12 V		-250	120	250	mA
		Bus pin A,B short current				150	mA
I_{IN}	Bus input current(driver disabled)	V_{CC} = 4.5 to 5.5 V or V_{CC} = 0 V, DE at 0 V	VI= 12 V			120	uA
			VI= -7 V	-110			
I_{CC}	Supply current(quiescent)	Driver and receiver enabled	DE = V_{CC}, /RE = GND, No LOAD		1.9	2.2	mA
		Driver enabled, receiver disabled	DE = V_{CC}, /RE = V_{CC}, No LOAD		1.8	2.2	
		Driver disabled, receiver enabled	DE = GND, /RE = GND, No LOAD		1.7	2.0	
		Driver and receiver disabled	DE = GND, /RE = V_{CC}, D= V_{cc} No LOAD		1.65	2.0	

Switching Characteristics

PARAMETER		CONDITIONS		MIN	TYP	MAX	UNITS
DRIVER							
f_{MAX}	Maximum Data Rate [1]	$V_{OD} \geq \pm 1.5V$, $R_L = 54\Omega$, $C_L = 100pF$ (Figure 4)				10	Mbps
t_r, t_f	Driver differential-output rise and fall times [1]	R_L = 54 Ω, C_L=50pF	See Figure 2		8		ns
t_{PHL}, t_{PLH}	Driver propagation delay				21	30	
$t_{SK(P)}$	Driver pulse skew, |tPHL – tPLH|				3	6	
t_{PHZ}, t_{PLZ}	Driver disable time		See Figure 3		30	50	ns
t_{PZH}, t_{PZL}	Driver enable time	Receiver enabled			20	45	
	Driver enable time	Receiver disabled			30	50	ns
RECEIVER							
t_r, t_f	Receiver output rise and fall times [1]	C_L=15 pF	See Figure 5		14		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				30	60	ns
t_{PZH}, t_{PZL}	Receiver enable time	Driver enabled			20	30	ns
	Receiver enable time	Driver disabled			25	40	ns
ESD							
Human Body Model, per ANSI/ESDA/JEDEC JS-001 / ANSI/ESD STM5.5.1		RS-485 Pins (A, B)		±15			kV
		All Other Pins		±4			kV
CDM, per ANSI/ESDA/JEDEC JS-002		RS-485		±1.5			kV
IEC-61000-4-2, IEC-Contact ESD, Bus Pins		RS-485 Pins (A, B)		±15			kV

