

High-Speed 3.3V/5V RS-485/RS-422 Transceiver with $\pm 35\text{kV}$ HBM ESD Protection

■ Description

The TK14783 is a half-duplex RS-485/422 transceiver that operates at either 3.3V or 5V rails with high $\pm 35\text{kV}$ ESD performance and up to 40Mbps data rate. The device is optimized for high speeds over extended cable runs while maximizing tolerance to noise.

The TK14783 is available in 8-pin SOIC package. The TK14783 operates over the -40°C to $+125^{\circ}\text{C}$ temperature ranges.

■ Features

- 1 transmitter and 1 receivers of the serial data of the standard RS-485
- Auto Shutdown function provide low power consumption
- 3V to 5.5V Supply Voltage Range
- Operating temperature range: $-40 \sim +125^{\circ}\text{C}$
- Data rate: 40Mbps
- Low $10\mu\text{A}$ (max) Shutdown Current for Lower Power Consumption
- Allows Up to 32 Transceivers on the Bus
- Enhanced ESD Specifications:
 $\pm 20\text{kV}$ IEC61000-4-2 Air Discharge
 $\pm 12\text{kV}$ IEC61000-4-2 Contact Discharge
 $\pm 35\text{kV}$ JS-001-2012 HBM ESD

■ Ordering Information

Part Number	Package	Packing	Temperature(TA)	Package Qty	ESD
TK14783FSR	SOIC-8	Reel	$-40^{\circ}\text{C} \sim 85^{\circ}\text{C}$	2500	$\pm 15\text{KV}$

Note: Please contact us to customize other packaging devices.

■ Pin Description

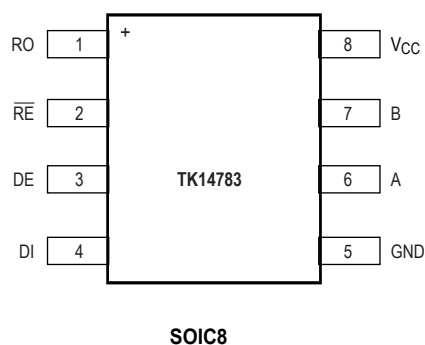


Table 1. Pin Description

PIN	NAME	FUNCTION
1	RO	Receiver Output. See <i>Function Tables</i> .
2	$\overline{RE}$	Receiver Output Enable. Drive $\overline{RE}$ low to enable RO. Drive $\overline{RE}$ high to disable the receiver. RO is high impedance when $\overline{RE}$ is high. Drive $\overline{RE}$ high and pull DE low to enter low-power shutdown mode.
3	DE	Driver Output Enable. Drive DE high to enable the driver. Drive DE low to disable the driver. Driver outputs are high-impedance when the driver is disabled. Drive $\overline{RE}$ high and pull DE low to enter low-power shutdown mode.
4	DI	Driver Input. With DE high, a low on DI forces the A output low and the B output high. Similarly, a high on DI forces the A output high and B output low.
5	GND	Ground
6	A	Noninverting RS-485/RS-422 Receiver Input and Driver Output
7	B	Inverting RS-485/RS-422 Receiver Input and Driver Output
8	V _{CC}	Positive Supply Voltage Input. Bypass V _{CC} with a 0.1μF ceramic capacitor to ground.

Functional Diagram

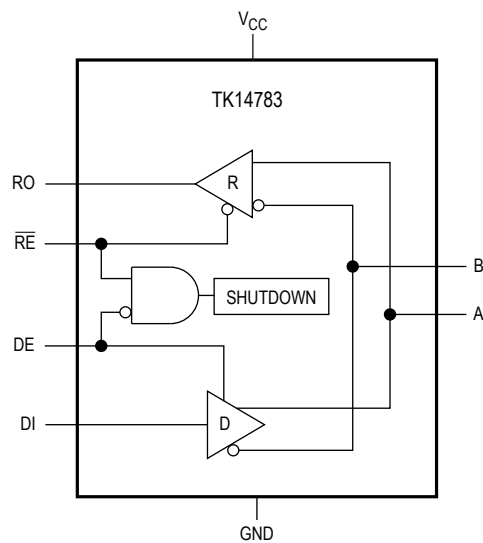


Table 2. Function Tables Transmitter Truth Table

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

Note : H – high level, L – low level , X –don't care, Z – third state

Table 3. Function Tables Receiver Truth Table

RECEIVING				
INPUTS			OUTPUTS	MODE
$\overline{RE}$	DE	A-B	RO	
L	X	$\geq -10\text{mV}$	H	Active
L	X	$\leq -200\text{mV}$	L	Active
L	X	Open/Shorted	H	Active
H	H	X	High Impedance	Receiver Disabled
H	L	X	High Impedance	Shutdown

