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# HD26LS32

## Quadruple Differential Line Receivers With 3 State Outputs



ADE-205-577 (Z)

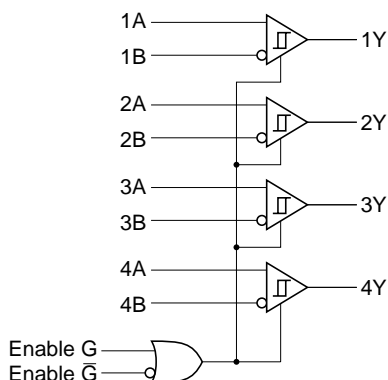
1st. Edition

Dec. 2000

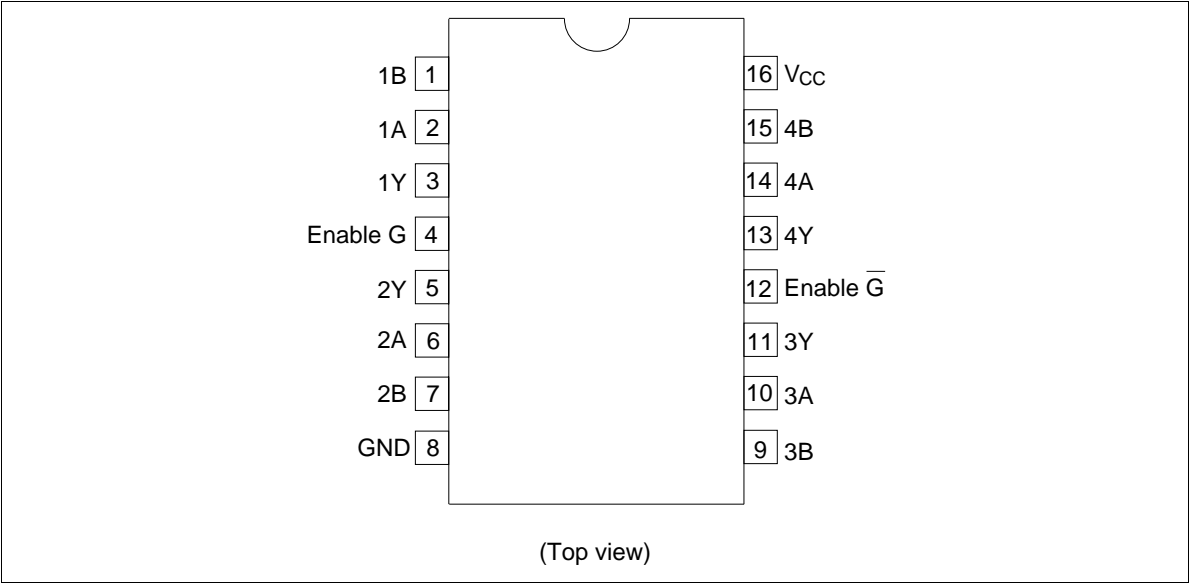
### Description

The HD26LS32 features quadruple line receivers designed to meet the specs of EIA standard RS-422A and RS-423. This device operates from a single 5 V power supply. The enable function is common to all four receivers and offers a choice of active high or active low input. Fail safe design ensures that if the inputs are open, the outputs will always be high.

### Logic Diagram



Pin Arrangement



Function Table

Differential Input A – B	Enable		Output Y
	G	G̅	
$V_{ID} \geq V_{TH}$	H	X	H
	X	L	H
$V_{TL} < V_{ID} < V_{TH}$	H	X	?
	X	L	?
$V_{ID} \leq V_{TL}$	H	X	L
	X	L	L
X	L	H	Z

H : High level  
L : Low level  
X : Immaterial  
? : Irrelevant  
Z : High impedance

## Absolute Maximum Ratings

Item	Symbol	Ratings	Unit
Supply Voltage	$V_{CC}^{*1}$	7.0	V
In Phase Input Voltage	$V_{IC}$	$\pm 25$	V
Differential Input Voltage	$V_{ID}^{*2}$	$\pm 25$	V
Enable Input Voltage	$V_{IN}$	7	V
Output Sink Current	$I_{out}$	50	mA
Continuous Total Dissipation	$P_T$	1	W
Operating Temperature Range	$T_{opr}$	0 to +70	°C
Storage Temperature Range	$T_{stg}$	-65 to 150	°C

- Notes: 1. All voltage values except for differential input voltage are with respect to network ground terminal.
2. Differential input voltage is measured at the noninverting input with respect to the corresponding inverting output.
3. The absolute maximum ratings are values which must not individually be exceeded, and furthermore, no two of which may be realized at the same time.

