

+5.0V, $\pm 15\text{kV}$ ESD-Protected, Fail-Safe, Hot-Swap, RS-485/RS-422 Transceivers

■ **Description**

The TK13089E +5.0V, $\pm 15\text{kV}$ ESD-protect-ed, RS-485/RS-422 transceivers feature one driver and one receiver. These devices include fail-safe circuitry, guaranteeing a logic-high receiver output when receiver inputs are open or shorted. The receiver outputs a logic-high if all transmitters on a terminated bus are disabled (high impedance). The TK13089E family include a hot-swap capability to eliminate false transitions on the bus during power-up or hot insertion.

The TK13089E slew rate is pin selectable for 250kbps, 500kbps, and 16Mbps. .It is intended for full-duplex communica-tions.The TK13089E is selectable for half-duplex or full-duplex operation. It also features independently programmable receiver and transmitter output phase through separate pins.

All devices have a 1/8-unit load receiver input impedance, allowing up to 256 trans-ceivers on the bus.It is available in 14-pin SOIC packages.The devices operate over the commercial, extended, and automotive temperature ranges.

■ **Features**

- 1 transmitter and 1 receivers of the serial data of the standard RS-485
- Pin-Selectable Full-/Half-Duplex Operation
- Free Data Transmission,Allow Up to 256 Transceivers on the Bus
- Supply voltage range: $5.0\text{V} \pm 5\%$
- Operating temperature range: $-40 \sim +85^\circ\text{C}$
- ESD protection up to 2000V for transmitter input and receiver output (TTL/CMOS levels) and up to 15000V for transmitter output and receiver input (RS-485 levels)
- Enhanced ESD Specifications:
 - $\pm 15\text{kV}$ IEC61000-4-2 Air Discharge
 - $\pm 8\text{kV}$ IEC61000-4-2 Contact Discharge

■ **Ordering Information**

Part Number	Package	Packing	Temperature(TA)	Package Qty	ESD
TK13089ECSD	SOIC-14	Reel	$0^\circ\text{C} \sim 70^\circ\text{C}$	2500	$\pm 15\text{KV}$
TK13089EASD	SOIC-14	Reel	$-40^\circ\text{C} \sim 125^\circ\text{C}$	2500	$\pm 15\text{KV}$
TK13089EESD	SOIC-14	Reel	$-40^\circ\text{C} \sim 85^\circ\text{C}$	2500	$\pm 15\text{KV}$

Note: Please contact us to customize DIP packaging device.

