HYDRONIC Factory Setup Configuration procedure

Contents

1   Terms and Definitions

Master device	A CON64A HYDRONIC device
Slave Devices	Any one of the following devices: AIN5A, AOUT8A, CIO5A, DIN8A, DDIN5A, DOUT8A, ROUT5A
UI	User Interface
Manufacturer State	A state of the microprocessor as delivered from the manufacturer. An empty device without any kind of firmware in the memory
Factory State	A state of the microprocessor as configured from the factory. A device with necessary firmware to run the HYDRONIC project

2   Purpose of this document

This document describes the necessary procedures to be followed in order to bring an HYDRONIC Hardware device after production into a functional state before sales. It is meant to be read from people that are familiar with the Hardware design of the HYDRONIC products and responsible for sales preparation.

It is divided into three basic sections:

- System setup:
  This section describes the first essential steps to be followed in order to setup the system successfully.

- Firmware flashing:
  This section describes the flashing procedure for the master device as well as for the slave devices.

- Calibration:
  This section describes the calibration procedure for the analog slave devices (AIN5A, AOUT8A, CIO5A).

Warning: This manual is not intended for the final customer.

3 System setup

In this section, the basic preliminary steps for the system set up are described. It is assumed that the devices are not flashed into their memory rather they are in a manufacturer state.

Necessary Tools:

- A 12V power supply
- 1 ST Link V2 debugger connected to a computer
- 1 Ethernet cable

Necessary files:

> HYDRONIC_<description>_Release_YYYYMMDD.zip release package

Note : The user shall unzip the HYDRONIC_<description>_Release_YYYYMMDD.zip file inside a directory that does not contain any spaces or non-english characters, i.e.
C:/HYDRONIC_Release
and not C:/HYDRONIC Release

1. Connect, the master device to a computer, via Ethernet cable. This can be done in two ways:

    a. Direct connection with the computer, without intermediary router and without being connected to any network. This will be described in details this manual. (**Suggested**)

    b. Local network connection with a router. In this case, it is very common some IP conflicts to occur between the master device IP and other IP addresses inside the local network. The user must change properly these IP addresses (no duplicate IP) in order to solve any IP conflict issues. (**NOT suggested**)

2. Use a static IP for your computer. Follow the instructions in the Appendix - HYDRONIC_Network_Configuration

3. Connect the ST Link V2 device and a power supply to the master device and power up the system at 12V (refer to Image 1).

4. The master device has 4 LED indications. The first LED that indicates the power supply shall be steady ON.
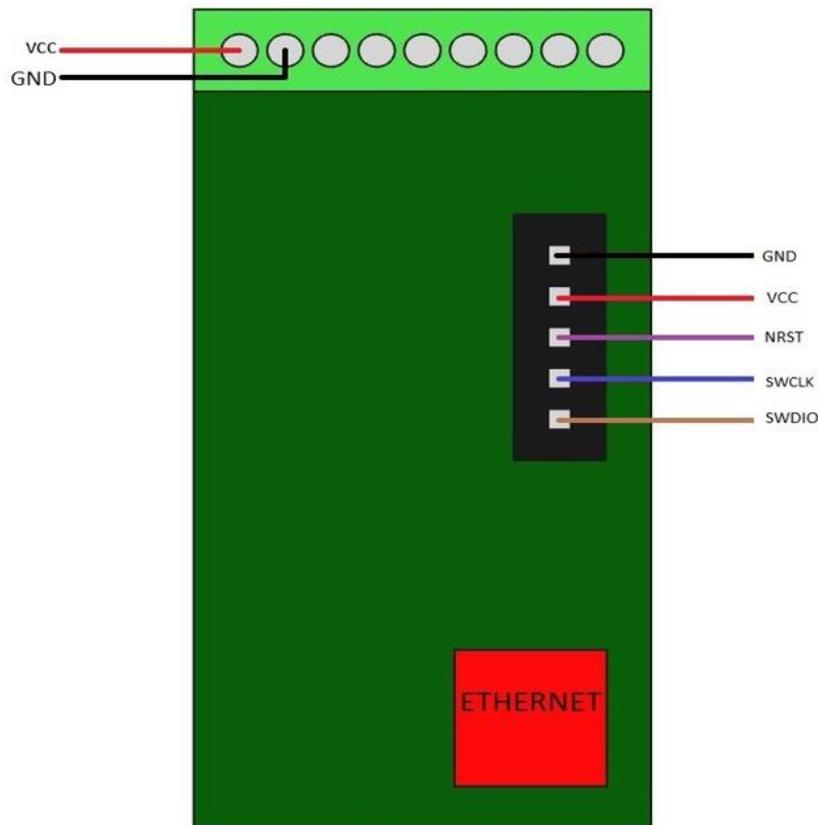
Image 1: ST Link V2 and power connectivity simple diagram

