

## 74VCX16841

# Low Voltage 20-Bit Transparent Latch with 3.6V Tolerant Inputs and Outputs

### General Description

The VCX16841 contains twenty non-inverting latches with 3-STATE outputs and is intended for bus oriented applications. The device is byte controlled. The flip-flops appear transparent to the data when the Latch enable (LE) is HIGH. When LE is LOW, the data that meets the setup time is latched. Data appears on the bus when the Output Enable ( $\overline{OE}$ ) is LOW. When  $\overline{OE}$  is HIGH, the outputs are in a high impedance state.

The 74VCX16841 is designed for low voltage (1.65V to 3.6V)  $V_{CC}$  applications with I/O compatibility up to 3.6V.

The 74VCX16841 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining low CMOS power dissipation.

### Features

- 1.65V–3.6V  $V_{CC}$  supply operation
- 3.6V tolerant inputs and outputs
- $t_{PD}$  ( $D_n$  to  $O_n$ )
  - 3.0 ns max for 3.0V to 3.6V  $V_{CC}$
  - 3.4 ns max for 2.3V to 2.7V  $V_{CC}$
  - 6.8 ns max for 1.65V to 1.95V  $V_{CC}$
- Power-off high impedance inputs and outputs
- Supports live insertion and withdrawal (Note 1)
- Static Drive ( $I_{OH}/I_{OL}$ )
  - $\pm 24$  mA @ 3.0V  $V_{CC}$
  - $\pm 18$  mA @ 2.3V  $V_{CC}$
  - $\pm 6$  mA @ 1.65V  $V_{CC}$
- Uses patented noise/EMI reduction circuitry
- Latch-up performance exceeds 300 mA
- ESD performance:
  - Human body model > 2000V
  - Machine model > 200V

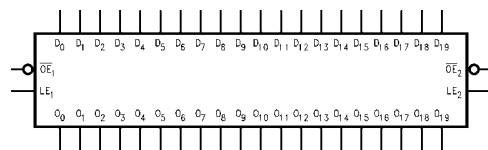
**Note 1:** To ensure the high-impedance state during power up or power down,  $\overline{OE}$  should be tied to  $V_{CC}$  through a pull-up resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver.

### Ordering Code:

| Order Number  | Package Number | Package Description   |
|---------------|----------------|---|
| 74VCX16841MTD | MTD56          | 56-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide |

Device also available in Tape and Reel. Specify by appending suffix letter "X" to the ordering code.

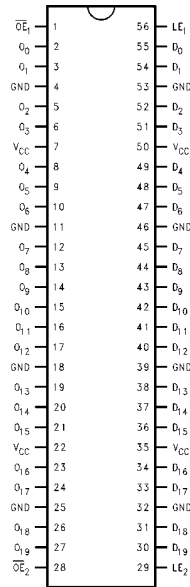
### Logic Symbol



### Pin Descriptions

| Pin Names         | Description                      |
|-------------------|----------------------------------|
| $\overline{OE}_n$ | Output Enable Input (Active LOW) |
| $LE_n$            | Latch Enable Input               |
| $D_0$ – $D_{19}$  | Inputs                           |
| $O_0$ – $O_{19}$  | Outputs                          |

**Connection Diagram**



**Truth Tables**

| Inputs          |                 |                                | Outputs                        |
|-----------------|-----------------|--------------------------------|--------------------------------|
| LE <sub>1</sub> | OE <sub>1</sub> | D <sub>0</sub> -D <sub>9</sub> | O <sub>0</sub> -O <sub>9</sub> |
| X               | H               | X                              | Z                              |
| H               | L               | L                              | L                              |
| H               | L               | H                              | H                              |
| L               | L               | X                              | O <sub>0</sub>                 |

| Inputs          |                 |                                  | Outputs                          |
|-----------------|-----------------|----------------------------------|----------------------------------|
| LE <sub>2</sub> | OE <sub>2</sub> | D <sub>10</sub> -D <sub>19</sub> | O <sub>10</sub> -O <sub>19</sub> |
| X               | H               | X                                | Z                                |
| H               | L               | L                                | L                                |
| H               | L               | H                                | H                                |
| L               | L               | X                                | O <sub>0</sub>                   |

