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# HD26LS31

## Quadruple Differential Line Drivers With 3 State Outputs

**RENESAS**

ADE-205-576 (Z)

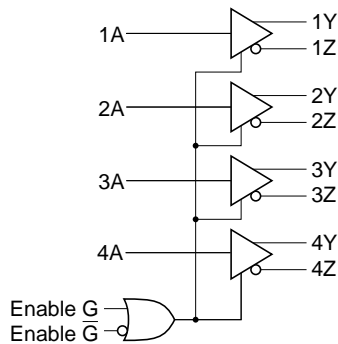
1st. Edition

Dec. 2000

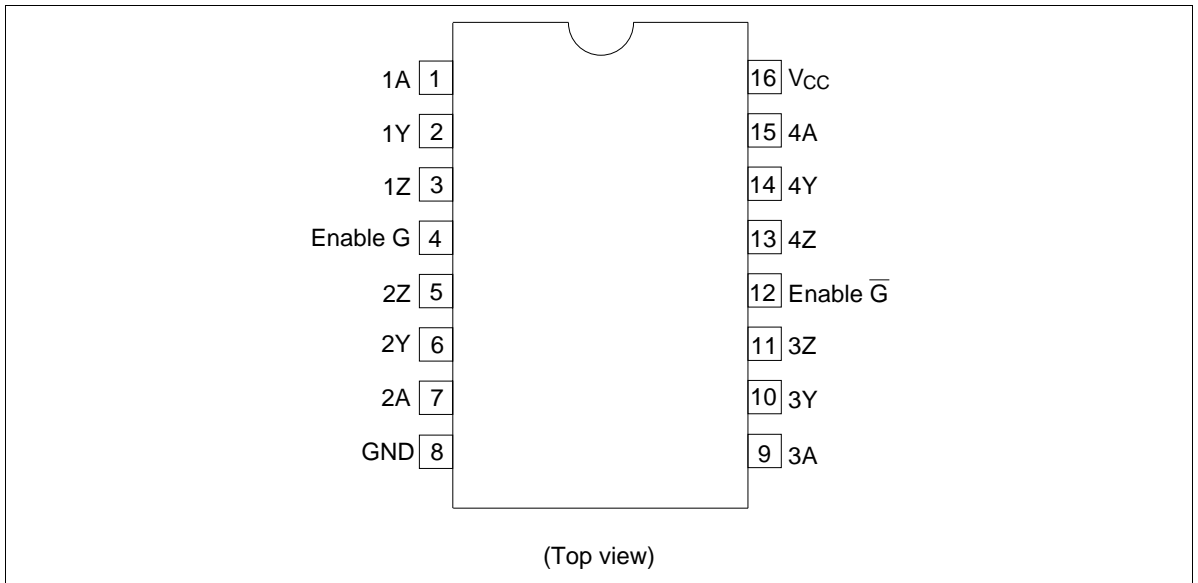
### Description

The HD26LS31 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 40 mA.

### Logic Diagram



## Pin Arrangement



## Function Table

Input <b>A</b>	Enables		Outputs	
	<b>G</b>	$\bar{\mathbf{G}}$	<b>Y</b>	<b>Z</b>
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 (Off)

## Absolute Maximum Ratings

Item	Symbol	Ratings	Unit
Supply Voltage	$V_{CC}$	7.0	V
Input Voltage	$V_{IN}$	7.0	V
Output Voltage	$V_{OUT}$	5.5	V
Power Dissipation	$P_T$	1	W
Storage Temperature Range	$T_{opr}$	0 to +70	°C
Lead Temperature Range	$T_{stg}$	-65 to +150	°C

Note: 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.

## Recommended Operating Conditions

Item	Symbol	Min	Typ	Max	Unit	Application Terminal
Supply Voltage	$V_{CC}$	4.75	5.0	5.25	V	VCC
Output Current	$I_{OH}$	—	—	-40	mA	All Output
Output Current	$I_{OL}$	—	—	40	mA	All Output
Operating Temperature	$T_{opr}$	0	25	70	—	—

