

Raspberry Pi Internet Radio

Constructors Manual



A comprehensive guide to building Internet radios using the Raspberry Pi and MPD (Music Player Daemon)

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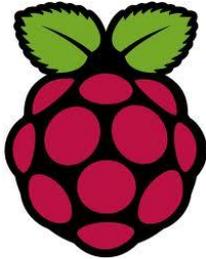
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Chapter 1 - Introduction



This manual describes how to create one of the most popular Internet Radios using the Raspberry Pi educational computer. This manual provides a detailed overview of construction and software installation.

The source and basic construction details are available from the following Web site:

https://bobrathbone.com/raspberrypi/pi_internet_radio.html

The main features of the Raspberry Pi internet radio are:



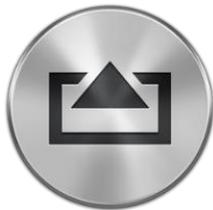
Raspberry Pi Internet Radio

Turn your Raspberry Pi into an Internet Radio using a variety of designs as shown in this manual. It runs on both 32 and 64-bit systems.



Media Player

Play your favourite MP3 tracks from a USB stick, SD card or from a NAS (Network Attached Storage).



Airplay Receiver

This design allows the Raspberry Pi to act as an Airplay receiver. Music tracks can be played from your Apple or Android mobile phone or tablet.



Spotify Receiver

Turn your Raspberry Pi into a Spotify Receiver. This requires a Spotify Premium account.



RSS Feed Reader

This software also allows you to read any configured RSS feed. For example, your favourite news feed.



Bluetooth speaker/headphone support

This manual contains instructions how to run the radio software with Bluetooth speakers or headphones. Bluetooth versions 1.x through 5.x supported depending upon the Raspberry Pi model used.



Digital Clock

The Internet Radio software displays as standard a digital clock and date with alarm and snooze functions.



Shoutcast

Shoutcast radio is a streaming audio which is used by some 50,000 Internet Radio stations across the internet. This radio software, using a Web interface, allows multiple playlist creation from Shoutcast radio stations by genre or country which can then be selected through the radio or Web interface menus.



Icecast

Icecast is free streaming software which supports a variety of streams such as MP3 and OGG. Icecast can optionally be installed on the Raspberry Pi and allows the currently playing station or track to be streamed around the local network or out to the Internet (Legal and Copyright issues apply).



User Interface and displays

This design caters for a number of user interfaces such as push-buttons, rotary encoders or touch screens. Also, a number of displays such as 2 and 4-line LCDs, OLED displays, TFT or full graphical displays such as HDMI and touch-screen are supported. Examples are shown later on in this manual.



Web interface

The radio software includes an optional Web interface powered by Apache. This allows stations and playlists to be selected via Web pages on your PC, mobile telephone or tablet.



The **eSpeak** engine is a small, lightweight text-to-speech (TTS) program that supports a large number of languages. It is used with the radio software to assist blind or visually impaired users by “speaking” the menus. It can also be used with radios without a screen to navigate the menus.



Language files enable the messages to be displayed in the user's own language, such as French, Dutch or Spanish. The user can easily create their own language file if required.



Highly configurable allowing a broad range of displays such as 2 or 4-line LCDs, TFTs, graphic screens or HDMI monitors to be selected at installation time. Likewise, the user input devices such as rotary encoders or buttons etc. An audio configuration script selects a range of audio devices such as DACs or Bluetooth speakers.



Support for English, Russian/Cyrillic and Western European character set, dependent upon LCD capabilities. Both native and Romanized (Convert to Latin) characters supported.

A full specification can be found in *Appendix B – Technical specification* on page 368.

REMEMBER TO HAVE FUN DOING THIS PROJECT!



Figure 1 Fun radio using an old toaster (Courtesy Robert Knight)



This is a large document. Use the **Quick Links** at the start of this document to navigate to the section you are interested in. The chapters are laid out in the order you will need them.



This manual is continually being updated. Please check to see if there is a more up to date manual before commencing any work.

Is the size of this manual worrying you then try starting with *Raspberry Pi Internet Radio, A Beginners Guide* at:

<https://bobrathbone.com/raspberrypi/documents/RPi%20Radio%20beginners%20guide.pdf>

Examples

This design caters for both the complete novice and more advanced constructors. Do not be put off by the size of this manual as it shows a lot of different designs. Simply read through the following examples and decide which one is the best for you. Some examples are shown in the following pages. This manual is designed to provide inspiration for your own ideas and unique solution to building an Internet Radio using the Raspberry Pi.

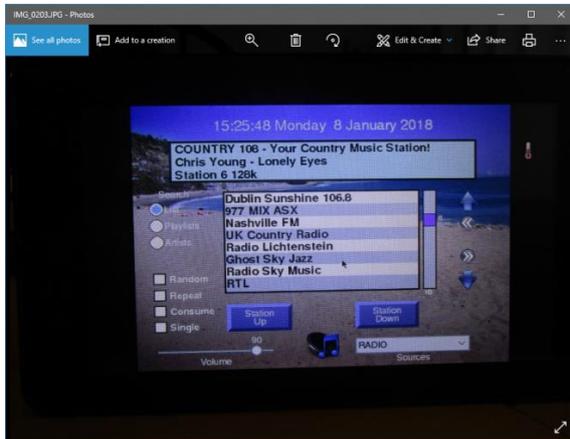


Figure 2 Raspberry pi 7-inch touchscreen radio



Figure 3 HDMI Television running the radio



Figure 4 Vintage tuning touch-screen radio

The Radio software supports the Raspberry Pi 7-inch touch screen. Using the graphic version of this software, the radio can be operated using the touch screen or a mouse and HDMI screen or TV with HDMI. A keyboard can also be attached and used to operate the radio. The touch screen version supports the same functionality as the LCD versions of the radio except for timer and alarm functions. The touch screen can also be configured to use either rotary encoders or buttons.

The HDMI/Touch screen version of the radio can also be configured to run in a window on the Raspberry Pi desktop. Here it is running on the HDMI input of a typical flat-screen television. It can also be configured to use an IR remote control using a FLIRC USB IR detector.

As an alternative to the above design this touch-screen radio is made to look like a vintage radio with a tuning dial. The green slider marks the currently playing station. When a station name is touched on the screen then the slider jumps to that position and plays the selected radio station. The design supports multiple pages of radio stations which can be scrolled left or right. The volume control slider is at the bottom of the screen. This version currently only plays radio stations and not media or Airplay. The touchscreen can also be configured to use either rotary encoders or buttons.



Figure 5 Adafruit 3.5-inch TFT

This example shows an Adafruit 3.5-inch TFT (Thin Film Transistor) touch-screen running the graphical version of the software (Version 6.7 onwards). This is the smallest screen that is currently supported.

Installation of the Adafruit TFT touchscreen is found in the section called *Installing the Adafruit 2.5 and 3.5-inch TFT* on page 122.



Figure 6 Radio using the Adafruit LCD plate

Example of the PI internet radio using an Adafruit RGB-backlit LCD plate for Raspberry PI from AdaFruit industries. It has five push buttons and is one of the easiest options to construct. If you want to build this into a case then don't use the buttons supplied with the kit but use external buttons.



Figure 7 Lego Internet Radio

Example of a fun radio built using this design and Lego from Alan Broad (United Kingdom). This really puts the fun back into computing.



Figure 8 Pi radio using rotary encoders

The rotary encoder switch version of the radio consists of a Raspberry PI connected to an Adafruit 20-character x 4-line RGB LCD display housed. It is all housed in a LogiLink PC speaker set with two rotary encoders. The rotary encoders also have push buttons (Push the knob in). The left one is the *Mute* switch and the right one is the *Menu* switch. The blue glow in the sub-woofer opening comes from a bright blue LED.



Figure 9 Old Zenith radio using rotary encoders

Example of the PI radio from Jon Jenkins built into an old Zenith valve radio case. The two original controls have been replaced by two rotary encoders. The old valve radio inside has been completely removed and replaced with the Raspberry Pi and radio components. The LCD display has been built into the top so as not to spoil the original face of the radio. This is a fine example of what can be done with this project.



Figure 10 Transparent Perspex Radio



Figure 11 Perspex radio rear view

The above example built by the author has a transparent perspex front and back panel. It uses a Raspberry Pi with a HiFiBerry sound card and a Velleman 30 watt amplifier.



Figure 12 The Radio running on a Pi Zero

This is an example of the radio running on a Raspberry Pi Zero. In this example it uses a micro to standard USB adaptor to connect a simple USB hub. A USB sound dongle and Tenda wireless adapter are plugged into the USB hub. A USB to Ethernet adapter can also be used in place of the wireless adapter. The display used is the Adafruit LCD plate. Also note that the Pi Zero comes with an unpopulated 40 pin GPIO interface. You need to either directly solder wires to the GPIO interface (Not advised) or solder either a 26 or 40 pin male header (Advised).

This beautiful radio is a fine example of the latest version of the design built by the author. It is using a Raspberry Pi model 2B and rotary encoders with inbuilt push button. The display is a 4 x 20 LCD. The sound system is a Velleman 30-Watt amplifier (bottom right) and two 5 ¼ inch 50-watt speakers. It has an IR sensor (Left speaker on the right side) and an activity LED (between the two knobs).



Figure 13 Boom Box radio front view

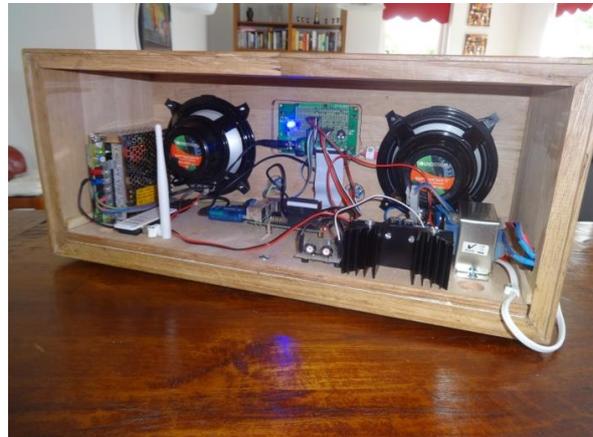


Figure 14 Boom Box Radio rear view

Below is a Raspberry Pi radio built into a old wine box. It uses a 2x8 character LCD and rotary encoders. The amplifier and loud speakers are from a set of old PC speakers.



Figure 15 Raspberry Pi Wine Box radio



Figure 16 Wine box internet radio internal view



Figure 17 Very small radio using the Cosmic Controller

Here is a really cute radio made using the IQaudIO Cosmic Controller and Olimex 128x64 pixel OLED display. The Cosmic Controller provides an excellent solution where space is limited or you simply want a very small radio. The audio output is on the rear of the case.

Note: The Cosmic Controller has been discontinued and is difficult to find but you can still build the radio with separate components.

Below is a fascinating use of both modern and bygone era technology. The radio shown below was created by Broesel from Austria. In this design a Raspberry Pi has been used with the software described in this manual. However, the audio amplifier has been constructed with an ECL84 vacuum valve. The ECL84 valve provides a two-stage mono audio amplifier driving an elliptical wide frequency response loud speaker. Broesel has very kindly provided the full construction details at the Radio Board Forum. See: <http://theradioboard.com/rb/viewtopic.php?t=6314>



Figure 18 RPi radio with two-stage valve amplifier



Figure 19 The RPi valve radio chassis view



Figure 20 Pimoroni Pirate Radio

The radio software supports the Pimoroni Pirate radio with pHat BEAT.

The pHAT BEAT gives high-quality, digital, amplified, stereo or mono audio and 16 RGB LEDs, in two rows of 8, which are ideal as a VU (Volume Unit) indicator, and 6 buttons to control the radio (Five on the left and one at the top). See:

<https://shop.pimoroni.com/products/pirate-radio-pi-zero-w-project-kit>

It can also be ordered with an additional speaker.



Figure 21 PiFace CAD Radio with IR Remote Control

The radio supports the PiFace Control and Display (CAD) board. This is a good choice for complete beginners but is quite slow. See: http://www.piface.org.uk/products/piface_control_and_display/

The PiFace CAD has 5 push buttons, a reset button (not currently used) and an Infra Red (IR) sensor for a remote control. It has one drawback in that the push buttons are on the bottom of the unit. The PiFace CAD uses the Serial Peripheral Bus interface (SPI) on the Raspberry Pi.

Below is an example of a Raspberry Pi Internet radio, made by the author, running the graphic version of the radio which gives a vintage look-and-feel to the final radio. Two vintage Bakelite knobs help complete the vintage appearance.



Figure 22 Vintage look-and-feel Internet radio

The Raspberry Pi model 3B outputs to a Pimoroni 3W stereo D-Class amplifier driving two 3-inch loudspeakers. It is housed in a wooden case painted black with two vintage radio Bakelite knobs.



Figure 23 Vintage look-and-feel - rear view

Vintage Radio Conversion

This version of the software allows for the program to be configured without a screen for use with a vintage radio as shown below:



Figure 24 Philips BX490A (1949) Vintage Internet Radio

The radio is a Philips BX490A manufactured in the Netherlands in 1949. The purpose of this design is retain as much of the original look and feel of a vintage radio which has been converted to run as an Internet radio. It does not have any LCD display. In the above example the following controls are used:

- Far left switch - Simple tone control
- Middle left switch - Volume and mute switch
- Middle right switch – Radio channel (Tuner) or media track selection
- Far right switch – Menu switch (8 positions)
- Push button on right side (Not shown) - Standard menu switch

At the top left the so-called magic eye tuning indicator has been replaced with a Red,Green,Blue status LED. In the above picture the LED is glowing green (Normal operation). This window also contains the IR sensor and activity LED for a remote control. If the radio is busy (loading stations for example) it glows blue. For an error or shutdown the LED glows RED. The IR remote control also flashes red to indicate IR remote control activity.

The software allows espeak to be configured to ‘speak’ station and search information etc. The details on how to construct a similar project is contained in the following documents:

<http://www.bobrathbone.com/raspberrypi/documents/Raspberry%20PI%20Vintage%20Radio.pdf>

<http://www.bobrathbone.com/raspberrypi/documents/Raspberry%20PI%20Vintage%20Radio%20operating%20Instructions.pdf>

The illustration below shows a French Radio Schneider Frères Rondo from the 1950's which has been converted to an internet radio by Franz-Josef Haffner, from Germany.



Figure 25 Vintage radio using a touch screen

What makes this project also very interesting is that he has removed all of the RF section of the valve radio leaving only the audio amplifier and power supply. This is an excellent example of combining old and new technology to extend the life of these increasingly rare radios.

See the Vintage Radio supplement for further details using the following link:

<https://bobrathbone.com/raspberrypi/documents/Raspberry%20PI%20Vintage%20Radio.pdf>



Figure 26 Vintage Radio with AM transmitter

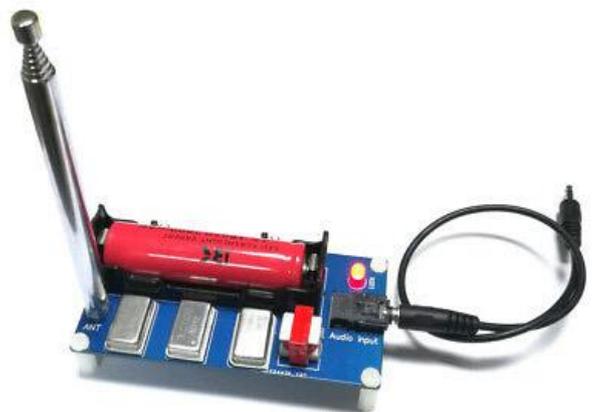


Figure 27 Lusia DIY 3-channel AM transmitter

Another way to connect to a vintage radio (if it is working) is to use a Raspberry Pi and a low power AM transmitter. In the above illustration, the box on the right contains a Pi Zero W running the radio software with a tuning knob. The audio comes out of a USB DAC which connects to the Lusia 3-channel AM transmitter which transmits on the 300 Meter wavelength (AM waveband) to a vintage radio. In this example the radio is the British made **Bush DAC 90A** medium/longwave receiver.

Details on construction can be found in the following document:

<https://bobrathbone.com/raspberrypi/documents/Raspberry%20PI%20Vintage%20Radio.pdf>

Chapter 2 - Hardware overview

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Radio variants	33
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Principle components

The principal hardware required to build the radio consists of the following components:

- Current versions of the Raspberry PI computer (Version 1 boards no longer supported)
- Push buttons or rotary encoders for the user interface
- A display such as a HD44780U LCD, OLED or a Raspberry PI touch-screen display
- Optional Digital to Analogue Converter (DAC) Sound card
- Optional InfraRed (IR remote control)

Raspberry Pi computer

The **Raspberry Pi** is a credit-card-sized single-board computer developed in the United Kingdom by the [Raspberry Pi Foundation](https://www.raspberrypi.com) originally with the intention of promoting the teaching of basic computer science in schools. It has however become immensely popular with hobbyists and engineers. The official site for the Raspberry Pi Web site is <https://www.raspberrypi.com>

The Raspberry Pi model 3B



Figure 28 Raspberry Pi Model 3B Computer

The Raspberry Pi 3B has full size HDMI port.