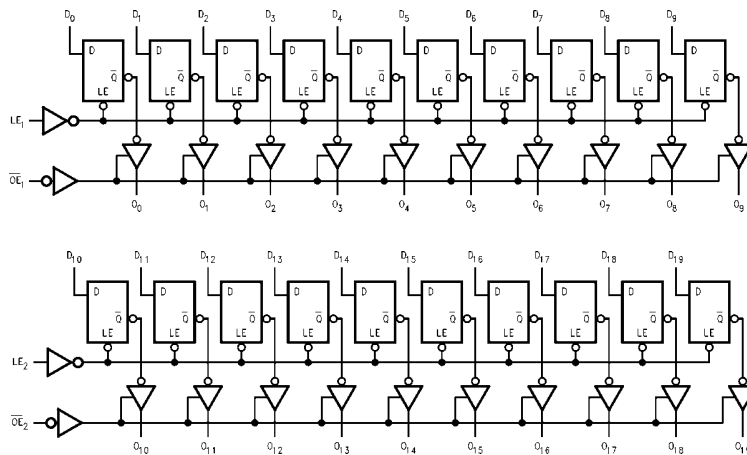
H = HIGH Voltage Level  
 L = LOW Voltage Level  
 X = Immaterial (HIGH or LOW, inputs may not float)  
 Z = High Impedance  
 O<sub>0</sub> = Previous O<sub>0</sub> before HIGH-to-LOW of Latch Enable

**Functional Description**

The 74VCX16841 contains twenty D-type latches with 3-STATE outputs. The device is byte controlled with each byte functioning identically, but independent of the other. Control pins can be shorted together to obtain full 20-bit operation. The following description applies to each byte. When the Latch Enable (LE<sub>n</sub>) input is HIGH, data on the D<sub>n</sub> enters the latches. In this condition the latches are transparent, i.e., a latch output will change states each time its

D-type input changes. When LE<sub>n</sub> is LOW, the latches store information that was present on the D-type inputs a setup time preceding the HIGH-to-LOW transition on LE<sub>n</sub>. The 3-STATE outputs are controlled by the Output Enable ( $\overline{OE}_n$ ) input. When  $\overline{OE}_n$  is LOW the standard outputs are in the 2-state mode. When  $\overline{OE}_n$  is HIGH, the standard outputs are in the high impedance mode but this does not interfere with entering new data into the latches.

