

Efficient Digital Binary Calculator using Arduino Uno

Palash Jain¹, Jay Kumar Jain² and Minali Gupta³

¹VIT University, Bhopal, India

Email: palash1789@gmail.com

²SIRT, Bhopal, India

Email: jayjain.research@gmail.com

³Robert Bosch, Bangalore, India

Email: minaligupta634@gmail.com

Abstract—This paper represents a three-bit binary calculator which performs three-bit binary logical operations like AND, OR, NAND, NOR, XNOR, XOR, and other operations like binary addition, subtraction, and comparison of two binary numbers. The components used in this device are Arduino Uno, an LCD display, and a numeric keypad. The Arduino is used to program the device, the numeric keypad is used for giving inputs and the LCD display is used to show output. The device will be useful in a laboratory and educational institutions.

Index Terms— Arduino Uno, Keypad, LCD, Binary.

I. INTRODUCTION

Digital electronic is a type of electronic that make use of Boolean logic which is represented by logic gates. Information is easy to store in digital than in analog ones. In digital electronics, any number represented in base 2 formats is called a binary number [1]. The binary system consists of two symbols 0 and 1. A binary system is most widely used in modern computers and other electronic circuits. For a more precise representation of a signal, we can use more binary numbers to represent it [2]. Digital circuits are circuits that are made up of analog components.

II. HARDWARE DESIGN

A. Structure of Arduino Uno

Introduction: There are a wide variety of Arduino boards available. We have used Arduino Uno. The Arduino Uno is a microcontroller board that consists of ATmega328. The device operates between 1.8-5 volts. The Arduino Uno consists of 14 digital input/output pins, 6 analog inputs, a USB connection, a power jack, and a reset button. We only need to connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

Power: we can give power to the Arduino using the USB connection or with an external power supply.

Input/Output: Each of the 14 digital pins on the Arduino can be used as an input or output. This can be done using the pin Mode (), digital Write () and digital Read () functions [5].

B. Liquid crystal display

A liquid crystal display works by using the light modulating properties of liquid crystals. The LCD is made up of

a grid of pixels and these are arranged into smaller grids that make up the characters. A typical 16x2 LCD will have 16 character grids in two rows. Each character grid is made up of 5 pixels wide by 8 pixels high. LCDs are displays used in calculators and alarm clocks. Many Arduino projects involve LCDs.

- The LCD used in this device is a 16*2 LCD. It consists of 16 pins [8].
- A register selects (RS) pin that controls where we are writing data to.
- A Read/Write (R/W) pin that selects the LCD will operate in ready mode or write mode.
- An Enable pin which allows to write in the registers.
- 8 Data pins (D0-D7) which shows the bits we are writing or reading. [6].

C. Numeric Keypad

A keypad is generally used to provide input to any system. A 16 buttons keypad has been used for this device. It has 4 rows and 4 columns. Under each button, there is a membrane switch. Pressing a button will short the corresponding row and column to create a path for the current to flow. The keys of the keypad are defined as below:

1(binary one), AND, OR, XOR (exclusive OR), NAND, NOR, XNOR (exclusive NOR), COMP(Comparator), ADD (Binary addition), CLR(Clear), 0(binary zero), = (Equal), SUB (binary subtraction) and 0 (binary zero).

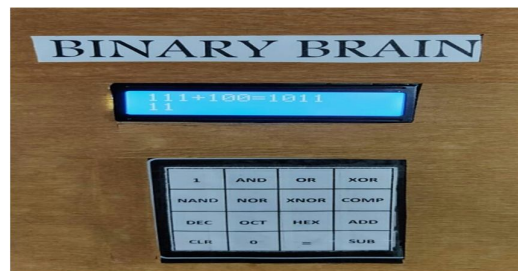


Figure 1. Binary Brain

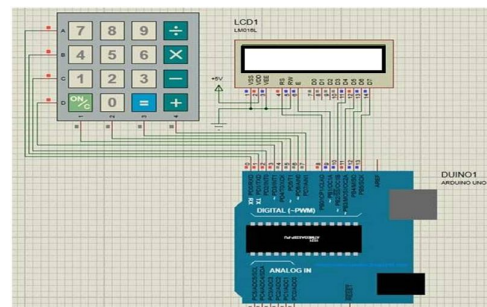


Figure 2. Circuit Diagram

III. SOFTWARE

Arduino environment is open-source and easy to use. It is written in Java and based on Processing another open-source software. It runs on various platforms such as Windows, Mac OS X, and Linux. Arduino software also helps in compiling and uploading programs to the Arduino board with a single click. A program or code written is known as a "sketch". Arduino sketches are written in C or C++. The Arduino integrated development environment (IDE) consists of a software library which is called as wiring that makes many common input/output operations much easier [7].

IV. SYSTEM IMPLEMENTATION

A. Methodology

The numeric keypad and LCD are interfaced with the Arduino Uno. The numeric keypad is used to enter the binary numbers. The LCD is used to show the output first the user will enter a binary number and that value will be stored in the microcontroller in some register A and the LCD will display it, then the user will enter the key corresponding to the operation he wants to perform on the binary numbers after which he will enter second

binary number through the keypad which will be stored in microcontroller register B. Then the user will press equal to key. As soon as he presses “=” the microcontroller will perform the operation which the user wanted to perform and it will give the output and the corresponding output will be shown by the LCD [9].