More information on the Raspberry Pi computer may be found here:

http://en.wikipedia.org/wiki/Raspberry_Pi

If you are new to the Raspberry Pi try the following “Getting started” guide:

<https://www.raspberrypi.com/documentation>

Raspberry Pi model 4B

The Raspberry Pi model 4B was released in June 2019.



Figure 29 Raspberry Pi Model 4B Computer



Note: The Raspberry Pi 4B requires **Raspberry Pi Buster** or **Bookworm** SD card. It will not work with earlier OS versions. However, the recommended OS for the Radio software is **Bookworm**.



Figure 30 USB-C plug

The power supply on the model 4B uses a USB-C connector. The usual micro-USB power supply will not fit used for other Raspberry Pi models will not fit. The USB-C specification allows the cable to be inserted either way around. When purchasing the model 4B also purchase the official model 4B power supply which is 5 Volt 3 Amps.



Figure 31 Raspberry Pi MicroHDMI cable

The model 4B also requires an official Raspberry Pi Micro-HDMI cable for each of the micro-HDMI ports (This is not the same as the Pi Zero HDMI adapter). Order one or two of these adaptors if using an HDMI or TV screen.

Audio and video output jack

Earlier versions of the Raspberry Pi have a separate audio output jack and composite video output. Later versions (3 and 4) of the Raspberry Pi have a new AV (Audio/Video) port which combines the audio and video signals in a single jack. Instead of using a standard composite cable, this new connector requires a 4 pole 3.5mm AV cable. To complicate matters: not all of these cables are the same! However, existing audio jack plugs are compatible with the new AV connector.

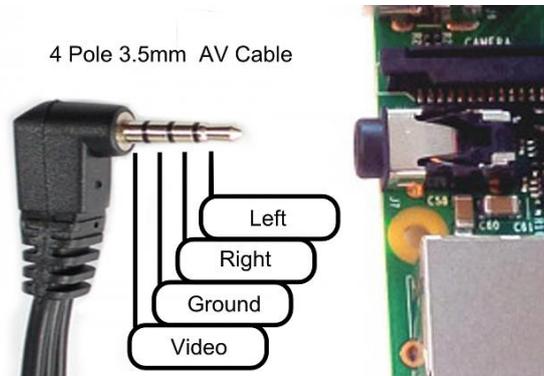


Figure 32 Raspberry Pi B+ AV cable

When choosing a cable, seek an **iPod 4 pole AV** cable. This will however result in the left and right audio channels being reversed but otherwise provides the proper connections. Using other cables, such as a camcorder cable will be hit or miss. Typically, camcorder cables have the wrong pin connections for Video and Ground. This change also can cause some issues with shared grounding with audio speakers. If separate audio and composite AV connector is required, these can be split apart using the same jack inputs as for the model A and B.

Raspberry Pi Zero and Pi Zero W

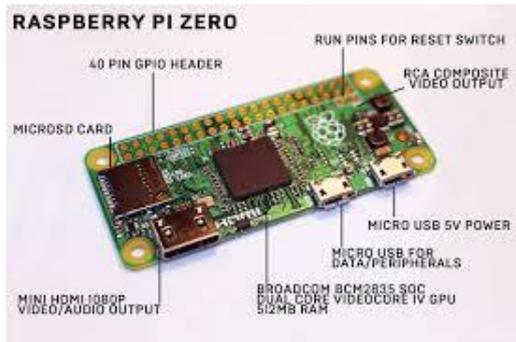


Figure 33 Raspberry Pi Zero

On the original Pi Zero network connection is only possible with either a USB to Ethernet adapter or a Wi-Fi Dongle. Note that the USB is a Micro USB and will need a micro-USB to standard USB adapter. The Pi Zero W has onboard Wi-Fi and Bluetooth and is a better choice for the radio.



Figure 34 USB Ethernet adapter

In October 2021 the 1GHz quad core Pi Zero 2 was added to the list of Raspberry Pi's.

The Raspberry Pi Zero does not have an onboard audio output jack. Sound must be played through either the HDMI port or a USB sound dongle (See Figure 12) or one of the Pi Zero DAC boards available from manufacturers such as **IQaudio**, **HiFiBerry**, **Pimoroni** or **JustBoom**. Alternatively, use Bluetooth speakers. See *Connecting a Bluetooth audio device* on page 138.

One useful and simplest audio device is the **Pimoroni Audio DAC Shim** for the Pi Zero/W. Because the Audio DAC SHIM adds no extra bulk to the Raspberry Pi Zero it allows the GPIO header to be accessed as normal, for example other HATs can be fitted on top of it. It pushes over the GPIO header and doesn't require any soldering. It is a very simple way to provide audio output to the Raspberry Pi Zero/W. See *Pimoroni Audio DAC Shim for Pi Zero* on page 26

It is also possible to use a so-called Low-pass filters which allow output from the GPIO PWM (Pulse Width Modulation) pins. This requires soldering and board construction skills and isn't recommended for beginners.

See *Using PWM GPIOs for sound output on a Pi Zero* on page 340 in *Chapter 16 Advanced topics*.

Pi-Pico is not supported



Figure 35 Unsupported Pi Pico

The **Pi Pico** is **NOT** supported nor will it ever be. The Pi Pico uses the RP2040 processor which is a micro-controller. It is completely different from the usual Raspberry Pi's. Unlike the Raspberry Pi, it does not run Linux and therefore cannot run the radio software or the Music Player daemon (MPD). It uses either **Circuit Python** or **C/C++** for development.

Also, there is no HDMI, Ethernet or Wi-Fi port available without additional expansion boards.

More information on the Raspberry Pi Pico can be found at:

<https://www.raspberrypi.org/products/raspberry-pi-pico/>

Raspberry Pi 400

In November 2020 the Raspberry Pi foundation released the model 400. This is housed in a keyboard case with all connectors including a 40-pin GPIO header at the back of the unit. Most notably it does not have a 3.5mm audio Jack. If connected to a HDMI monitor or TV then sound can be played through the HDMI interfaced speakers on the monitor/TV. Alternatively, a USB DAC or Bluetooth speakers can be used. As the RPi 400 has a 40-pin GPIO header it can, in theory, be connected to a suitable DAC via a ribbon cable.



Note: At the time of writing no testing with a DAC other than a USB DAC has been done by the author.



Figure 36 Raspberry Pi 400 running the graphical radio

Specification

- Broadcom BCM2711 quad-core Cortex-A72 (ARM v8) 64-bit SoC @ 1.8GHz
- 4GB LPDDR4-3200
- Dual-band (2.4GHz and 5.0GHz) IEEE 802.11b/g/n/ac wireless LAN
- Bluetooth 5.0, BLE
- Gigabit Ethernet
- 2 × USB 3.0 and 1 × USB 2.0 ports
- Horizontal 40-pin GPIO header
- 2 × micro-HDMI ports (supports up to 4Kp60)
- H.265 (4Kp60 decode); H.264 (1080p60 decode, 1080p30 encode); OpenGL ES 3.0 graphics
- MicroSD card slot for operating system and data storage
- 78- or 79-key compact keyboard (depending on regional variant)
- 5V DC via USB C connector

Displays

The HD44780U LCD display



Figure 37 The HD44780U LCD display

The HD44780U LCD interface is an industry standard interface for a variety of LCD displays. These can come in various sizes but the two lines by 2x16 or 4x20 character displays are the most popular. The software for this Internet radio supports either display. Most of these modules compatible with the Hitachi HD44780U LCD controller so there is a wide choice of these displays.



Figure 38 OLED 4 x20 LCD display

The latest displays use **OLED character** displays (Organic Light Emitting Diode) and give very good results and are becoming more popular when compared to traditional LCD displays.

See <https://en.wikipedia.org/wiki/OLED>

For pin-out details see LCD pin outs on page 40.



Also see *Configuring Russian/Cyrillic text* on page 193.

Midas LCD displays with VEE



Figure 39 Midas LCD display with VEE

Some LCDs from Midas are compatible with the HD44780U except for pin 15 (VEE) which outputs a negative voltage. For pin-out details see LCD pin outs on page 40.

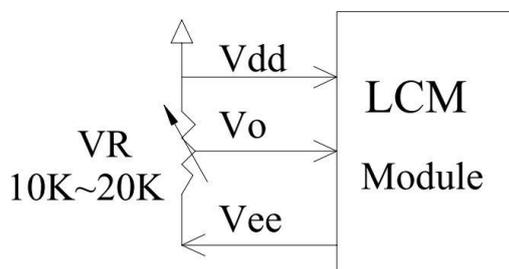


Figure 40 HD44780 potentiometer wiring

The diagram on the left shows the wiring for the 10K contrast potentiometer.

Pin	Name	Description
2	VDD	+5 Volt
3	VO	Contrast adjustment
15	VEE	Negative voltage output



Do not connect pin 15(VEE) to the +5V supply. It will damage the LCD and possibly the Raspberry Pi.



WARNING: DO NOT CONNECT AN I2C BACKPACK TO THIS TYPE OF DEVICE AS BACKPACKS CONNECT +5V ONTO PIN 15 AND WILL DAMAGE BOTH THE BACKPACK AND THE LCD.



The term **LCD** is used throughout this manual to mean both traditional **LCDs** and **OLED character** displays which are gradually replacing **LCDs**.

Midas Character OLED with MC0100 Controller

So-called Character OLEDs are gradually replacing LCDs. Midas market a wide range of such displays.

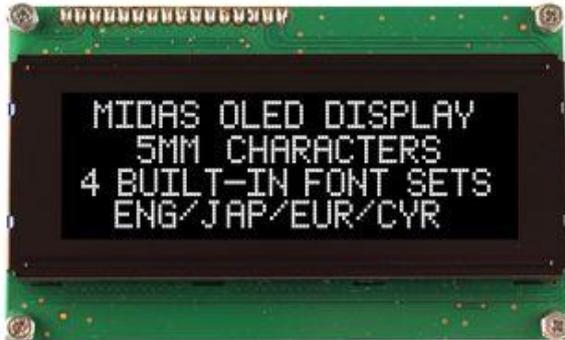


Figure 41 Midas character OLED

These displays use the **MC0100** controller which is largely compatible with the Hitachi **HD44780U** controller.

This controller can support various built-in font sets such as English, Western European, Japanese and Russian.

Since OLEDs generate their own illumination, they do not need pins 15 and 16 connected for backlighting.

Olimex OLED 128x64 pixel screen



The Olimex 128x64 pixel OLED is a low cost, low power, high contrast LCD display with a UEXT connector. It is controlled via the I2C or SPI interface. The power supply required is only in the range of 1 uA in sleep mode, 200 uA in operating mode and 7mA in display ON mode. View area is 21 x 11 mm. It is particularly useful where space is very limited.

See:

<https://www.olimex.com/Products/Modules/LC/D/MOD-OLED-128x64/open-source-hardware>



Note: The Olimex OLED screen is not a particularly fast device when compared with say an LCD or graphics screen. However, its biggest advantage is its size.

Sitronix SSD1306 128x64 pixel OLED



Figure 42 Sitronix SSD1306 128x64 pixel monochrome OLED

The Sitronix SSD1306 128x64 pixel 0.96-inch OLED is display marketed under various names (Such as Makerhawk) has just four connections for the I2C interface.

The wiring from left to right is:

1. VCC +5 volts – GPIO header pin 2
2. GND (0 volts) – GPIO header pin 6
3. SCL I2C Clock – GPIO 3 (pin 5)
4. SDA I2C Data – GPIO 2 (pin 3)

The I2C interface hex address for this device **0x3C**. It uses the `ssd1306_class.py` driver.



Note: It is not currently possible to flip the display up-side down due to limitations of the SSD1306 driver software. Use the LUMA.SSD1306 driver instead which can be flipped.

SSH1106 1.3-inch I2C monochrome OLED



Figure 43 1.3-inch SH1106 I2C OLED

This 1.3-inch monochrome display connects via the I2C interface. It uses the SH1106 display chip.

The wiring from left to right is:

1. VCC +5 volts – GPIO header pin 2
2. GND (0 volts) – GPIO header pin 6
3. SCL I2C Clock – GPIO 3 (pin 5)
4. SDA I2C Data – GPIO 2 (pin 3)

The I2C interface hex address for this device **0x3C**. This OLED uses the LUMA driver. See *Installing LUMA monochrome OLEDs* on page 124.

SH1106 128x32 pixel OLED monochrome OLED

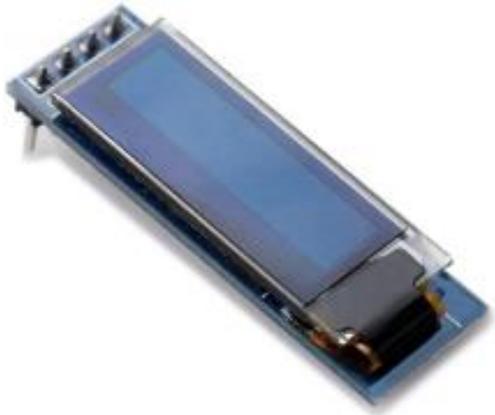


Figure 44 - 0.91-Inch 128x32 OLED

These 0.91 x 0.38-inch 128x32 pixel monochrome OLED display modules connect via the I2C Serial Interface. They are marketed under various names such as WayinTop or AzDelivery. This is the smallest display supported by this project.

Because of its size, the text can be hard to read. Also, one peculiarity is that the PIL driver software recognises the display as being 128x64 pixels and not 128x32. It is most useful where there is little space available for a display.



Note: OLED devices are very slow when compared to character LCDs or Graphics (touch) screens. Their main advantage is their size.

Grove LCD RGB Backlight



Figure 45 Grove LCD RGB Backlight

The **Grove JHD1313 LCD RGB** backlight is a 2x16 character LCD with an RGB backlight.

The Grove LCD RGB uses two controllers. **AIP31068L** – I2C controller for the LCD **PCA9632DP1** – I2C RGB backlight driver

The interface is the 2-wire I2C interface plus +5V power supply. The backlight can be set to any colour and is configurable in the radio software.

RPi 1.3" 128x64 OLED (SH1106) with joystick



Figure 46 RPi 1.3" 128x64 OLED with joystick

This device uses a 1.3-inch 128x64 pixel OLED display driven by an SH1106 chip and the SPI interface.

It comes with a 5-button joystick (on the left) and three push buttons (on the right). It is designed to fit on a 40-pi Raspberry Pi Zero-W but can also fit on a standard Raspberry Pi such as a 3B or 4B. If fitted to a Pi Zero Audio, audio output can be provided using a USB to jack-plug audio adaptor or Bluetooth speakers. speakers/headphones Pimoroni Audio Shim (See: *Pimoroni Audio DAC Shim for Pi Zero* on page 26).



Note: This device comes wired to use an SPI interface. It can be modified to use the I2C interface using the I2C address **0x03**. In such a case use the LUMA-SH1106 I2C driver (See *Converting the 1.3" OLED pHat to use the I2C interface on page 379*).



Please note that the Pimoroni Audio DAC shim is not compatible with devices using SPI. This is because the OLED driver uses GPIO 25 which is also the MUTE pin on the Audio DAC shim. It Audio shim can only be used if the OLED with joystick is re-wired to use the I2C interface.

The following table shows the functions of the various switches and the GPIO pins that they are using. The Joystick and button wiring cannot be physically rewired however the Radio software needs to know what the wiring of each switch is and this is configured using the **configure_radio.sh** program.

Table 1 - 1.3" OLED with joystick button designations

Joystick	Buttons	Radio Function	GPIO Pin
Up		Channel Up	6
Down		Channel Down	19
Left		Volume Down	5
Right		Volume Up	26
Push		Menu switch	13
	KEY1	Mute Switch	21
	KEY2	Not used	n/a
	KEY3	Not used	n/a

Using DAC Sound Cards

The sound output of the on-board audio jack on the Raspberry Pi is known to be limited. Using a DAC (Digital Audio Converter) will give much better quality and output. Several types are available. The one you choose depends upon your requirements. These DAC cards use PCM (Pulse Code Modulation) technology and the Raspberry Pi i2s interface.

The following sound cards and adapters are supported in this project:

Manufacturer	Section	Page
HiFiBerry	HiFiBerry DAC	22
IQaudio	IQaudio DAC sound products	23
Justboom	JustBoom DAC products	23
Various	PCM5102A DAC Sound Card	25
Pimoroni	Pimoroni audio DACs	25
Adafruit	Adafruit speaker bonnet	27
Allo	Allo DAC products	27
Waveshare	Waveshare WM8960 Audio Hi-Fi Sound Card	28

If you are going to use an external amplifier then almost any DAC will do. If you want a complete solution, a DAC card with an in-built amplifier (typically 3W up to 25W) is a good choice. The output from these in-built amplifiers is usually so-called class D-type amplification. Another consideration is the required connection to the amplifier copper, S/PDIF or optical audio connection (Toslink).