Note : H – high level, L – low level , BH – inputs not used, X –don't care, Z – third state,
 ZZ – inputs and outputs are in the third state

Table 4. Recommended Operating Condition

Symbol	Parameter	Limit		Unit
		min	max	
V_{CC}	Supply voltage	4.75	5.25	V
V_{IL}	Input low voltage DI, DE, $\overline{RE}$ pins	0	0.8	V
V_{IH}	Input high voltage DI, DE, $\overline{RE}$ pins	2.0	V_{CC}	V
V_{OD}	Transmitter output voltage	-7.0	12.0	V
V_{IR}	Receiver input voltage	-7.0	12.0	V
V_{OR}	Receiver output voltage	0	V_{CC}	V
V_{TH}	Receiver differential threshold voltage	$ \pm 50 $	$ \pm 200 $	V
T	Ambient temperature	-40	120	°C

Table 5. Maximum Ratings

Symbol	Parameter	Limit		Unit
		min	max	
V_{CC}	Supply voltage	-0.3	6.0	V
V_{IL}	Input voltage on pins DI, DE, $\overline{RE}$	-0.3	6.0	V
V_{OD}	Transmitter output voltage	-8	13	V
V_{IR}	Receiver input voltage	-8	13	V
V_{OR}	Receiver output voltage	-0.3	$V_{CC}+0.3$	V

* Stresses beyond those listed under “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 under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Table 6. Electrical Parameters

(VCC = +3.0V to +5.5V, TA = TMIN to TMAX, Typical values are at VCC = +5V and TA = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
POWER SUPPLY (Test)							
Supply Voltage	V _{CC}			3.0		5.5	V
Supply Current	I _{CC}	DE = V _{CC} , $\overline{RE}$ = GND, no load			1.9	4	mA
Shutdown Supply Current	I _{SHDN}	DE = GND, $\overline{RE}$ = V _{CC}				10	μA
DRIVER							
Differential Driver Output	V _{OD}	V _{CC} = 4.5V, R _L = 54Ω, Figure 1		2.1		V	
		V _{CC} = 3V, R _L = 100Ω, Figure 1		2.0			
		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 (Note1)		-0.2	0	+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 (Note1)		-0.2		+0.2	V
Single-Ended Driver Output High	V _{OH}	A or B output, I _{A or B} = -20mA		2.2			V
Single-Ended Driver Output Low	V _{OL}	A or B output, I _{A or B} = 20mA				0.8	V
Differential Output Capacitance	C _{OD}	DE = $\overline{RE}$ = V _{CC} , f = 4MHz		12			pF
Driver Short-Circuit Output Current	I _{OST}	0 ≤ V _{OUT} ≤ +12V, output low				250	mA
		-7V ≤ V _{OUT} ≤ V _{CC} , output high				250	mA
RECEIVER							
Input Current	I _{A, B}	DE = GND, V _{CC} = GND or +5.5V	V _{IN} = +12V	400		1000	μA
			V _{IN} = -7V	-800	300		
Differential Input Capacitanc	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		12			kΩ
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, $\overline{RE}$				±1	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} - 0.4			V
RO Output Voltage Low	V _{OLRO}	$\overline{RE}$ = GND, I _{RO} = 2mA, (V _A - V _B) < -200mV				0.4	V

Table 6. Electrical Parameters (continued)

