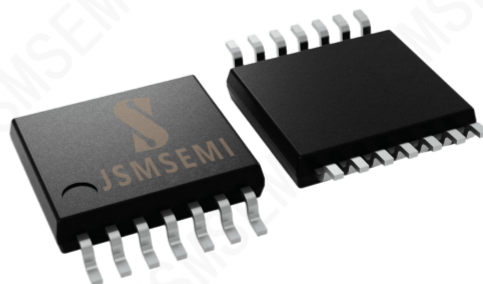


## General Description

The SN74LVC04APWR-JSM is a hex buffer with open-drain outputs. Inputs can be driven from either 3.3 V or 5 V 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  $I_{OFF}$ . The  $I_{OFF}$  circuitry disables the output, preventing the potentially damaging backflow current through the device when it is powered down.



## Features and Benefits

- Wide supply voltage range from 1.2 V to 5.5 V
- Overvoltage tolerant inputs to 5.5 V
- CMOS low power dissipation
- $I_{OFF}$  circuitry provides partial Power-down mode operation
- Latch-up performance exceeds 250 mA
- Direct interface with TTL levels
- Complies with JEDEC standard:
  - JESD8-7 (1.65 V to 1.95 V)
  - JESD8-5 (2.3 V to 2.7 V)
  - JESD8C (2.7 V to 3.6 V)
  - JESD36 (4.5 V to 5.5 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
- Multiple package options

## Function Diagram

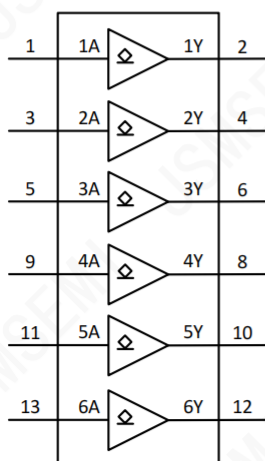


Fig. 1. Logic symbol

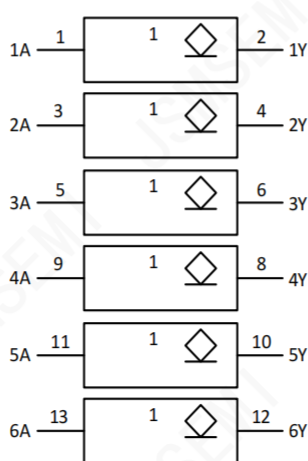


Fig. 2. IEC logic symbol

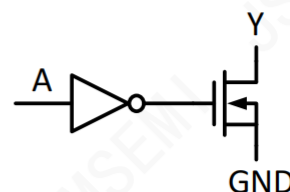


Fig. 3. Logic diagram (one gate)

## Pinning Information

### Pinning

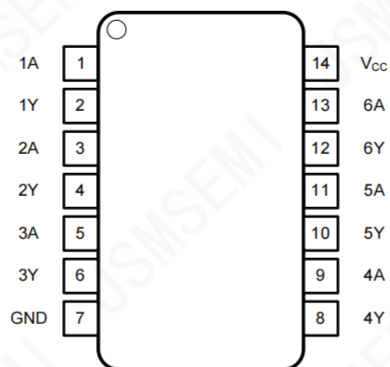


Fig. 4. Top view pin configuration TSSOP

## Pin description

Table 2. Pin description

| Symbol                 | Pin                | Description    |
|------------------------|--------------------|----------------|
| 1A, 2A, 3A, 4A, 5A, 6A | 1, 3, 5, 9, 11, 13 | Data input     |
| 1Y, 2Y, 3Y, 4Y, 5Y, 6Y | 2, 4, 6, 8, 10, 12 | Data output    |
| GND                    | 7                  | Ground (0V)    |
| V <sub>CC</sub>        | 14                 | Supply voltage |

## 6. Functional Description

Table 3. Function table

H = HIGH voltage level; L = LOW voltage level; Z = high-impedance OFF-state.

| Input nA | Output nY |
|----------|-----------|
| L        | L         |
| H        | 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.