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

Item	Symbol	Min	Typ*1	Max	Unit	Application Terminal	Conditions
Input Voltage	V <sub>IH</sub>	2.0	—	—	V	All Inputs	
	V <sub>IL</sub>	—	—	0.8			
Input Clamp Voltage	V <sub>IK</sub>	—	—	-1.5			V <sub>CC</sub> = 4.75 V, I <sub>I</sub> = -18 mA
Output Voltage	V <sub>OH</sub>	2.5	—	—		All Outputs	V <sub>CC</sub> = 4.75 V I <sub>OH</sub> = -20 mA I <sub>OH</sub> = -40 mA I <sub>OL</sub> = 40 mA
	V <sub>O<sub>H</sub></sub>	—	—	2.4			
	V <sub>OL</sub>	—	—	0.5			
Output Current	I <sub>OZL</sub>	—	—	-20	mA		V <sub>CC</sub> = 5.25 V V <sub>O</sub> = 0.5 V
	I <sub>OZH</sub>	—	—	20			V <sub>CC</sub> = 5.25 V V <sub>O</sub> = 2.5 V
Input Current	I <sub>I</sub>	—	—	0.1	mA	All Inputs	V <sub>CC</sub> = 5.25 V V <sub>I</sub> = 7 V V <sub>I</sub> = 2.7 V V <sub>I</sub> = 0.4 V
	I <sub>IH</sub>	—	—	20	μA		
	I <sub>IL</sub>	—	—	-0.36	mA		
Short Circuit Output Current	I <sub>OS</sub> *2	-30	—	-150		All Outputs	V <sub>CC</sub> = 5.25 V
Supply Current	I <sub>CC</sub>	—	32	80		V <sub>CC</sub>	V <sub>CC</sub> = 5.25 V

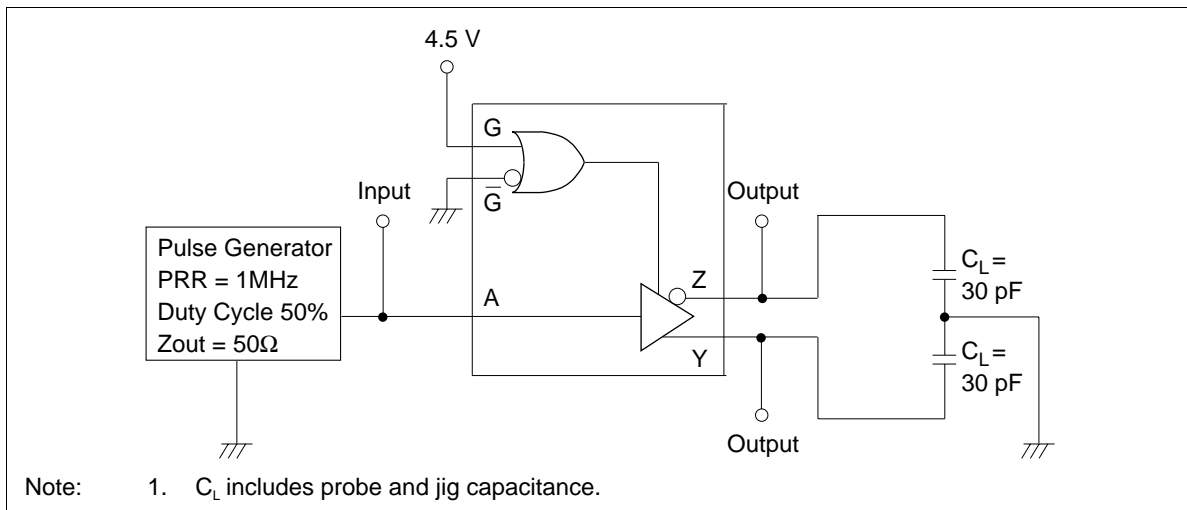
Notes: 1. All typical values are at V<sub>CC</sub> = 5 V, Ta = 25°C

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

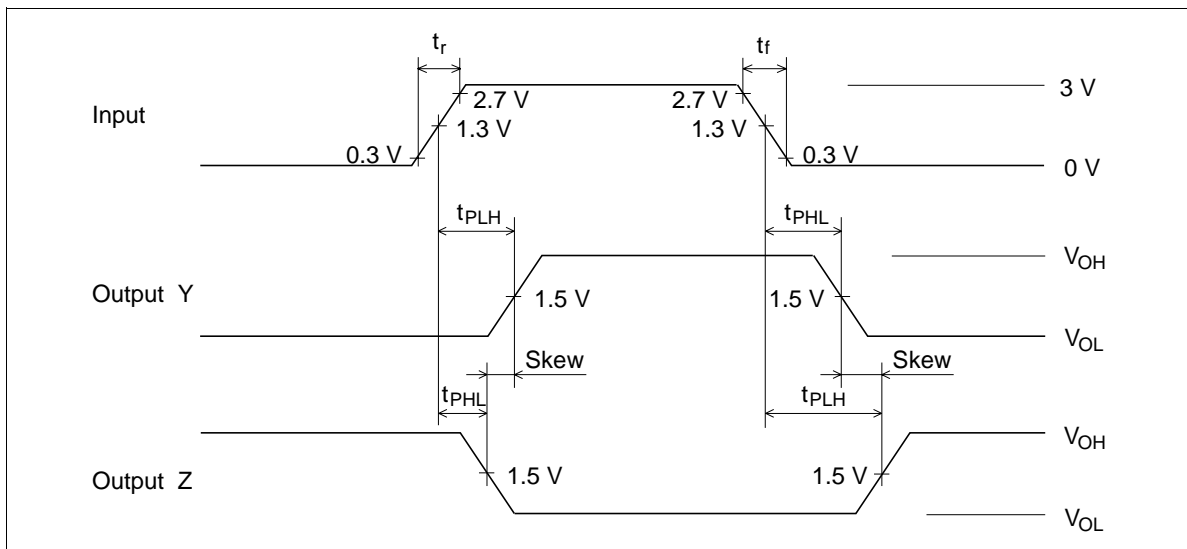
## Switching Characteristics (V<sub>CC</sub> = 5 V, Ta = 25°C)

