

- Communication Infrastructure

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

Description

The TPT481 are IEC61000 ESD protected, 3.0V to 5.5V 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 54Ω load. These 20Mbps 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.

TPT481 is designed for half-duplex RS485, and support SOP8, MSOP8 and DFN3X3-8L package, which is characterized from -40°C to 125°C.

Applications

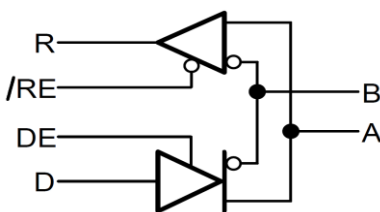
- Motor Drives
- Industrial Control

Device Table

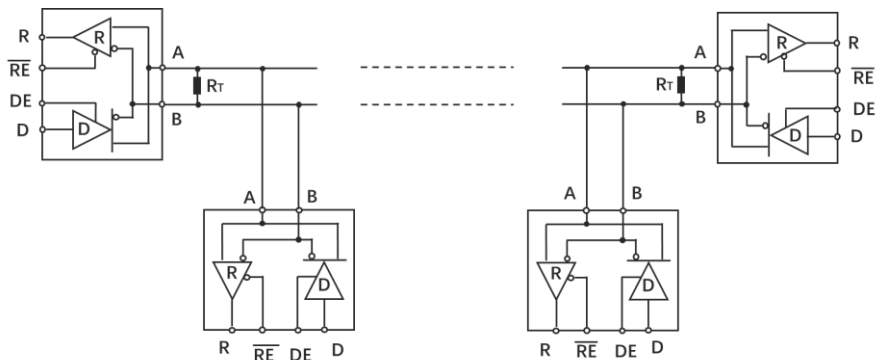
Part	Duplex	Enable	Data Rate	Nodes
TPT481	Half	Yes	20Mbps	256

Simplified Schematic

TPT481 Block Diagram



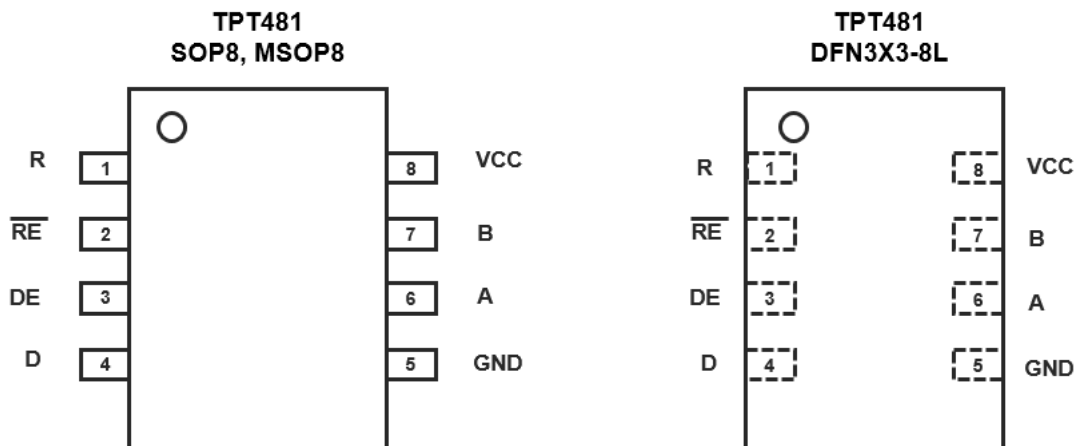
TPT481 Network



Revision History

Date	Revision	Notes
2019/4/8	Rev. Pre 0.1	Definition Version
2019/8/6	Rev. Pre 0.2	Update ESD data
2019/9/3	Rev. Pre 0.3	Update Electrical data
2019/9/26	Rev. 0	Final version
2020/3/24	Rev. A	Update A/B pin absolute rating, VID and VI recommended value
2020/5/16	Rev. B	Update HBM level to 18kV

Pin Configuration and Functions



Pin Table

Pin No.	Pin Name	I/O	Description
1	R	Digital output	Receiver Output.
2	$\overline{\text{RE}}$	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 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 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 by default

X = don't care

Z = high impedance

Receiver Function Table

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

Order Information

Model Name	Order Number	Package	MSL Level	Transport Media, Quantity	Marking Information
TPT481	TPT481L1-SO1R	8-Pin SOP	MSL1	Tape and Reel 4,000	T481
TPT481	TPT481-VS1R	8-Pin MSOP	MSL3	Tape and Reel 3,000	T481
TPT481	TPT481L1-DF6R	8-Pin DFN3X3	MSL1	Tape and Reel 4,000	T481

Absolute Maximum Ratings

Parameters	Rating
V _{CC} to GND	-0.3V to +7V
Voltage at Logic pin: D, DE, /RE, R	-0.3V to V _{CC} + 0.3V
Voltage at Bus pin: A, B	-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) 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
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 minimum is used in this data sheet.

