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# HD26C31

## Quadruple Differential Line Drivers With 3 State Outputs

# HITACHI

ADE-205-574 (Z)  
1st. Edition  
Dec. 2000

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### Description

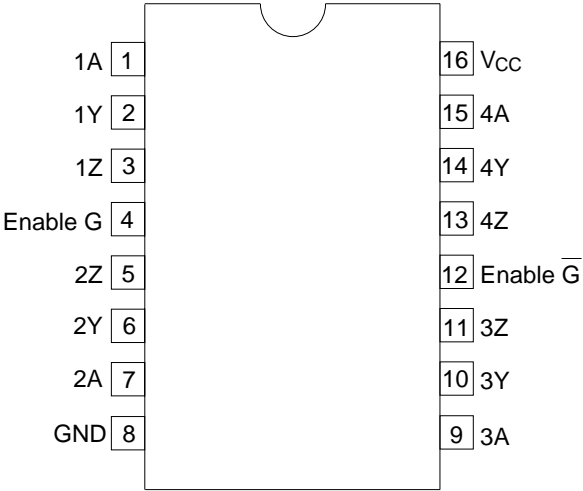
The HD26C31 features quadruple differential line drivers which satisfy the requirements of EIA standard RS-422A. This device is designed to provide differential signals with high current capability on bus lines. The circuit provides enable input to control all four drivers. The output circuit has active pull up and pull down and is capable of sinking or sourcing 20 mA.

### Features

- TTL input compatibility
- Propagation delay time: 6 ns typ
- Output to output skew: 0.5 ns typ
- High output impedance in power off conditions
- Meets EIA standard RS-422A
- Operates from a single 5 V supply
- Three state outputs
- Low power dissipation with CMOS process
- Power up and power down protection
- Pin to pin compatible with HD26LS31

# HD26C31

## Pin Arrangement



(Top view)

## Function Table

Input A	Enables		Outputs	
	G	Ḡ	Y	Z
H	H	X	H	L
L	H	X	L	H
H	X	L	H	L
L	X	L	L	H
X	L	H	Z	Z

- H : High level
- L : Low level
- X : Irrelevant
- Z : High impedance

**Absolute Maximum Ratings** ( $T_a = 25^{\circ}\text{C}$ )

Item	Symbol	Ratings	Unit
Supply Voltage* <sup>2</sup>	$V_{CC}$	−0.5 to 7.0	V
Input Voltage	$V_{IN}$	−1.5 to $V_{CC} + 1.5$	V
Output Voltage	$V_{OUT}$	−0.5 to $V_{CC} + 0.5$	V
Power Dissipation	$P_T$	500	mW
Storage Temperature Range	Tstg	−65 to 150	°C
Lead Temperature* <sup>3</sup>	Tlead	260	°C
Output Current	$I_{OUT}$	±150	mA
Supply Current	$I_{CC}$	±150	mA

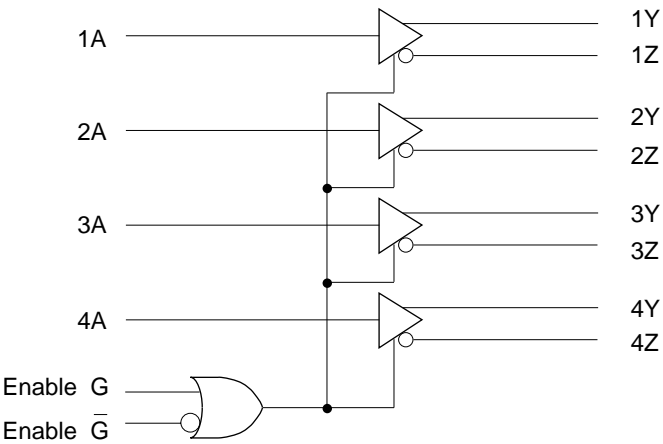
Notes: 1. The absolute maximum ratings are values which must not individually be exceeded, and furthermore, no two of which may be realized at the same time.  
 2. The values is defined as of ground terminal.  
 3. The values at 1.6 mm away from the package within 10 second, when soldering.

**Recommended Operating Conditions** ( $T_a = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ )

Item	Symbol	Min	Typ	Max	Unit
Supply Voltage	$V_{CC}$	4.5	5.0	5.5	V
Input Voltage	$V_{IN}$	0	—	$V_{CC}$	V
Output Voltage	$V_{OUT}$	0	—	$V_{CC}$	V
Operating Temperature	$T_a$	−40	25	85	°C
Input Rise/Fall Time* <sup>1</sup>	$t_r, t_f$	—	—	500	ns

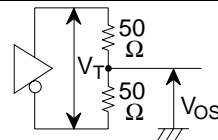
Note: 1. This guarantees maximum limit when one input switches.