If price is a big consideration there are a number of very reasonably priced DACs which emulate some of the better-known ones and use the same device driver software as the one, they are emulating. See *Table 29 Sound card Device Tree overlays* on page 370.

For more information on DACs see https://en.wikipedia.org/wiki/Digital-to-analog_converter

HiFiBerry DAC

This version supports the HiFiBerry DAC from HiFiBerry. See <https://www.hifiberry.com>. There is a comprehensive range of DACs available from this manufacturer. A few are shown below:

1. HiFiBerry DAC+ Light/Light – Entry level and standard solution
2. HiFiBerry Digi+ Light – Optical (TOSLink) and RCA connectors
3. HiFiBerry AMP+ –Standard DAC with a 25W D-Class amplifier
4. HiFiBerry DAC+ Zero Form Factor
5. HiFiBerry 3W Miniamp Zero Form Factor

The HiFiBerry DAC Plus

The HiFiBerry DAC PLUS uses the 40-pin connector and has an unpopulated 40-pin header to extend the GPIO pins on the HiFiBerry DAC to use with other cards.



Figure 47 HiFiBerry DAC Plus

The DAC plus uses the 40-pin connector on new Raspberry Pis. A 40-pin dual in line male header is required (purchase separately).

Solder the 40-pin male header into the component side of the HiFiBerry DAC as shown Figure 48 below. The Radio controls and LCD screen for example are then connected on this this header.



Figure 48 HiFiBerry mounted on the Raspberry Pi

The A+/B+/Pi2 uses the following pins supporting PCM.

Pin 12 GPIO18 PCM_CLK (**Conflict!**)

Pin 35 GPIO19 PCM_FS

Pin 38 GPIO20 PCM_DIN

Pin 40 GPIO21 PCM_DOUT

(All set to mode ALT0)

Pin 12 (GPIO) conflicts with the down switch on the radio. Wire the down switch to GPIO 10 (Pin 19) and configure the **down_switch=10** parameter in **/etc/radiod.conf** or by running the **configure_radio.py** program.



Note: All settings in the `/etc/radiod.conf` file use GPIO numbers and NOT physical pin numbers. So, in the above example `down_switch` is GPIO 10 (Physical pin 19).



The Pimoroni pHat is compatible with HiFiBerry DAC (Not DAC+) and uses the same Device Tree (DT) overlay.

IQaudio DAC sound products

IQaudio DAC also have a comprehensive range of products. Again, these provide excellent results. These cards fit within the Pi's form factor and provide additional full access to the Pi's 40way I/O signals allowing easy addition of IR sensors, Rotary Encoder or i2c devices (such as OLED screens) etc. See <http://iqaudio.co.uk>

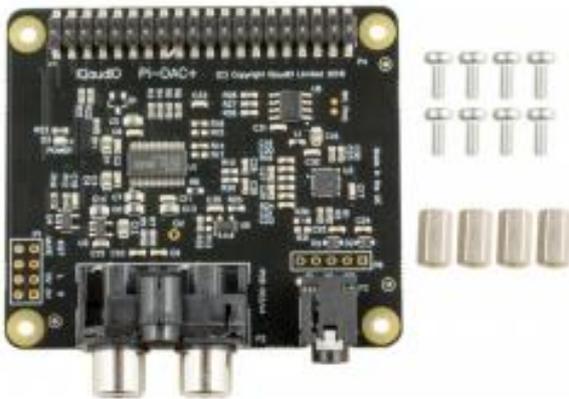


Figure 49 IQaudio DAC plus

DAC for the Raspberry Pi. This latest revision of the IQaudio Pi-DAC PRO and is pre-programmed for auto detection. Line out: 2x Phono/RCA
Headphone: 3.5mm socket.

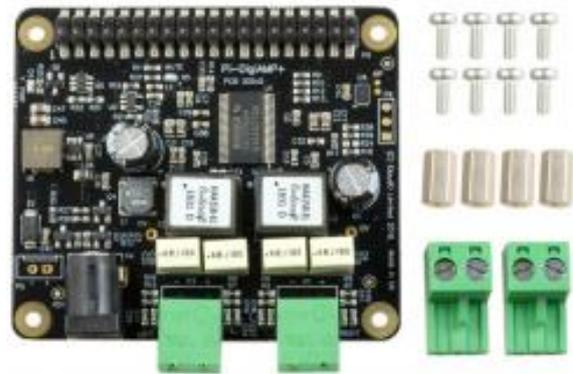


Figure 50 IQaudio Pi-DigiAMP+

This provides the DAC+ along with a 35W amplifier which fits the. Raspberry Pi A+/B+/RPi2/3/3B+. This card requires supports up to 24v power supply and delivers the full 2.5amp to the Pi.

JustBoom DAC products

The construction using **JustBoom** products is similar to other sound cards. The radio must be wired as shown in *Table 5 Radio and DAC devices 40-pin wiring* and NOT the 26-pin wiring version shown in Table 4. The `/etc/radiod.conf` configuration file must also be configured to support these devices by running the audio configuration program.

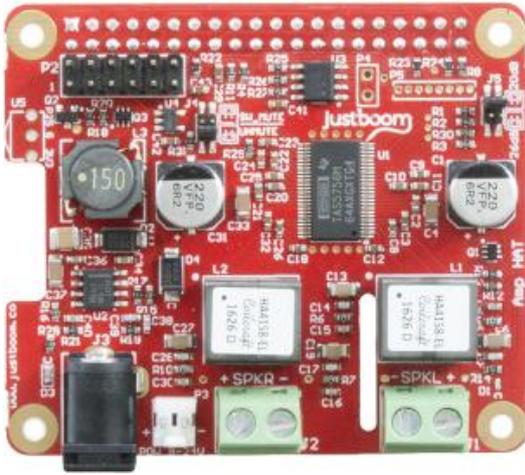


Figure 51 JustBoom Amp HAT

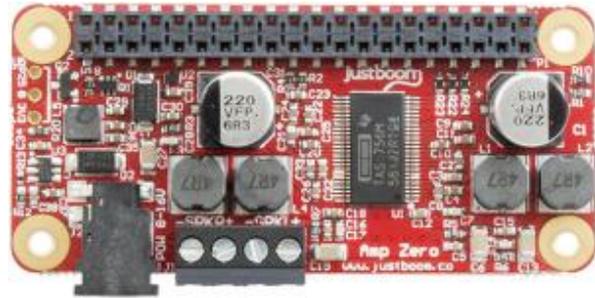


Figure 52 JustBoom Amp Zero pHAT

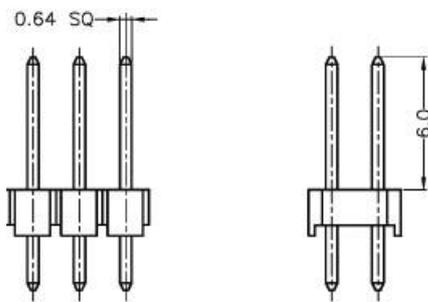


Figure 53 JustBoom Zero stacker requirements

The **JustBoom** Zero boards are used with stackers or installed directly on the Raspberry Pi Zero. Some stackers and some 2x20 male headers on the market though are too thin or too short to provide good contact with the board. Use stackers that the pins are squared and are at least 0.6mm in width. If you are soldering the 2x20 male header on the Raspberry Pi Zero make sure that the pins are 0.6mm in width and 6mm in usable height.

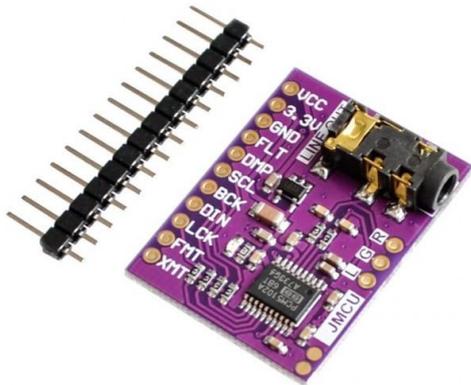


Figure 54 Using the 40-pin stacker

Plug a suitable stacker onto the Raspberry Pi Zero. Plug the JustBoom Zero board on top of the stacker so that the pins protrude through the JustBoom Zero board.

Plug the radio interface card or ribbon cable (not shown) on top of these protruding pins.

PCM5102A DAC Sound Card



DAC	Function
FLT	Filter Select. Normal latency (Low) / Low latency (High)
DMP	De-emphasis control for 44.1kHz sampling rate: Off (Low) / On (High)
FMT	Audio format selection: I2S (Low) / Left justified (High)

Also edit `/boot/config.txt` and enable the I2S dtoverlay.

```
dtparam=i2s=on
```

There are a number of inexpensive DACs which use the PCM5102A chip and have a 3.5mm Stereo Jack 24. These give a very reasonable 24-bit sound. Despite the fact that they claim to be a pHat they do not plug directly into the Raspberry Pi. Use either jumper wires or build your own interface board. These boards use the HiFiBerry DAC device driver and the I2S dtoverlay. Wiring as below:

DAC	RPi	Pin
VCC	5V	2
3.3V	N.C.	-
GND	GND	6
FLT	N.C.	-
DMP	N.C.	-
SCL	N.C.	-
BCK	GPIO18	12
DIN	GPIO21	40
LCK	GPIO19	35
FMT	N.C.	-
XMT (1)	3.3V	1

N.C. Not Connected. (1) Connect via 10K resistor.

Pimoroni audio DACs

Pimoroni pHat DAC

The Pimoroni pHAT DAC provides an affordable high-quality DAC for the Raspberry Pi. The 3.5mm stereo jack comes soldered onto the board already. Though designed to match the format of the Raspberry Pi Zero it is compatible with all 40-pin GPIO Raspberry Pi variants.

Features:

- 24-bit audio at 192KHz
- Line out stereo jack
- pHAT format board
- Uses the PCM5102A DAC to work with the Raspberry Pi I2S interface

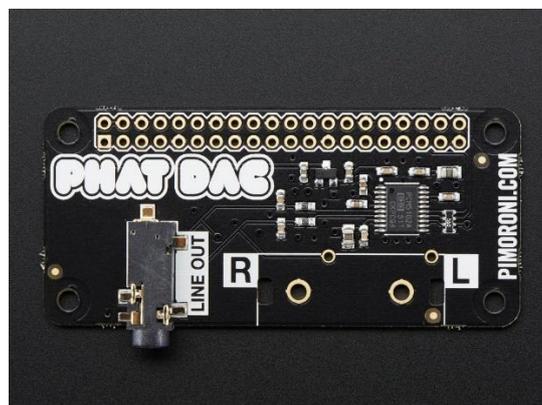


Figure 55 Pimoroni pHAT DAC



Note 1: Do not use the 40 female header that comes with the board but use a 40-pin extender so that other cards can be used on top of it.



Note 2: The Pimoroni pHat is not completely compatible with the HiFiBerry DAC although it uses the same software driver. In particular to use the Alsa sound mixer a package called **pulseaudio** is required. However, **pulseaudio** is not compatible with several of the features of this package such as the **espeak** speech package. Normally the **pulseaudio** package must be removed as shown in the section called *Installing pulseaudio* on page 103. The Pimoroni pHat DAC will run fine without any mixer controls.

Pimoroni Audio DAC Shim for Pi Zero



Please note that the Pimoroni Audio DAC shim is not compatible with *RPi 1.3" 128x64 OLED (SH1106) with joystick* (See page 20). This is because the OLED driver uses GPIO 25 which is also the MUTE pin on the Audio DAC shim. It Audio shim can only be used if the OLED with joystick is re-wired to use the I2C interface (See *Converting the 1.3" OLED pHat to use the I2C interface* on page 379).

Pimoroni now supply a DAC which uses PCM5100A DAC chip. It has a friction fit header which slips pushes down over the Pi Zero 40-pin GPIO header and doesn't require any soldering and is removable.

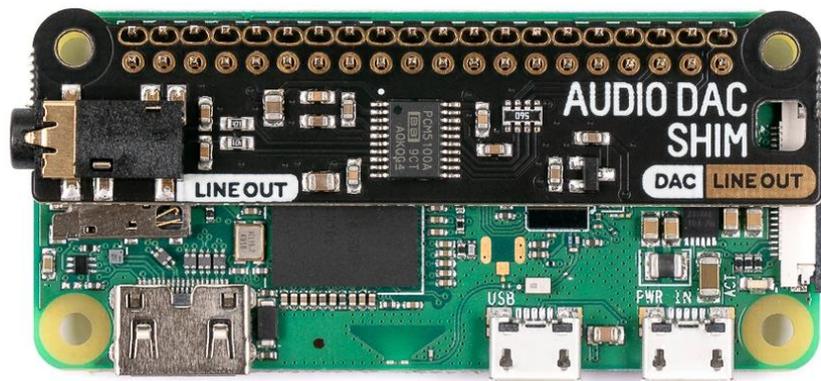


Figure 56 Pimoroni Audio DAC Shim for Pi Zero/W

The above figure shows a Pimoroni Audio DAC shim fitted to a Pi Zero W. The PCM5100A DAC chip takes high quality digital audio from the Pi Zero and pipes out crisp, line-level 24-bit / 192KHz stereo audio through the 3.5mm jack.

Because the Audio DAC SHIM adds no extra bulk to the Raspberry Pi Zero it allows the GPIO header to be accessed as normal, for example other HATs can be fitted on top of it. It should also fit easily inside any standard case. It's a simple way to add an audio output to the Pi Zero. Pimoroni even claim that it can also be fitted to a Raspberry Pi 400.

It uses the same driver as HiFiBerry DAC (Not DAC Plus or Digi). This can be configured during installation of the radio software.

Alternatively, it can be manually configured using by adding the following lines to the [All] section of `/boot/config.txt` file:

```
dtoverlay=hifiberry-dac
gpio=25=op,dh
```

If you're using a Pi that has an audio jack you might also need to disable onboard audio by either adding a # to the beginning of the following line or setting **on** to **off**.

```
#dtparam=audio=on
```

Adafruit speaker bonnet



Figure 57 Adafruit Speaker Bonnet

The Adafruit speaker bonnet is primarily designed for the Raspberry Pi Zero format but can be used on any Raspberry Pi.

It consists of a stereo 3W amplifier connected to the I2S interface of the Raspberry Pi via a 40-pin DIL female header.

It can be purchased with two miniature speakers or it may be used with any small 4 or 8-Ohm speakers.

Allo DAC products

Allo is a manufacturer of very high-quality audiophile sound products. A good example is the **Allo Piano 2.1 HiFi DAC (EU)** with **woofer output** as shown below.

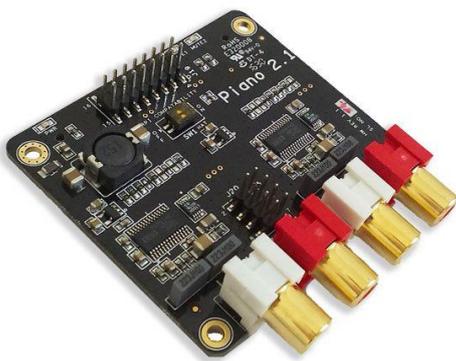


Figure 58 Allo Piano 2.1 HiFi DAC with woofer

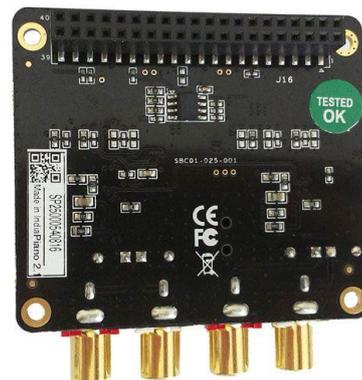


Figure 59 Allo Piano 2.1 HiFi DAC (Rear)

The **Allo Piano** has two outputs, one for normal sound ranges and one for a sound woofer. The board comes pre-programmed as 2.1 for the Raspberry Pi.

The subwoofer has 2 outputs (Stereo left and Right) but is mono only. However, it uses a second I2S channel on GPIO5 and mute signal on GPIO6 both used to control the woofer amplifier. This conflicts with the LCD signals `lcd_data4` and `lcd_data5` pins.



Allo products currently need to be specially configured to correct this conflict. See *Configuring Allo Sound Cards* on page 132.

Further information about Allo products can be found at <https://www.allo.com/sparky/index-dac.html>

Waveshare WM8960 Audio Hi-Fi Sound Card

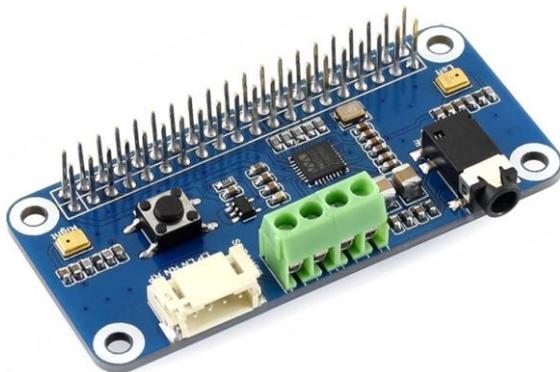


Figure 60 Waveshare WM8960 Sound Card

The Waveshare WM8960 Audio Hi-Fi Sound Card integrates WM8960 low power stereo CODEC, which communicates via I2S interface. It also has two high-quality MEMS silicon Microphones (Not used in this project) mounted on the left and right of the board. Onboard standard 3.5mm earphone jack, play music via external earphones. Onboard dual-channel speaker interface, directly drives speakers.