**Logic Diagram**



Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

| Absolute Maximum Ratings (Note 2)   |                                | Recommended Operating Conditions (Note 4)   |                |                |           |         |
|---|--------------------------------|---|----------------|----------------|-----------|---------|
| Supply Voltage ( $V_{CC}$ )   | -0.5V to +4.6V                 | Power Supply  |                |                |           |         |
| DC Input Voltage ( $V_I$ )  | -0.5V to +4.6V                 | Operating   | 1.65V to 3.6V  |                |           |         |
| Output Voltage ( $V_O$ )  |                                | Data Retention Only   | 1.2V to 3.6V   |                |           |         |
| Outputs 3-STATE   | -0.5V to +4.6V                 | Input Voltage   | -0.3V to +3.6V |                |           |         |
| Outputs Active (Note 3)   | -0.5V to $V_{CC} + 0.5V$       | Output Voltage ( $V_O$ )  |                |                |           |         |
| DC Input Diode Current ( $I_{IK}$ ) $V_I < 0V$                              | -50 mA                         | Output in Active States   | 0V to $V_{CC}$ |                |           |         |
| DC Output Diode Current ( $I_{OK}$ )  |                                | Output in "OFF" State   | 0.0V to 3.6V   |                |           |         |
| $V_O < 0V$  | -50 mA                         | Output Current in $I_{OH}/I_{OL}$   |                |                |           |         |
| $V_O > V_{CC}$  | +50 mA                         | $V_{CC} = 3.0V$ to $3.6V$   | $\pm 24$ mA    |                |           |         |
| DC Output Source/Sink Current   |                                | $V_{CC} = 2.3V$ to $2.7V$   | $\pm 18$ mA    |                |           |         |
| ( $I_{OH}/I_{OL}$ )   | $\pm 50$ mA                    | $V_{CC} = 1.65V$ to $2.3V$  | $\pm 6$ mA     |                |           |         |
| DC $V_{CC}$ or GND Current per  |                                | Free Air Operating Temperature  |                |                |           |         |
| Supply Pin ( $I_{CC}$ or GND)   | $\pm 100$ mA                   | ( $T_A$ )   | -40°C to +85°C |                |           |         |
| Storage Temperature Range ( $T_{STG}$ )                                     | -65°C to +150°C                | Minimum Input Edge Rate ( $\Delta t/\Delta V$ )   |                |                |           |         |
|   |                                | $V_{IN} = 0.8V$ to $2.0V$ , $V_{CC} = 3.0V$   | 10 ns/V        |                |           |         |
|   |                                | <p><b>Note 2:</b> The Absolute Maximum Ratings are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the Absolute Maximum Ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.</p> <p><b>Note 3:</b> <math>I_O</math> Absolute Maximum Rating must be observed.</p> <p><b>Note 4:</b> Floating or unused inputs must be held HIGH or LOW.</p> |                |                |           |         |
| <b>DC Electrical Characteristics (2.7V &lt; <math>V_{CC}</math> ≤ 3.6V)</b> |                                |   |                |                |           |         |
| Symbol  | Parameter                      | Conditions  | $V_{CC}$ (V)   | Min            | Max       | Units   |
| $V_{IH}$  | HIGH Level Input Voltage       |   | 2.7 – 3.6      | 2.0            |           | V       |
| $V_{IL}$  | LOW Level Input Voltage        |   | 2.7 – 3.6      |                | 0.8       | V       |
| $V_{OH}$  | HIGH Level Output Voltage      | $I_{OH} = -100 \mu A$   | 2.7 – 3.6      | $V_{CC} - 0.2$ |           | V       |
|   |                                | $I_{OH} = -12 \text{ mA}$   | 2.7            | 2.2            |           | V       |
|   |                                | $I_{OH} = -18 \text{ mA}$   | 3.0            | 2.4            |           | V       |
|   |                                | $I_{OH} = -24 \text{ mA}$   | 3.0            | 2.2            |           | V       |
| $V_{OL}$  | LOW Level Output Voltage       | $I_{OL} = 100 \mu A$  | 2.7 – 3.6      |                | 0.2       | V       |
|   |                                | $I_{OL} = 12 \text{ mA}$  | 2.7            |                | 0.4       | V       |
|   |                                | $I_{OL} = 18 \text{ mA}$  | 3.0            |                | 0.4       | V       |
|   |                                | $I_{OL} = 24 \text{ mA}$  | 3.0            |                | 0.55      | V       |
| $I_I$   | Input Leakage Current          | $0 \leq V_I \leq 3.6V$  | 2.7 – 3.6      |                | $\pm 5.0$ | $\mu A$ |
| $I_{OZ}$  | 3-STATE Output Leakage         | $0 \leq V_O \leq 3.6V$<br>$V_I = V_{IH}$ or $V_{IL}$  | 2.7 – 3.6      |                | $\pm 10$  | $\mu A$ |
| $I_{OFF}$   | Power-OFF Leakage Current      | $0 \leq (V_I, V_O) \leq 3.6V$   | 0              |                | 10        | $\mu A$ |
| $I_{CC}$  | Quiescent Supply Current       | $V_I = V_{CC}$ or GND   | 2.7 – 3.6      |                | 20        | $\mu A$ |
|   |                                | $V_{CC} \leq (V_I, V_O) \leq 3.6V$ (Note 5)   | 2.7 – 3.6      |                | $\pm 20$  | $\mu A$ |
| $\Delta I_{CC}$   | Increase in $I_{CC}$ per Input | $V_{IH} = V_{CC} - 0.6V$  | 2.7 – 3.6      |                | 750       | $\mu A$ |
| <b>Note 5:</b> Outputs disabled or 3-STATE only.                            |                                |   |                |                |           |         |