Logic Diagram



**Electrical Characteristics** ( $T_a = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ )

Item	Symbol	Min	Typ	Max	Unit	Conditions
Input Voltage	$V_{IH}$	2.0	—	—	V	
	$V_{IL}$	—	—	0.8	V	
Output Voltage	$V_{OH}$	2.4	3.4	—	V	$V_{IN} = V_{IH}$ or $V_{IL}$ , $I_{OH} = -20$ mA
	$V_{OL}$	—	0.2	0.4	V	$V_{IN} = V_{IH}$ or $V_{IL}$ , $I_{OL} = 20$ mA
Differential Output Voltage	$V_T$	2.0	3.1	—	V	$R_L = 100\ \Omega$
Difference In Differential Output	$ V_T  - \overline{ V_T }$	—	—	0.4	V	
Common Mode Output Voltage	$V_{OS}$	—	1.8	3.0	V	
Difference In Output Common Mode	$ V_{OS} - \overline{V_{OS}} $	—	—	0.4	V	
Input Current	$I_{IN}$	—	—	$\pm 1.0$	$\mu\text{A}$	$V_{IN} = V_{CC}$ , GND, $V_{IH}$ or $V_{IL}$
Supply Current	$I_{CC}$	—	200	500	$\mu\text{A}$	$I_{OUT} = 0\ \mu\text{A}$ , $V_{IN} = V_{CC}$ or GND
	$I_{CC}^{*2}$	—	0.8	2.0	mA	$I_{OUT} = 0\ \mu\text{A}$ , $V_{IN} = 2.4$ V or 0.5 V
Off State Output Current	$I_{OZ}$	—	$\pm 0.5$	$\pm 5.0$	$\mu\text{A}$	$V_{OUT} = V_{CC}$ or GND, $\overline{G} = V_{IL}$ , $G = V_{IH}$
Short Circuit Output Current	$I_{SC}^{*3}$	-30	—	-150	mA	$V_{IN} = V_{CC}$ or GND
Output Current with Power	$I_{OFF}$	—	—	100	$\mu\text{A}$	$V_{CC} = 0$ V, $V_{OUT} = 6$ V
Off	$I_{OFF}$	—	—	-100	$\mu\text{A}$	$V_{CC} = 0$ V, $V_{OUT} = -0.25$ V



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

2. 1 input:  $V_{IN} = 2.4$  V or 0.5 V, other inputs:  $V_{IN} = V_{CC}$  or GND

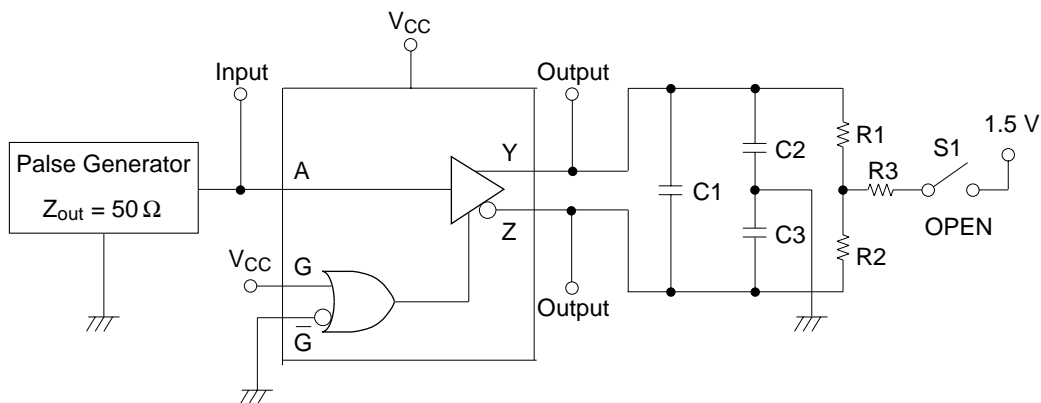
3. Not more than one output should be shorted at a time and duration of the short circuit should not exceed one second.