■ Pin Description

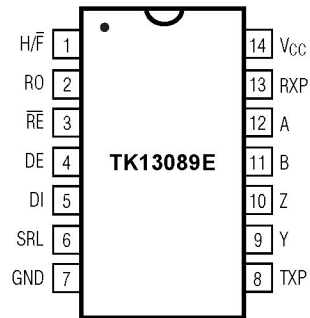


Table 1. Pin Description

FULL-DUPLEX MODE	HALF-DUPLEX MODE	NAME	FUNCTION
1	1	H/ $\overline{F}$	Half-/Full-Duplex Select Input. Connect H/ $\overline{F}$ to V _{CC} for half-duplex mode; connect H/ $\overline{F}$ to GND or leave unconnected for full-duplex mode.
2	2	RO	Receiver Output. When $\overline{RE}$ is low and if (A - B) $\geq$ -50mV, RO is high; if (A - B) $\leq$ -200mV, RO is low.
3	3	$\overline{RE}$	Receiver Output Enable. Drive $\overline{RE}$ low 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. $\overline{RE}$ is a hot-swap input (see the <i>Hot-Swap Capability</i> section for details).
4	4	DE	Driver Output Enable. Drive DE high to enable driver outputs. These outputs are high impedance when DE is low. Drive $\overline{RE}$ high and DE low to enter low-power shutdown mode. DE is a hot-swap input (see the <i>Hot-Swap Capability</i> section for details).
5	5	DI	Driver Input. With DE high, a low on DI forces noninverting output low and inverting output high. Similarly, a high on DI forces noninverting output high and inverting output low.
6	6	SRL	Slew-Rate Limit Selector Input. Connect SRL to ground for 16Mbps communication rate; connect SRL to V _{CC} for 500kbps communication rate. Leave SRL unconnected for 250kbps communication rate.
7	7	GND	Ground
8	8	TXP	Transmitter Phase. Connect TXP to ground or leave TXP unconnected for normal transmitter phase/polarity. Connect TXP to V _{CC} to invert the transmitter phase/polarity.
9	—	Y	Noninverting Driver Output
—	9	Y	Noninverting Driver Output and Noninverting Receiver Input*
10	—	Z	Inverting Driver Output
—	10	Z	Inverting Driver Output and Inverting Receiver Input*
11	—	B	Inverting Receiver Input
—	11	B	Receiver Input Resistors*
12	—	A	Noninverting Receiver Input
—	12	A	Receiver Input Resistors*
13	13	RXP	Receiver Phase. Connect RXP to GND or leave RXP unconnected for normal transmitter phase/polarity. Connect RXP to V _{CC} to invert receiver phase/polarity.
14	14	V _{CC}	Positive Supply V _{CC} = +5.0V $\pm$ 10%. Bypass V _{CC} to GND with a 0.1 μ F capacitor.

Table 2. Transmitter Truth Table

TRANSMITTING					
INPUTS				OUTPUTS	
TXP	$\overline{RE}$	DE	DI	Z	Y
L	X	H	H	L	H
L	X	H	L	H	L
H	X	H	H	H	L
H	X	H	L	L	H
X	L	L	X	High-Z	High-Z
X	H	L	X	Shutdown	

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

Table 3. Receiver Truth Table

RECEIVING						
INPUTS						OUTPUTS
H/ $\overline{F}$	RXP	$\overline{RE}$	DE	A, B	Y, Z	RO
L	L	L	X	> -50mV	X	H
L	L	L	X	< -200mV	X	L
L	H	L	X	> -50mV	X	L
L	H	L	X	< -200mV	X	H
H	L	L	L	X	> -50mV	H
H	L	L	L	X	< -200mV	L
H	H	L	L	X	> -50mV	L
H	H	L	L	X	< -200mV	H
L	L	L	X	Open/shorted	X	H
H	L	L	L	X	Open/shorted	H
L	H	L	X	Open/shorted	X	L
H	H	L	L	X	Open/shorted	L
X	X	H	H	X	X	High-Z
X	X	H	L	X	X	Shutdown

Note : H – high level, L – low level, X –don't care, Z – 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	± 50	± 200	V
T	Ambient temperature	-40	85	°C

Table 5. Maximum Ratings

Symbol	Parameter	Limit		Unit
		min	max	
V_{CC}	Supply voltage	–	7.0	V
V_{IL}	Input voltage on pins DI, DE, $\overline{RE}$	-0.3	7.0	V
V_{OD}	Transmitter output voltage	-13	13	V
V_{IR}	Receiver input voltage	-13	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

