

## Half-Duplex RS-485-/RS-422-Compatible Transceiver with AutoDirection Control

### ■ Description

The TK13488E +5V, half-duplex,  $\pm 15\text{kV}$  ESD-protected RS-485/RS-422-compatible transceivers feature one driver and one receiver. It includes a hot-swap capability to eliminate false transitions on the bus during power-up or live insertion.

The TK13488E feature propri-etary AutoDirection control. This architecture makes the devices ideal for applications, such as isolated RS-485 ports, where the driver input is used in conjunction with the driver-enable signal to drive the differential bus. It is intended for half-duplex communications. It is available in an 8-pin SOIC package.

### ■ Features

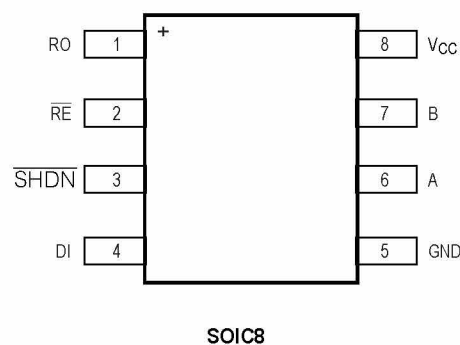
- 1 transmitter and 1 receivers of the serial data of the standard RS-485
- Robust Protection Features for Telecom, Industrial, and Isolated Applications
- 5V Supply Voltage Range
- Operating temperature range:  $-40 \sim +85\text{ }^{\circ}\text{C}$
- Data rate: 16Mbps
- AutoDirection Saves Space and BOM Cost
- Allows Up to 128 Transceivers on the Bus, 1/4-unit load receiver
- Enhanced ESD Specifications:  
 $\pm 15\text{kV}$  Extended ESD Protection

### ■ Ordering Information

Part Number	Package	Packing	Temperature(TA)	Package Qty	ESD
TK13488EESA	SOIC-8	Reel	$-40^{\circ}\text{C} \sim 85^{\circ}\text{C}$	2500	$\pm 15\text{KV}$

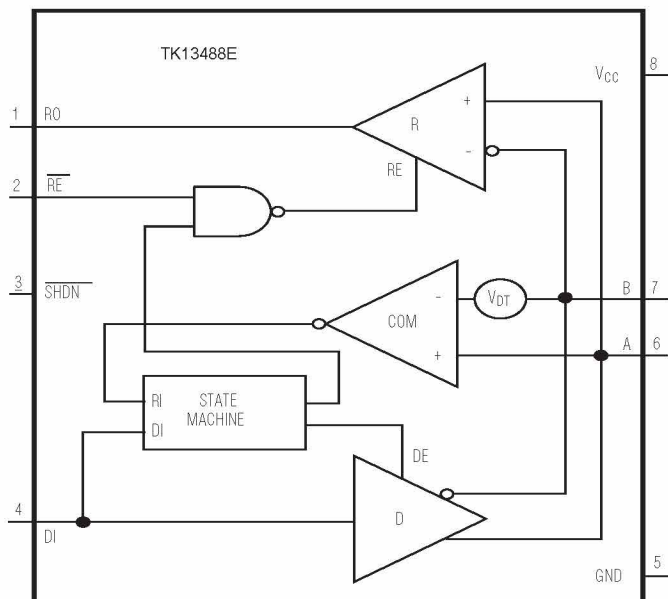
Note: Please contact us to customize DIP packaging device.