ESD Rating

		Value	Unit
IEC-61000-4-2, Contact Discharge	Bus Pin	15	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	18	kV
	All Pin Except Bus Pin	4	kV
CDM, per ANSI/ESDA/JEDEC JS-002	All Pin	1.5	kV

Electrical Characteristics

Test Conditions: 5V with temperature range

Parameter		Conditions		Min	Typ	Max	Units
V _{OD}	Driver differential-output voltage magnitude	RL = 60 Ω with V _A or V _B from -7 to +12 V, V _{CC} = 4.5V~5.5V	See Figure 1B	2.1	2.7		V
		RL = 60 Ω with V _A or V _B from -7 to +12 V, V _{CC} = 3.0~3.6V	See Figure 1B	1.5	2.3		
		RL = 54 Ω, V _{CC} = 5V	See Figure 1A	2.1	2.7		
		RL = 54 Ω, V _{CC} = 3V		1.5	2.3		
		RL = 100 Ω, V _{CC} = 5V		2.1	2.7		
		RL = 100 Ω, V _{CC} = 3V		1.5	2.3		
Δ V _{OD}	Change in magnitude of driver differential-output voltage	RL = 54 Ω, CL=50 pF, V _{CC} = 5V	See Figure 1A	-50		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			-50		50	mV
V _{OC(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	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		2.4	V _{CC} - 0.3		V
V _{OL}	Receiver low-level output voltage	I _{OL} = 8 mA				0.4	V
R _{in}	BUS pin input resistance	-7V ≤ V _{CM} ≤ +12V		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} , /RE at V _{CC}		-1		1	μA
I _{os}	Driver short-circuit output current	I _{os} with V _A or V _B from -7 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 to 5.5 V or V _{CC} = 0 V, DE at 0 V	V _I = 12 V		100	150	μA
			V _I = -7 V	-120	-60		
I _{CC}	Supply current(quiescent)	Driver and receiver enabled	DE = V _{CC} , /RE = GND, No LOAD		1800	2700	μA
		Driver enabled, receiver disabled	DE = V _{CC} , /RE = V _{CC} , No LOAD		500	800	

Parameter		Conditions		Min	Typ	Max	Units
		Driver disabled, receiver enabled	DE = GND, /RE = GND, No LOAD		1600	2100	
		Driver and receiver disabled	DE = GND, /RE = V _{CC} , D= V _{CC} No LOAD		5	10	

Switching Characteristics

Parameter		Conditions		Min	Typ	Max	Units
Driver							
t _r , t _f	Driver differential-output rise and fall times	RL = 54 Ω, CL=50pF	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 times	CL=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 _{PZL} , t _{PZH}	Receiver enable time	Driver enabled			75	120	ns
		Driver disabled			2350	3000	