## Recommended Operating Conditions

Item	Symbol	Min	Typ	Max	Unit
Supply Voltage	$V_{CC}$	4.75	5.00	5.25	V
In Phase Input Voltage	$V_{IC}$	—	—	$\pm 7.0$	V
Output Current	$I_{OH}$	—	—	-440	$\mu A$
	$I_{OL}$	—	—	8	mA
Operating Temperature	$T_{opr}$	0	—	70	°C

## Electrical Characteristics (Ta = 0 to +70°C)

Item	Symbol	Min	Typ*1	Max	Unit	Conditions
Differential Input High Threshold Voltage	$V_{TH}$	—	—	0.2	V	$V_{IC} = -7$ to $+7$ V $V_{OH} = 2.7$ V, $I_{OH} = -440$ $\mu$ A
Differential Input Low Threshold Voltage	$V_{TL}$	—	—	-0.2		$V_{OL} = 0.4$ V, $I_{OL} = 4$ mA
Input Hysteresis*2	$V_{TH} - V_{TL}$	—	30	—	mV	$V_{OL} = 0.45$ V, $I_{OL} = 8$ mA
Enable Input Voltage	$V_{IH}$	2.0	—	—	V	
	$V_{IL}$	—	—	0.8		
Enable Input Clamp Voltage	$V_{IK}$	—	—	1.5		$V_{CC} = 4.75$ V, $I_{IN} = -18$ mA
Output Voltage	$V_{OH}$	2.7	—	—		$V_{CC} = 4.75$ V $V_{ID} = 1$ V, $I_{OH} = -440$ $\mu$ A
	$V_{OL}$	—	—	0.4		$V_{IL} (\bar{G}) = 0.8$ V $V_{ID} = -1$ V, $I_{OL} = 4$ mA
		—	—	0.45		$V_{ID} = -1$ V, $I_{OL} = 8$ mA
Off State (High Impedance) Output Current	$I_{OZ}$	—	—	20	$\mu$ A	$V_{CC} = 5.25$ V $V_O = 2.4$ V
		—	—	-20		$V_O = 0.4$ V
Line Input Current	$I_I$	—	—	2.3	mA	$V_I = 15$ V, Other Inputs -10 to +15 V
		—	—	2.8		$V_I = -15$ V, Other Inputs -15 to +10 V
Enable Input Current	$I_I$ (EN)	—	—	100	$\mu$ A	$V_I = 5.5$ V
	$I_{IH}$	—	—	20		$V_I = 2.7$ V
	$I_{IL}$	—	—	-0.36	mA	$V_I = 0.4$ V
Input Resistance	$r_i$	6	9.8	—	k $\Omega$	$V_{IC} = -15$ to $+15$ V (Other Inputs AC GND)
Short Circuit Output Current	$I_{OS}^{*3}$	-15	—	-85	mA	$V_{CC} = 5.25$ V
Supply Current	$I_{CC}$	—	52	70		$V_{CC} = 5.25$ V, $V_I = 0$ V (All Outputs Disable)

Notes: 1. All typical values are at  $V_{CC} = 5$  V,  $T_a = 25^\circ\text{C}$ ,  $V_{IC} = 0$ .

2. Hysteresis is the differential between the positive going input threshold voltage and the negative going input threshold voltage.

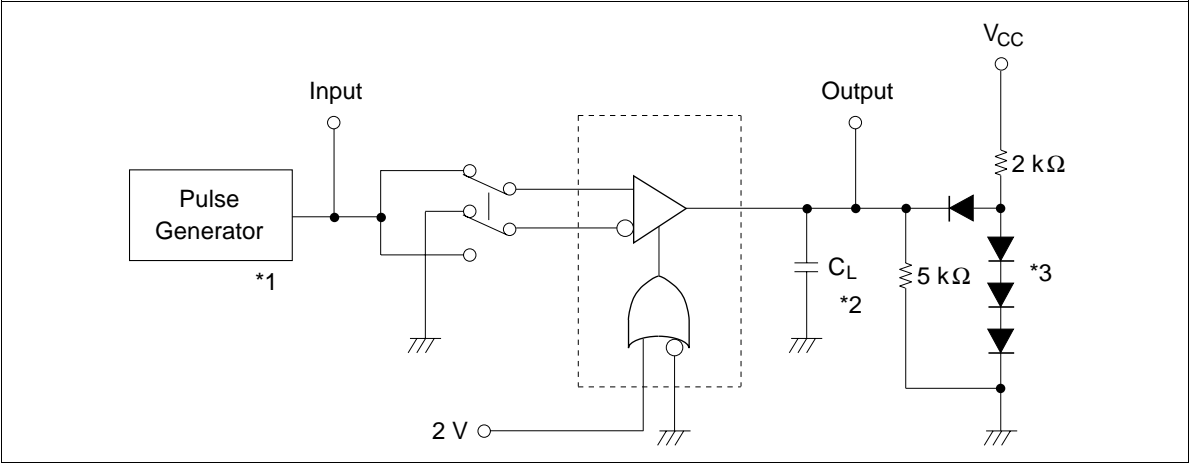
3. Not more than one output should be shorted at a time.