**Table 4. Absolute Maximum Ratings**

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  | $V_I < 0$ V                         | -50  |     | mA   |
| $V_I$     | input voltage           | [1]                                 | -0.5 | 6.5 | V    |
| $I_{OK}$  | output clamping current | $V_O < 0$ V                         | -50  |     | mA   |
| $V_O$     | output voltage          | Active mode [1]                     | -0.5 | 6.5 | V    |
|           |                         | Power-down mode; $V_{CC} = 0$ V [1] | -0.5 | 6.5 | V    |
| $I_O$     | output current          | $V_O = 0$ V to $V_{CC}$             |      | 50  | mA   |
| $I_{CC}$  | supply current          |                                     |      | 100 | mA   |
| $I_{GND}$ | ground current          |                                     | -100 |     | mA   |
| $P_{tot}$ | total power dissipation | $T_{amb} = -40$ °C to $+125$ °C     |      | 500 | mW   |
| $T_{stg}$ | storage temperature     |                                     | -65  | 150 | °C   |

[1] The input and output voltage ratings may be exceeded if the input and 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.

**Table 5. Recommended Operating Conditions**

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

## Static Characteristics

**Table 6. Static characteristics**

At recommended operating conditions. Voltages are referenced to GND (ground = 0 V).

| 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             |
| $V_{OL}$        | LOW-level output voltage  | $V_I = V_{IH}\text{ or }V_{IL}$                                                                                    |                  |           |              |                   |              |               |
|                 |                           | $I_O = 100\mu\text{A}$ ;<br>$V_{CC} = 1.65\text{ V to }5.5\text{ V}$                                               |                  |           | 0.10         |                   | 0.10         | V             |
|                 |                           | $I_O = 4\text{ mA}$ ; $V_{CC} = 1.65\text{ V}$                                                                     |                  |           | 0.45         |                   | 0.70         | V             |
|                 |                           | $I_O = 8\text{ mA}$ ; $V_{CC} = 2.3\text{ V}$                                                                      |                  |           | 0.30         |                   | 0.45         | V             |
|                 |                           | $I_O = 12\text{ mA}$ ; $V_{CC} = 2.7\text{ V}$                                                                     |                  |           | 0.40         |                   | 0.60         | V             |
|                 |                           | $I_O = 24\text{ mA}$ ; $V_{CC} = 3.0\text{ V}$                                                                     |                  |           | 0.55         |                   | 0.80         | V             |
|                 |                           | $I_O = 32\text{ mA}$ ; $V_{CC} = 4.5\text{ V}$                                                                     |                  |           | 0.55         |                   | 0.80         | V             |
| $I_I$           | input leakage current     | $V_I = 5.5\text{ V or GND}$ ;<br>$V_{CC} = 0\text{ V to }5.5\text{ V}$                                             |                  | $\pm 0.1$ | $\pm 5$      |                   | $\pm 20$     | $\mu\text{A}$ |
| $I_{OZ}$        | OFF-state output current  | $V_I = V_{IH}$ ; $V_O = 5.5\text{ V or GND}$ ;<br>$V_{CC} = 1.65\text{ V to }5.5\text{ V}$                         |                  | $\pm 0.1$ | $\pm 10$     |                   | $\pm 20$     | $\mu\text{A}$ |
| $I_{OFF}$       | power-off leakage current | $V_{CC} = 0\text{ V}$ ;<br>$V_I\text{ or }V_O = 5.5\text{ V}$                                                      |                  | $\pm 0.1$ | $\pm 10$     |                   | $\pm 20$     | $\mu\text{A}$ |
| $I_{CC}$        | supply current            | $V_{CC} = 1.65\text{ V to }5.5\text{ V}$ ;<br>$V_I = V_{CC}\text{ or GND}$ ; $I_O = 0\text{ A}$ ;                  |                  | 0.01      | 10           |                   | 40           | $\mu\text{A}$ |
| $\Delta I_{CC}$ | additional supply current | per input pin ;<br>$V_{CC} = 2.3\text{ V to }5.5\text{ V}$ ;<br>$V_I = V_{CC} - 0.6\text{ V}$ ; $I_O = 0\text{ A}$ |                  | 0.2       | 500          |                   | 5000         | $\mu\text{A}$ |
| $C_I$           | input capacitance         | $V_{CC} = 3.3\text{ V}$ ;<br>$V_I = \text{GND to }V_{CC}$                                                          |                  | 4         |              |                   |              | pF            |

