Logic Components

Module 3

UGTA - Corey Lancelotta

Key Takeaways

CONVENTIONS
Referencing Bits & Inputs/Outputs

MULTIPLEXER
Many to One

DEMULTIPLEXER
One to Many

ENCODER
Decimal to Binary

PRIORITY ENCODER
Decimal to Binary

DECODER
Binary to Decimal

CONVENTIONS

(MSB) Most Significant Bit (bit position with the greatest value)
- 0b**1**011
- 0b**1**1110

(LSB) Least Significant Bit (bit position with the least value)
- 0b11011**0**
- 0b10110**1**

4x1 Multiplexers have **4 Inputs** and **1 Output**

1x8 Demultiplexers have **1 Input** and **8 Outputs**

8x3 Encoders have **8 Inputs** and **3 Outputs**

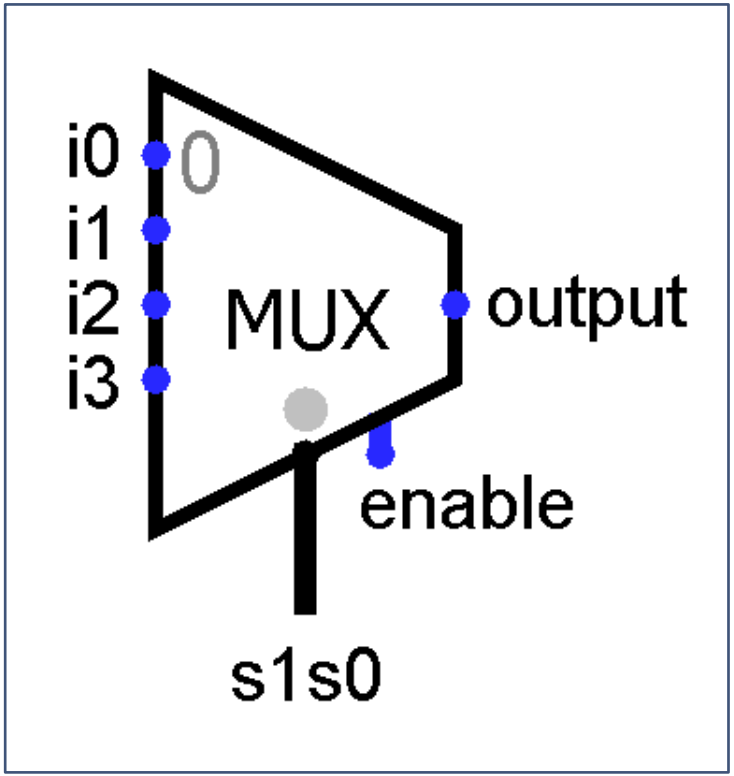
3x8 Decoders have **3 Inputs** and **8 Outputs**

DON'T FORGET!

1. MSB and LSB are **relative** and follow convention.
   - The **value** of the bit position dictates whether the MSB/LSB will be on the right or left.

2. When describing components:
   - The **First** number is the number of **Inputs**
   - The **Second** number is the number of **Outputs**

