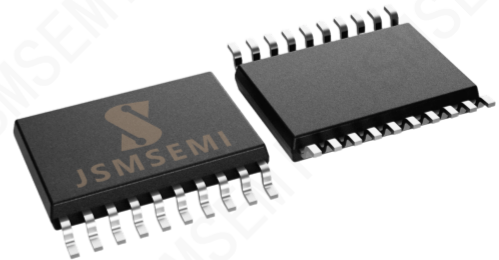


## General Description

The 74LVC244APW,118-JSM are 8-bit buffer/line drivers with 3-state outputs. The devices can be used as two 4-bit buffers or one 8-bit buffer. Both devices features two output enables (1OE and 2OE), each controlling four of the 3-state outputs. A HIGH on nOE and causes the outputs to assume a high-impedance OFF-state. Inputs can be driven from either 3.3 V or 5V devices.

This feature allows the use of these devices as translators in mixed 3.3 V and 5 V environments. Schmitt trigger action at all inputs makes the circuit tolerant of slower input rise and fall times. This device is fully specified for partial power down applications using I<sub>OFF</sub>. The I<sub>OFF</sub> circuitry disables the output, preventing the potentially damaging backflow current through the device when it is powered down.



**TSSOP-20**

## Features and Benefits

- Wide supply voltage range from 1.2 V to 5.5 V
- Direct interface with TTL levels
- CMOS low power dissipation
- Overvoltage tolerant inputs to 5.5 V
- I<sub>OFF</sub> circuitry provides partial Power-down mode operation
- Latch-up performance exceeds 250 mA
- Complies with JEDEC standards:
  - JESD8-7A (1.65 V to 1.95 V)
  - JESD8-5A (2.3 V to 2.7 V)
  - JESD8-C/JESD36 (2.7 V to 3.6 V)
- ESD protection:
  - HBM ANSI/ESDA/JEDEC JS-001 Class 3A exceeds 6000 V
  - CDM ANSI/ESDA/JEDEC JS-002 Class C3 exceeds 2000 V

## Function Diagram

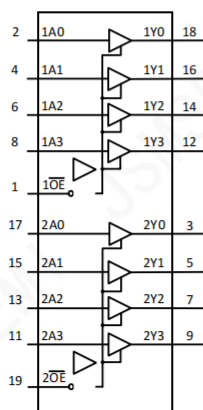


Fig. 1. Functional diagram

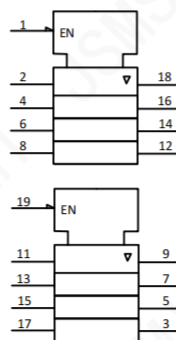


Fig. 2 .IEC logic symbol

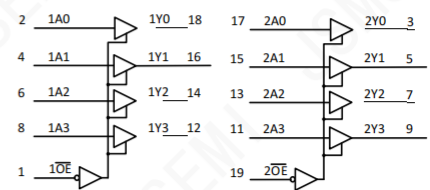


Fig. 3. Logic symbol

## Pinning Information

### Pinning

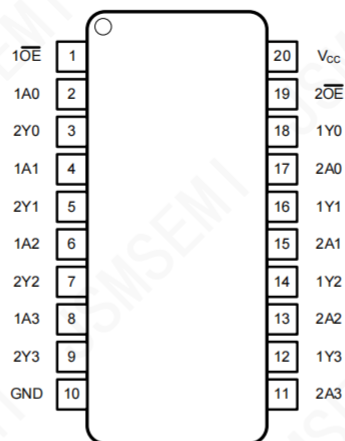


Fig. 4.Top view pin configuration TSSOP

### Pin description

| Symbol                           | Pin            | Description                     |
|----------------------------------|----------------|---------------------------------|
| $\overline{1OE}, \overline{2OE}$ | 1, 19          | Output enable input(active LOW) |
| 1A0, 1A1, 1A2, 1A3               | 2, 4, 6, 8     | Data input                      |
| 2Y0, 2Y1, 2Y2, 2Y3               | 3, 5, 7, 9     | Bus output                      |
| GND                              | 10             | Ground (0V)                     |
| 2A0, 2A1, 2A2, 2A3               | 17, 15, 13, 11 | Data input                      |
| 1Y0, 1Y1, 1Y2, 1Y3               | 18, 16, 14, 12 | Bus output                      |
| V <sub>cc</sub>                  | 20             | Supply voltage                  |