(VCC = +3.0V to +5.5V, TA = TMIN to TMAX, Typical values are at VCC = +5V and TA = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Receiver Tri-State Output Current	IOZR	$\overline{RE} = V_{CC}, 0 \leq V_{RO} \leq V_{CC}$			±1	μA
Receiver Output Short-Circuit Current	IOSR	$0 \leq V_{RO} \leq V_{CC}$			±110	mA
PROTECTION						
Thermal Shutdown Threshold	TSHDN	Temperature rising			+160	°C
Thermal Shutdown Hysteresis					15	°C
ESD Protection on A and B Pins		IEC 61000-4-2 Air Gap Discharge to GND			±20	kV
		IEC 61000-4-2 Contact Discharge to GND			±12	
		Human Body Model			±35	
ESD Protection, All Other Pins		Human Body Model			±2	kV

Table 7. Switching Characteristics

(VCC = +3V to +5.5V, TA = TMIN to TMAX, . Typical values are at VCC = +5V and TA = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
DRIVER						
Driver Propagation Delay	tDPLH	RL = 54Ω, CL = 50pF, Figures 2 and 3			20	ns
	tDPLH				20	
Driver Differential Output Rise or Fall Time	tHL, tLH	RL = 54Ω, CL = 50pF, Figures 2 and 3			7	ns
Differential Driver Output Skew tDPLH - tDPLH	tDSKEW	RL = 54Ω, CL = 50pF, Figures 2 and 3 (Note 2)			3	ns
Maximum Data Rate	DRMAX	TK14783EATA			42	Mbps
		TK14783EEUA			30	
		TK14783EESA			40	
		TK14783EAUA	3.0V ≤ VCC ≤ 3.6V		42	
					6	
		TK14783EASA	3.0V ≤ VCC ≤ 5.5V		42	
					16	

Table 7 Switching Characteristics (continued)

($V_{CC} = +3V$ to $+5.5V$, $T_A = T_{MIN}$ to T_{MAX} , Typical values are at $V_{CC} = +5V$ and $T_A = +25^{\circ}C$.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Driver Enable to Output High	t_{DZH}	$R_L = 110\Omega$, $C_L = 50pF$, Figures 4 and 5 (Note 3)			30	ns
Driver Enable to Output Low	t_{DZL}	$R_L = 110\Omega$, $C_L = 50pF$, Figures 4 and 5 (Note 3)			30	ns
Driver Disable Time from Low	t_{DLZ}	$R_L = 110\Omega$, $C_L = 50pF$, Figures 4 and 5			30	ns
Driver Disable Time from High	t_{DHZ}	$R_L = 110\Omega$, $C_L = 50pF$, Figures 4 and 5			30	ns
Driver Enable from Shutdown to Output High	$t_{DLZ}(SHDN)$	$R_L = 110\Omega$, $C_L = 15pF$, Figures 4 and 5 (Note 3)			6	μs
Driver Enable from Shutdown to Output Low	$t_{DHZ}(SHDN)$	$R_L = 110\Omega$, $C_L = 15pF$, Figures 4 and 5 (Note 3)			6	μs
Time to Shutdown	t_{SHDN}	(Note 3)	50		800	ns
RECEIVER						
Receiver Propagation Delay	t_{RPLH}	$C_L = 15pF$, Figures 6 and 7			25	ns
	t_{RPHL}	$C_L = 15pF$, Figures 6 and 7			25	
Receiver Output Skew	t_{RSKEW}	(Note 2)			2	ns
Maximum Data Rate	DR_{MAX}		42			Mbps
Receiver Enable to Output High	t_{RZH}	$R_L = 1k\Omega$, $C_L = 15pF$, Figure 8 (Note 3)			30	ns
Receiver Enable to Output Low	t_{RZL}	$R_L = 1k\Omega$, $C_L = 15pF$, Figure 8 (Note 3)			30	ns
Receiver Disable Time from Low	t_{RLZ}	$R_L = 1k\Omega$, $C_L = 15pF$, Figure 8			30	ns
Receiver Disable Time from High	t_{RHZ}	$R_L = 1k\Omega$, $C_L = 15pF$, Figure 8			30	ns
Receiver Enable from Shutdown to Output High	$t_{RLZ}(SHDN)$	$R_L = 1k\Omega$, $C_L = 15pF$, Figure 8 (Note 3)			6	μs
Receiver Enable from Shutdown to Output Low	$t_{RHZ}(SHDN)$	$R_L = 1k\Omega$, $C_L = 15pF$, Figure 8 (Note 3)			6	μs
Time to Shutdown	t_{SHDN}	(Note 3)	50		800	ns

Note 1: ΔV_{OD} and ΔV_{OC} are the changes in V_{OD} and V_{OC} , respectively, when the DI input changes state.