## Switching Characteristics ( $V_{CC} = 5$ V, $T_a = 25^\circ\text{C}$ )

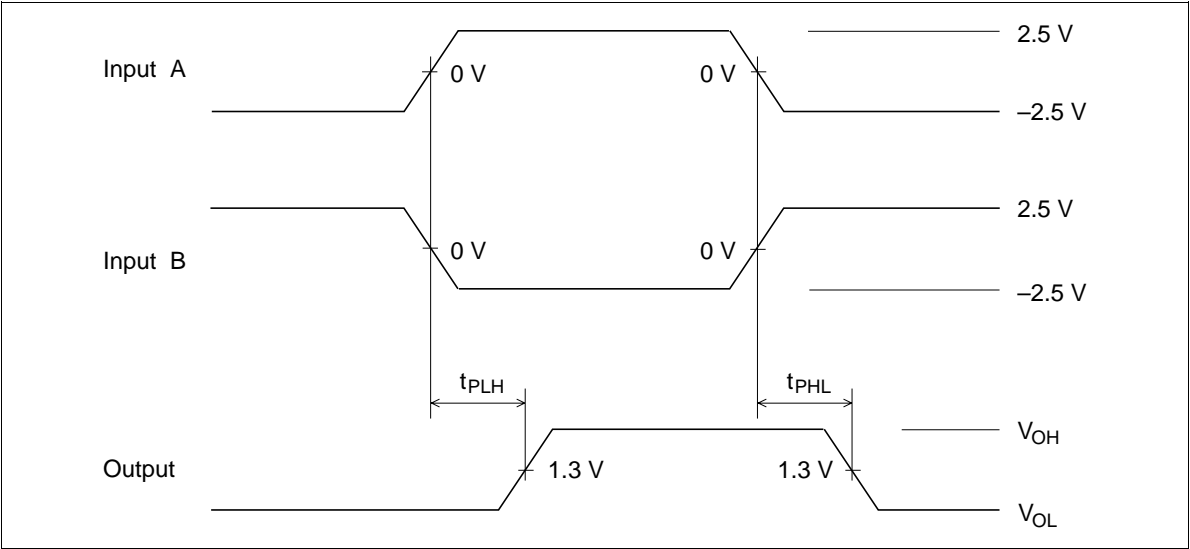
Item	Symbol	Min	typ	Max	Unit	Conditions
Propagation Delay Time	$t_{PLH}, t_{PHL}$	—	17	25	ns	$C_L = 15$ pF
Output Enable Time	$t_{ZH}, t_{ZL}$	—	15	22		
Output Disable Time	$t_{HZ}$	—	15	22		$C_L = 5$ pF
	$t_{LZ}$	—	20	30		

