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# HD74ALVC16334

16-bit Universal Bus Driver with 3-state Outputs

## HITACHI

ADE-205-208 (Z)  
Preliminary  
1st. Edition  
December 1997

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### Description

This HD74ALVC16334 is a 16-bit universal bus driver is designed for 2.3 V to 3.6 V  $V_{CC}$  operation.

Data flow from A to Y is controlled by the output enable ( $\overline{OE}$ ) input. The device operates in the transparent mode when the latch enable ( $\overline{LE}$ ) input is low. When  $\overline{LE}$  is high, the A data is latched if the clock (CLK) input is held at a high or low logic level. If  $\overline{LE}$  is high, the A data is stored in the latch/flip flop on the low to high transition of CLK. When  $\overline{OE}$  is high, the outputs are in the high impedance state.

To ensure the high impedance state during power up or power down,  $\overline{OE}$  should be tied to  $V_{CC}$  through a pullup resistor; the minimum value of the resistor is determined by the current sinking capability of the driver.

### Features

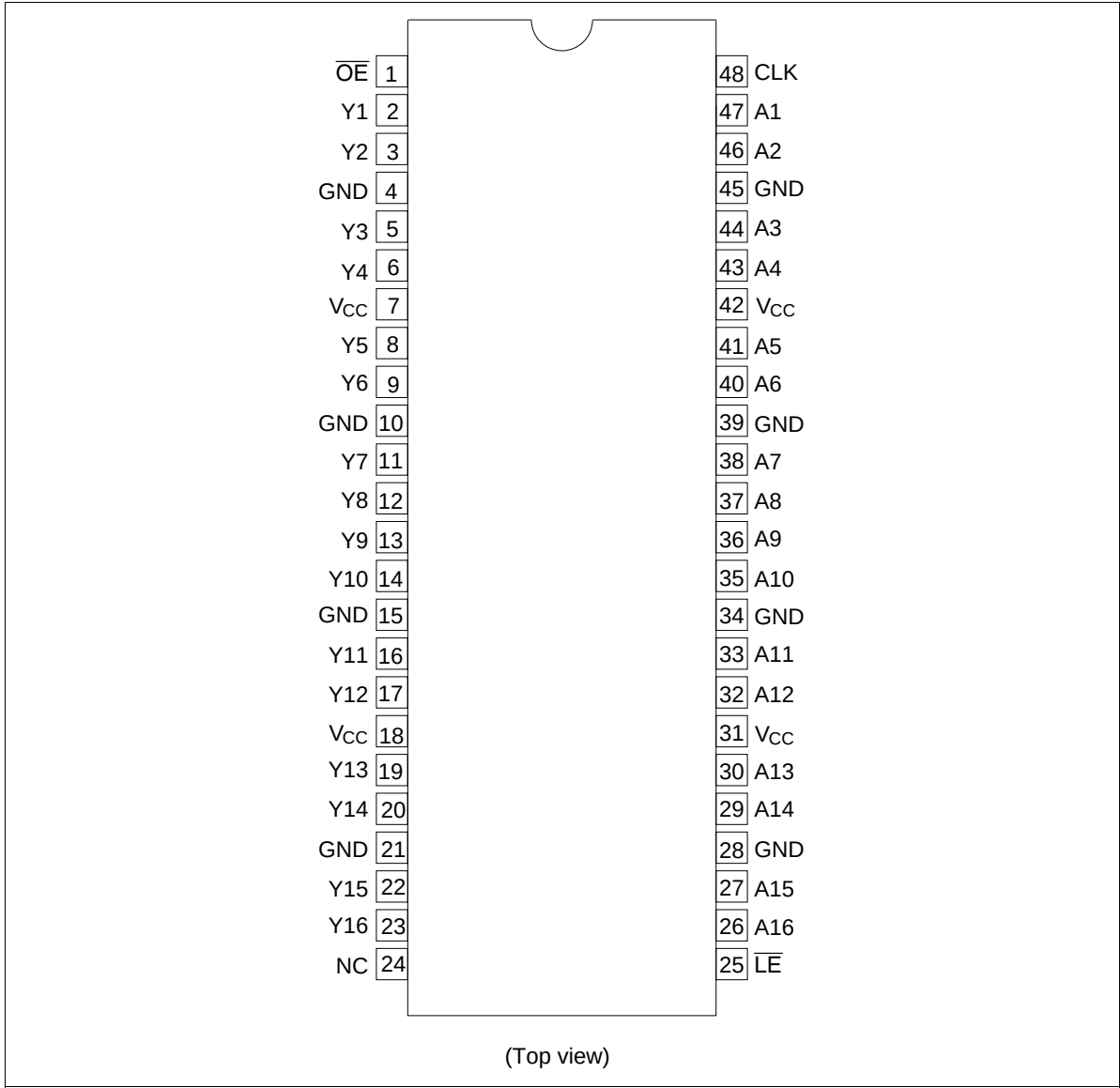
- $V_{CC} = 2.3 \text{ V to } 3.6 \text{ V}$
- Typical  $V_{OL}$  ground bounce  $< 0.8 \text{ V}$  (@ $V_{CC} = 3.3 \text{ V}$ ,  $T_a = 25^\circ\text{C}$ )
- Typical  $V_{OH}$  undershoot  $> 2.0 \text{ V}$  (@ $V_{CC} = 3.3 \text{ V}$ ,  $T_a = 25^\circ\text{C}$ )
- High output current  $\pm 24 \text{ mA}$  (@ $V_{CC} = 3.0 \text{ V}$ )

