Flip-Flop Applications

This presentation will provide an overview of the following flip-flop applications:

- Event Detect
- Data Synchronizer
- Frequency Divider
- Shift Register

Additional flip-flop applications will be covered in future lessons:

- Asynchronous (Ripple) Counters (Unit 3.2)
- Synchronous (Parallel) Counters (Unit 3.3)
- State Machines (Unit 3.4)

Event Detector

- An event detector circuit is one that is capable of detecting and holding a signal until the event that changed the signal can be addressed.
- For example, door sensors on a home burglar alarm system use an event detector circuit. Once someone opens the door, the alarm will sound until the system is turned off.
- If it were not for the event detection circuit, the alarm would only be on when the door was open. Thus, someone could quickly open the door, enter the house, and close the door. In this situation the alarm would only sound for the brief time that the door was actually open.
Event Detect

Case #1
- Single Event
- Clear
- Held Event

Case #2
- Single Event
- Clear
- Held Event

Data Synchronizer

Normally, timing is not a concern with combinational logic. However, due to gate delays, the outputs of combinational logic can change at different times. This can lead to potential timing problems. Take a look at the combinational logic circuit shown below. Because functions A, B, & C have different circuit complexity, they change logic levels at different times.

To solve this problem, a data synchronizer circuit can be added to the outputs.

Data Synchronizer: Circuit

Data Synchronizer: Timing

The signal can be a zero or a one, depending on the previous latched values.
Frequency Divider

- As the name implies, a frequency divider is a circuit that produces a digital output signal that is half the frequency of the input.
- The frequency divider is used extensively in the design of asynchronous counters.

Frequency Divider: Circuit

Frequency Divider: Timing

Shift Register

- A shift register is a group of flip-flops (typically 4 or 8) that are arranged so that the values stored in the flip-flops are shifted from one flip-flop to the next for every clock.
- Shift registers are used extensively in logic circuits to control digital displays.
- A classic example is numbers being typed into a calculator. As the numbers are entered, the digits shift to the left one position. This shifting is controlled by a shift register.
Shift Register

Serial In / Serial Out
Left-to-Right

Serial In / Serial Out
Right-to-Left

Parallel In / Serial Out

Serial In / Parallel Out

Shift Register: Circuit (D)

Shift Register: Circuit (J/K)

Shift Register: Timing
MSI Shift Register

74LS194 (4-bit Bi-Directional Universal Shift Register)

- Parallel Inputs
- Serial Inputs
- Mode Control
- Clear & Clock

Parallel Outputs & Serial Outputs

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74LS194 Shift Register: Circuit

74LS194 Shift Register: Timing