Chapter 1

Types, Selection, and Applications of Microcontrollers

Lesson 1

Numbering and Coding Systems

1. Logic 0 and 1

Logic 1 and 0 in a TTL logic circuit

- **State 1**

5 V >V > 2.8 V at output;

Current in it between collector and emitter is OFF

- **State 0**

0.8 V >V > 0 V at output;

Current in it between collector and emitter is ON

Logic 1 and 0 in a CMOS logic circuit

- **State 1**

V_{DD} >V > 2/3 V_{DD} at output; V_{SS} = 0

- **State 0**

1/3 V_{DD} >V > 0 at output; VSS = 0

2. Binary Representation of Numbers

Number and Binary Representations

- A number can be represented by a set of 8 logic states
- 00000000 represents decimal 0,
- 00000001 represents decimal 1,
- .
- .
- 11111111 represents decimal 255,

A Representation

- 4-bit 0000 represent 0_d,
- 8-bit 1111 0000 represent 240_d,
- 16-bit 0000 0001 1111 0000 represent 596_d,
- 32-bit 1000 0000 0000 0001 0000 0001 1111 0000 represent $(2^{31} + 2^{16} + 596)_d$

3. Binary Representation of Positive and Negative Numbers

Number and 4-bit Binary Two's complement Representation

- A two's complement number represents a set of logic states
- 0000 represent decimal 0,
- 0001 represent decimal 1,
- .
- 0111 represent decimal 7
- 1000 represent decimal –8,

Number and a 4-bit Binary Two's complement Representation

- A number represents a set of logic states
- 1001 represent decimal –7,
- 1010 can represent decimal –6,
- .
- .
- 1110 can represent decimal –2
- 1111 can represent decimal –1

Number and 8-bit Binary Two's complement Representation

- A number represents a set of logic states
- 00000000 represent decimal 0,
- 00000001 can represent decimal 1,
- .
- 01111111 can represent decimal 127
- 1000 0000 can represent decimal –128,

Number and Binary Two’s complement Representation

- A number represents by a set of logic states
- 10000001 represent decimal –127,
- 10000010 represent decimal –126,
- .
- .
- 11111110 represent decimal –2
- 11111111 represent decimal –1

Two's Complement Representation

- 4-bit 0000 represent 0_d,
- 8-bit 1111 0000 represent – 16_d,
- 16-bit 0000 0001 1111 0000 represent 596_d,
- 32-bit 1111 1111 1111 1111 1111 1111 1111 1111 represent – 1_d

4. Hexadecimal Representation of decimal Numbers

Number and hexadecimal Representation

- A number represents a set of logic states
- 00_H represent decimal 0,
- 01_H can represent decimal 1,
- .
- FE_H can represent decimal 254,
- FF_H can represent decimal 255,

A Representation

- 0_h represent 0_d,
- $F0_h$ represent 240_d,
- $01F0_h$ represent 596_d,
- $100101F0_h$ represent $(2^{28} + 2^{16} + 596)_d$

5. Hexadecimal Representation of Positive and Negative Numbers

Number and Hexadecimal Two's complement Representation

- 8-bit number = 1 Byte. Two nibbles = One byte A nibble number represents a set of 4 logic states (4-bit number)
- 00_h represent decimal 0 (Two nibbles/One byte)
- 01_h represent decimal 1 (Two nibbles/One byte)
- .
- $7F_h$ represent decimal 127 (Two nibbles/One byte)
- 80_h represent decimal –128 (Two nibbles/One byte)

Number and Binary Two's complement Representation

- A hex-number represents a set of logic states
- 81_h represent decimal –127 (Two nibbles/One byte)
- 82_h represent decimal –126 (Two nibbles/One byte)
- .
- FE_h represent decimal –2 (Two nibbles/One byte)
- FF_h represent decimal –1 (Two nibbles/One byte)

Two's Complement Representation

- 0_h represent 0_d,
- $F0_h$ represent – 16_d,
- $01F0_h$ represent 596_d,
- $FFFFFFFF_h$ represent – 1_d

6. ASCII Representation of Characters

ASCII Code Number Representation

- ASCII Code represents a set of 8 logic states
- 41_h — ASCII Code of A
- 42_h — ASCII Code of B
- .
- 61_h — ASCII Code of a
- 62_h — ASCII Code of b
- Refer Appendix A for ASCII codes

Summary

We learnt

- Binary number system
- Two's complement number for +ve and –ve signed numbers
- Hexadecimal number system
- ASCII code