Weather Station Raspberry Pi Software Setup

For the Standard and Pro Version of the MyWX Android App

V2.3.8

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Contents

This personal weather station uses the SparkFun weather sensors (Argent Data Systems), and the BC Robotics add-on hardware (HAT) to interface these sensors to the Raspberry Pi.

See: https://www.sparkfun.com/products/8942 and https://www.bc-robotics.com/tutorials/raspberry-pi-weather-station-part-1/

The weather station monitors (and optionally shares the data with Wunderground):

- **Wind Speed** – in km/h
- **Wind Direction** – in degrees
- **Rainfall** – in mm
- **rainRate** – in mm/hr
- **Temperature** – in degrees C
- **Air Pressure** – in hecto Pascals
- **Humidity** – in percent

Instructions for constructing this weather station and all the required components are in the "`Weather-Station-Raspberry-Pi-construction.pdf`" PDF file.

Raspberry Pi

The weather station is connected to a Raspberry Pi … it is actually a HAT (Hardware Attached on Top). The HAT is from BC Robotics and uses the BME280 temperature, pressure, and humidity sensor, the DS18B20 Digital temperature sensor, and the SparkFun Weather sensors from Argent Data Systems for wind and rain.

Raspbian does not have a default login, so create your own during the setup:

- **Default username**: *user*
- **Password**: *password*

Setup Raspbian for WeeWX and the BC Robotics Hardware

The following assumes that you already have Raspbian running on your Pi (this document is based upon the *Bookworm* version). If not, follow these instructions:

If setting up your SD card on Windows get the `balenaEtcher` flash utility here. I use the "portable" version, which does not require an install on Windows:

`https://www.balena.io/etcher/`

Install this utility or run Etcher from this downloaded file.

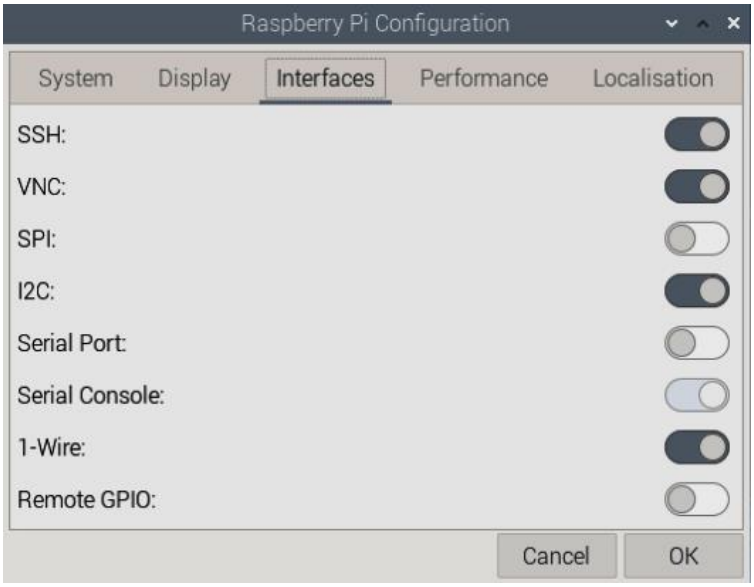
Now download the latest "Raspberry Pi OS with desktop" image from here (I install the *Raspberry Pi OS with desktop and recommended software* version):

`https://www.raspberrypi.org/downloads/raspberry-pi-os/`

Unpack the Raspbian image, and then use the `balenaEtcher` flash utility to flash it to your SD card. Now insert the card into your Raspberry Pi and follow the instructions when it boots up, which may take a while. Setup the country, Wi-Fi network, and other settings. Then let the system update itself. Also, see:

`https://www.raspberrypi.org/documentation/installation/installing-images/`

On the main screen, go to `Preferences / Raspberry Pi Configuration` and define your `Hostname` on the `System` tab, and then enable `SSH`, `VNC`, `I2C` and `1-Wire` interfaces on the `Interface` tab, as shown below (your choice for Hostname):



Now setup a few configurations on your Pi to make it easier to use and manage. VNC allows for remote virtual terminal access, which is necessary to manage the system remotely.

> ***Note***: If you change the host name or IP address you may have to edit the `etc/hosts` file and add the new name and IP address to the list.

Setup FTP

Install the `vsftpd` FTP service (`commands below`), and then enable FTP write access to the Pi; edit `etc/vsftpd.conf` and uncomment the `write_enable` line (`see below`). Start the File Manager, find the `etc` folder.

```
sudo apt update
sudo apt upgrade
sudo apt install vsftpd       # install FTP
sudo mousepad vsftpd.conf     # go to etc folder: enable writing, etc.
      write_enable=YES        # i.e., remove the "#"
      local_umask=022         # Most FTPs use this setting (optional)
```

The other way to install it is to open the `Preferences / Add / Remove Software` app, search for `vsftp` and install the "lightweight, efficient FTP server written for security". And then edit the `vsftp.conf` file as required.

