

钍地半导体
Tudi Semiconductor

Product Specification

TUDI-MAX3483/3485/3491AE

+3.3V-Powered, ±20kV ESD-Protected, 20Mbps and Slew-Rate-Limited RS-485/RS-422 Transceivers

网址 www.sztdbdt.com

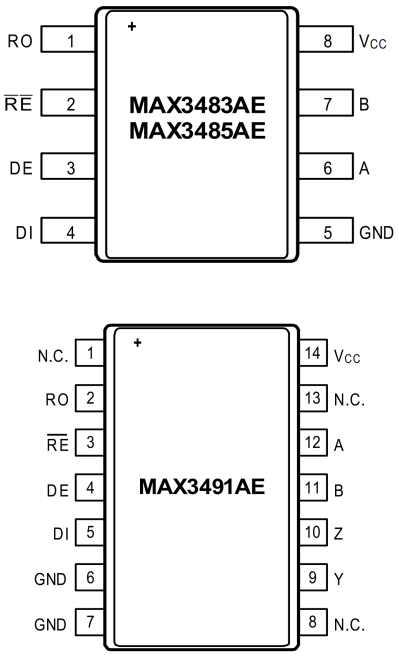
用芯智造·卓越品质

semiconductor device manufacturer

- Design
- research and development
- production
- and sales

Benefits and Features

TOP VIEW



- Integrated Protection Increases Robustness
- High ESD Protection

±20kV HBM ESD per JEDEC JS-001-2012
±15kV Air Gap per IEC 61000-4-2
±8kV Contact ESD per IEC 61000-4-2

- Short-Circuit Protected Outputs
- True Fail-Safe Receiver Prevents False Transition on Receiver Input Short or Open Events
- Hot-Swap Capability Eliminates False Transitions During Power-Up or Hot Insertion
- High-Speed Data Rates up to 20Mbps
- Up to -40 ° C to +125 ° C Operating Temperature
- Allows Up to 128 Transceivers on the Bus

Applications

- Industrial-Control Local Area Networks
- Transceivers for EMI-Sensitive Applications
- Telecommuncations

General Description

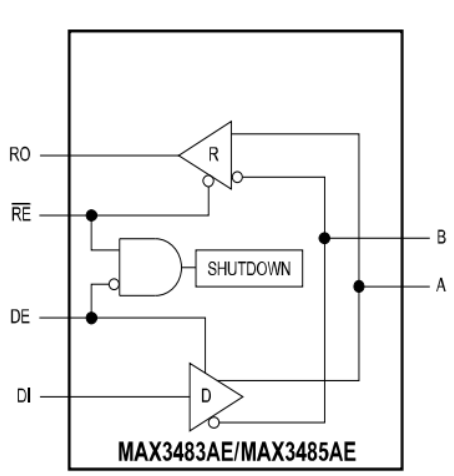
Devices in the MAX3483AE family (MAX3483AE/ MAX3485AE/MAX3488AE/MAX3490AE/ MAX3491AE) are ±20kV ESD-protected RS-485/422 transceivers, optimized for extended cable runs in noisy environments. All devices operate from a single 3.3V supply.

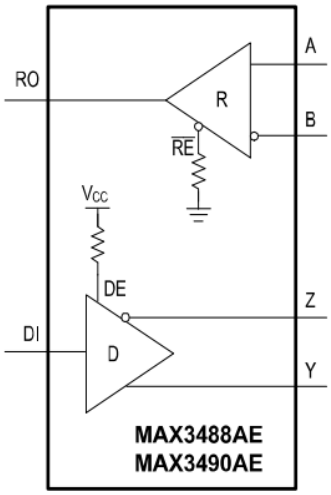
The MAX3483AE and MAX3485AE are half-duplex transceivers. The MAX3488AE, MAX3490AE, and MAX3491AE are full-duplex transceivers. The MAX3483AE/85AE have a 1-unit load receiver input impedance, allowing up to 32 transceivers on the bus. The MAX3488AE/90AE/91AE have a 1/4-unit load receiver input impedance, allowing up to 128 transceivers on the bus. Each transceiver includes a fail-safe receiver, ensuring that the receiver output (RO) is high when inputs are shorted, open, or connected to a three-state bus.

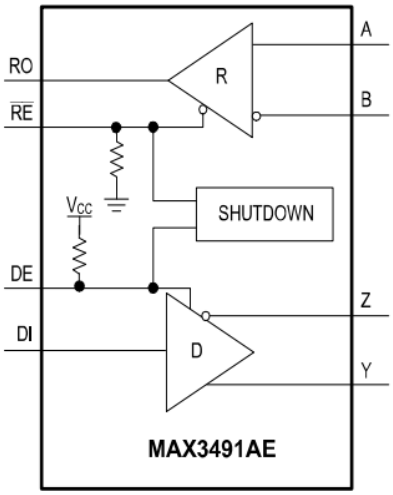
All devices feature enhanced electrostatic discharge (ESD) protection. All transmitter outputs and receiver inputs are protected to ±20kV HBM ESD, ±15kV Air-Gap ESD and ±8kV Contact ESD in accordance to IEC 61000-4-2.

The MAX3483AE, MAX3485AE, MAX3488AE, and MAX3490AE are available in industry standard 8-pin SO package, while the MAX3491AE is available in a 14-pin SO package.

Functional Diagram







Absolute Maximum Ratings

(Voltages referenced to GND.)

V_{CC} .....-0.3V to +4.0V
RO .....-0.3V to (V_{CC} + 0.3V)
$\overline{RE}$, DE, DI .....-0.3V to +4.0V
A, B, Y, Z .....-9.0V to +13.0V
Short-Circuit Duration (RO, A, B, Y, Z) to GND.....Continuous
Operating Temperature Range
MAX3483AE/85AE/88AE/90AE/91AE..... -40°C to +125°C
MAX3488AE/90AE ..... -40°C to +105°C
Junction Temperature.....+150°C
Storage Temperature Range..... -65°C to +150°C
Continuous Power Dissipation (T_A = +70°C)
8 SO (derate at 7.6mW/°C above +70°C).....606mW
14 SO (derate at 11.9mW/°C above +70°C) 952mW
Lead Temperature (soldering, 10s) .....+300°C
Soldering Temperature (reflow) ..... +260°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Package Thermal Characteristics (Note 1)

Junction-to-Case Thermal Resistance (θ_{JC})
8-pin SO .....38°C/W
14-pin SO .....34°C/W
Junction-to-Ambient Thermal Resistance (θ_{JA})
8-pin SO .....132°C/W
14-pin SO .....84°C/W

Note 1: Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board.