Note 2: Guaranteed by design; not production tested.

Note 3: The timing parameter refers to the driver or receiver enable delay, when the device has exited the initial hot-swap protect

Test and Timing Diagrams

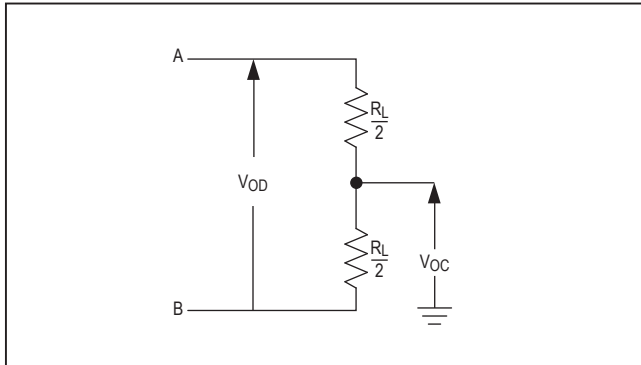


Figure 1. Driver DC Test Load

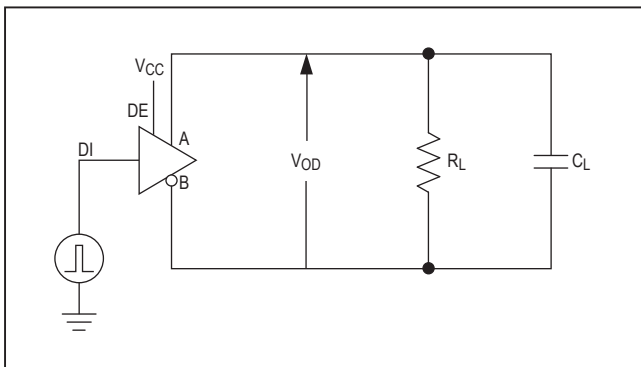