($V_{CC} = 5V \pm 5\%$)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
DRIVER							
V _{CC} Supply-Voltage Range	V _{CC}			4.5		5.5	V
Differential Driver Output	V _{OD}	R _L = 100Ω (RS-422), Figure 1		3		V _{CC}	V
		R _L = 54Ω (RS-485), Figure 1		2		V _{CC}	
		No load				V _{CC}	
Change in Magnitude of Differential Output Voltage	ΔV _{OD}	R _L = 100Ω or 54Ω, Figure 1 (Note 2)				0.2	V
Driver Common-Mode Output Voltage	V _{OC}	R _L = 100Ω or 54Ω, Figure 1		V _{CC} / 2		3	V
Change in Magnitude of Common-Mode Voltage	ΔV _{OC}	R _L = 100Ω or 54Ω, Figure 1 (Note 2)				0.2	V
Input-High Voltage	V _{IH}	DE, DI, $\overline{RE}$, TXP, RXP, H/ $\overline{F}$		3			V
Input-Low Voltage	V _{IL}	DE, DI, $\overline{RE}$, TXP, RXP, H/ $\overline{F}$				0.8	V
Input Hysteresis	V _{HYS}	DE, DI, $\overline{RE}$, TXP, RXP, H/ $\overline{F}$		100			mV
Input Current	I _{IN1}	DE, DI, $\overline{RE}$				±1	μA
Input Impedance First Transition		DE		1		10	kΩ
Input Current	I _{IN2}	TXP, RXP, H/ $\overline{F}$ internal pulldown		10		40	μA
SRL Input-High Voltage				V _{CC} - 0.4			V
SRL Input-Middle Voltage				V _{CC} x 0.3		V _{CC} x 0.7	V
SRL Input-Low Voltage						0.4	V
SRL Input Current		SRL = V _{CC}				75	μA
		SRL = GND		-75			
Output Leakage (Y and Z) Full Duplex	I _O	DE = GND, V _{CC} = GND or V _{CC}	V _{IN} = +12V			125	μA
			V _{IN} = -7V	-100			
Driver Short-Circuit Output Current	I _{OSD}	0 ≤ V _{OUT} ≤ +12V (Note 3)		40		250	mA
		-7V ≤ V _{OUT} ≤ V _{CC} (Note 3)		-250		-40	
		0 ≤ V _{OUT} ≤ +12V, +85°C ≤ T _A ≤ +125°C (Note 3)		40		270	
		-7V ≤ V _{OUT} ≤ V _{CC} , +85°C ≤ T _A ≤ +125°C (Note 3)		-270		-40	
Driver Short-Circuit Foldback Output Current	I _{OSDF}	(V _{CC} - 1V) ≤ V _{OUT} ≤ +12V (Note 3)		20			mA
		-7V ≤ V _{OUT} ≤ +1V (Note 3)				-20	
Thermal-Shutdown Threshold	T _{TS}			175			°C
Thermal-Shutdown Hysteresis	T _{TSH}			15			°C
Input Current (A and B)	I _{A, B}	DE = GND, V _{CC} = GND or V _{CC}	V _N = +12V			125	μA
			V _N = -7V	-100			
RECEIVER							
Receiver Differential Threshold Voltage	V _{TH}	-7V ≤ V _{CM} ≤ +12V		-200	-125	-50	mV
Receiver Input Hysteresis	ΔV _{TH}	V _A + V _B = 0V		15			mV
RO Output-High Voltage	V _{OH}	I _O = -1mA		V _{CC} - 0.6			V
RO Output-Low Voltage	V _{OL}	I _O = 1mA				0.4	V
Three-State Output Current at Receiver	I _{OZR}	0 ≤ V _O ≤ V _{CC}				± 1	μA
Receiver Input Resistance	R _{IN}	-7V ≤ V _{CM} ≤ +12V		96			kΩ
Receiver Output Short-Circuit Current	I _{OSR}	0V ≤ V _{RO} ≤ V _{CC}				±110	mA

Table 6. Electrical Parameters (continued)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
SUPPLY CURRENT						
Supply Current	I _{CC}	No load, $\overline{RE} = 0$, DE = V _{CC}		1.2	1.8	mA
		No load, $\overline{RE} = V_{CC}$, DE = V _{CC}		1.2	1.8	
		No load, $\overline{RE} = 0$, DE = 0		1.2	1.8	
Supply Current in Shutdown Mode	I _{SHDN}	$\overline{RE} = V_{CC}$, DE = GND		2.8	10	μA
ESD PROTECTION						
ESD Protection for Y, Z, A, and B		Human Body Model		±15		kV
		Contact Discharge IEC 61000-4-2		±6		kV