4 Firmware flashing

In this section, the flashing procedure for the master device and the slave devices is presented in detail.

In a manufacturer state the master device must be flashed with the bootloader and firmware binaries. After the flashing procedure is finished, the format and the upload of the User Interface (UI) must be initiated from a different script to complete the device preparation.

A simpler process must be followed for the all the slave devices as well.

Navigate to the *Flash_and_Calibration* folder and read carefully the README file before starting the procedure. The **CON64A_Firmware** folder contains all the necessary bin files for the master device firmware. The **IO_Firmware** folder contains all the necessary hex files for the slave devices' firmware. Finally, the **Batch** folder contains the main batch script file that the user will run in order to flash the master and the slave devices and to calibrate the slave devices.

The available options of the main.bat script file are:

- ➢ to "flash" a device (master or slave device)
- ➢ to directly download locally to your computer a list with the serial numbers of all the connected slaves using the "sn" command
- ➢ to directly download locally to your computer an HYDRONIC UI password recovery file using the "recov" command

For detailed information and instructions follow the steps shown in the command window.

To secure the Intellectual Property from theft, the microcontroller's Readout Protection mechanism is enabled during the flashing procedure. This mechanism locks the internal flash memory as soon as an attacking device is connected to the microcontroller from the debug interface.

While being locked, flash memory cannot be read by any means, even by the CPU. Program execution is halted and the firmware remains safe and unreachable inside the flash memory. A power cycle is required for the memory to unlock which will also cause the attacking device to disconnect from the microcontroller. After a power cycle is applied, the CPU will be able to fetch and execute code from flash memory.

Readout Protection does not prevent flash memory from being erased and rewritten. Boards with Readout Protection enabled can be updated and re-flashed anytime by repeating the same procedures.

4.1 Flashing the master (firmware & UI files)

4.1.1   Using ST Link V2 device

Warning1: The user must connect the ST Link V2 device to the master device before executing this procedure. If the master device is in factory state, firmware flashing is required. If the master device has been formatted, UI files upload is required.

Warning2: In case the IP address has been changed and is not the default one (192.168.10.10), the user must follow the procedure under subsection 4.1.1.3 for "Reset IP address & firmware flashing".

4.1.1.1   Firmware flashing

1. From the Batch folder run the shell.bat file.

2. Type "main" in the command window and press Enter.

3. Type "flash" and press Enter.

4. Type "1" for flashing the "Master" and press Enter.

5. Type "1" for selecting the "HYDRONIC Bootloader and Firmware" option and press Enter. The master device flashing will be completed shortly.

6. After flashing is completed, perform a power cycle to the board to activate the Readout Protection mechanism.

After power cycle:

- In case the master device was in <u>manufacturer state</u>, the third and fourth leds start to blink.
- In case the master device was in <u>factory state</u> only the third led will blink.

Now the user must upload all the necessary UI files to the master device.