### Functional Description

H = HIGH voltage level; L = LOW voltage level; X = don't care; Z = high-impedance OFF-state

| Input            |     | Output |
|------------------|-----|--------|
| $\overline{nOE}$ | nAn | nYn    |
| L                | L   | L      |
| L                | H   | H      |
| H                | X   | Z      |

## Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND.

| Symbol    | Parameter               | Conditions                           | Min  | Max          | Unit |
|-----------|-------------------------|--------------------------------------|------|--------------|------|
| $V_{CC}$  | supply voltage          |                                      | -0.5 | 6.5          | V    |
| $I_{IK}$  | input clamping current  | $V_I < 0\text{ V}$                   | -50  |              | mA   |
| $V_I$     | Input voltage           | [1]                                  | -0.5 | 6.5          | V    |
| $I_{OK}$  | output clamping current | $V_O < 0\text{ V}$ or $V_O > V_{CC}$ |      | $\pm 50$     | mA   |
| $V_O$     | output voltage          | output HIGH or LOW [2]               | -0.5 | $V_{CC}+0.5$ | V    |
|           |                         | output 3-state                       | -0.5 | 6.5          | V    |
| $I_O$     | output current          | $V_O = 0\text{ V}$ to $V_{CC}$       |      | $\pm 50$     | mA   |
| $I_{CC}$  | supply current          |                                      |      | 100          | mA   |
| $I_{GND}$ | ground current          |                                      | -100 |              | mA   |
| $P_{tot}$ | total power dissipation |                                      |      | 500          | mW   |
| $T_{stg}$ | storage temperature     |                                      | -65  | 150          | °C   |

[1] The minimum input voltage ratings may be exceeded if the input current ratings are observed.

[2] The output voltage ratings may be exceeded if the output current ratings are observed.

## Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. EnergyMath does not recommend exceeding them or designing to Absolute Maximum Ratings.

| Symbol              | Parameter                           | Conditions                                | Min  | Typ | Max      | Unit |
|---------------------|-------------------------------------|-------------------------------------------|------|-----|----------|------|
| $V_{CC}$            | supply voltage                      |                                           | 1.65 |     | 5.5      | V    |
|                     |                                     | functional                                | 1.2  |     | 5.5      | V    |
| $V_I$               | input voltage                       |                                           | 0    |     | 5.5      | V    |
| $V_O$               | output voltage                      | output HIGH or LOW                        | 0    |     | $V_{CC}$ | V    |
|                     |                                     | output 3-state                            | 0    |     | 5.5      | V    |
| $T_{amb}$           | ambient temperature                 |                                           | -40  |     | 125      | °C   |
| $\Delta t/\Delta V$ | input transition rise and fall rate | $V_{CC} = 1.2\text{ V}$ to $2.7\text{ V}$ |      |     | 20       | ns/V |
|                     |                                     | $V_{CC} = 2.7\text{ V}$ to $5.5\text{ V}$ |      |     | 10       | ns/V |

## Static Characteristics

At recommended operating conditions. Voltages are referenced to GND (ground = 0 V). Typical values measured at  $T_{amb} = 25^{\circ}\text{C}$  (unless otherwise noted).