Test Circuits and Waveforms

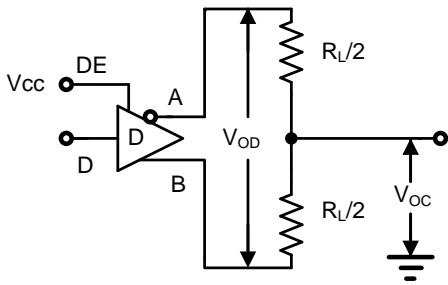


Figure 1A. VOD and VOC

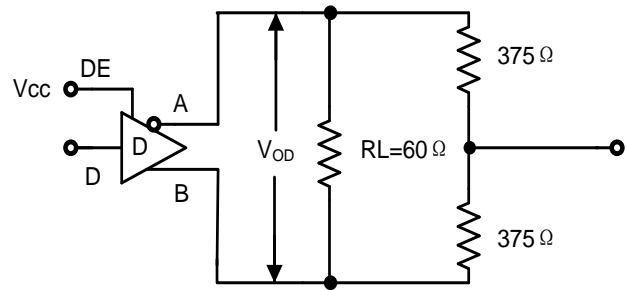


Figure 1B. VOD with Common Mode Load

FIGURE 1. DC Driver Test Circuits

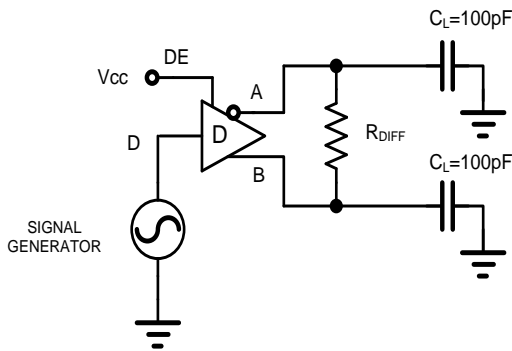


Figure 2A. Test Circuit

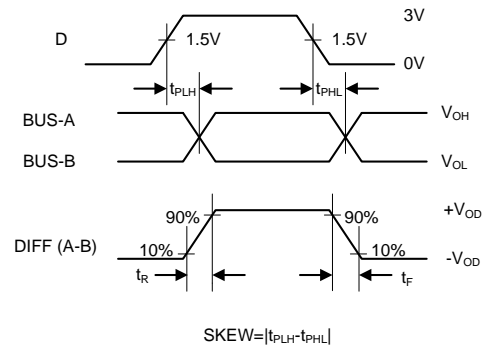


Figure 2B. Measurement Points

Figure 2. Driver Propagation Delay and Differential Transition Times

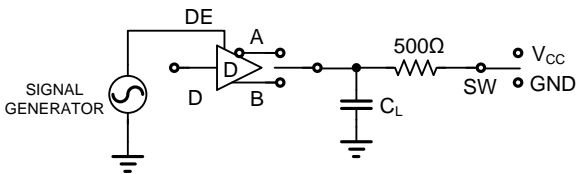


Figure 3A. Test Circuit

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

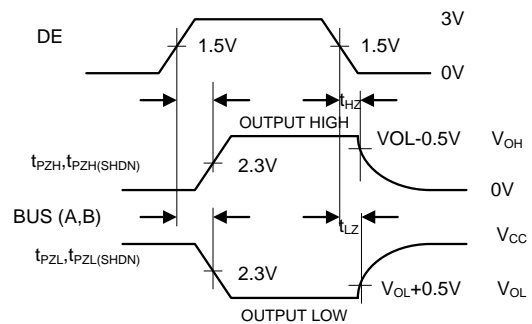


Figure 3B. Measurement Points

Figure 3. Driver Enable and Disable Times

Test Circuits and Waveforms (continue)