Setup a Static IP Address

The Raspberry Pi is setup with a static IP, to connect to and manage the Pi easier. Do this by editing the following file (Old Method: `sudo mousepad dhcpcd.conf`), or click on the Wi-Fi icon and open the "`Advanced Options / Edit Connections…`" utility. Give the device a static IP address.

`Old method``: manually edit etc/dhcpcd.conf as follows:`

```
static ip_address=10.0.0.70
static routers=10.0.0.1
static domain_name_servers=208.67.220.220
static domain_search=208.67.222.222
```

Note: If the syslog continuously registers approval messages:

`dhcpcd[361]: eth0: received approval for 10.0.0.200`

then edit the `dhcpcd.conf` file (`sudo mousepad dhcpcd.conf`) and comment out the `inform` line.

Setup All Required Software

Note that WeeWX should be installed in a virtual PYTHON environment, along with all the other PYTHON packages.

Ensure that the prerequisite software is installed:

```
sudo apt-get update
sudo apt-get upgrade
# Python V3 installation (make sure that PIP and VENV are installed)
sudo apt install python3-pip -y         # Install PIP
sudo apt install python3-venv -y        # Install Python module

# Create & activate the virtual environment
python -m venv weeve              # Create the weeve environment
source weeve/bin/activate         # Activate virtual environment
```

```
# Python V3 installation (check to make sure that it is installed)
sudo apt install python3-configobj
sudo apt install python3-pil
sudo apt install python3-serial
sudo apt install python3-usb
sudo apt install python3-pip

# Add the cheetah library
sudo apt install python3-cheetah

# Optional: for extended almanac information
sudo apt install python3-ephem

# Required: to use the MySQL (MariaDB):
sudo apt-get install mariadb-client
sudo apt-get install mariadb-server
sudo apt-get install python3-mysqldb
```

Setup the VNC Remote Desktop Access

The VNC viewer server is likely already be installed on your Pi. VNC (Virtual Network Computing) is a graphical desktop-sharing system that uses the Remote Frame Buffer protocol to control another computer remotely. It comes bundled with the full Raspberry Pi software install, and we turned it on in the initial setup described above.

You can install the VNC Viewer on your Windows PC to access and administer your Pi over the network:

```
https://www.realvnc.com/en/connect/download/viewer/
```

Installing Required Libraries

These libraries support the weather hardware.

Install the Adafruit Python GPIO Library

```
# The following assumes Debian 12 or higher

sudo apt-get update
sudo apt-get upgrade
# See: https://learn.adafruit.com/circuitpython-on-raspberrypi-
linux/installing-circuitpython-on-raspberry-pi
#
sudo apt-get install python3-pip

sudo apt install --upgrade python3-setuptools
```

```
python -m venv weeve --system-site-packages    # Update weeve virtual env
source weeve/bin/activate                      # Activate virtual environment


pip3 install --upgrade adafruit-python-shell   # --break-system-packages
# Set up Blinka
wget https://raw.githubusercontent.com/adafruit/Raspberry-Pi-Installer-
Scripts/master/raspi-blinka.py
sudo -E env PATH=$PATH python3 raspi-blinka.py
# >>>>>>>>>>> Now Reboot when asked


# ---------------- Only if needed -----------------
# An alternate (manual) method to Set up Blinka
# ---------------- Only if needed -----------------
source weeve/bin/activate               # Activate weeve virtual environment
sudo apt-get install -y i2c-tools libgpiod-dev python3-libgpiod
pip3 install --upgrade RPi.GPIO --break-system-packages
pip3 install --upgrade adafruit-blinka --break-system-packages
```

Install the Adafruit BME280 Library

```
pip3 install adafruit-circuitpython-bme280 # --break-system-packages
```

Install the ADS1x15 Library, the ADS1015 Analog to Digital chip (wind direction)

```
pip3 install adafruit-circuitpython-ads1x15 # --break-system-packages
```

Setup the DS18B20 temperature sensor and install the software library

```
cd
sudo modprobe w1-gpio
sudo modprobe w1-therm
cd /sys/bus/w1/devices
ls
```

The "`ls`" command will display the contents of the devices "folder" in the window. The DS18B20 (*if connected!*) shows up as an address something like "`28-0316853d8fff`" — but each sensor has a unique ID.

```
cd *sensor ID*
cat w1_slave
```

The temperature is located in the second line, take the number given and divide by 1000 to get the temperature in degrees Celsius. Now install the software library:

```
cd
pip3 install w1thermsensor # --break-system-packages
```

You can test all the sensors by running the included test app: `BCRobotics-test-app.py`

Run the Python IDE:

```
>> Thonny
```

Now open the “BCRobotics-test-app.py” test app from the IDE and hit 'F5' to run it. It will continuously print out the readings from the sensors, including the value read from the ADC for the wind direction. Use these values (and a test template for the wind direction) to double check the values used in the driver. Hit “<ctrl> c” to stop the program.