# HD26C31

### Switching Characteristics (Ta = -40°C to +85°C, V<sub>CC</sub> = 5 V ± 10%)

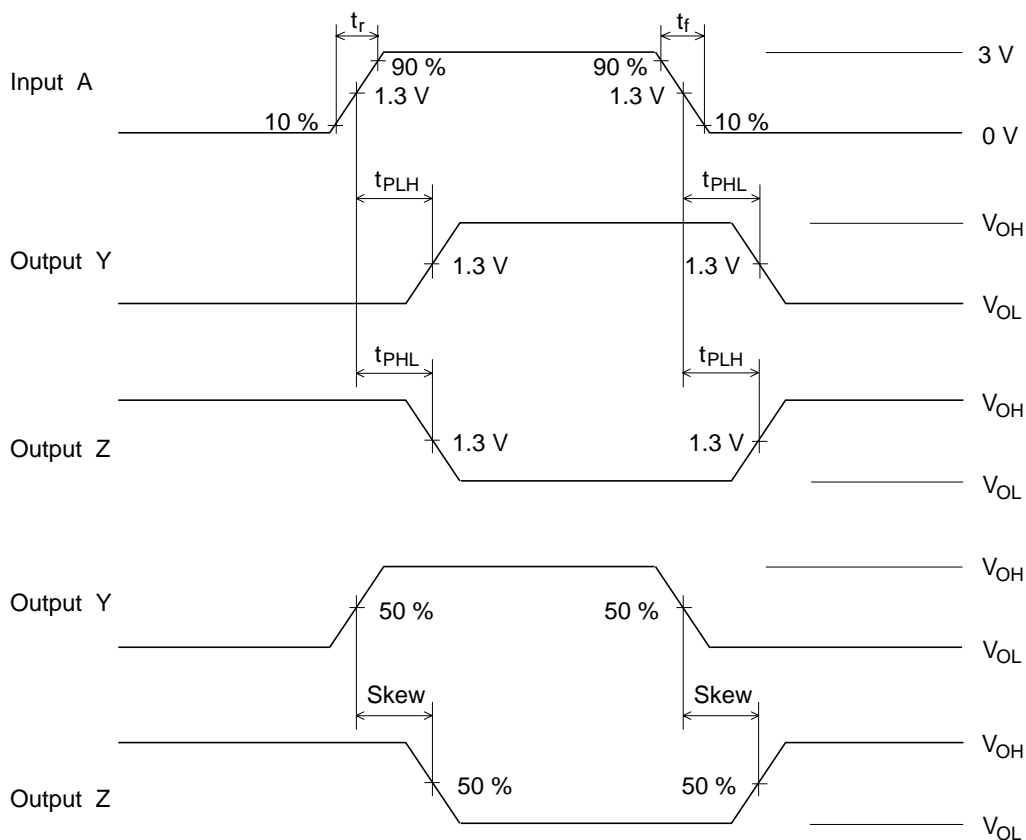
Item	Symbol	Min	Typ	Max	Unit	Conditions
Propagation Delay Time	$t_{PLH}$	2.0	6.0	11.0	ns	Test Circuit (1)
	$t_{PHL}$	2.0	6.0	11.0	ns	
Output To Output Skew	Skew	—	0.5	2.0	ns	
Differential Output Transition Time	$t_{TLH}$		6.0	10.0	ns	Test Circuit (3)
	$t_{THL}$		6.0	10.0	ns	
Output Enable Time	$t_{ZL}$		11.0	19.0	ns	Test Circuit (2)
	$t_{ZH}$	—	13.0	21.0	ns	
Output Disable Time	$t_{LZ}$	—	5.0	9.0	ns	
	$t_{HZ}$	—	7.0	11.0	ns	
Power Dissipation Capacitance	$C_{PD}$	—	50.0	—	pF	
Input Capacitance	$C_{IN}$	—	6.0	—	pF	

## Test Circuit 1



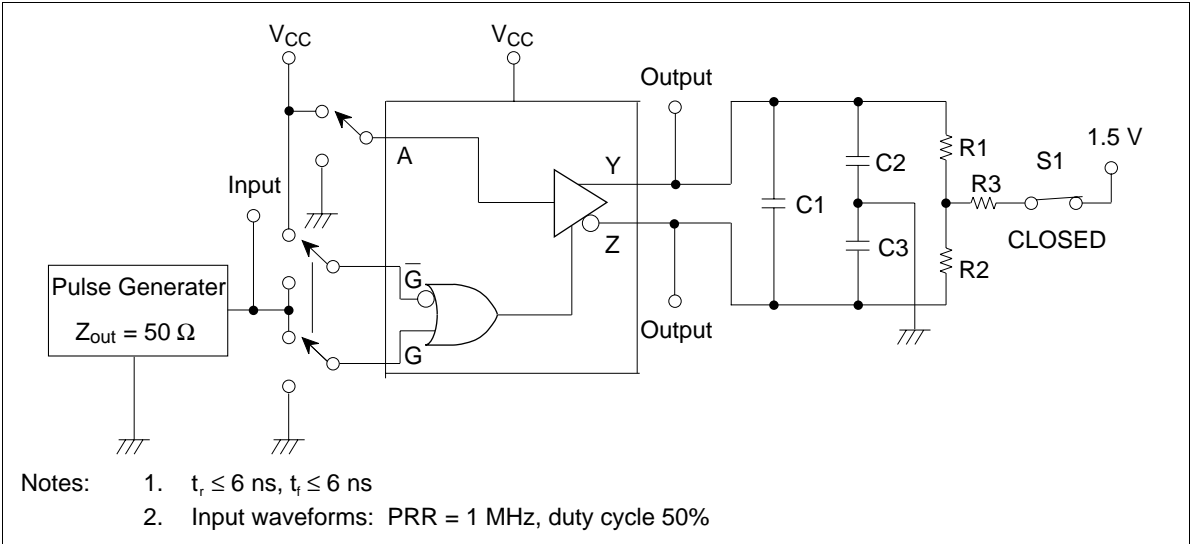
Note: 1. C1, C2 and C3 (40 pF) include probe and jig capacitance.  
R1 = R2 = 50  $\Omega$ , R3 = 500  $\Omega$

