



DIGITAL SYSTEMS AND MICROCONTROLLERS

Experiment - 1

Monsoon 2025

Familiarisation with Digital Test Kit and Binary Logic Levels

This laboratory session will be devoted to (i) getting conversant with the features of the Digital Test Kit to be used for this course, and (ii) using this Test Kit to understand the implications of binary logic levels.

Digital Test Kit:

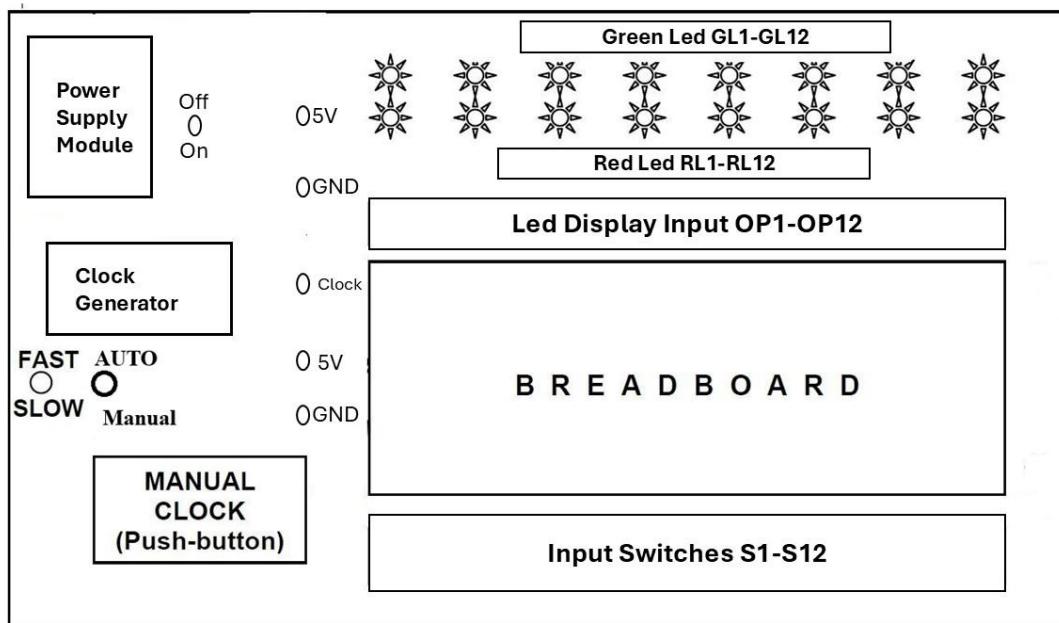


Fig. 1.1 Features of the Digital Test Kit

Fig.1 Features of the Digital Test Kit

This Digital Test Kit has been specially designed at IIIT for this course. Its broad layout and features are shown in Fig. 1. As digital circuits are required to handle just two levels of voltage – to represent the two possible values of any binary variable, functional testing of simple digital circuits can be conveniently carried out by applying each input (binary) variable through a switch and observing each output (binary) variable on a simple LED display. In this kit, 12 Input Switches and 12 LED Displays have been provided, enabling one to apply up to 12 input (binary) variables and to observe up to 12 output (binary) variables. Each Input Pin (S1-S12) is either at LOW (\equiv Ground \cong 0V.) level or at a HIGH (\cong 5V.) level depending on whether the corresponding switch is OFF or ON. Each LED Display circuit consists of a Red LED (RL1-RL12) and a Green LED (GL1-GL12); the Red LED glows when the corresponding Display input Pin (OP1-OP12) is at a HIGH level and the Green LED glows when it is at a LOW level. For accurate detection of HIGH and LOW levels, the design ensures that none of the LEDs glows either if the display input lies in between (neither HIGH nor LOW) or if it is left open.



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All circuits we will study in this course will need a 5V DC power supply, and this has been provided in the Digital Test Kit. The ON/OFF switch on the left side controls the VCC supply to the Clock Generator and the Breadboard area.