4.1.1.2   UI files upload

7. Navigate to the UI_Files folder and run the FTP_UPLOAD.bat file.

8. Wait for the folder structure detection operation to be completed.

9. Type "y" to upload the UI files and press Enter.

It will take some minutes till the format of the flash chip and the upload of the UI files are completed. The FTP_UPLOAD.bat script creates all the required folders in the Master device and uses the FTP protocol to transfer all the required files.

The result of the upload of the UI files is logged in the UploadLog.txt file.

There may be some errors in this file which are not real errors since they are the result of the FTP protocol trying to upload folders. The FTP protocol is able to upload only single files. So, these types of errors are expected.

To verify that the UI files upload procedure has been completed successfully:

10. Open an internet browser and navigate to "http://192.168.10.10". The index page of the UI shall load successfully. Th Master device is ready.

4.1.1.3   Reset IP address & firmware flashing

In order to reset the IP address of the master device to the default 192.168.10.10 IP address, execute the following procedure:

1.   From the Batch folder run the shell.bat file.

2.   Type "main" in the command window and press Enter.

3.   Type "flash" and press Enter.

4.   Type "1" for flashing the "Master" and press Enter.

5.   Type "2" for selecting the "HYDRONIC Bootloader and Firmware (default IP)" option and press Enter. The master device flashing will be completed shortly. In the background the IP address is written to be the default one 192.168.10.10

A message to run Application to Exit will appear.

6.   Press "Enter".

7.   Important! Power cycle the master device.

8.   In choose another mode prompt, type "y" and press "Enter".

9.   Type "flash" and press Enter.

10. Type "1" for flashing the "Master" and press Enter.

11. Type "1" for selecting the "HYDRONIC Bootloader and Firmware" option and press Enter. The master device flashing will be completed shortly.

A message to run Application to Exit will appear.

12. Press "Enter".

13. Power cycle the master device.

Now the Master is accessible from the IP 192.168.10.10.

Notes:
i) This procedure must be followed in case the user forgets the IP address of the master device and cannot reach the UI from the browser.
ii) This procedure must be followed before firmware flashing, in case the IP address has been changed.

4.1.2 Using UI

An alternative way to flash the master (firmware & files), is through the UI as programmer, without the use of an ST Link V2 device.
Warning: This procedure shall be followed only when at least once the procedure as described in 4.1.1 has been performed, thus the Master is not in Factory state mode.

4.1.2.1 Firmware flashing

This procedure can be executed only by the <u>programmer</u>. The user shall:

1. Open the UI and login successfully as programmer.
2. Open the *HYDRONIC uController Configuration* modal window and go to the "uC Firmware" subsection.
3. Click on "Choose File" in order to select the proper firmware file to flash. This file is the "HYDRONIC_Firmware_V<version>.bin" file inside the "Files_For_Web_Update" folder of the provided release package.
4. Click the "Flash" button and wait for the procedure to complete.

Warning: DO NOT close or reload the UI page. DO NOT power-off the master device.

4.1.2.2 UI files update

This procedure can be executed only by the <u>programmer</u>. The user shall:

1. Open the UI and login successfully as programmer.
2. Open the *HYDRONIC uController Configuration* modal window and go to the "Web Interface" subsection.
3. Click on "Choose File" in order to select the proper UI update file to upload. This file is the "HYDRONIC_v<version>.zip" file inside the "Files_For_Web_Update" folder of the provided release package.
4. Click the "Update" button and wait for the procedure to complete.

Warning: DO NOT close or reload the UI page. DO NOT power-off the master device.

4.2 Flashing the slave devices

Proceed with the slave devices firmware flashing. The user must flash one-by-one individually all the desired slaves.

Before the procedure starts it assumed that:

➢ Each slave device is connected to a power supply (for the slave devices pinout refer to the HYDRONIC_Hardware_Modules_Specification.pdf file)

➢ The ST Link V2 debugger is connected to the slave device.