Electrical Characteristics

(V_{CC} = +3.0V to +3.6V, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at V_{CC} = +3.3V and T_A = +25°C.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
POWER SUPPLY						
Supply Voltage	V_{CC}		3.0		3.6	V
Supply Current	I_{CC}	DE = V_{CC}, $\overline{RE}$ = GND, no load		1.9	4	mA
		DE = 0, $\overline{RE}$ = 0, no load, DI = 0 or V_{CC}	1.2		4.0	
Shutdown Supply Current	I_{SHDN}	DE = GND, $\overline{RE}$ = V_{CC}, MAX3483AE/85AE/91AE			10	µA
DRIVER						
Differential Driver Output	V_{OD}	V_{CC} = 3V, R_L = 100Ω, Figure 1	2.0			V
		V_{CC} = 3V, R_L = 54Ω, Figure 1	1.5			
Change in Magnitude of Differential Output Voltage	ΔV_{OD}	R_L = 54Ω or 100Ω, Figure 1 (Note 4)	-0.2		+0.2	V
Driver Common-Mode Output Voltage	V_{OC}	R_L = 54Ω or 100Ω, Figure 1		V_{CC}/2	3	V
Change in Magnitude of Common-Mode Voltage	ΔV_{OC}	R_L = 54Ω or 100Ω, Figure 1 (Note 4)	-0.2		+0.2	V
Single-Ended Driver Output High	V_{OH}	A or B output, $I_{A \text{ or } B}$ = -20mA	2.2			V
Single-Ended Driver Output Low	V_{OL}	A or B output, $I_{A \text{ or } B}$ = 20mA			0.8	V
Driver Short-Circuit Output Current	I_{OSD}	V_{OUT} = -7V	-250			mA
		V_{OUT} = +12V			250	mA

Electrical Characteristics (continued)

(V_{CC} = +3.0V to +3.6V, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at V_{CC} = +3.3V and T_A = +25°C.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
RECEIVER							
Input Current	$I_{A, B}$	DE = GND, V_{CC} = GND or +3.6V	V_{IN} = +12V		430	1000	µA
			V_{IN} = -7V	-450	-300		
Differential Input Capacitance	$C_{A, B}$	Between A and B, DE = GND, f = 4MHz			12		pF
Receiver Differential Threshold Voltage	V_{TH}	-7V ≤ V_{CM} ≤ +12V		-200	-105	-10	mV
Receiver Input Hysteresis	ΔV_{TH}	V_{CM} = 0V			10		mV
Receiver Input Resistance	R_{IN}	-7V ≤ V_{CM} ≤ +12V	MAX3483AE/85AE	12			kΩ
			MAX3488AE/90AE/91AE	48			
LOGIC INTERFACE (DI, DE, $\overline{RE}$, RO)							
Input Voltage High	V_{IH}	DE, DI, $\overline{RE}$		2.0			V
Input Voltage Low	V_{IL}	DE, DI, $\overline{RE}$				0.8	V
Input Hysteresis	V_{HYS}	DE, DI, $\overline{RE}$			50		mV
Input Current	I_{IN}	DE, DI, $\overline{RE}$				±2	µA
Input Impedance on First Transition		DE, $\overline{RE}$		1		10	kΩ
RO Output Voltage High	V_{OHRO}	$\overline{RE}$ = GND, I_{RO} = -2mA, (V_A - V_B) > 200mV		V_{CC} - 1.5			V
RO Output Voltage Low	V_{OLRO}	$\overline{RE}$ = GND, I_{RO} = 2mA, (V_A - V_B) < -200mV				0.4	V
Receiver Three-State Output Current	I_{OZR}	$\overline{RE}$ = V_{CC}, 0 ≤ V_{RO} ≤ V_{CC}				±1	µA
$\overline{RE}$ Pulldown and DE Pullup Resistance	R_{IN}				1		MΩ
Receiver Output Short-Circuit Current	I_{OSR}	0 ≤ V_{RO} ≤ V_{CC}				±110	mA
PROTECTION							
Thermal Shutdown Threshold	T_{SHDN}	Temperature rising			+160		°C
Thermal Shutdown Hysteresis					15		°C
ESD Protection on A, B, Z, and Y Pins		IEC 61000-4-2 Air Gap Discharge to GND			±15		kV
		IEC 61000-4-2 Contact Discharge to GND			±8		
		Human Body Model to GND			±20		
ESD Protection, All Other Pins		Human Body Model			±2		kV

