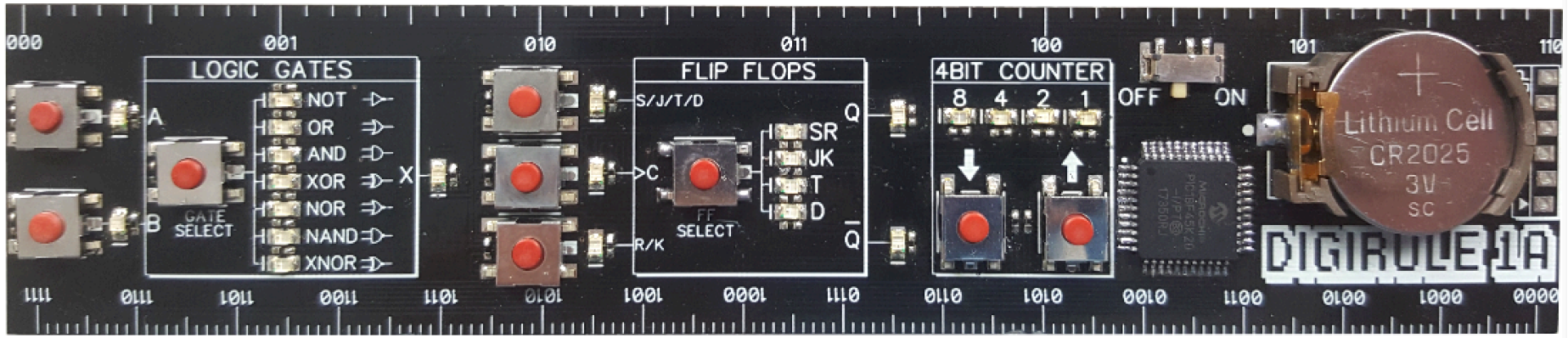
DIGIRULE 1A



USER MANUAL

DESCRIPTION

The Digirule 1A is an interactive – 15cm (6”) PCB ruler which features seven in-built logic gates, four flip flops and a 4-bit binary counter which is all powered by an 8-bit Microchip PIC18F45K20 microcontroller. The Digirule 1A is completely open source and full details and downloads can be found at the following link:

https://bradsprojects.com/the-digirule/

NOTE

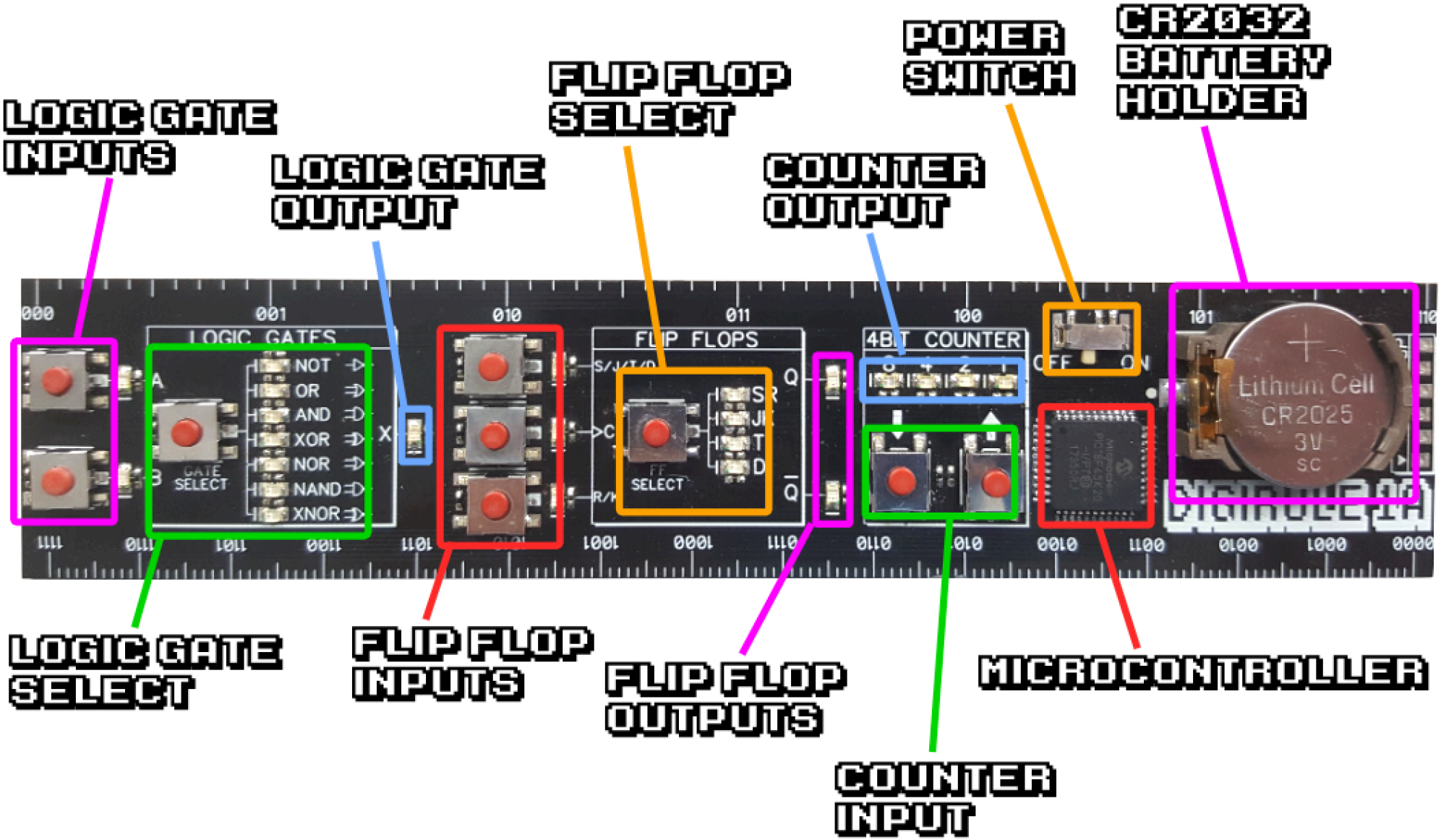
The Digirule 1A is an updated version of the original Digirule 1. In terms of hardware - the updated version 1A features new and improved buttons, the surface mount component footprints have been removed, new logos have been added and finally – an auxiliary pad has been included to line up with the pinout of Microchip PICkit 2 and 3 programmers.