Note

[1] Parameter is provided by lab bench test and design simulation

Test Circuits and Waveforms

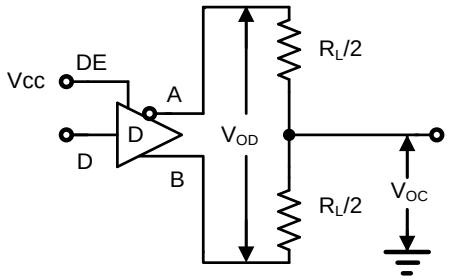


Figure 1A. VOD and VOC

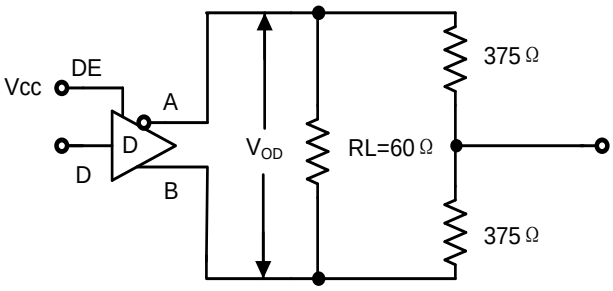


Figure 1B. VOD with Common Mode Load

Figure 1. DC Driver Test Circuits

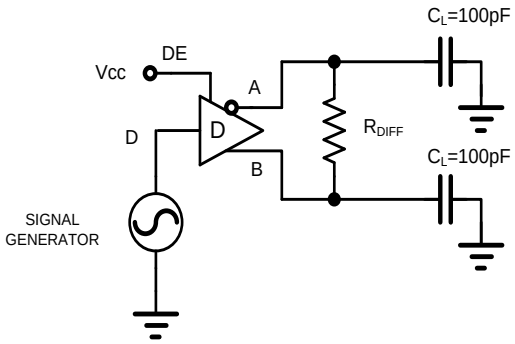


Figure 2A. Test Circuit

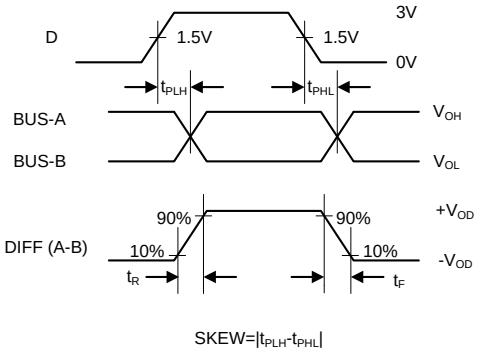
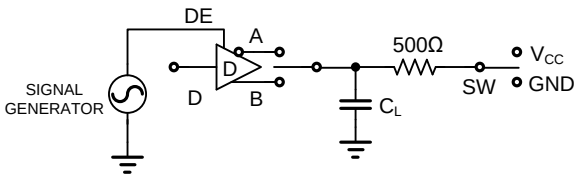


Figure 2B. Measurement Points

Figure 2. Driver Propagation Delay and Differential Transition Times



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 3A. Test Circuit

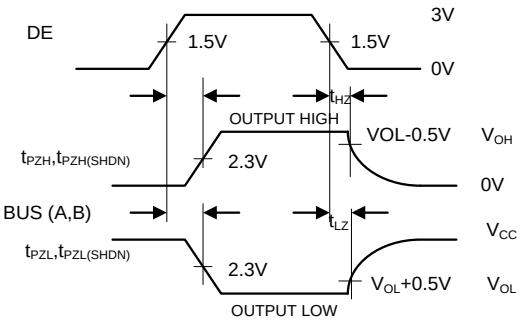


Figure 3B. Measurement Points

Figure 3. Driver Enable and Disable Times

Test Circuits and Waveforms (continue)

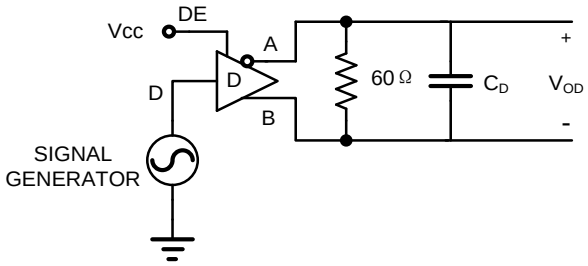


Figure 4A. Test Circuit

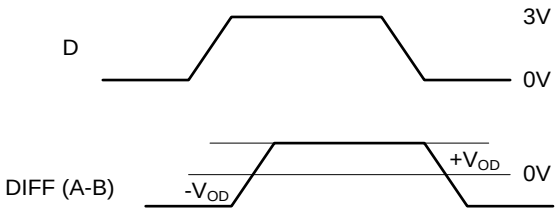


Figure 4B. Measurement Points

Figure 4. Driver Data rate

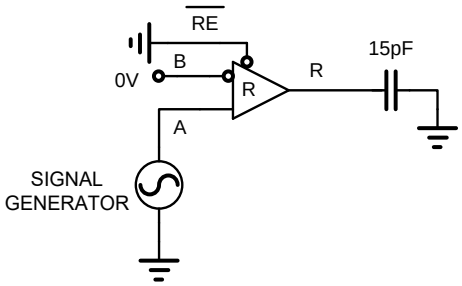


Figure 5A. Test Circuit

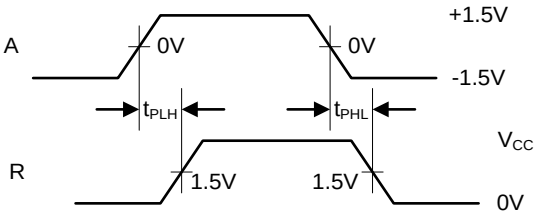
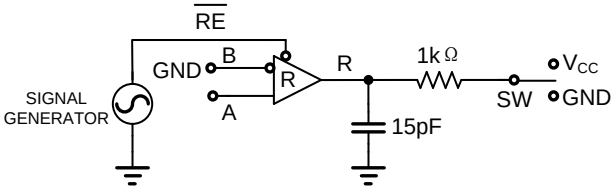