Switching Characteristics MAX3485AE/MAX3490AE/MAX3491AE

(V_{CC} = +3V to +3.6V, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at V_{CC} = +3.3V and T_A = +25°C.) (Notes 2, 3, 5)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
DRIVER						
Driver Propagation Delay	t_{DPLH}	R_L = 54Ω, C_L = 50pF, Figures 2 and 3			30	ns
	t_{DPHL}				30	
Driver Differential Output Rise or Fall Time	t_{HL}, t_{LH}	R_L = 54Ω, C_L = 50pF, Figures 2 and 3			7	ns
Differential Driver Output Skew $\lvert t_{DPLH} - t_{DPHL} \rvert$	t_{DSKEW}	R_L = 54Ω, C_L = 50pF, Figures 2 and 3 (Note 6)			3	ns
Maximum Data Rate	DR_{MAX}		20			Mbps
Driver Enable to Output High	t_{DZH}	R_L = 110Ω, C_L = 50pF, MAX3485AE, MAX3491AE Figures 4 and 5 (Note 7)			40	ns
Driver Enable to Output Low	t_{DZL}	R_L = 110Ω, C_L = 50pF, MAX3485AE, MAX3491AE Figures 4 and 5 (Note 7)			40	ns
Driver Disable Time from Low	t_{DLZ}	R_L = 110Ω, C_L = 50pF, MAX3485AE, MAX3491AE Figures 4 and 5			40	ns
Driver Disable Time from High	t_{DHZ}	R_L = 110Ω, C_L = 50pF, MAX3485AE, MAX3491AE Figures 4 and 5			40	ns
Driver Enable from Shutdown to Output High	$t_{DLZ(SHDN)}$	R_L = 110Ω, C_L = 15pF, MAX3485AE, Figures 4 and 5 (Note 7)			6	µs
		R_L = 1kΩ, C_L = 15pF, MAX3491AE, Figure 8			100	µs
Driver Enable from Shutdown to Output Low	$t_{DHZ(SHDN)}$	R_L = 110Ω, C_L = 15pF, MAX3485AE Figures 4 and 5 (Note 7)			6	µs
Time to Shutdown	t_{SHDN}	(Note 8)	50		800	ns
RECEIVER						
Receiver Propagation Delay	t_{RPLH}	C_L = 15pF, Figures 6 and 7			35	ns
	t_{RPHL}				35	
Receiver Output Skew	t_{RSKEW}	C_L = 15pF, Figures 6 and 7 (Note 6)			2	ns
Maximum Data Rate	DR_{MAX}		20			Mbps
Receiver Enable to Output High	t_{RZH}	R_L = 1kΩ, C_L = 15pF, MAX3485AE, MAX3491AE, Figure 8 (Note 7)			40	ns
Receiver Enable to Output Low	t_{RZL}	R_L = 1kΩ, C_L = 15pF, MAX3485AE, MAX3491AE, Figure 8 (Note 7)			40	ns
Receiver Disable Time from Low	t_{RLZ}	R_L = 1kΩ, C_L = 15pF, MAX3485AE, MAX3491AE, Figure 8			40	ns

Switching Characteristics MAX3485AE/MAX3490AE/MAX3491AE (continued)

(V_{CC} = +3V to +3.6V, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at V_{CC} = +3.3V and T_A = +25°C.) (Notes 2, 3, 5)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Receiver Disable Time from High	t_{RHZ}	R_L = 1kΩ, C_L = 15pF, MAX3485AE, MAX3491AE, Figure 8			40	ns
Receiver Enable from Shutdown to Output High	$t_{RLZ(SHDN)}$	R_L = 1kΩ, C_L = 15pF, MAX3485AE, Figure 8 (Note 7)			6	µs
		R_L = 1kΩ, C_L = 15pF, MAX3491AE, Figure 8			100	µs
Receiver Enable from Shutdown to Output Low	$t_{RHZ(SHDN)}$	R_L = 1kΩ, C_L = 15pF, MAX3485AE, Figure 8 (Note 7)			6	µs
		R_L = 1kΩ, C_L = 15pF, MAX3491AE, Figure 8			100	µs
Time to Shutdown	t_{SHDN}	(Note 8)	50		800	ns

Switching Characteristics (MAX3483AE/MAX3488AE)

(V_{CC} = +3V to +3.6V, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at V_{CC} = +3.3V and T_A = +25°C.) (Notes 2, 3, 5)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
DRIVER						
Driver Propagation Delay	t_{DPLH}	R_L = 54Ω, C_L = 50pF, Figures 2 and 3			1000	ns
	t_{DPHL}				1000	
Driver Differential Output Rise or Fall Time	t_{HL}, t_{LH}	R_L = 54Ω, C_L = 50pF, Figures 2 and 3	200		900	ns
Differential Driver Output Skew $\|t_{DPLH} - t_{DPHL}\|$	t_{DSKEW}	R_L = 54Ω, C_L = 50pF, Figures 2 and 3			140	ns
Maximum Data Rate	DR_{MAX}		250			kbps
Driver Enable to Output High	t_{DZH}	R_L = 110Ω, C_L = 50pF, MAX3483AE Figures 4 and 5 (Note 6)			2500	ns
Driver Enable to Output Low	t_{DZL}	R_L = 110Ω, C_L = 50pF, MAX3483AE Figures 4 and 5 (Note 6)			2500	ns
Driver Disable Time from Low	t_{DLZ}	R_L = 110Ω, C_L = 50pF, MAX3483AE Figures 4 and 5			100	ns
Driver Disable Time from High	t_{DHZ}	R_L = 110Ω, C_L = 50pF, MAX3483AE Figures 4 and 5			100	ns
Driver Enable from Shutdown to Output High	$t_{DLZ(SHDN)}$	R_L = 110Ω, C_L = 15pF, MAX3483AE Figures 4 and 5 (Note 6)			10	µs

Switching Characteristics (MAX3483AE/MAX3488AE) (continued)

(V_{CC} = +3V to +3.6V, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at V_{CC} = +3.3V and T_A = +25°C.) (Notes 2, 3, 5)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Driver Enable from Shutdown to Output Low	$t_{DHZ(SHDN)}$	R_L = 110Ω, C_L = 15pF, MAX3483AE Figures 4 and 5 (Note 6)			5.5	µs
Time to Shutdown	t_{SHDN}	(Note 8) MAX3483AE	50	340	700	ns
RECEIVER						
Receiver Propagation Delay	t_{RPLH}	C_L = 15pF, Figures 6 and 7			200	ns
	t_{RPHL}				200	
Receiver Output Skew	t_{RSKEW}	C_L = 15pF, Figures 6 and 7 (Note 6)			30	ns
Maximum Data Rate	DR_{MAX}		250			kbps
Receiver Enable to Output High	t_{RZH}	R_L = 1kΩ, C_L = 15pF, MAX3483AE Figure 8 (Note 6)			50	ns
Receiver Enable to Output Low	t_{RZL}	R_L = 1kΩ, C_L = 15pF, MAX3483AE Figure 8 (Note 6)			50	ns
Receiver Disable Time from Low	t_{RLZ}	R_L = 1kΩ, C_L = 15pF, MAX3483AE Figure 8			50	ns
Receiver Disable Time from High	t_{RHZ}	R_L = 1kΩ, C_L = 15pF, MAX3483AE Figure 8			50	ns
Receiver Enable from Shutdown to Output High	$t_{RLZ(SHDN)}$	R_L = 1kΩ, C_L = 15pF, MAX3483AE Figure 8 (Note 6)			10	µs
Receiver Enable from Shutdown to Output Low	$t_{RHZ(SHDN)}$	R_L = 1kΩ, C_L = 15pF, MAX3483AE Figure 8 (Note 6)			10	µs
Time to Shutdown	t_{SHDN}	(Note 8) MAX3483AE	50	340	800	ns

