

# Mini Neutron Monitor User Manual



Centre for Space Research  
North-West University

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# Hardware

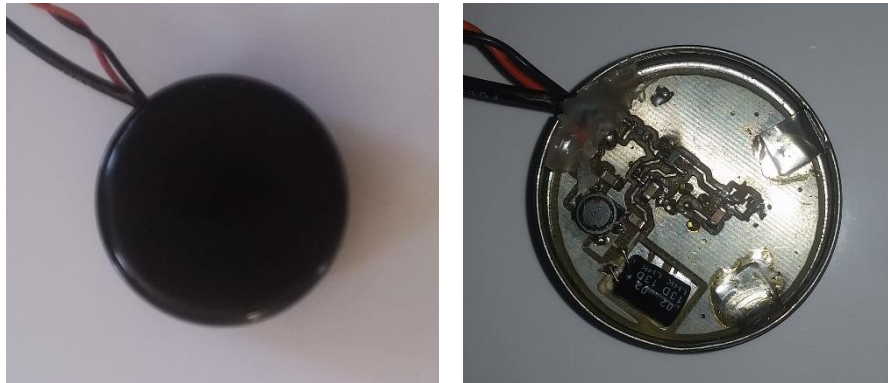
This section of the user manual gives a brief oversight of the individual hardware modules that comprises the mini-nm data acquisition unit.



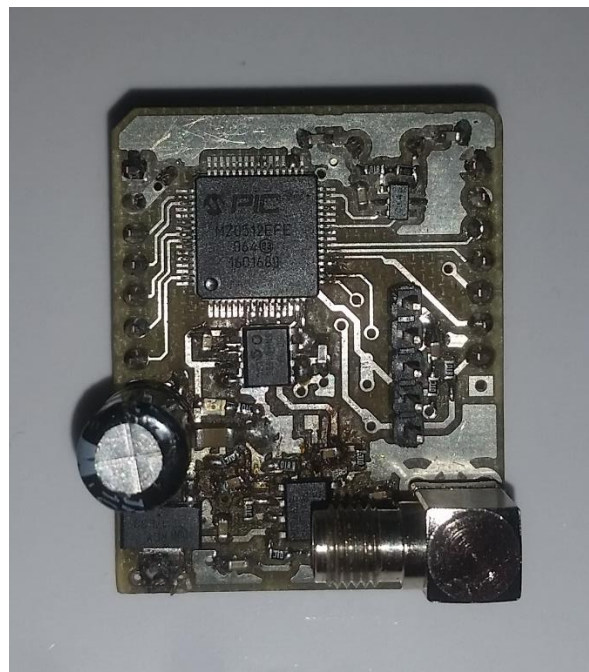
Figure 1: The complete Mini-NM data acquisition unit

## Pre-amplifier

The pre-amplifier, or pre-amp, is responsible for filtering out all of the potential noise that could be picked up by the detector and amplifies the pulses received from the counter tube. This unit consists of two stages. The first stage performs initial amplification on the signal received from the counter tube. The second stage amplifies, filters and registers the counts that are received from the counter tube.



*Figure 2: Pre-amp - First phase*



*Figure 3: Pre-amp - Second phase*

## Pressure board

This module's (Bosch BME280 Weather Click) main responsibility is to record atmospheric pressure. It also records temperature and humidity. Directly underneath the BME280 there is a custom made expansion board which allows it to interface with the Raspberry Pi via the main board.