1.  $t_{PLH}$ ,  $t_{PHL}$

Test circuit

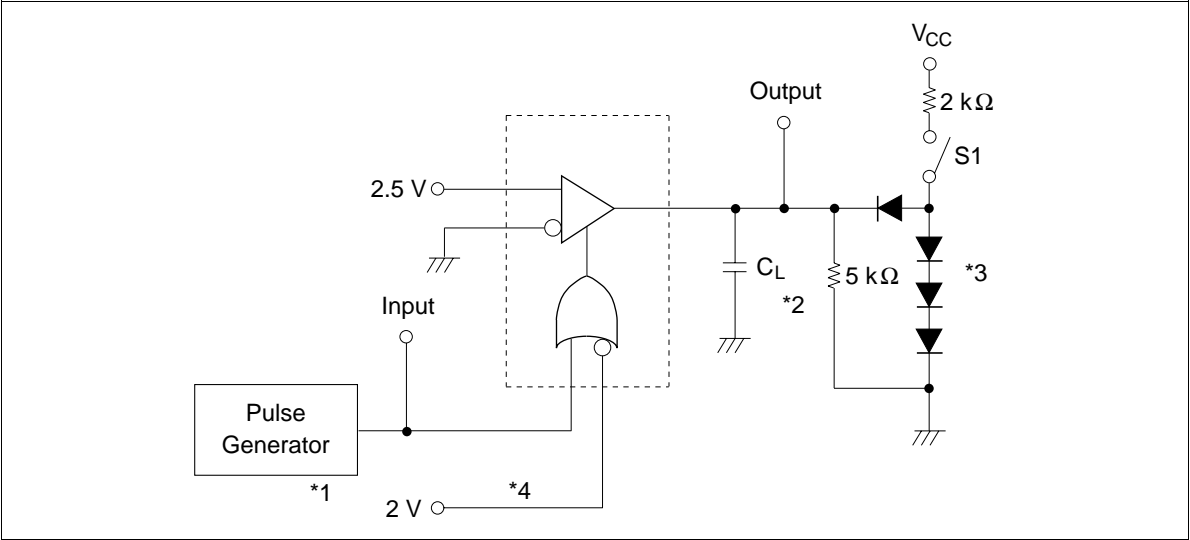


Waveforms

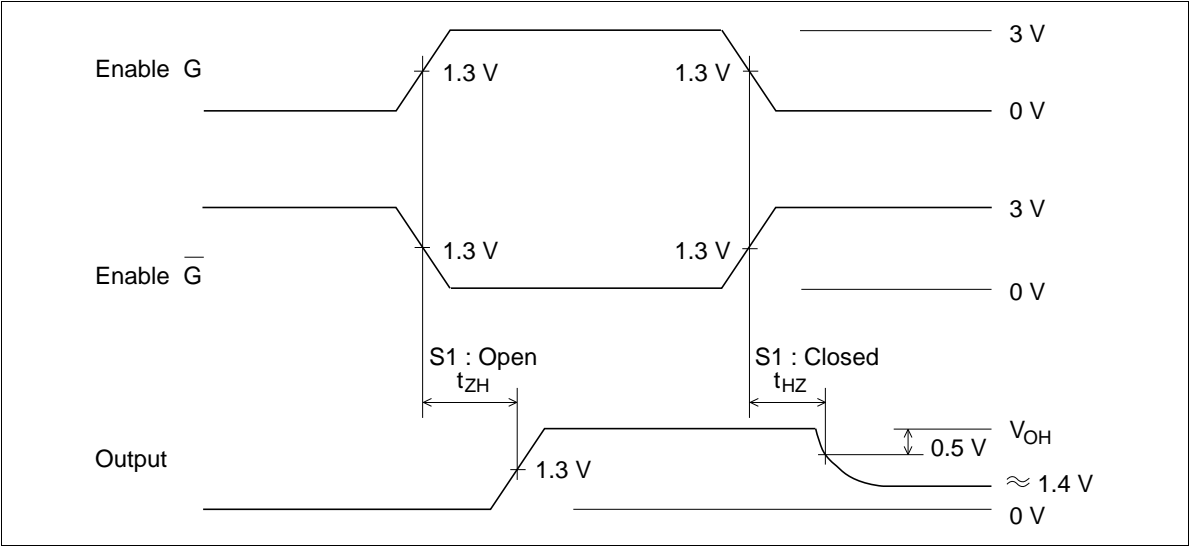


2.  $t_{HZ}$ ,  $t_{ZH}$

Test circuit



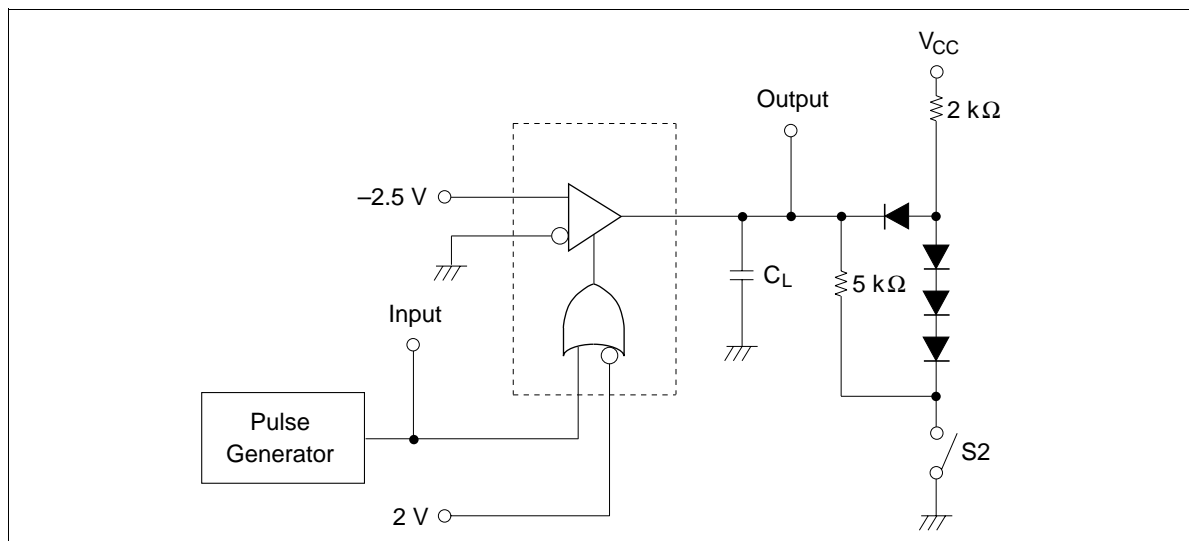
Waveforms



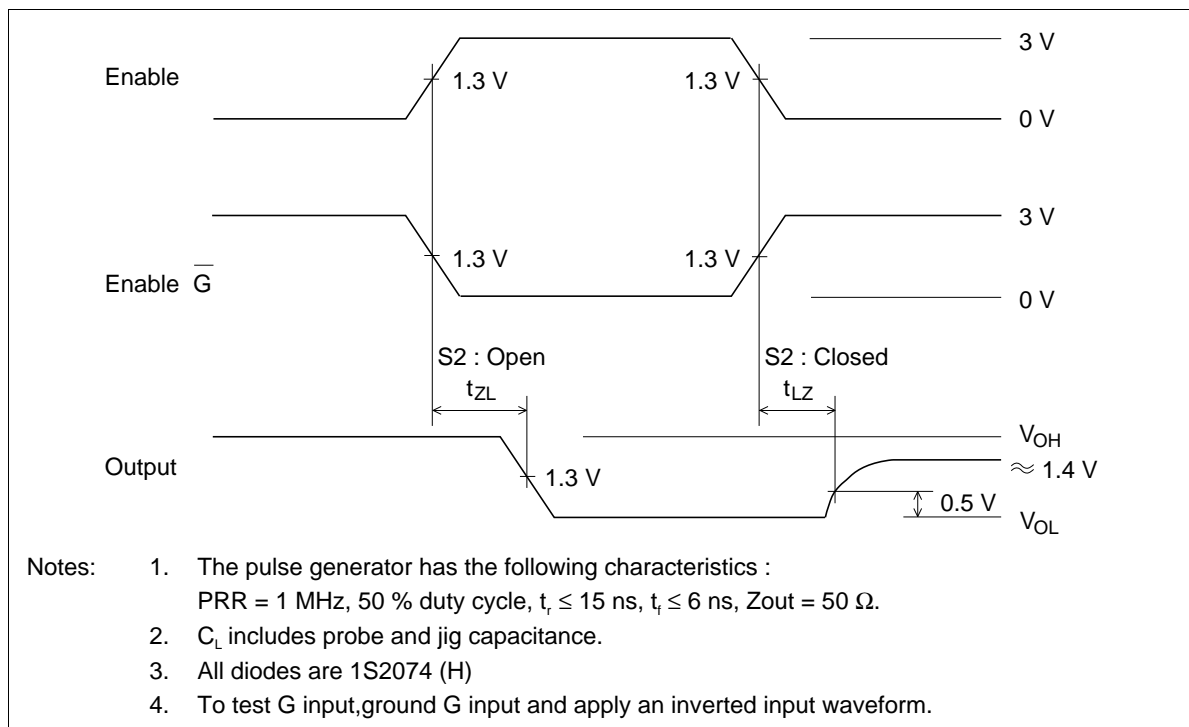


### 3. $t_{LZ}$ , $t_{ZL}$

#### Test circuit



#### Waveforms



## HD26LS32 Line Receiver Applications

The HD26LS32 is a line receiver that meets the EIA RS-422A and RS-423A conditions. It has a high in-phase input voltage range, both positive and negative, enabling highly reliable transmission to be performed even in noisy environments.

Its main features are listed below.

- Operates on a single 5 V power supply.
- Three-state output
- On-chip fail-safe circuit
- $\pm 7$  V in-phase input voltage range
- $\pm 200$  mV input sensitivity
- Minimum 6 k $\Omega$  input resistance

A block diagram is shown in figure 1. The enable function is common to all four drivers, and either active-high or active-low input can be selected.

When exchange is carried out using a party line system, it is better to keep the receiver input bias current constituting the driver load small, as this allows more receivers to be connected.

Consequently, whereas an input resistance of 4 k $\Omega$  or above is stipulated in RS-422A and RS-423A, the HD26LS32 has been designed to allow a greater margin, with a minimum resistance of 6 k $\Omega$ .

Figure 2 shows the input current characteristics of the HD26LS32.

