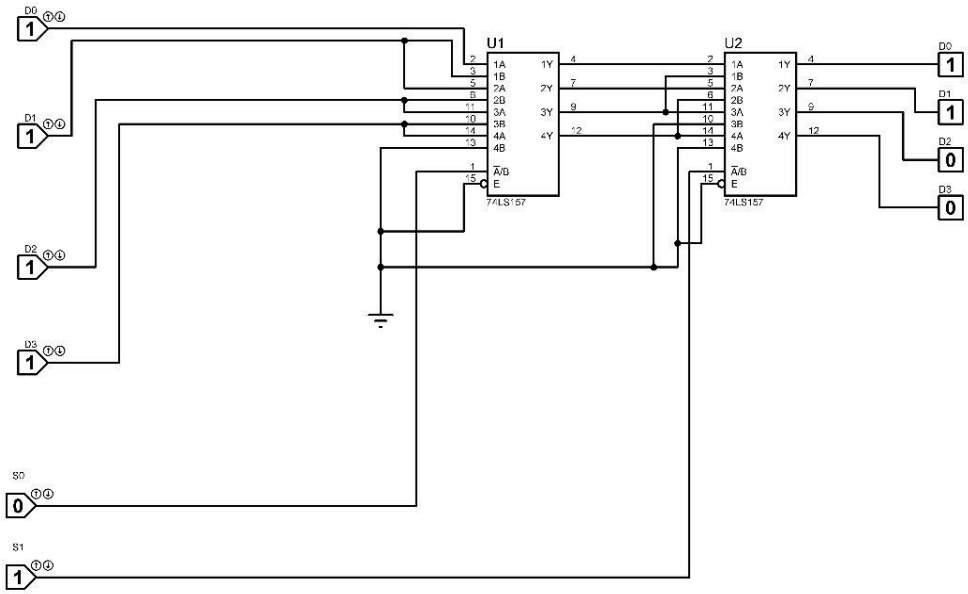
Project 1: Combinational Logic Barrel Shifter (2-bit right shift) using only 2x1 Multiplexers

Circuit diagram



Description of the components

- **74HC157 multiplexer** It is a high-speed IC or integrated circuit that includes four 2-input based digital multiplexers. This IC uses an advanced Si gate CMOS technology and is well-matched through less power Schottky TTL. 74HC157 multiplexer includes two inputs like enable & select input and also two groups of registers. The select input will decide the register from which the information arrives. This IC includes 4 two i/p digital multiplexers along with common select & STROBE inputs. Once the STROBE pin is at a low state, and then the 4 outputs will imagine the values preferred from the inputs. Similarly, once the STROBE input is at a high state, the 4 outputs will be imaginary like logical “0”. This IC includes 16-pins where each pin with its functionality is discussed below.
    1. Pin1 (SELECT) Pin1 is an enable select pin that is mainly used to choose the input lines from which the information is accessible at the outputs.

2. Pins 2, 5, 11 & 14 (PinA) These four pins are the first i/p line of the four 2:1 multiplexers.
3. Pins 4, 7, 9 & 12 (Output Y) These are the four output pins of the IC.
4. Pin8 (GND) This pin is directly connected to the GND terminal of the circuit.
5. Pin15 (STROBE) This is an active-low pin & is accountable for allowing or immobilized outputs.
6. Pin16 (Vcc) This pin provides the power to the IC like +5V.

- **Trainer Board** The Analog & Digital Training System is an ideal teaching aid for all types of electronic circuits. A variety of functional input and output circuits is located all around the 2820 Tie-point removable breadboard. These circuits can be used to generate or measure electrical signals from the circuit under test or development. The removable breadboard area is not connected to these peripheral circuits and is meant to be connected by the user using standard wires that comes with this Analog & Digital Training System. These circuit functions allow for the breadboarding and testing of circuits without the need for many expensive individual pieces of equipment.
  Features:
  1. Complete self-contained unit
  2. Short circuit protected power-supplies with short circuit indicators
  3. Variable voltage DC power supply (-14V to +14V)
  4. Two fixed voltage DC power supply (+5V and -5V)
  5. Function generator with sine, triangle and square wave outputs (1 Hz to 110kHz and amplitude of up to 12V pick to pick)
  6. 16 two position logic switches (+5V, 0V)
  7. Two pulse switches (each with inverted and non-inverted outputs)
  8. 8 ohm speaker
  9. Input/output connectors, BNC and banana connectors
  10. 2 digit binary-coded decimal (BCD) display
  11. 16 bit LED display with buffers
  12. Removable breadboard with 2820 interconnected silver plated tie-points