Note 2: All devices 100% production tested at T_A = +25°C. Specifications over temperature are guaranteed by design.
Note 3: All currents into the device are positive; all currents out of the device are negative. All voltages are referenced to ground, unless otherwise noted.
Note 4: ΔV_{OD} and ΔV_{OC} are the changes in V_{OD} and V_{OC}, respectively, when the DI input changes state.
Note 5: Capacitive load includes test probe and fixture capacitance.
Note 6: Guaranteed by design; not production tested.
Note 7: The timing parameter refers to the driver or receiver enable delay, when the device has exited the initial hot-swap protect state and is in normal operating mode.
Note 8: Shutdown is enabled by driving $\overline{RE}$ high and DE low. The device is guaranteed to have entered shutdown after t_{SHDN} has elapsed.

Test and Timing Diagrams

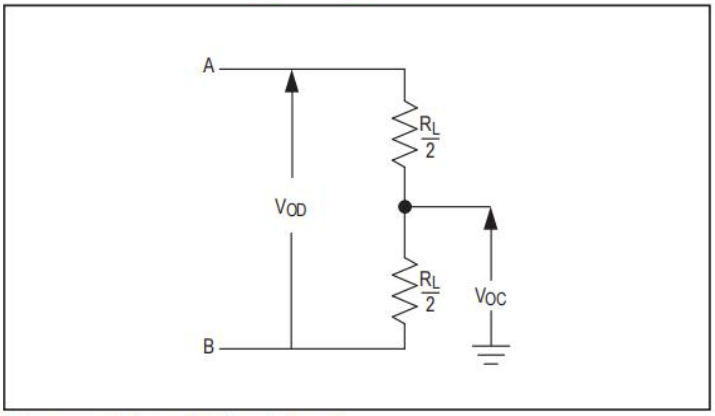


Figure 1. Driver DC Test Load

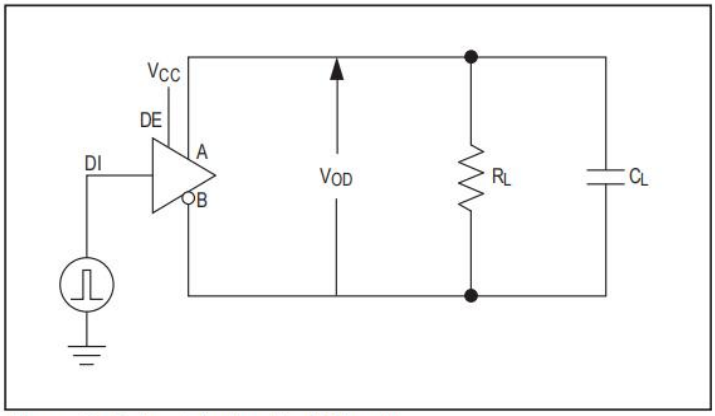


Figure 2. Driver Timing Test Circuit

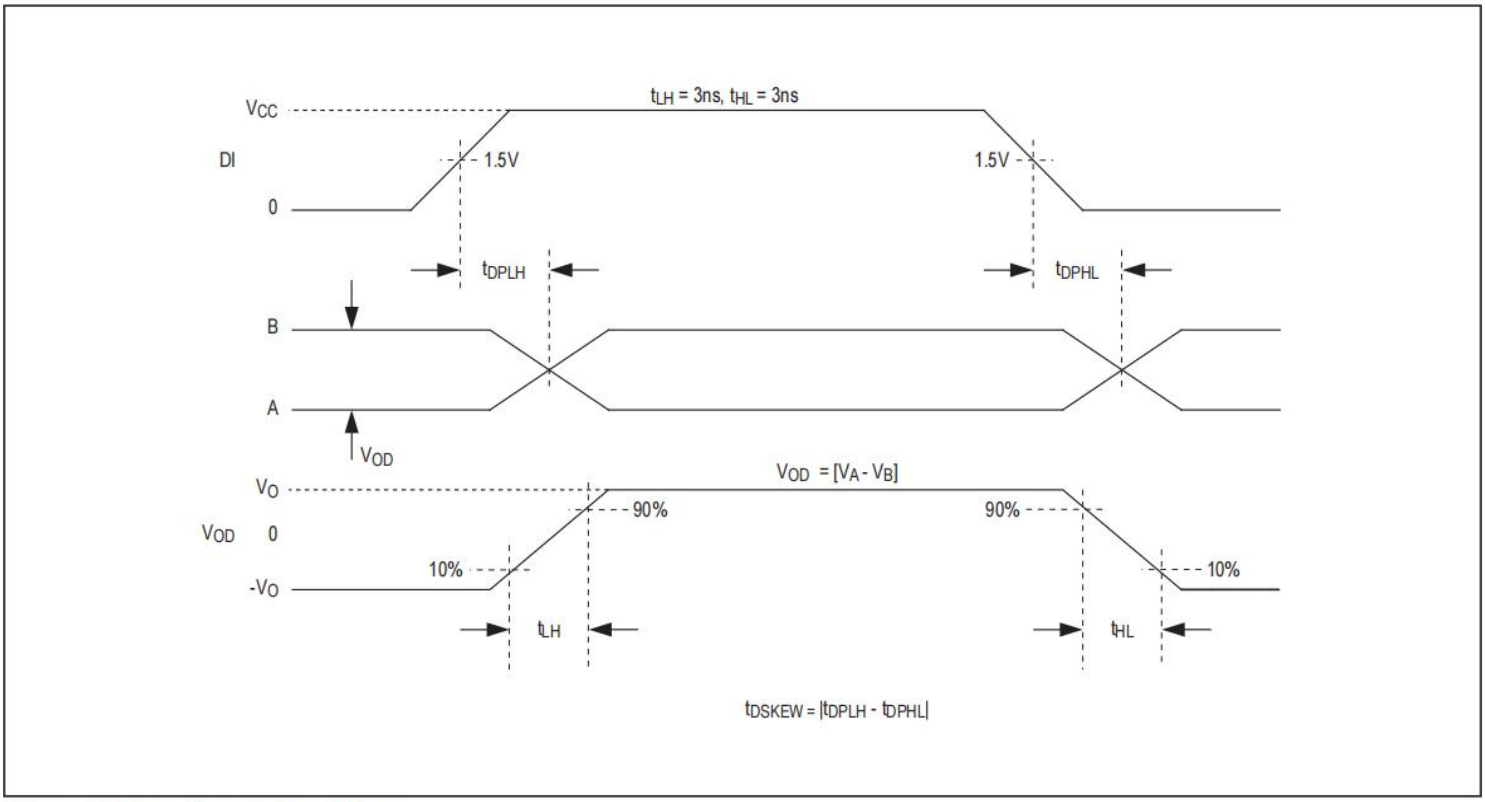


Figure 3. Driver Propagation Delays

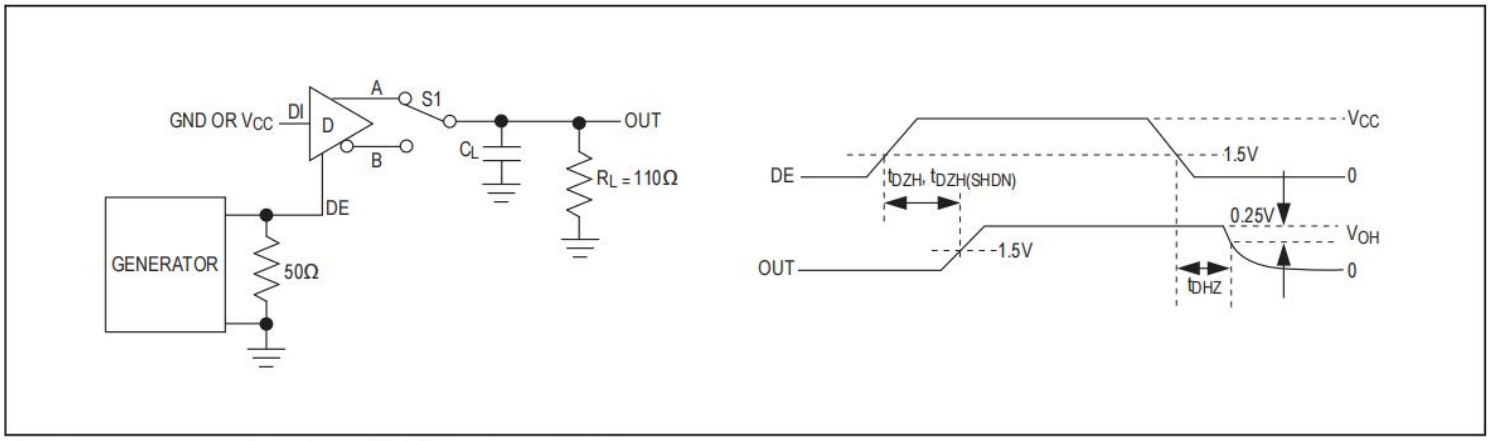


Figure 4. Driver Enable and Disable Times (t_{DZH}, t_{DHZ})

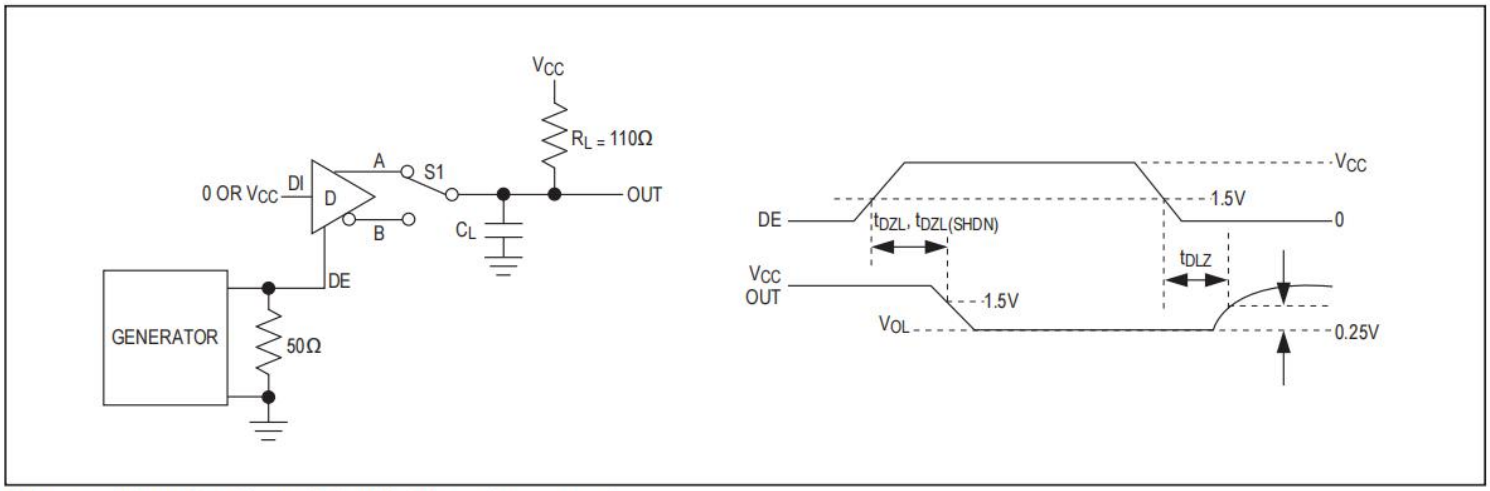


Figure 5. Driver Enable and Disable Times (t_{DZL}, t_{DLZ})