### ■ Pin Description



**Table 1. Pin Description**

PIN	NAME	FUNCTION
1	RO	Receiver Output. When receiver is enabled and $V(A) - V(B) > +200\text{mV}$ , RO is high. If $V(A) - V(B) < -200\text{mV}$ , RO is low.
2	$\overline{\text{RE}}$	Receiver Output Enable. Drive $\overline{\text{RE}}$ low to enable RO. Drive $\overline{\text{RE}}$ high to let the AutoDirection circuit control the receiver. $\overline{\text{RE}}$ is a hot-swap input.
3	$\overline{\text{SHDN}}$	Shutdown. Drive $\overline{\text{SHDN}}$ high to let the device operate in normal operation. Drive $\overline{\text{SHDN}}$ low to put the part in shutdown.
4	DI	Driver Input. Drive DI low to force noninverting output low and inverting output high. Drive DI high to force noninverting output high and inverting output low, DI is an input to the internal state machine.
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 <sub>CC</sub>	Positive Supply. V <sub>CC</sub> = +5V ±5%. Bypass V <sub>CC</sub> with a 0.1 μF ceramic capacitor to ground.

**Functional Diagram**


**Table 2. Function Tables Transmitter Truth Table**

TRANSMITTING					
INPUTS				OUTPUTS	
$\overline{\text{SHDN}}$	DI	A-B > V <sub>DT</sub>	ACTION	A	B
H	L	X	Turn driver ON	L	H
H	H	False	If driver was OFF, keep it OFF	HIGH IMPEDANCE	HIGH IMPEDANCE
H	H	False	If driver was ON, keep it ON	H	L
H	H	True	Turn driver OFF	HIGH IMPEDANCE	HIGH IMPEDANCE
L	X	X	X	SHUTDOWN	

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

**Table 3. Function Tables Receiver Truth Table**

RECEIVING					
INPUTS					OUTPUT
$\overline{\text{SHDN}}$	$\overline{\text{RE}}$	A-B	DRIVER STATE	RECEIVER STATE	RO
H	L	$\geq +200\text{mV}$	X	ON	H
H	L	$\leq -200\text{mV}$	X	ON	L
H	H	X	ON	OFF	HIGH IMPEDANCE
H	H	$\geq +200\text{mV}$	OFF	ON	H
H	H	$\leq -200\text{mV}$	OFF	ON	L
L	X	X	X	X	SHUTDOWN

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

**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 $\overline{SHDN}$ , $\overline{RE}$ , DI	0	0.8	V
$V_{IH}$	Input high voltage $\overline{SHDN}$ , $\overline{RE}$ , DI	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	°C

**Table 5. Maximum Ratings**

Symbol	Parameter	Limit		Unit
		min	max	
$V_{CC}$	Supply voltage	-0.3	6.0	V
$V_{IL}$	$\overline{SHDN}$ , $\overline{RE}$ , DI	-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**