Follow the next steps:

1. Power up the system and from the Batch folder run the shell.bat file
2. Type "main" and press Enter
3. Type "flash" and press Enter
4. Type "2" for "Slave" and press Enter
5. Depending on the slave device type, type the respective number from the menu options and press Enter
6. To flash continuously multiple slave devices of the same type with the same settings, type "c". Otherwise, to return to the previous menu type "b". Pressing "q" will result in quitting the application.
7. After flashing is completed, perform a power cycle to the slave to activate the Readout Protection mechanism.

There is a chance for a failure message to appear, it is a known bug in ST-Link application that affects this series of microcontrollers and has not been yet fixed by ST. Regardless of the type of message, a power cycle is necessary.

Repeat the procedure for all the desired slave devices that are in a manufacturer state.

Notes:
i) All the slave devices that are properly flashed and connected to the master device, upon system power on, shall blink six times their communication led (second led). This indicates that the master device recognizes them and the communication has been successfully established.

ii) The new slave devices of hardware version 0.92 must be flashed in the same way as described above, running the script file and typing the respective number from the menu. The new devices shall have a "(v0.92)" suffix to their model name in the menu.

5 Devices Serial Numbers

In this section it is described the procedure to be followed in order to print the Serial Numbers of the master device and the connected slave devices, as well as the MAC address of the master device. These data can be downloaded as a .txt file into the Batch folder.

- The master device has a unique serial number of the format *id1.id>*.CON-*id3*, for example 2359335.808866071.CON-842478129.

- Each slave device has a unique serial number of the format *id1.id2.slave_device_type-id3*, for example for AIN5A slave device: 98315571.875842894.AIN5A-1124543279.

- The unique MAC address of the master device is logged too. The MAC address is of the format AA:14:xx:xx:xx:xx, where the "xx:xx:xx:xx" digits correspond to the hexadecimal equivalent of the master device's bitwise XOR operation between *id1*, *id2*, *id3*, for example AA:14:02:25:63:01.

To obtain the devices serial numbers and the master device's MAC address, follow the steps below:

1. Connect the ethernet cable to the master device and power up the system.

2. From the Batch folder run the shell.bat file

3. Type either "main" or "calibration" in the command window and press Enter.

4. Type "sn" and press Enter

5. The Serial Numbers will be printed on screen. In the batch folder, there has been automatically created a SerialNumbers.txt file temporarily that contains these data.

6. Enter "y" to save and keep the SerialNumbers.txt file locally or "n" to permanently delete it.

7. Follow the menu instructions to return to the main menu or to exit the script.

6 Calibration procedure

In this section, the calibration procedure for the slave devices is presented. The calibration procedure applies only to the analog slave devices AIN5A, AOUT8A, CIO5A.The user must calibrate individually one-by-one all the desired slave devices that will be used in the project and their channels one-by-one as well. It is assumed that the slave device flashing according to section 4.2 is complete for each of the salves to be calibrated.

Warning:

Before beginning the calibration procedure, the user must first deactivate any active project if exists and must close any UI tabs or windows that may be open.

Additional Tools needed:

For the calibration procedure a set of circuit parts is necessary additionally to the ones described in section 3.

- An additional power supply for the intermediary current/voltage driver circuit
- 1 Amperemeter
- 1 Voltmeter
- Resistors: 100 Ohm, 120 Ohm, 1k Ohm, 3.3k Ohm, 10k Ohm και 47k Ohm

During the calibration steps execution, in case the calibration procedure fails, the user shall repeat the last executed step and if it fails again, power cycle the system and start over the calibration procedure.

If the calibration procedure still fails, it is strongly recommended to first run the "sn" command in the batch script in order to force the system to load the slave devices for calibration. The output of this command execution also informs the user about the connected slave devices that the master device has successfully recognized. Then, the user shall start over the calibration procedure.

Typical calibration failures are either due to the fact that the devices are not properly connected to the RS485 bus or that a slave device fails to be recognized by the master device.