The shaded areas in the graph indicate the input current allowable range stipulated in RS-422A and RS-423A.

HD26LS32 output is LS-TTL compatible and has a three-state function, enabling the output to be placed in the high-impedance state, and so making the device suitable for bus line type applications.

With an in-phase input voltage range of  $\pm 7$  V and a  $\pm 200$  mV input sensitivity, the HD26LS32 can withstand use in noisy environments.

Also, since signals sent over a long-distance transmission line require a long transition time, it also takes a long time to cross the receiver's input threshold level.

Therefore, the input is provided with hysteresis of around 30 mV to prevent receiver output misoperation due to noise.

An example of input hysteresis is shown in figure 3.

The fail-safe function consists of resistances R connecting input A to  $V_{CC}$  and input B to GND, as shown in figure 4.

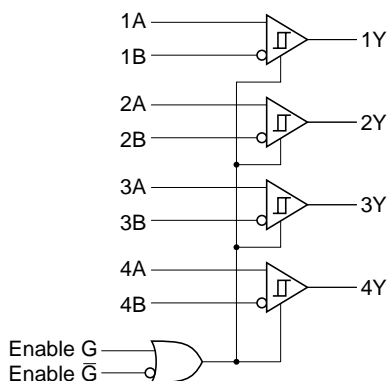
This circuit provides for the receiver input section to be pulled up or down by a high resistance that prevents it from becoming a driver load so that the output goes high in the event of a transmission line breakage or connector detachment.

When the input pin is placed in the open state by the pull-up/pull-down resistance, the differential input voltage  $V_{ID}$  is as follows:

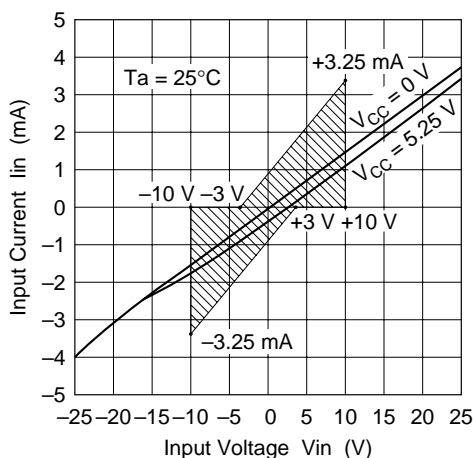
$$V_{ID}: (V_{IA} - V_{IB}) \geq 0.2 \text{ V}$$

and the output is fixed high.