***Note**: This test app is available on Github, and it will run without the external temperature and wind sensors installed. See:*

https://github.com/David-Enst/WeeWX-BCRobotics

To check the versions of all software libraries, enter:

```
>> pip3 freeze
```

WeeWX Setup

The Raspberry Pi runs WeeWX, a freely available weather application written in Python. The installation instructions for WeeWX, repeated below, are also online here:

http://www.weewx.com/docs/5.0/quickstarts/pip/#install-pip-and-venv

Installing WeeWX

Note that the following is based upon WeeWX version 5 installation and setup. Also note that since we are going to be installing a custom driver, weewx must be installed using PIP into a virtual Python environment.

```
sudo apt update                 # You must do this!


# Install WeeWX into the virtual environment
source weeve/bin/activate       # Activate virtual environment
python -m pip install weewx


# Create the station data
weectl station create


# Make WeeWX start when system is booted
sudo sh ~/weewx-data/scripts/setup-daemon.sh   # Make WeeWX start on boot
sudo systemctl start weewx                     # Or just reboot now
```

Enter these parameters, when prompted for by WeeWX, upon start-up:

- **Location** – short description (e.g., BCRobotics in Ottawa, Canada)
- **Latitude & Longitude** – 45.48044, -75.89585
- **Altitude** – 87, meter

- **Units** – metric
- **Station Type** = Simulator (start with this definition)

When you are done, WeeWX will be running in the background as a daemon and simulated readings.

To make sure things are running properly look in the system log for messages from WeeWX.

```
sudo journalctl -u weewx --since today
```

After about 5 minutes, open the station web page in a web browser. You should see your station information and data:

```
~/weewx-data/public_html/index.html       # Or explicitly …
file:///home/user/weewx-data/public_html/index.html
```

The installation of WeeWX results in the following layout:

Role	Symbolic Name	Location
WeeWX Root Directory	*WEEWX_ROOT*	~/weewx-data/
Skins and templates	*SKIN_ROOT*	skins/
User directory	*USER_ROOT*	bin/user
Examples	*EXAMPLE_ROOT*	examples/
Executables	*BIN_ROOT*	~/weewx-data/
SQLite databases	*SQLITE_ROOT*	archive/
MySQL databases		/var/lib/mysql/weewx/
Web pages and images	*HTML_ROOT*	public_html/
Documentation	*DOC_ROOT*	https://weewx.com/docs
Extensions (i.e., the driver)		~/weewx-data/bin/user/

In the locations above, relative paths are *relative to WEEWX_ROOT*. Absolute paths begin with a forward slash (/). The tilde character (~) represents the *home* directory of the user. The executables' location is based upon the installation method defined above.

Installing the Driver

Your hardware requires a driver that is not included with WeeWX, therefore use the WeeWX extension management utility to install the driver. Download the BCRobotics.zip file and install it as follows:

```
source weewx/bin/activate           # Activate virtual environment
weectl extension install  WeeWX-BCRobotics-master.zip
```

Configuring WeeWX

Now we reconfigure the WeeWX setup to use this new driver.

```
sudo systemctl stop weewx
```

```
weectl station reconfigure --driver=user.BCRobotics
rm ~/weewx-data/archive/weewx.sdb   # remove the old database
```

Before Restarting weewx, we now configure the MySQL database and edit the `weewx.conf` file as described below.

Configuring MySQL (Maria Database)

MySQL was installed above. This section sets up the mandatory MySQL database for MyWX application, instead of the default SQLite database. Using the MySQL database is required for multi-user applications (i.e., sharing the data with another client over your local LAN or the Internet).

First step is to install the security certificates for secure SSL connections to the database. There is detailed information on how to create certificates, and installed them, in the document *Weather Station Raspberry Pi Security Setup for MyWX Pro* that can be found here:

`https://github.com/David-Enst/WeeWX-BCRobotics`

Follow these procedures to allow remote access to the MySQL server on your Pi. Note that by default the Maria Data Base only allows local access (i.e., to localhost 127.0.0.1).

In the example below, the local LAN to which the Pi is connected (and your MyWX Android / Windows app and device) has IP addresses in the range `10.0.0.2` to `10.0.0.256`. Adjust as required.

1. In the `/etc/mysql/mariadb.conf.d/50-server.cnf` file change the line as follows to allow remote TCP/IP connections (also make sure that it is not commented out (i.e., `#`)):

   ```
   bind-address = *

   # Add references to required SSL certificates (if needed)
   #
   ssl-ca = /etc/mysql/certs/ca-chain.pem        #ca-certif.pem
   ssl-cert = /etc/mysql/certs/server-cert.pem   #mywx-server-cert.pem
   ssl-key = /etc/mysql/certs/server-key.pem     #mywx-server-key.pem
   ```

2. In the `/etc/mysql/mariadb.conf.d/50-client.cnf` file add the line as follows, to add references to the certificates (if needed):

   ```
   # Example of client certificate usage
   ssl-cert=/etc/mysql/certs/client-cert.pem
   ssl-key=/etc/mysql/certs/client-key.pem
   ```

3. Setup MySQL users with required privileges for remote access:

   Start the MariaDB app, and enter these commands (the user account “weewx” is created when weewx is setup and started). Note that the “`%`” character is a wildcard. Adjust the IP address to match your LAN setup.