| Symbol   | Parameter                 | Conditions                                                              | -40 °C to +85 °C |        |              | -40 °C to +125 °C |              | Unit          |
|----------|---------------------------|-------------------------------------------------------------------------|------------------|--------|--------------|-------------------|--------------|---------------|
|          |                           |                                                                         | Min              | Typ[1] | Max          | Min               | Max          |               |
| $V_{IH}$ | HIGH-level input voltage  | $V_{CC} = 1.2\text{ V}$                                                 | 1.08             |        |              | 1.08              |              | V             |
|          |                           | $V_{CC} = 1.65\text{ V to }1.95\text{ V}$                               | $0.65V_{CC}$     |        |              | $0.65V_{CC}$      |              | V             |
|          |                           | $V_{CC} = 2.3\text{ V to }2.7\text{ V}$                                 | 1.7              |        |              | 1.7               |              | V             |
|          |                           | $V_{CC} = 2.7\text{ V to }3.6\text{ V}$                                 | 2.0              |        |              | 2.0               |              | V             |
|          |                           | $V_{CC} = 4.5\text{ V to }5.5\text{ V}$                                 | $0.7V_{CC}$      |        |              | $0.7V_{CC}$       |              | V             |
| $V_{IL}$ | LOW-level input voltage   | $V_{CC} = 1.2\text{ V}$                                                 |                  |        | 0.12         |                   | 0.12         | V             |
|          |                           | $V_{CC} = 1.65\text{ V to }1.95\text{ V}$                               |                  |        | $0.35V_{CC}$ |                   | $0.35V_{CC}$ | V             |
|          |                           | $V_{CC} = 2.3\text{ V to }2.7\text{ V}$                                 |                  |        | 0.7          |                   | 0.7          | V             |
|          |                           | $V_{CC} = 2.7\text{ V to }3.6\text{ V}$                                 |                  |        | 0.8          |                   | 0.8          | V             |
|          |                           | $V_{CC} = 4.5\text{ V to }5.5\text{ V}$                                 |                  |        | $0.3V_{CC}$  |                   | $0.3V_{CC}$  | V             |
| $V_{OH}$ | HIGH-level output voltage | $V_I = V_{IH}\text{ or }V_{IL}$                                         |                  |        |              |                   |              |               |
|          |                           | $I_O = -100\text{ }\mu\text{A}; V_{CC} = 1.65\text{ V to }5.5\text{ V}$ | $V_{CC} - 0.1$   |        |              | $V_{CC} - 0.1$    |              | V             |
|          |                           | $I_O = -4\text{ mA}; V_{CC} = 1.65\text{ V}$                            | 1.2              |        |              | 1.05              |              | V             |
|          |                           | $I_O = -8\text{ mA}; V_{CC} = 2.3\text{ V}$                             | 1.9              |        |              | 1.7               |              | V             |
|          |                           | $I_O = -12\text{ mA}; V_{CC} = 2.7\text{ V}$                            | 2.2              |        |              | 2.1               |              | V             |
|          |                           | $I_O = -24\text{ mA}; V_{CC} = 3.0\text{ V}$                            | 2.4              |        |              | 2.2               |              | V             |
|          |                           | $I_O = -32\text{ mA}; V_{CC} = 4.5\text{ V}$                            | 3.8              |        |              | 3.4               |              | V             |
| $V_{OL}$ | LOW-level output voltage  | $V_I = V_{IH}\text{ or }V_{IL}$                                         |                  |        |              |                   |              |               |
|          |                           | $I_O = 100\text{ }\mu\text{A}; V_{CC} = 1.65\text{ V to }5.5\text{ V}$  |                  |        | 0.1          |                   | 0.1          | V             |
|          |                           | $I_O = 4\text{ mA}; V_{CC} = 1.65\text{ V}$                             |                  |        | 0.45         |                   | 0.65         | V             |
|          |                           | $I_O = 8\text{ mA}; V_{CC} = 2.3\text{ V}$                              |                  |        | 0.3          |                   | 0.45         | V             |
|          |                           | $I_O = 12\text{ mA}; V_{CC} = 2.7\text{ V}$                             |                  |        | 0.4          |                   | 0.6          | V             |
|          |                           | $I_O = 24\text{ mA}; V_{CC} = 3.0\text{ V}$                             |                  |        | 0.55         |                   | 0.8          | V             |
|          |                           | $I_O = 32\text{ mA}; V_{CC} = 4.5\text{ V}$                             |                  |        | 0.55         |                   | 0.8          | V             |
| $I_I$    | input leakage current     | $V_I = V_{CC}\text{ or GND}; V_{CC} = 5.5\text{ V}$ [2]                 |                  |        | $\pm 2$      |                   | $\pm 10$     | $\mu\text{A}$ |