Warning: Even when the calibration procedure is completed successfully, there is a chance that the calculated parameters are invalidated and the system rejects them. This means that the IO returns to its original uncalibrated state.
The reason behind is that the system during calibrate calculates two parameters in order to correct the analog measurements and to approach a linear equation. If the system detects that these parameters are not in a logically valid range, then they are automatically invalidated and

the calibration has to be executed again. As it is <u>not</u> possible for the system to inform the user for this change the only way for the user to realize that the calibration was not successful is by observing the channel values in the run page and compare the measurements before and after the calibration procedure.

6.1   CIO5A – Input channels

In order to achieve calibration for CIO input channels, the following are necessary:

1. A resistor of 1kΩ (*)
2. An Amperemeter
3. An external voltage supply

For the CIO5A Input channels calibration, a current source is necessary in order to feed this current to the Input channel. The current to be produced shall be 4mA and 18mA. As a simple alternative to current source, an intermediary current driver circuit can be implemented in order to produce the necessary calibration current.

As shown in the picture below, a 1kOhm resistor is connected in series with an external voltage supply in order to achieve the desired currents.
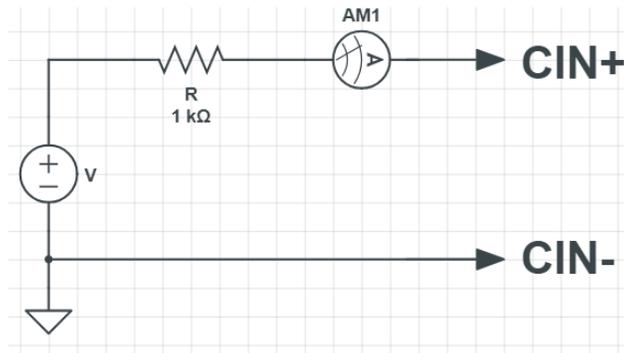
Image 2: Intermediary current driver circuit

The external voltage supply with the resistor in series produce a current that can be measured using an amperemeter. The desired current value has to be achieved by trimming the external voltage supply until the desired current is measured by the amperemeter.

(*) In this case, the voltage of the external voltage supply is calculated by Ohm's Law and it is 4V for 4mA and 18V for 18mA. In case the user decides to use a different resistor, the voltage provided by the external voltage supply shall be recalculated.

<u>Warning</u>: Make sure that the GND signal is common between the main power supply and the external voltage supply.

To run the calibration procedure, follow the steps below:

1. Connect the ethernet cable to the master device and power up the system

2. From the Batch folder run the shell.bat file

3. Type "calibration" in the command window and press Enter.

4. Type "calib" and enter the number corresponding to the slave device position (1-64) counting after the master.

5. Follow the batch script instructions

6.2 CIO5A – Output channels

In order to achieve calibration for CIO output channels, the following are necessary:

1. A resistor of 120-Ohm
2. An Amperemeter

For the CIO5A Output channels calibration a resistor (120Ohm) must be connected between the COUT+ and COUT- channels in series with an amperemeter. One resistor wire to COUT- and the other one to the first lead of the amperemeter with the second lead of the amperemeter connected to COUT+. The two current values that shall be produced are 4mA and 18mA respectively.

Warning:
The resistor must not exceed the value of 120Ohm. Typically, a resistor of 100 Ohm or 120 Ohm must be used.

To run the calibration procedure, follow the steps below:

1. Connect the ethernet cable to the master device and power up the system

2. From the Batch folder run the shell.bat file

3. Type "calibration" in the command window and press Enter.

4. Type "calib" and enter the number corresponding to the slave device position (1-64) counting after the master.

5. Follow the batch script instructions

Note: The user must enter the absolute value of the measured currents in <u>milliAmperes (mA) (not Amperes)</u> when prompted for the measured current values.

**Note:* The two values that the user enters must differ at least 10mA.

6.3   AOUT8A

In order to achieve calibration for AOUT channels, only a Voltmeter is necessary, in order to measure the output voltage level with reference to the GND signal. The two voltage values that shall be produced are 0.5V and 9V respectively.