   ```
   $ sudo mysql -u root -p       // Start the interactive access to the database
   Enter password:               // your root password

   // Definition of the LAN access account (adjust IP addresses as required)
   //   The default weewx account and your own LAN access account:

   MariaDB [(none)]> GRANT ALL ON weewx.* TO 'weewx'@'localhost' IDENTIFIED BY 'pwd';
   MariaDB [(none)]> CREATE USER 'myweewx'@'10.0.0.%' IDENTIFIED BY 'password';
   MariaDB [(none)]> GRANT ALL ON weewx.* TO 'myweewx'@'10.0.0.%';

   // Definition of the WAN (Internet) access account:

   MariaDB [(none)]> CREATE USER 'secweewx'@'%' IDENTIFIED BY 'password';
   ```

```
MariaDB [(none)]> GRANT ALL ON weewx.* TO 'secweewx'@'%' REQUIRE X509;
MariaDB [(none)]> FLUSH PRIVILEGES;   // ensures the accesses are updated
MariaDB [(none)]> exit;
```

4. To change a password (if needed):

```
> SET PASSWORD FOR 'weewx'@'10.0.0.%' = PASSWORD('newpass');   or
> ALTER USER 'weewx'@'localhost' IDENTIFIED BY 'NEWPASSWORD';
```

NOTE: There is a difference between `REQUIRE X509` vs. `REQUIRE SSL`:

- **SSL** – a user can only connect over secured transport (SSL), but still can still authenticate with *username* and *password*
- **X509** – a user can only connect over secured transport (SSL) *and* the client requires a certificate for authentication.

See the referenced document regarding the creation and installation of required certificates.

You will need to give the necessary permissions to the `weewx` database to whatever MySQL user you choose, by default the WeeWX software uses user `weewx` with the password `weewx`. Defining the default `weewx` user with appropriate permissions, and defining a user with necessary permissions for remote access, for example:

```
sudo mysql -u root                      # Start the interactive access to the database
Enter password:                         # no password by default initially! Just hit <enter>
MariaDB [(none)]> connect weewx         # select the weewx database (optional)
MariaDB [weewx]> ALTER USER 'root'@'localhost' IDENTIFIED BY 'pwd';        # Change the root password!
MariaDB [weewx]> GRANT ALL ON weewx.* TO 'weewx'@'localhost' IDENTIFIED BY 'pwd';   # Basic login for weewx
MariaDB [weewx]> GRANT ALL ON weewx.* TO 'weewx'@'%' IDENTIFIED BY 'pwd';           # WAN access
MariaDB [weewx]> GRANT ALL ON weewx.* TO 'weewx'@'10.0.0.%' IDENTIFIED BY 'pwd';    # LAN access
MariaDB [weewx]> GRANT ALL ON weewx.* TO 'wasweewx'@'%' IDENTIFIED BY 'pwd' REQUIRE X509; # WAN Two way SSL
MariaDB [weewx]>
MariaDB [weewx]> SELECT User, Host FROM mysql.user WHERE Host <> 'localhost';       # Verify accesses
MariaDB [weewx]> ALTER USER 'weewx'@'localhost' IDENTIFIED BY 'newPwd';             # FYI, if needed
MariaDB [weewx]> FLUSH PRIVILEGES;                                          # ensures the accesses are updated
MariaDB [weewx]> SHOW VARIABLES LIKE '%ssl%';                               # Check SSL access
+---------------------+---------------------------------+
| Variable_name       | Value                           |
+---------------------+---------------------------------+
| have_openssl        | YES                             |
| have_ssl            | YES                             |
| ssl_ca              | /etc/mysql/certs/ca-chain.pem   |
| ssl_capath          |                                 |
| ssl_cert            | /etc/mysql/certs/server-cert.pem |
| ssl_cipher          |                                 |
| ssl_crl             |                                 |
| ssl_crlpath         |                                 |
| ssl_key             | /etc/mysql/certs/server-key.pem |
| version_ssl_library | OpenSSL 1.1.1n  15 Mar 2022     |
+---------------------+---------------------------------+
MariaDB [weewx]> exit;
```

```
#
# IMPORTANT: (to avoid issues with your ISP) run this script to secure the MARIADB
#
  pi@MyPi: mysql_secure_installation   # Change Root password, delete test DB etc.
  pi@MyPi:
  pi@MyPi: sudo mysql -u root –p       # Log in with new password now (prompted)
```

See: https://www.tecmint.com/mysql-mariadb-security-best-practices-for-linux/

Configuring WeeWX

Next, you ***must*** change the WeeWX configuration file `weewx.conf` to use MySQL instead of SQLite. In the WeeWX configuration file `weewx.conf`, change the `[[wx_binding]]` section to point to the MySQL database, `archive_mysql`, instead of the SQLite database `archive_sqlite`.