The Digirule 1A source code has been completely re-written in C by Brent Hauser and he has been kind enough to make it freely available to everyone as open source. The functionality is essentially the same, but now features a cool startup animation, device reset functionality and an improved bonus menu system.

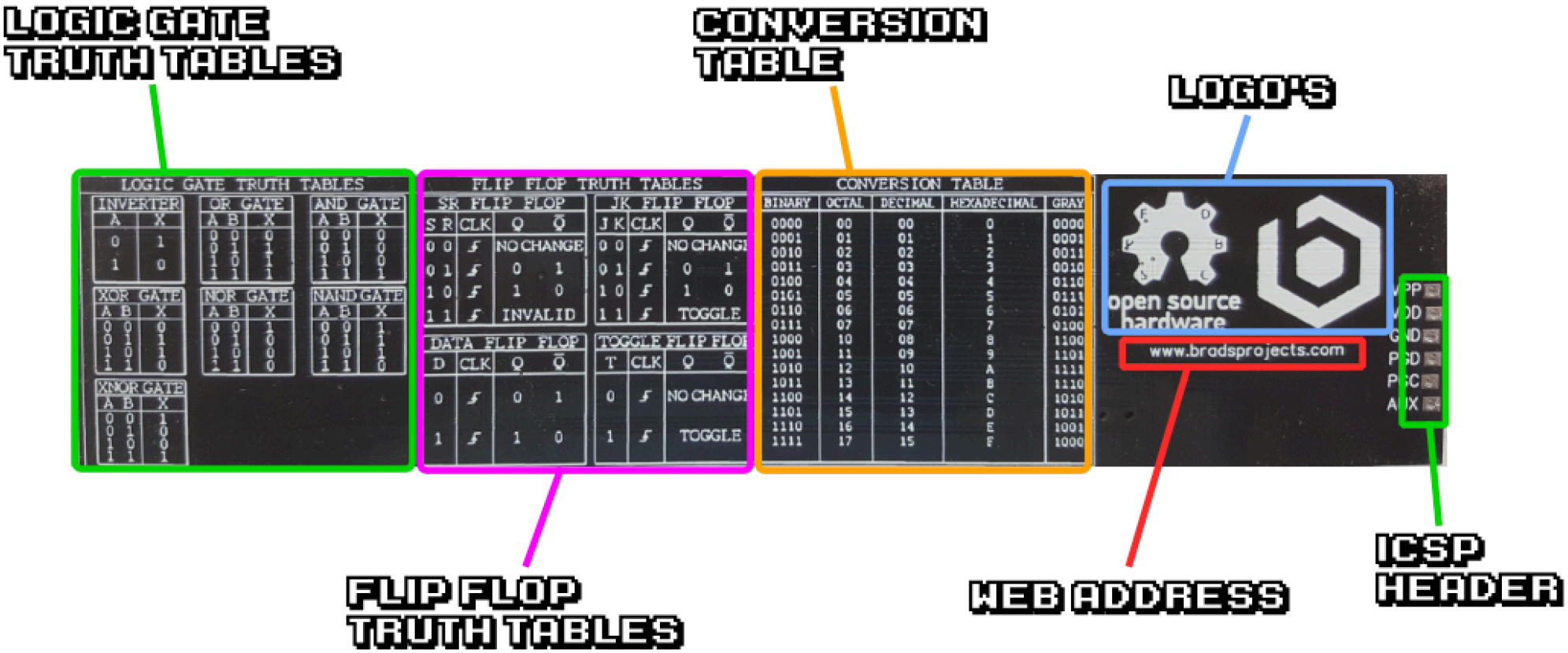
The Digirule 1A firmware may be downloaded from the webpage above and can be uploaded to a Digirule 1 by using an ICSP programmer such as a PICkit 2 or 3.