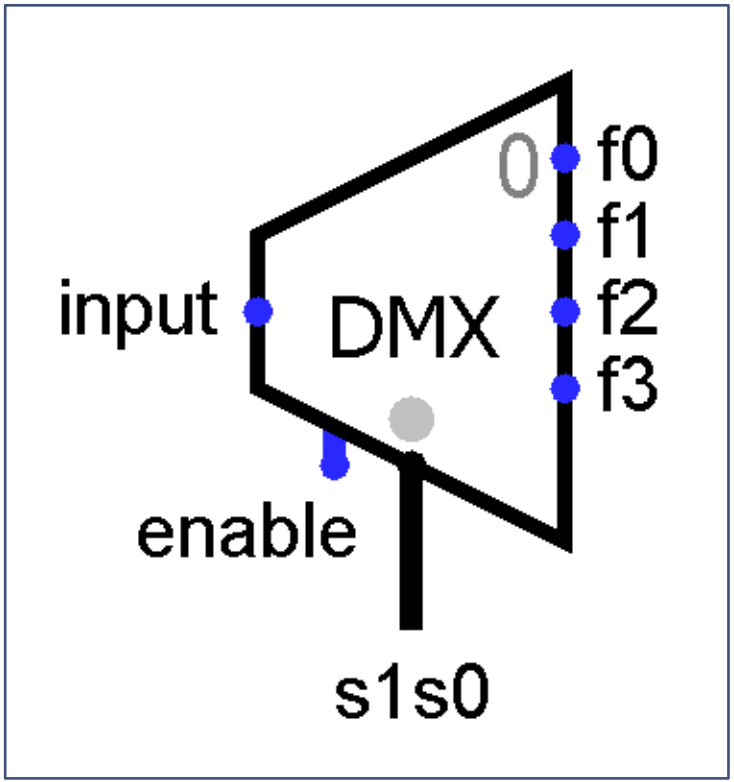
3. The 2^n relationship is everywhere.



WHAT TO REMEMBER?

1. Shortened to MUX.
2. Many inputs to One output.
3. Uses Select Bits with the following relationship:
   - n Select Bits allows for 2^n Inputs.
4. The decimal value of the binary select bits indicates which input is passed through to the output.
5. The value of the selected input is passed to the output.

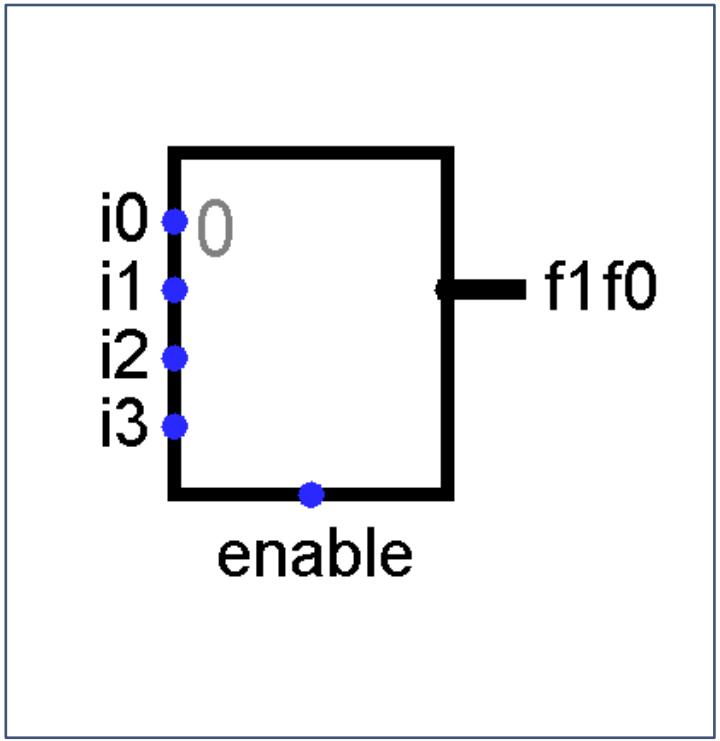
DEMULTIPLEXER



WHAT TO REMEMBER?

1. Shortened to DEMUX.
2. One input to Many outputs.
3. Uses Select Bits with the following relationship:
   - n Select Bits allows for 2^n Outputs.
4. The decimal value of the binary select bits indicates which output receives the input.
5. The value of the input is passed to the selected output.
6. All non-selected outputs have a value of 0.

