+5.0V, ±15kV ESD-Protected, Fail-Safe, Hot-Swap, RS-485/RS-422 Transceivers

■ Description

The TK13088E +5.0V, ±15kV 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 TK13088E family include a hot-swap capability to eliminate false transitions on the bus during power-up or hot insertion.

The TK13088E driver slew rates are not limited, making transmit speeds up to 16Mbps possible.It is intended for half-duplex communications.

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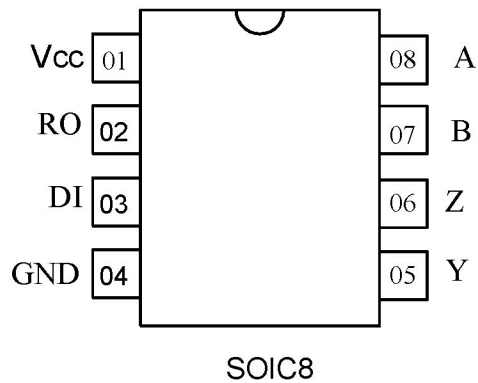
■ Features

- 1 transmitter and 1 receivers of the serial data of the standard RS-485
- Free Data Transmission,Allow Up to 256 Transceivers on the Bus
- Supply voltage range: 5.0V ± 5%
- Operating temperature range: -40 ~ +85 °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:
  ±15kV IEC61000-4-2 Air Discharge
  ±8kV IEC61000-4-2 Contact Discharge

■ Ordering Information

Part Number	Package	Packing	Temperature(TA)	Package Qty	ESD
TK13088ECSA	SOIC-8	Reel	0°C ~ 70°C	2500	±15KV
TK13088EESA	SOIC-8	Reel	–40°C ~ 85°C	2500	±15KV
TK13088EASA	SOIC-8	Reel	–40°C ~ 125°C	2500	±15KV

Note: Please contact us to customize DIP packaging device.

■ **Pin Description**

SOIC8

Table 1. **Pin Description**

Pin Number	Symbol	Pin Description
01	RO	Receiver Output. When $\overline{RE}$ is low and if (A - B) ≥ -50mV, RO is high; if (A - B) ≤ -200mV, RO is low.
02	$\overline{RE}$	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 *Hot-Swap Capability* section for details).
03	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 *Hot-Swap Capability* section for details).
04	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.
05	GND	Ground
06	A	Noninverting Receiver Input and Noninverting Driver Output
07	B	Inverting Receiver Input and Inverting Driver Output
08	V_{CC}	Positive Supply V_{CC} = +5.0V ±10%. Bypass V_{CC} to GND with a 0.1µF capacitor.

Table 2. **Transmitter Truth Table**

TRANSMITTING				
INPUTS			OUTPUTS	
$\overline{RE}$	DE	DI	B/Z	A/Y
X	H	H	L	H
X	H	L	H	L
L	L	X	High-Z	High-Z
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
$\overline{RE}$	DE	A-B	RO
L	X	≥ -50mV	H
L	X	≤ -200mV	L
L	X	Open/shorted	H
H	H	X	High-Z
H	L	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	$|{\pm}50|$	$|{\pm}200|$	V
T	Ambient temperature	−40	85	℃

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**

(Vcc = 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$_{IN}$ = +12V			125	µA
			V$_{IN}$ = -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.)