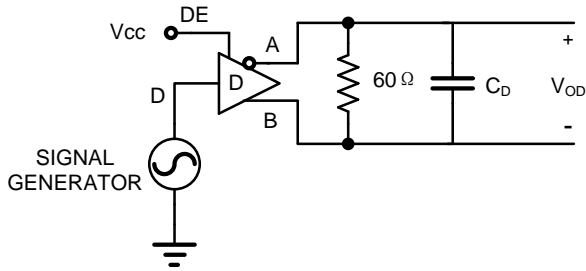


Figure 4A. Test Circuit

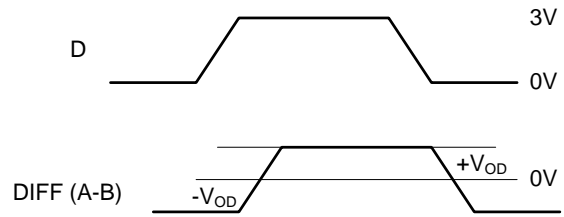


Figure 4B. Measurement Points

Figure 4. Driver Data rate

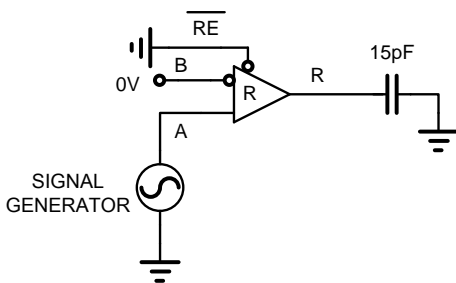


Figure 5A. Test Circuit

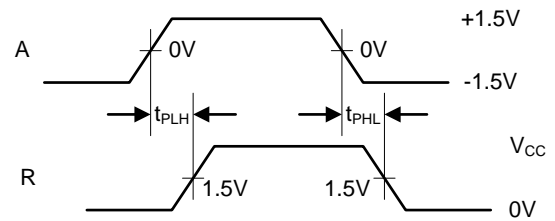


Figure 5B. Measurement Points

Figure 5. Receiver Propagation Delay and Data rate

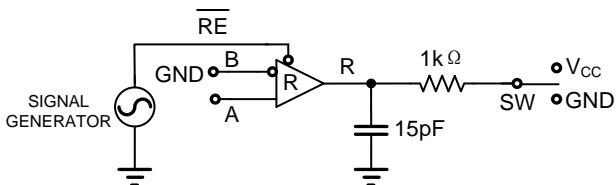


Figure 6A. Test Circuit

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

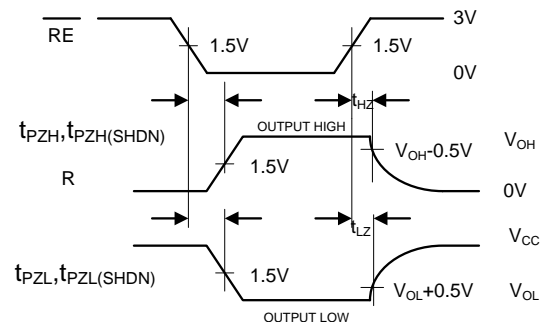
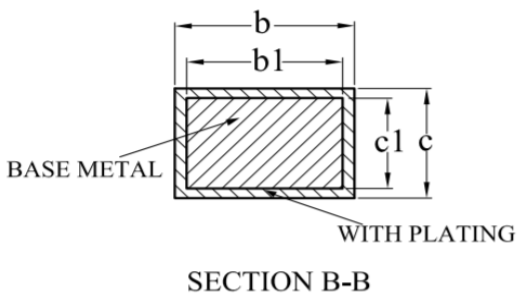
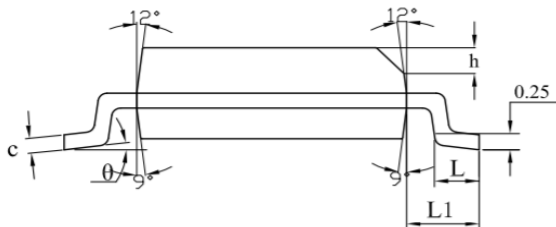
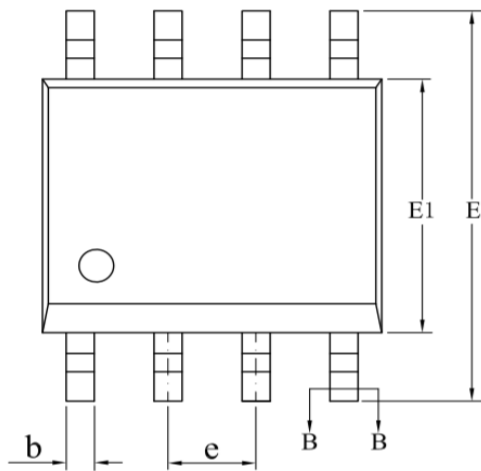
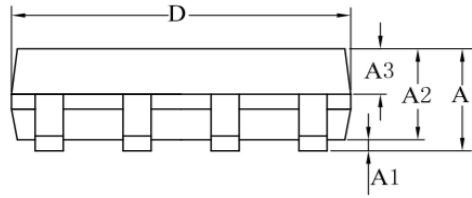