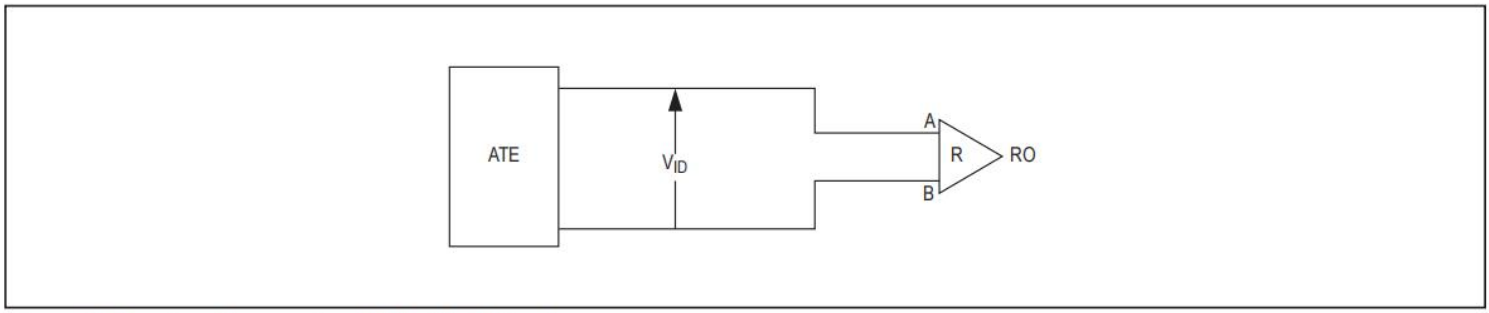


Figure 6. Receiver Propagation Delay Test Circuit

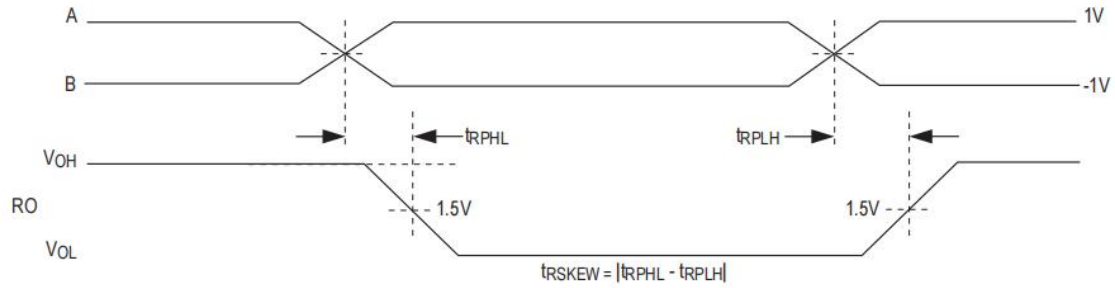


Figure 7. Receiver Propagation Delays

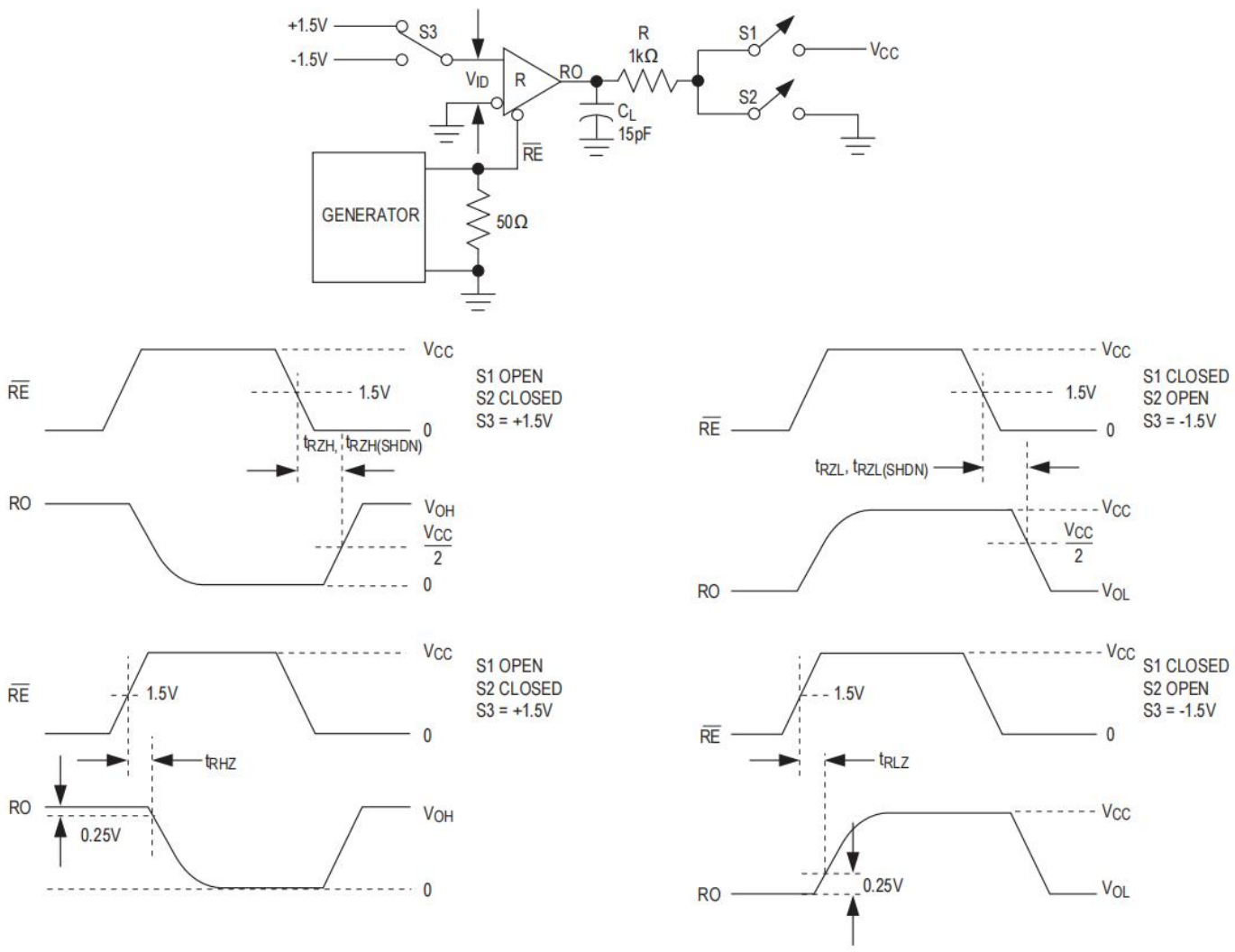


Figure 8. Receiver Enable and Disable Times

Pin Description

PIN			NAME	FUNCTION
MAX3483AE MAX3485AE	MAX3488AE MAX3490AE	MAX3491AE		
—	—	1, 8, 13	N.C.	No Connection. Not internally connected.
1	2	2	RO	Receiver Output. Drive $\overline{RE}$ low to enable RO. RO is always active on the MAX3488AE and MAX3490AE. RO is high when the receiver inputs (VA - VB) > -10mV and low when (VA -VB) ≤200mV. See the Function Tables.
2	—	3	$\overline{RE}$	Receiver Output Enable. Drive $\overline{RE}$ low, or leave unconnected, to enable RO. RO is high impedance when $\overline{RE}$ is high. Drive $\overline{RE}$ high and DE low to enter low-power shutdown mode. $\overline{RE}$ has a weak pulldown to GND.
3	—	4	DE	Driver Enable. Drive DE high, or leave unconnected, to enable the driver outputs (Y and Z for full duplex, A and B for half duplex). The driver outputs are high impedance when DE is low. Drive $\overline{RE}$ high and DE low to enter low-power shutdown mode. DE has a weak pullup to V_{CC}.
4	3	5	DI	Driver Input. A low on DI forces the noninverting output (Y or A) low and the inverting output (Z or B) high. Similarly, a high on DI forces the noninverting output (Y or A) high and the inverting output (Z or B) low. See the Function Tables.