DRIVER SWITCHING CHARACTERISTICS

(V_{CC} = +5.0V ±10%, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V_{CC} = +5.0V and T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Driver Propagation Delay	t _{DPLH}	C _L = 50pF, R _L = 54Ω, Figures 2 and 3			50	ns
	t _{DPHL}				50	
Driver Differential Output Rise or Fall Time	t _R , t _F	C _L = 50pF, R _L = 54Ω, Figures 2 and 3			15	ns
Differential Driver Output Skew t _{DPLH} - t _{DPHL}	t _{DSKEW}	C _L = 50pF, R _L = 54Ω, Figures 2 and 3			8	ns
Maximum Data Rate			16			Mbps
Driver Enable to Output High	t _{DZH}	Figure 4			150	ns
Driver Enable to Output Low	t _{DZL}	Figure 5			150	ns
Driver Disable Time from Low	t _{DLZ}	Figure 5			100	ns
Driver Disable Time from High	t _{DHZ}	Figure 4			100	ns
Driver Enable from Shutdown to Output High	t _{DZH(SHDN)}	Figure 4			2200	ns
Driver Enable from Shutdown to Output Low	t _{DZL(SHDN)}	Figure 5			2200	ns
Time to Shutdown	t _{SHDN}		50	340	700	ns

RECEIVER SWITCHING CHARACTERISTICS

V_{CC} = +5.0V ±10%, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at V_{CC} = +5.0V and T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Receiver Propagation Delay	t _{RPLH}	C _L = 15pF, Figures 6 and 7		50	80	ns
	t _{RPHL}			50	80	
Receiver Output Skew t _{RPLH} - t _{RPHL}	t _{RSKEW}	C _L = 15pF, Figures 6 and 7			13	ns
Maximum Data Rate			16			Mbps
Receiver Enable to Output Low	t _{RZL}	Figure 8			50	ns
Receiver Enable to Output High	t _{RZH}	Figure 8			50	ns
Receiver Disable Time from Low	t _{RLZ}	Figure 8			50	ns
Receiver Disable Time from High	t _{RHZ}	Figure 8			50	ns
Receiver Enable from Shutdown to Output High	t _{RZH(SHDN)}	Figure 8			2200	ns
Receiver Enable from Shutdown to Output Low	t _{RZL(SHDN)}	Figure 8			2200	ns
Time to Shutdown	t _{SHDN}		50	340	700	ns