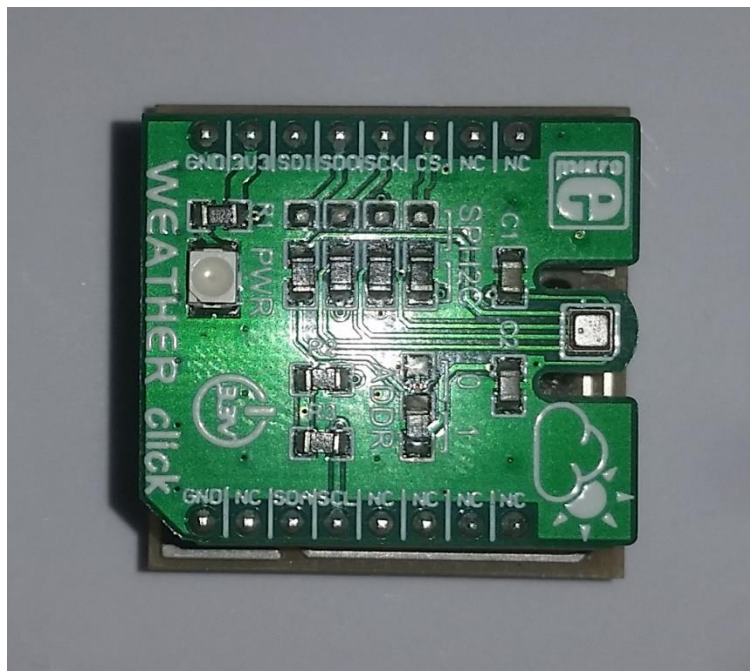


Figure 4: Bosch BME280 Weather Click

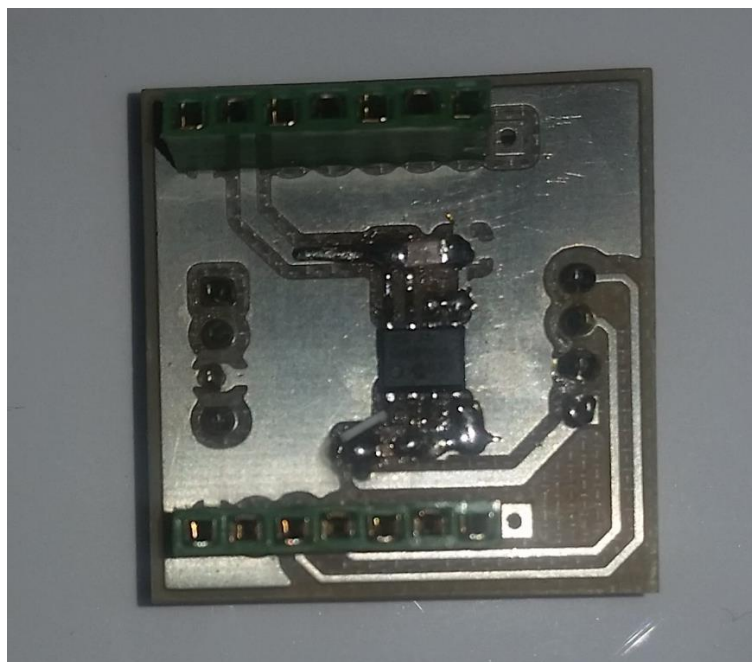
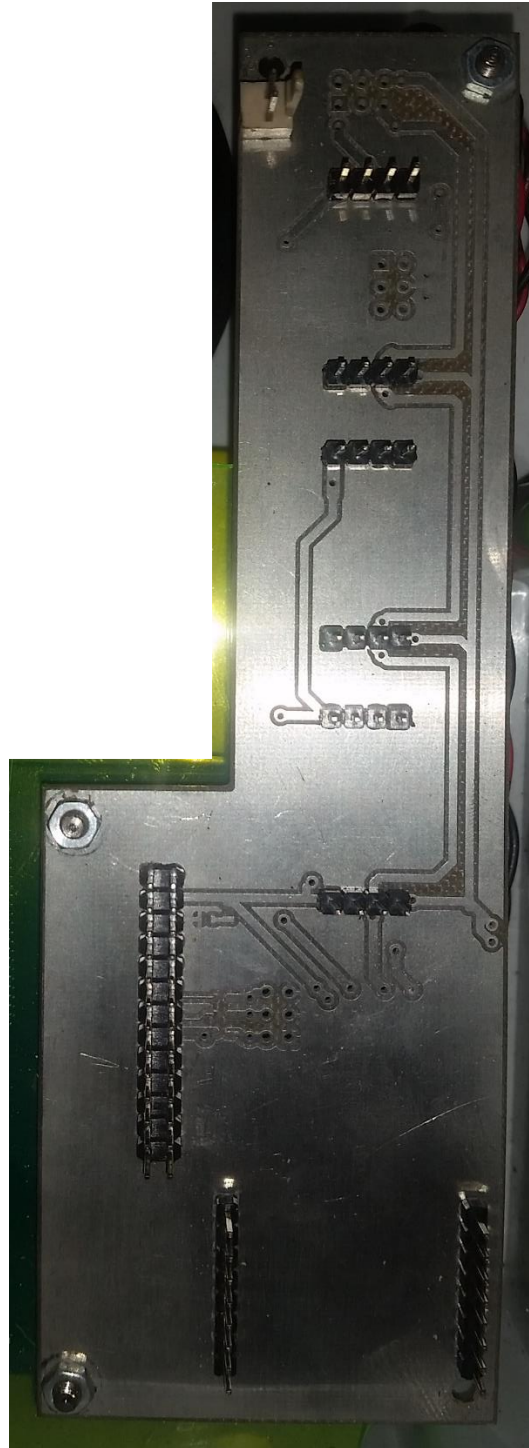


Figure 5: Expansion board

## Main board

The main board houses all of the units that supplies crucial data to the Raspberry Pi, such as the second phase of the pre-amp, BME280 and GPS).



*Figure 6: Main Board*

## High voltage supply

This module is responsible for supplying the counter tube with the required voltage for correct operation. The output voltage can be controlled from the Raspberry Pi via a script. This module is located directly underneath the Raspberry Pi.



*Figure 7: High voltage supply*

## Raspberry Pi

The Raspberry Pi collects all of the data from the various units and generates a log file that contains all of the count, pressure and GPS data. The Raspberry Pi is also capable of controlling the voltage that the high voltage unit produces. It also provides the MiniNM with networking capabilities.



Figure 8: Raspberry Pi Model 3



# Software

The software on the Raspberry Pi is responsible for processing the received data from the pre-amplifier, GPS and pressure board. This data is then stored in a log file. There are multiple python scripts running on the Raspberry Pi that individually handle all of the data transfer between the Raspberry Pi and each module. These scripts are automatically initiated when the Raspberry Pi starts up and should not be tampered with, as any changes could result in the loss of data or incorrect operation of the MiniNM head.