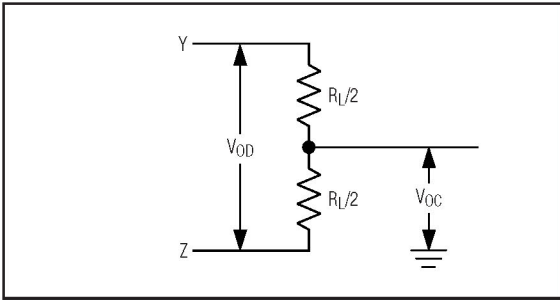| PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Receiver Propagation Delay	t_{RPLH}	C_L = 15pF, Figures 6 and 7		50	80	ns
	t_{RPHL}			50	80	
Receiver Output Skew |t_{RPLH} - t_{RPHL}|	t_{RSKEW}	C_L = 15pF, Figures 6 and 7			13	ns
Maximum Data Rate			16			Mbps
Receiver Enable to Output Low	t_{RZL}	Figure 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
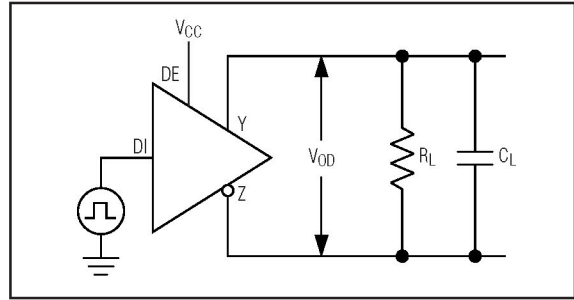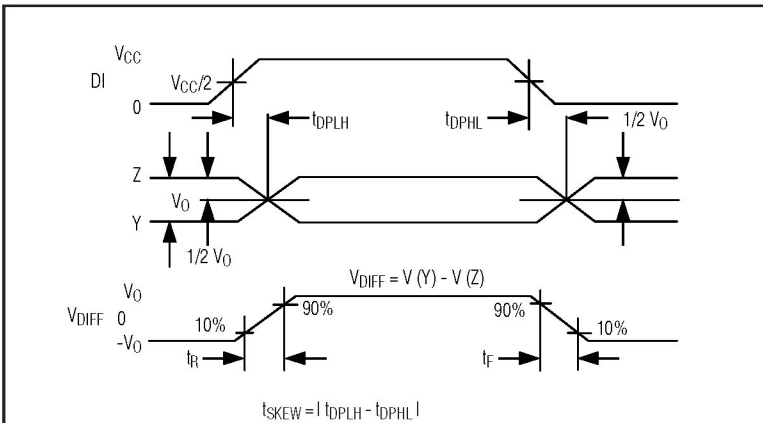