Figure 2. Driver Timing Test Circuit

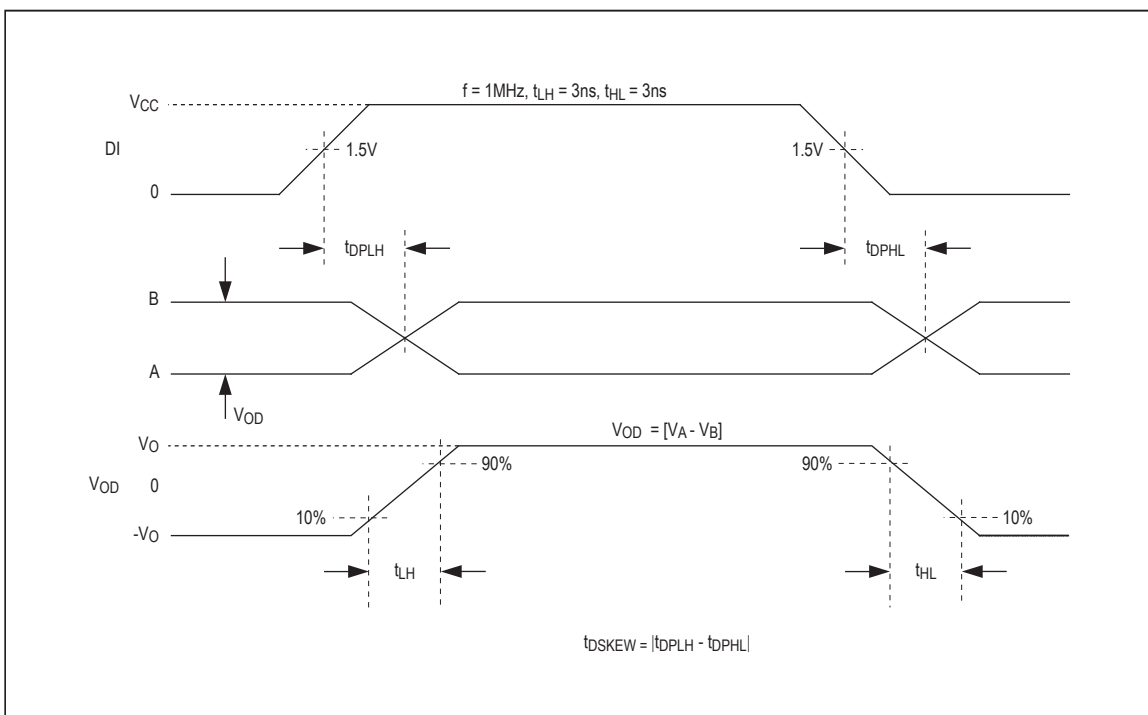


Figure 3. Driver Propagation Delays

Test and Timing Diagrams(continued)

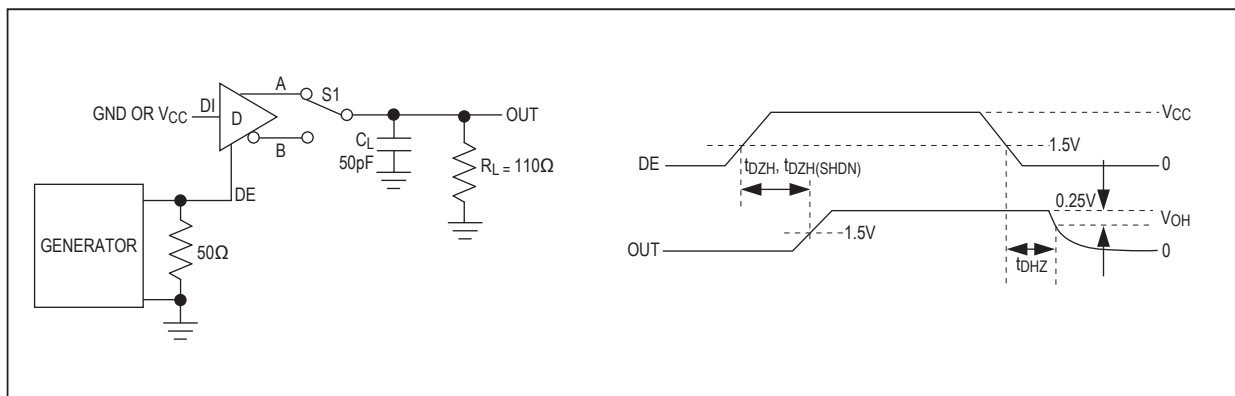


Figure 4. Driver Enable and Disable Times (t_{DZH} , t_{DHZ})

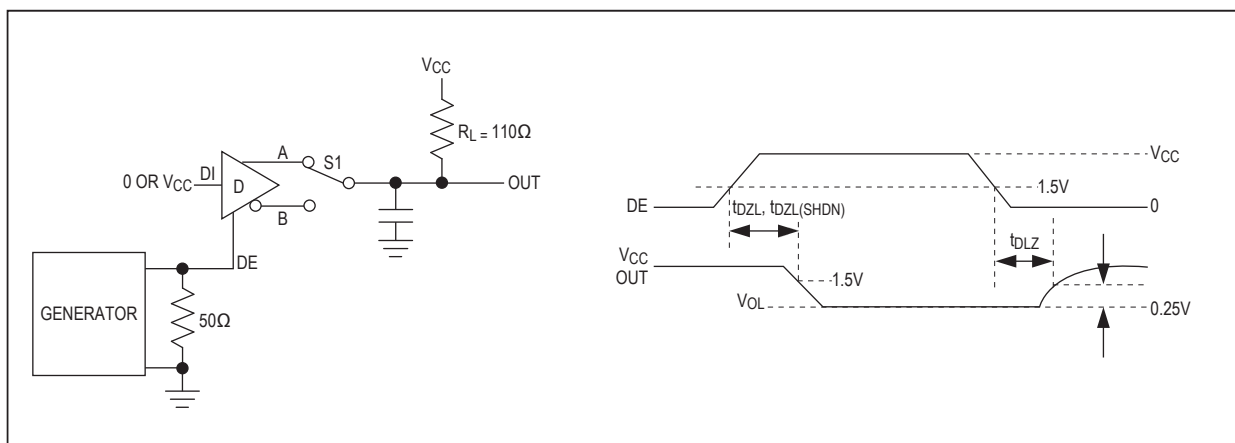


Figure 5. Driver Enable and Disable Times (t_{DZL} , t_{DLZ})