To run the calibration procedure, follow the steps below:

1. Connect the ethernet cable to the master device and power up the system

2. From the Batch folder run the shell.bat file

3. Type "calibration" in the command window and press Enter.

4. Type "calib" and enter the number corresponding to the slave device position (1-64) counting after the master.

5. Follow the batch script instructions.

Note: The user must enter the absolute value of the measured voltages in <u>Volts</u> when prompted for the measured voltage values.

**Note:* The two values that the user enters for the AIN active case must differ at least 7V.

6.4   AIN5A

In order to achieve calibration for AIN channels, the following are necessary:

1. An external voltage supply
2. Resistors of 100 Ohm, 3.3kOhm, 10kOhm and 47kOhm

For the AIN channels calibration, a double calibration procedure shall be followed as the Hardware supports two different functionalities. The same procedure shall be followed for the Active functionality and the Resistive. For the Active functionality an external voltage supply is necessary to produce 0.5V and 9V. For the Resistive case, in each channel, 4 resistors must be connected consecutively, 100-Ohm, 3.3kOhm, 10kOhm and 47kOhm. Make sure that the GND signal is common between the main power supply and the external voltage supply.

To run the calibration procedure, follow the steps below:

1. Connect the ethernet cable to the master device and power up the system

2. From the Batch folder run the shell.bat file

3. Type "calibration" in the command window and press Enter.

4. Type "calib" and enter the number corresponding to the slave device position (1-64) counting after the master.

5. Follow the batch script instructions.

7   Recover UI Programming Mode Password

In the special case where the user of the HYDRONIC system has forgot the password required for entering the UI Programming Mode, a recovery password file can be used. This file can be generated using:

1. The Generate Recovery File button in the *HYDRONIC uController Configuration* modal window.
2. The "recov" option in the main.bat file found in the Batch folder.

For the option 2 above, the specific steps are:

1. From the Batch folder run the shell.bat file.
2. Type "main" and press Enter.
3. Type "recov" and press Enter.
4. In the new window that opens type the serial number of the master device in the form 3866666.808866070.CON-892483889 and press Enter.
5. Press Enter again to close the new window and type "n" to stop the main.bat file execution.

A recovery file is generated named CON-892483889_RecoveryFile.bin. This file can be used to login into the programming mode by clicking at the "Login using recovery file" link found under the "Login" button of the Programming Mode.

8 Appendix

8.1 HYDRONIC_Network_Configuration

This section describes all the necessary steps to properly set a static IP in a computer running the Windows OS. This network configuration is strongly recommended for the HYDRONIC product. By default, the IP address of the master device is set to 192.168.10.10. This is the first IP that a user must use to address commands to the master device.

8.1.1   IP Configuration

1. Turn off WiFi and disconnect from any LAN network. There should be no intermediary router device between the computer-master device communication.

2. Connect directly the Ethernet cable from the master device to your computer.

3. Set a static IP address, following the steps below:

    a. Open Control Panel.

    b. Click on Network and Internet.

    c. Click on Network and Sharing Center.