# Basic hardware maintenance

In this section, basic maintenance procedures will be covered. These procedures will typically be followed when one or more of the modules inside the MiniNM unit needs to be replaced with a new module. Before any of these procedures are performed, please ensure that the system is powered down. Before hardware maintenance is performed it would also be much easier and safer for the counter tube if the MiniNM head is removed from the counter tube.

## MiniNM head

### Removing the head from the counter tube

- Power down the system by unplugging the power cable.
- Remove the eight screws that fix the MiniNM head to the monitor body. These screws are located in the L-brackets on the sides of the MiniNM head.



*Figure 9: L-Bracket screws to be removed.*

- Once all screws are removed, gently pull the head and attached counter tube slightly out of the monitor body (see Figure 10).
- While holding the MiniNM head with one hand, grip the connector at the back and turn it anti-clockwise. Keep the connector head aligned with the tube to ensure easy and safe removal.
- Lastly (if access to the electronics inside the head is required), remove the front panel of the MiniNM head by unscrewing the 6 screws that keep the front panel in place.



Figure 10: MiniNM head removal

### Putting the head back

- The process for putting the head back is essentially the steps for the process mentioned above in the head removal section in reverse order.
- Align the connector in the head with the counter tube and screw (clockwise – opposite direction as depicted in figure 10) the connector onto the tube. It is not necessary to over-tighten the connection.

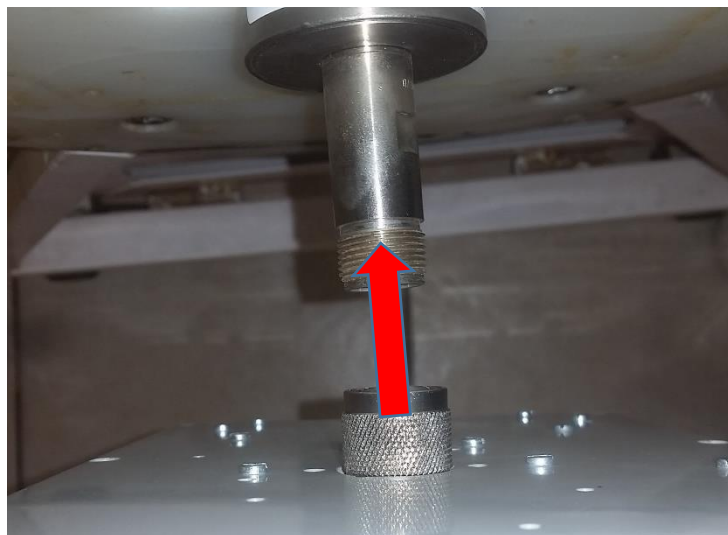


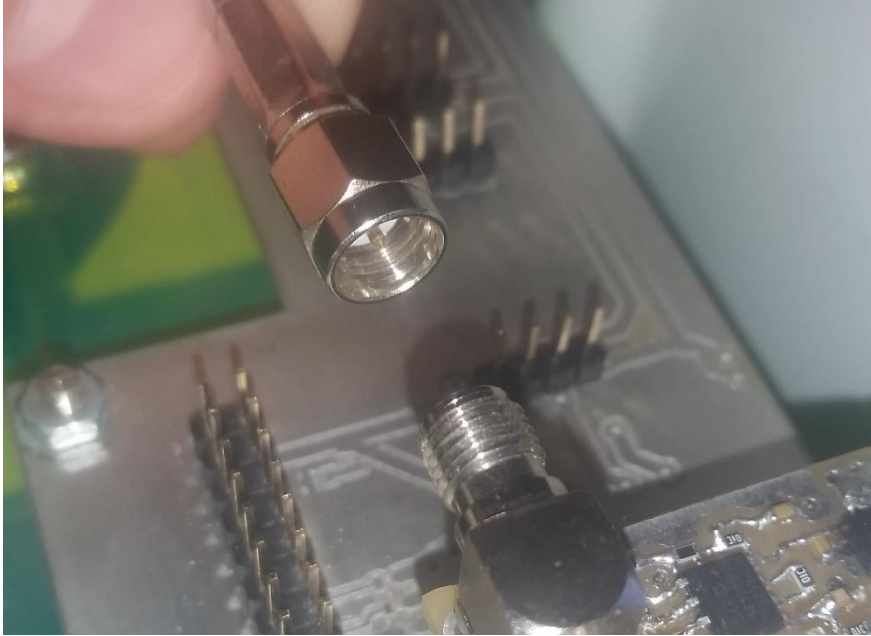
Figure 11: Tube connector alignment

- Slide the tube into the monitor body until the head is flush with the front of the body.
- Insert and tighten the screws that keep the head in place. (Refer to figure 9)
- Put the front panel back onto the MiniNM head and tighten the screws that keep it in place.