After the change, it will look something like this (change highlighted):

```
[[wx_binding]]
    # The database should match one of the sections in [Databases]
    database = archive_mysql
    # The name of the table within the database
    table_name = archive
    # The class to manage the database
    manager = weewx.wxmanager.WXDaySummaryManager
    # The schema defines to structure of the database contents
    schema = schemas.wview.schema
```

Assuming that you want to use the default database configuration, the `[[MySQL]]` section should look something like this:

```
[[MySQL]]
    driver = weedb.mysql
    host = localhost
    user = weewx
    password = "weewx-password"
```

This assumes user `weewx` has the password “weewx”. Adjust as necessary.

Detailed information on the `weewx.conf` file is found below: *BCRobotics Manual Driver Installation.*

The above commands create the `weewx` user accounts with password `pwd` for use by the WeeWX app and for LAN access to the Maria DB, and the `wasweewx` user with password `pwd` for WAN access from the MyWX Pro app. The `weewx` user account may connect from all possible addresses on the local LAN: `10.0.0.*` (adjust as required for your LAN). The `wasweewx` user account may connect from all possible addresses on the WAN, but only if the required X509 certificates are verified.

The MySQL database files will be in the following location (protected access):

```
/var/lib/mysql/weewx/
```

If you need privileged access to these folders, start the file explorer from the command line as follows:

```
sudo pcmanfm
```

If needed, you can start MySQL as follows:

```
sudo service mysqld start
sudo systemctl start weewx          # Now start the WeeWX daemon
```

***Note**: Also consult the manual driver section below. Certain parameters within the `weewx.conf` file need to be modified!*

Raspbian Command Summary

To edit a system file in Raspbian: `sudo Mousepad filename.` This command may be executed from the File Manager: *`Tools / Run a Command in Current Folder …`*)

***Note**: `sudo` – provides privileged access to files and commands, and `Mousepad` – starts up a simple GUI text editor.*

To make a folder or file writable (via FTP): `sudo chmod a+rwx filename` — the following might be useful to define after installing WeeWX:

```
sudo pcmanfm                                  (start File Manager with privileges)

sudo chmod a+rwx /etc/mysql/mariadb.conf.d/50-server.cnf   (config mariadb)
sudo chmod a+rwx /etc/mysql/mariadb.conf.d/50-client.cnf   (config mariadb)

sudo chmod a-w /etc/mysql/mariadb.conf.d/50-server.cnf (remove writing permission)
sudo chmod a-w /etc/mysql/mariadb.conf.d/50-client.cnf ( so MySQL will work)

sudo chmod a+rwx /etc/mysql/        (for creating cert folder)
sudo chmod a+rwx /etc/mysql/certs/  (for copying certs to the Pi)
sudo chmod a-w /etc/mysql/certs/*   (you must change protections to no-writing or
                                    MySql will not use them!)
sudo chmod a-w /etc/mysql/*
```

To shutdown the Pi:

```
sudo shutdown -h now
```

To start/stop WeeWX:

```
sudo systemctl start weewx
sudo systemctl stop weewx
sudo systemctl restart weewx
```

BCRobotics Manual Driver Installation

Edit the `[Station]` section in `etc/weewx/weewx.conf` to add the following parameters, adjusted for your particular situation:

- `station_type = **BCRobotics**`
- `station_url = https://www.wunderground.com/dashboard?ID=IOTTAWA98`

The value in bold is mandatory definitions for the BCRobotics driver.

Once done, download the BCRobotics.py driver file to your Raspberry Pi from here:

https://github.com/David-Enst/WeeWX-BCRobotics/blob/master/bin/user/

Copy the `BCRobotics.py` file to `/home/dave/weewx-data/bin/user/`

Now manually define and update the parameters in `weewx.conf` as described below.

Definition of the BCRobotics driver by replacing the `[Simulator]` section with the following:

```
[BCRobotics]
   # This defines the "Spark Fun" SEN-08942 / BC Robotics weather stations.
   # See:  https://www.sparkfun.com/products/8942
   #       https://www.bc-robotics.com/tutorials/raspberry-pi-weather-station-part-1/
   # The time (in seconds) between LOOP packets.
   loop_interval = 3
   # Driver mode - tcp, udp, or serial
   mode = serial
   # If serial, specify the serial port device. (ex. /dev/ttyS0, /dev/ttyUSB0,
   # or /dev/cuaU0)
   # If TCP, specify the IP address and port number. (ex. 192.168.36.25:3000)
   port = /dev/ttyS0
   # The amount of time, in seconds, before the connection fails if
   # there is no response
   timeout = 3
   # Debug level - the level of message logging. The higher
   # the number, the more info is logged.
   debug_read = 0
   # The driver to use:
   driver = user.BCRobotics
```