(V<sub>CC</sub> = +5V ±5%, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, Typical values are at V<sub>CC</sub> = +5V and T<sub>A</sub> = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>DRIVER</b>						
Differential Driver Output	V <sub>OD</sub>	R <sub>DIFF</sub> = 100Ω, Figure 1	2.0		V <sub>CC</sub>	
		R <sub>DIFF</sub> = 54Ω, Figure 1	1.5			V
		No load			V <sub>CC</sub>	
Driver Common-Mode Output Voltage	V <sub>OC</sub>	R <sub>L</sub> = 100Ω or 54Ω, Figure 1		V <sub>CC</sub> / 2	3	V
Driver Disable Threshold	V <sub>DT</sub>	Figure 2 (Note 1)	+0.6		+1	V
Input-High Voltage	V <sub>IH</sub>	DI, $\overline{\text{SHDN}}$ , $\overline{\text{RE}}$	2.0			V
Input-Low Voltage	V <sub>IL</sub>	DI, $\overline{\text{SHDN}}$ , $\overline{\text{RE}}$			0.8	V
Input Current	I <sub>IN</sub>	DI, $\overline{\text{SHDN}}$ , $\overline{\text{RE}}$			±1	μA
Driver Short-Circuit Output Current (Note 2)	I <sub>OSD</sub>	0V ≤ V <sub>OUT</sub> ≤ +12V	+50		+250	mA
		-7V ≤ V <sub>OUT</sub> ≤ 0V	-250		-50	
Driver Short-Circuit Foldback Output Current (Note 2)	I <sub>OSDF</sub>	(V <sub>CC</sub> - 1V) ≤ V <sub>OUT</sub> ≤ +12V	20			mA
		-7V ≤ V <sub>OUT</sub> ≤ 0V			-20	
<b>RECEIVER</b>						
Input Current (A and B)	I <sub>A, B</sub>	DI = V <sub>CC</sub> , V <sub>CC</sub> = GND or +5V	V <sub>IN</sub> = +12V		250	μA
			V <sub>IN</sub> = -7V	-200		
Receiver Differential Threshold Voltage	V <sub>TH</sub>	-7V ≤ V <sub>CM</sub> ≤ +12V	-200		+200	mV
Receiver Input Hysteresis	ΔV <sub>TH</sub>	V <sub>A</sub> + V <sub>B</sub> = 0V		25		mV
Output-High Voltage	V <sub>OH</sub>	I <sub>O</sub> = -1.6mA, V <sub>A</sub> - V <sub>B</sub> > V <sub>TH</sub>	V <sub>CC</sub> - 1.5			V
Output-Low Voltage	V <sub>OL</sub>	I <sub>O</sub> = 1mA, V <sub>A</sub> - V <sub>B</sub> < -V <sub>TH</sub>			0.4	V
Tri-State Output Current at Receiver	I <sub>OZR</sub>	0V ≤ V <sub>O</sub> ≤ V <sub>CC</sub>			±1	μA
Receiver Input Resistance	R <sub>IN</sub>	-7V ≤ V <sub>CM</sub> ≤ +12V	48			kΩ
Receiver Output Short-Circuit Current	I <sub>OSR</sub>	0V ≤ V <sub>RO</sub> ≤ V <sub>CC</sub>	±7		±95	mA
<b>POWER SUPPLY</b>						
Supply Voltage	V <sub>CC</sub>		4.75		5.25	V
Supply Current	I <sub>CC</sub>	$\overline{\text{SHDN}}$ = 1, $\overline{\text{RE}}$ = 0, no load			4.5	mA
Shutdown Supply Current	I <sub>SHDN</sub>	$\overline{\text{SHDN}}$ = 0			10	μA
<b>ESD PROTECTION</b>						
ESD Protection (A, B)		Air Gap Discharge IEC 61000-4-2 (TK13487E)		±15		kV
		Human Body Model		±15		
ESD Protection (All Other Pins)		Human Body Model		±2		kV

**Table 7. Switching Characteristics**

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

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>DRIVER</b>						
Driver Propagation Delay	$t_{DPLH}$	$R_L = 110\Omega$ , $C_L = 50pF$ , Figures 2 and 3			50	ns
	$t_{DPHL}$				50	
Driver Differential Output Rise or Fall Time	$t_{HL}$	$R_L = 110\Omega$ , $C_L = 50pF$ , Figures 2 and 3			15	ns
	$t_{LH}$				15	
Maximum Data Rate			16			Mbps
Driver Disable Delay	$t_{DDD}$	Figure 3			70	ns
Driver Enable from Shutdown to Output High	$t_{DZH}(SHDN)$	Figure 4			2.2	$\mu s$
Driver Enable from Shutdown to Output Low	$t_{DZL}(SHDN)$	Figure 4			2.2	$\mu s$
Time to Shutdown	$t_{SHDN}$		50	340	700	ns
<b>RECEIVER</b>						
Receiver Propagation Delay	$t_{RPLH}$	$C_L = 15pF$ , Figures 5 and 6			80	ns
	$t_{RPHL}$				80	
Receiver Output Skew	$t_{RSKEW}$	$C_L = 15pF$ , Figure 6			13	ns
Maximum Data Rate			16			Mbps
Receiver Enable to Output High	$t_{RZH}$	Figure 7			50	ns
Receiver Enable to Output Low	$t_{RZL}$	Figure 7			50	ns
Receiver Disable Time from High	$t_{RHZ}$	Figure 7			50	ns
Receiver Disable Time from Low	$t_{RLZ}$	Figure 7			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
Receiver Enable Delay	$t_{RED}$	Figure 3			70	ns
Time to Shutdown	$t_{SHDN}$		50	340	700	ns

**Note 1:** This is a differential voltage from A to B that the driving device must see on the bus to disable its driver.