| Symbol          | Parameter                       | Conditions                                                                                                          | -40 °C to +85 °C |        |          | -40 °C to +125 °C |          | Unit          |
|-----------------|---------------------------------|---------------------------------------------------------------------------------------------------------------------|------------------|--------|----------|-------------------|----------|---------------|
|                 |                                 |                                                                                                                     | Min              | Typ[1] | Max      | Min               | Max      |               |
| $I_{OZ}$        | OFF-state output current        | $V_I = V_{IH}$ or $V_{IL}$ ; $V_{CC} = 5.5\text{ V}$ ; [2]<br>$V_O = V_{CC}$ or GND                                 |                  |        | $\pm 5$  |                   | $\pm 10$ | $\mu\text{A}$ |
| $I_{OFF}$       | power-off leakage current       | $V_I$ or $V_O = 5.5\text{ V}$ ; $V_{CC} = 0\text{ V}$                                                               |                  |        | $\pm 10$ |                   | $\pm 20$ | $\mu\text{A}$ |
| $I_{CC}$        | supply current                  | $V_I = V_{IH}$ or GND; $I_O = 0\text{ A}$ ;<br>$V_{CC} = 5.5\text{ V}$                                              |                  |        | 10       |                   | 20       | $\mu\text{A}$ |
| $\Delta I_{CC}$ | additional supply current       | per input pin;<br>$V_I = V_{CC} - 0.6\text{ V}$ ;<br>$I_O = 0\text{ A}$ ; $V_{CC} = 2.7\text{ V}$ to $5.5\text{ V}$ |                  |        | 500      |                   | 5000     | $\mu\text{A}$ |
| $C_i$           | input capacitance               | Pin $\overline{OE}$                                                                                                 |                  | 4.0    |          |                   |          | pF            |
|                 |                                 | Pin nAn                                                                                                             |                  | 7.7    |          |                   |          | pF            |
| $I_{BHL}$       | bus hold LOW current            | $V_I = 0.58\text{ V}$ ; $V_{CCI} = 1.65\text{ V}$ [3][4]                                                            | 25               |        |          | 20                |          | $\mu\text{A}$ |
|                 |                                 | $V_I = 0.70\text{ V}$ ; $V_{CCI} = 2.3\text{ V}$                                                                    | 45               |        |          | 45                |          | $\mu\text{A}$ |
|                 |                                 | $V_I = 0.80\text{ V}$ ; $V_{CCI} = 3.0\text{ V}$                                                                    | 100              |        |          | 80                |          | $\mu\text{A}$ |
|                 |                                 | $V_I = 1.35\text{ V}$ ; $V_{CCI} = 4.5\text{ V}$                                                                    | 100              |        |          | 100               |          | $\mu\text{A}$ |
| $I_{BHH}$       | bus hold HIGH current           | $V_I = 1.07\text{ V}$ ; $V_{CCI} = 1.65\text{ V}$ [3][4]                                                            | -1               |        |          | -1                |          | $\mu\text{A}$ |
|                 |                                 | $V_I = 1.70\text{ V}$ ; $V_{CCI} = 2.3\text{ V}$                                                                    | -7               |        |          | -7                |          | $\mu\text{A}$ |
|                 |                                 | $V_I = 2.00\text{ V}$ ; $V_{CCI} = 3.0\text{ V}$                                                                    | -35              |        |          | -35               |          | $\mu\text{A}$ |
|                 |                                 | $V_I = 3.15\text{ V}$ ; $V_{CCI} = 4.5\text{ V}$                                                                    | -95              |        |          | -95               |          | $\mu\text{A}$ |
| $I_{BHLO}$      | bus hold LOW overdrive current  | $V_{CCI} = 1.95\text{ V}$ [3][5]                                                                                    | 200              |        |          | 200               |          | $\mu\text{A}$ |
|                 |                                 | $V_{CCI} = 2.7\text{ V}$                                                                                            | 300              |        |          | 300               |          | $\mu\text{A}$ |
|                 |                                 | $V_{CCI} = 3.6\text{ V}$                                                                                            | 500              |        |          | 500               |          | $\mu\text{A}$ |
|                 |                                 | $V_{CCI} = 5.5\text{ V}$                                                                                            | 900              |        |          | 900               |          | $\mu\text{A}$ |
| $I_{BHHO}$      | bus hold HIGH overdrive current | $V_{CCI} = 1.95\text{ V}$ [3][5]                                                                                    | -200             |        |          | -200              |          | $\mu\text{A}$ |
|                 |                                 | $V_{CCI} = 2.7\text{ V}$                                                                                            | -300             |        |          | -300              |          | $\mu\text{A}$ |
|                 |                                 | $V_{CCI} = 3.6\text{ V}$                                                                                            | -500             |        |          | -500              |          | $\mu\text{A}$ |
|                 |                                 | $V_{CCI} = 5.5\text{ V}$                                                                                            | -900             |        |          | -900              |          | $\mu\text{A}$ |