The Clock Generator provides a continuously running clock when switch Auto/Manual is at Auto at Clock pin, which can run either at a slow (≤ 1 pulse per sec) speed or at a fast (≥ 1000 pulses per sec) speed, as selected by the SLOW/FAST switch on the left side. It also provides a MANUAL CLOCK at Clock pin when switch Auto/Manual is at Manual, which is normally at LOW level and goes HIGH when the Push-button is pressed. Observations using FAST Clock would require other instruments (e.g. a DSO).

The circuit to be studied will have to be assembled on the breadboard. Fig.2 shows the schematic of the breadboard. It has 128 vertical strips, 64 on each side of the horizontal divider in the middle, each strip consisting of 5 spring-loaded tie-points internally connected to another. Each connection among the circuit components is made with the help of tie-points connected together on the same strip. The breadboard also has 8 horizontal strips, four on the top side and 4 on the bottom side, each having 25 tie points. These strips are generally used for making power supply connections.

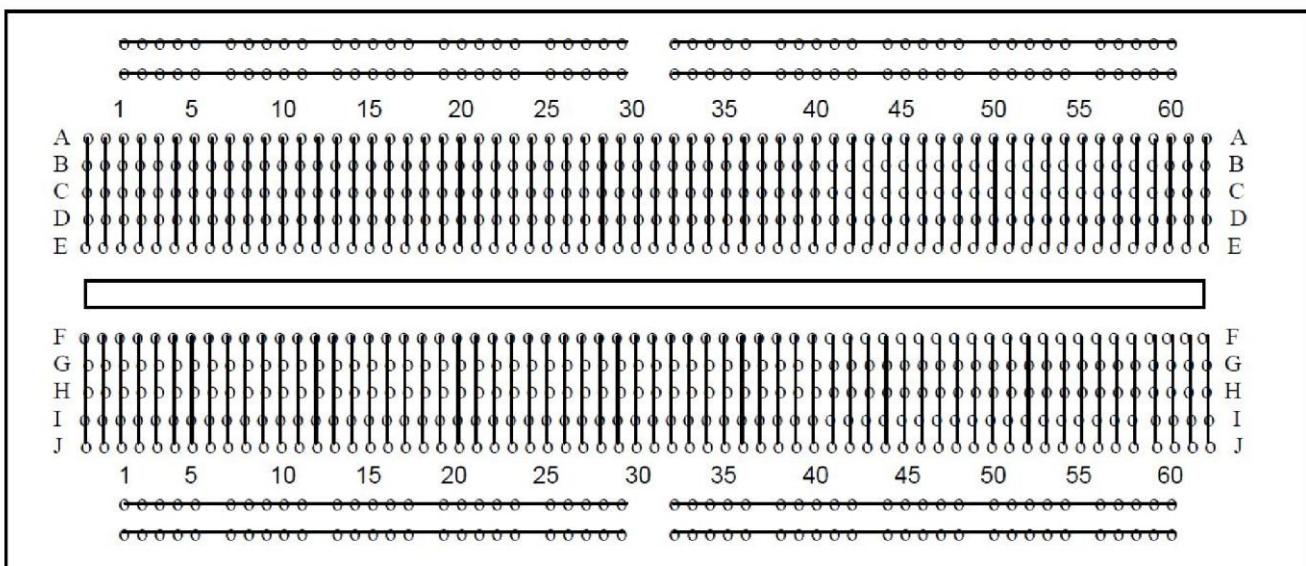


Fig.2 BreadBoard Schematic



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Experiment-1:

1. Get familiar with the schematic and the usage of the breadboard. Get a feel for the proper grip of the wire inserted into a tie-point.
2. Put the Clock control switch in the FAST position and switch on the VCC supply. Note that the CLK-R LED starts glowing. Using the Digital Multimeter in the DC VOLTAGE mode, measure and note the voltage between the VCC and GND pins.
3. Verify the working of all the Input Pins IP1-IP12 by measuring the voltages at these pins for both positions of the Input Switches. Verify the working of all the LED displays by applying an input from one of the Input Pins to DP1-DP8 and observing the LEDs as the Input is switched.
4. Implementation of NOT Gate - NOT gates are simply inverters. They simply invert the input logic for the output. Here we are going to use 7404 IC for demonstration. This IC has 6 NOT gates in it. These SIX gate are connected internally as shown in the figure.

