What is LogiScan?

LogiScan is a USB-based digital-circuit testing system developed by Prof. Taek Kwon as a digital testing tool for the circuits used in the ECE 1315 Lab experiments. It consists of an interface box and software that runs on a PC. The interface box is controlled from a PC and generates input patterns for digital-logic circuits. The outputs of the circuit connected to the LogiScan interface box is scanned in real-time and displayed on the PC screen. LogiScan is capable for testing both combinatorial and synchronous sequential circuits. LogiScan is used for all labs in ECE1315.

Pin-out Diagram of the 24 pin in-line Connector

The most important information that students need to know to use the LogiScan is the pin-outs of the 24-pin ribbon-cable connector of the interface box. This connector provides all necessary interfaces between your breadboard and the LogiScan. The pin-outs are shown below;

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, X0</td>
<td>+5V, 24</td>
</tr>
<tr>
<td>2, X1</td>
<td>n/c, 23</td>
</tr>
<tr>
<td>3, X2</td>
<td>CLK, 22</td>
</tr>
<tr>
<td>4, X3</td>
<td>n/c, 21</td>
</tr>
<tr>
<td>5, X4</td>
<td>n/c, 20</td>
</tr>
<tr>
<td>6, X5</td>
<td>n/c, 19</td>
</tr>
<tr>
<td>7, F5</td>
<td>n/c, 18</td>
</tr>
<tr>
<td>8, F4</td>
<td>n/c, 17</td>
</tr>
<tr>
<td>9, F3</td>
<td>n/c, 16</td>
</tr>
<tr>
<td>10, F2</td>
<td>n/c, 15</td>
</tr>
<tr>
<td>11, F1</td>
<td>n/c, 14</td>
</tr>
<tr>
<td>12, F0</td>
<td>G, 13</td>
</tr>
</tbody>
</table>

Pins: X0, X1, ..., X5
These pins must be connected to the inputs of your circuit. The bit patterns (0 and 5Volts) generated by the PC are sent out to these pins.
Pins: F0, F1, ..., F5
These pins must be connected to the outputs of your circuit. The PC reads these pins and display the results on the PC screen.

Pin 24: +5V
This pin provides +5V power source and should connected to power your circuit. Every TTL chips require +5V and 0V power connection, and this pin should be used for +5V.

Pin 13: G
This pin provides 0V (GND).

Pin 22: CLK
This pin provides a clock signal for running sequential logic circuits.

Software
The software is run by double clicking the icon

![LogiScan.exe](image)
**Part 1: Combinational Logic**

**LogiScan** produces +5V for logic 1 and 0V for logic 0 and sends out the signals to the pins X0 through X5. The red squares under the labels X0-X5 toggle between 0 and 1 when you click on it using the left mouse button, which then immediately sends the corresponding voltages (0V or +5V) to the corresponding pins. The check boxes under the red squares are used to define inputs for your circuit for generating a truth table.

The outputs of your circuit are read when you connect them to pins F0-F5. The 1 or 0 value in the yellow boxes under the label “Signal To LogiScan” is the real-time read-out results corresponding to +5V or 0V on the respective pin. The check boxes under the yellow boxes are used to define which outputs are used for generating the truth table for combinational-logic circuits.

**Walk-Through Example: OR gate**

This example illustrates how to connect and test an OR function using a 74LS32 chip. A 74x32 chip includes four 2-input OR gates, and we will use only one of the four gates. Using your breadboard, connect the two inputs of the first OR gate to X0 and X1 and the output of the OR gate to F0, and Vcc to +5V and GND to G, as shown in the connection diagram below.

Next, using the LogiScan software toggle X0 and X1 and observe the F0 value. You should be able to observe the following OR relation.

<table>
<thead>
<tr>
<th>X1</th>
<th>X0</th>
<th>F0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
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<tr>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Now, select the check boxes under X0, X1, and F0, and then click the Run Truth Table button. You should be able to see a pop-up truth table window that contains the above table. That is all you need to do to confirm the correct operation of the circuit.

All combinational circuits are tested by following the similar steps shown in the walkthrough example. If you wish to run only a subset of all possible input combinations, you should define the input table using the menu: “User Input Table” \(\rightarrow\) “Build New One”. And then run the circuit using the “Run User Defined Input Table” button.

**Part 2: Synchronous Sequential Logic**

In a sequential circuit, the output is no longer just a function of the present input signals but also a function of past history of inputs. More specifically, the circuit may produce a different output even if the present inputs are the same but if the past inputs were different. It also uses a clock to differentiate the timing of signals on the past and the present.

Testing of sequential logic requires the following steps.
- Connect your circuit to LogiScan, i.e., inputs of your circuit to X0-X5 and outputs of your circuit to F0-F5.
- Connect the clock input of your circuit to LogiScan Clock pin (pin 22)
- Select the check boxes for the inputs and outputs you connected.
- Next define the input sequences using the “Define New Input Seq.” button in the Sequential Logic box of LogiScan.
- Make sure to save the input sequence by clicking on the Save button. Remember that the run function uses only the saved input sequence. If saving is done, you can now close the Input Sequence window.
- Run your circuit by clicking on the “Run Defined Input Sequences” button.
- The run result will appear on a new window and you should analyze the results to check if the output sequences are correct. If it is not, you will need to correct your circuit.

**Walk-Through Example: D-FF**

Let’s test the functionality of a D-FF Q* output (* denotes NOT). 74x74 has two D-FFs and we will using only one them. The output sequence expected is the inverted input sequence synchronized by the clock if you recall the basic function of D-FF.

**Step 1** First, make the following connection using your breadboard. Notice that input D is connected to X0, the output Q* is connected to F0, and clock to clock. CLR* and PRE* should be connected to +5V (Logic 1).
Step 2) Since X0 is used as input sequence and F0 is used as the output sequence, check mark on X0 and F0.

Step 3) Define the input sequence.
Click on the “Define New Input Seq” which would bring up the following screen. Enter 20 and click OK.

Next, you will see the input sequence screen. Choose rising edge since 74LS74 is synchronized to the rising edge of the clock and then randomize the input sequence by clicking on the “Randomize Input Sequence” for this particular example. You click on the individual input sequence to toggle them.
Next, the important step is saving the generated sequence using the Save button. Click on the Save button and close the Input Sequence Table. The saved sequence is the one the LogiScan uses. Now, you are in the main window.

**Step 4)** Run the sequential circuit by clicking on the “Run Defined Input Sequences” button.

**Step 5)** Analyze the run results, i.e. the output sequence
You will see the following run results window if you did not make any mistakes. Notice that all input sequence appears in the output sequence as inverted after rising edge of the clock, i.e., one clock delay. This is exactly what Q* of D-FF supposed to function.
You are now successfully completed this walk-through example and ready to do more complicated sequential logic circuits.

One of the important things to remember is to save the input sequence after you created on the input sequences. LogiScan only recognizes the saved input sequence. Once it is saved, the data is in the memory and you can review the data by clicking on the “Open Existing Seq” button.