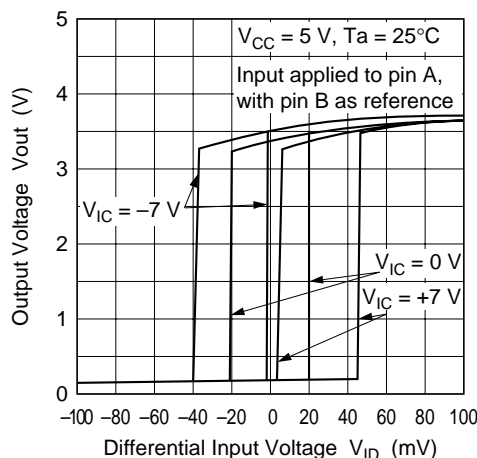
However, if the receiver-side termination resistance remains connected despite a line breakage or connector detachment, the output will be undetermined (figure 5).



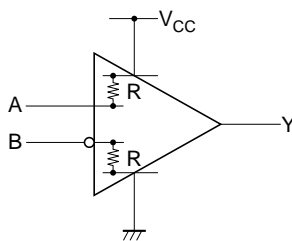
**Figure 1 HD26LS32 Block Diagram**



**Figure 2 Input Voltage vs. Input Current Characteristics**



**Figure 3 Differential Input Voltage vs. Output Voltage Characteristics**



**Figure 4 Fail-Safe Function**

This is because, since the termination resistance is normally matched to the transmission line characteristic impedance, the value falls to several tens of hundreds of ohms, and the differential input pins are shorted by this termination resistance. That is, the differential input voltage  $V_{ID}$  comes within the range

$$V_{ID}: -0.2 \text{ V} < V_{IA} - V_{IB} < 0.2 \text{ V}$$

and the output becomes undetermined.

To prevent this, resistance  $R_1$  is inserted in series with the transmission line as shown in figure 6, minimizing the effect of the termination resistance. Resistance  $R_2$  is added to increase the current flowing between the termination resistance and  $R_1$ , enabling the value of  $R_1$  to be kept small.

Inserting resistances  $R_1$  and  $R_2$  in this way provides for the differential input voltage  $V_{ID}$  to become 200 mV or higher, but the following points must be noted.

- Smallest possible  $R_1$  value  
If this value is large, the receiver input sensitivity will fall.
- Largest possible  $R_2$  value  
If this value is small, the load on the driver will be large.

Figure 7 shows experimental differential input voltages for variations in  $R_1$  and  $R_2$ .

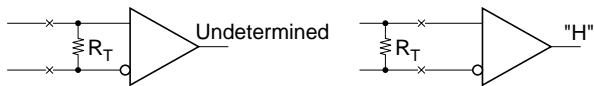


Figure 5 Examples of Transmission Line Disconnection

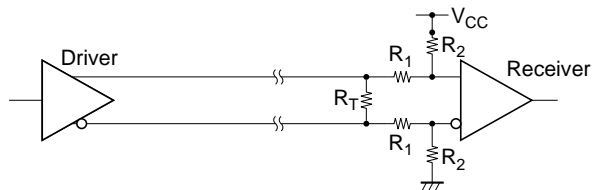


Figure 6 Method of Enhancing Fail-Safe Function

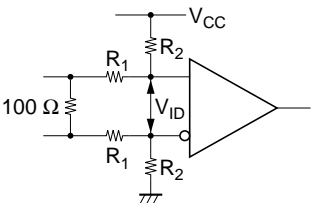
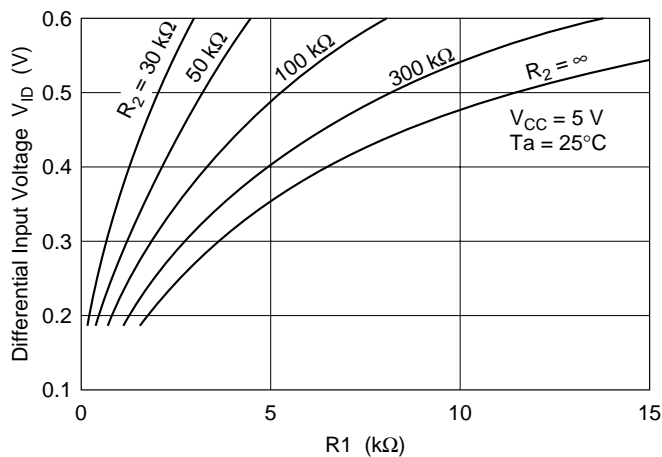


Figure 7  $R_1$ ,  $R_2$  vs. Differential Input Voltage

RS-442A Interface Standard Applications

Figure 9 shows sample operation waveforms at various points with 1200 m and 12 m cable lengths.