## Replacing pre-amp, first phase

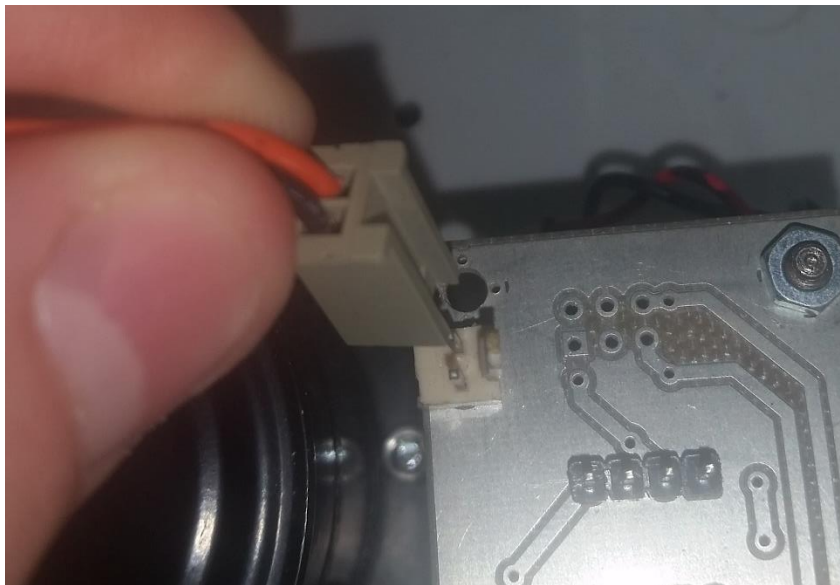
Removing the old unit:

- Unscrew the SMA connector that connects the first and second phases of the pre-amplifier.



*Figure 12: SMA connector*

- Unplug the power connector from the main board. To identify this connector, follow the twisted wire pair that comes out of the first phase casing all the way to the main board. When removing this connector, remember the orientation of the connector and wires, when you reconnect the new unit, the connector and wire orientation should be the same.



*Figure 13: Power Connector*

- Remove the pre-amplifier's first phase by firmly gripping the unit close to the base and pulling upwards, away from the MiniNM unit as indicated by the image below:



*Figure 14: Pre-Amp first phase removal*

#### Inserting the new unit:

- Repeat the first two steps of the removal process in reverse. Connect the first phase to the second phase by screwing the SMA connector into place and connect the power connector keeping the connector and cable orientation in mind from the previous first phase when unit that was removed.
- Connect the new pre-amplifier first phase module to the MiniNM paying special attention to the SMB connector. Press down on the unit ensuring that the SMB connector is lined up properly until the unit is secured.



Figure 15: SMB connector alignment

## Replacing pre-amp, second phase

### Removing the old unit

- Unscrew the SMA connector that connects the first and second phases of the pre-amplifier. (Refer to figure 12)
- Grip the board on the sides, while trying to make minimal contact with any of the circuitry on the board itself, and gently pull the board away from the main board until it slots out of the main board.

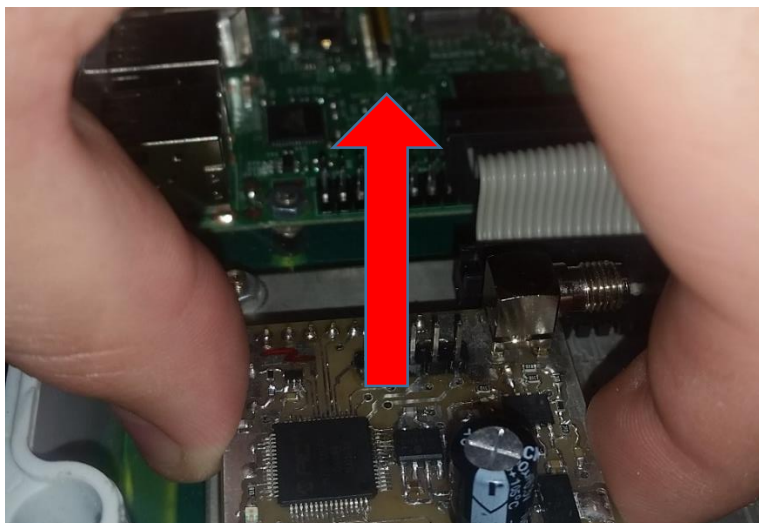
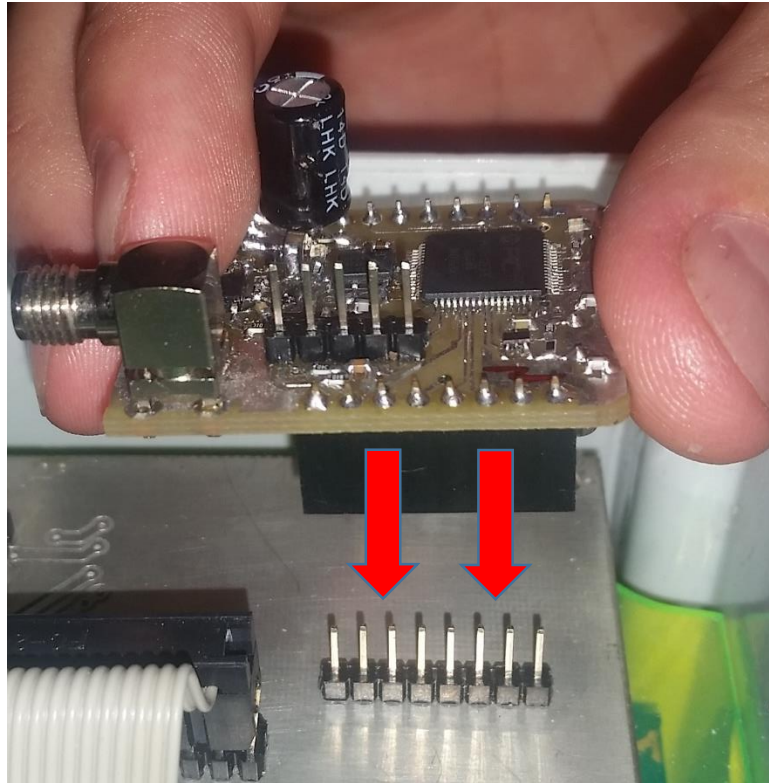


