DSM Lab Report

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Experiment Part A

Objective

To get familiar with the working of a tri state buffer and understand data flow control using a tristate buffer.

Theory

The tri-state buffer (Fig 1) functions just as a regular digital buffer where the value at its input is propagated to its output. But it has an additional capability that allows us to configure its output to a Hi-Z (high impedance) state.

When the output of the buffer is in Hi-Z state it is basically disconnected (isolated) from the rest of the electric circuit. This makes it very useful when connecting multiple devices on a single bus, as its isolation prevents the occurrence of a short circuit event.

Experiment setup/ procedure

Materials required:

1	Quad NAND gate
1	pMOS Transistor (MOSFET)
1	nMOS Transistor (MOSFET)
1	Arduino Uno R3
1	1 kΩ Resistor
1	Red LED
1	Resistance Multimeter

Procedure:

1. In the experiment, you will verify the working of a tristate as shown in the circuit diagram use the tri state buffers to transfer contents of one shift register (74HC595 IC) to another shift register. Note that the output of the shift register is parallel (you will be using only the first 4 bits) while the input is serial. Therefore, you would be connecting the outputs to a single data bus using tristate buffers and reading the input to the second register from that bus.
2. Verify the working of the tri state buffer and create the truth table.

Code:

```
int latchPin = 13;

//Pin connected to SH_CP of 74HC595

int clockPin = 12;

////Pin connected to DS of 74HC595

int dataPin = 11;


void setup() {

  //set pins to output because they are addressed in the main loop

  pinMode(latchPin, OUTPUT);

  pinMode(clockPin, OUTPUT);

  pinMode(dataPin, OUTPUT);

  Serial.begin(9600);

}

int val;

int A;

int B,C;

void loop()

{

  if(Serial.available() > 0)

  {

    while(!Serial.available())

    {}

    B = Serial.read(); // x would be an integer between 0 and 255

    // depending on the ascii value of the character read

    B = B - '0'; // Subtracting ascii value of 0 from x.
    if(B == 0)
    {
      digitalWrite(12,LOW);
      Serial.print("Enable = ");
      Serial.println(B);
    }
    if(B == 1)
    {
      digitalWrite(12,HIGH);
      Serial.print("Enable = ");
      Serial.println(B);
    }
    while(!Serial.available())
    {}

    A = Serial.read(); // x would be an integer between 0 and 255
    // depending on the ascii value of the character read
    A = A - '0'; // Subtracting ascii value of 0 from x.

    if(A == 0)
    {
      digitalWrite(13,LOW);
      Serial.print("Input = ");
      Serial.println(A);
    }
    if(A == 1)
    {
      digitalWrite(13,HIGH);
      Serial.print("Input = ");
      Serial.println(A);
    }
  }
```

}

Observations

The truth table for the tri-state buffer is as follows:

Input	Enable	Output
0	0	MΩ (High Impedance)
1	0	MΩ (High Impedance)
1	1	5V
0	1	0V