Item	Symbol	Min	Typ	Max	Unit	Application terminal	Test circuit	Conditions
Propagation Delay Time	t <sub>PLH</sub>	—	14	20	ns	All Outputs	1	CL = 30 pF
	t <sub>PHL</sub>	—	14	20	ns			
Output Enable Time	t <sub>ZH</sub>	—	25	40	ns		2	C <sub>L</sub> = 30 pF, R <sub>L</sub> = 75 Ω
	t <sub>ZL</sub>	—	37	45	ns		3	C <sub>L</sub> = 30 pF, R <sub>L</sub> = 180 Ω
Output Disable Time	t <sub>HZ</sub>	—	21	30	ns		2	C <sub>L</sub> = 10 pF
	t <sub>LZ</sub>	—	23	35	ns		3	C <sub>L</sub> = 10 pF
Complementary Output To Output	Skew	—	1	6	ns		1	C <sub>L</sub> = 30 pF

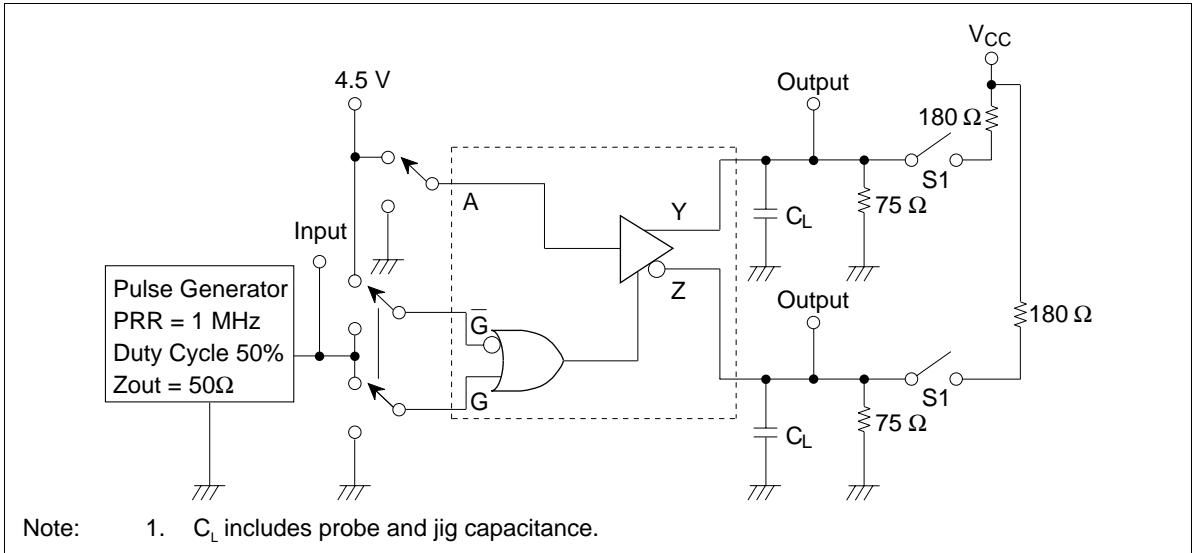
Test Circuit 1



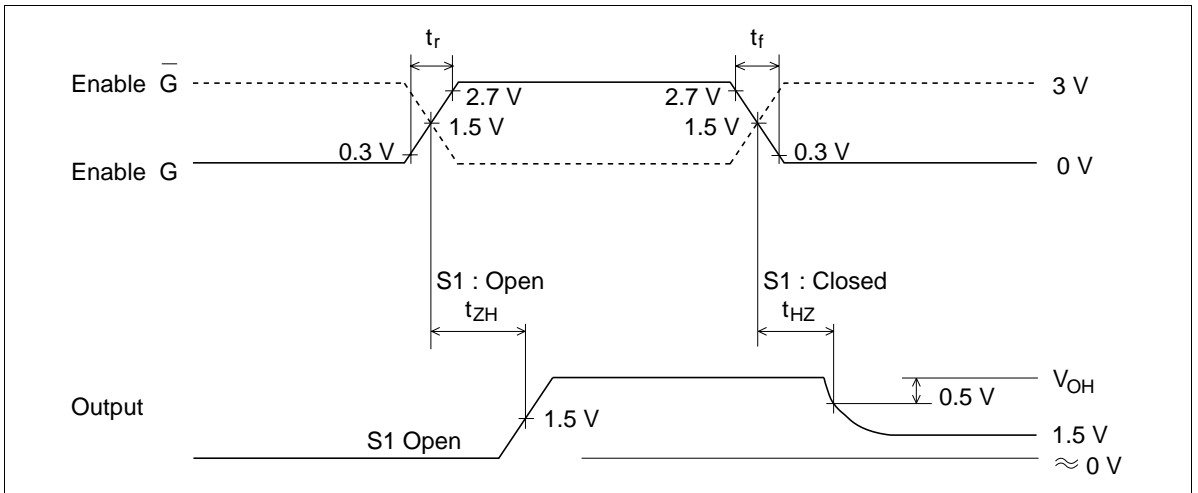
Waveforms