Update the Weather Underground (or other feed) definition, if desired:

```
    [[Wunderground]]
        # This section is for configuring posts to the Weather Underground.
        # If you wish to do this, set the option 'enable' to true,
        # and specify a station (e.g., 'KORHOODR3') and password.
        # To guard against parsing errors, put the password in quotes.
        enable = true
        station = IOTTAWA98
        password = 'abcdebfg'
```

Verify the definition of `[[[Units]]]` to ensure the web pages generated display the correct units:

```
    [[StandardReport]]
        # The StandardReport uses the 'Standard' skin, which contains the
        # images, templates and plots for the report.
        skin = Standard

        [[[Units]]]
            [[[[Groups]]]]
                # group_altitude    = meter
                group_pressure    = hPa        # displayed in hectopascals
                # group_rain        = mm
                # group_rainrate    = mm_per_hour
                # group_temperature = degree_C
                # group_degree_day  = degree_C_day
                # group_speed       = km_per_hour
                # group_speed2      = km_per_hour2
```

Verify the definition of `[[[Labels]]]` to ensure the web pages generated display the correct labels for your data:

```
        [[[Labels]]]
            # Generic labels, keyed by an observation type.
            [[[[Generic]]]]
                inHumidity     = Case Humidity
                inTemp         = Case Temperature
```

```
            # outHumidity    = Outside Humidity
            # outTemp        = Outside Temperature
            # extraTemp1     = Temperature1
            # extraTemp2     = Temperature2
            # extraTemp3     = Temperature3
            # The line below is used to keep the above lines indented properly.
            # It can be ignored.
            unused = unused
```

Update the `[StdConvert]` section is to reflect the fact that all data in the database is stored in `METRIC` by default:

```
    target_unit = METRIC    # Options are 'US', 'METRICWX', or 'METRIC'
```

Update the `[StdCalibrate]` section is to update readings for calibrations purposes. For example, the outside humidity is calculated, but often has a fixed offset from the actual outside humidity; the following expression corrects this:

```
[StdCalibrate]

    [[Corrections]]
        # For each type, an arbitrary calibration expression can be given.
        # It should be in the units defined in the StdConvert section.
        # For example, adjust a 11% standard error of the humidity reading:
        outHumidity = outHumidity+11 if outHumidity+11 < 100.0 else 100.0
```

The database and driver is setup to store values in `METRIC` by default. Therefore, the following updates to the quality control parameters are required:

```
[StdQC]

    [[MinMax]]
        barometer =   800, 1110, mbar # = hPa
        pressure =    800, 1110, mbar  # = hPa
        outTemp =     -50, 49, degree_C
        inTemp =      -25, 49, degree_C
        outHumidity = 0, 100
        inHumidity =  0, 100
        windSpeed =   0, 300, km_per_hour
        rain =        0, 250, mm
```

Finally, update the `archive` section to force `WeeWX` to generate archive records through software generation, since the BCRobotics hardware does not generate them:

```
[StdArchive]
    # If possible, new archive records are downloaded from the station
    # hardware. If the hardware does not support this, then new archive
    # records will be generated in software.
    # Set the following to "software" to force software record generation.
    record_generation = software
```

And also specify that the MySQL database should be used along with the username and password to use:

```
[DataBindings]

    [[wx_binding]]
        # The database must match one of the sections in [Databases].
        # This is likely to be the only option you would want to change.
        database = archive_mysql

[DatabaseTypes]
    # Defaults for SQLite databases
```

```
[[SQLite]]
    driver = weedb.sqlite
    # Directory in which the database files are located
    SQLITE_ROOT = /var/lib/weewx

# Defaults for MySQL databases
[[MySQL]]
    driver = weedb.mysql
    # The host where the database is located
    host = localhost
    # The user name for logging in to the host
    user = weewx
    # The password for the user name (quotes guard against parsing errors)
    password = "12345678"
```

These parameters should all be verified — now restart WeeWX (`sudo /etc/init.d/weewx start`) and check to see if it is running correctly. You can do this by opening the Pi web browser and going to the following page:

```
~/weewx-data/public_html/index.html
```

Or by looking at the end of the syslog file for WeeWX entries:

```
sudo journalctl -u weewx --since today
```

Station data

The following table shows the data provided by the station hardware and those calculated by `WeeWX`.