## Waveforms 1

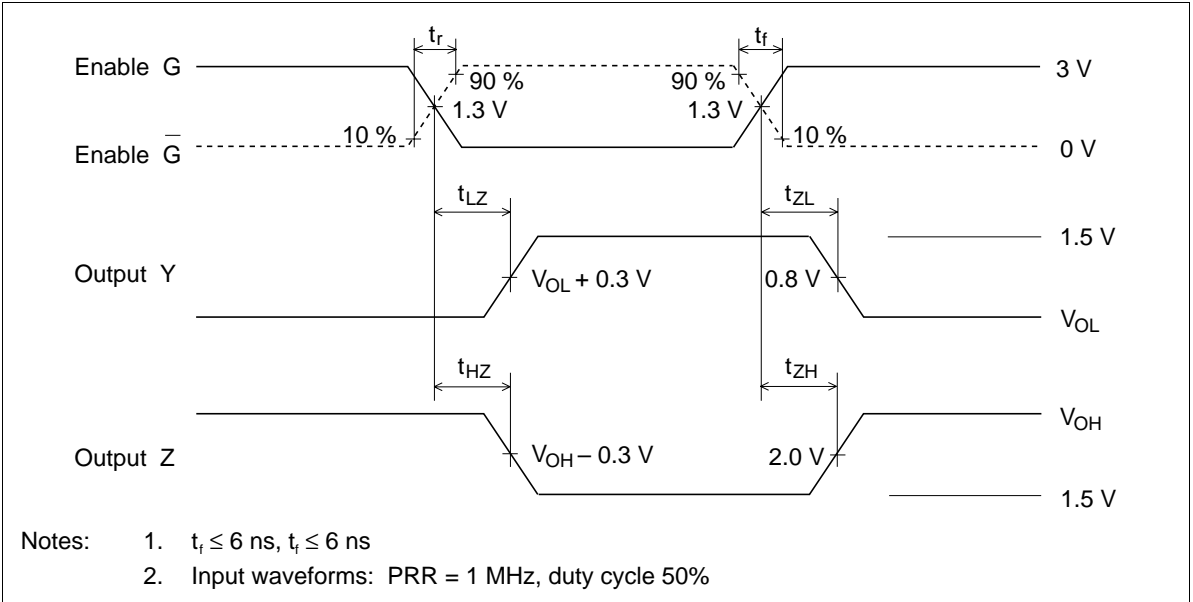


- Notes:
1.  $t_r \leq 6 \text{ ns}$ ,  $t_f \leq 6 \text{ ns}$
  2. Input waveforms: PRR = 1 MHz, duty cycle 50%