## Test Circuit 2

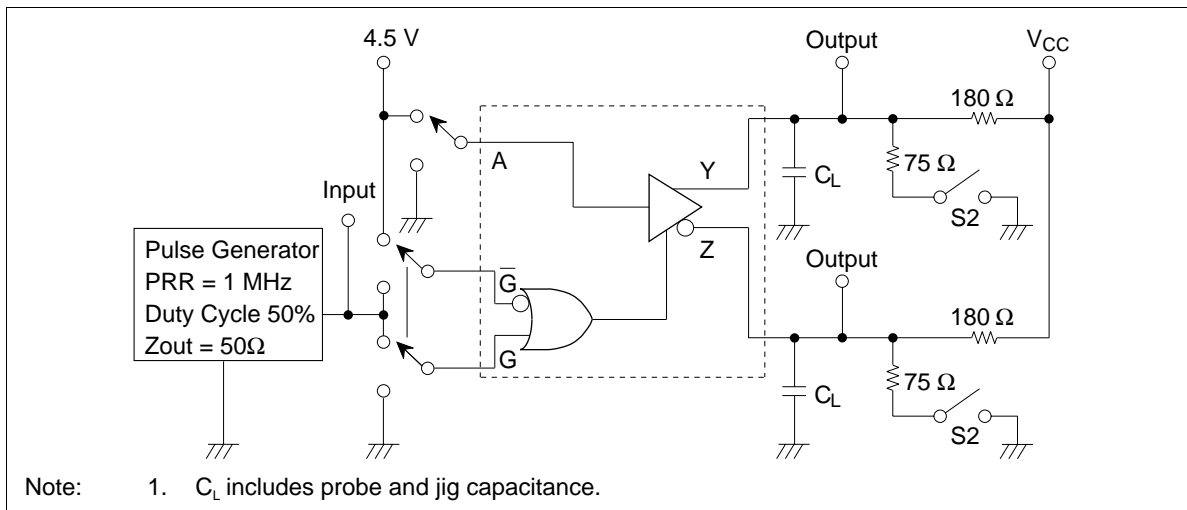


## Waveforms

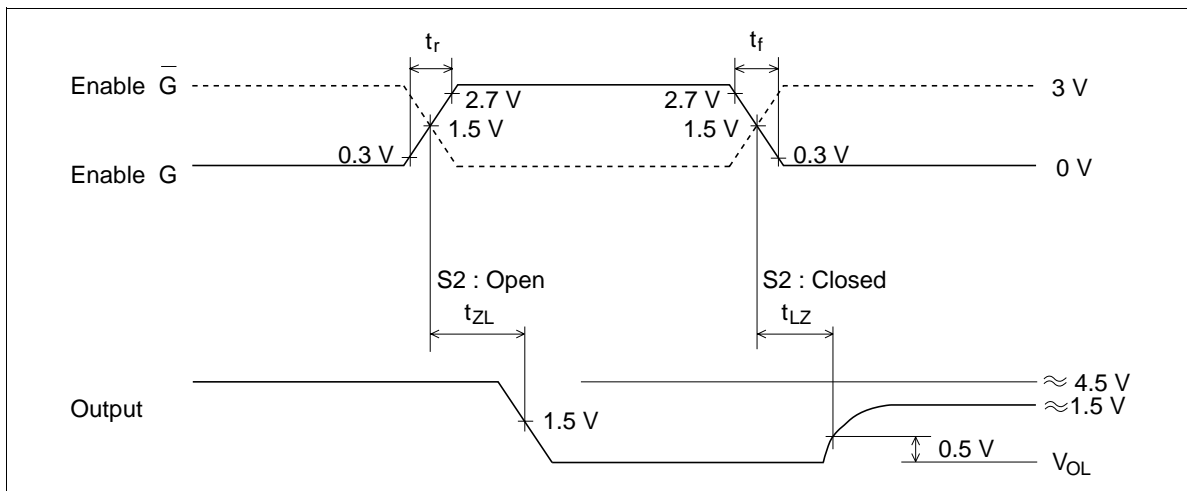




Test Circuit 3



Waveforms



## HD26LS31 Line Driver Applications

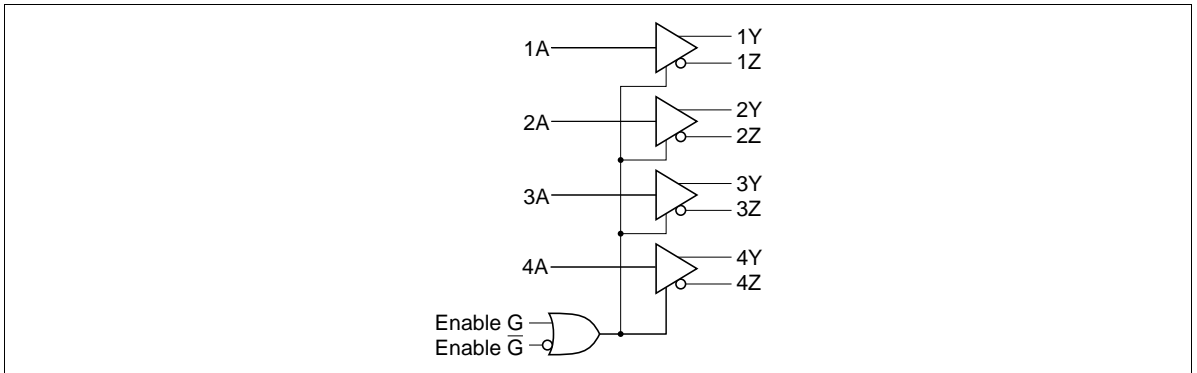
The HD26LS31 is a line driver that meets the EIA RS-422A conditions, and has been designed to supply a high current for differential signals to a bus line. Its features are listed below.

- Operates on a single 5 V power supply.
- High output impedance when power is off
- Three-state output
- On-chip current limiter circuit
- Sink current and source current both 40 mA

A block diagram is shown in figure 1. 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.