Figure 16: Pre-Amp second phase removal

## Inserting the new unit

- Grip the board on the sides, while trying to make minimal contact with any of the circuitry on the board itself, and gently push the board into the main board's connectors. Be mindful of the board's orientation and ensure that the pins on the main board align properly with the sockets on the pre-amplifier second phase's board (Figure 17).
- Connect the first phase to the second phase by screwing the SMA connector into place.



*Figure 17: Board orientation and pin/socket alignment*

## Replacing the pressure board

### Removing the old unit

- Grip the expansion board at the bottom on the sides, while trying to make minimal contact with any of the circuitry on the board itself, and gently pull the board away from the main board until it slots out of the main board.

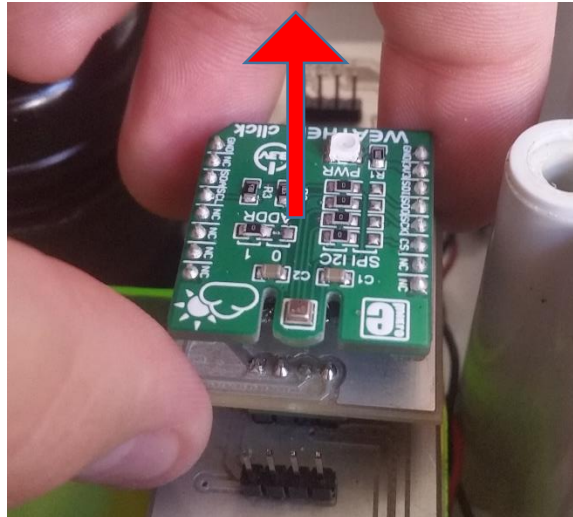


Figure 18: Pressure board removal

### Inserting the new unit

- Grip the expansion board on the sides, while trying to make minimal contact with any of the circuitry on the board itself, and gently push the board into the main board's connectors. Be mindful of the board's orientation and ensure that the pins on the main board align properly with the sockets on the expansion board.

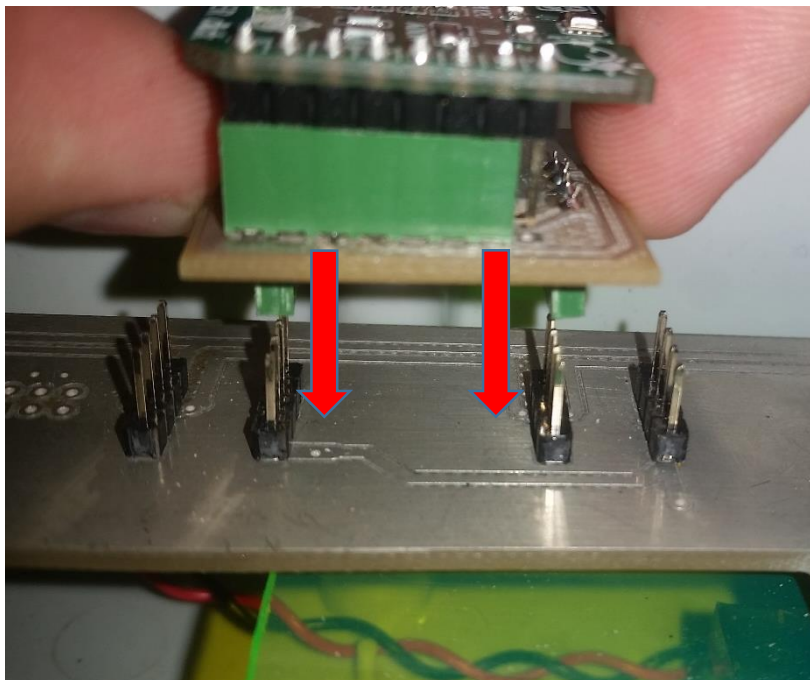


Figure 19: Pressure board insertion



## Replacing the Raspberry Pi

### Removing the old unit

- Disconnect the ribbon cable from the Raspberry Pi's GPIO pins by gripping the connector on the sides and pull upwards. Do not pull on the cable!