Figure 5B. Measurement Points

Figure 5. Receiver Propagation Delay and Data rate



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

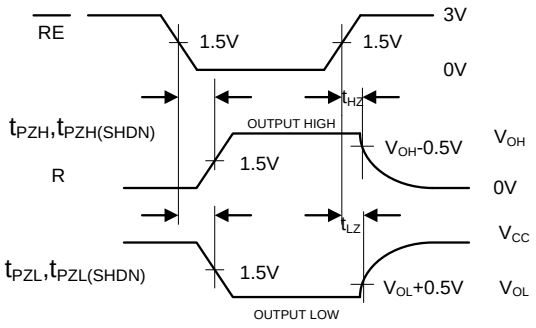


Figure 6B. Measurement Points

Figure 6. Receiver Enable and Disable Times

Detailed Description

High Data Rate

RS-485/RS-422 are intended for network lengths up to 4000', but the maximum system data rate decreases as the transmission length increases. Devices operating at 10Mbps are limited to lengths less than 100'.

Twisted pair is the cable of choice for RS-485/RS-422 networks. Twisted pair cables tend to pick up noise and other electromagnetically induced voltages as common mode signals, which are effectively rejected by the differential receiver in this IC.

Proper termination is imperative to minimize reflections. In point-to-point, or point-to-multipoint (single driver on bus) networks, the main cable should be terminated in its characteristic impedance (typically 120Ω) at the end farthest from the driver. In multi-receiver applications, stubs connecting receivers to the main cable should be kept as short as possible. Multipoint (multi-driver) systems require that the main cable be terminated in its characteristic impedance at both ends. Stubs connecting a transceiver to the main cable should be kept as short as possible.

The TPT75176H may also be used at slower data rates over longer cables, but there are some limitations. The Rx is optimized for high speed operation, so its output may glitch if the Rx input differential transition times are too slow. Keeping the transition times below 500ns, which equates to the Tx driving a 1000' (305m) CAT 5 cable, yields excellent performance over the full operating temperature range. For below test waveform, the transmitter was driven at 10Mps and/or with 100' (31m) CAT 5 cable, the transmitters were loaded with an RS-485 receiver in parallel with 54Ω.

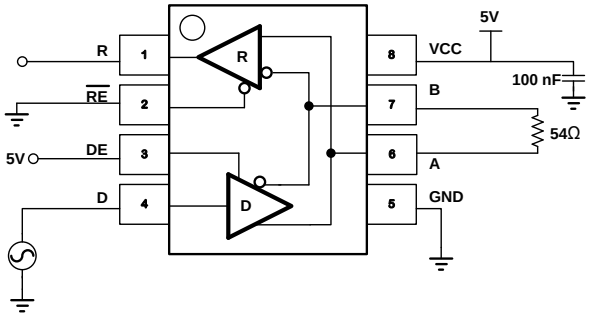


Figure 7. Loopback Test Circuit

Full Fail-Safe

All the receivers include a "full fail-safe" function that guarantees a high level receiver output if the receiver inputs are unconnected (floating), shorted together, or connected to a terminated bus with all the transmitters disabled. Receivers easily meet the data rates supported by the corresponding driver, and all receiver outputs are three-stable via the active low RE input.

Hot Plug Function

When a piece of equipment powers up, there is a period of time where the processor or ASIC driving the RS-485 control lines (DE, RE) is unable to ensure that the RS-485 Tx and Rx outputs are kept disabled. If the equipment is connected to the bus, a driver activating prematurely during power-up may crash the bus. To avoid this scenario, the TPT75176H devices incorporate a "Hot Plug" function. Circuitry monitoring V_{CC} ensures that, during power-up and power-down, the Tx and Rx outputs remain disabled, regardless of the state of DE and RE, if V_{CC} is less than ~2.5V. This gives the processor/ASIC a chance to stabilize and drive the RS-485 control lines to the proper states.