- **Male to male jumper wires** A jump wire (also known as jumper, jumper wire, DuPont wire) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

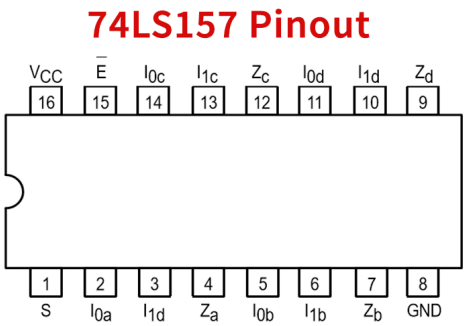


Fig 1: 74LS157 Multiplexer

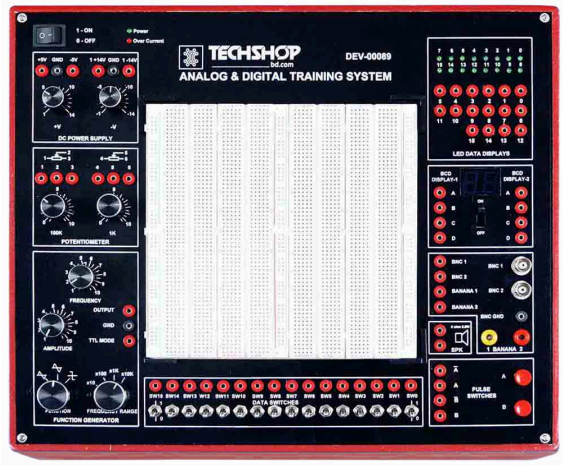
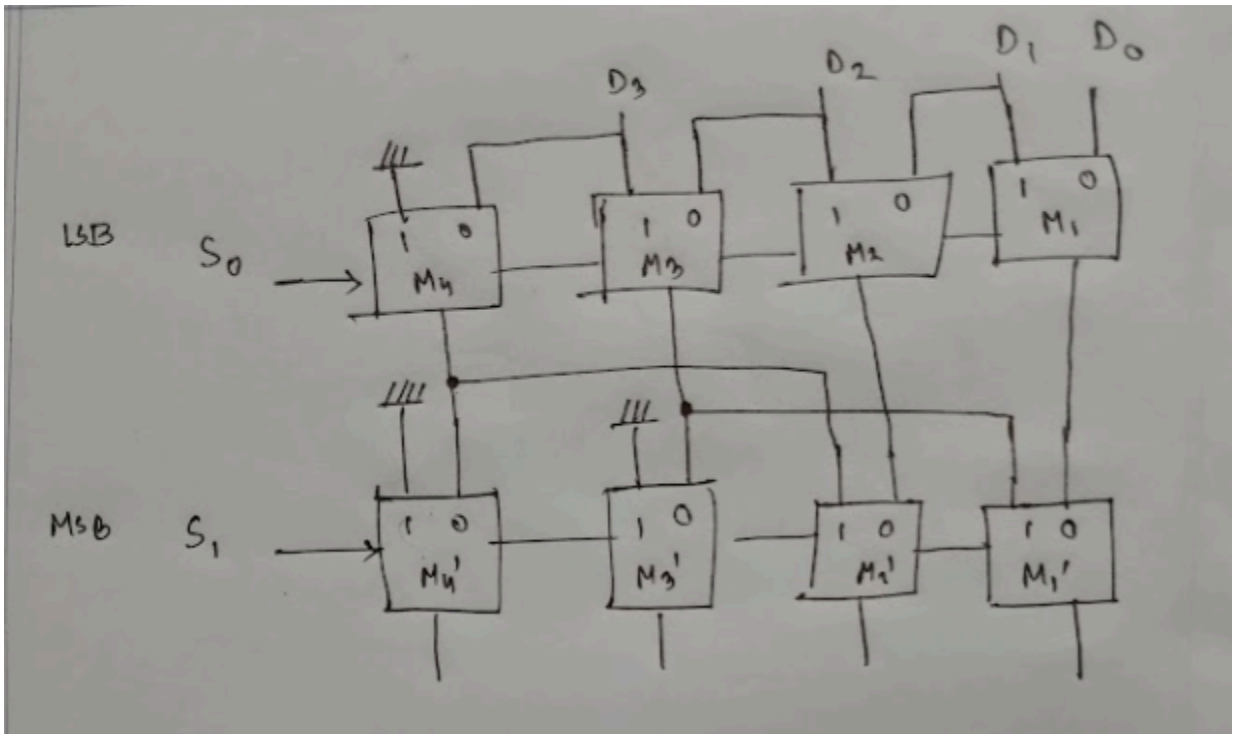