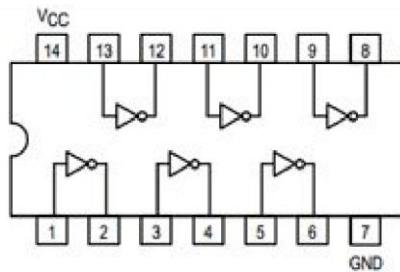


Fig.3 NOT Gate IC 7404

5. Setup the circuit by following the steps

- Connect the VCC and Gnd pins of the IC to the VCC and Gnd lines on the top and the bottom of the breadboard, using RED and BLACK wires respectively.
- Connect the input pin of any one gate in the IC to one of the IP1-IP12 input switches, and the corresponding output pin of the IC to one of the DP1-DP8 display points provided in the Test Kit.

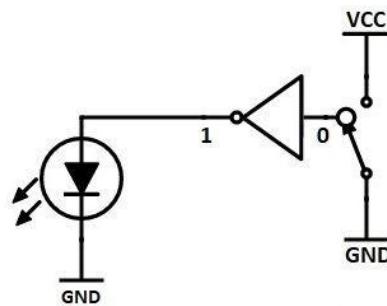


Fig.4 Circuit Diagram



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Experiment-2:

This will be the first experiment that deals with microcontrollers. In this experiment you are supposed to learn how to write and compile C code for ATMega328P in Arduino ISP . In addition you will dump this file into the microcontroller, run the program and observe its output. The experiment is to output "Hello World" on the serial monitor if the output of the NOT gate is 1 and nothing if the NOT gate output is 0.

(PCINT14/RESET) PC6	<input type="checkbox"/> 1	28	<input type="checkbox"/> PC5 (ADC5/SCL/PCINT13)
(PCINT16/RXD) PD0	<input type="checkbox"/> 2	27	<input type="checkbox"/> PC4 (ADC4/SDA/PCINT12)
(PCINT17/TXD) PD1	<input type="checkbox"/> 3	26	<input type="checkbox"/> PC3 (ADC3/PCINT11)
(PCINT18/INT0) PD2	<input type="checkbox"/> 4	25	<input type="checkbox"/> PC2 (ADC2/PCINT10)
(PCINT19/OC2B/INT1) PD3	<input type="checkbox"/> 5	24	<input type="checkbox"/> PC1 (ADC1/PCINT9)
(PCINT20/XCK/T0) PD4	<input type="checkbox"/> 6	23	<input type="checkbox"/> PC0 (ADC0/PCINT8)
VCC	<input type="checkbox"/> 7	22	<input type="checkbox"/> GND
GND	<input type="checkbox"/> 8	21	<input type="checkbox"/> AREF
(PCINT6/XTAL1/TOSC1) PB6	<input type="checkbox"/> 9	20	<input type="checkbox"/> AVCC
(PCINT7/XTAL2/TOSC2) PB7	<input type="checkbox"/> 10	19	<input type="checkbox"/> PB5 (SCK/PCINT5)
(PCINT21/OC0B/T1) PD5	<input type="checkbox"/> 11	18	<input type="checkbox"/> PB4 (MISO/PCINT4)
(PCINT22/OC0A/AIN0) PD6	<input type="checkbox"/> 12	17	<input type="checkbox"/> PB3 (MOSI/OC2A/PCINT3)
(PCINT23/AIN1) PD7	<input type="checkbox"/> 13	16	<input type="checkbox"/> PB2 (SS/OC1B/PCINT2)
(PCINT0/CLKO/ICP1) PB0	<input type="checkbox"/> 14	15	<input type="checkbox"/> PB1 (OC1A/PCINT1)

Familiarisation with Arduino:

1. Download the given code and open it using Arduino ISP.
2. Compile the code and check for errors.
3. In 'Tools section' select the 'Board' Type and the corresponding 'PORT'.
4. Make the necessary connections and dump the code on to the microcontroller.
5. Check for the output on the Serial Monitor.

Connect the output of the circuit in "Part A" to any one of the 14 digital pins of Arduino and check the output(s) for the various combination of inputs on the Serial Monitor.