Test Circuit 2

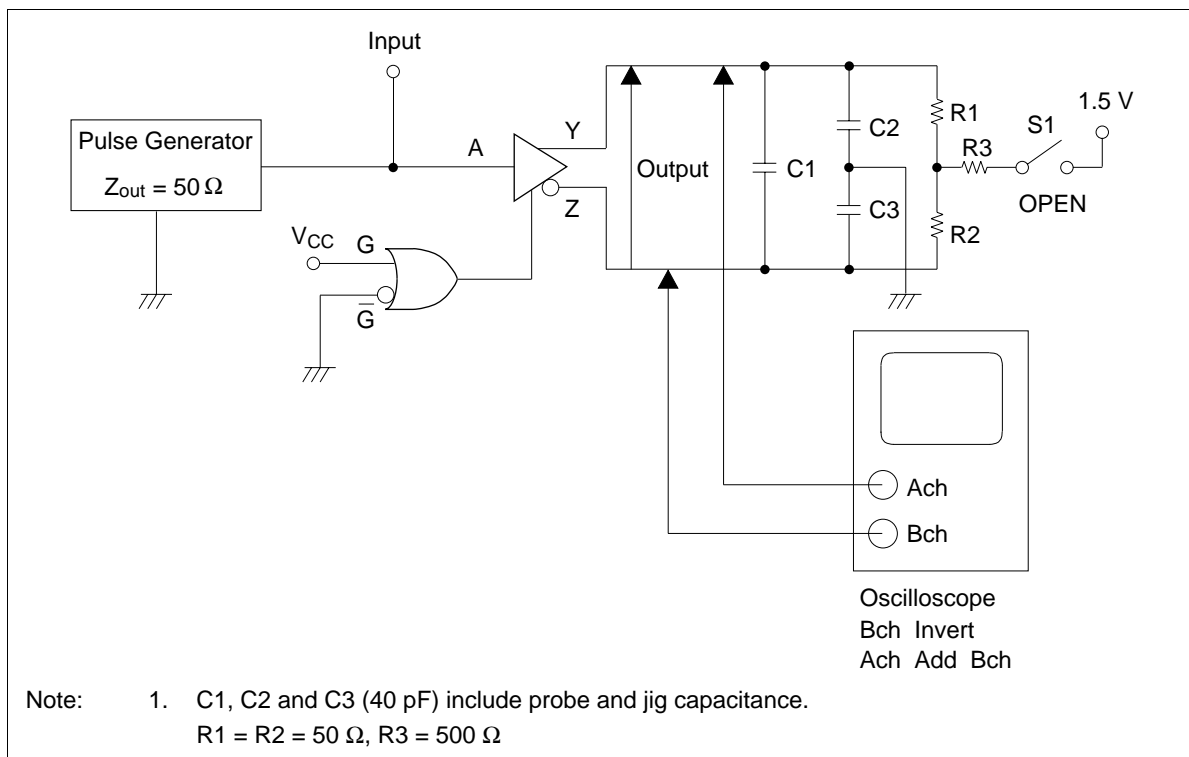


Waveforms 2

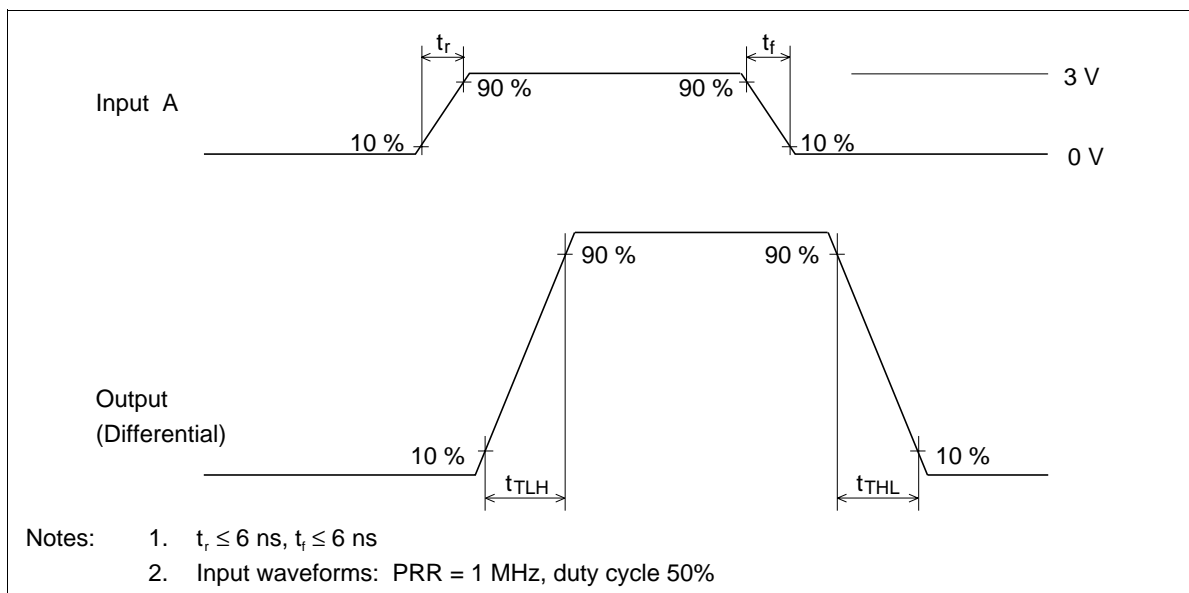




### Test Circuit 3



### Waveforms 3



HD26C31 Line Driver Applications

The HD26C31 is a line driver that meets the EIA RS-422A conditions, and has been designed to supply a high current for differential signals to a bus line. Its features are listed below.