| DC Electrical Characteristics ( $2.3V \leq V_{CC} \leq 2.7V$ ) |                           |  |              |                      |                      |         |
|--|---------------------------|--|--------------|----------------------|----------------------|---------|
| Symbol   | Parameter                 | Conditions   | $V_{CC}$ (V) | Min                  | Max                  | Units   |
| $V_{IH}$   | HIGH Level Input Voltage  |  | 2.3 - 2.7    | 1.6                  |                      | V       |
| $V_{IL}$   | LOW Level Input Voltage   |  | 2.3 - 2.7    |                      | 0.7                  | V       |
| $V_{OH}$   | HIGH Level Output Voltage | $I_{OH} = -100 \mu A$                                | 2.3 - 2.7    | $V_{CC} - 0.2$       |                      | V       |
|  |                           | $I_{OH} = -6 \text{ mA}$                             | 2.3          | 2.0                  |                      | V       |
|  |                           | $I_{OH} = -12 \text{ mA}$                            | 2.3          | 1.8                  |                      | V       |
|  |                           | $I_{OH} = -18 \text{ mA}$                            | 2.3          | 1.7                  |                      | V       |
| $V_{OL}$   | LOW Level Output Voltage  | $I_{OL} = 100 \mu A$                                 | 2.3 - 2.7    |                      | 0.2                  | V       |
|  |                           | $I_{OL} = 12 \text{ mA}$                             | 2.3          |                      | 0.4                  | V       |
|  |                           | $I_{OL} = 18 \text{ mA}$                             | 2.3          |                      | 0.6                  | V       |
| $I_I$  | Input Leakage Current     | $0 \leq V_I \leq 3.6V$                               | 2.3 - 2.7    |                      | $\pm 5.0$            | $\mu A$ |
| $I_{OZ}$   | 3-STATE Output Leakage    | $0 \leq V_O \leq 3.6V$<br>$V_I = V_{IH}$ or $V_{IL}$ | 2.3 - 2.7    |                      | $\pm 10$             | $\mu A$ |
| $I_{OFF}$  | Power-OFF Leakage Current | $0 \leq (V_I, V_O) \leq 3.6V$                        | 0            |                      | 10                   | $\mu A$ |
| $I_{CC}$   | Quiescent Supply Current  | $V_I = V_{CC}$ or GND                                | 2.3 - 2.7    |                      | 20                   | $\mu A$ |
|  |                           | $V_{CC} \leq (V_I, V_O) \leq 3.6V$ (Note 6)          | 2.3 - 2.7    |                      | $\pm 20$             | $\mu A$ |
| <b>Note 6:</b> Outputs disabled or 3-STATE only.               |                           |  |              |                      |                      |         |
| DC Electrical Characteristics ( $1.65V \leq V_{CC} < 2.3V$ )   |                           |  |              |                      |                      |         |
| Symbol   | Parameter                 | Conditions   | $V_{CC}$ (V) | Min                  | Max                  | Units   |
| $V_{IH}$   | HIGH Level Input Voltage  |  | 1.65 - 2.3   | $0.65 \times V_{CC}$ |                      | V       |
| $V_{IL}$   | LOW Level Input Voltage   |  | 1.65 - 2.3   |                      | $0.35 \times V_{CC}$ | V       |
| $V_{OH}$   | HIGH Level Output Voltage | $I_{OH} = -100 \mu A$                                | 1.65 - 2.3   | $V_{CC} - 0.2$       |                      | V       |
|  |                           | $I_{OH} = -6 \text{ mA}$                             | 1.65         | 1.25                 |                      | V       |
| $V_{OL}$   | LOW Level Output Voltage  | $I_{OL} = 100 \mu A$                                 | 1.65 - 2.3   |                      | 0.2                  | V       |
|  |                           | $I_{OL} = 6 \text{ mA}$                              | 1.65         |                      | 0.3                  | V       |
| $I_I$  | Input Leakage Current     | $0 \leq V_I \leq 3.6V$                               | 1.65 - 2.3   |                      | $\pm 5.0$            | $\mu A$ |
| $I_{OZ}$   | 3-STATE Output Leakage    | $0 \leq V_O \leq 3.6V$<br>$V_I = V_{IH}$ or $V_{IL}$ | 1.65 - 2.3   |                      | $\pm 10$             | $\mu A$ |
| $I_{OFF}$  | Power-OFF Leakage Current | $0 \leq (V_I, V_O) \leq 3.6V$                        | 0            |                      | 10                   | $\mu A$ |
| $I_{CC}$   | Quiescent Supply Current  | $V_I = V_{CC}$ or GND                                | 1.65 - 2.3   |                      | 20                   | $\mu A$ |
|  |                           | $V_{CC} \leq (V_I, V_O) \leq 3.6V$ (Note 7)          | 1.65 - 2.3   |                      | $\pm 20$             | $\mu A$ |
| <b>Note 7:</b> Outputs disabled or 3-STATE only.               |                           |  |              |                      |                      |         |