1. Unidirectional Transmission (1 : 1 Configuration)

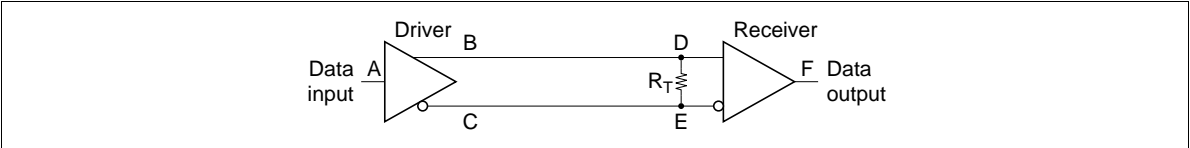


Figure 8 1 : 1 Unidirectional Transmission

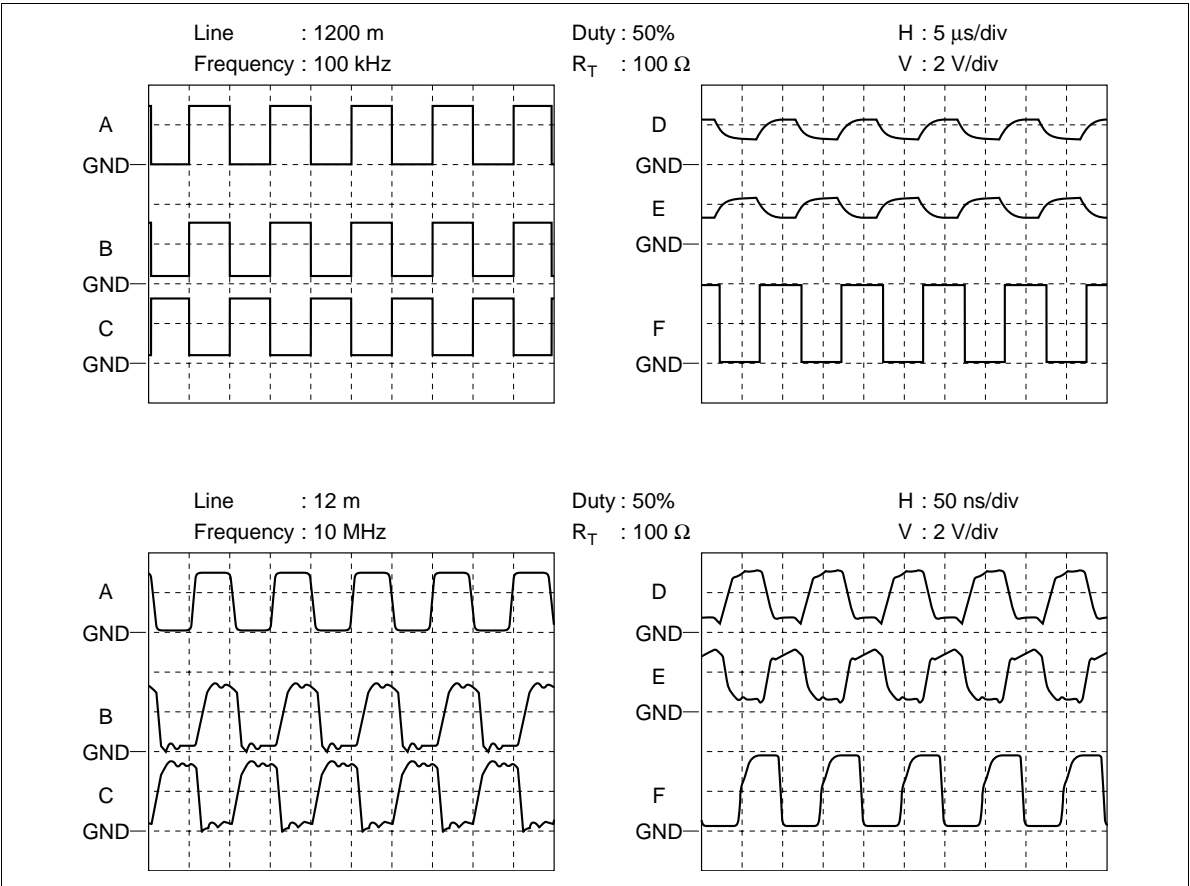
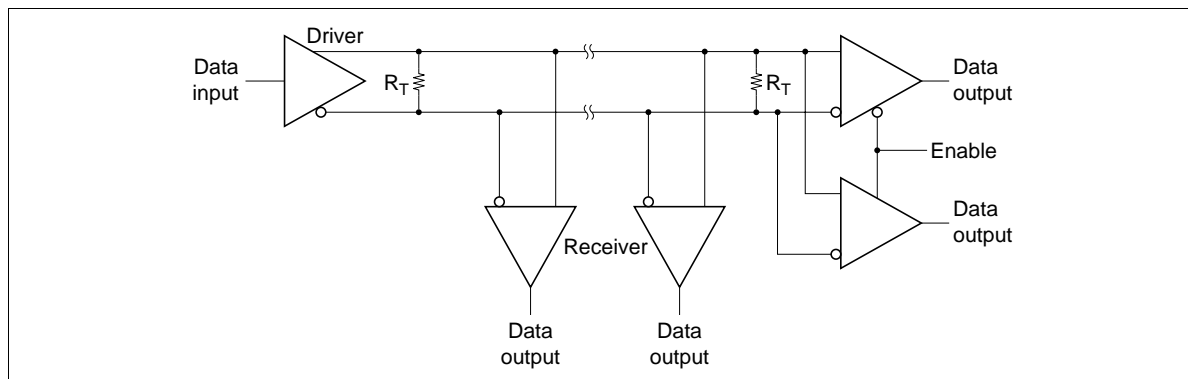