[1] All typical values are measured at  $V_{CC} = 3.3\text{ V}$  (unless stated otherwise) and  $T_{amb} = 25\text{ }^\circ\text{C}$ .

[2] The bus hold circuit is switched off when  $V_I > V_{CC}$  allowing 5.5 V on the input terminal.

[3] Note that control inputs do not have a bus hold circuit.

[4] The specified sustaining current at the data input holds the input below the specified  $V_I$  level.

[5] The specified overdrive current at the data input forces the data input to the opposite input state.

## Dynamic Characteristics

Voltages are referenced to GND (ground = 0 V); for test circuit see Fig. 7. Typical values measured at  $T_{amb} = 25^{\circ}\text{C}$  (unless otherwise noted).

| Symbol      | Parameter                     | Conditions                                                               | -40 °C to +85 °C |        |     | -40 °C to +125 °C |     | Unit |
|-------------|-------------------------------|--------------------------------------------------------------------------|------------------|--------|-----|-------------------|-----|------|
|             |                               |                                                                          | Min              | Typ[1] | Max | Min               | Max |      |
| $t_{pd}$    | propagation delay             | nAn to nYn; see Fig. 5 [2]                                               |                  |        |     |                   |     |      |
|             |                               | $V_{CC} = 1.65\text{ V to }1.95\text{ V}$                                |                  |        | 35  |                   | 40  | ns   |
|             |                               | $V_{CC} = 2.3\text{ V to }2.7\text{ V}$                                  |                  |        | 20  |                   | 25  | ns   |
|             |                               | $V_{CC} = 3.0\text{ V to }3.6\text{ V}$                                  |                  |        | 15  |                   | 20  | ns   |
|             |                               | $V_{CC} = 4.5\text{ V to }5.5\text{ V}$                                  |                  |        | 10  |                   | 15  | ns   |
| $t_{en}$    | enable time                   | nOE to nYn; see Fig. 6 [2]                                               |                  |        |     |                   |     |      |
|             |                               | $V_{CC} = 1.65\text{ V to }1.95\text{ V}$                                |                  |        | 35  |                   | 40  | ns   |
|             |                               | $V_{CC} = 2.3\text{ V to }2.7\text{ V}$                                  |                  |        | 20  |                   | 25  | ns   |
|             |                               | $V_{CC} = 3.0\text{ V to }3.6\text{ V}$                                  |                  |        | 15  |                   | 20  | ns   |
|             |                               | $V_{CC} = 4.5\text{ V to }5.5\text{ V}$                                  |                  |        | 10  |                   | 15  | ns   |
| $t_{dis}$   | disable time                  | nOE to nYn; see Fig. 6 [2]                                               |                  |        |     |                   |     |      |
|             |                               | $V_{CC} = 1.65\text{ V to }1.95\text{ V}$                                |                  |        | 35  |                   | 40  | ns   |
|             |                               | $V_{CC} = 2.3\text{ V to }2.7\text{ V}$                                  |                  |        | 20  |                   | 25  | ns   |
|             |                               | $V_{CC} = 3.0\text{ V to }3.6\text{ V}$                                  |                  |        | 15  |                   | 20  | ns   |
|             |                               | $V_{CC} = 4.5\text{ V to }5.5\text{ V}$                                  |                  |        | 10  |                   | 15  | ns   |
| $t_{sk(o)}$ | output skew time              | [3]                                                                      |                  |        | 1   |                   | 1.5 | ns   |
| $C_{PD}$    | power dissipation capacitance | Per buffer ; $V_{CC} = 3.3\text{ V}$<br>$V_I = \text{GND to }V_{CC}$ [4] |                  | 18     |     |                   |     | pF   |