- Operates on a single 5 V power supply.
- High output impedance when power is off
- Sink current and source current both 20 mA
- On-chip power up/down protection circuit

As shown by the logic diagram, the enable function is common to all four drivers, and either active-high or active-low can be selected.

The output section consists of two output stages (the Y side and Z side), each of which has the same sink current and source current capacity.

Connection of a termination resistance when the HD26C31 is used as a balanced differential type driver is shown.

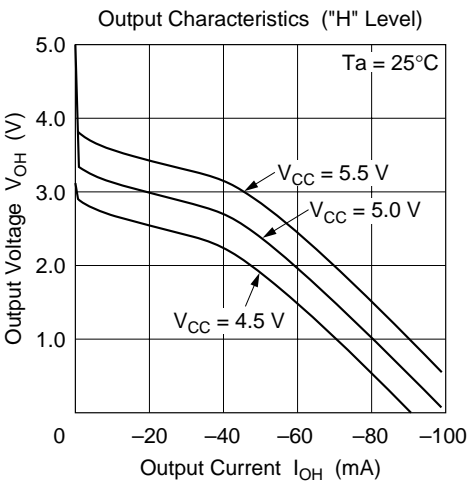
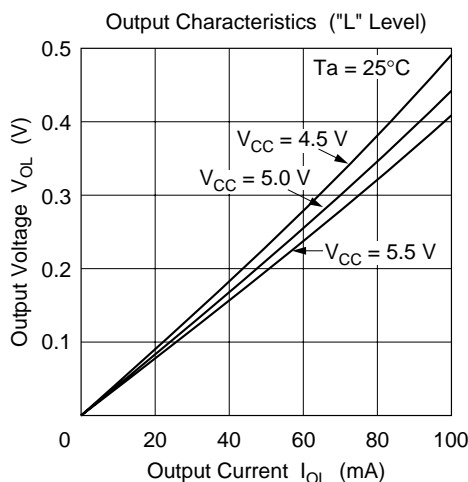


Figure 1  $I_{OH}$  vs.  $V_{OH}$  Characteristics



**Figure 2  $I_{OL}$  vs.  $V_{OL}$  Characteristics**

When termination resistance  $R_T$  is connected between the two transmission lines, as shown in figure 3 the current path situation is that current  $I_{OH}$  on the side outputting a high level (in this case, the Y output) flows to the side outputting a low level (in this case, the Z output) via  $R_T$ , with the result that the low level rise is large.

If termination resistance  $R_T$  is dropped to GND on both transmit lines, as shown in figure 4 the current path situation is that the current that flows into the side outputting a low level (in this case, the Z output) is only the input bias current from the receiver. As this input bias current is small compared with the signal current, it has almost no effect on the differential input signal at the receiver end.

Figure 5 shows the output voltage characteristic when termination resistance  $R_T$  is varied.

Also, when used in a party line system, etc., the low level rises further due to the receiver input bias current, so that it is probably advisable to drop the termination resistance to GND.

However, the fact that it is possible to make the value of  $R_T$  equal to the characteristic impedance of the transmission line offers the advantage of being able to hold the power dissipation on the side outputting a high level to a lower level than in the above case.

Consequently, the appropriate use must be decided according to the actual operating conditions (transmission line characteristics, transmission distance, whether a party line is used, etc.).

Figure 6 shows the output characteristics when termination resistance  $R_T$  is varied.