Input is TTL compatible, and an output current limiter circuit is built into the output stage as shown in figure 2.



**Figure 1 HD26LS31 Block Diagram**

The output current limiter circuit consists of transistor  $Q_1$  and resistance  $R_1$ , and operates when the voltage drop on both sides of  $R_1$  reaches approximately 0.7 V. At this time the current,  $i$ , is as follows:

$$i = 0.7 \text{ (V)} / 9 \text{ (\Omega)} \approx 78 \text{ (mA)}$$

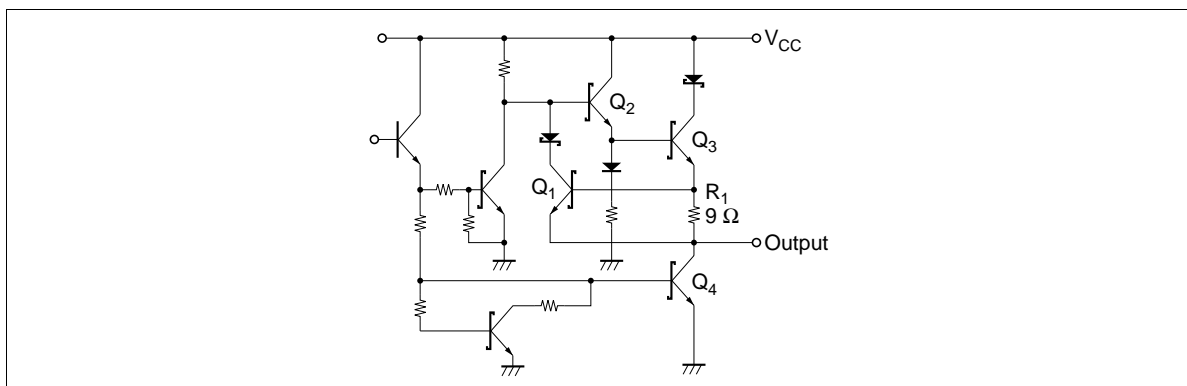
When a current greater than this flows,  $Q_1$  is turned on, the  $Q_2$  base current flows to the output side, and the flow of an excessively large output current is prevented.