[1] Typical values are measured at  $T_{amb} = 25^{\circ}\text{C}$  and  $V_{CC} = 1.8\text{ V}, 2.5\text{ V}, 3.3\text{ V}$ , and  $5\text{ V}$  respectively.

[2]  $t_{pd}$  is the same as  $t_{PLH}$  and  $t_{PHL}$ .  $t_{en}$  is the same as  $t_{PZL}$  and  $t_{PZH}$ .  $t_{dis}$  is the same as  $t_{PLZ}$  and  $t_{PHZ}$ .

[3] Skew between any two outputs of the same package switching in the same direction. This parameter is guaranteed by design.

[4]  $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu\text{W}$ ).

$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(C_L \times V_{CC}^2 \times f_o)$  where:

$f_i$  = input frequency in MHz;  $f_o$  = output frequency in MHz

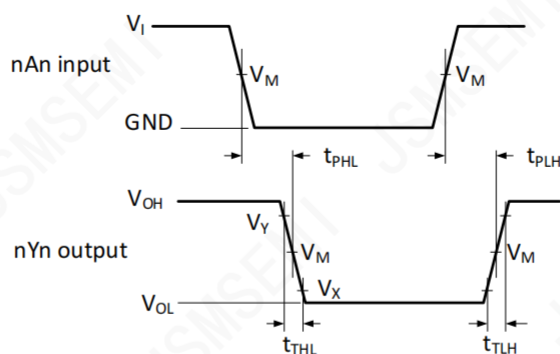
$C_L$  = output load capacitance in pF

$V_{CC}$  = supply voltage in Volts

$N$  = number of inputs switching

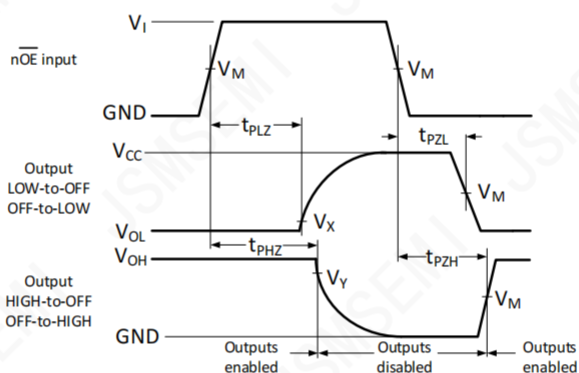
$\Sigma(C_L \times V_{CC}^2 \times f_o)$  = sum of the outputs.