| AC Electrical Characteristics (Note 8) |                                   |   |     |  |     |                                 |      |       |
|--|-----------------------------------|---|-----|--|-----|---------------------------------|------|-------|
| Symbol                                 | Parameter                         | $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ , $C_L = 30\text{ pF}$ , $R_L = 500\Omega$ |     |  |     |                                 |      | Units |
|  |                                   | $V_{CC} = 3.3\text{V} \pm 0.3\text{V}$  |     | $V_{CC} = 2.5\text{V} \pm 0.2\text{V}$ |     | $V_{CC} = 1.8 \pm 0.15\text{V}$ |      |       |
|  |                                   | Min   | Max | Min                                    | Max | Min                             | Max  |       |
| $t_{PHL}$ , $t_{PLH}$                  | Prop Delay $D_n$ to $O_n$         | 0.8   | 3.0 | 1.0                                    | 3.4 | 1.5                             | 6.8  | ns    |
| $t_{PHL}$ , $t_{PLH}$                  | Prop Delay LE to $O_n$            | 0.8   | 3.5 | 1.0                                    | 4.4 | 1.5                             | 8.8  | ns    |
| $t_{PZL}$ , $t_{PZH}$                  | Output Enable Time                | 0.8   | 3.8 | 1.0                                    | 4.9 | 1.5                             | 9.8  | ns    |
| $t_{PLZ}$ , $t_{PHZ}$                  | Output Disable Time               | 0.8   | 3.7 | 1.0                                    | 4.2 | 1.5                             | 7.6  | ns    |
| $t_S$                                  | Setup Time                        | 1.5   |     | 1.5                                    |     | 2.5                             |      | ns    |
| $t_H$                                  | Hold Time                         | 1.0   |     | 1.0                                    |     | 1.0                             |      | ns    |
| $t_W$                                  | Pulse Width                       | 1.5   |     | 1.5                                    |     | 4.0                             |      | ns    |
| $t_{OSHL}$<br>$t_{OSLH}$               | Output to Output Skew<br>(Note 9) |   | 0.5 |  | 0.5 |                                 | 0.75 | ns    |

**Note 8:** For  $C_L = 50\text{ pF}$ , add approximately 300 ps to the AC maximum specification.

**Note 9:** Skew is defined as the absolute value of the difference between the actual propagation delay for any two separate outputs of the same device. The specification applies to any outputs switching in the same direction, either HIGH-to-LOW ( $t_{OSHL}$ ) or LOW-to-HIGH ( $t_{OSLH}$ ).

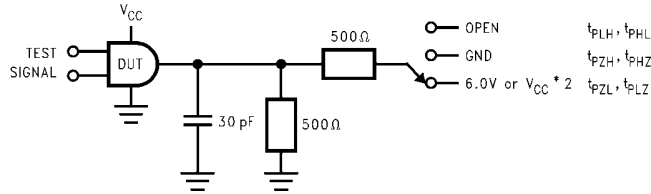
### Dynamic Switching Characteristics

| Symbol    | Parameter                            | Conditions  | $V_{CC}$<br>(V)   | $T_A = +25^{\circ}\text{C}$ | Units |
|-----------|--------------------------------------|---|-------------------|-----------------------------|-------|
|           |                                      |   |                   | Typical                     |       |
| $V_{OLP}$ | Quiet Output Dynamic Peak $V_{OL}$   | $C_L = 30\text{ pF}$ , $V_{IH} = V_{CC}$ , $V_{IL} = 0\text{V}$ | 1.8<br>2.5<br>3.3 | 0.25<br>0.6<br>0.8          | V     |
| $V_{OLV}$ | Quiet Output Dynamic Valley $V_{OL}$ | $C_L = 30\text{ pF}$ , $V_{IH} = V_{CC}$ , $V_{IL} = 0\text{V}$ | 1.8<br>2.5<br>3.3 | -0.25<br>-0.6<br>-0.8       | V     |
| $V_{OHV}$ | Quiet Output Dynamic Valley $V_{OH}$ | $C_L = 30\text{ pF}$ , $V_{IH} = V_{CC}$ , $V_{IL} = 0\text{V}$ | 1.8<br>2.5<br>3.3 | 1.5<br>1.9<br>2.2           | V     |