However, since this type of current limiter circuit has the characteristics shown in figure 3, the output stage power dissipation is large.

Therefore, when the output is shorted, this should be limited to a maximum of one second for one pin only.

The  $I_{OL}$  vs.  $V_{OL}$  characteristic for low-level output is shown in figure 4.

An example of termination resistance connection when the HD26LS31 is used as a balanced differential type driver is shown.



**Figure 2 Output Stage Circuit Configuration**

When termination resistance  $R_T$  is connected between the two transmission lines, as shown in figure 7 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 5 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.

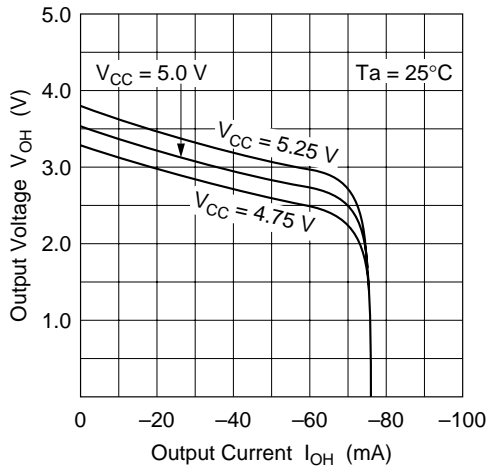
Figure 6 shows the output voltage characteristics when termination resistance  $R_T$  is varied.

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.

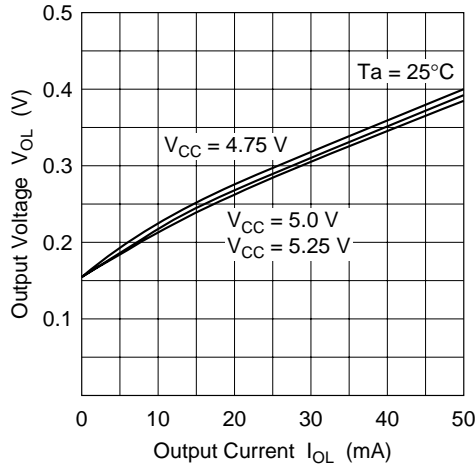
However, the fact that it is possible to make the value of  $R_T$  equal to the characteristic impedance of the transmission line offers the advantage of being able to hold the power dissipation on the side outputting a high level to a lower level than in the above case.

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.).

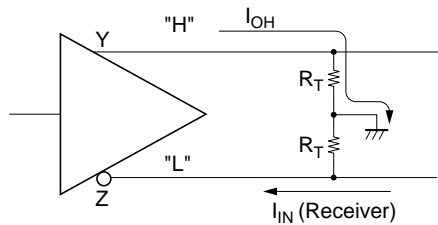
Figure 8 shows the output voltage characteristics when termination resistance  $R_T$  is varied.



**Figure 3**  $I_{OH}$  vs.  $V_{OH}$  Characteristics



**Figure 4**  $I_{OL}$  vs.  $V_{OL}$  Characteristics



$$R_T = \frac{Z_O}{2}$$

$Z_O$  is the transmission line characteristic impedance

Figure 5 Example of Driver Use-1

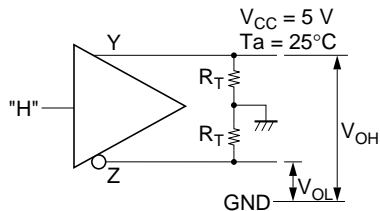
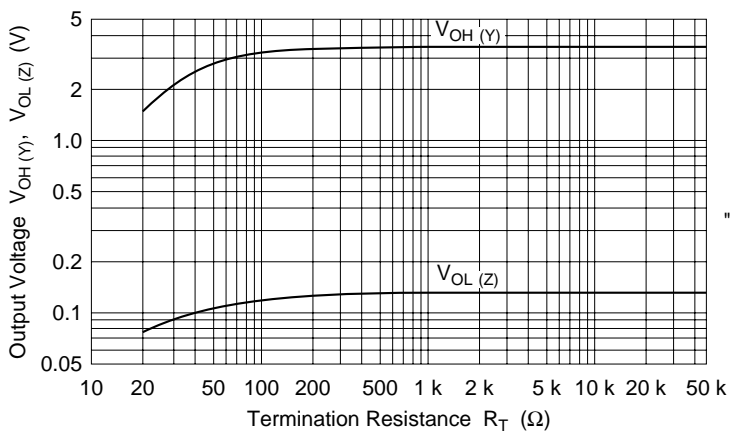
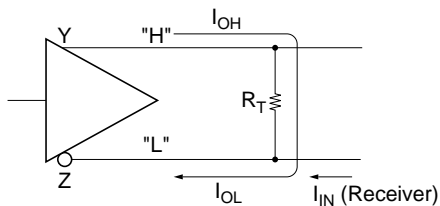