These cards are often sold with a pair of speakers which plug directly into the card. The particular speakers shown are 5W enclosed speakers.

For more information about this sound card see <https://www.waveshare.com/wm8960-audio-hat.htm>

This card has special installation and uninstallation scripts. See *Installing the Waveshare WM8960 DAC* on page 134.

Pimoroni Products

Pimoroni are a UK based company who produce electronic products for both Raspberry Pi and Arduino. They make a range of all-in-one audio boards for Raspberry Pi, with high-quality digital audio. Their Website is at <https://shop.pimoroni.com/>

Pimoroni Pirate Radio



Figure 61 Pimoroni Pirate Radio - Rear view

The illustration on the left shows the rear of Pimoroni Pirate radio. The amplifier consists of dual I2S DAC/amplifiers for stereo audio (MAX98357A) at 3 Watts per channel.

The Pirate radio comes as a kit (Soldering skills required). The Pimoroni software is disabled and the software from this project used instead. See *Installing Pimoroni Pirate Radio (pHat BEAT)* on page 119. Note: It does not have a screen.

Pimoroni Pirate Audio



Figure 62 Pimoroni Pirate Audio

No soldering skills are required to construct this project when using a Pimoroni Pirate Audio range of products and a Raspberry Pi Zero with a pre-soldered 40-pin header. This unit requires version 6.14 or later of the radio software.

It comes with a 240x240 pixel colour 1.3-inch IPS (In-plane switching) display which gives a very good viewing angle. The display is driven by an ST7789 controller.

There are four variants of the Pimoroni Audio but they all use the same DAC and display software:

1. Pirate Audio Speaker - MAX98357A DAC with mini 1W / 8Ω speaker
2. Pirate Audio Line-out - PCM5100A DAC chip with 3.5mm output stereo jack
3. Pirate 3W Stereo Amp - MAX98357A DAC with mini 3W amplifier output
4. Pirate 3W Headphone Amp - PCM5100A DAC driving a PAM8908 headphone amplifier



Note: The software for Pimoroni Pirate Audio is very basic at the moment in particular the menu selection function. It is hoped to improve this at a later date.

Touch-screens

Raspberry Pi 7-inch touch screen

As an alternative to building a radio using limited LCD screens it is possible to build a radio using the Raspberry Pi 7-inch or 3.5-inch touch screen or any other HDMI screen (touch-screen or otherwise). If the screen does not have touch capability, then it is possible to use it with a mouse or keyboard or both. Also, the touch screen can be used in conjunction with rotary encoders or push buttons.



Figure 63 Raspberry Pi 3 with 7-inch touch screen

There is a very good setup guide for the Raspberry Pi touch-screen at:

<https://www.modmypi.com/blog/raspberry-pi-7-touch-screen-assembly-guide>

Adafruit 2.8 and 3.5-inch TFT touch-screens

The radio software supports the Adafruit 2.8 and 3.5-inch TFT touch screen (480x320 and 720x480 pixels respectively). The small size can make the controls difficult to use but it will still work. It is best to use a touch-screen stylus.



Figure 64 Adafruit 3.5-inch TFT touchscreen



Note: This software has only been tested with the Raspberry Pi 7-inch touch screen and the Adafruit 3.5-inch TFT touch-screen . Smaller than 7-inch screens may prove difficult to operate. The following resolutions are supported: 800x480, 720x320, 480x320 or 1024x600 pixels.



Please also note that touch screen functionality has nothing to do with the radio software. Touch screens emulate mouse functions such as click, drag and hover using standard mouse routines. Should you use another touch-screen other than the one recommended and this does not work then you need to solve this first (or use a mouse/keyboard). Regrettably the author cannot provide any support on how to configure other touch screens.

If the screen is displaying upside-down then edit the **/boot/config.txt** configuration file and add the following line.

```
lcd_rotate=2
```

Note: you must disable the *DRM VC4 V3D driver* as shown on page 90 for this to work. Reboot the Raspberry Pi for the change to take effect.

Waveshare 2.8 and 3.5-inch TFT touch-screens

Waveshare provide a 2.8 and 3.5-inch TFT touch screen (480x320 and 720x480 pixels respectively). These have 26-pin DIL connector which plugs in directly to the GPIO header.

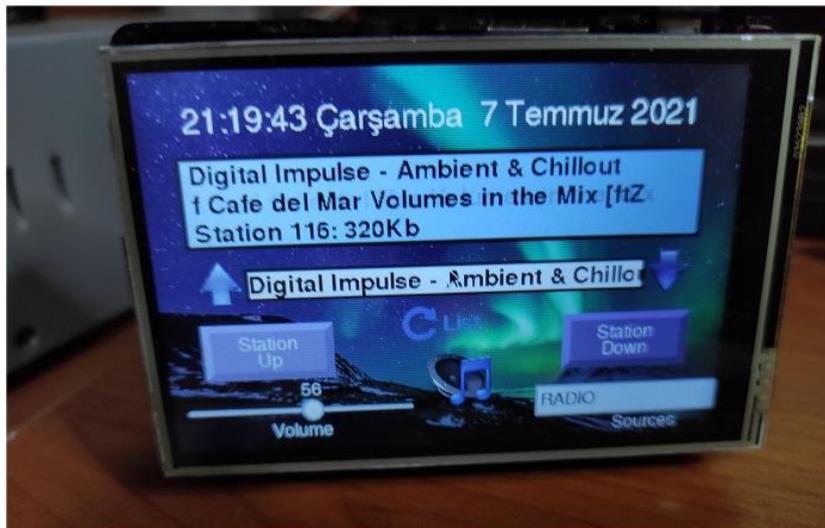


Figure 65 Waveshare 2.8-inch TFT touch screen

The above screen shows a 2.8-inch Waveshare touch screen (Courtesy - Recep A. Güleç). Note the revised layout due to its size when compared to the 3.5 and 7-inch touch screens.

Connection via ribbon cable

Smaller touch screens usually plug directly into the Raspberry Pi GPIO header, however that may not be convenient especially if you want to build it all into a case. Fortunately, it is possible to purchase a 40-way DIL male to female ribbon cable which allows the display to be panel mounted.

The following illustration shows TFT screen on the connectors side. If it is required the display can be put on the GPIO side but will be displayed upside down. Luckily it is easy to flip the display upside down as shown in the installation instructions.



Figure 66 TFT connected by a 40-pin male/female ribbon cable

MHS 3.5-inch RPi Display

The MHS 3.5-inch RPi Display appears to be a badged version of the same hardware as the Waveshare 3.5" TFT. The installation software is also very similar.



Figure 67 MHS-3.5-inch RPi Display (Courtesy Brent Fraser)

More information the MHS 3.5-inch RPi Display will be found at:
http://www.lcdwiki.com/MHS-3.5inch_RPi_Display

Radio variants

Before starting you need to make a choice which type of radio you are going to build. There are several combinations of user interface and display type which can be constructed as shown in the following tables.

Table 2 Display Type options

Display Type	
1	Two-line 8-character LCD
2	Two-line 16-character LCD
3	Four-line 16-character LCD
4	Four-line 20-character LCD
5	Adafruit 2x16 RGB Plate (I2C)
6	Raspberry Pi 7-inch touch screen
7	Olimex 128 by 64-pixel OLED
8	Adafruit 3.5-inch TFT touch screen
9	No display (Vintage radio design)
10	Pirate Radio (No display)
11	Waveshare 1.8/2.3" touchscreen
12	Grove I2C 2-line 16-char. LCD
13	OLED displays supported by LUMA (SH1106, SSD1306 etc.)
14	SH1106 128x64 1.3" OLED (SPI interface)

Table 3 User interface options

User interface	
1	Five or six push buttons
2	Two rotary encoders with push buttons
3	Adafruit RGB plate with push buttons
4	Raspberry Pi 7-inch touch-screen
5	Adafruit 2.8" or 3.5" TFT
6	Mouse (HDMI/Touchscreen only)
7	Keyboard (HDMI/Touchscreen only)
8	IQaudio Cosmic controller
9	Pirate Radio – 6 push-buttons
10	IR remote control – all versions
11	Waveshare 1.8/2.3" touchscreen
12	pHat with 5-position joystick and 3-buttons

Any type of HD44780U LCD display can be used with any user interface. The HD44780U can either be connected directly to the GPIO pins or via a so-called I2C (also known as IIC) backpack.

The Adafruit RGB plate has a two-line 16-character display and comes with five inbuilt pushbuttons. It also has its own I2C interface using the MCP23017 chip so it does not require a separate I2C backpack.

The **PiFace CAD** comes with a two-line 16-character display and comes with six inbuilt pushbuttons. It uses the SPI interface from Motorola. The touch screens can be used with or without rotary encoders or push buttons. The touch screen variants can also use a mouse and keyboard.

It is a simple choice of which display (two or four lines, 8,16 or 20-characters LCDs or a touch screen or HDMI screen, OLED display or Pirate radio) and whether to use rotary encoders or push-button switches as the user interface. The rotary encoder options give the most natural feel for the radio as most conventional radios use knobs to control the volume and station tuning. The keyboard interface, whilst supported on the touch-screen versions, is a very limited option.

There is a configuration program called **configure_radio.sh** which configures the choice of display and user interface required. It can be safely re-run at any time.

The vintage radio software (Display option 9) specifically intended for converting an old radio to an Internet radio whilst retaining the original look and feel of the radio. It has no LCD display. The four lines LCD can display more information than two-line versions.



Note: The touch screen software (**gradio.py** or **vgradio.py**) cannot be run at the same time as the LCD version of the radio software (**radiod.py**). It is a case of using one or the other. It is however possible to switch between **gradio.py** or **vgradio.py** programs during operation.

Connecting the LCD display

There are two ways of wiring up the display:

- Directly connect the LCD to the GPIO pins. This uses six GPIO pins.
- Connection via an I2C backpack. This uses the two-pin I2C interface

The first choice uses more wiring but is the cheapest option. The second choice uses an I2C backpack which is an extra component to be purchased. However, I2C backpacks are reasonably cheap.

Housing the radio

This manual describes a couple of ways of housing the radio. A few ideas are below:

- A custom-built case as shown in this manual
- Old plastic boxes or food containers
- Construct a case using Lego
- Use a pair of speaker housings that have enough room
- Install in an old vintage radio (really cool)
- Use an old wooden wine box
- Use an old video recorder, CD player or desktop set
- Buy a PC speaker set with enough room to build in the radio.

Figure 68 Some examples of radio cases



Take a look at the constructor's gallery at https://bobrathbone.com/raspberrypi/pi_internet_radio.html to get some ideas that other constructors have used.



Note: Don't forget to make sure that there is adequate airflow through the radio housing to allow cooling of the Raspberry PI and other components. If necessary, drill at least five or six holes at the top and bottom of the housing.



If you decide to use a metal case (not advised) you will need a Wi-Fi dongle with an aerial mounted externally to the case. Also, the case must be earthed at the main supply both for safety reasons and to prevent interference with sound and/or the LCD screen

Building in an IR sensor and remote control

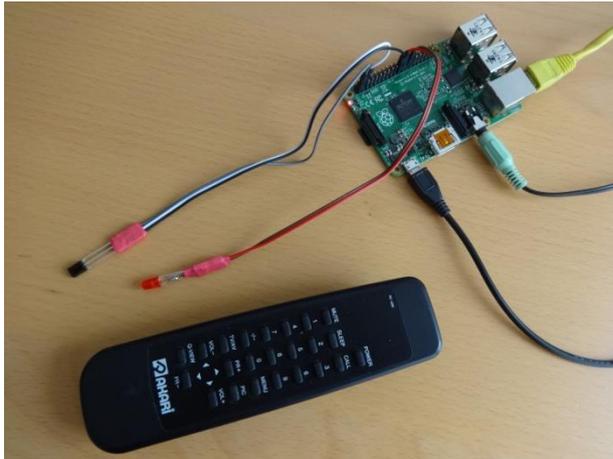


Figure 69 IR Sensor and Remote control

The radio can be built with an IR Sensor and remote control. Also included is an activity LED which flashes when the remote control is used.

A **TSOP382xx** series IR Sensor is used in conjunction with almost any remote control.

An activity LED can also be added which flashes every time remote control signal is detected. The remote control provides the same functionality as the buttons or rotary encoders.

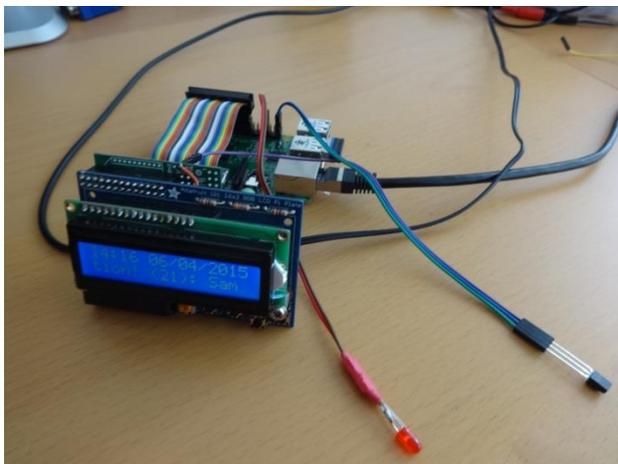


Figure 70 Adafruit and IR sensor and activity LED

The **AdaFruit** RGB plate can also be fitted with an IR sensor and activity LED but needs a model B+, 2B or 3B (40 GPIO pins) and 26 pin extender as shown in Figure 87 on page 50.



Note that a 40 pin Raspberry PI is needed as the Adafruit Plate occupies all 26 pins on the 26 pin versions of the Raspberry PI. If not planning to fit an IR sensor and activity LED then the 26-pin version Raspberry Pi may be used.

Chapter 3 – Wiring and Hardware

Contents chapter 3	Page
Raspberry Pi wiring	37
Rotary encoder wiring	40
LCD Module Wiring	47
Power supply considerations	49
GPIO Hardware Notes	50
Parts List	51

Raspberry Pi wiring

Table 4 and Table 5 on the following pages 37 and 38 respectively show the interface wiring for both the push button and rotary encoder versions of the radio. There are two versions of the wiring, 26 and 40-pin versions (Table 4 and Table 5 respectively). The connections used by the radio are highlighted in yellow. The **IQaudio** or **JustBoom** and newer **HiFiBerry** DACs require 40-pin versions of the Raspberry Pi. The 40-pin version of the wiring is recommended for all new projects.



If using DAC products do not use the 26-pin version of the wiring but use the wiring shown in Table 5 on page 38. The table below is now redundant except for very early versions of the radio.

Table 4 Controls and LCD wiring 26 pin version

Pin	Description	Radio Function	Name	LCD pin	Push Buttons	Encoder (Tuner)	Encoder (Volume)
1	3V3	+3.3V supply			COMMON		
2	5V	5V for LCD		2,15			
3	GPIO2	I2C Data*	I2C Data				
4	5V						
5	GPIO3	I2C Clock*	I2C Clock				
6	GND	Zero volts		1,3*,5,16		Common	Common
7	GPIO 4	Mute volume			MUTE		Knob Switch
8	GPIO 14	Volume down	UART TX		LEFT		Output A
9	GND	Zero Volts					
10	GPIO 15	Volume up	UART RX		RIGHT		Output B
11	GPIO 17	Channel Up			UP	Output B	
12	GPIO 18**	Channel Down			DOWN	Output A	
13	GPIO 27	LCD Data 4		11			
14	GND	Zero Volts					
15	GPIO 22	LCD Data 5		12			
16	GPIO 23	LCD Data 6		13			
17	3V3	+3.3V supply					
18	GPIO 24	LCD Data 7		14			
19	GPIO 10**	Channel Down	SPI-MOSI		DOWN	Output A	
20	GND	Zero Volts					
21	GPIO 9	IR Sensor in (1)	SPI-MOSO				
22	GPIO 25	Menu Switch			MENU	Knob Switch	
23	GPIO 11	IR LED out (1)	SPI-SCLK				
24	GPIO 8	LCD E	SPI-CE0	6			
25	GND	Zero Volts					
26	GPIO 7	LCD RS	SPI-CE1	4			

Colour Legend Radio I2C (shared) SPI Interface

* These pins are used for the I2C LCD backpack if used instead of the directly wired LCD to GPIO pins.