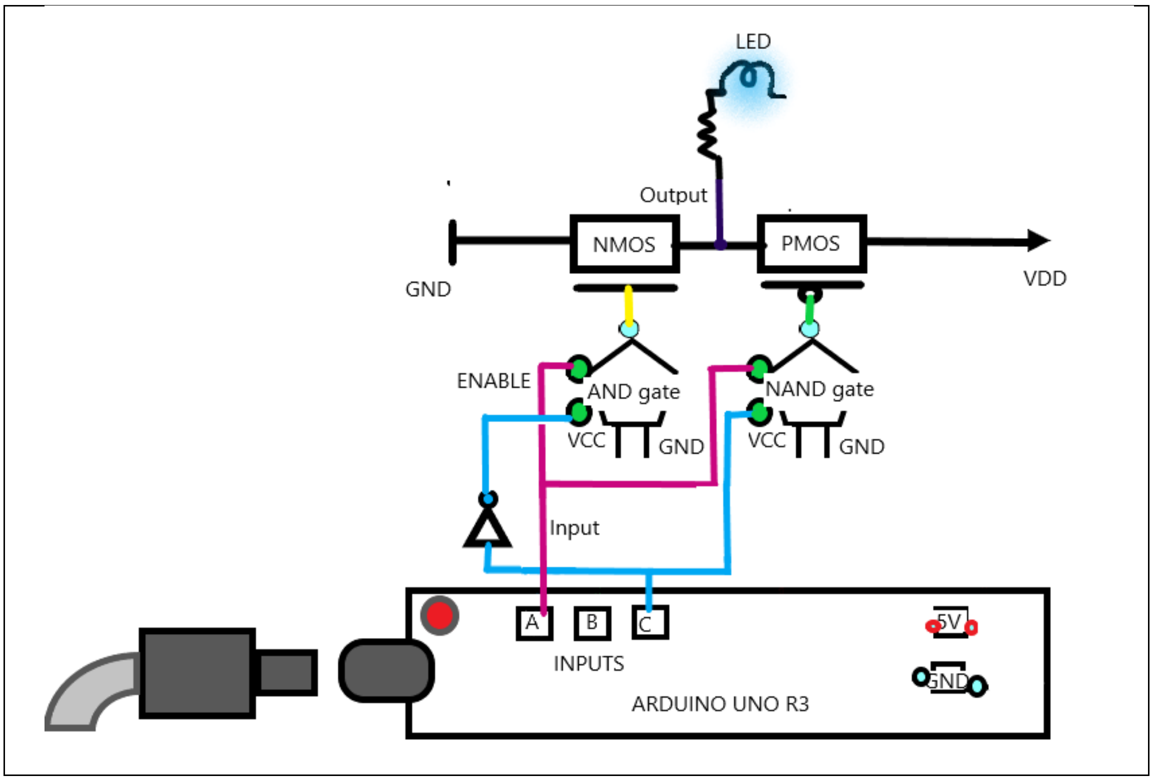
Conclusion

The tri-state buffer works as expected. It gives an output corresponding to the Input value when Enable is set to 1. When Enable is set to 0 it enters high impedance state where the input doesn't affect the output, the LED doesn't glow and the multimeter shows MΩ (High impedance) and the voltage output is 48.6mV.

Tinkercad link with circuit

https://www.tinkercad.com/things/lS4U33kh1ux-lab-8-part-a/editel?sharecode=9m__jErLqsAv0mXYa_1jd4TXE-idIIYt_a2VjBQHTFg

Circuit Diagram



Experiment Part B

Objective

To learn about Data flow using Tri state Buffers

Experiment setup/ procedure

Materials required:

4	Quad NAND gate
4	pMOS Transistor (MOSFET)
4	nMOS Transistor (MOSFET)
2	8-Bit Shift Register
1	Arduino Uno R3
8	1 kΩ Resistor
8	Red LED
2	Voltage Multimeter
1	Quad OR gate

Procedure:

● Take an input number (0-15) and send it to the first register (Recall Lab 6).

● Write code to enable the tristate buffers in order and correspondingly apply clock pulses to the second shift register such that the content from the first register is transferred.

Code:

```
int latchPin = 13;
```

```
//Pin connected to SH_CP of 74HC595
int clockPin = 12;
////Pin connected to DS of 74HC595
int dataPin = 11;

int latchPin2 = 9;
int clockPin2 = 10;

int a[4] = {0};

void setup() {
  //set pins to output because they are addressed in the main loop
  pinMode(latchPin, OUTPUT);
  pinMode(clockPin, OUTPUT);
  pinMode(dataPin, OUTPUT);
  pinMode(latchPin2, OUTPUT);
  pinMode(clockPin2, OUTPUT);
  pinMode(7, OUTPUT);
  pinMode(6, OUTPUT);
  pinMode(5, OUTPUT);
  pinMode(4, OUTPUT);
  digitalWrite(7,LOW);
  digitalWrite(6,LOW);
  digitalWrite(5,LOW);
  digitalWrite(4,LOW);
  Serial.begin(9600);
}
int i;
int A;
int j =0;
void loop()
{
 if(Serial.available() > 0)
 {
   A = Serial.parseInt();
   digitalWrite(latchPin, LOW);
   shiftOut(dataPin, clockPin, MSBFIRST ,A);
   //return the latch pin high to signal chip that it
   //no longer needs to listen for information
   digitalWrite(latchPin, HIGH);
   Serial.print("A = ");
   Serial.println(A);

   digitalWrite(latchPin2, LOW);
   for(i=0;i<4;i++)
   {
     a[i]=1;
     if(i>0)
     {
       a[i-1] = 0;
     }
     Copy();
     digitalWrite(clockPin2, LOW);
     digitalWrite(clockPin2, HIGH);



   }
   digitalWrite(latchPin2, HIGH);
   Erase();




 }
}
```

```
void Copy()
{
  digitalWrite(7,a[0]);
  digitalWrite(6,a[1]);
  digitalWrite(5,a[2]);
  digitalWrite(4,a[3]);
}
void Erase()
{

  for(i=0;i<4;i++)
  {
    a[i] = 0;
  }
}
```

Observations

Upon Entering an integer between 0 and 15 the corresponding integer is obtained in binary for as the Final Output from the Second Shift register.