Figure 6B. Measurement Points

Figure 6. Receiver Enable and Disable Times

Package Outline Dimensions

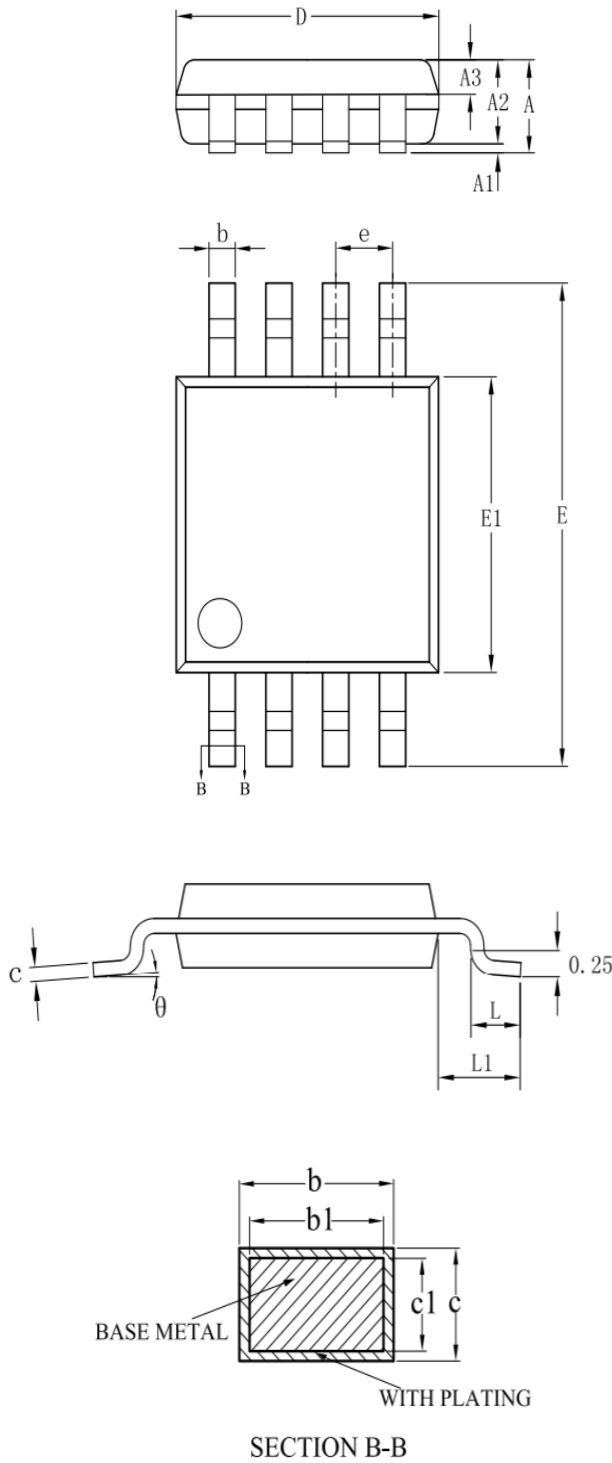
S01R (SOP8)



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)

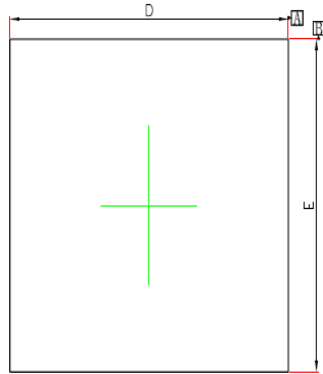


SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.10
A1	0.05	—	0.15
A2	0.75	0.85	0.95
A3	0.30	0.35	0.40
b	0.28	—	0.36
b1	0.27	0.30	0.33
c	0.15	—	0.19
c1	0.14	0.15	0.16
D	2.90	3.00	3.10
E	4.70	4.90	5.10
E1	2.90	3.00	3.10
e	0.65BSC		
L	0.40	—	0.70
L1	0.95REF		
θ	0	—	8°

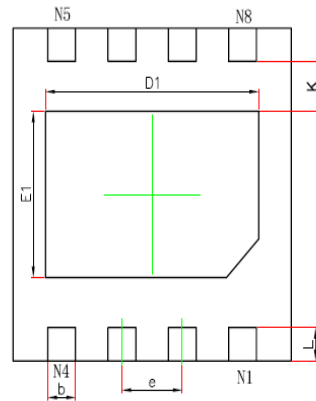
Package Outline Dimensions

DF6R (DFN3X3-8L)

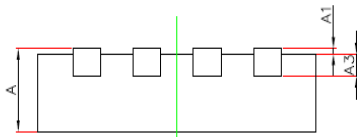
DFNWB3×3-8L-F(P0.65T0.75/0.85) PACKAGE OUTLINE DIMENSIONS



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