**Note 2:** The short-circuit output current applied to peak current just prior to foldback current limiting. The short-circuit foldback out-put current applies during current limiting to allow a recovery from bus contention.

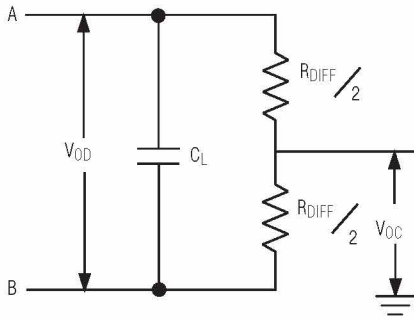
**Test and Timing Diagrams**


Figure 1. Driver DC Test Load

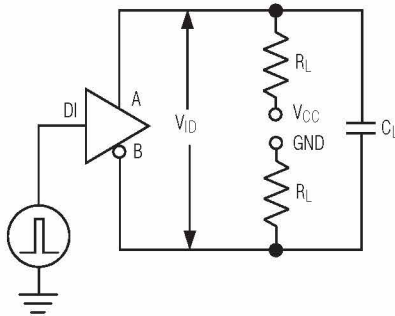


Figure 2. Driver Timing Test Circuit

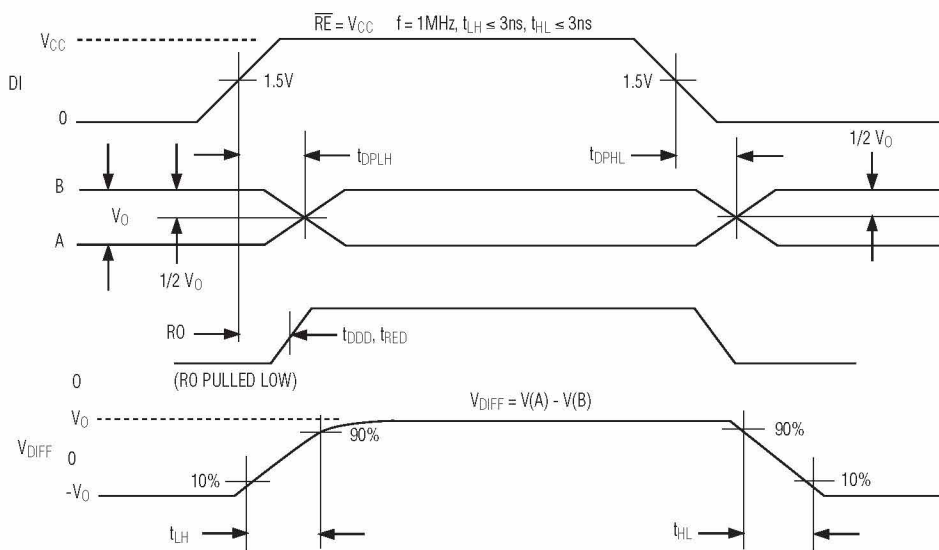