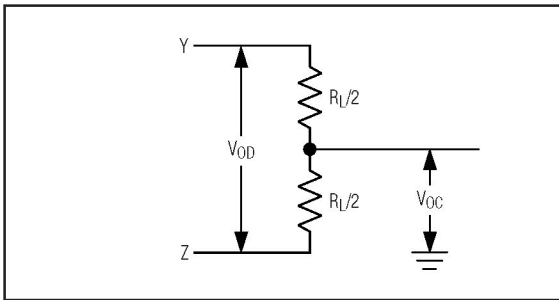


Figure 1. Driver DC Test Load

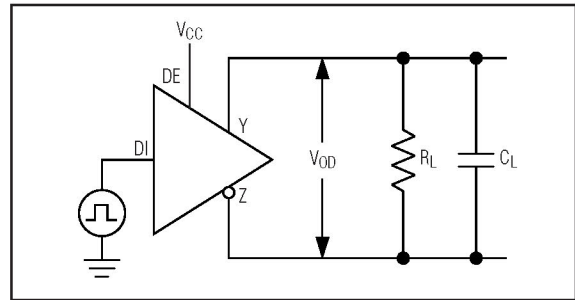


Figure 2. Driver Timing Test Circuit

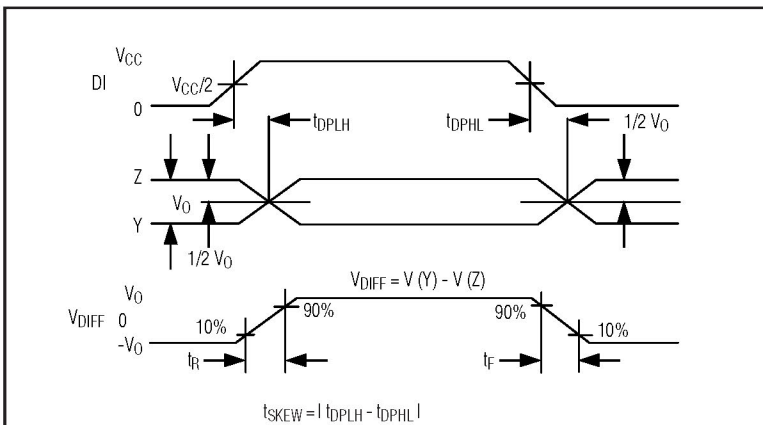


Figure 3. Driver Propagation Delays

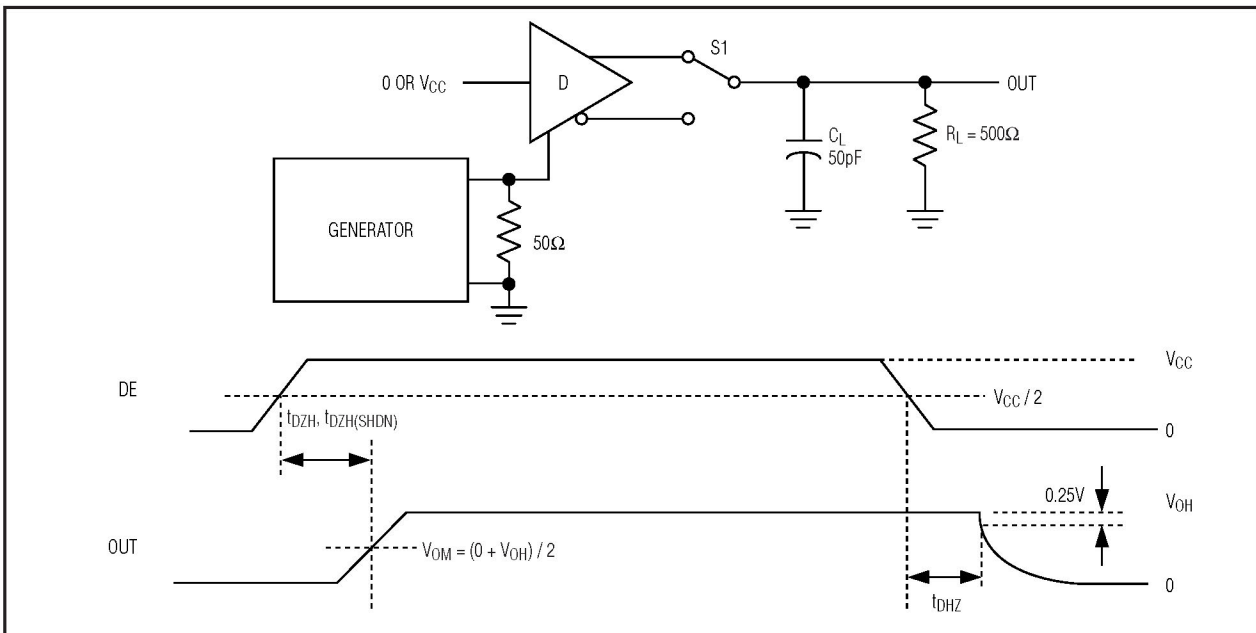


Figure 4. Driver Enable and Disable Times (t_{DZH} , $t_{DZH(SHDN)}$, t_{DHZ})