5	4	6, 7	GND	Ground
—	5	9	Y	Noninverting Driver Output
—	6	10	Z	Inverting Driver Output
7	7	11	B	Inverting Receiver Input/Driver Output (MAX3483AE/MAX3485AE). Inverting Receiver Input (MAX3488AE/MAX3490AE/MAX3491AE).
6	8	12	A	Noninverting Receiver Input/Driver Output (MAX3483AE/MAX3485AE). Noninverting Receiver Input (MAX3488AE/MAx3490AE/MAX3491AE).
8	1	14	V_{CC}	Positive Supply. Bypass V_{CC} to GND with a 0.1µF capacitor as close as possible to the IC.

Function Tables (MAX3483AE, MAX3485AE)

TRANSMITTING					
INPUTS			OUTPUTS		MODE
$\overline{RE}$	DE	DI	B	A	
X	1	1	0	1	Active
X	1	0	1	0	Active
0	0	X	High Impedance		Driver Disabled
1	0	X	High Impedance		Shutdown

RECEIVING				
INPUTS			OUTPUTS	MODE
$\overline{RE}$	DE	A-B	RO	
0	X	≥ -10mV	1	Active
0	X	≤ -200mV	0	Active
0	X	Open/Shorted	1	Active
1	1	X	High Impedance	Receiver Disabled
1	0	X	High Impedance	Shutdown

X = Don't care

Function Tables MAX3491AE

TRANSMITTING				
INPUTS			OUTPUTS	
$\overline{RE}$*	DE*	DI	Y	Z
X	1	1	1	0
X	1	0	0	1
0	0	X	High-Impedance	
1	0	X	Shutdown	

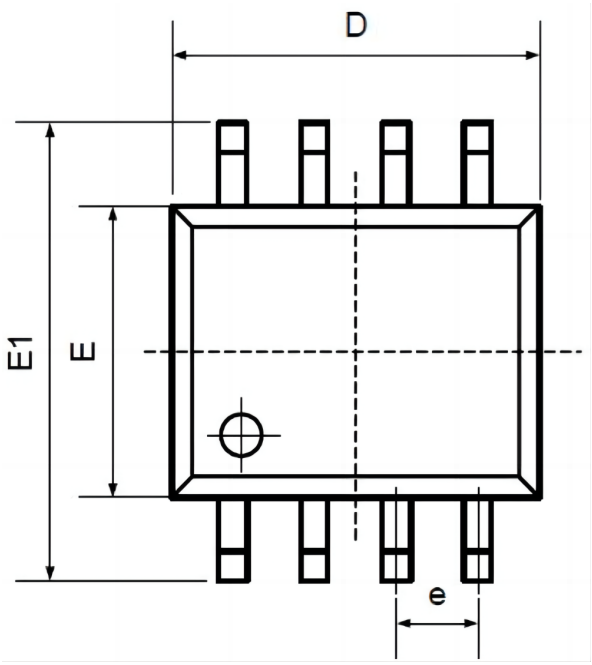
RECEIVING			
INPUTs			OUTPUT
$\overline{RE}$*	DE*	$V_A - V_B$	RO
0	X	≥ -10mV	1
0	X	≤ -200mV	0
0	X	Open/Shorted	1
1	1	X	High-Impedance
1	0	X	Shutdown

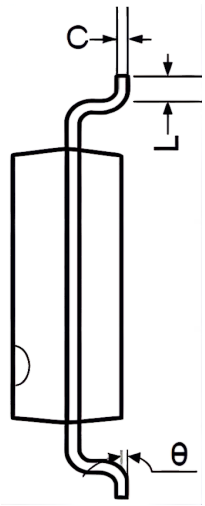
**$\overline{RE}$ and DE on the MAX3488AE and MAX3490AE are internal. The driver outputs and receiver are always active in these devices.*