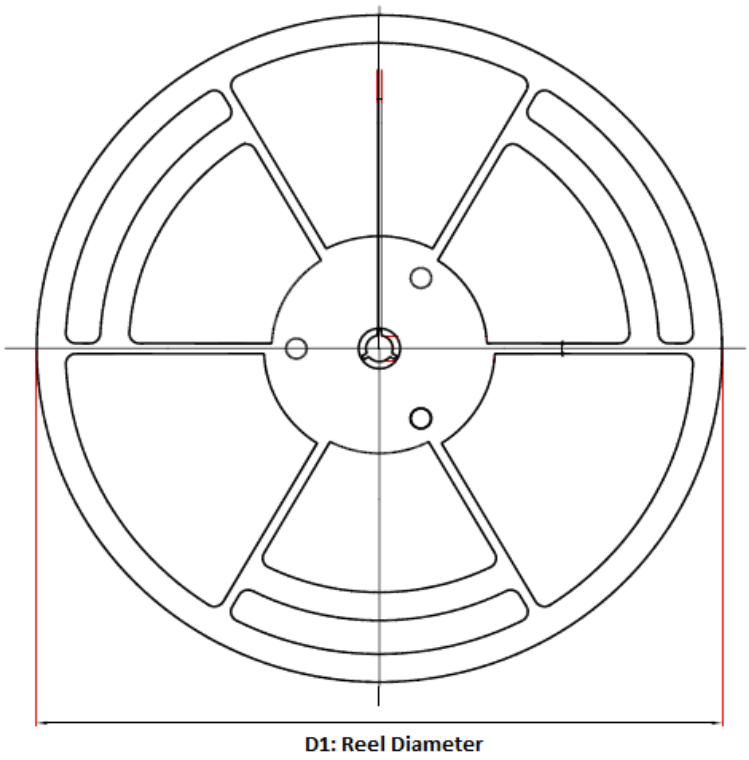
Transient Protection

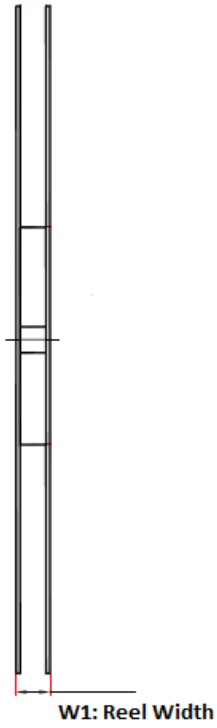
The bus terminals of the TPT75176H transceiver family possess on-chip ESD protection against ±15 kV HBM. The International

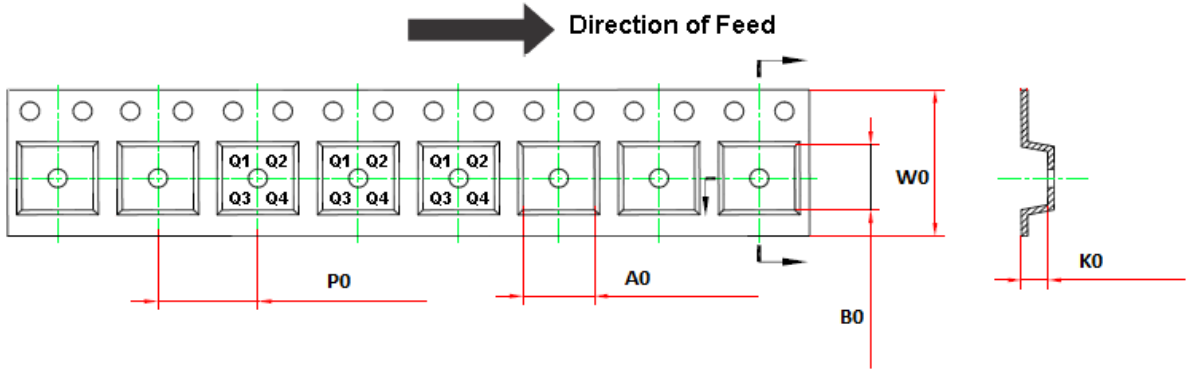
Electrotechnical Commision (IEC) ESD test is far more severe than the HBM ESD test. The 50% higher charge capacitance, CS, and 78% lower discharge resistance, RD of the IEC model produce significantly higher discharge currents than the HBM model.

As stated in the IEC 61000-4-2 standard, contact discharge is the preferred transient protection test method. Although IEC air-gap testing is less repeatable than contact testing, air discharge protection levels are inferred from the contact discharge test results.