DIGIRULE 1A OVERVIEW

The top of the Digirule 1A contains the buttons, power switch, battery, microcontroller and LED's:

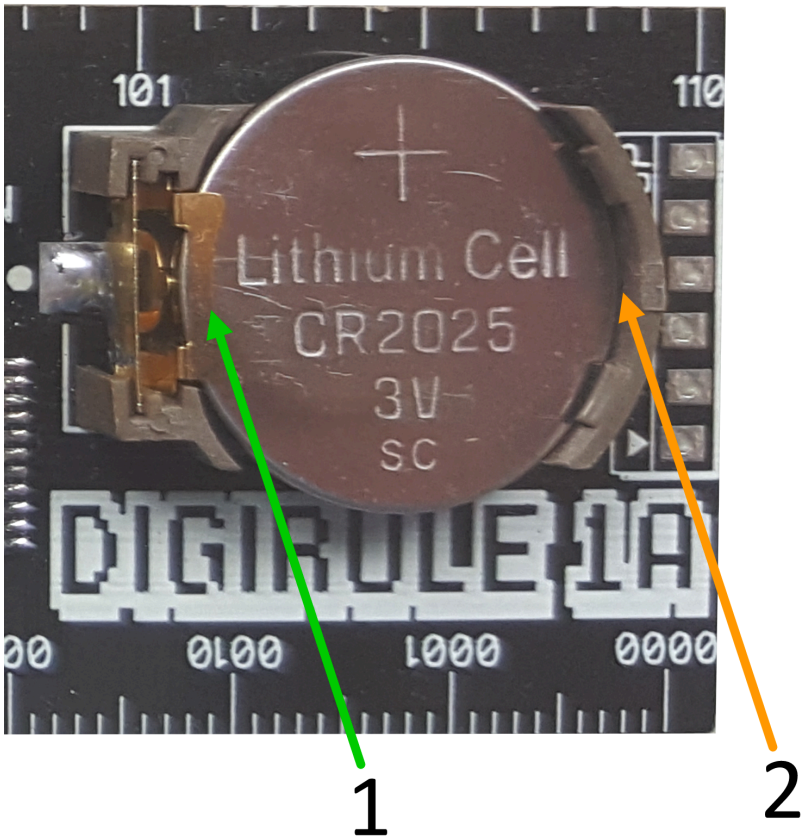


The Rear of the Digirule 1A contains logic gate and flip flop truth tables, a binary, hexadecimal, decimal and gray code conversion chart, logo's and a 6-pin In Circuit Serial Programming (ICSP) header:



INSERTING THE BATTERY

It is important that care be taken when installing the CR2032 battery. Ensure the battery has the positive label facing up (away from the Digirule 1A) and the battery is slotted under the metal tab FIRST and then pressed down to be held by the plastic tabs. Failing to follow this procedure may result in damage to the metal tab.



FEATURES AND SPECIFICATIONS

- 8-bit PIC18F45K20 Microcontroller
- Powered by a 3V CR2032 coin cell battery
- Seven logic gates:
    - Not Gate
    - Or Gate
    - And Gate
    - Xor Gate
    - Nor Gate
    - Nand Gate
    - Xnor Gate
- Four flip flops (all positive edge triggered):
    - SR Flip Flop
    - JK Flip Flop
    - Toggle Flip Flop
    - Data Flip Flop
- 4-bit binary counter
- Eight bonus modes of operation:
    - Mode 2 (Binary 0010) – All functions remain the same except the counter is now a gray code counter
    - Mode 3 (Binary 0011) – Sparkly LED's
    - Mode 4 (Binary 0100) – Seven-Bit Serial-In Shift Register
    - Mode 5 (Binary 0101) – LED Test
    - Mode 6 (Binary 0110) – Persistence of Vision (POV) Display
    - Mode 7 (Binary 0111) – Binary Dice
    - Mode 8 (Binary 1000) – Catch-the-XOR Game
    - Mode 9 (Binary 1001) – 4-bit Logic Unit

USING THE DIGIRULE 1A

Standard Mode.
To enter the standard mode of operation, simply turn the DigiRule on with the slide switch without pressing any other buttons.