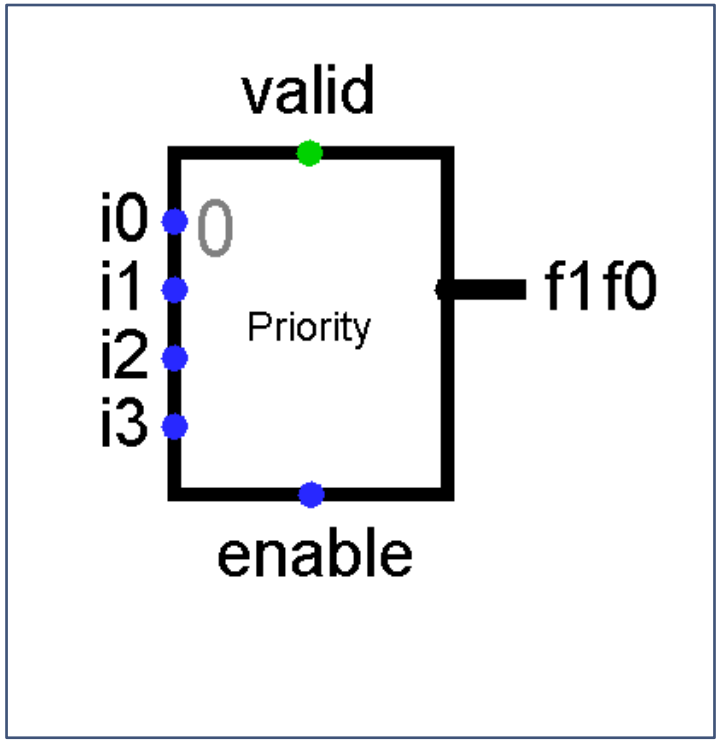
ENCODER



WHAT TO REMEMBER?

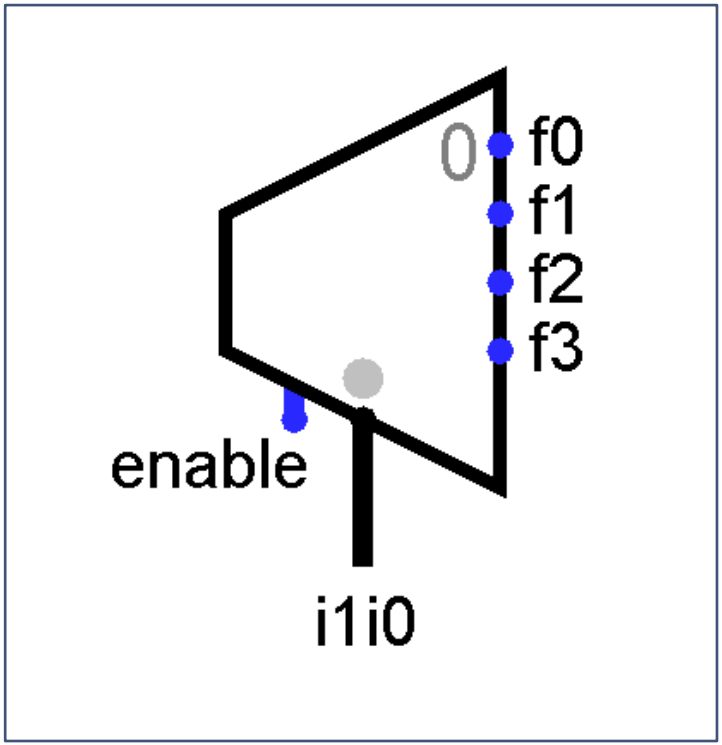
1. Converts Decimal to Binary.
2. Does not use Select Bits.
3. The number of Inputs/Outputs follows the relationship:
   - n Outputs are needed for 2^n Inputs.
4. The decimal index of the non-zero Input is converted to a binary number.
5. Only One Input can have a value of 1 and one of the inputs must have a value of 1.

PRIORITY ENCODER



WHAT TO REMEMBER?