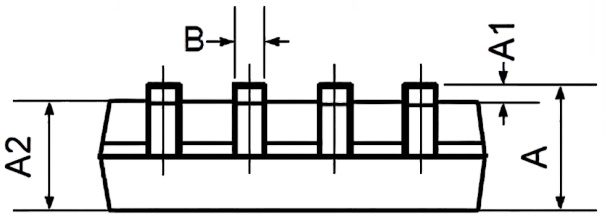
ORDERING INFORMATION

Order Number	Package	Package Quantity	Marking On The park
MAX3483AEAS-TUDI	SOP8	Tape,Reel,2500	MAX3483AEAS
MAX3485AEASA-TUDI	SOP8	Tape,Reel,2500	MAX3485AEASA
MAX3491AEASD-TUDI	SOP14	Tape,Reel,2500	MAX3491AEASD

Package SOP8

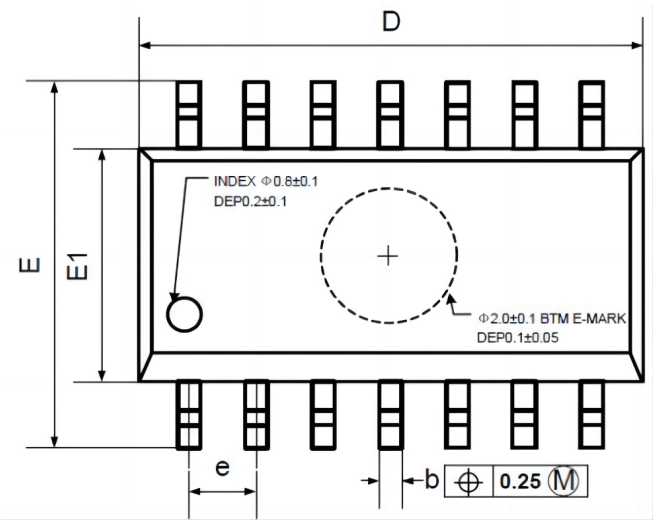


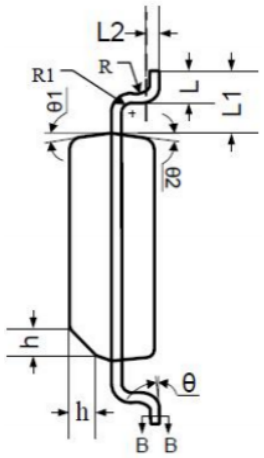


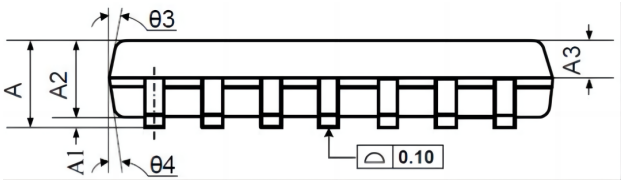


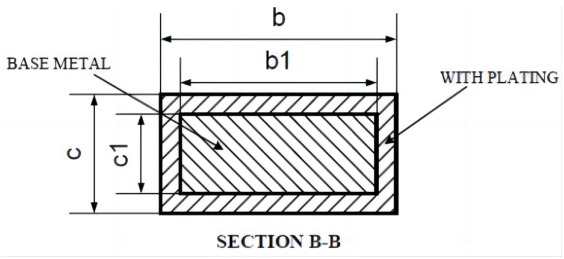
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
B	0.330	0.510	0.013	0.020
C	0.190	0.250	0.007	0.010
D	4.780	5.000	0.188	0.197
E	3.800	4.000	0.150	0.157
E1	5.800	6.300	0.228	0.248
e	1.270TYP		0.050TYP	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

Package SOP14









Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	1.35	1.60	1.75
A1	0.10	0.15	0.25
A2	1.25	1.45	1.65
A3	0.55	0.65	0.75
b	0.36		0.49
b1	0.35	0.40	0.45
C	0.16		0.25
c1	0.15	0.20	0.25
D	8.53	8.63	8.73
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27 BSC		
L	0.45	0.60	0.80
L1	1.04 REF		
L2	0.25 BSC		
R	0.07		
R1	0.07		
h	0.30	0.40	0.50
θ	0°		8°
θ1	6°	8°	10°
θ2	6°	8°	10°
θ3	5°	7°	9°
θ4	5°	7°	9°

Important statement:

●TUDI Semiconductor reserves the right to modify the product manual without prior notice! Before placing an order, customers need to confirm whether the obtained information is the latest version and verify the completeness of the relevant information.

●Any semi-guide product is subject to failure or malfunction under specified conditions. It is the buyer's responsibility to comply with safety standards when using TUDI Semiconductor products for system design and whole machine manufacturing.And take the appropriate safety measures to avoid the potential in the risk of loss of personal injury or loss of property situation!

●TUDI Semiconductor products have not been licensed for life support, military, and aerospace applications,and therefore TUDI Semiconductor is not responsible for any consequences arising from the use of this product in these areas.

●If any or all TUDI Semiconductor products (including technical data, services) described or contained in this document are subject to any applicable local export control laws and regulations, they may not be exported without an export license from the relevant authorities in accordance with such laws.

●The specifications of any and all TUDI Semiconductor products described or contained in this document specify the performance, characteristics, and functionality of said products in their standalone state, but do not guarantee the performance, characteristics, and functionality of said products installed in Customer's products or equipment. In order to verify symptoms and conditions that cannot be evaluated in a standalone device, the Customer should ultimately evaluate and test the device installed in the Customer's product device.

●TUDI Semiconductor documentation is only allowed to be copied without any alteration of the content and with the relevant authorization.TUDI Semiconductor assumes no responsibility or liability for altered documents.

●TUDI Semiconductor is committed to becoming the preferred semiconductor brand for customers, and TUDI Semiconductor will strive to provide customers with better performance and better quallity products.