Function Table

| Inputs |    |        |   | Output Y                     |
|--------|----|--------|---|------------------------------|
| OE     | LE | CLK    | A |                              |
| H      | X  | X      | X | Z                            |
| L      | L  | X      | L | L                            |
| L      | L  | X      | H | H                            |
| L      | H  | ↑      | L | L                            |
| L      | H  | ↑      | H | H                            |
| L      | H  | L or H | X | Y <sub>0</sub> <sup>*1</sup> |

H : High level  
L : Low level  
X : Immaterial  
Z : High impedance  
↑ : Low to high transition  
Note: 1. Output level before the indicated steady state input conditions were established.

Pin Arrangement



Absolute Maximum Ratings

| Item                                                                                 | Symbol                | Ratings                | Unit               | Conditions                  |
|--------------------------------------------------------------------------------------|-----------------------|------------------------|--------------------|-----------------------------|
| Supply voltage                                                                       | $V_{CC}$              | −0.5 to 4.6            | V                  |                             |
| Input voltage <sup>*1</sup>                                                          | $V_I$                 | −0.5 to 4.6            | V                  |                             |
| Output voltage <sup>*1, 2</sup>                                                      | $V_O$                 | −0.5 to $V_{CC} + 0.5$ | V                  |                             |
| Input clamp current                                                                  | $I_{IK}$              | −50                    | mA                 | $V_I < 0$                   |
| Output clamp current                                                                 | $I_{OK}$              | ±50                    | mA                 | $V_O < 0$ or $V_O > V_{CC}$ |
| Continuous output current                                                            | $I_O$                 | ±50                    | mA                 | $V_O = 0$ to $V_{CC}$       |
| $V_{CC}$ , GND current / pin                                                         | $I_{CC}$ or $I_{GND}$ | ±100                   | mA                 |                             |
| Maximum power dissipation at $T_a = 55^{\circ}\text{C}$ (in still air) <sup>*3</sup> | $P_T$                 | 0.85                   | W                  | TSSOP                       |
| Storage temperature                                                                  | $T_{stg}$             | −65 to 150             | $^{\circ}\text{C}$ |                             |