** Pin 18 is used by some DACs so pin 10 should be used for the down switch.

Table 5 Radio and DAC devices 40-pin wiring

Pin	Description	Radio Function	Name	Audio DAC Function	LCD Pin	Push Button	Encoder (Tuner)	Encoder (Volume)
1	3V3	+3.3V supply	+3.3V	+3.3V		+3.3V		
2	5V	5V for LCD	+5V	+5V	2,15			
3	GPIO2	I2C Data	I2C Data	I2C Data				
4	5V			+5V				
5	GPIO3	I2C Clock	I2C Clock	I2C Clock				
6	GND	Zero volts	0V	0V	1,3*,5,16		Common	Common
7	GPIO 4	Mute volume				MUTE		Knob Switch
8	GPIO 14	Volume down	UART TX			LEFT		Output A
9	GND	Zero Volts		0V				
10	GPIO 15	Volume up	UART RX			RIGHT		Output B
11	GPIO 17	Menu switch				MENU	Knob Switch	
12	GPIO 18			I2S CLK				
13	GPIO 27							
14	GND	Zero Volts		0V				
15	GPIO 22			Mute				
16	GPIO 23	Channel down		Rotary enc A		DOWN	Output A	
17	3V3	+3.3V supply		0V				
18	GPIO 24	Channel up		Rotary Enc B		UP	Output B	
19	GPIO 10		SPI-MOSI					
20	GND	Zero Volts						
21	GPIO9		SPI-MISO					
22	GPIO 25	IR Sensor		IR sensor				
23	GPIO 11		SPI-SCLK					
24	GPIO 8	LCD E	SPI-CE0		6			
25	GND	Zero Volts		0V				
26	GPIO 7	LCD RS	SPI-CE1		4			
27	DNC			PiDac+ Eprom				
28	DNC			PiDac+ Eprom				
29	GPIO5	LCD Data 4			11			
30	GND	Zero Volts						
31	GPIO6	LCD Data 5			12			
32	GPIO12	LCD Data 6			13			
33	GPIO 13	LCD Data 7			14			
34	GND	Zero Volts						
35	GPIO 19	IQaudio DAC+	I2S	I2S				
36	GPIO 16	IR LED out						
37	GPIO 26							
38	GPIO 20	IQaudio DAC+	I2S DIN	I2S DIN				
39	GND	Zero Volts						
40	GPIO 21	IQaudio DAC+	I2S DOUT	I2S DOUT				
Colour Legend		Radio	IQaudio	I2C (shared)	SPI Interface			



Note: Make sure you are using the correct columns in the above wiring tables. Use column 6 (Push Buttons) for the push button version and the last two columns (Encoder Tuner/Volume) for the rotary encoder version. Also note that the configuration in `/etc/radiod.conf` uses **GPIO** numbers and not physical pin numbers. For example, `menu_switch=17` is using **GPIO 17** (Physical pin 11).

Version 1 boards (early boards)

Version 1 boards only had 26 pins and did not have internal pull-up resistors on the GPIO inputs. It has become increasingly difficult to support version 1.0 boards and you are advised to purchase a newer Raspberry Pi board for this project. Tips for using version 1 boards will be retained in this manual; however, if there is a problem, regrettably no support can be provided. As shown in the diagram below, wire one side of the switches to the 3.3V pin. Wire the other side of each switch to the GPIO pin as shown in the last column of the above table. Also wire this same side of the switch to the GND(0V) pin via a 10KΩ resistor. See Figure 71 below.

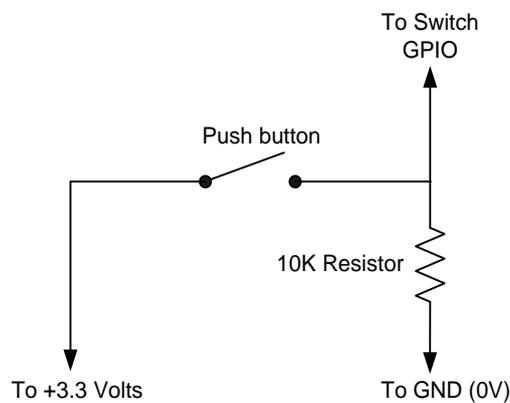


Figure 71 Push-button Wiring version 1 boards

Version 2, 3 or model B+ boards

Wire one side of the push-buttons the GPIO pin as shown in the last column of Table 5 on page 38. Wire the other side of the switches to either +3.3V (Old wiring scheme) or to GND (0V) (Preferred wiring scheme recommended for new projects). Whichever wiring you use; the radio configuration program will ask which wiring scheme is being used. Version 2 onwards boards have internal pull up/down resistors and don't require external resistors. In fact, including these can cause problems.

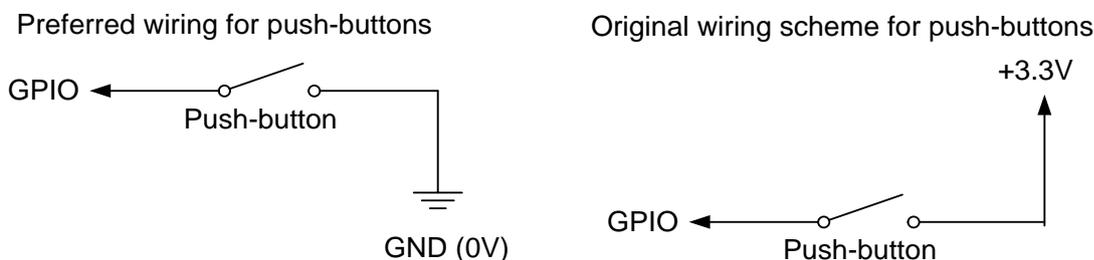


Figure 72 Push-button wiring version 2 onwards boards

The scheme chosen must be configured using the `pull_up_down` parameter in `/etc/radiod.conf` to 'up' or 'down'. See the section called *Configuring button interface with pull up resistors* on page 180.

Rotary encoder wiring

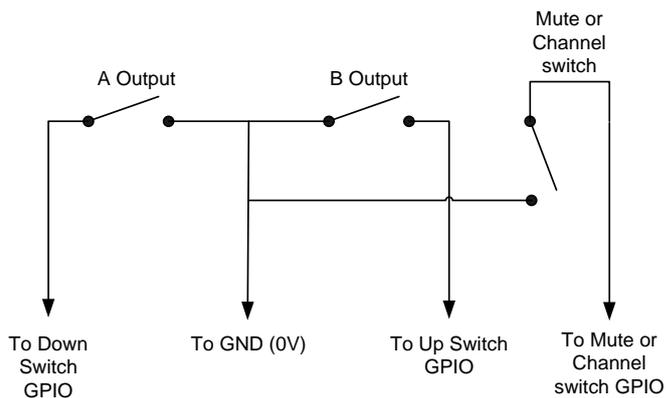


Figure 73 Rotary Encoder Diagram

Rotary encoders have three inputs namely Ground, Pin A and B as shown in the diagram on the left. Wire the encoders according that shown in Table 4 on page 37. If the encoder also has a push button knob, then wire one side to ground and the other to the GPIO pin. In the case of the mute switch this will be pin 7 (GPIO 4). Version 1 boards are not supported but will probably work.



Warning: The push switches (if fitted) on the rotary encoder are wired differently from the push buttons in the earlier push button versions of the radio. For these encoders one side of the push button is wired to GND (not 3.3V) and the other to the relevant GPIO.

If using a Revision 1 board it is necessary to use 10K pull up resistors connected between the GPIO inputs of the rotary encoder outputs and the 3.3-volt line. Do not add resistors if using revision 2 boards and onwards.



This project originally uses a COM-09117 12-step rotary encoder or PEC11R series encoders. It also has a select switch (by pushing in on the knob). These are “Incremental Rotary Encoders”. An incremental rotary encoder provides cyclical outputs (only) when the encoder is rotated. The other type is an absolute rotary encoder which maintains position information even when switched off (See Wikipedia article on rotary encoders).

Figure 74 Rotary encoder with push switch

The rotary encoders used in this project are wired with the COMMON or GND pin in the middle and the A and B outputs either side. However, some rotary encoders are wired with A and B as the first two pins and GND (COM) as the third pin. Note that not all encoders come with a switch, so separate switches for the Menu and Mute button will need to be installed. Check the specification first.

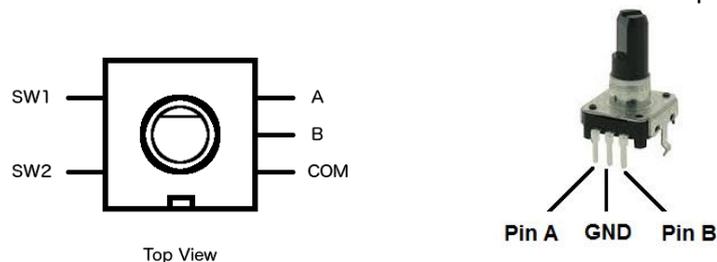


Figure 75 Rotary encoder pin-outs



Note: Not all manufacturers’ rotary encoders will work with this project. If they work then fine if not regrettably you will need to purchase the recommended encoders.

Using KY040 Rotary encoders

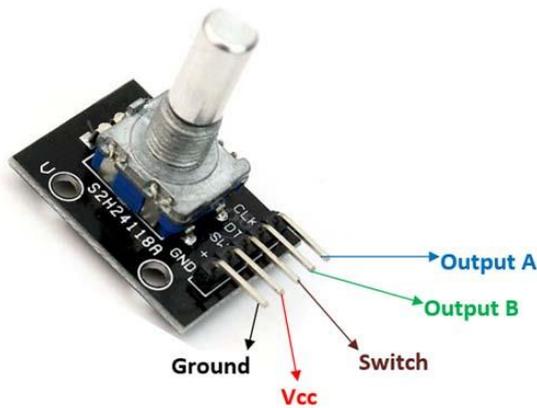
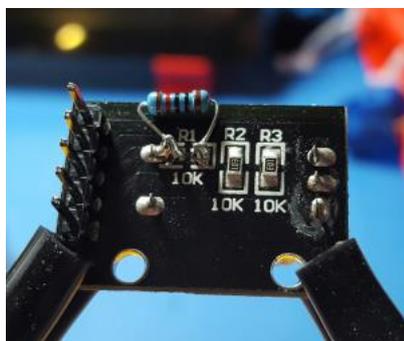


Figure 76 KY-040 Rotary Encoder



Figure 77 KY040 Missing 10K resistor



These cost-effective Rotary Encoders from Handson Technology originally designed for use with Arduino are now being used more and more by constructors. The KY-040 Rotary Encoder specification shows that these are powered by +5V to the VCC pin.

However, the Raspberry Pi uses a +3.3V supply and cannot tolerate +5V on the GPIO's so the advice is to connect VCC to +3.3V. These encoders work fine with VCC as +3.3V with this project.

More recently, manufacturers have been supplying KY040 encoders with the R1 10K pull-up resistor for the push-button missing. It is uncertain why suppliers aren't including this resistor. For the push button feature to work with these units, the missing 10K ohm resistor needs to be added or configure the pull-up resistors in with the Radio Configuration program described later.

Try to order KY040 encoders with all three resistors fitted.

If you have the soldering skills, you can add a 10K resistor across the R1 pads. If you don't have the ability to use a soldering iron then don't worry as the pull-up resistors can be configured later with software.



Colours: Brown, black orange.

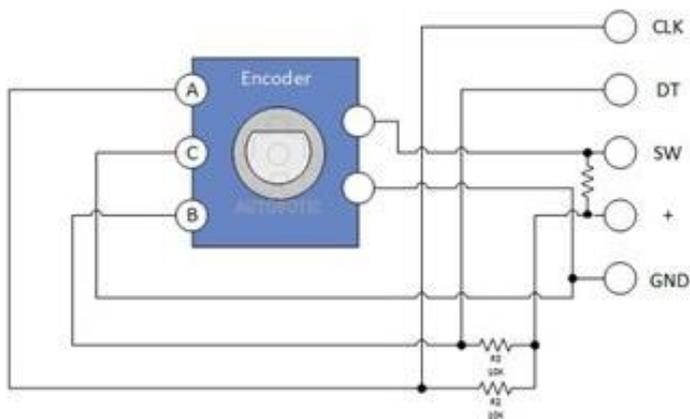


Figure 78 KY-040 Circuit Diagram

The specification shows the rotary encoders are labelled CLK(Clock), DT(Data) and + (VCC) however it is more usual to label these A, B and C.

Connect + to the +3.3V supply. Do **not** connect to +5V.

Note: Some KY-040 alternatives do not have the resistor between SW and GND.

From version 7.2 onwards the internal pull-up resistors can be disabled with the radio configuration program as they are not required for the KY040 encoder as it has its own pull-up resistors. See Figure 159 *Rotary encoder* on page 108.



Note: The terms VCC, VEE etc. are explained in *382Appendix E – Explanation of Vcc, Vdd, Vss and Vee* on page 382.

Rotary encoders with RGB LEDs



Figure 79 Sparkfun RGB rotary encoder

There are also rotary encoders available with RGB (Red, Green, Blue) LEDs which light up the transparent shaft. These also have a press switch. There are also versions which just have Red and Green LEDs. These encoders are also supported by the radio software from version 7.4 onwards.

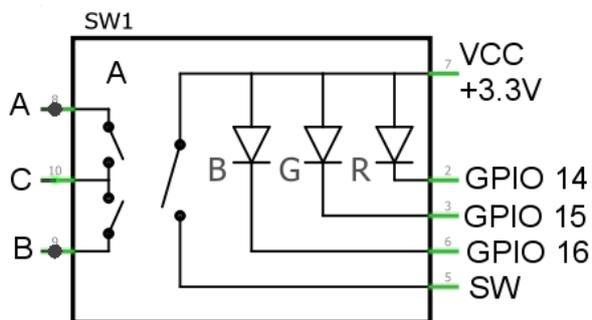


Figure 80 RGB Rotary Encoder circuit

For this type of rotary encoder, the cathodes of the LEDs are connected to VCC (3.3V). Unlike the standard encoders one side of the switch is also connected to VCC which means that the push-switch works the opposite way around to the on the standard rotary encoder. In this case the `rgb_rotary` driver has to be selected.



Figure 81 Transparent knob

There are transparent plastic knobs available which on the standard 6mm shaft. These simply press-fit onto the shaft of the rotary encoder.

They are clear so that they can be used with illuminated rotary encoders such as the Sparkfun RGB encoder.

The LEDs can be driven by configuring the following parameters in `/etc/radiod.conf` as shown below:

```
rgb_red=14
rgb_green=15
rgb_blue=16
```

The LEDs are driven by the `status_led_class.py` driver software. The LEDs connect directly to the above GPIO pins 14, 15 and 16 and are driven by 3.3 volts so do not particularly need resistors but 100 Ohm resistors can be used to reduce the brightness.



Warning: Do not, under any circumstances connect these rotary encoders to +5 Volts, even if the specification says so, otherwise the Raspberry Pi will be irreparably damaged!

RGB I2C rotary encoders

These Rotary Encoders use three Red, Green and Blue (RGB) LEDs in the Rotary Encoder Shaft. This type of rotary encoder is entirely driven by the I2C interface. One drawback of these encoders is that they do not have a push button meaning that these must be installed extra to the encoders.



Figure 82 Pimoroni RGB I2C Rotary Encoders

These encoders contain Nuvoton MS51XB9AE microcontroller which let you directly control the RGB LEDs inside the encoder. The default I2C address is 0x0F but it is possible to configure a second device with a separate I2C address (0x1F for the radio project).

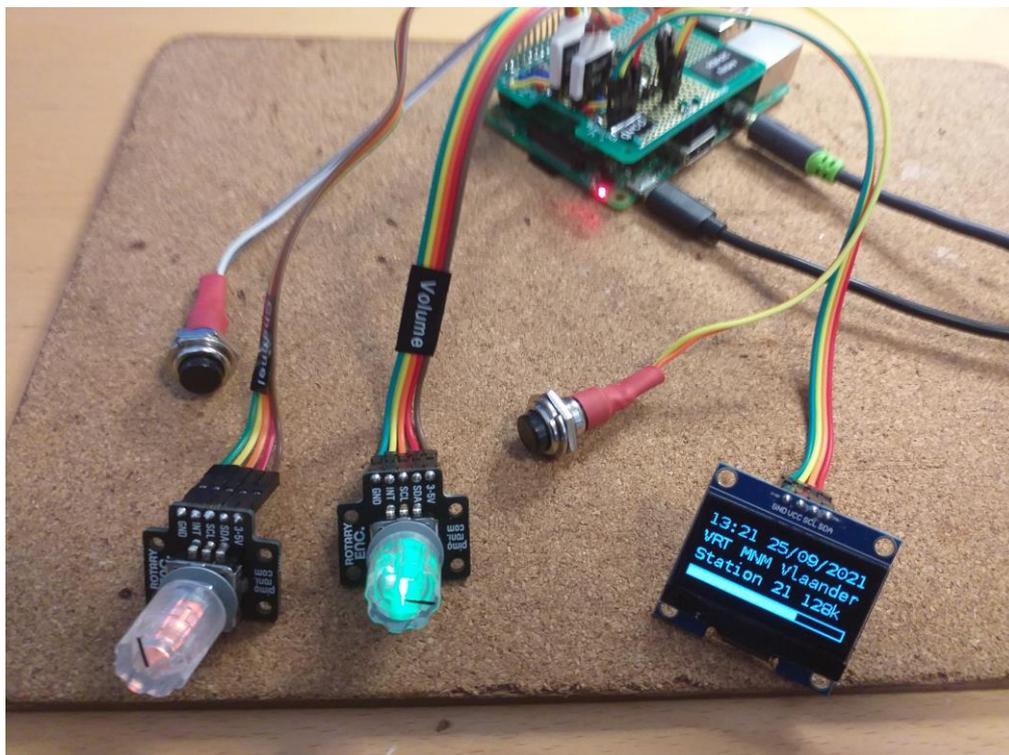


Figure 83 Radio project using RGB I2C rotary encoders

The above photo shows two RGB I2C encoders (Volume 0x0F and Channel 0x1F) running the radio software. The Mute and Menu buttons are wired the same as the standard encoders. Also shown is 128x64 pixel OLED also connected by I2C (In this case with 0x3C as the address).