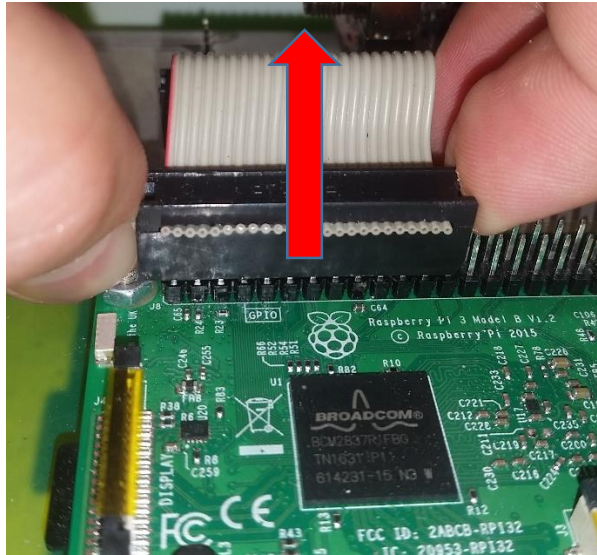


Figure 20: Ribbon cable removal

- Unscrew the four nuts in the corners of the Raspberry Pi board.

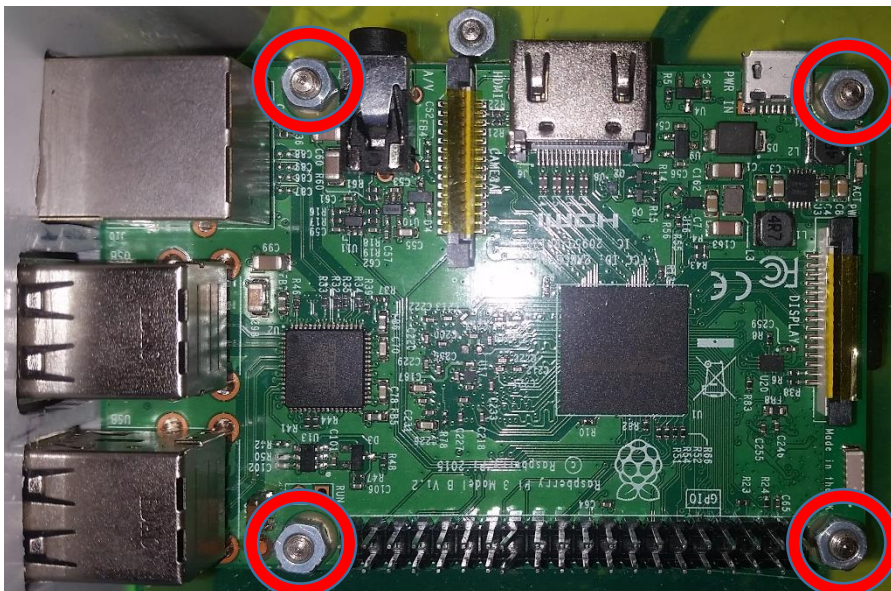


Figure 21: Raspberry Pi nut removal

- Remove the Raspberry Pi board by lifting upwards from the back of the board

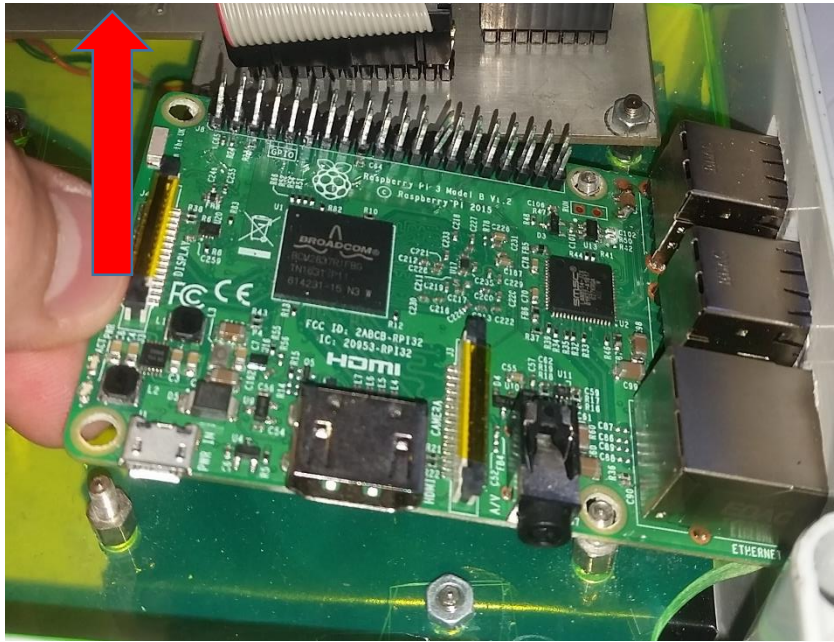


Figure 22: Raspberry Pi board removal

### Inserting the new unit

- Insert the new Raspberry Pi board's Ethernet and USB ports into the holes at a slanted angle on the side of the MiniNM cover while at the same time aligning the two holes for the bolts closest to the Ethernet and USB ports with the holes in the Raspberry Pi board.