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

## Dynamic Characteristics

**Table 7. Dynamic characteristics**

Voltages are referenced to GND (ground = 0 V); for test circuit see Fig. 6.

| Symbol    | Parameter                          | Conditions                                        | -40 °C to +85 °C |        |      | -40 °C to +125 °C |     | Unit |
|-----------|------------------------------------|---------------------------------------------------|------------------|--------|------|-------------------|-----|------|
|           |                                    |                                                   | Min              | Typ[1] | Max  | Min               | Max |      |
| $t_{PZL}$ | OFF-state to LOW propagation delay | nA to nY; see Fig. 5                              |                  |        |      |                   |     |      |
|           |                                    | $V_{CC} = 1.2 \text{ V}$                          |                  | 28.3   |      |                   |     | ns   |
|           |                                    | $V_{CC} = 1.65 \text{ V to } 1.95 \text{ V}$      | 3.5              | 8.5    | 16.5 | 3.5               | 17  | ns   |
|           |                                    | $V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$        | 2.0              | 4.8    | 8.0  | 2.0               | 9.0 | ns   |
|           |                                    | $V_{CC} = 3.0 \text{ V to } 3.6 \text{ V}$        | 1.5              | 3.5    | 5.5  | 1.5               | 6.0 | ns   |
|           |                                    | $V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$        | 1.0              | 2.9    | 4.5  | 1.0               | 5.0 | ns   |
| $t_{PLZ}$ | LOW to OFF-state propagation delay | nA to nY; see Fig. 5                              |                  |        |      |                   |     |      |
|           |                                    | $V_{CC} = 1.2 \text{ V}$                          |                  | 25.3   |      |                   |     | ns   |
|           |                                    | $V_{CC} = 1.65 \text{ V to } 1.95 \text{ V}$      | 3.5              | 7.7    | 14.5 | 3.5               | 15  | ns   |
|           |                                    | $V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$        | 2.0              | 5.0    | 7.5  | 2.0               | 8.0 | ns   |
|           |                                    | $V_{CC} = 3.0 \text{ V to } 3.6 \text{ V}$        | 1.5              | 3.5    | 5.5  | 1.5               | 6.0 | ns   |
|           |                                    | $V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$        | 1.0              | 2.4    | 3.5  | 1.0               | 4.0 | ns   |
| $C_{PD}$  | power dissipation capacitance      | per buffer ;<br>$V_I = \text{GND to } V_{CC}$ [2] |                  |        |      |                   |     |      |
|           |                                    | $V_{CC} = 1.65 \text{ V to } 1.95 \text{ V}$      |                  | 3.3    |      |                   |     | pF   |
|           |                                    | $V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$        |                  | 3.4    |      |                   |     | pF   |
|           |                                    | $V_{CC} = 3.0 \text{ V to } 3.6 \text{ V}$        |                  | 3.9    |      |                   |     | pF   |
|           |                                    | $V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$        |                  | 4.8    |      |                   |     | pF   |

[1] Typical values are measured at  $T_{amb} = 25 \text{ °C}$  and  $V_{CC} = 1.2 \text{ V}, 1.8 \text{ V}, 2.5 \text{ V}, 3.3 \text{ V}$  and  $5.0 \text{ V}$  respectively.