Rotary encoder wiring

The following tables show how to wire up the four types of rotary encoders used in this project. The first table shows how to wire up conventional rotary encoders (without pull-up resistors). These have five connections A, B, C and two connections to the switch. See *Figure 75* on page 40.

Table 6 Radio A, B, C Rotary Encoder Wiring

GPIO Pin	Description	Radio Function	Volume Rotary Encoder	Channel Rotary Encoder
6	GND	Zero volts	Common C	
8	GPIO 14	Volume up/down	Output A	
10	GPIO 15	Volume up/down	Output B	
7	GPIO 4	Mute volume	Knob Switch 1 *	
GND	GND 0V	Mute volume	Knob Switch 2 *	
9	GND	Zero volts		Common C
16	GPIO 23	Channel up/down		Output A
18	GPIO 24	Channel up/down		Output B
11	GPIO 17	Menu switch		Knob Switch 1 *
GND	GND 0V	Menu switch GND		Knob Switch 2 *

GND is found on physical pins 6, 9, 14, 20, 25, 30, 34 and 39.

* Note: In the case of RGB LED Rotary Encoders one side of the push switch is wired to the VCC (3.3V) supply internally in the switch. The GPIO goes from low to high when the button is pushed.

Table 7 RGB LED Rotary Encoder switch wiring

7	GPIO 4	Mute volume	Knob Switch 1	
+3.3V	VCC	“ “	Internal connection	
11	GPIO 17	Menu switch		Knob Switch 1
+3.3V	VCC	“ “		Internal connection

The second table shows how to wire up KY-040 rotary encoders (fitted with pull-up resistors). These have five connections namely CLK, DT, SW, VCC and GND. See *Figure 78* on page 42.

Table 8 KY-040 Rotary Encoder Wiring

GPIO Pin	Description	Radio Function	Volume Rotary Encoder	Channel Rotary Encoder
1	3V3	+3.3V supply	+3.3V (VCC)	
6	GND	Zero volts	Common (GND)	
7	GPIO 4	Mute volume	Knob Switch (SW)	
8	GPIO 14 (TX)	Volume up/down	Output B (DT)	
10	GPIO 15 (RX)	Volume up/down	Output A (CLK)	
17	3V3	+3.3V supply		+3.3V (VCC 3.3V)
9	GND	Zero volts		Common C (GND)
11	GPIO 17	Menu switch		Knob Switch (SW)
16	GPIO 23	Channel up/down		Output B (DT)
18	GPIO 24	Channel up/down		Output A (CLK)

Table 9 RGB I2C Rotary Encoders wiring

GPIO Pin	Description	Radio Function	Volume RGB I2C Rotary Encoder	Channel RGB I2C Rotary Encoder	Optional I2C display
1	3V3	+3.3V supply	VCC +3.3V	VCC +3.3V	VCC +3.3V
3	GPIO2	SDA	SDA	SDA	SDA
5	GPIO3	SCL	SCL	SCL	SCL
NC	n/a	n/a	INT (Interrupt)	INT (Interrupt)	
6	GND	Zero volts	GND	GND	GND
		I2C address	Hex 0x0F	Hex 0x1F	Hex 0x3C*
7	GPIO4	Mute	Mute Button		
11	GPIO17	Menu		Menu Button	

* Example OLED I2C address which will differ depending upon the attached device.

The above table shows two RGB I2C encoders. The I2C address for the Channel Rotary encoder is configured with the `gb_set_i2c_address.py` utility.

```
$ ./rgb_set_i2c_address.py
RGB I2C Rotary Encoder set new I2C address 0xf

Usage: sudo ./rgb_set_i2c_address.py --help
      --i2c_address=<i2c_address>
      --new_i2c_address=<new_i2c_address>

Recommended values for current and new addresses are 0x0F and 0x1F
Run "i2cdetect -y 1" to check I2C address before and after
```

First only plug in one RGB I2C Rotary encoder with hex address **0x0F**.

```
$ cd /usr/share/radiod
$ sudo ./rgb_set_i2c_address.py --i2c_address=0x0f --new_i2c_address=0x1F
```

Below is the output of the `i2cdetect -y 1` utility with two RGB I2C rotary encoders (**0x0F** and **0x1F**) and an OLED display (**0x3C**)

```
$ i2cdetect -y 1
   0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f
00:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  -- 0f
10:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  -- 1f
20:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
30:  --  --  --  --  --  --  --  --  --  --  --  --  -- 3c  --  --
40:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
50:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
60:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
70:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
```

Optical Rotary encoders

Optical rotary encoders are much more expensive than the mechanical (conductive) rotary encoders previously shown. They offer the higher resolution compared to mechanical ones. They are usually used for scientific and industrial applications. They are overkill for this project but may be used. This software has been successfully tested with an HRPG-ASCA #16F optical encoder from Avago. See https://media.digikey.com/pdf/Data%20Sheets/Avago%20PDFs/HRPG_Series.pdf

LCD Module Wiring

The following shows the wiring for a directly wired HD44780U LCD controller. It has 16 or 18 pins. There are two ways of wiring the LCD data lines using either the 26 pin or 40-pin wiring schemes (Table 4 and Table 5 respectively). For all new 40-pin Raspberry Pi's the 40-pin wiring is strongly recommended. The 26-pin version of the wiring can be used on both 26 and 40-pin Raspberry Pi's.

Table 10 LCD module wiring for 26 and 40-pin Raspberry Pi's

LCD Pin	GPIO 26-pin	Pin 26 #	GPIO 40-pin	Pin 40 #	Description
1	n/a	6	n/a	6	Ground (0V) – Wire this directly to LCD pin 5
2	n/a	2	n/a	2	VCC +5V
3	n/a	Note1	n/a	Note1	Contrast adjustment (0V gives maximum contrast)
4	GPIO7	26	GPIO7	26	Register Select (RS). RS=0: Command, RS=1: Data
5	n/a	6 or 9	n/a	6 or 9	Read/Write (RW). Very important this pin must be grounded! R/W=0 (GND): Write, R/W=1 (+5V): Read. Will damage the PI if not grounded (0V). Wire LCD pin 5 and 1 together
6	GPIO8	24	GPIO8	24	Enable (EN)
7					Data Bit 0 (Not required in 4-bit operation)
8					Data Bit 1 (Not required in 4-bit operation)
9					Data Bit 2 (Not required in 4-bit operation)
10					Data Bit 3 (Not required in 4-bit operation)
11	GPIO27	13	GPIO5	29	Data Bit 4 (D4)
12	GPIO22	15	GPIO6	31	Data Bit 5 (D5) Note if using IQaudio products GPIO22 conflicts !!
13	GPIO23	16	GPIO12	32	Data Bit 6 (D6)
14	GPIO24	18	GPIO13	33	Data Bit 7 (D7)
15	n/a	2	n/a	2	LED Backlight Anode (+5V) or Red LED (Adafruit RGB plate) [2] or VEE negative voltage on Midas HD44780
16	n/a	6 or 9	n/a	6 or 9	LED Backlight Cathode (GND) or Red LED [2]
17					Optional Green LED (Adafruit RGB plate) [2]
18					Optional Blue LED (Adafruit RGB plate) [2]

If using **IQaudio**, **HiFiBerry** or similar DAC products it is necessary to use the 40-pin version of the wiring (See Table 5).



Note 1: If using the Midas display with VEE on pin 15 do not connect this pin to the +5V supply or you will damage the display. Connect pin 15 as shown in the section called *Midas LCD display* on page 17.



Note 2: The contrast pin 3 (VE) should be connected to the center pin of a 10K potentiometer. Connect the other two pins of the potentiometer to 5v (VDD) and 0v (VSS) respectively. Adjust the preset potentiometer for the best contrast.



Note 3: The standard LCD comes with 16 pins. Adafruit supply an RGB backlit LCD with two extra pins namely pins 17 and 18. These are non-standard. These must be wired to ground (0 Volts) to work. For more information see the section *Using the Adafruit backlit RGB LCD display* on page 72.

The following diagram (Courtesy protostack.com) shows the electrical connections for the standard 16 pin LCD. Do not use this diagram for Midas displays. See instead *Midas LCD display* on page 17.

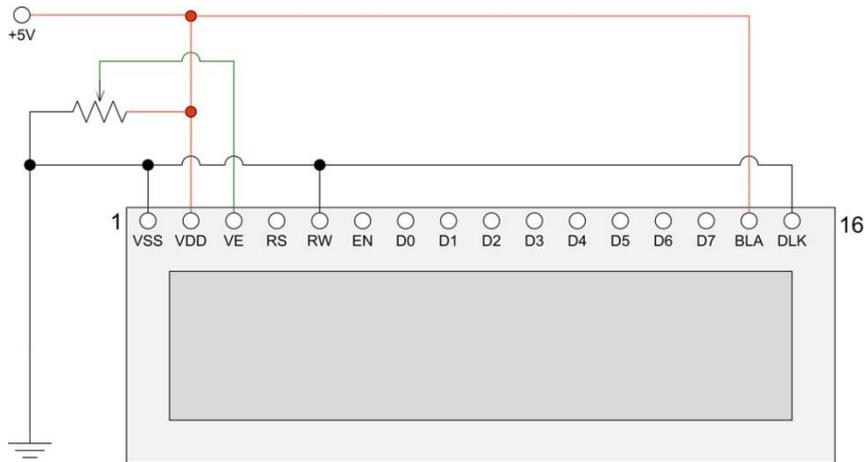


Figure 84 HD44780U LCD electrical circuit



The standard LCD comes with 16 pins. Adafruit supply an RGB backlit LCD with two extra pins namely pins 17 and 18. These are non-standard. These must be wired to ground (GND 0 Volts) to work. For more information see the section *Using the Adafruit backlit RGB LCD display* on page 72.

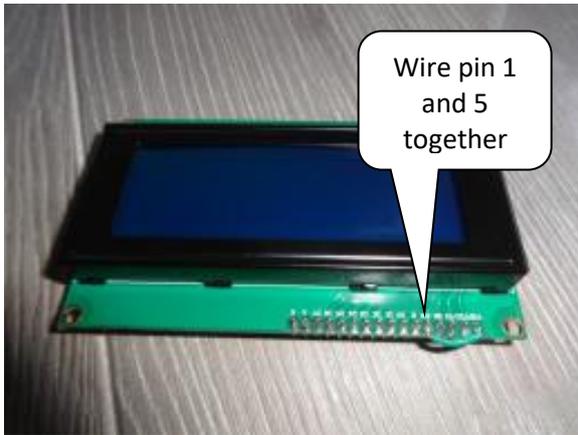


Figure 85 Wire LCD pin 1 (GND) and 5 (RW) together



The Read/Write (RW) pin 5 must be connected to pin 1 (0V). It is very important that this pin is grounded!

If pin 5 is not grounded it will damage the Raspberry Pi. Always wire LCD pin 5 and 1 directly together. Do not rely on grounding pin 5 with a GND wire on the connector. If this wire drops off then the LCD data lines will be put into write mode putting +5V on the GPIO pins which will probably cause irreparable damage to the Raspberry Pi. If using an I2C backpack this step is not necessary as it is already done in the backpack.



Warning – Some LCD displays such as the Midas with VEE have a different voltage arrangement for Pin 15 and Pin 5 (Contrast). Pin 15 is an output which provides a negative voltage (VEE) which connects to one end of the 10K contrast potentiometer and the other end to +5V (VDD). Connecting +5 Volts to pin 15 will destroy the LCD device. See section called *Midas LCD display* on page 17 for further information.



Note: All settings in the `/etc/radiod.conf` file use GPIO numbers and NOT physical pin numbers. So, in the above example `lcd_width` is GPIO 16 (Physical pin 36).

There is a useful program called `wiring.py` which will display physical the wiring required for the settings found in `/etc/radiod.conf`. See page 279.



Also, there is another program called `test_gpios.py` which will test for button or rotary encoder events. For example, you are not sure how you have wired a button or rotary encoder this program will confirm this for you. See page 280.

Power supply considerations

The Raspberry Pi except for the model 4B uses a standard Micro USB (type B) power connector, which runs at +5V. The model 4B uses a 5 Volt 3 Ampere power supply with a USB-C adaptor. In general, the Raspberry Pi can draw up to 700mA. Many telephone adapters deliver less than that and can lead to problems. You also need to consider the LCD screen which can also need up to 20mA but depends on the type of backlight. However, due to the extra current that can be drawn by connected USB or other devices, a minimum 2.5A supply will be needed.

Try to find a power adapter that delivers at least 1.5 Ampere. As mentioned above a 2.5A supply may be required if USB are used. See the following article. The newer RPi models can draw up to 1.5 Amps if USB peripherals or sound cards are attached.

http://elinux.org/RPi_VerifiedPeripherals#Power_adapters

The Raspberry Pi can be powered either the USB port or via the GPIO header (Pin 2 or 4). Some prototyping boards used to provide power in this way.

If using an adaptor or separate 5-volt Power Supply try to use a switched-mode power supply adaptor. This takes less current and generate less heat that a power dissipation device. If a power supply is designed to be earthed then use a 3-core cable with live, neutral and earth wires.

Things not to do:

- Do not try to tap off power from the Power supply or transformer used by the speaker's amplifier. This won't work (earth loops) and can cause damage to the PI and peripherals.
- Do not tap off (cascade) from the amplifier DC supply (12 volts for example) with another 5V voltage regulator. This will most likely cause interference.
- Do not feed power to the PI from two sources (USB hub and Power adapter). Try to use USB hubs that don't feed 5 volts back through the USB ports of the Raspberry Pi
- Do not connect an untested power supply to the Raspberry Pi without checking the voltage first.

Things to do:

- Use double pole mains switches for isolating the mains supply when switched off. A lot of European plugs can be reversed leaving the live wire un-switched if using a single pole switch.
- If using a metal case always earth it and use a three-pin plug with earth pin.
- In general feed the 5-volt supply via the Raspberry Pi rather than via the GPIO header. This is because the Raspberry Pi is fitted with a so-called poly-fuse for protection.

You should try to use a single power supply switch for the radio. Connect the AC power supply of the adaptor to the mains switch. This switch can also provide the mains supply to the speaker amplifier. Also see the section on *preventing electrical interference* on page 69



Always consider safety first and make sure that no-one including yourself can receive an electric shock from your project including when the case is open. Also see disclaimer on page 352.

Also see *Appendix D – Using a battery pack* on page 381

GPIO Hardware Notes

The following shows the pin outs for the GPIO pins on revision 1 and 2 boards. For more information see: http://elinux.org/RPi_Low-level_peripherals.

GPIO Numbers

Raspberry Pi B Rev 1 P1 GPIO Header

	Pin No.		
3.3V	1	2	5V
GPIO0	3	4	5V
GPIO1	5	6	GND
GPIO4	7	8	GPIO14
GND	9	10	GPIO15
GPIO17	11	12	GPIO18
GPIO21	13	14	GND
GPIO22	15	16	GPIO23
3.3V	17	18	GPIO24
GPIO10	19	20	GND
GPIO9	21	22	GPIO25
GPIO11	23	24	GPIO8
GND	25	26	GPIO7

Raspberry Pi A/B Rev 2 P1 GPIO Header

	Pin No.		
3.3V	1	2	5V
GPIO2	3	4	5V
GPIO3	5	6	GND
GPIO4	7	8	GPIO14
GND	9	10	GPIO15
GPIO17	11	12	GPIO18
GPIO27	13	14	GND
GPIO22	15	16	GPIO23
3.3V	17	18	GPIO24
GPIO10	19	20	GND
GPIO9	21	22	GPIO25
GPIO11	23	24	GPIO8
GND	25	26	GPIO7

Raspberry Pi B+ B+ J8 GPIO Header

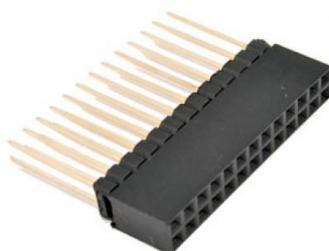
	Pin No.		
3.3V	1	2	5V
GPIO2	3	4	5V
GPIO3	5	6	GND
GPIO4	7	8	GPIO14
GND	9	10	GPIO15
GPIO17	11	12	GPIO18
GPIO27	13	14	GND
GPIO22	15	16	GPIO23
3.3V	17	18	GPIO24
GPIO10	19	20	GND
GPIO9	21	22	GPIO25
GPIO11	23	24	GPIO8
GND	25	26	GPIO7
	DNC	27	DNC
GPIO5	29	30	GND
GPIO6	31	32	GPIO12
GPIO13	33	34	GND
GPIO19	35	36	GPIO16
GPIO26	37	38	GPIO20
GND	39	40	GPIO21

Key	
Power +	UART
GND	SPI
I ² C	GPIO

Figure 86 GPIO Numbers



Note: The B+, 2B, 3B, 4B and P400 have the same pin-outs.