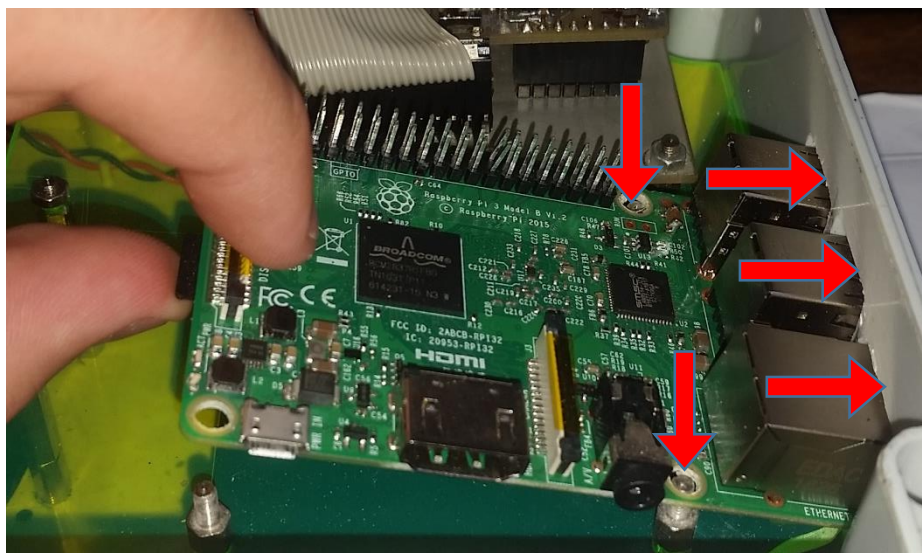


Figure 23: Raspberry Pi alignment

- Once all of the mentioned alignments are made, the Raspberry Pi can be pushed downwards from the back side until all four of the blots are protruding out of their respective holes on the Raspberry Pi board.

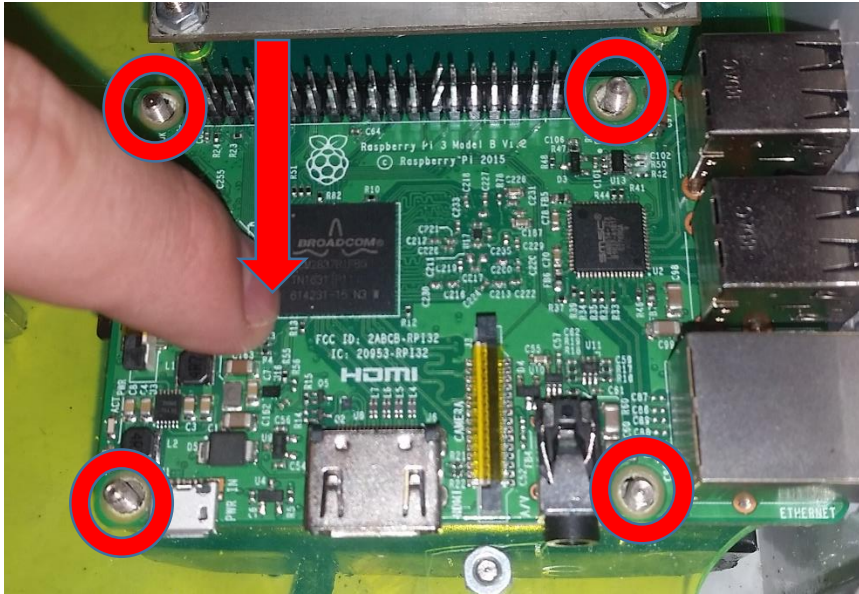


Figure 24: Raspberry Pi bolt alignment

- After the final alignment, the four nuts can be screwed back into place to secure the Raspberry Pi.
- Lastly, reconnect the Raspberry Pi to the main board by connection the ribbon cable to the GPIO pins on the board. Be mindful of the connector's orientation.

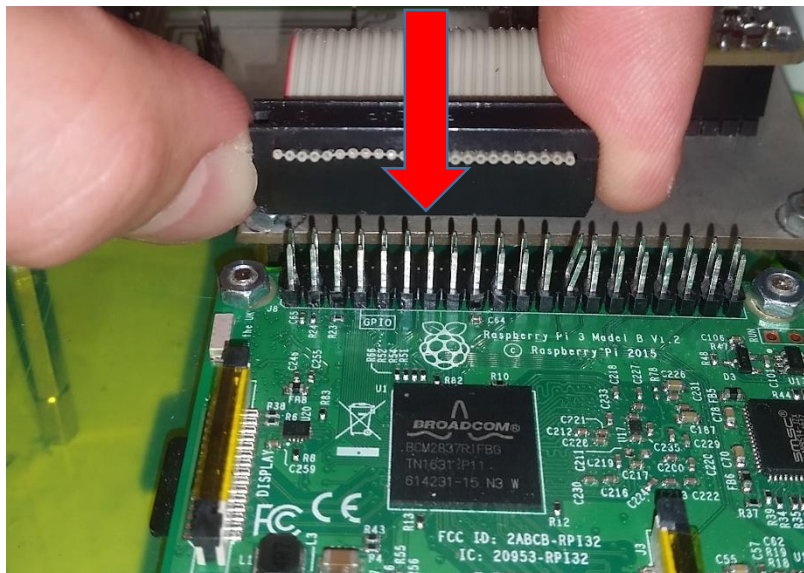


Figure 25: Ribbon cable reconnection

# Basic software maintenance

## Updating or installing new scripts

At times upgrades to the software on the Raspberry Pi will be made by the technical team at the Centre for Space Research at the North West University. These changes would typically address certain bugs or inefficiencies in the software. When such an upgrade has been completed, a notification will be sent out that there is new software available. In such a case, the new software will be uploaded to google drive (<https://drive.google.com/open?id=0B0lVnNOYW10JVWdFb09sZlR4M0U>).