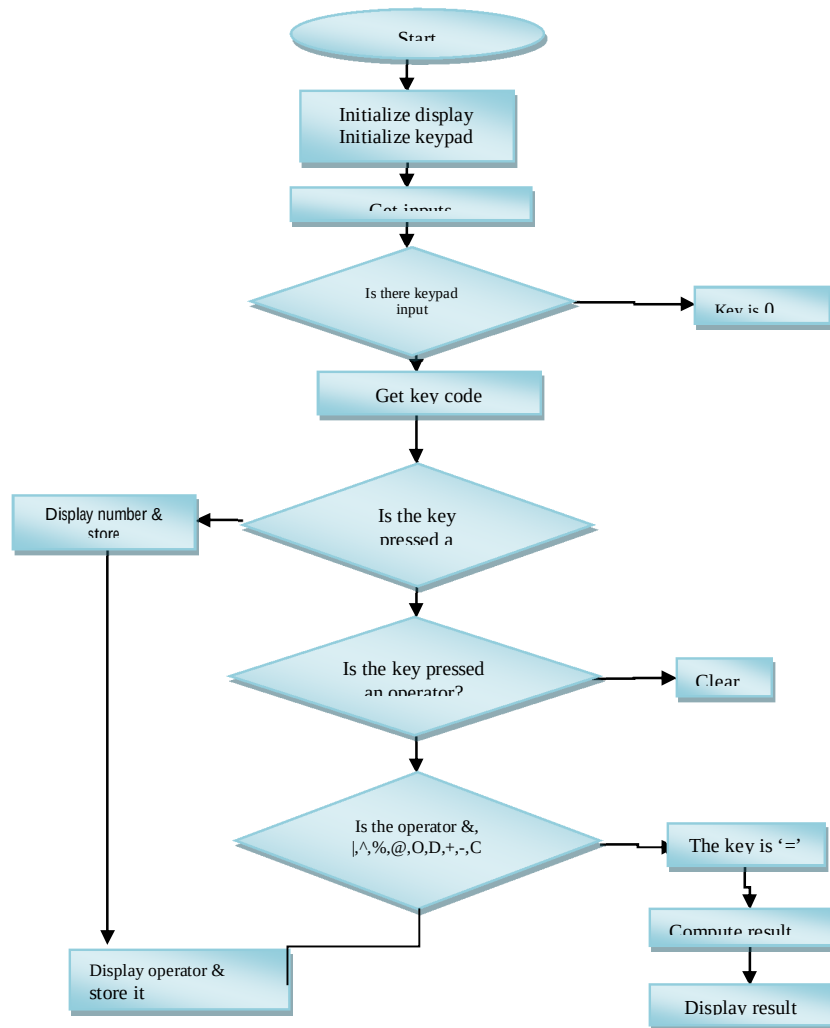


Figure 3. Flowchart

V. RESULTS AND DISCUSSION

We have used following symbols as operators:

TABLE I. SYMBOLS USED AS OPERATORS

Name	Symbols
AND gate	&
OR gate	
XOR gate	^
NAND gate	%
NOR gate	@
XNOR gate	\$
Comparator	/
Addition	+
Subtraction	-

Following are some observations:

A. AND gate operations



Figure 5. OR operation

The above figure shows three-bit OR operation of two binary numbers 11 and 11. The symbol | is for OR operation. The number on the RHS is the result of the operation (11). In the next row the number is the decimal equivalent of the answer.

B. XOR Operations

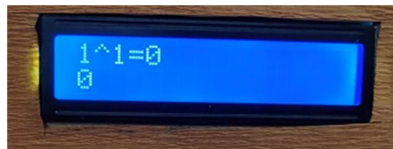


Figure 6. XOR operation

The above figure shows one bit XOR operation of two binary numbers 1 and 1. The symbol ^ is for XOR operation. The number on the RHS is the result of the operation. In the next row the number is the decimal equivalent of the answer.

C. XNOR Operations

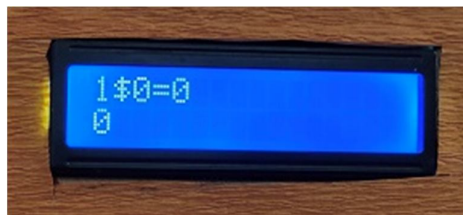


Figure 6. XNOR operation

The above figure shows one bit XNOR operation of two binary numbers 1 and 0. The symbol \$ is for XNOR operation. The number on the RHS is the result of the operation. In the next row the number is the decimal equivalent of the answer.

D. NAND Operation



Figure 7. NAND operation

The above figure shows one bit NAND operation of two binary numbers 1 and 0. The symbol % is for NAND operation. The number on the RHS is the result of the operation. In the next row the number is the decimal equivalent of the answer.

E. NOR Operations



Figure 8. NOR operation

Above figure shows one bit NOR operation of two binary numbers 1 and 1. The symbol @ is for NOR operation. The number on the RHS is the result of the operation. In the next row the number is the decimal equivalent of the answer.

F. Comparison



Figure 9. 2 Bit Comparison

Above figure shows comparison between two binary numbers 11 and 10. The symbol / is for comparison. The number on the RHS is the result of the operation.

G. Binary Subtraction:



Figure 10. 2 Binary Subtraction

Above figure shows subtraction operation of two binary numbers 111 and 11. The symbol - is for subtraction. The number on the RHS is the result of the operation. In the next row the number is the decimal equivalent of the answer.

H. Binary Addition



Figure 11. 2 Binary Addition

Above figure shows two bit AND operation of two binary numbers 11 and 10. The symbol & is for AND operation. . The number on the RHS is the result of the operation. In the next row the number is the decimal equivalent of the answer.

VI. CONCLUSION

Our device verifies all the logical operations, binary addition, subtraction, comparison and conversion of binary number into other bases. Our device is a very versatile and portable device which can be used in educational institutes for students.

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