Fig 2: Trainer Board

Barrel shifter working procedure



Based on the circuit the shifting process can be explained as below, Based on the selection pins S1, S0, The working bits [D3, D2, D1, D0] in the MUX will also change.

Selection Pin		1st 4 MUX MSB -> LSB				2nd 4 MUX MSB -> LSB				Bit shifted
S1 MSB	S0 LSB	M4 MSB	M3	M2	M1 LSB	M4” MSB	M3”	M2”	M1” LSB	
0	0	D3	D2	D1	D0	D3	D2	D1	D0	-
0	1	0	D3	D2	D1	0	D3	D2	D1	1 BIT
1	0	D3	D2	D1	D0	0	0	D3	D2	2 BIT
1	1	0	D3	D2	D1	0	0	0	D3	3 BIT

One example is given below, suppose the working bit is 1111, then the barrel shifting process will be of below

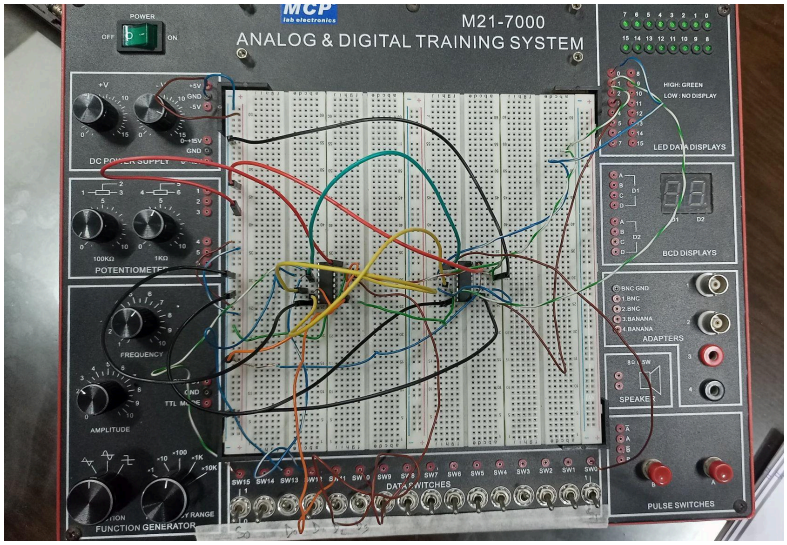
Selection Pin		1st 4 MUX MSB -> LSB				2nd 4 MUX MSB -> LSB				Bit shifted
S1 MSB	S0 LSB	M4 MSB	M3	M2	M1 LSB	M4” MSB	M3”	M2”	M1” LSB	
0	0	1	1	1	1	1	1	1	1	-
0	1	0	1	1	1	0	1	1	1	1 BIT
1	0	1	1	1	1	0	0	1	1	2 BIT
1	1	0	1	1	1	0	0	0	1	3 BIT

Another example is given below, suppose the working bit is 1011, then the barrel shifting process will be of below