Figure 3. Driver Propagation Delays

**Test and Timing Diagrams(continued)**

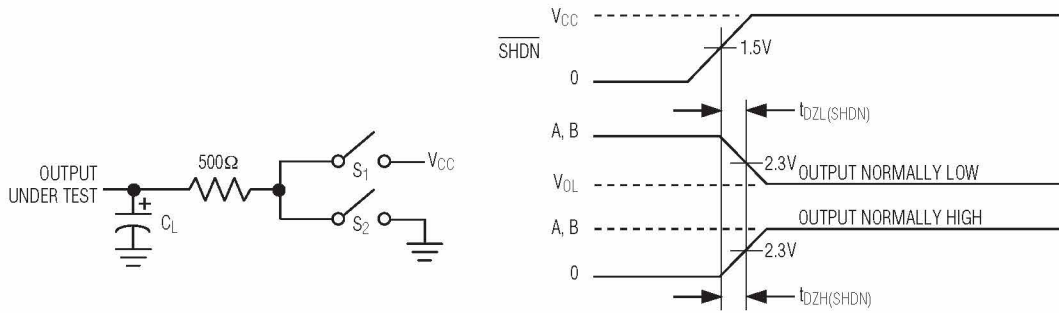


Figure 4. Driver Enable and Disable Times ( $t_{DZH}$ ,  $t_{DZL}$ )

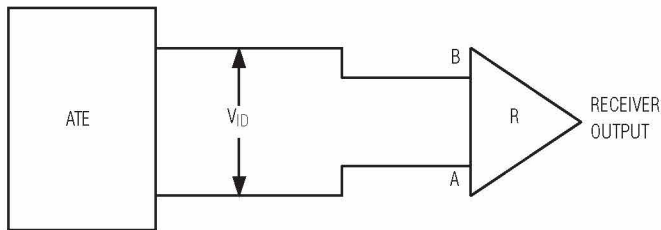


Figure 5. Driver Enable and Disable Times ( $t_{DZL}$ ,  $t_{DLZ}$ )

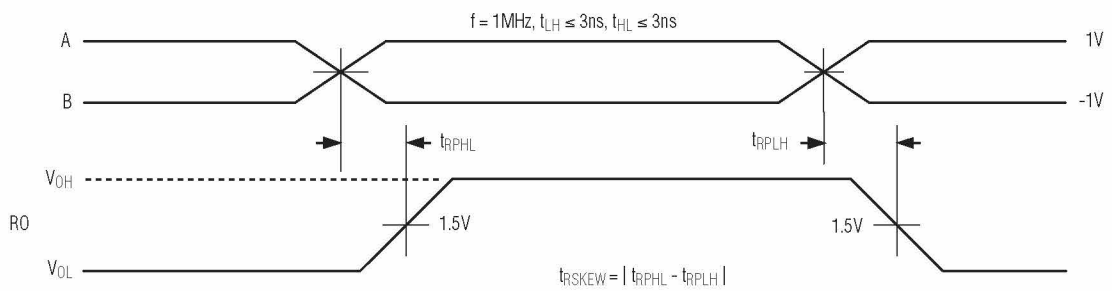


Figure 6. Receiver Propagation Delay Test Circuit



Test and Timing Diagrams(continued)