Tape and Reel Information



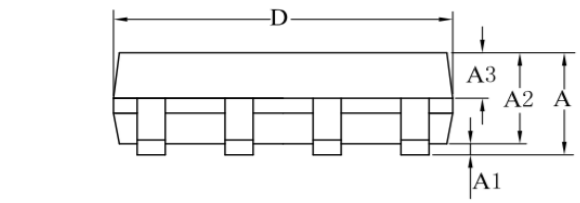


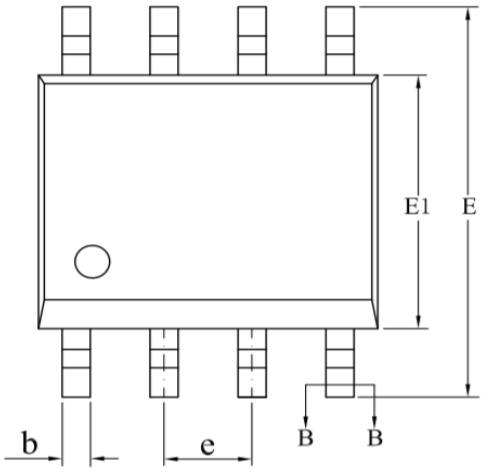


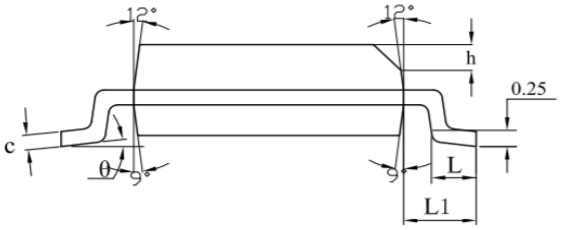
Order Number	Package	D1	W1	A0	B0	K0	P0	W0	Pin1 Quadrant
TPT75176HL1-SO1R	8-Pin SOP	330.0	17.6	6.4	5.4	2.1	8.0	12.0	Q1
TPT75176H-VS1R	8-Pin MSOP	330.0	17.6	5.2	3.3	1.5	8.0	12.0	Q1
TPT75176HL1-DF6R	8-Pin DFN3X3	330.0	17.6	3.4	3.4	1.1	8.0	12.0	Q1

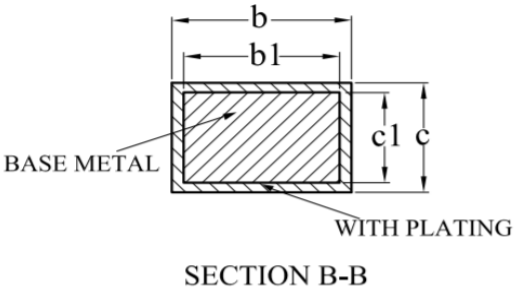
Package Outline Dimensions

SO1R (SOP8)