BCRobotics Station Data			
Database Field	**Observation**	**Loop**	**Archive**
dateTime	-	D	S
usUnits	-	D	S
interval	-	D	S
barometer		S	S
pressure	pressure	H	S
altimeter		S	S
inTemp (Case)	case_temp	H	S
outTemp	outTemp	H	S
outHumidity	outHumidity	H	S
windSpeed	windSpeed	H	S
windDir	windDir	H	S
rain	rain	D	S
rainRate	rainRate	D	S
rainTotal	-	S	S
dewpoint	-	S	S
windchill	-	S	S
heatindex	-	S	S

H indicates data provided by **H**ardware
D indicates data calculated by the **D**river
S indicates data calculated by the StdWXCalculate **S**ervice

Some references:

https://www.bc-robotics.com/tutorials/raspberry-pi-weather-station-part-2/

http://www.weewx.com/docs/usersguide.htm#about

https://docs.python.org/2.7/contents.html

https://www.lenntech.com/calculators/humidity/relative-humidity.htm

https://sourceforge.net/p/raspberry-gpio-python/wiki/Inputs/

https://github.com/David-Enst/WeeWX-BCRobotics

https://mariadb.com/resources/

https://mariadb.com/kb/en/about-mariadb-connector-j/

https://javarevisited.blogspot.com/2016/09/javasqlsqlexception-no-suitable-driver-mysql-jdbc-localhost.html

https://mariadb.com/kb/en/mariadb-vs-mysql-compatibility/

Weather Formulæ

Wind Direction

The wind direction sensor outputs a different number read by an ADC (analog-to-digital converter) based upon the direction—but this number will change a small amount based on temperature, power fluctuations, and the actual resistors in the sensor. so you can't just check if the ADC output matches a number in a list. Instead, they fall within a range as shown in the table.

Actual readings from my sensor, used to fine-tune the Python code in the driver, are shown below. Note that in the `BCRobotics.py` driver the following selections are used to try to cover *all* possible values. This eliminates an out-of-range error, and therefore a faulty wind direction (or program crash!). It is quite likely that the driver will work properly with the range selection values shown, but it does not hurt to do a little test to see the actual values from your device. The numbers are found by manually moving the wind direction sensor to each of the 16 directions and reading the output. Write these numbers down. See the compass rose template provided at the end of this document for your convenience.

Direction (Degrees)	Resistance (Ohms)	Voltage (V=5v, R=10k)	ADC Reading	Range Selection
N (0)	33k	3.84v	20352	19600-20999
NNE (22.5)	6.57k	1.98v	10512	9000-10799
NE (45)	8.2k	2.25v	11952	10800-13999
ENE (67.5)	891	0.41v	2176	2000-2299
E (90)	1k	0.45v	2416	2300-2999
ESE (112.5)	688	0.32v	1712	1000-1999
SE (135)	2.2k	0.90v	4768	4000-4999
SSE (157.5)	1.41k	0.62v	3264	3000-3999
S (180)	3.9k	1.40v	7440	6600-8999
SSW (202.5)	3.14k	1.19v	6336	5000-6599
SW (225)	16k	3.08v	16336	15900-16999
WSW (247.5)	14.12k	2.93v	15536	14000-15899
W (270)	120k	4.62v	24464	24000-24999
WNW (292.5)	42.12k	4.04v	21440	21000-21999
NW (315)	64.9k	4.78v	22992	22000-23999
NNW (337.5)	21.88k	3.43v	18208	17000-19599

Wind Speed

Wind speed is the rate of horizontally moving air past a fixed point, and measured by an anemometer. Some definitions for the weather app (on the Raspberry Pi):

> **Wind Speed** – Current wind speed is the average wind speed recorded over a defined period, 3 seconds for example (i.e., the "LOOP" period).
>
> **Average Speed** – An average of all wind speed-readings (i.e., LOOP readings) collected over a defined period, 5 minutes for example (i.e., the ARCHIVE period).
>
> **Peak Speed** – A rolling value showing the highest wind speed recorded over a given interval (usually the ARCHIVE interval).

Wind Chill and Feels-Like Temperature

Wind Chill

Wind chill temperature only works for temperatures at or below 10°C (50°F) and wind speeds above 4.8kph (3.0 mph). The standard Wind Chill formula from Environment Canada (using °C and km/h; but the same formula converted to °F and MPH is used in the USA) is:

$$T_{wc} = 13.12 + 0.6215T_a - 11.37v^{+0.16} + 0.3965T_a v^{+0.16}$$

Where:

$\mathbf{T_{wc}}$ is the wind chill index, based on the Celsius temperature scale;

$\mathbf{T_a}$ is the air temperature in degrees Celsius; and

$\boldsymbol{v}$ is the wind speed at 10m (33 ft.) standard anemometer height, in kilometres per hour.

When the temperature is −20 °C (−4 °F) and the wind speed is 5 km/h (3.1 mph), the wind chill index is −24. If the temperature remains at −20 °C and the wind speed increases to 30 km/h (19 mph), the wind chill index falls to −33.

Feels-Like Temperature

A heat index value is valid for temperatures at or over 27° Celsius.

There are many formulae devised to approximate the original tables by Steadman. Anderson et al (2013), NWS (2011), Jonson and Long (2004), and Schoen (2005) have lesser residuals in this order. The former two are a set of polynomials, but the third one is by a single formula with exponential functions.