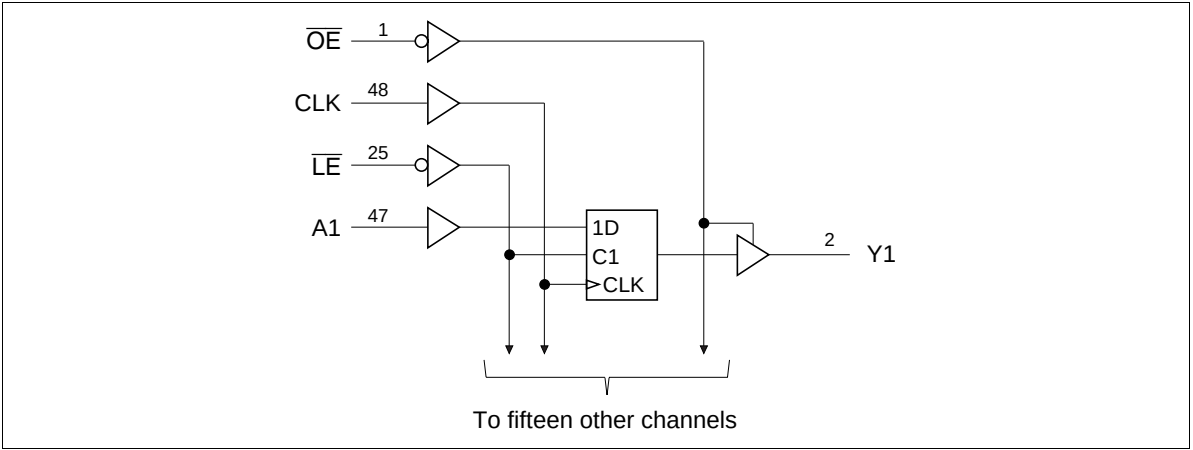
- Notes:
- Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.
1. The input and output negative voltage ratings may be exceeded if the input and output clamp current ratings are observed.
  2. This value is limited to 4.6 V maximum.
  3. The maximum package power dissipation is calculated using a junction temperature of 150°C and a board trace length of 750 mils.

Recommended Operating Conditions

| Item                               | Symbol                | Min | Max      | Unit               | Conditions              |
|------------------------------------|-----------------------|-----|----------|--------------------|-------------------------|
| Supply voltage                     | $V_{CC}$              | 2.3 | 3.6      | V                  |                         |
| Input voltage                      | $V_I$                 | 0   | $V_{CC}$ | V                  |                         |
| Output voltage                     | $V_O$                 | 0   | $V_{CC}$ | V                  |                         |
| High level output current          | $I_{OH}$              | —   | −12      | mA                 | $V_{CC} = 2.3\text{ V}$ |
|                                    |                       | —   | −12      |                    | $V_{CC} = 2.7\text{ V}$ |
|                                    |                       | —   | −24      |                    | $V_{CC} = 3.0\text{ V}$ |
| Low level output current           | $I_{OL}$              | —   | 12       | mA                 | $V_{CC} = 2.3\text{ V}$ |
|                                    |                       | —   | 12       |                    | $V_{CC} = 2.7\text{ V}$ |
|                                    |                       | —   | 24       |                    | $V_{CC} = 3.0\text{ V}$ |
| Input transition rise or fall rate | $\Delta t / \Delta v$ | 0   | 10       | ns / V             |                         |
| Operating temperature              | $T_a$                 | −40 | 85       | $^{\circ}\text{C}$ |                         |

Note: Unused control inputs must be held high or low to prevent them from floating.

Logic Diagram



Electrical Characteristics (Ta = -40 to 85°C)