Figure 6 Termination Resistance vs. Output Voltage Characteristics



$$R_T = Z_O$$

$Z_O$  is the transmission line characteristic impedance

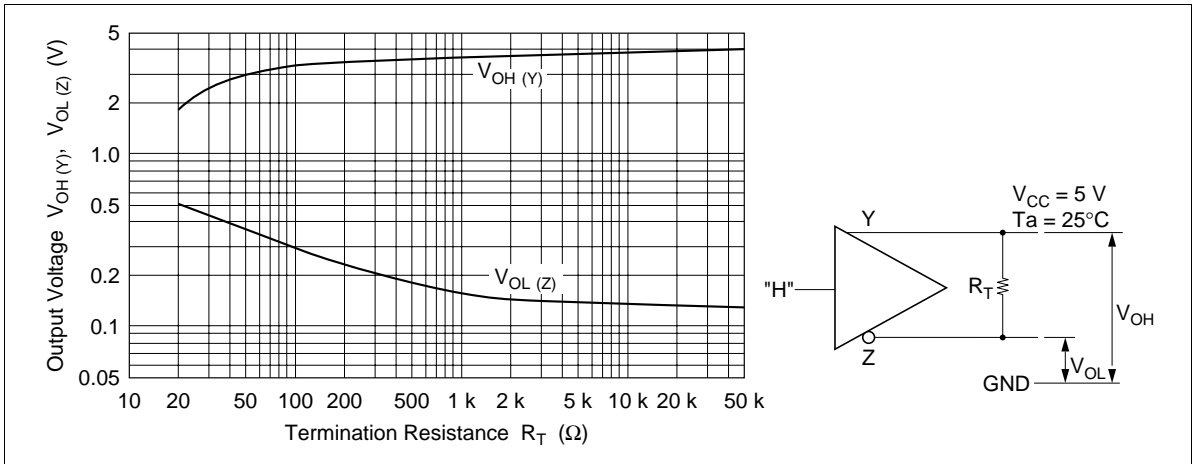
Figure 7 Example of Driver Use-2

A feature of termination implemented as shown in figure 9 is that power dissipation is low when the duty of the transmitted signal is high.

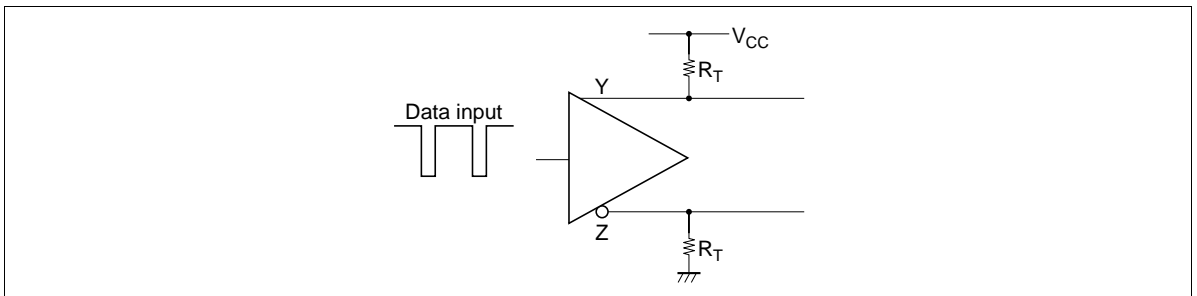
However, care is required, since if  $R_T$  is sufficiently small, when the output on the pulled-up side goes low, since the inverter transistor ( $Q_4$  in figure 2) has no protection circuit, and so a large current will flow and the output low level will rise.

Figure 10 shows the output voltage characteristics when termination resistance  $R_T$  is varied.

With the method of using the driver described above, if termination resistance  $R_T$  becomes sufficiently small, the region within which the output current limiter circuit operates will be entered, as can be seen from the  $I_{OH}$  vs.  $V_{OH}$  characteristics shown in figure 3. In this region, the output stage power dissipation is large and the output voltage changes abruptly. A measure such as insertion of a capacitor in series with the termination resistance is therefore necessary. Consequently, when selecting the transmission line, the circuit termination resistance to be used requires careful consideration.