If connecting any 40-pin interface board via a 26-way ribbon cable it will be necessary to fit a 26-pin header extender and plug the ribbon cable into it.

Figure 87 26-pin header extender

Parts List

The following table shows the parts list for a basic Raspberry Pi Internet Radio. This list is for the version using the HD44780U LCD directly connected to the GPIO pins. If using the Adafruit five button LCD Plate then don't order the parts marked with an Asterix (*)

Table 11 Parts list (LCD versions)

Qty	Part	Supplier
1	Raspberry Pi Computer	Farnell Element 14
1	Clear Raspberry Case	RS Components
1	8GByte SD Card	Any PC or Photographic supplier
1	Radio Case	See Housing the radio page 34
1	Raspbian Bookworm OS	Raspberry Pi foundation downloads
2	Four-inch loudspeakers	From set of old PC speakers
2	Four-inch loudspeaker grills	Any electronics shop
1	Stereo Amplifier (3 to 35 watt)	Any electronics shop
1	Transformer for amplifier	Any electronics shop
1	LCD HD44780U 2 x 16 Display *	Farnell Element 14
1	Prototype board	Ciseco PLC
4	Round push buttons *	Any electronics shop
1	Square push button *	Any electronics shop
2	Rotary encoders if using this option * **	Sparkfun.com
1	26 or 40-way ribbon cable	Tandy or Farnell Element 14
5	10KΩ resistors * (Revision 1 boards only)	Tandy or Farnell Element 14
5	1K resistors * (Revision 1 boards only)	Tandy or Farnell Element 14
1	External power supply for USB hub (1200 mA)	Any PC supplier
1	26-way PCB mount male connector	Any electronics shop
1	26-way GPIO extender (model B+ boards only)	ModMyPi and others
1	Mains cable	Hardware shop
1	Double pole mains switch with neon	Farnell Element 14
5	Male 2 pin PCB mount connectors	Any electronics shop
2	Female 4 pin PCB connectors	Any electronics shop
1	Female 2 pin PCB connectors	Any electronics shop
1	16 pin male in-line PCB mount connector	Any electronics shop
1	Stereo jack plug socket	Any electronics shop
1	Panel mount Ethernet socket	Any electronics shop
1	Adafruit I2C LCD interface Backpack ***	http://www.adafruit.com/
1	TSOP38238 IR Sensor	Adafruit industries and others
1	Red or Green LED and 220 Ohm resistor	Any electronics shop
1	Optional sound card (DAC)	IQaudIO, HifFiBerry or JustBoom
	Shrink wrap and thin wire for PCB wiring	Any electronics shop

* These components are not required if using the Adafruit LCD plate.

** If using rotary encoders.

*** If using the Adafruit I2C backpack

The above list is not relevant if using a touch screen except when used with rotary encoders or push buttons.

Chapter 4 - Construction details

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Construction using an interface board

It isn't necessary to construct the radio connect via an interface board but it does make maintenance easier and is much more reliable and will be needed if you wish to connect to the Raspberry Pi using a ribbon cable. Always bring the ribbon cable into the top of the board as shown in Figure 88 below. If the ribbon cable is connected to the back (underside) of the board the two rows of the 40-pin connector will be swapped over. In the next section how to use breakout boards is covered which may be an easier alternative for many constructors rather than building your own.

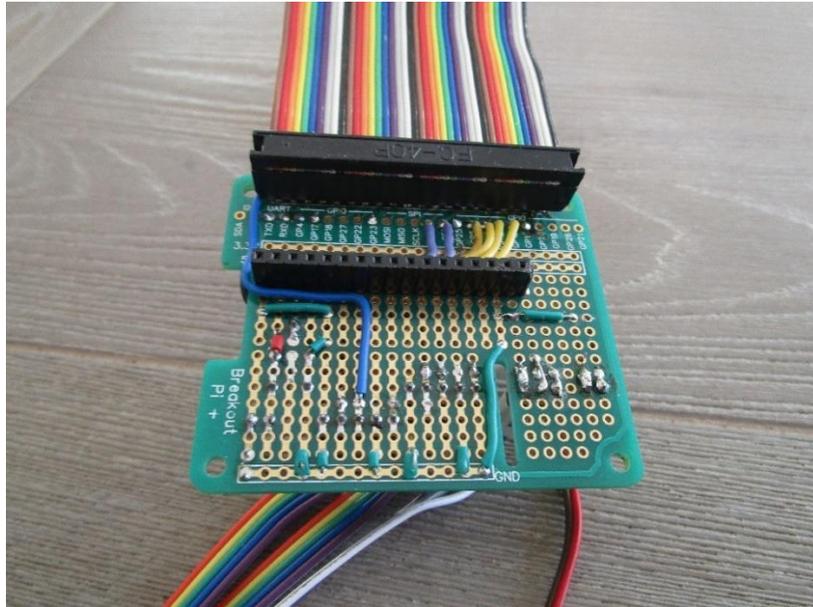


Figure 88 40-pin Interface board with ribbon cable

The figure below shows a 4x20 HD44780U LCD plugged into the interface board.



Figure 89 Interface board with LCD screen attached

Below is the other side of the interface board showing the connections to the rotary encoders, an IR sensor the IR activity LED.

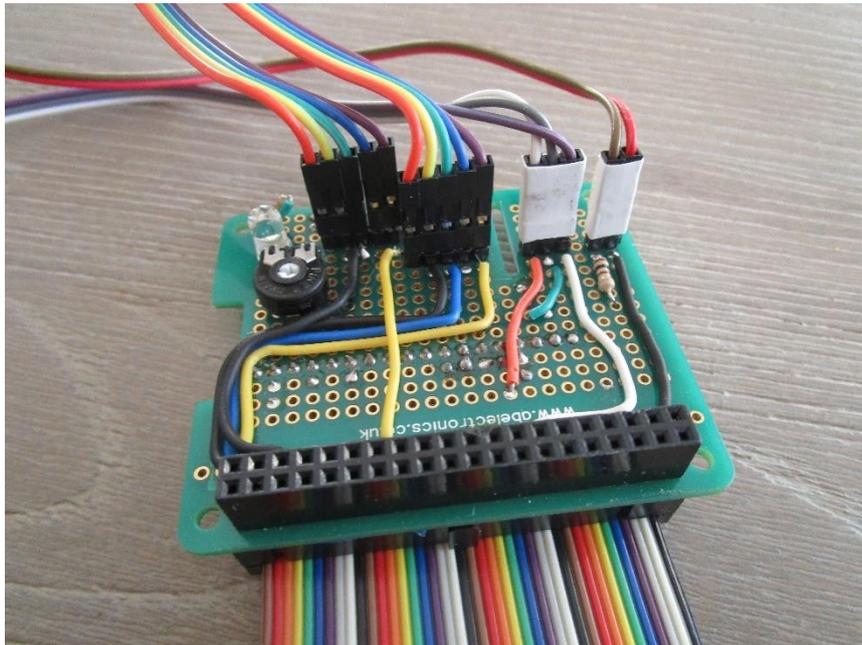


Figure 90 Radio controls connections

Below is the complete overview of the interface card with some test rotary encoders, an IR sensor the IR activity LED.

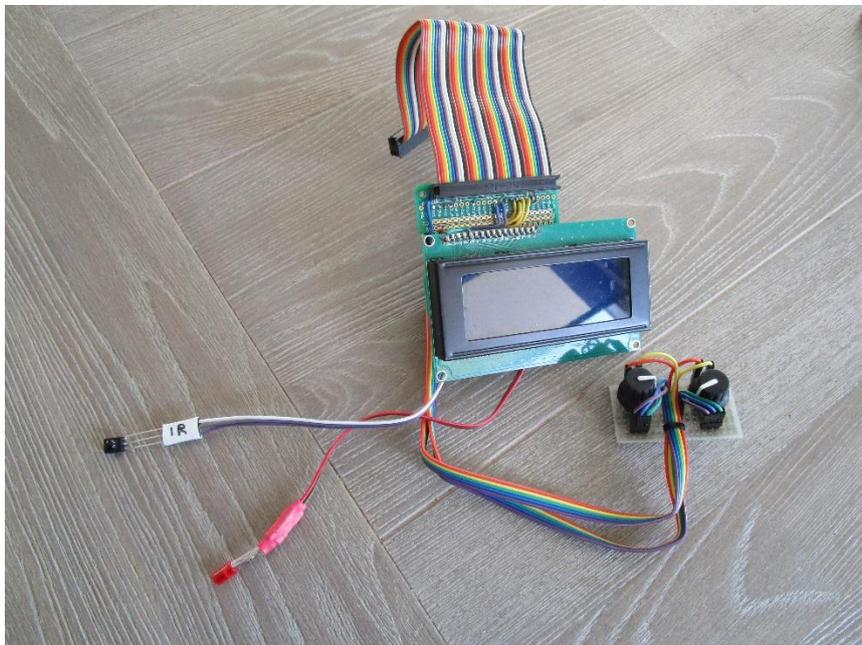


Figure 91 Interface board overview

There are various interface boards available on the market for both 26-pin and 40-pin Raspberry Pis.

Construction using breakout boards

When this project was begun in the early days of Raspberry Pi there was very little in the way of breakout boards. It was necessary to make connections to buttons, LCDs and Rotary encoders either direct on the GPIO header or via a specially constructed breakout board. Things became more complex when digital sound cards (DAC) were introduced as these occupied the GPIO header and either did not extend the header pins, or if they did so, only extended a few of them.

This has now changed and there is a wide variety of breakout boards available.

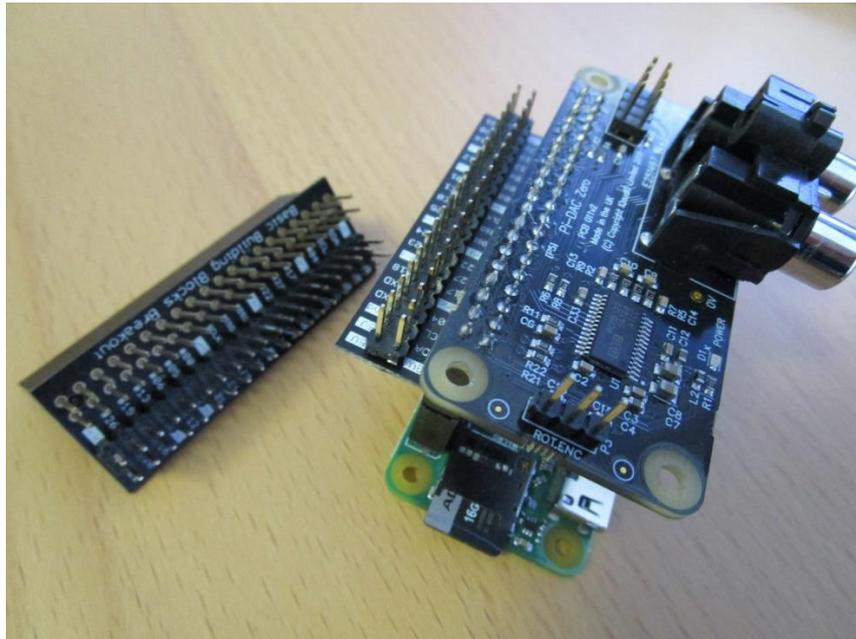


Figure 92 GPIO header breakout board

On the left of the above photo is an example of the 4Tronix GPIO breakout and extender board. On the right of the same photo is the break-out board used with a Raspberry Pi Zero W and an IQaudio DAC plus. All 40-pins are now made available, except for those used by the DAC, to attach buttons and the like to the GPIO pins.

These boards are available from <http://4tronix.co.uk>

See:

<https://shop.4tronix.co.uk/products/gpio-interceptor-gpio-breakout-for-40-pin-raspberry-pi>



Note: Soldering skills are required to solder the 40-pin header to the breakout board. The above breakout board is only shown as an example and many more are available on the Internet.

Construction using an Adafruit LCD plate

Introduction

This section is for the radio using an Adafruit RGB-backlit LCD plate for Raspberry PI. The complete instructions for both ordering and building this product are available from the following Web site: <http://www.adafruit.com/products/1110> (See tutorials)

Note: Don't confuse this product (which has an I2C interface chip) with the two-line and four-line RGB LCDs which Adafruit also sell.



Figure 93 Adafruit LCD plate

The Adafruit LCD plate is designed to directly into the GPIO header on the Raspberry PI. These fit into a female 26 way header. If you want to connect the Adafruit LCD via a ribbon cable you will need to mount a 26 way male header instead of the female header and you will also need to construct a reversing board (Shown on the left of the picture on the left). Because ribbon cable swaps the two rows of pins over the reversing card is required to swap the two rows of pins back to their correct orientation.

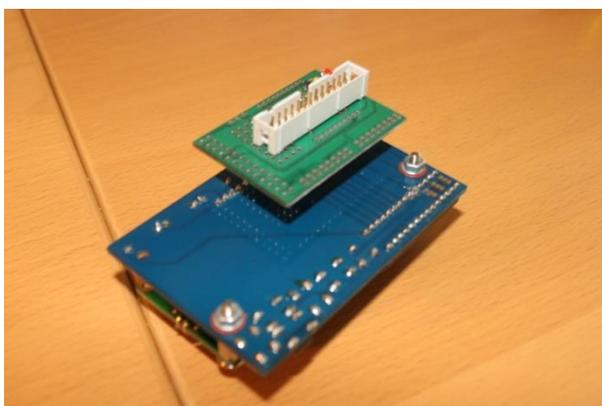


Figure 94 Adafruit LCD plate with ribbon cable adapter

Back view of the reversing board plugged into the Adafruit LCD plate.

The GPIO pins used are:

1. 3.3 Volts
2. 5.0 volts
3. SDA0
4. -
5. SCL0
6. Ground



Note 1: If you are going to plug the Adafruit LCD plate directly into the GPIO header on the Raspberry PI then you don't need the above reversing plate. Just follow the construction instructions on the tutorial on the Adafruit site.



Note 2: The "Select" button on the Adafruit plate is the "Menu" button for the radio.

Using other switches

The Adafruit Plate comes with five 4-pin switches which are mounted on the interface board. You will almost certainly want to use other switches say mounted on a front panel. It doesn't matter which type of switch you use as long as it is a push to make type. The only reason that a four-connector switch is used is for mechanical strength. If you look closely, you will see push button symbol between pins 2 and 4 and 1 or 3 on the component side for four of the switches. Either 2 and 4 and 1 or 3 should be connected to the switches.

It is advisable to solder two posts (male pins) for each switch on the reverse side of the board (The non-component side). Don't solder wires directly into the board. It is better to use push-on jumper wires connected to the switches to connect to the posts on the card.



Note: Rotary encoders cannot be used with the Adafruit Plate as these require three connections and the Adafruit routines to utilise them are not supplied by Adafruit.

Using the Adafruit LCD plate with the model B+, 2B and 3B

The plate is designed for revisions of the Raspberry Pi. It uses the I2C (SDA/SCL) pins. Adafruit supply a special extra tall 26-pin header so the plate sits above the USB and Ethernet jacks. For Pi Model B+, the resistors sit right above the new set of USB ports. To keep them from shorting against the metal, a piece of electrical tape must be placed on the top of the USB ports.

Using alternatives to the Adafruit display

Caution is advised. There are a number RGB boards which are compatible with the software provided by Adafruit Industries. Below is such an example of a Chinese 1602 I2C LCD. When originally tried the backlight wasn't lit and it was necessary to wire Pin 1 (GND 0V) and Pin 16 (Backlight). This is no longer necessary this version of the software as the backlight is software controlled.



Figure 95 Chinese 1602 I2C LCD

Note that the RGB part is a RGB LED that you see shining very brightly in the above picture. It is not actually lighting up the LCD backlight unlike the Adafruit RGB plate.

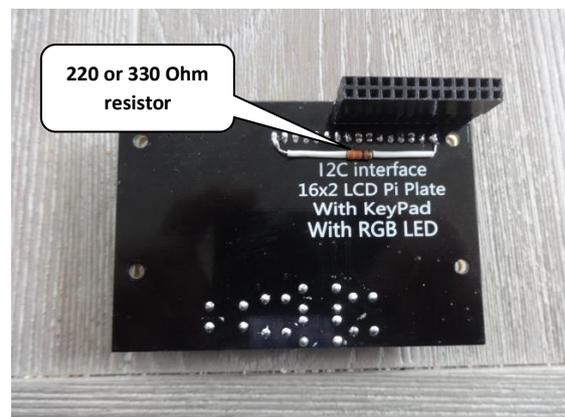


Figure 96 Enabling the backlight.