The formula below approximates the heat index in degrees Fahrenheit, to within ±1.3 °F (0.7 °C). It is the result of a multivariate fit to a model of the human body. The temperature must be equal to or greater than 80 °F (27 °C) and relative humidity equal to or greater than 40%. This equation reproduces the above NOAA National Weather Service table (except the values at 90 °F (32 °C) and 45%-70% relative humidity varies unrounded by less than ±1, respectively). *(WeeWX uses this one)*

$$HI = c_1 + c_2T + c_3R + c_4TR + c_5T^2 + c_6R^2 + c_7T^2R + c_8TR^2 + c_9T^2R^2$$

Where:

HI = heat index (in degrees Fahrenheit)
T = ambient dry-bulb temperature (in degrees Fahrenheit)
R = relative humidity (percentage value between 0 and 100)

$c_1 = -42.379$	$c_2 = 2.04901523$	$c_3 = 10.14333127$
$c_4 = -0.22475541$	$c_5 = -6.83783 \times 10^{-3}$	$c_6 = -5.481717 \times 10^{-2}$
$c_7 = 1.228\,74 \times 10^{-3}$	$c_8 = 8.5282 \times 10^{-4}$	$c_9 = -1.99 \times 10^{-6}$

Temperature

The DS18B20 temperature sensor shows up on the Raspberry Pi with an address something like `28-0517c13642ff` as noted in the setup instructions above. The sensor provides a value in centigrade.

The simple formula to convert between Fahrenheit (°F) and degrees Celsius (°C):

$$T_c = {}^{9}/_{5} \times (T_f - 32)$$
$$T_f = ({}^{5}/_{9}) \times T_c + 32$$

Where:

T_c is temperature in Celsius

T_f is temperature in Fahrenheit

WeeWX looks after all these conversions … see the documentation on the Standard web report.

Humidity

The humidity is measured inside the case containing the Pi, therefore this relative humidity (RH) reading is relative to the temperature inside the case (i.e., `case_temp`) and must be converted to a RH for the temperature outside (i.e., the `outTemp`). The following formulæ are used:

See: https://www.lenntech.com/calculators/humidity/relative-humidity.htm

```
# This humidity is measured inside the case, which is warmer than the
# ambient air. Therefore it is converted to external humidity based
# upon the case_temp, in_humidity, pressure, and out_Temp.
#
# Use NOAA formulae:
VapPress = (6.112*math.exp(17.67*case_temp / (case_temp + 243.5)))*(in_humidity/100)
DewPoint = (243.5*math.log(VapPress / 6.112))/(17.67 - math.log(VapPress / 6.112))
absVapPress = 6.11*math.pow(10, (7.5*DewPoint / (237.7 + DewPoint)))
actMixRatio = 621.97*absVapPress / (pressure - absVapPress)

# Adjust humidity reading to the outside temperature
# using NOAA values:
out_humidity = actMixRatio * 10 / (0.42 * math.exp(out_Temp * 0.06235394))
    if out_humidity > 100:
        out_humidity = 100.0
```

Pressure

The current pressure displays in hectopascals (hPa). A trend of the changing pressure shows what has happened over the last 3 hours.

Rainfall

The rainfall amount accumulated over the LOOP period is tracked. Weather Underground displays:

- **Rain** – the accumulation of rain in the past 1 hr and the past 24 hrs
- **Rate** – the current rate of rainfall in mm/hr for the LOOP period

There are certain situations where a single random rain "tick" may occur:

- Certain gusts of strong wind could cause a random tick—if the "bucket" is not exactly level and when at rest on the high side a strong gust could knock it back;
- Melting frost or dew may accumulate enough to cause a random tick over time;
- An almost full "bucket" and a sudden gust of wind can also cause it to tick over.

The WeeWX driver therefore has a random tick detector to catch single ticks. The downside is that the first tick when it actually starts to rain will be ignored.

Wunderground

The WeeWX software can share its reading with your own Weather Underground web page. Register your Personal Weather Station (PWS) at wunderground.com, where you will receive a station ID along with a password. Enter these into the `weewx.conf` file as directed here:

http://weewx.com/docs/usersguide.htm#[StdRESTful]

Wunderground registration detail example:

Your Station ID: **ABCDEFGxx**

Your Station Key/Password: **abxycdij**

Example WU PWS URL:

https://www.wunderground.com/personal-weather-station/dashboard?ID=IOTTAWA98

Once your PWS is setup you can use this WU URL in your `[Station]` section's `station_url` setting.

Raspberry Pi Documentation

Follow these links:

https://github.com/David-Enst/WeeWX-BCRobotics/tree/version3 # The BCRobotics Driver

https://www.raspberrypi.org/documentation/configuration/

https://www.raspberrypi.org/documentation/remote-access/

https://domoticproject.com/accessing-raspberry-ddns/ (Accessing from the Internet)

Each segment is a 22½° ark; therefore, NNE (22½°) would encompass readings from 11¼° to 33¾°.