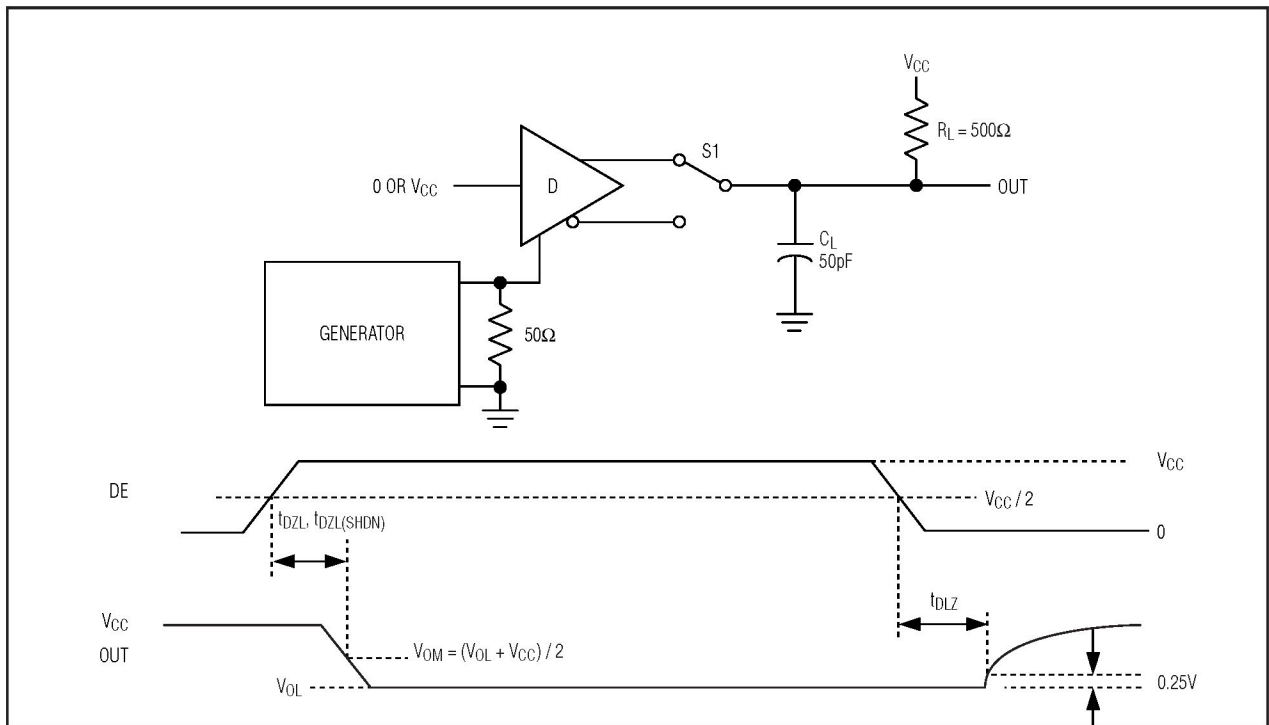


Figure 5. Driver Enable and Disable Times (t_{DZL} , t_{DLZ} , $t_{DLZ(SHDN)}$)