The new script/s can just be copied onto the unit with the following details (A Linux terminal, or an FTP client such as WinSCP can be used for this function):

***Username: pi***

***Password: raspberry***

***IP: The IP address that was allocated to the device when the MiniNM was installed.***

The new, updated, version of the specific script can just simply be copied to the home directory. This will automatically overwrite the old script. After transferring the new script, the system should be restarted.

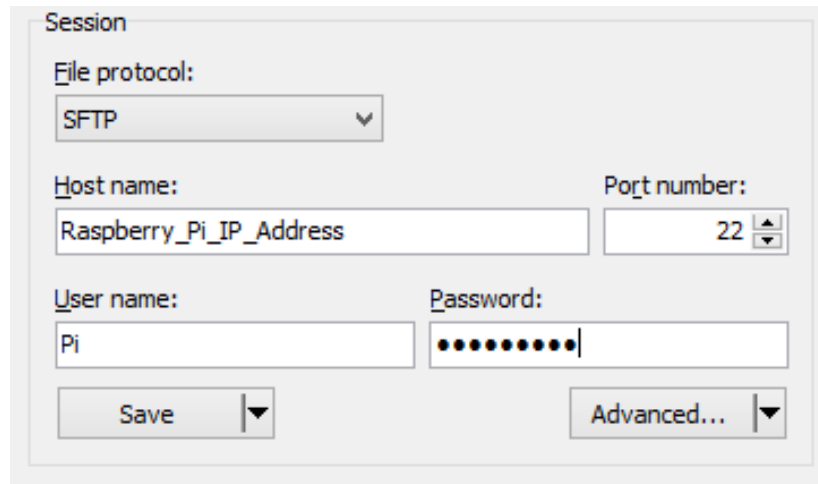
## Linux terminal

When using a Linux terminal, the following command can be used if you are already in the directory where the new script is stored on your local machine:

```
$ scp -rp script_to_be_copied pi@RaspberryPi_IP:~
```

## FTP client

When using an FTP client like WinSCP enter the IP address in the Host name field, and fill in the other details as required. You should be able to leave the port number on the default value.

The image shows a screenshot of the WinSCP 'Session' dialog box. It has a title bar 'Session'. Below it, there are several fields: 'File protocol:' with a dropdown menu set to 'SFTP'; 'Host name:' with a text box containing 'Raspberry\_Pi\_IP\_Address'; 'Port number:' with a spinner box set to '22'; 'User name:' with a text box containing 'Pi'; and 'Password:' with a text box containing ten dots. At the bottom, there are two buttons: 'Save' and 'Advanced...'.

Session	
File protocol:	SFTP
Host name:	Raspberry_Pi_IP_Address
Port number:	22
User name:	Pi
Password:	••••••••••
Save	Advanced...

Figure 26: WinSCP example

After logging into the Raspberry Pi via your FTP client, just simply transfer the new script to the home directory of the Raspberry Pi.

## New Raspberry Pi setup

In the case of replacing the Raspberry Pi, all of the required scripts will have to be copied onto the Raspberry Pi following the same procedure as mentioned above. The crontab will also have to be installed on the new Raspberry Pi and the IP address of the new module will also have to be changed to match that of the old module.

## Crontab installation

- Retrieve the crontab.txt file from google drive.
- Copy it from the local machine to the Raspberry Pi by using the same method as described in the “Updating or installing new scripts” section.
- Log into the Raspberry Pi via a Linux terminal or an SSH client such as PuTTY.
- Navigate to the home directory. (If the method in the “Updating or installing new scripts” section was followed, the crontab.txt file should be in the home directory).
- Run the following command in the terminal:

**\$ cat crontab.txt | crontab -**

- The new crontab is now installed and all scripts will execute automatically.

## Change of IP address

- Log into the Raspberry Pi via a Linux terminal or an SSH client such as PuTTY.
- Then run the following command:

**\$ sudo ifconfig eth0 1.1.1.1 netmask 255.255.255.0**

- 1.1.1.1 Is only an example and represents whatever the old Raspberry Pi's IP address was.
- 255.255.255.0 Is only an example and represents whatever the old Raspberry Pi's subnet mask was.
- If the network setup on the old Raspberry Pi requires a default gateway, run the following command:

**\$ sudo route add default gw 192.168.0.1 eth0**

- 192.168.0.1 is only an example and represents whatever the default gateway of the old Raspberry Pi was.