| Item                     | Symbol           | V <sub>CC</sub> (V) | Min                  | Max  | Unit | Test Conditions                                                                                 |
|--------------------------|------------------|---------------------|----------------------|------|------|-------------------------------------------------------------------------------------------------|
| Input voltage            | V <sub>IH</sub>  | 2.3 to 2.7          | 1.7                  | —    | V    |                                                                                                 |
|                          |                  | 2.7 to 3.6          | 2.0                  | —    |      |                                                                                                 |
|                          | V <sub>IL</sub>  | 2.3 to 2.7          | —                    | 0.7  |      |                                                                                                 |
|                          |                  | 2.7 to 3.6          | —                    | 0.8  |      |                                                                                                 |
| Output voltage           | V <sub>OH</sub>  | 2.3 to 3.6          | V <sub>CC</sub> -0.2 | —    | V    | I <sub>OH</sub> = -100 μA                                                                       |
|                          |                  | 2.3                 | 2.0                  | —    |      | I <sub>OH</sub> = -6 mA, V <sub>IH</sub> = 1.7 V                                                |
|                          |                  | 2.3                 | 1.7                  | —    |      | I <sub>OH</sub> = -12 mA, V <sub>IH</sub> = 1.7 V                                               |
|                          |                  | 2.7                 | 2.2                  | —    |      | I <sub>OH</sub> = -12 mA, V <sub>IH</sub> = 2.0 V                                               |
|                          |                  | 3.0                 | 2.4                  | —    |      | I <sub>OH</sub> = -12 mA, V <sub>IH</sub> = 2.0 V                                               |
|                          |                  | 3.0                 | 2.0                  | —    |      | I <sub>OH</sub> = -24 mA, V <sub>IH</sub> = 2.0 V                                               |
|                          | V <sub>OL</sub>  | 2.3 to 3.6          | —                    | 0.2  |      | I <sub>OL</sub> = 100 μA                                                                        |
|                          |                  | 2.3                 | —                    | 0.4  |      | I <sub>OL</sub> = 6 mA, V <sub>IL</sub> = 0.7 V                                                 |
|                          |                  | 2.3                 | —                    | 0.7  |      | I <sub>OL</sub> = 12 mA, V <sub>IL</sub> = 0.7 V                                                |
|                          |                  | 2.7                 | —                    | 0.4  |      | I <sub>OL</sub> = 12 mA, V <sub>IL</sub> = 0.8 V                                                |
|                          |                  | 3.0                 | —                    | 0.55 |      | I <sub>OL</sub> = 24 mA, V <sub>IL</sub> = 0.8 V                                                |
| Input current            | I <sub>IN</sub>  | 3.6                 | —                    | ±5   | μA   | V <sub>IN</sub> = V <sub>CC</sub> or GND                                                        |
| Off state output current | I <sub>OZ</sub>  | 3.6                 | —                    | ±10  | μA   | V <sub>OUT</sub> = V <sub>CC</sub> or GND                                                       |
| Quiescent supply current | I <sub>CC</sub>  | 3.6                 | —                    | 40   | μA   | V <sub>IN</sub> = V <sub>CC</sub> or GND                                                        |
|                          | ΔI <sub>CC</sub> | 3.0 to 3.6          | —                    | 750  | μA   | V <sub>IN</sub> = one input at (V <sub>CC</sub> -0.6) V, other inputs at V <sub>CC</sub> or GND |

Switching Characteristics (Ta = -40 to 85°C)