## Waveforms and test circuit



$V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

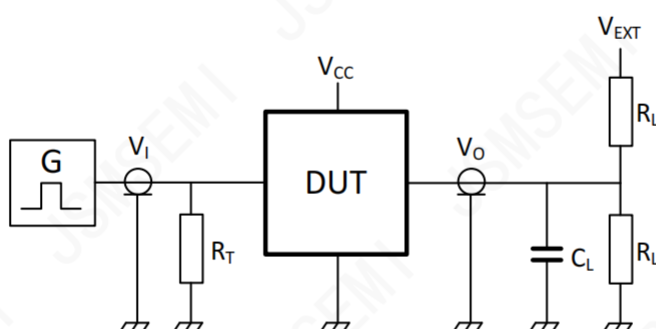
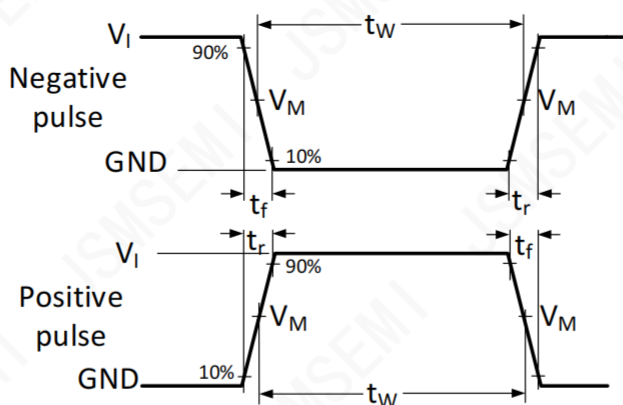
Fig. 5. The input  $nAn$  to output  $nYn$  propagation delays



$V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

Fig. 6. 3-state enable and disable times

| Supply voltage   | Input    |             | Output      |                   |                   |
|------------------|----------|-------------|-------------|-------------------|-------------------|
| $V_{CC}$         | $V_I$    | $V_M$       | $V_M$       | $V_X$             | $V_Y$             |
| 1.65 V to 1.95 V | $V_{CC}$ | $0.5V_{CC}$ | $0.5V_{CC}$ | $V_{OL} + 0.15 V$ | $V_{OH} - 0.15 V$ |
| 2.3 V to 2.7 V   | $V_{CC}$ | $0.5V_{CC}$ | $0.5V_{CC}$ | $V_{OL} + 0.15 V$ | $V_{OH} - 0.15 V$ |
| 3.0 V to 3.6 V   | $V_{CC}$ | $0.5V_{CC}$ | $0.5V_{CC}$ | $V_{OL} + 0.3 V$  | $V_{OH} - 0.3 V$  |
| 4.5 V to 5.5 V   | $V_{CC}$ | $0.5V_{CC}$ | $0.5V_{CC}$ | $V_{OL} + 0.3 V$  | $V_{OH} - 0.3 V$  |



Definitions for test circuit:

$R_L$  = Load resistance.

$C_L$  = Load capacitance including jig and probe capacitance.

$R_T$  = Termination resistance should be equal to the output impedance  $Z_o$  of the pulse generator.