### Capacitance

| Symbol    | Parameter                     | Conditions   | $T_A = +25^{\circ}\text{C}$ | Units |
|-----------|-------------------------------|--|-----------------------------|-------|
|           |                               |  | Typical                     |       |
| $C_{IN}$  | Input Capacitance             | $V_{CC} = 1.8\text{V}$ , $2.5\text{V}$ or $3.3\text{V}$ , $V_I = 0\text{V}$ or $V_{CC}$                          | 6                           | pF    |
| $C_{OUT}$ | Output Capacitance            | $V_I = 0\text{V}$ or $V_{CC}$ , $V_{CC} = 1.8\text{V}$ , $2.5\text{V}$ or $3.3\text{V}$                          | 7                           | pF    |
| $C_{PD}$  | Power Dissipation Capacitance | $V_I = 0\text{V}$ or $V_{CC}$ , $f = 10\text{ MHz}$ ,<br>$V_{CC} = 1.8\text{V}$ , $2.5\text{V}$ or $3.3\text{V}$ | 20                          | pF    |

### AC Loading and Waveforms



| TEST               | SWITCH  |
|--------------------|---|
| $t_{PLH}, t_{PHL}$ | Open  |
| $t_{PZL}, t_{PLZ}$ | 6V at $V_{CC} = 3.3 \pm 0.3V$ ;<br>$V_{CC} \times 2$ at $V_{CC} = 2.5 \pm 0.2V; 1.8V \pm 0.15V$ |
| $t_{PZH}, t_{PHZ}$ | GND   |