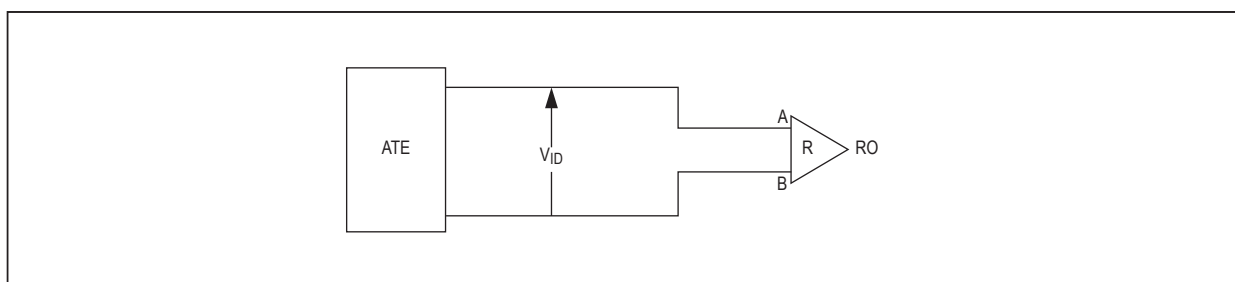


Figure 6. Receiver Propagation Delay Test Circuit

Test and Timing Diagrams(continued)