**Figure 8 Termination Resistance vs. Output Voltage Characteristics**



**Figure 9 Example of Driver Use-3**

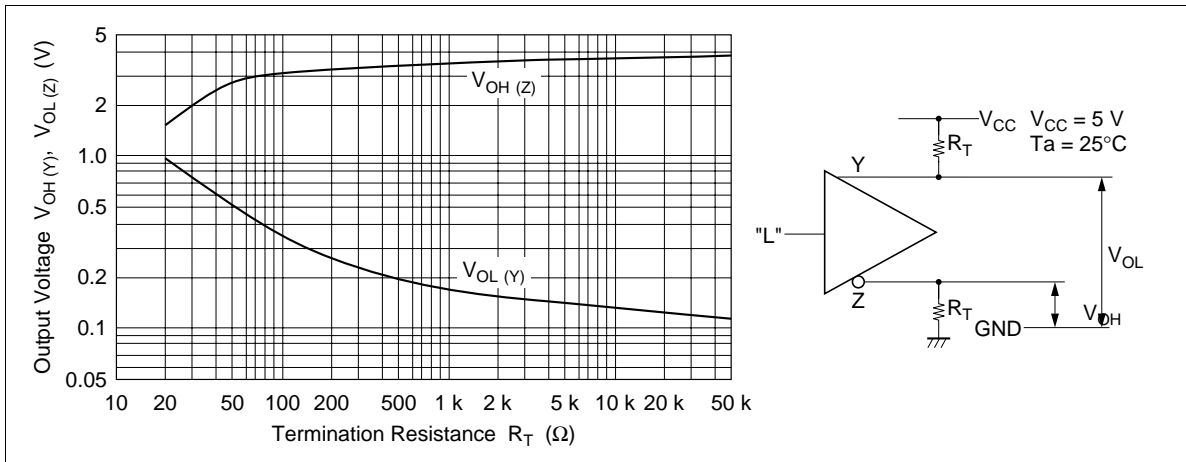
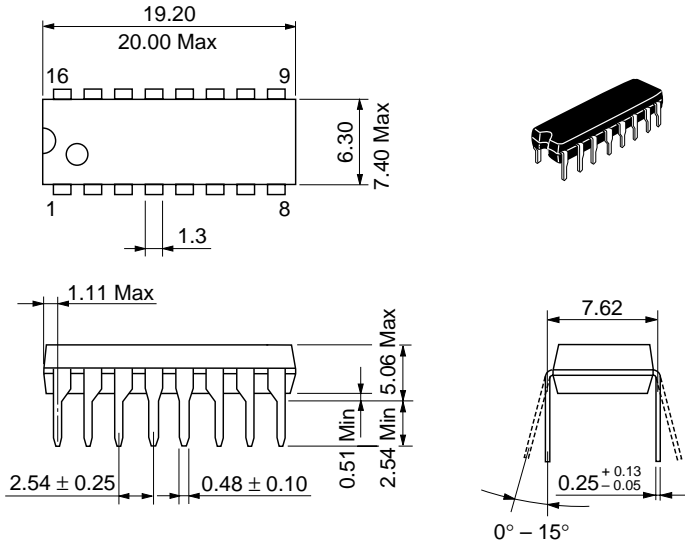


Figure 10 Termination Resistance vs. Output Voltage Characteristic

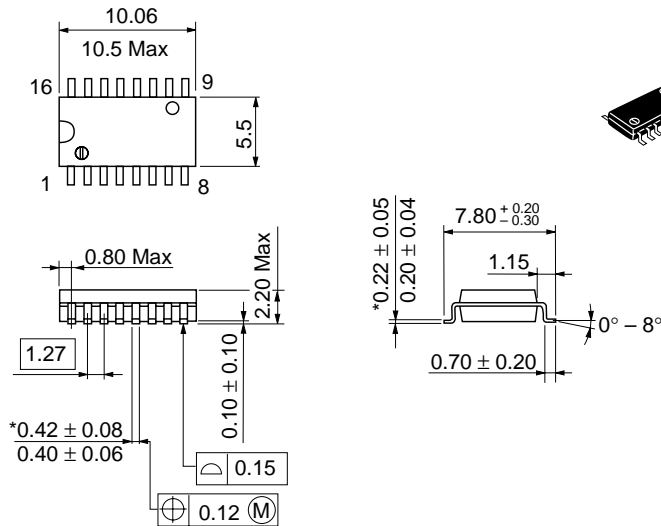
## Package Dimensions

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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