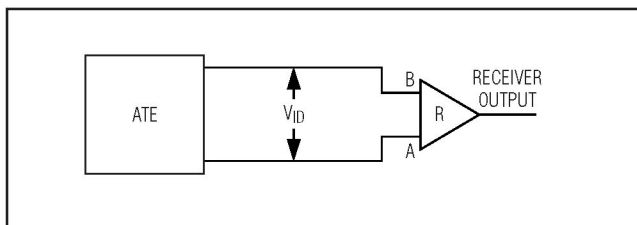


Figure 6. Receiver Propagation Delay Test Circuit

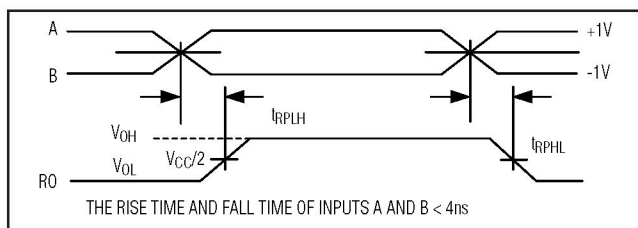


Figure 7. Receiver Propagation Delays

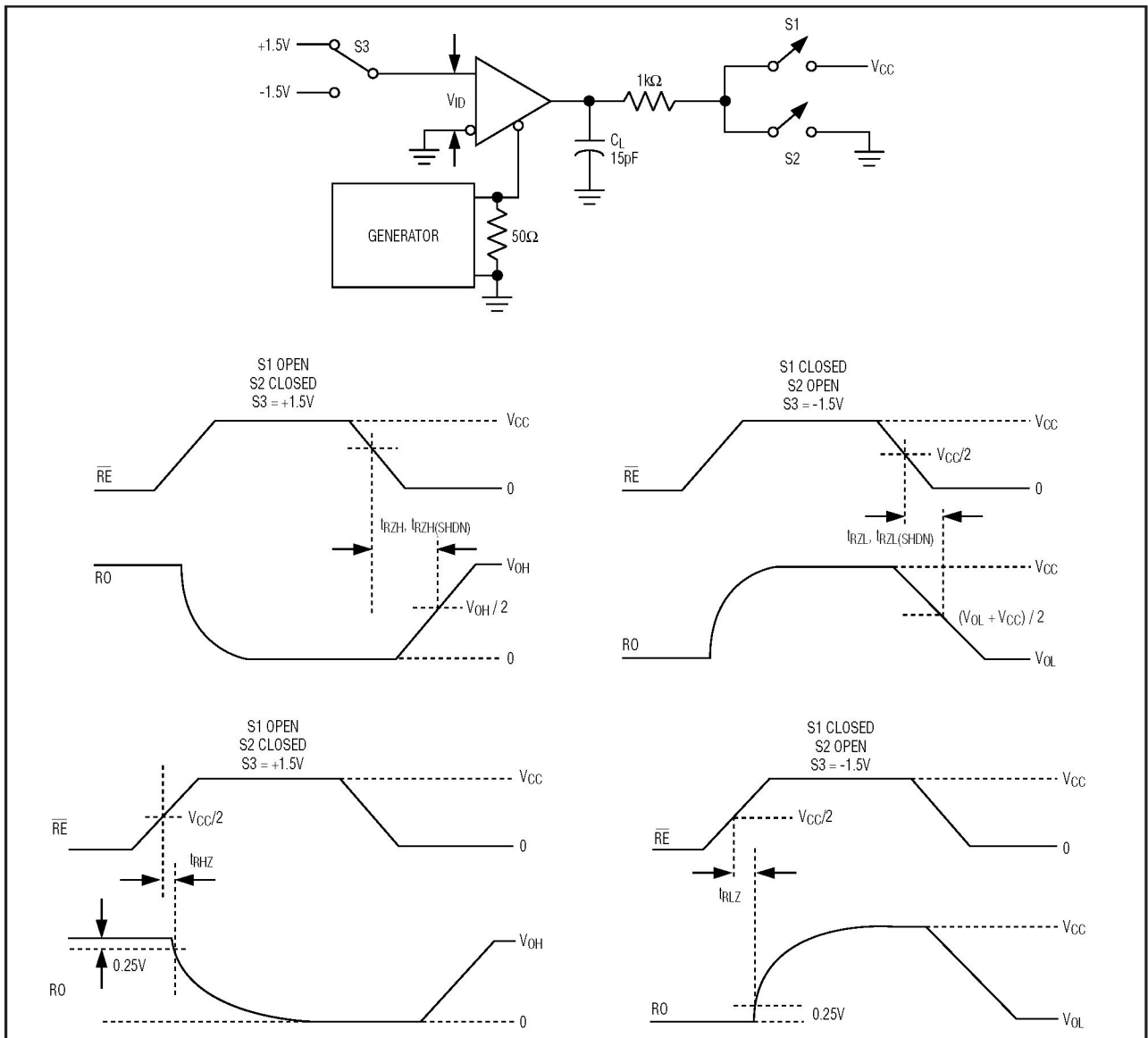


Figure 8. Receiver Enable and Disable Times

PACKAGE OUTLINE SOIC - 8, 1.75 mm max height