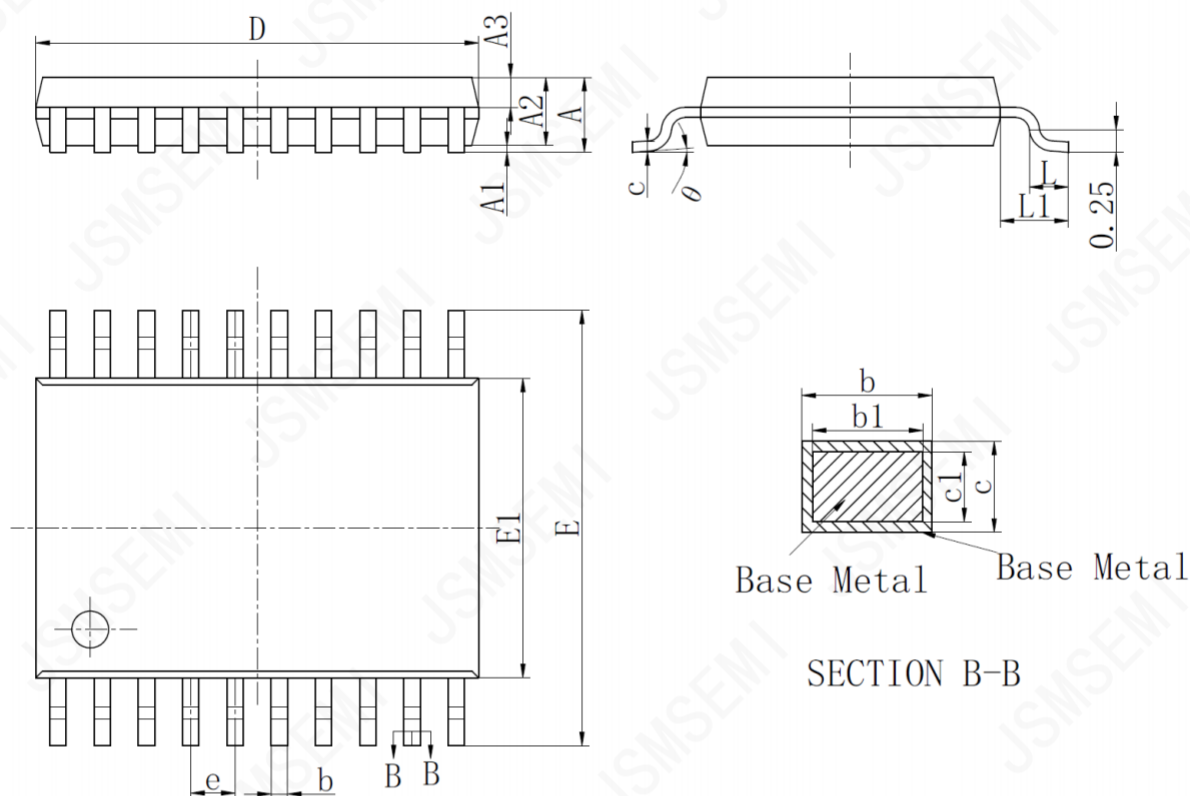
$V_{EXT}$  = External voltage for measuring switching times.

Fig. 7. Test circuit for measuring switching times

| Supply voltage | Input    |             | Load  |             | $V_{EXT}$          |                    |                    |
|----------------|----------|-------------|-------|-------------|--------------------|--------------------|--------------------|
|                | $V_I$    | $t_r = t_f$ | $C_L$ | $R_L$       | $t_{PLH}, t_{PHL}$ | $t_{PZH}, t_{PHZ}$ | $t_{PZL}, t_{PLZ}$ |
| 1.65V to 1.95V | $V_{CC}$ | $\leq 2$ ns | 15 pF | 2k $\Omega$ | open               | GND                | $2V_{CC}$          |
| 2.3 V to 2.7 V | $V_{CC}$ | $\leq 2$ ns | 15 pF | 2k $\Omega$ | open               | GND                | $2V_{CC}$          |
| 3.0 V to 3.6 V | $V_{CC}$ | $\leq 2$ ns | 15 pF | 2k $\Omega$ | open               | GND                | $2V_{CC}$          |
| 4.5 V to 5.5 V | $V_{CC}$ | $\leq 2$ ns | 15 pF | 2k $\Omega$ | open               | GND                | $2V_{CC}$          |

## Package Outline

TSSOP-20L



| Symbol | Dimensions In Millimeters |      | Symbol   | Dimensions In Millimeters |      |
|--------|---------------------------|------|----------|---------------------------|------|
|        | Min.                      | Max. |          | Min.                      | Max. |
| A      | -                         | 1.20 | E        | 6.20                      | 6.60 |
| A1     | 0.05                      | 0.15 | e        | 0.65BSC                   |      |
| A2     | 0.80                      | 1.05 | L        | 0.45                      | 0.75 |
| A3     | 0.39                      | 0.49 | L1       | 1.00REF                   |      |
| b      | 0.20                      | 0.28 | $\theta$ | 0°                        | 8°   |
| b1     | 0.19                      | 0.25 |          |                           |      |
| c      | 0.13                      | 0.17 |          |                           |      |
| c1     | 0.12                      | 0.14 |          |                           |      |
| D      | 6.40                      | 6.60 |          |                           |      |
| E1     | 4.30                      | 4.50 |          |                           |      |

## Revision History

| Rev. | Change          | Date      |
|------|-----------------|-----------|
| V1.0 | Initial version | 6/27/2021 |
|      |                 |           |

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