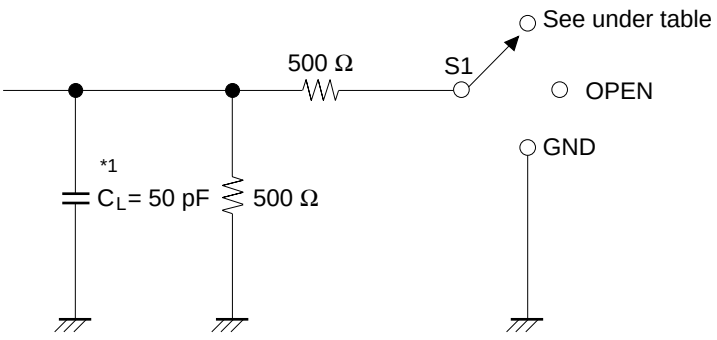
| Item                    | Symbol           | V <sub>CC</sub> (V) | Min | Typ | Max | Unit | FROM<br>(Input)        | TO<br>(Output) |  |  |
|-------------------------|------------------|---------------------|-----|-----|-----|------|------------------------|----------------|--|--|
| Maximum clock frequency | f <sub>max</sub> | 2.5±0.2             | 150 | —   | —   | MHz  |                        |                |  |  |
|                         |                  | 2.7                 | 150 | —   | —   |      |                        |                |  |  |
|                         |                  | 3.3±0.3             | 150 | —   | —   |      |                        |                |  |  |
| Propagation delay time  | t <sub>PLH</sub> | 2.5±0.2             | 1.0 | —   | 3.7 | ns   | A                      | Y              |  |  |
|                         |                  | 2.7                 | —   | —   | 3.6 |      |                        |                |  |  |
|                         |                  | 3.3±0.3             | 1.1 | —   | 3.3 |      |                        |                |  |  |
|                         | t <sub>PHL</sub> | 2.5±0.2             | 1.0 | —   | 4.8 |      | $\overline{\text{LE}}$ | Y              |  |  |
|                         |                  | 2.7                 | —   | —   | 4.4 |      |                        |                |  |  |
|                         |                  | 3.3±0.3             | 1.3 | —   | 4.4 |      |                        |                |  |  |
|                         |                  | 2.5±0.2             | 1.0 | —   | 4.4 |      | CLK                    | Y              |  |  |
|                         |                  | 2.7                 | —   | —   | 4.1 |      |                        |                |  |  |
|                         |                  | 3.3±0.3             | 1.0 | —   | 4.1 |      |                        |                |  |  |
| Output enable time      | t <sub>ZH</sub>  | 2.5±0.2             | 1.0 | —   | 5.4 | ns   | $\overline{\text{OE}}$ | Y              |  |  |
|                         |                  | 2.7                 | —   | —   | 4.6 |      |                        |                |  |  |
|                         |                  | 3.3±0.3             | 1.1 | —   | 4.6 |      |                        |                |  |  |
| Output disable time     | t <sub>HZ</sub>  | 2.5±0.2             | 1.0 | —   | 4.1 | ns   | $\overline{\text{OE}}$ | Y              |  |  |
|                         |                  | 2.7                 | —   | —   | 4.4 |      |                        |                |  |  |
|                         |                  | 3.3±0.3             | 1.7 | —   | 4.4 |      |                        |                |  |  |
| Input capacitance       | C <sub>IN</sub>  | 3.3                 | —   | 5.5 | —   | pF   | Control inputs         |                |  |  |
|                         |                  | 3.3                 | —   | 6.0 | —   |      | Data inputs            |                |  |  |
| Output capacitance      | C <sub>O</sub>   | 3.3                 | —   | 8.0 | —   | pF   | Outputs                |                |  |  |

Switching Characteristics (Ta = -40 to 85°C) (cont)

| Item        | Symbol          | V <sub>CC</sub> (V) | Min | Typ | Max | Unit | FROM (Input)                  |
|-------------|-----------------|---------------------|-----|-----|-----|------|-------------------------------|
| Setup time  | t <sub>su</sub> | 2.5±0.2             | 1.4 | —   | —   | ns   | Data before CLK↑              |
|             |                 | 2.7                 | 1.7 | —   | —   |      |                               |
|             |                 | 3.3±0.3             | 1.5 | —   | —   |      |                               |
|             |                 | 2.5±0.2             | 1.2 | —   | —   |      | Data before $\overline{LE}$ ↑ |
|             |                 | 2.7                 | 1.6 | —   | —   |      | CLK "H"                       |
|             |                 | 3.3±0.3             | 1.3 | —   | —   |      |                               |
|             |                 | 2.5±0.2             | 1.4 | —   | —   |      | Data before $\overline{LE}$ ↑ |
|             |                 | 2.7                 | 1.5 | —   | —   |      | CLK "L"                       |
|             |                 | 3.3±0.3             | 1.2 | —   | —   |      |                               |
| Hold time   | t <sub>h</sub>  | 2.5±0.2             | 0.9 | —   | —   | ns   | Data after CLK↑               |
|             |                 | 2.7                 | 0.8 | —   | —   |      |                               |
|             |                 | 3.3±0.3             | 0.9 | —   | —   |      |                               |
|             |                 | 2.5±0.2             | 1.2 | —   | —   |      | Data after $\overline{LE}$ ↑  |
|             |                 | 2.7                 | 1.1 | —   | —   |      | CLK "H" or "L"                |
|             |                 | 3.3±0.3             | 1.1 | —   | —   |      |                               |
| Pulse width | t <sub>w</sub>  | 2.5±0.2             | 3.3 | —   | —   | ns   | $\overline{LE}$ "L"           |
|             |                 | 2.7                 | 3.3 | —   | —   |      |                               |
|             |                 | 3.3±0.3             | 3.3 | —   | —   |      |                               |
|             |                 | 2.5±0.2             | 3.3 | —   | —   |      | CLK "H" or "L"                |
|             |                 | 2.7                 | 3.3 | —   | —   |      |                               |
|             |                 | 3.3±0.3             | 3.3 | —   | —   |      |                               |