Figure 9 Sample Transmission Waveforms

## 2. Unidirectional Transmission (1 : n Configuration)

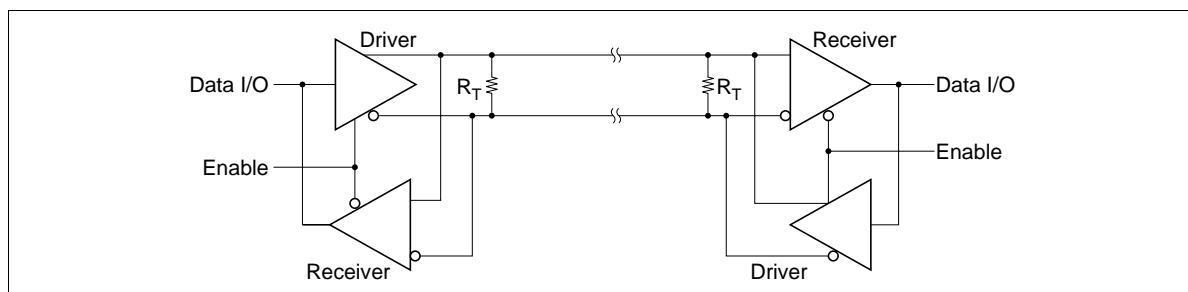


**Figure 10 1 : n Unidirectional Transmission**

With this connection method,  $n$  receivers are connected for one driver. In the RS-422A standard, ten receivers can be connected simultaneously for one driver.

Conversely, it is also possible to connect one receiver for  $n$  drivers.

## 3. Bidirectional Transmission



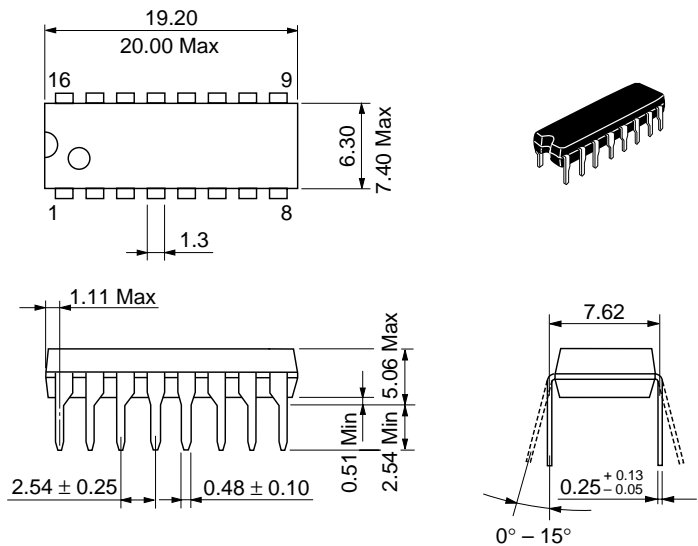
**Figure 11 Bidirectional Transmission**

When bidirectional data exchange is performed using a combination of the HD26LS31 and HD26LS32, since either high or low output control is possible, using complementary enable inputs for the driver and receiver makes it easy to configure the kind of combination illustrated in figure 11 .

Extending this combination makes it possible to exchange  $n$ -bit data simultaneously, and handle a party line system.

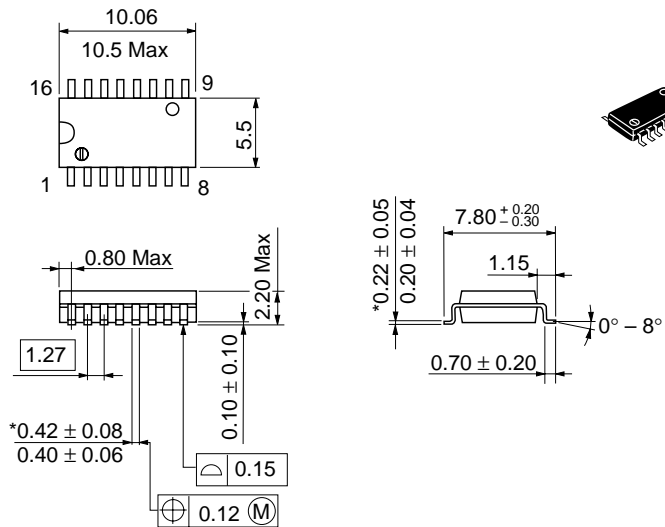
Package Dimensions

Unit: mm



Hitachi Code	DP-16
JEDEC	Conforms
EIAJ	Conforms
Mass (reference value)	1.07 g

Unit: mm



\*Dimension including the plating thickness  
Base material dimension

Hitachi Code	FP-16DA
JEDEC	—
EIAJ	Conforms
Mass (reference value)	0.24 g



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