[2]  $C_{PD}$  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;

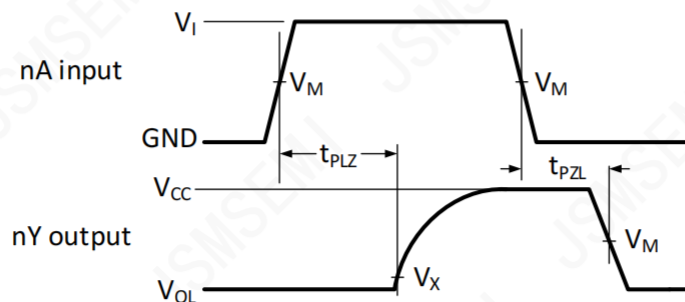
$C_L$  = output load capacitance in pF;

$V_{CC}$  = supply voltage in V;

$N$  = number of inputs switching;

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

## Waveforms and test circuit



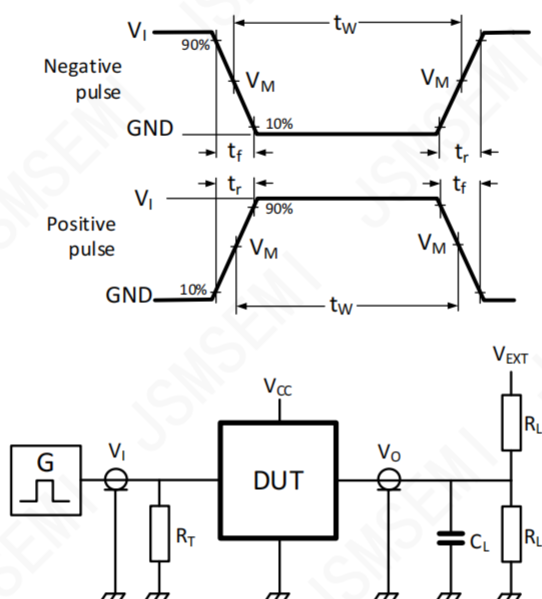
Measurement points are given in Table 8.

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

Fig. 5. The input nA to output nY propagation delays

**Table 8. Measurement points**

| Supply voltage   | Input       | Output            |             |
|------------------|-------------|-------------------|-------------|
| $V_{CC}$         | $V_M$       | $V_X$             | $V_M$       |
| 1.2 V            | $0.5V_{CC}$ | $V_{OL} + 0.15 V$ | $0.5V_{CC}$ |
| 1.65 V to 1.95 V | $0.5V_{CC}$ | $V_{OL} + 0.15 V$ | $0.5V_{CC}$ |
| 2.3 V to 2.7 V   | $0.5V_{CC}$ | $V_{OL} + 0.15 V$ | $0.5V_{CC}$ |
| 3.0 V to 3.6 V   | 1.5 V       | $V_{OL} + 0.3 V$  | 1.5 V       |
| 4.5 V to 5.5 V   | $0.5V_{CC}$ | $V_{OL} + 0.3 V$  | $0.5V_{CC}$ |



Test data is given in Table 9.

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.

