

# Experiment 0

## Self-Test

on HaHa v3.0 Board

In this experiment, you will go through a complete test of the Hardware Hacking (HaHa) v3.0 Board.

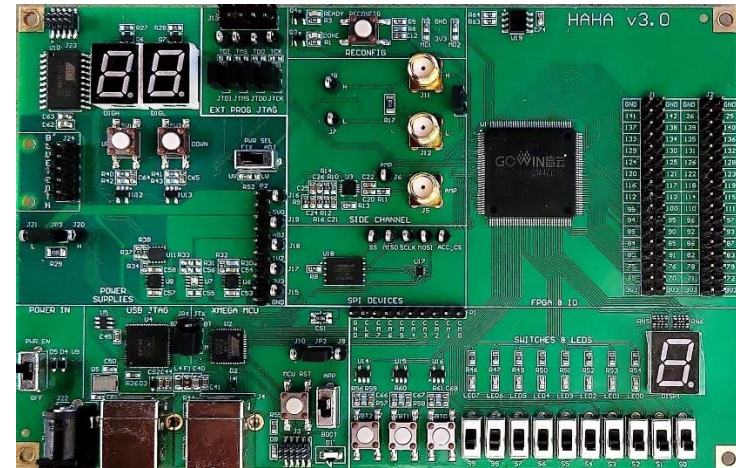
**Instructor**: Dr. Swarup Bhunia

**Co-Instructor**: Reiner Dizon-Paradis

# Experiment Set-up: Configuration

The hardware and software needed for this experiment include:

1. The HaHa v3.0 Board
2. A USB A-to-B cable
3. A Windows machine/computer with  $\geq 2$  USB ports.
  - a. GOWIN FPGA Designer ( $\geq 1.98$ ) to program the FPGA [1].
    - i. First, get your license using [2].
    - ii. Link [1] gives direct download. If you want to use a later version, you need to make an account [3].
  - b. Microchip Studio [4] to write programs for the microcontroller.
  - c. Atmel FLIP [5] to program code to the microcontroller.
4. An oscilloscope or Analog Discovery (AD) Board
  - a. *Optional* – Waveforms 2015 to view AD board signals [6].



## Instructions and Questions

To perform the following self-test procedures, you must download the Self-Test code binaries for the HaHa board. Also, you must install the GOWIN FPGA Designer ( $\geq 1.9.8$ ) [1], Microchip Studio, and Atmel FLIP programs into your Windows machine. Instructions for installing the required and optional software will be included at the end of this document.

**NOTE: If you have any questions for parts II-V, please refer to the FAQs at the end of this document or the HaHa Board Manual.**

### PART I: Test the Power Supply and Voltage Regulators

1. Connect the HaHa v3.0 board to the USB Power supply (J14) with a USB A-to-B cable to your Windows machine. Turn on the power to see if the power light is on.
  - a. Take a picture of the board while it is on with LED PWR lighting up.
2. Using an oscilloscope or Analog Discovery board, check the voltage of the input (left pin) and output (right pin) of the voltage regulator (U3) against ground. If the input is 5V but the output is not 3.3V, the voltage regulator should be replaced.
  - a. Take a picture showing the voltage of the input pin (5V).
  - b. Take a picture showing the voltage of the output pin (3.3V).
3. Check the voltage on test point 3.3A. Use button SW5 and SW6 to change the voltage.
  - a. Answer this question: what is the adjustable voltage range?
  - b. Take a picture showing the minimum voltage of the 3.3A test point.
  - c. Take a picture showing the maximum voltage of the 3.3A test point.

**NOTE: After doing voltage measurement, remember to set “PWR SEL” to “3.3F” to make sure you can program both chips successfully.**

## PART II: Test the FPGA and the Peripherals

1. Make sure the HaHa v3.0 board is still connected to the USB Power supply (J14) Open GOWIN FPGA Designer and navigate to **Tools > Programmer** in the menu bar. The *Programmer* window will appear with another window called *Cable Setting*. Make sure the *Port* is set to "Gowin USB Cable(FT2CH)/0/..." If this is not the case, try unplugging all USB cables and only plugging in the USB A-to-B cable from the HaHa v3.0 board. Otherwise, press **Save**. Clear any programming files/device from the Programmer window by selecting all files/device and click **Edit > Remove Device**. Navigate to **Edit > Add Device**. A new entry will now show up on the first row. Change the following settings on the first row:
  - a. Series = *GW1N*
  - b. Device = *GW1N-9C*
  - c. Operation (double click)
    - i. Access Mode = *Embedded Flash Mode*
    - ii. Operation = *embFlash Erase,Program,Verify*
    - iii. File name = <location/of/self\_test\_haha3.fs/file>
    - iv. Press **Save**

You are now ready to program the board. Navigate to **Edit > Program/Configure**. Wait until the programming is complete.