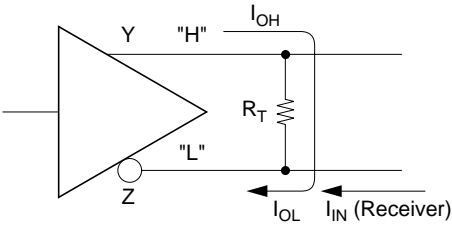


Figure 3 Example of Driver Use-1

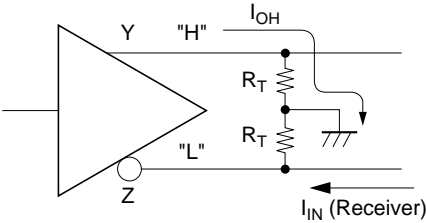


Figure 4 Example of Driver Use-2

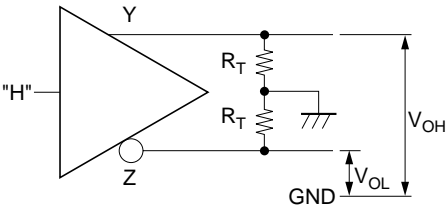
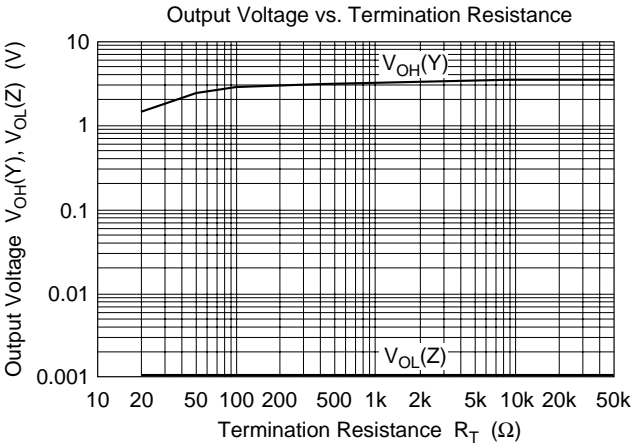


Figure 5 Termination Resistance vs. Output Voltage Characteristics

A feature of termination implemented as shown in figure 7 is that power dissipation is low when the duty of the transmitted signal is high.

However, care is required, since if  $R_T$  is sufficiently small, when the output on the pulled-up side goes high, a large current will flow and the output low level will rise.

Figure 8 shows the output characteristics when termination resistance  $R_T$  is varied.