    d. On the left menu, click on Change Adapter Settings.
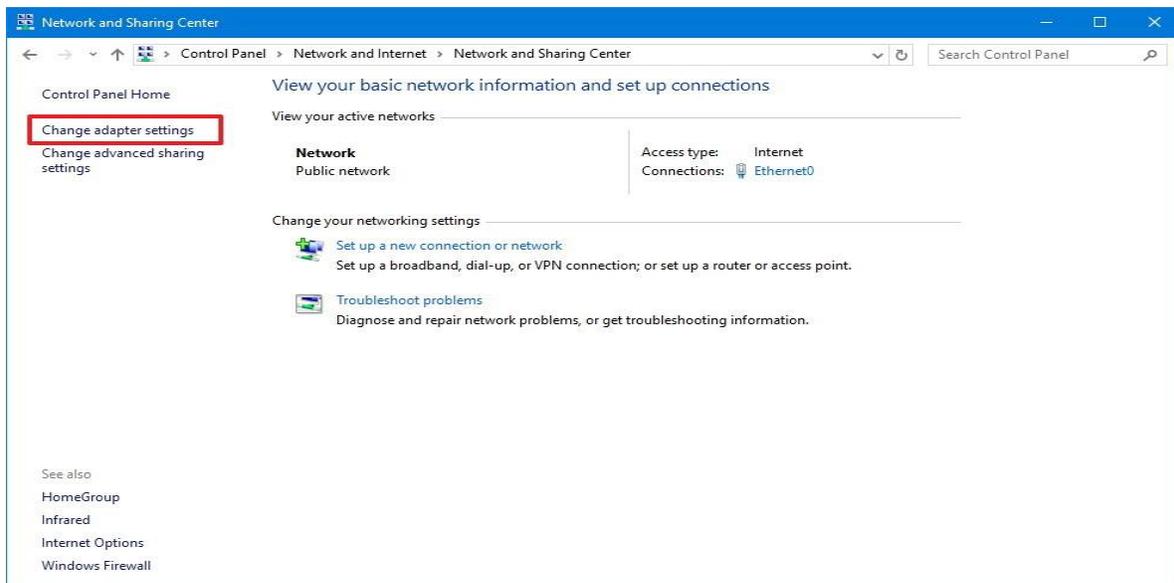
Image 3: Adapter settings

     e. Right click on the ethernet network that you use and go to Properties.
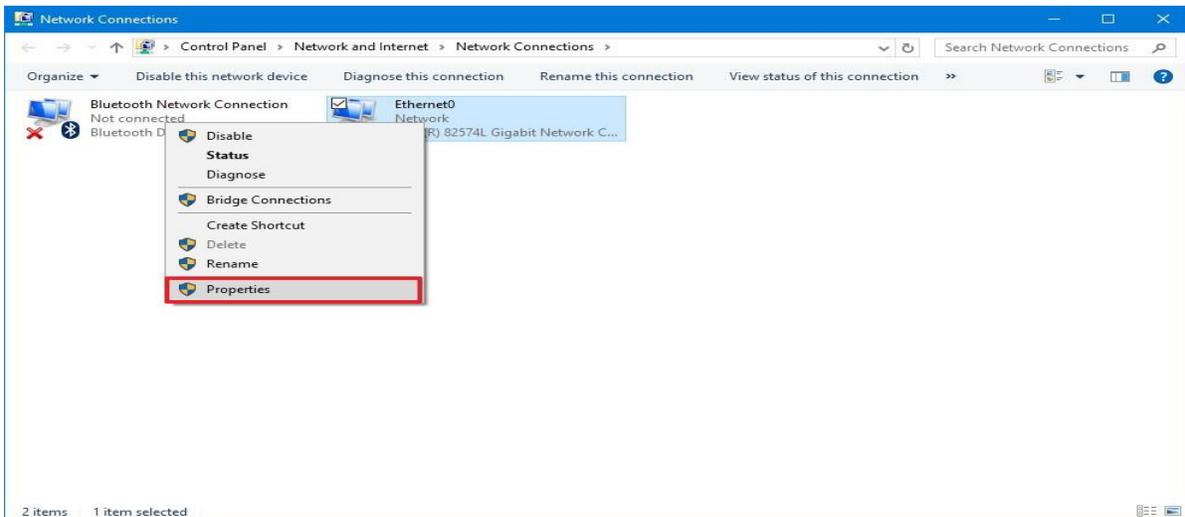
Image 4: Ethernet properties

     f. Select Internet Protocol Version 4(TCP/IPv4).