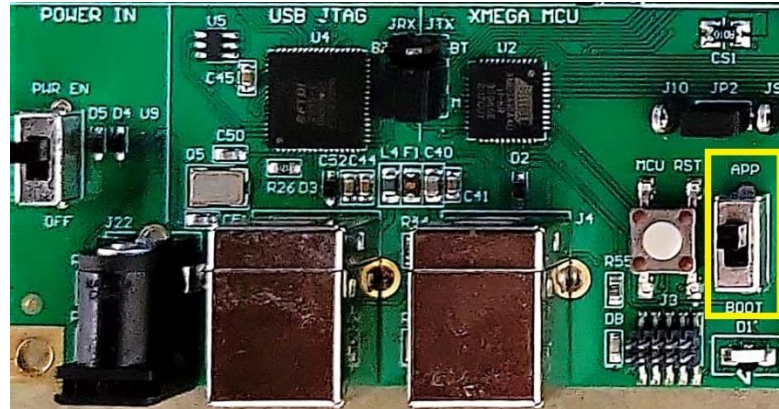
If this is successful, the 8 LEDs on the board should be blinking, and the 7-segment display a hexadecimal digit counting from 0 to F. To check the function of the 10 user switches, just switch any of them and you will see the 8 LEDs will change their pattern of blinking. There are two different patterns of blinking. Whenever any of the switches are flipped, the pattern should change. If not, please let the instructor or TAs know.

To check the function of the pushbuttons, just push any of them, and you should see the 7-segment display stops counting and start to repeat blinking with a fixed number. If not, please let the instructor or TAs know.


- a. **Answer these questions:**
  - a. What are the two LED patterns occurring in the board?
  - b. Which patterns of switches trigger either of the LED patterns?
- b. **Answer this question:** What happens to the digit on the 7-segment display when you keep pressing any of the key buttons?
- c. **Deliverable:** Attach a screenshot of the programmer window showing that you successfully programmed it.
- d. **Deliverable:** Take a picture of the board with one of the LED patterns and a hexadecimal digit displayed in 7-segment display.

### PART III: Test the Microcontroller and the Accelerometer

1. In the HaHa v3.0 board, place the following switch (see yellow rectangle below) to *BOOT* (switch down). Double tap **MCU RST** button.



Open Microchip Studio and navigate to **Tools > Device Programming** in the menu bar. Alternatively, you can press *Ctrl + Shift + P* to open the same window. Select *Atmel FLIP* for Tool and *ATxmega16A4U* for Device. Click **Apply**, then press **Read** under the *Device Signature*. Your computer now detects the microcontroller. You can now close Microchip Studio.

Open Atmel Flip and click  button. Select **USB (Ctrl + U)**. Press **Open** on the next window. Go to **File > Load HEX File...** menu. Navigate to the location of the provided file (*U\_ACC.hex*). Click **OK**, then press **Run**.

The microcontroller will read the acceleration data from the accelerometer and send it to the FPGA. The FPGA will show the value in binary on the eight LEDs if you place the most significant four switches to “1001”. Please rotate the board and see if the values are showing on the LEDs are changing. If not, please let the instructor or TAs know.

- a. **Deliverable:** Attach a photo of the board showing the acceleration value on the LEDs in your report.

#### PART IV: Test the Temperature Sensor

1. Finish Part II before proceeding. Refer to Part III for microcontroller programming steps. Program the microcontroller with the provided file (U\_TEMP.hex). The microcontroller will read the data from its internal temperature sensor and send it to the FPGA. Put switches S9 – S6 to “1001” to see the values on the LEDs.
  - a. **Deliverable:** Attach a photo of the board showing the microcontroller temperature value in your report.

#### PART V: Test the Flash Memory

1. Finish Part II before proceeding. Refer to Part III for microcontroller programming steps. Program the microcontroller with the provided file (U\_FLASH.hex). The microcontroller will read a signature of the EEPROM and send it to the FPGA. Put switches S9 – S6 to “1001” to see the values on the LEDs. The LEDs should be showing 00101001 (0x29).
  - a. **Deliverable:** Attach a photo of the board showing the value 0x29 on the LEDs in your report.

#### PART VI: Feedback

Please note this part is *not* optional. **Answer these questions:**

1. What problems have you met when doing the tests? How did you solve them?
2. What suggestions do you have to make the test process easier and more friendly to students?

# Lab Report Guidelines and Demonstration

1. In your report, answer ALL the questions.
2. Give screenshots and photos as required to your written report.
3. Record a video demonstration of your working HaHa board by showing all parts of the Self-Test.

## References

- [1] [https://cdn.gowinsemi.com.cn/Gowin\\_V1.9.8.11\\_win.zip](https://cdn.gowinsemi.com.cn/Gowin_V1.9.8.11_win.zip)
- [2] <https://www.gowinsemi.com/en/support/license/>
- [3] [https://www.gowinsemi.com/en/support/download\\_eda/](https://www.gowinsemi.com/en/support/download_eda/)
- [4] <https://ww1.microchip.com/downloads/aemDocuments/documents/DEV/ProductDocuments/SoftwareTools/as-installer-7.0.2594-full.exe>
- [5] <https://ww1.microchip.com/downloads/aemDocuments/documents/DEV/ProductDocuments/SoftwareTools/JRE-Flip-Installer-3.4.7.112.exe>
- [6] <https://mautic.digilentinc.com/asset/110:waveforms-windows-64-bit-download>