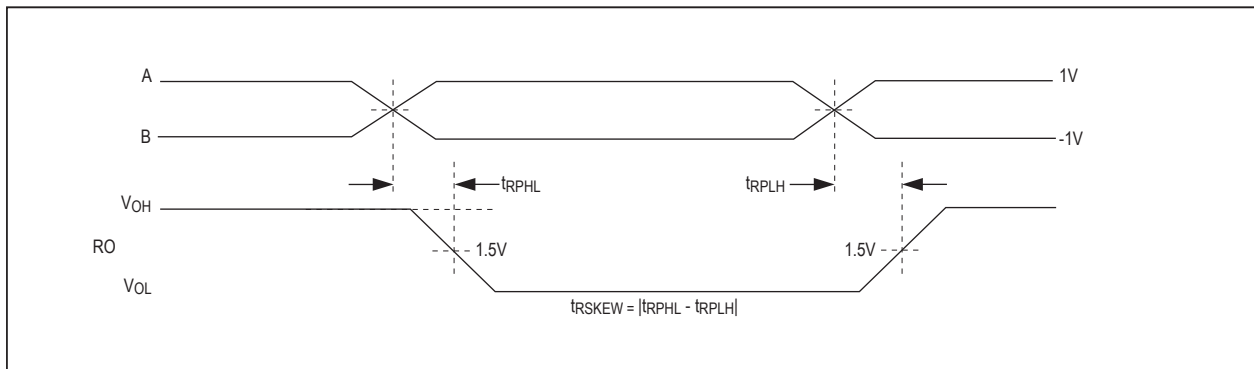


Figure 7. Receiver Propagation Delays

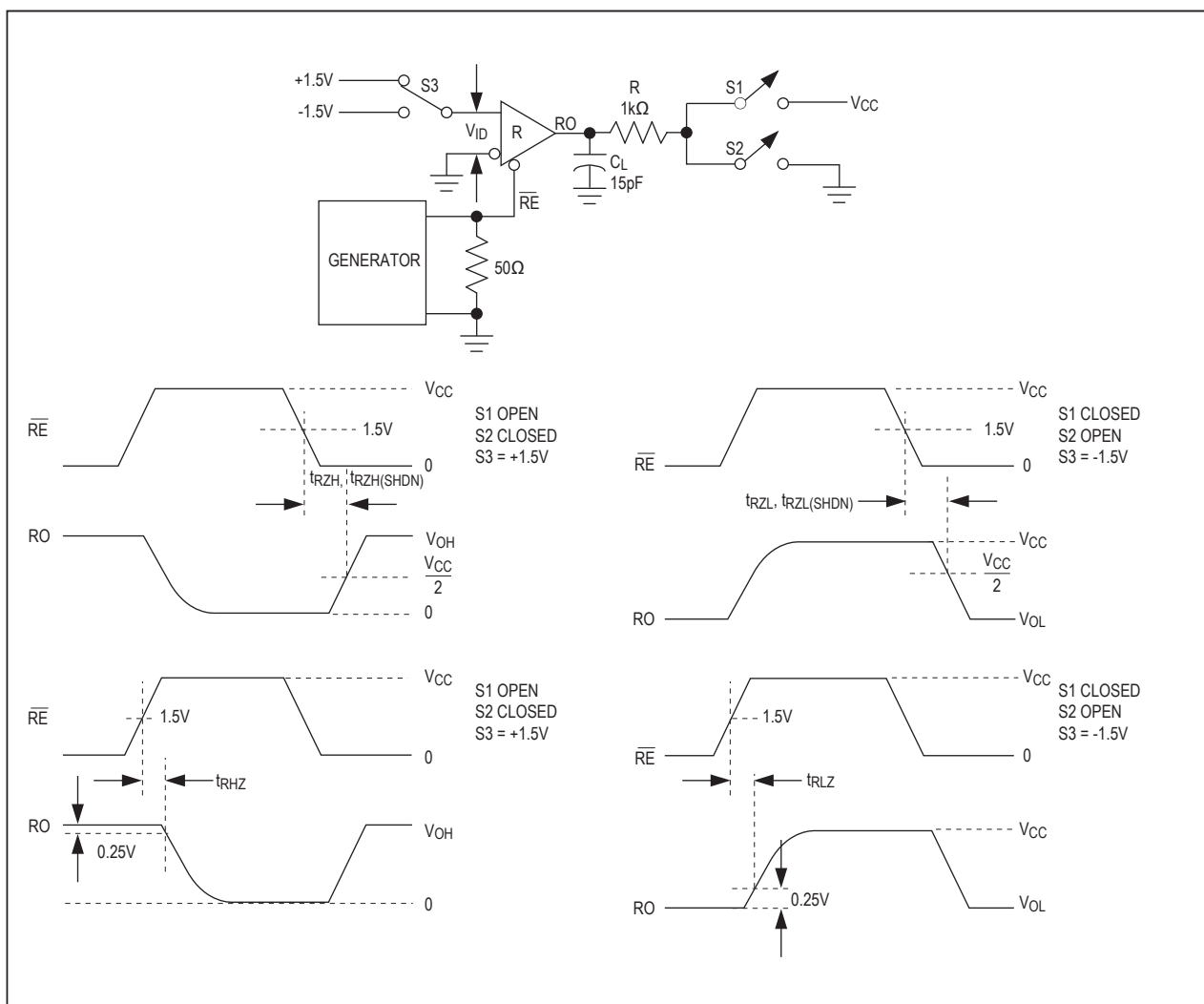
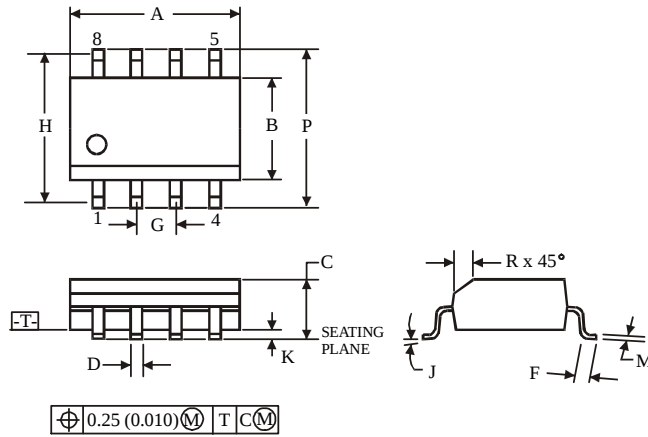


Figure 8. Receiver Enable and Disable Times

■ Package Dimensions

SOIC8



NOTES:

1. Dimensions A and B do not include mold flash or protrusion.
2. Maximum mold flash or protrusion 0.15 mm (0.006) per side for A; for B - 0.25 mm (0.010) per side.