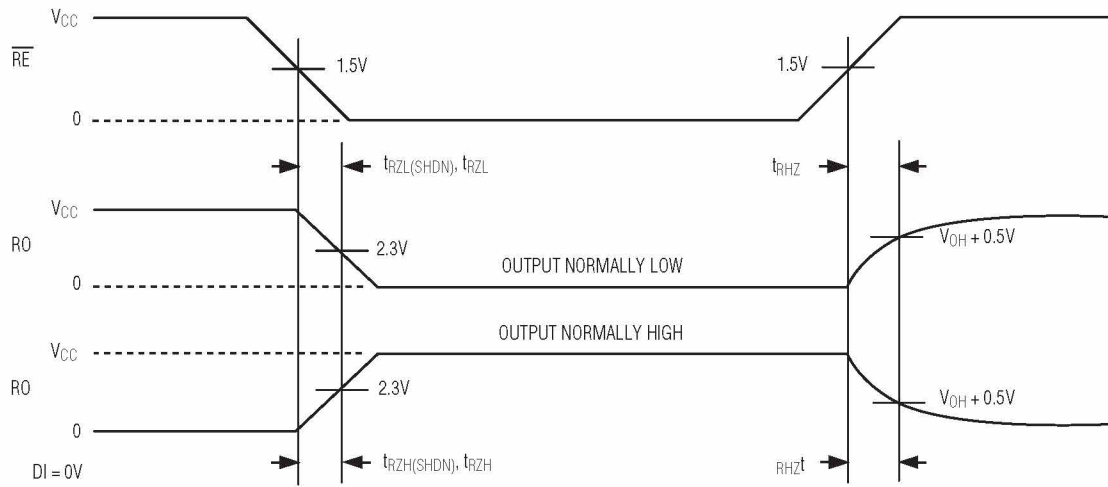


Figure 7. Receiver Propagation Delays

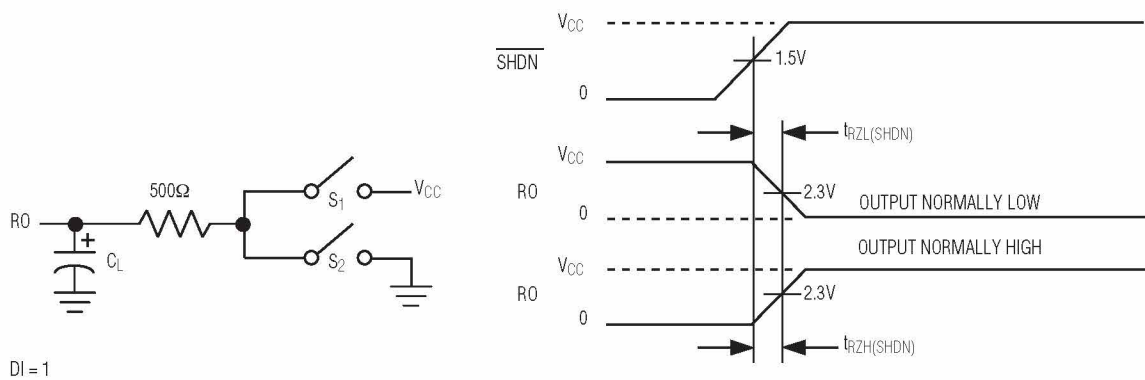
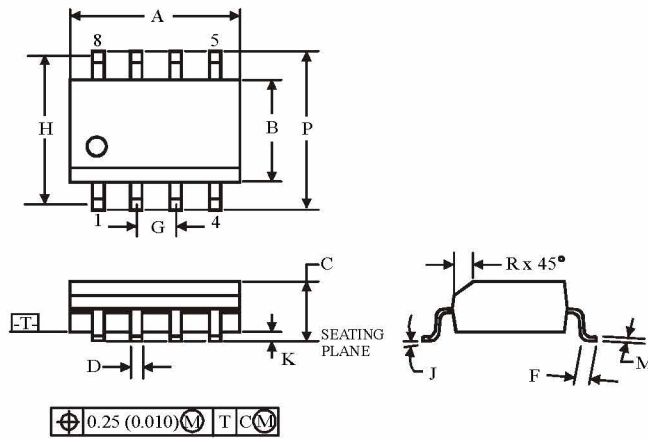


Figure 8. Receiver Enable and Disable Times

**■ Package Dimensions**
**SOIC8**


Symbol	Dimension, mm	
	MIN	MAX
<b>A</b>	4.8	5
<b>B</b>	3.8	4
<b>C</b>	1.35	1.75
<b>D</b>	0.33	0.51
<b>F</b>	0.4	1.27
<b>G</b>	1.27	
<b>H</b>	5.72	
<b>J</b>	0°	8°
<b>K</b>	0.1	0.25
<b>M</b>	0.19	0.25
<b>P</b>	5.8	6.2
<b>R</b>	0.25	0.5

**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.