FIGURE 1. AC Test Circuit

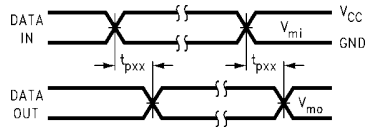


FIGURE 2. Waveform for Inverting and Non-Inverting Functions

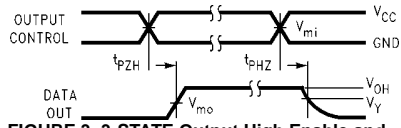


FIGURE 3. 3-STATE Output High Enable and Disable Times for Low Voltage Logic

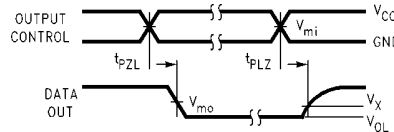


FIGURE 4. 3-STATE Output Low Enable and Disable Times for Low Voltage Logic

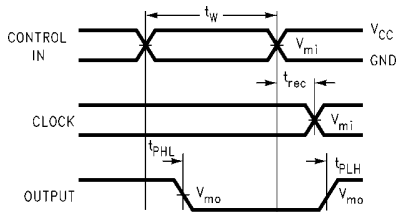


FIGURE 5. Propagation Delay, Pulse Width and  $t_{rec}$  Waveforms

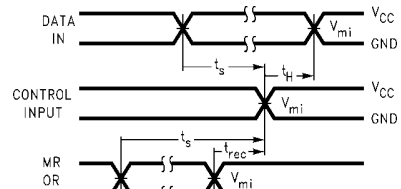
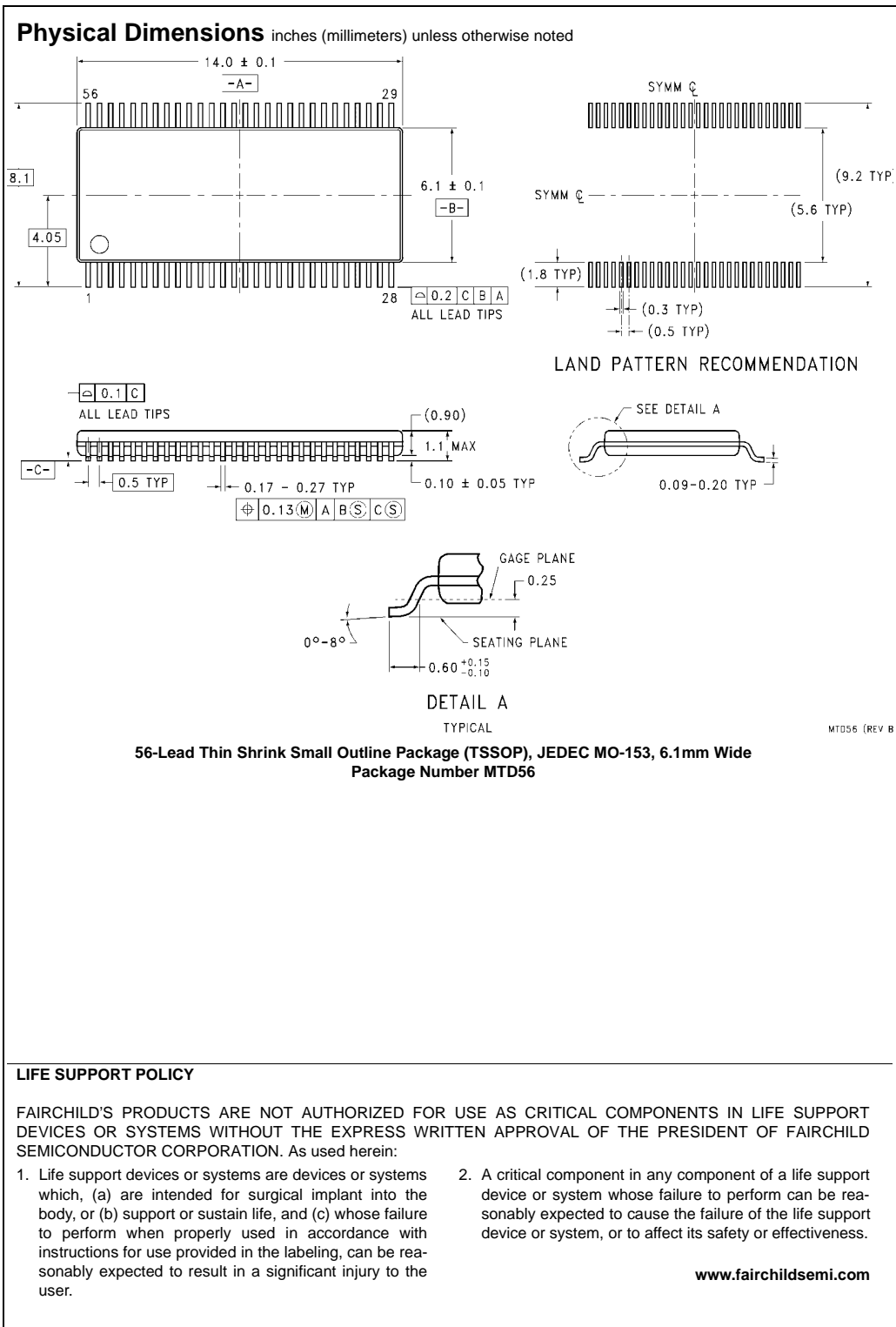


FIGURE 6. Setup Time, Hold Time and Recovery Time for Low Voltage Logic

| Symbol   | $V_{CC}$        |                  |                  |
|----------|-----------------|------------------|------------------|
|          | $3.3V \pm 0.3V$ | $2.5V \pm 0.2V$  | $1.8V \pm 0.15V$ |
| $V_{mi}$ | 1.5V            | $V_{CC}/2$       | $V_{CC}/2$       |
| $V_{mo}$ | 1.5V            | $V_{CC}/2$       | $V_{CC}/2$       |
| $V_X$    | $V_{OL} + 0.3V$ | $V_{OL} + 0.15V$ | $V_{OL} + 0.15V$ |
| $V_Y$    | $V_{OH} - 0.3V$ | $V_{OH} - 0.15V$ | $V_{OH} - 0.15V$ |



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