1. Converts Decimal to Binary.
2. Does not use Select Bits.
3. The number of Inputs/Outputs follows the relationship:
   - n Outputs are needed for 2^n Inputs.
4. The decimal index of the highest bit position input with a value of 1 is converted to a binary number.
5. Many Inputs can have a value of 1 and all of the inputs could have a value of 0.
6. The Valid Bit distinguishes between the following:
   - All Inputs are 0
   - Only i0 is 1



WHAT TO REMEMBER?

1. Converts Binary to Decimal.
2. Does not use Select Bits.
3. The number of Inputs/Outputs follows the relationship:
   - n Outputs are needed for 2^n Inputs.
4. The binary value of the Input is converted to a decimal index which dictates which Output will equal 1.
5. All other outputs will have a value of 0.

Practice Problems Questions

1. How many **Select Bits** are needed for a Multiplexer with **14 Inputs**?
2. A Multiplexer has **4 Select Bits** and we want to feed in **31 Inputs**. Is this possible?
3. How many **Select Bits** are needed for a Demultiplexer with **255 Outputs**?
4. A Demultiplexer has **6 Select Bits** and we want to send our Input to **65 Outputs**. Is this possible?
5. The **Inputs** of an Encoder are **i3 = 0**, **i2 = 0**, **i1 = 1**, **i0 = 0**. How many **Outputs** does it have and what are the **values** of the outputs?
6. The **Outputs** of an Encoder are **f2 = 1**, **f1 = 1**, **f0 = 0**. How many **Inputs** does it have and what are the **values** of the inputs?
7. The **Inputs** of a Priority Encoder are **i3 = 0**, **i2 = 1**, **i1 = 1**, **i0 = 1**. Is this **valid**? If so, what is the **Output**? What is the **value** of the **Valid Bit**?
8. The **Inputs** of a Priority Encoder are **i3 = 0**, **i2 = 0**, **i1 = 0**, **i0 = 1**. Is this **valid**? If so, what is the **Output**? What is the **value** of the **Valid Bit**?
9. You need to decode the number **0b1011**. Identify the values of the **A** and **B** for the **A**x**B** Decoder that you would use.
10. The **Outputs** of a Decoder are **f3 = 0**, **f2 = 0**, **f1 = 0**, **f0 = 1**. What was the **Input**?

Practice Problems Answers

1. 3 Select Bits can support 8 Inputs and 4 Select Bits can support 16 Inputs. Therefore, **we need at least 4 Select Bits**.
2. 4 Select Bits can only support 16 Inputs. Therefore, **we can't support 31 Inputs**.
3. 7 Select Bits can support 128 Outputs and 8 Select Bits can support 256 Outputs. Therefore, **we need 8 Select Bits.**
4. 6 Select Bits can only support 64 Outputs. Therefore, **we can't support 65 Outputs**.
5. In order to encode 4 decimal numbers, **we need 2 outputs**. We are encoding the decimal number 1 (**since i1 = 1**) into binary, so the output will be **f1f0 = 01**.
6. This Encoder is outputting a 3-Bit binary number. Therefore, we can encode 8 values and thus it has **8 Inputs**. Since we encoded the decimal value of 6, the inputs would be **i7 = 0, i6 = 1, i5 = 0, i4 = 0, i3 = 0, i2 = 0, i1 = 0, i0 = 0**.
7. A Priority Encoder can receive multiple inputs with a value of 1, so **this is valid** and the valid bit would be **v = 1**. We are encoding the highest decimal-valued bit that has a value of 1, so we encode the decimal value 2 (**since i2 = 1**) into binary. Therefore, the output is **f1f0 = 10**.
8. Yes, **this is valid** and the valid bit is **v = 1**. We are encoding the decimal value 0 (**since i0 = 1**) into binary. Therefore, the output is **f1f0 = 00**.
9. We have a 4-Bit binary number. This means we need 16 outputs to cover all possible decimal values. Thus, we have a **4x16 Decoder**.
10. The output of a Decoder is the decimal representation of the binary number that was decoded. Our output is the decimal value 0, so our input must have been **i1i0 = 00**.