Logic Gates
The gate select button enables you to cycle through the seven different logic gates. The truth table on the rear of the DigiRule shows the X output for a given input on the 'A' and 'B' buttons. For example, if you were to select the AND Gate you will notice that the only combination of inputs for 'A' and 'B' to give a logic 1 at output 'X' is the combination of '11'.

1. Select your desired logic gate with the gate select button.
2. Input your combination of 1's and 0's on the Logic Gate's 'A' and 'B' inputs.
3. The output LED 'X' will light up whenever the output is true for the given input (see the reverse side of the DigiRule for the logic gate truth tables.)
4. Selecting a new logic gate will clear your 'A' and 'B' inputs.

NOTE: The NOT gate is a single input gate, so only the 'A' input is functional in this mode.

Flip Flops
1. Select your desired flip flop with the flip flip select button.
2. Input your combination of 1's and 0's on the flip flops 'S/J/T/D' and 'R/K' inputs.
3. The outputs Q and notQ will only be affected by the inputs when the clock has a positive edge transition applied to it (when the button is pressed changing a logic 0 to a logic 1) – see reverse side of the DigiRule for the flip flop truth tables.
4. Selecting a new flip flop will clear your inputs and reset the output.

Using the Four bit Up / Down Binary Counter
1. Press the up arrow to increment the binary count by 1. The counter will loop back around to binary 0000 if the counter tries to count past binary 1111.
2. Press the down arrow to decrement the binary count by 1. The counter will loop back around to binary 1111 if the counter tries to count below binary 0000.

How to Use the DigiRule – Hidden Mode
To enter the hidden mode of operation, hold down the logic gates 'A' button and then turn the DigiRule on. The user can then cycle through the various modes from binary 0001 to binary 1001 using the 4bit counter up/down arrows. The logic gates 'B' button is then used to select a desired mode.

Using Mode 1 (binary 0001)
This mode is identical to the standard mode of operation.

Using Mode 2 (binary 0010)
This mode is identical to mode 1 except that the 4bit up/down counter now functions as a 4bit gray code counter.

Using Mode 3 (binary 0011)
This mode presents the user with some random sparkling LED's. The user can then increase and decrease the speed at which the LED's sparkle by using the 4bit binary up/down arrow buttons.

Using Mode 4 (binary 0100)
This mode is a seven-bit serial in shift register. The contents of the register are shown on the seven logic gate LED's.

1. The serial data input is logic gate input 'A'
2. The positive edge clock is the gate select button
3. The master reset is logic gate input 'B'

Using Mode 5 (binary 0101)
This mode simply turns on all LED's to test each for functionality.

Using Mode 6 (binary 0110)
This mode is a simple POV (persistence of vision) display. The user needs to either shake the DigiRule left and right really fast to separate the individual lines of information coming from the logic gates LED's or alternatively you can keep the DigiRule still and shake your head.

Pressing the logic gate input 'B' button will cycle through the three different images (sine wave, 'DIGIRULE RULES' text and smiley faces)

Using Mode 7 (binary 0111)
This mode is a random dice that gives the user a random binary number between 1 and 6 (binary 0001) and (binary 0110). Pressing the logic gate input 'B' button will 'roll' the dice.

Using Mode 8 (binary 1000)
This mode is a simple game whereby the user needs to press the logic gate select ‘B’ button while the XOR LED is lit. If successful, the binary counter will count up by one and the speed of the logic gate LED’s will increase. The idea is to get to the last level which is level 15 (binary 1111). If the button is pressed while any other LED is lit, all points are lost and the game returns to the starting speed.

Using Mode 9 (binary 1001)
This mode is a 4-bit logic unit. The user can select the desired logic function with the logic gates select button. Then a combination of 1’s and 0’s can be entered via the 4-bit up/down counter using the up/down arrows. This data can then be saved to the four bit ‘A’ register by pressing logic gate input ‘A’ or it can be saved to the four bit ‘B’ register by pressing logic gate input ‘B’. The answer to the selected logic function for the ‘A’ and ‘B’ registers will be shown on the flip flop select LED’s.