Test Circuit

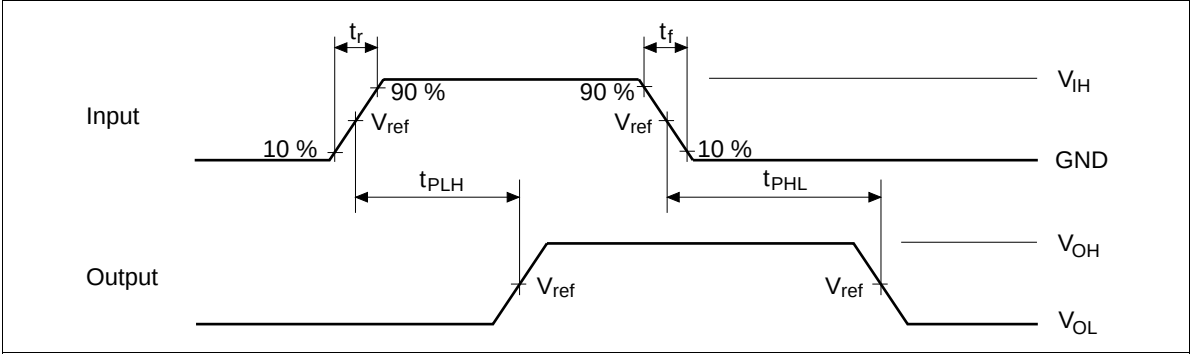


Load Circuit for Outputs

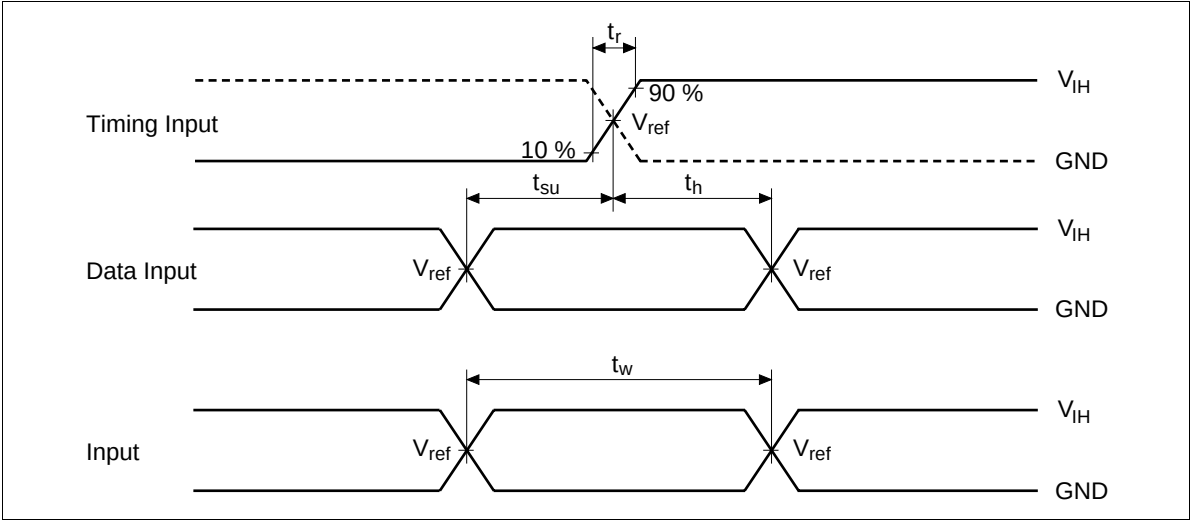
| Symbol                                          | V <sub>CC</sub> =2.5±0.2V | V <sub>CC</sub> =2.7V,<br>3.3±0.3V |
|-------------------------------------------------|---------------------------|------------------------------------|
| t <sub>PLH</sub> /t <sub>PHL</sub>              | OPEN                      | OPEN                               |
| t <sub>su</sub> /t <sub>h</sub> /t <sub>w</sub> |                           |                                    |
| t <sub>ZH</sub> /t <sub>HZ</sub>                | GND                       | GND                                |
| t <sub>ZL</sub> /t <sub>LZ</sub>                | 2 × V <sub>CC</sub>       | 6.0 V                              |