     g. Go to Properties.
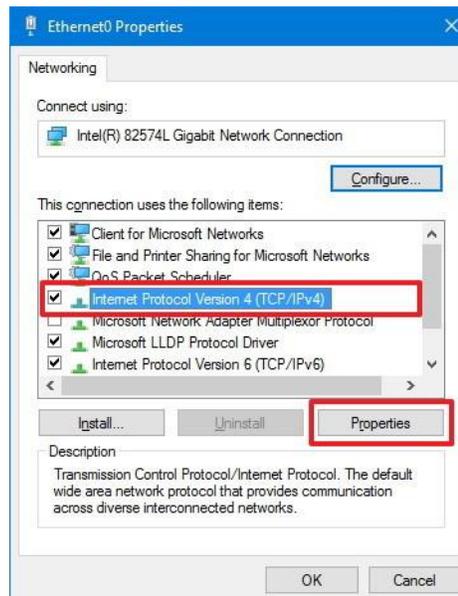
Image 5: TCP/IP properties

h. Select Use the following IP address and Use the following DNS server address and fill the fields as follows:

    i. IP address -> 192.168.10.x, where x is any number <u>except for 0, 10, 255</u>

    ii. Subnet mask -> 255.255.255.0

    iii. Default gateway -> Leave blank
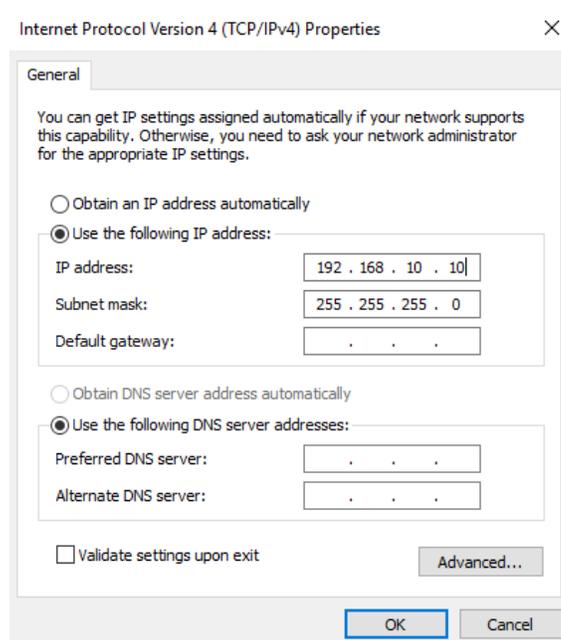
Image 6: Setting IP address

a. Click OK and Yes to the warning message displayed.

b. Under the Sharing tab, make sure that the option "Allow other network users to connect through this computer's internet connection" **IS NOT** selected.
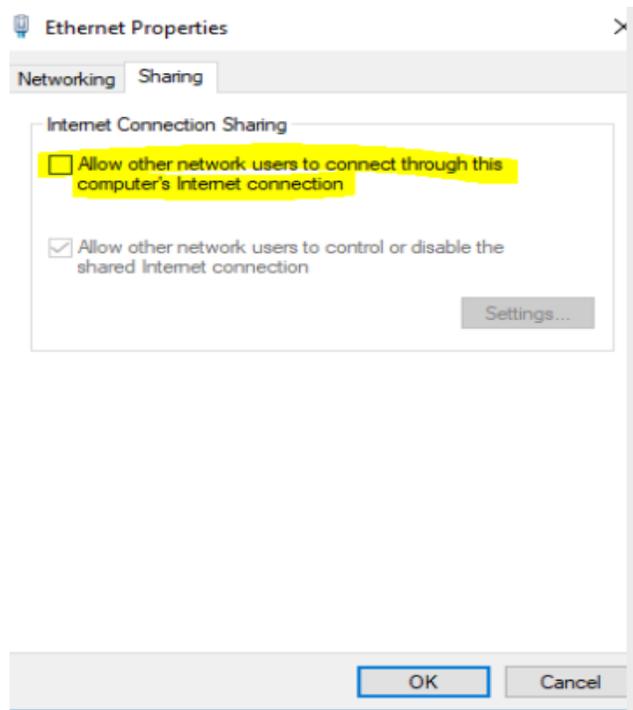
Image 7: Disable unnecessary settings

c. Click Close.

d. If for any reason you need to reverse the above procedure and the static IP, select "Obtain an IP address automatically" in step h.