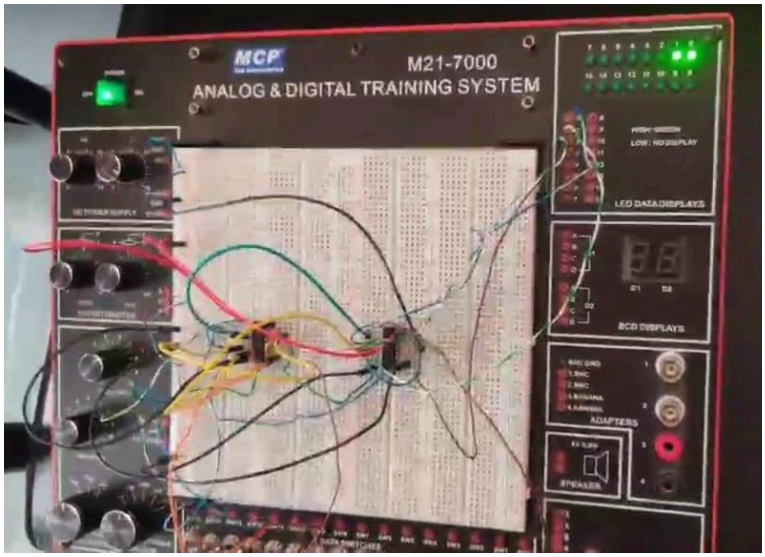
Selection Pin		1st 4 MUX MSB -> LSB				2nd 4 MUX MSB -> LSB				Bit shifted
S1 MSB	S0 LSB	M4 MSB	M3	M2	M1 LSB	M4” MSB	M3”	M2”	M1” LSB	
0	0	1	0	1	1	1	0	1	1	-
0	1	0	1	0	1	0	1	0	1	1 BIT
1	0	1	0	1	1	0	0	1	0	2 BIT
1	1	0	0	1	0	0	0	0	1	3 BIT

Discussion

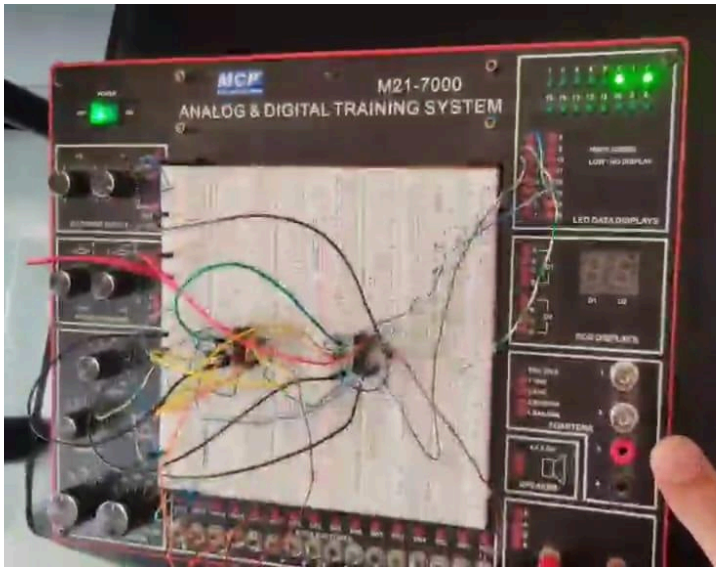
1. Before implementing hands on in circuitry, the total model was first run and simulated in proteus and checked under instructor guidance initially.
2. Mostly male to male jumper wires were used instead of twisted pair cables as they were difficult to cut, place and maintain for us. As some of the connections would get loosen in switch portions using jumper wires seemed more efficient. Also to avoid short circuits and open circuits as the twisted cables would get loose easily.
3. Based on the circuit diagram and pin diagram the placements of the wires were taken utmost care of our implemented circuit is thus shown below



4. Now for two cases when the working bit was 1111 the both selection bit was 10 meaning 2 bit right shift the output came was 0011, the figure shows as below



5. when the working bit was 1010 the both selection bit was 01 meaning 1 bit right shift the output came was 0101, the figure shows as below



6. Masking tape was used to label selection pins, switches, and input bits, minimizing the chances of wiring errors and enhancing clarity during the experiment.
7. All connections wee tested twice and the output was evaluated with multiple bits before instructor evaluation
8. Regularly the two multiplexers were checked for overheating, which could indicate a fault or overload in the circuit.