Conclusion

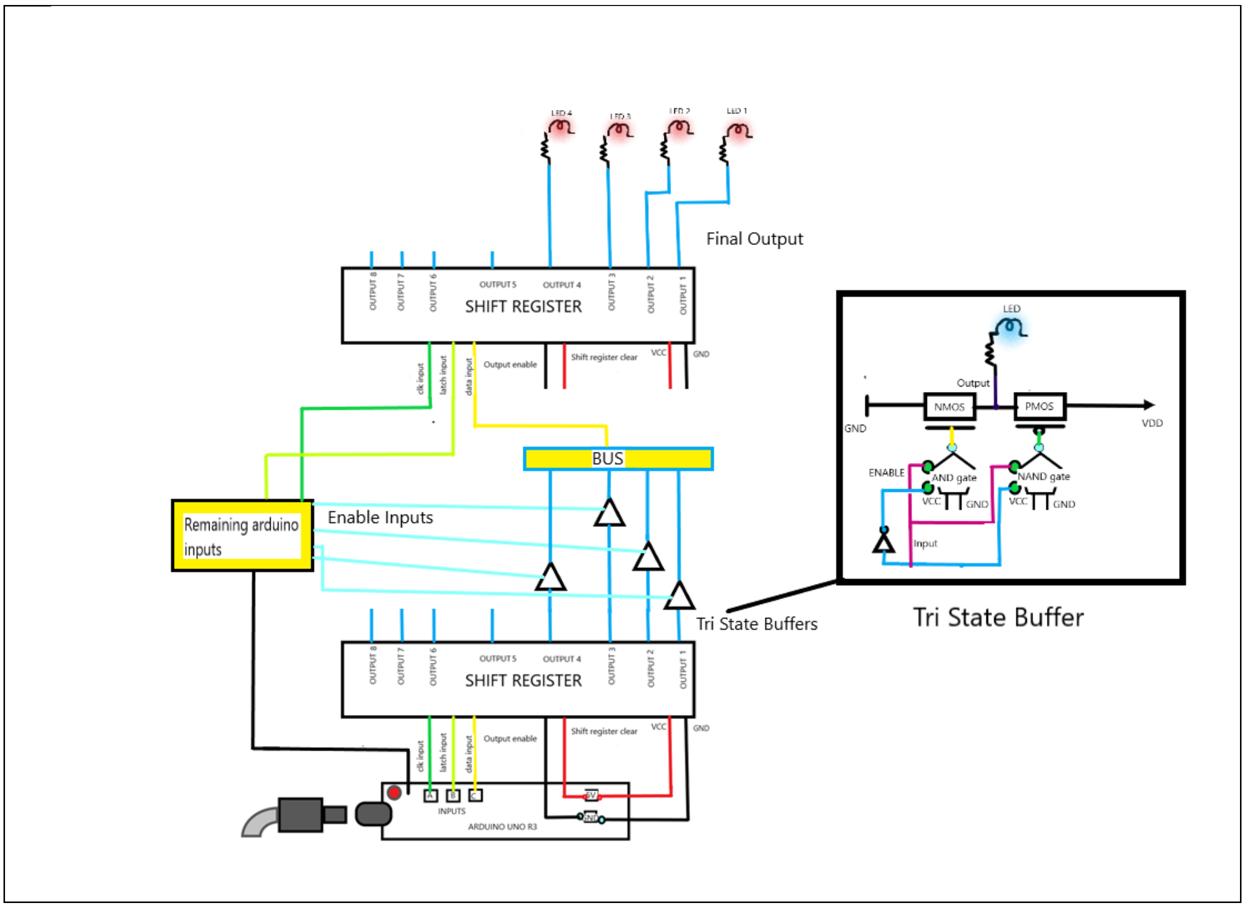
Successfully verified the function of the Tri state buffer and verified the flow of data flow using tristate buffer. The integer inputted to the first state buffer was obtained as the corresponding output of the second shift register. Hence the circuit is working as expected.

Tinkercad Link with Circuit

https://www.tinkercad.com/things/39EhLRM1y1a-lab-8-pat-b/editel?sharecode=BhTIh9-9cAIWVXKbSuxhsi7JpZSLn3btt-DZEHj7i5g

Please scroll down:

Circuit Diagram


LED 4
LED 3
LED 2
LED 1
Final Output
OUTPUT 8
OUTPUT 7
OUTPUT 6
OUTPUT 5
OUTPUT 4
OUTPUT 3
OUTPUT 2
OUTPUT 1
SHIFT REGISTER
clk input
latch input
data input
Output enable
Shift register clear
VCC
GND
BUS
Remaining arduino inputs
Enable Inputs
Tri State Buffers
INPUTS
5V
GND
ARDUINO UNO R3
LED
Output
GND
NMOS
PMOS
VDD
ENABLE
AND gate
NAND gate
VCC
GND
Input
Tri State Buffer