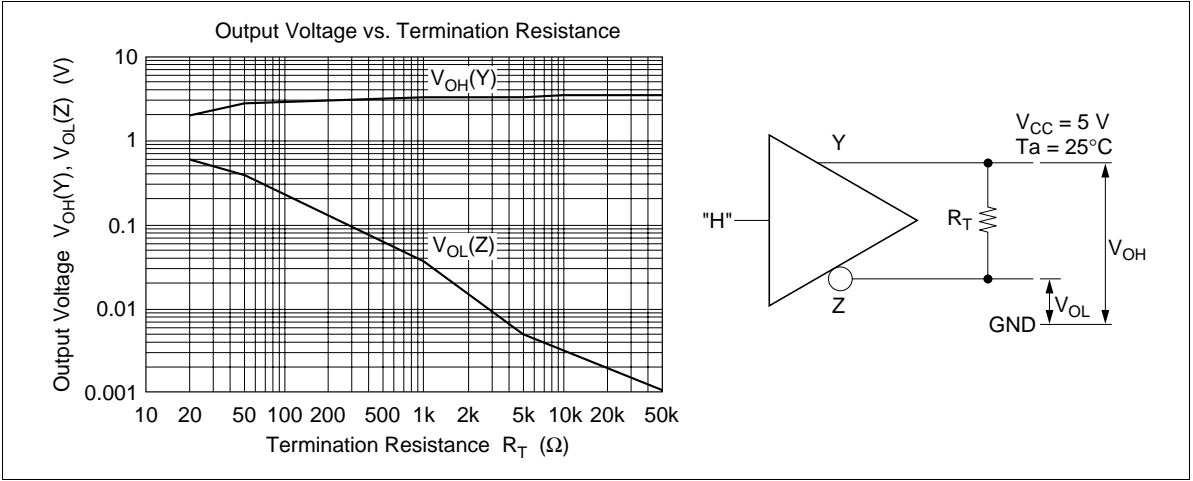


Figure 6 Termination Resistance vs. Output Voltage Characteristics

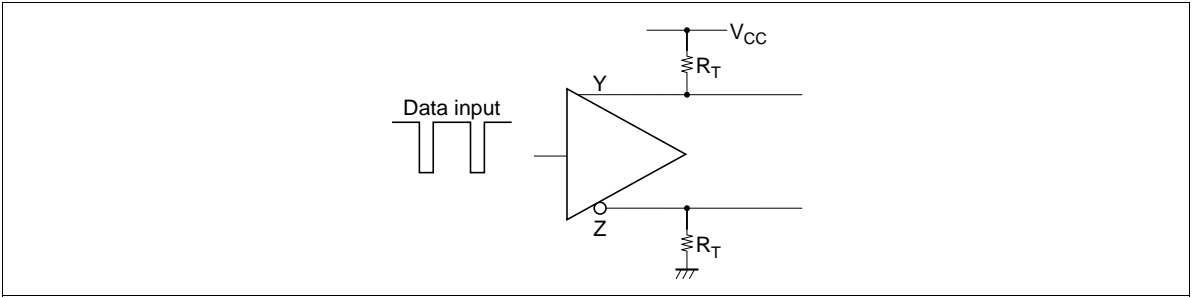


Figure 7 Example of Driver Use-3

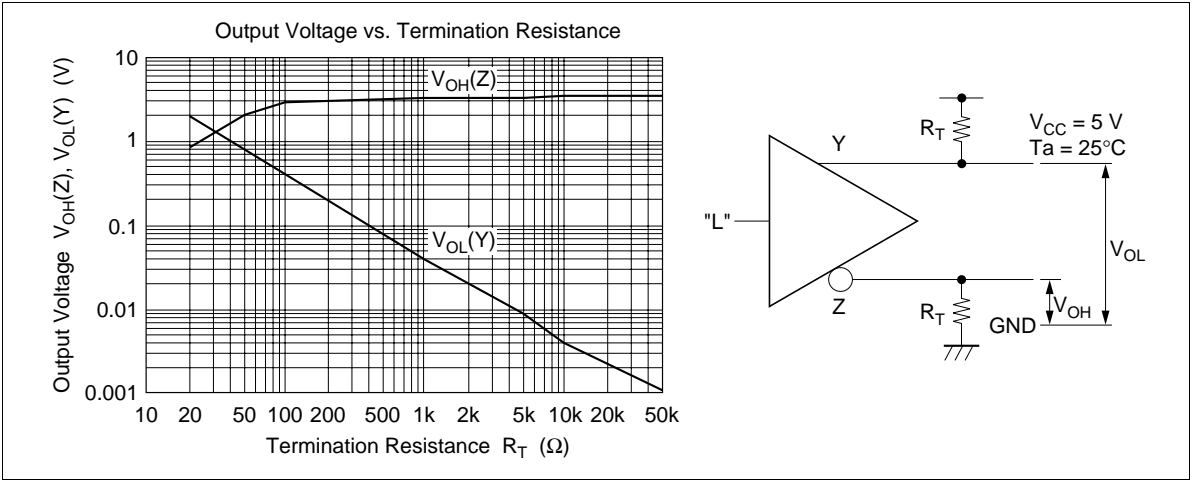
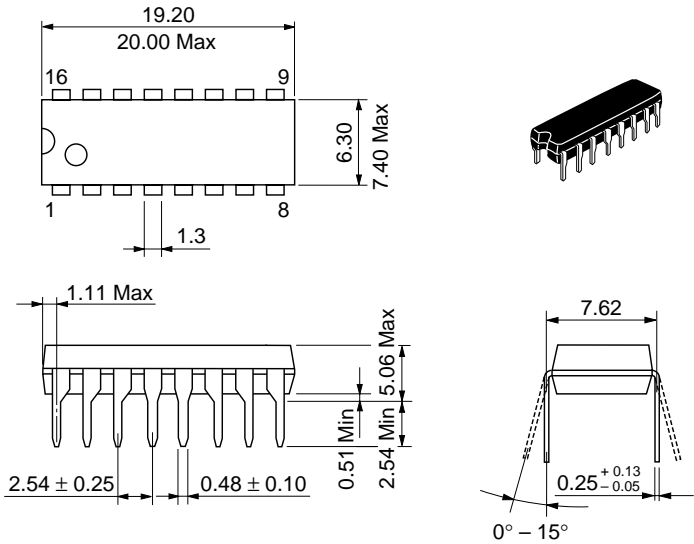


Figure 8 Termination Resistance vs. Output Voltage Characteristics

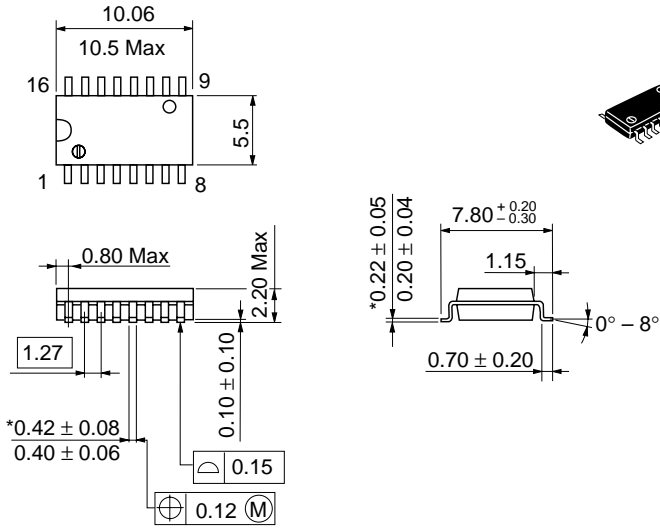
Package Dimensions

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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## Hitachi, Ltd.

Semiconductor & Integrated Circuits.  
Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100-0004, Japan  
Tel: Tokyo (03) 3270-2111 Fax: (03) 3270-5109

URL	NorthAmerica	: <a href="http://semiconductor.hitachi.com/">http://semiconductor.hitachi.com/</a>
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Hitachi Asia Ltd.  
Hitachi Tower  
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Singapore 049318  
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