Note: 1. C<sub>L</sub> includes probe and jig capacitance.

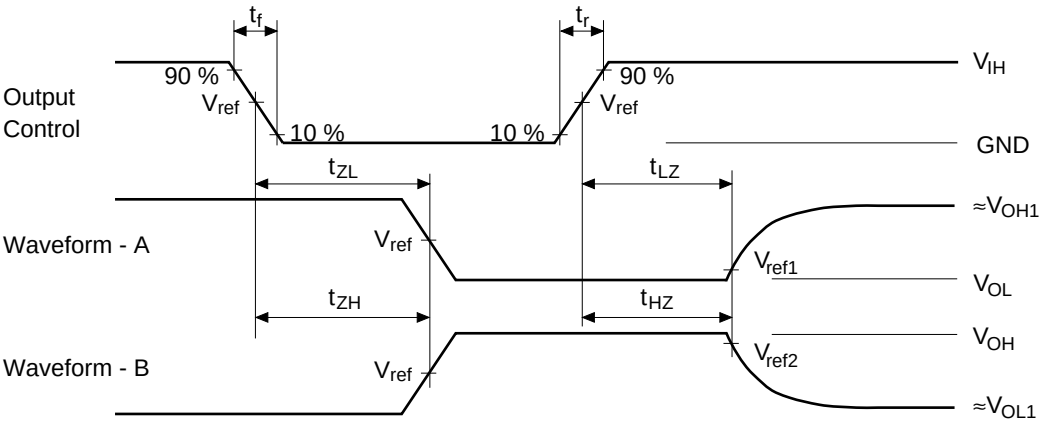
Waveforms – 1



Waveforms – 2



Waveforms – 3



| TEST       | $V_{CC}=2.5\pm0.2V$ | $V_{CC}=2.7V, 3.3\pm0.3V$ |
|------------|---------------------|---------------------------|
| $V_{IH}$   | $V_{CC}$            | 2.7 V                     |
| $V_{ref}$  | $1/2 V_{CC}$        | 1.5 V                     |
| $V_{ref1}$ | $V_{OL} + 0.15 V$   | $V_{OL} + 0.3 V$          |
| $V_{ref2}$ | $V_{OH} - 0.15 V$   | $V_{OH} - 0.3 V$          |
| $V_{OH1}$  | $V_{CC}$            | 3.0 V                     |
| $V_{OL1}$  | GND                 | GND                       |

- Notes:
1. All input pulses are supplied by generators having the following characteristics :  
PRR  $\leq$  10 MHz,  $Z_o = 50 \Omega$ ,  $t_r \leq 2.0$  ns,  $t_f \leq 2.0$  ns. ( $V_{CC} = 2.5\pm0.2$  V)  
PRR  $\leq$  10 MHz,  $Z_o = 50 \Omega$ ,  $t_r \leq 2.5$  ns,  $t_f \leq 2.5$  ns. ( $V_{CC} = 2.7$  V,  $3.3\pm0.3$  V)
  2. Waveform – A is for an output with internal conditions such that the output is low except when disabled by the output control.
  3. Waveform – B is for an output with internal conditions such that the output is high except when disabled by the output control.
  4. The output are measured one at a time with one transition per measurement.



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