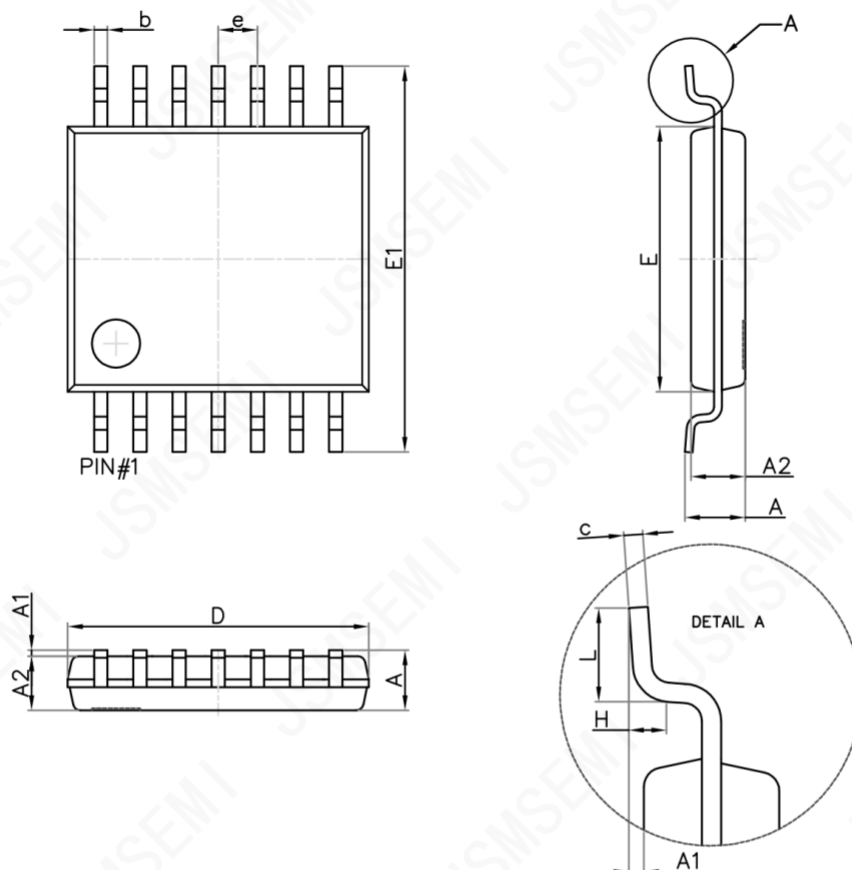
$V_{EXT}$  = External voltage for measuring switching times.

**Fig. 6. Test circuit for measuring switching times**
**Table 9. Test data**

| Supply voltage   | Input    |                       | Load  |              | $V_{EXT}$          |
|------------------|----------|-----------------------|-------|--------------|--------------------|
| $V_{CC}$         | $V_I$    | $t_r = t_f$           | $C_L$ | $R_L$        | $t_{PLZ}, t_{PZL}$ |
| 1.2V             | $V_{CC}$ | $\leq 2.0 \text{ ns}$ | 15 pF | 500 $\Omega$ | $2 \times V_{CC}$  |
| 1.65 V to 1.95 V | $V_{CC}$ | $\leq 2.0 \text{ ns}$ | 15 pF | 500 $\Omega$ | $2 \times V_{CC}$  |
| 2.3 V to 2.7 V   | $V_{CC}$ | $\leq 2.0 \text{ ns}$ | 15 pF | 500 $\Omega$ | $2 \times V_{CC}$  |
| 3.0 V to 3.6 V   | 3 V      | $\leq 2.0 \text{ ns}$ | 15 pF | 500 $\Omega$ | 6.0 V              |
| 4.5 V to 5.5 V   | $V_{CC}$ | $\leq 2.0 \text{ ns}$ | 15 pF | 500 $\Omega$ | $2 \times V_{CC}$  |

## Package Outline

TSSOP-14L



| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min.                      | Max.  | Min.                 | Max.  |
| D      | 4.900                     | 5.100 | 0.193                | 0.201 |
| E      | 4.300                     | 4.500 | 0.169                | 0.177 |
| b      | 0.190                     | 0.300 | 0.007                | 0.012 |
| c      | 0.090                     | 0.200 | 0.004                | 0.008 |
| E1     | 6.250                     | 6.550 | 0.246                | 0.258 |
| A      | —                         | 1.200 | —                    | 0.047 |
| A2     | 0.800                     | 1.000 | 0.031                | 0.039 |
| A1     | 0.050                     | 0.150 | 0.002                | 0.006 |
| e      | 0.65 (BSC)                |       | 0.026 (BSC)          |       |
| L      | 0.500                     | 0.700 | 0.020                | 0.028 |
| H      | 0.25(TYP)                 |       | 0.01(TYP)            |       |
| θ      | 1°                        | 7°    | 1°                   | 7°    |

## Revision History

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

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