Figure 2. Driver Timing Test Circuit
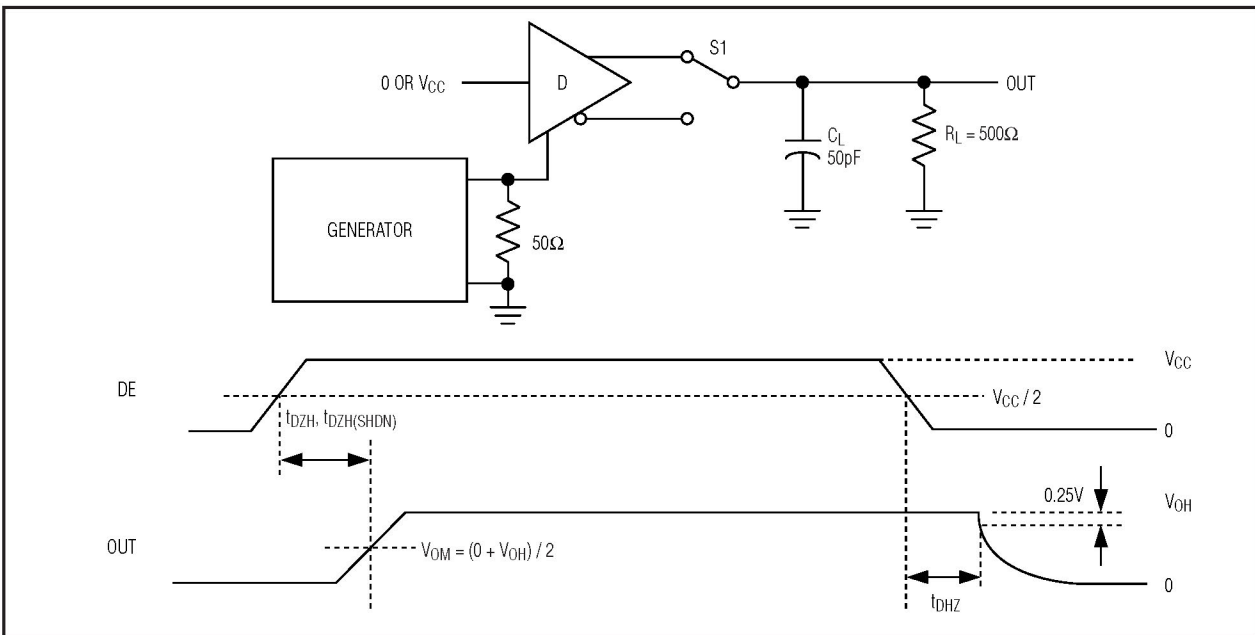

Figure 3. Driver Propagation Delays

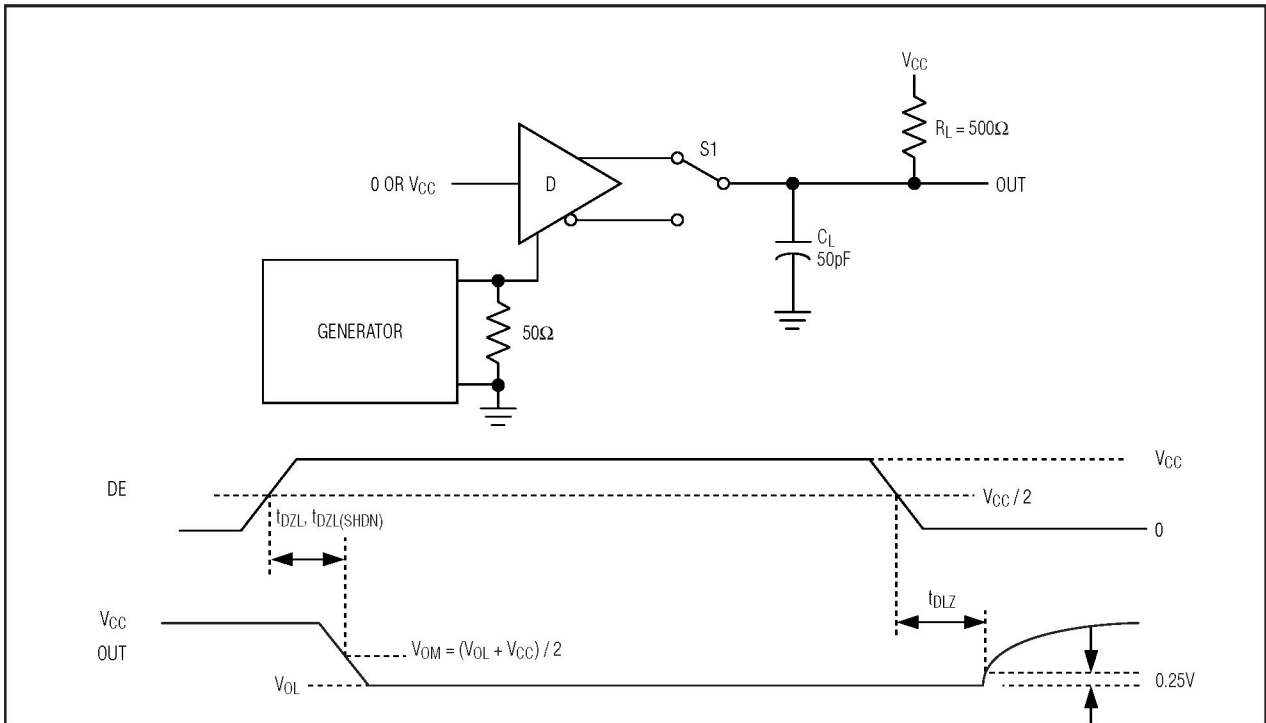Figure 4. Driver Enable and Disable Times (t_{DHZ}, t_{DZH}, $t_{DZH(SHDN)}$)

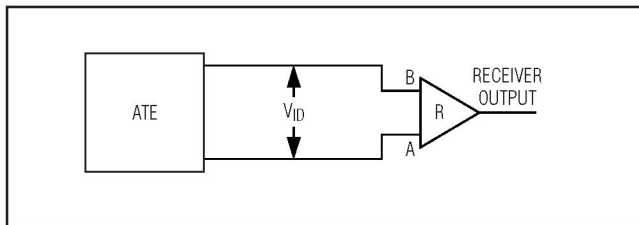Figure 5. Driver Enable and Disable Times (t_{DZL}, t_{DLZ}, $t_{DLZ(SHDN)}$)
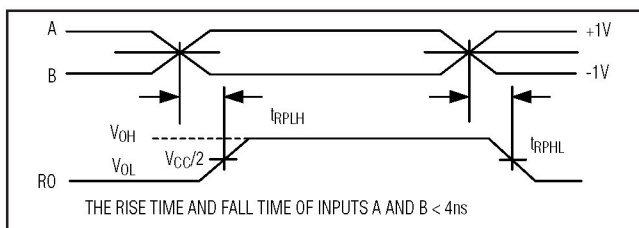