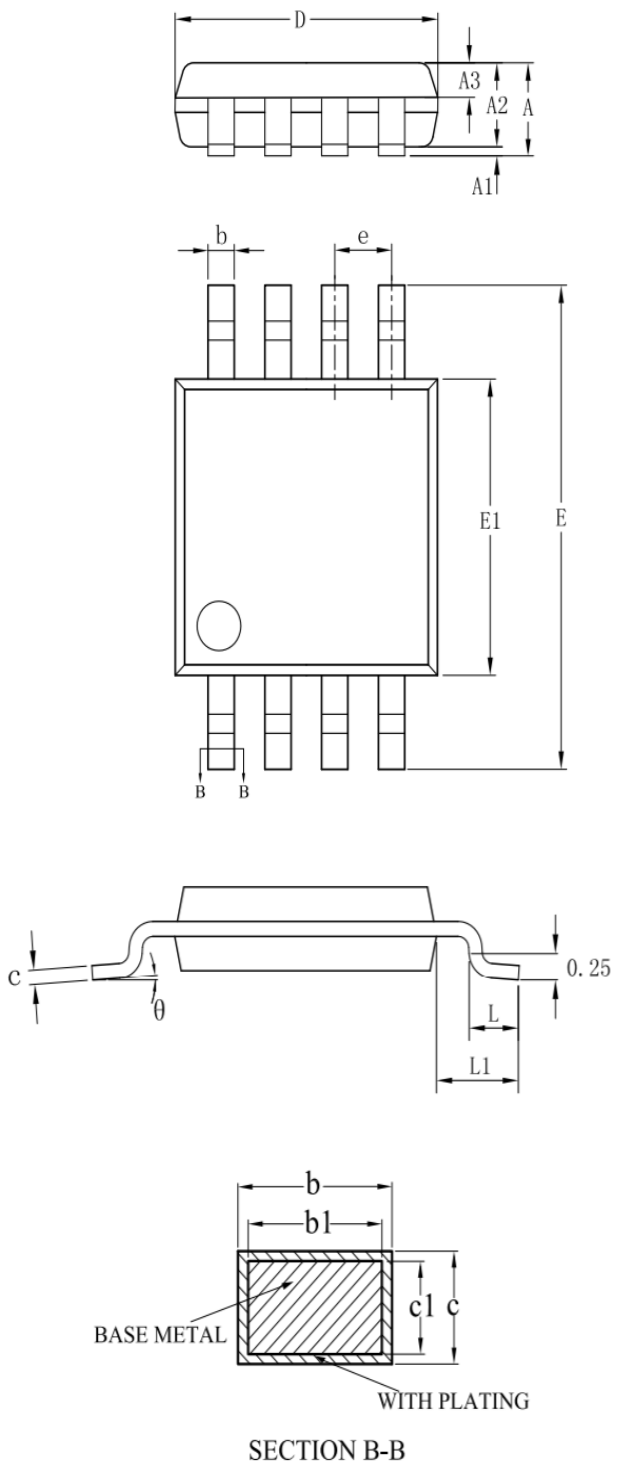


SECTION B-B

SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.75
A1	0.10	—	0.225
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	—	0.47
b1	0.38	0.41	0.44
c	0.20	—	0.24
c1	0.19	0.20	0.21
D	4.80	4.90	5.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27BSC		
h	0.25	—	0.50
L	0.50	—	0.80
L1	1.05REF		
θ	0	—	8°

Package Outline Dimensions

VS1R (MSOP8)

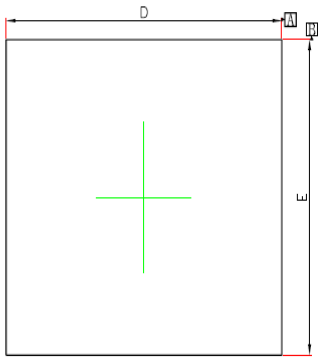


SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.10
A1	0.05	—	0.15
A2	0.75	0.85	0.95
A3	0.30	0.35	0.40
b	0.28	—	0.36
b1	0.27	0.30	0.33
c	0.15	—	0.19
c1	0.14	0.15	0.16
D	2.90	3.00	3.10
E	4.70	4.90	5.10
E1	2.90	3.00	3.10
e	0.65BSC		
L	0.40	—	0.70
L1	0.95REF		
θ	0	—	8°

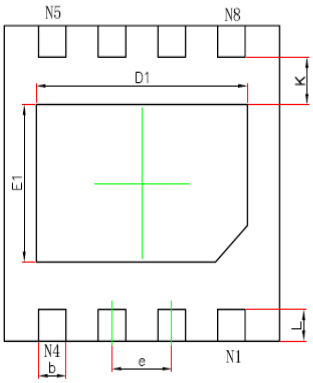
Package Outline Dimensions

DF6R (DFN3X3-8L)

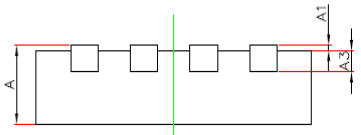
DFNWB3×3-8L-F(P0.65T0.75/0.85) PACKAGE OUTLINE DIMENSIONS



TOP VIEW



BOTTOM VIEW



SIDE VIEW

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	NOM.	Min.	NOM.
A	0.700/0.800	0.800/0.900	0.028/0.031	0.031/0.035
A1	0.000	0.050	0.000	0.002
A3	0.203REF.		0.008REF.	
D	3.000BSC.		0.118BSC.	
E	3.000BSC.		0.118BSC.	
D1	2.200	2.400	0.087	0.094
E1	1.400	1.600	0.055	0.063
k	0.250MIN.		0.010MIN.	
b	0.250	0.350	0.010	0.014
e	0.650TYP.		0.026TYP.	
L	0.224	0.376	0.009	0.015

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