Figure 6. Receiver Propagation Delay Test Circuit
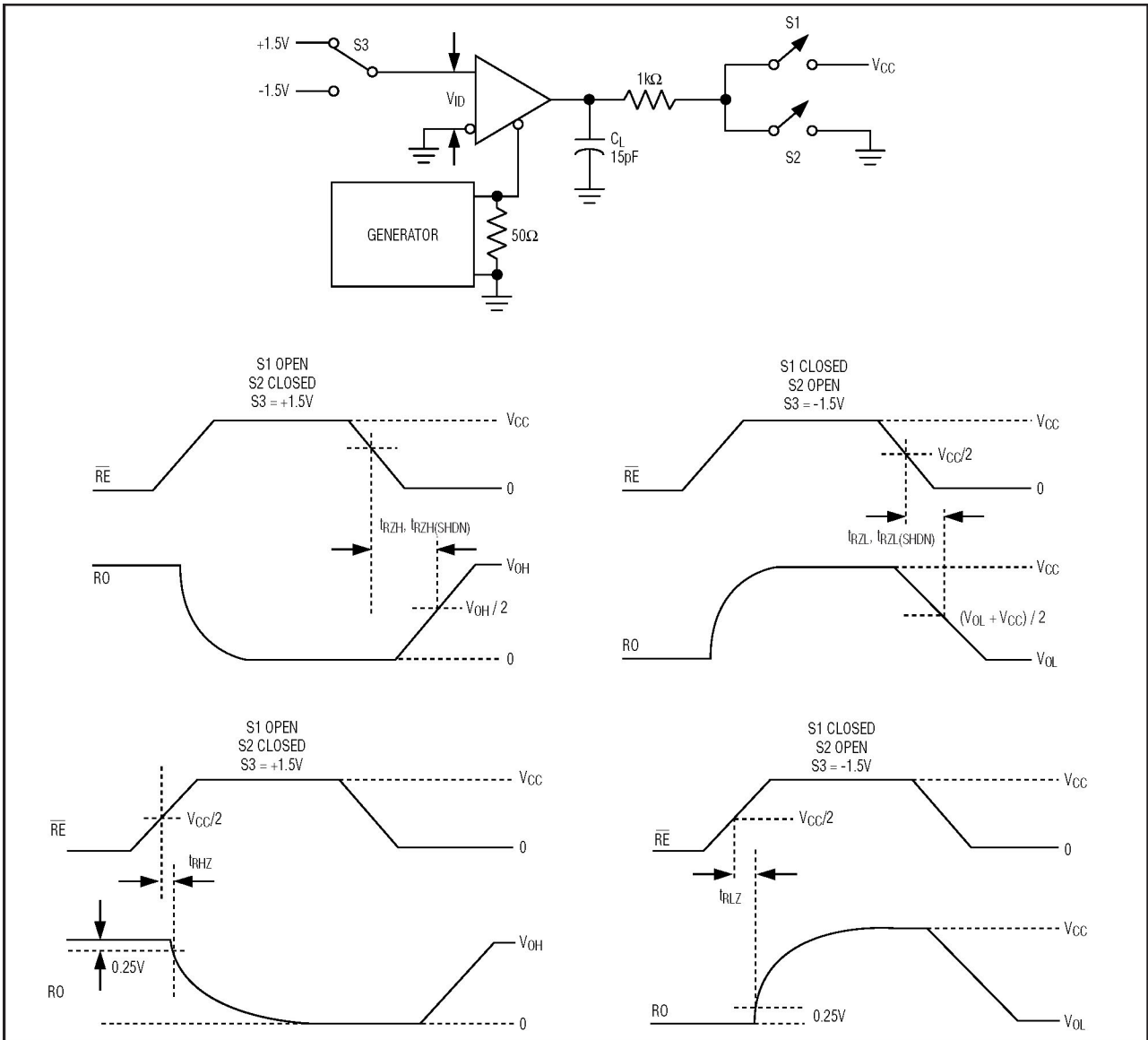

Figure 7. Receiver Propagation Delays

Figure 8. Receiver Enable and Disable Times

PACKAGE OUTLINE SOIC - 8,1.75 mm max height

.228-.244 TYP
[5.80-6.19]

A

PIN 1 mark hole

6X .050
[1.27]

1

8

.189-.197
[4.81-5.00]

2X

.150
[3.81]

4

5

B

.150-.157
[3.81-3.98]

8X .012-.020
[0.31-0.51]

C

SEATING PLANE

.004 [0.1] C

4X (0°-15°)

.069 MAX
[1.75]

.005-.010 TYP
[0.13-0.25]

4X (0°-15°)

SEE DETAIL A

.010
[0.25]

0° - 8°

.016-.050
[0.41-1.27]

(.041)
[1.04]

.004-.010
[0.11-0.25]

DETAIL A
TYPICAL

8X (.061)
[1.55]

SYMM
¢

SEE
DETAILS

1

8

8X (.024)
[0.6]

SYMM
¢

(R.002) TYP
[0.05]

4

5

6X (.050)
[1.27]

(.213)
[5.4]

⊕ .010 [0.25] Ⓜ C A B

NOTES: Linear dimensions are in inches [millimeters]. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 [0.15] per side.