If running the radio version 5.9 or earlier then solder a 220- or 330-Ohm resistor between pin 1 (0V GND) and pin 16 (Backlight). Version 5.10 or above this is no longer necessary.

To switch off the very bright RGB light switch off the colour definitions in `/etc/radiod.conf`. For example: `bg_color=OFF`

Construction using an I2C LCD backpack

Skip this section if you are not using an I2C backpack. There are two versions of the backpack supported:

1. Adafruit I2C backpack using an MCP23017 port expander – Hex address 0x20
2. Arduino I2C backpack using a PCF8574 port expander – Hex address 0x27 or 0x37

The I2C interface only requires two signals namely the I2C Data and Clock. This saves six GPIO pins when compared with the directly wired LCD interface. See <https://www.adafruit.com/product/292>.

The radio software also supports the more common PCF8574 chip-based backpack popular with the Arduino hobby computer may also be used. See <http://www.play-zone.ch/en/i2c-backpack-pcf8574t-fur-1602-lcds-5v.html> for example.

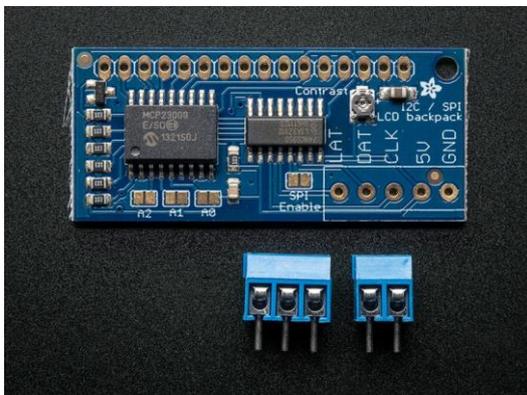
This is configurable in the `/etc/radiod.conf` file.

```
# The i2cbackpack is either ADAFRUIT or PCF8574
# i2c_backpack=PCF8574
i2c_backpack=ADAFRUIT
```



Note: In previous versions the `i2c_backpack` parameter was incorrectly shown as PCF8475 instead of PCF8574. Check the `/etc/radiod.conf` file.

Adafruit I2C Backpack



The Adafruit I2C/SPI backpack interface is shipped as shown in the diagram opposite. There are no connectors shipped to connect to the LCD itself to this interface. These must be ordered separately.

Order a 16 in-line connector.

The Adafruit backpack also supports the SPI interface but is not used in this project

Figure 97 Adafruit I2C Backpack

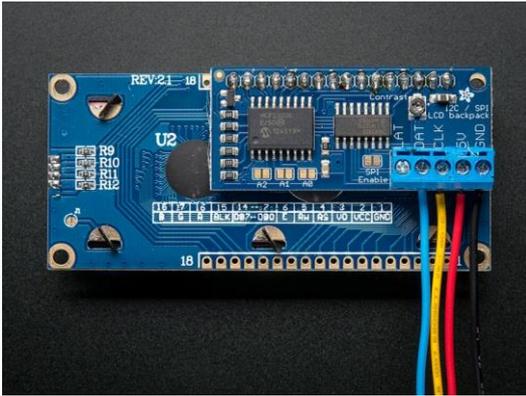


Figure 98 LCD connected to an Adafruit I2C backpack

The diagram shown on the left shows a 2x16 character LCD connected to the I2C backpack. The wiring right to left is:

1. LAT (Unused)
2. Blue: I2C Data – GPIO 2 (pin 3)
3. Yellow: I2C Clock – GPIO 3 (pin 5)
4. Red: +5 volts – GPIO header pin 2
5. Black: GND (0v) – GND GPIO header pin 6

The I2C Data (DAT) connects to pin 3 on the Raspberry Pi GPIO header and the I2C Clock (CLK) to pin 5 on the GPIO header.

Arduino PCF8574 I2C backpacks

These types of backpack are popular with Arduino users. The device address is usually hex 0x27. Another manufacture may use hex 0x37. This is configurable in the radio configuration program.

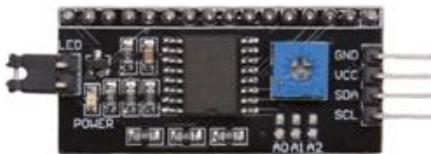


Figure 99 Arduino I2C backpack

The wiring From top to bottom is:

5. GND (0 volts) – GPIO header pin 6
6. VCC +5 volts – GPIO header pin 2
7. SDA I2C Data – GPIO 2 (pin 3)
8. SCL I2C Clock – GPIO 3 (pin 5)

The blue potentiometer on the right is the contrast adjustment.

```
i2c_backpack=PCF8574
#i2c_backpack=ADAFRUIT
```

To use this device either amend the **i2c_backpack** parameter in **/etc/radiod.conf** (Comment out the ADAFRUIT line) or run the **configure_radio.sh** program.

Table 12 I2C Backpack connections

Backpack	Label	Description	GPIO	Physical pin
1	GND	Zero volts	-	14
2	VCC	+5 Volts	-	4
3	SDA	I2C Data	2	3
4	SCL	I2C Clock	3	5
5	LAT	Latch – Not used	-	-

The LAT pin is for the Adafruit backpack only and is for the SPI interface but isn't used by I2C.

Creating the interface board for the I2C back pack

An interface board is recommended to connect the I2C backpack and rotary encoders etc. to the GPIO interface. Any number of Raspberry Pi prototyping boards are available for all versions of the Raspberry Pi. The Ciseco Humble Pi prototype board shown in Figure 100 has been discontinued.

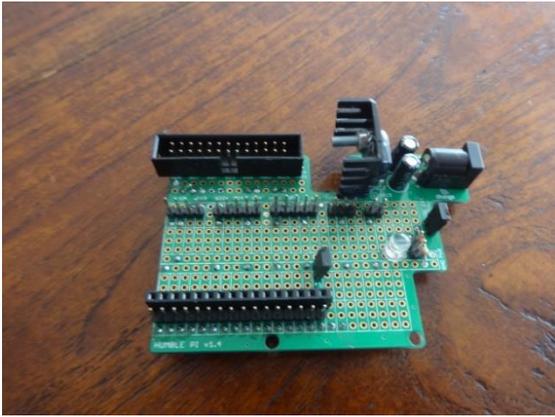


Figure 100 Ciseco Humble Pi I2C interface board

The above figure shows the I2C interface board using the Ciseco Humble Pi (Discontinued). The header pins in the centre from left to right are, I2C interface connector (4 pins), Volume rotary encoder (5 pins), Channel rotary encoder (5 pins), IR sensor (3 pins) and front panel LED (2 pins). In this version there are two rows of 18 pins (male and female) to allow different I2C backpack to be connected. You will normally only need one or the other.

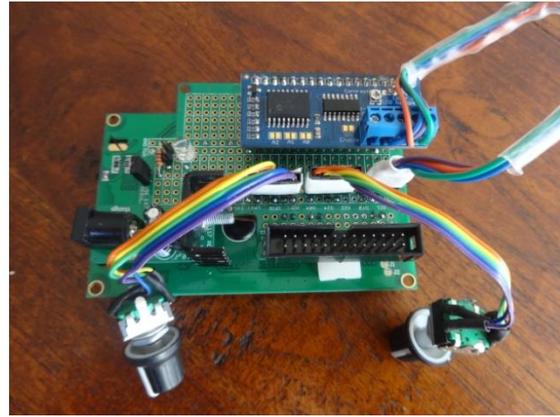


Figure 101 The I2C backpack interface board

The above diagram shows the Adafruit I2C backpack connected to the interface board along with the rotary encoders. The 26-pin male header connects to the GPIO ribbon cable on the Raspberry Pi. On the left is a 6V to 9V power input feeding a 5 Volt regulator.

Fitting a wake-up button

One of the features of this radio's design is that the menu button (LCD versions) or a special key (Touchscreen version) can do an orderly system shutdown. This is more desirable, and certainly safer and more convenient than pulling the power plug out. The system when properly shutdown goes into a so-called halt state. If the power is left connected the Raspberry Pi, it can be woken up by a button connected between pins 5 (GPIO3) and 6 (GND). GPIO3 can still be used as normal for example for I2C connections.

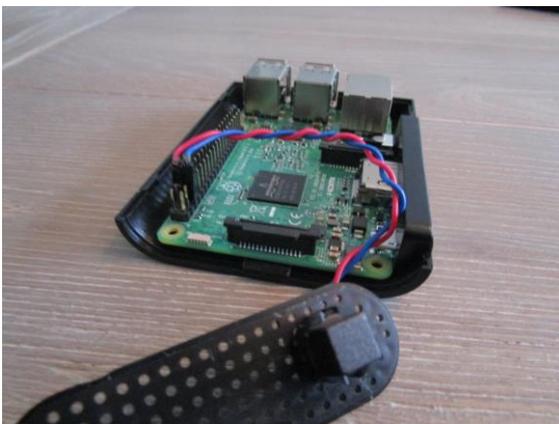


Figure 102 Wake-up button

On the left is the Raspberry Pi unit which is running the radio on a TV with HDMI inputs as shown in Figure 3 on page 4. A small black wake-up button is fitted to the case and connects to physical pins 5 and 6. When pressed with the Raspberry Pi in a halt state but power still applied it will start its boot-up sequence. It should be noted that pin 5 (GPIO3) is also used as the I2C data line. Although the button could still be fitted it is probably not a good idea as it will disrupt the I2C signal if the wake-up button is pressed.

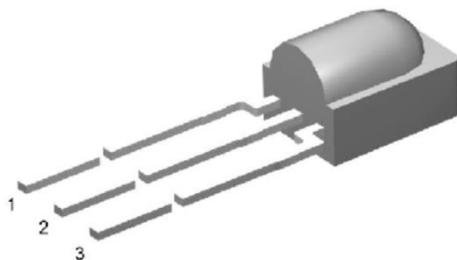
Installing an IR sensor and remote control



Note: This installation procedure is only for LCD versions of the radio. If using a HDMI or Touchscreen display see *Installing the FLIRC USB remote control* on page 65.

IR Sensor

If you wish to use an IR remote control with other variants of the radio then purchase an IR sensor TSOP38238 or similar. The output pin connectivity depends on the exact hardware being used. See *Table 19 IR Sensor Pin outs* on page 145 for the GPIO pin connection.



1 = OUT, 2 = GND, 3 = V_S

Figure 103 TSOP38238 IR sensor

The TSOP38xxx series works from 2.5 to 5.5 volts and is ideal for use the Raspberry PI.

IR sensor	Description	RPi
Pin 1	Signal Out	GPIO in *
Pin 2	Ground	Pin 6
Pin 3 **	Vs 3.3 Volts	Pin 1

* See on *Table 19 IR Sensor Pin outs* page 145.

** Caution; Do not accidentally connect to 5 volts

There are equivalent devices on the market such as the TSOP4838 which operate on 3.3 volts only.

See <http://www.vishay.com/docs/82491/tsop382.pdf> for more information on these IR sensors.



Tip: These IR sensors are very prone to damage by heat when soldering them. It is a good idea to use a 3-pin female connector and push the legs of the IR detector into them. If you solder the IR detector directly into a circuit then take precautions by connecting a crocodile clip across each pin in turn whilst soldering it. See figure below:

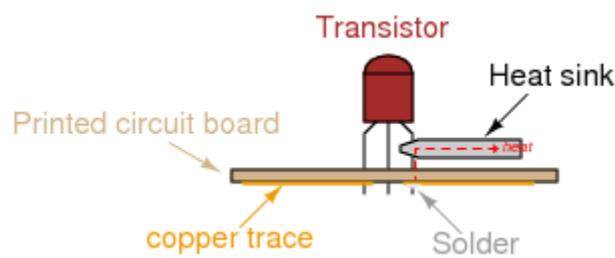


Figure 104 Soldering precautions

Remote control



Almost any surplus IR remote control can be used with this project. Later on, it is explained how to set up the remote control with the radio software. You will need to install the software for IR sensor.

See the section called *Installing the Infra-Red sensor software* on page 145.

Remote Control Activity LED

If wanted an activity LED can be connected to GPIO 11 or 13 depending on the type of radio. This flashes every remote control activity is detected. It is a good idea to include this.

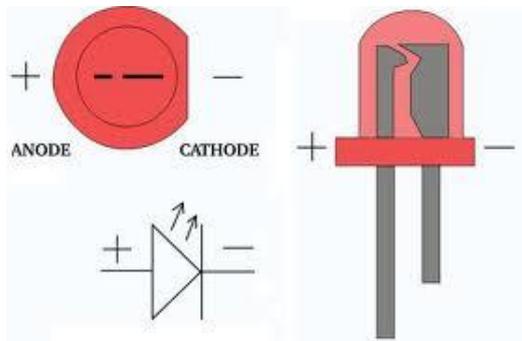


Figure 105 LED polarity

LEDs have polarity and must be wired correctly to work. The diagram shows the polarity of a typical LED. The longer lead is the positive (+) connection and connects to the Anode (The smaller terminal inside the LED)

Also, the LED must be wired in series with a resistor to limit the current, typically 100 Ohms is OK. Failure to do this may cause the LED to burn brightly for a while then burn out. Connect the cathode to GND (RPI Pin 6) and the Anode (+) to the GPIO pin shown in the following table via a 100 Ohm resistor.

The following table shows the GPIO pin used for the LED connections.

Table 13 Remote Control Activity LED

Radio Type	Pin	GPIO	Type of Raspberry PI
Activity LED not fitted	none	n/a	Not applicable
Two- or Four-line LCD with Push Buttons	23	11	26 or 40-pin version
Two- or Four-line LCD with Rotary encoders	23	11	26 or 40-pin version
Two- or Four-line LCD with I2C backpack	23	11	26 or 40-pin version
Adafruit RGB plate with push buttons	33	13	40-pin version only
Vintage radio with no LCD display	16	23	26 or 40-pin version
Designs using IQaudIO etc. sound boards	36	16	40-pin version only
PiFace CAD with IR sensor	16	23	26 or 40-pin version

How to configure the LED is shown on in the section called *Configuring the remote control activity LED* on page 180.

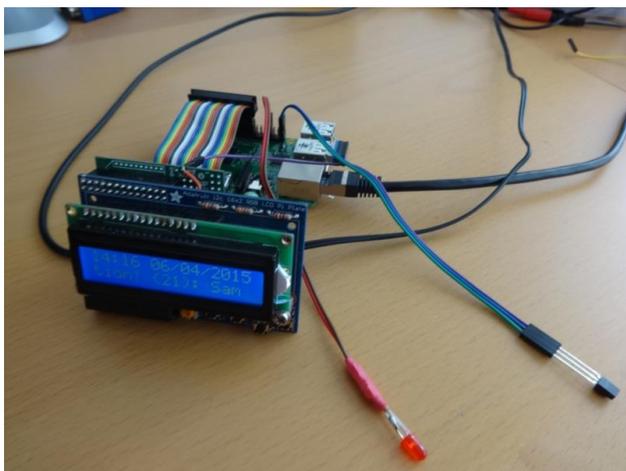


Figure 106 Adafruit plate with IR sensor and activity LED.

The illustration on the left shows an Adafruit RGB plate with IR sensor and activity LED.

The IR sensor picks up 3.3 volts from the reversing plate and connects the signal output to Pin 40 (GPIO 21) and GND (pin 39).

The LED connects to pin 33 (GPIO 13) and ground (pin 34).

Construction using an IQaudIO Cosmic Controller

IQaudIO manufacture a comprehensive range of sound devices and controller boards. See their Web site at: <http://www.iqaudio.co.uk/>

The radio software provides support for the IQaudIO Cosmic controller.

The IQaudIO Cosmic controller consists of the following:

- A three push-button interface (Channel UP/DOWN and Menu)
- A rotary encoder (Used as volume control)
- Three status LEDs (Normal, Busy and Error)
- A 128 by 64 pixel OLED display (I2C interface)
- Optional IR detector (Ordered separately)

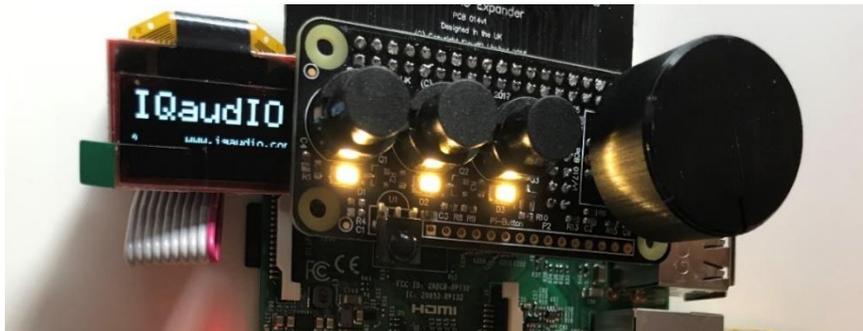


Figure 107 IQaudIO Cosmic controller and OLED display

The main advantage of this hardware, is that it contains everything required by the radio software.



Figure 108 Lego radio with IQaudIO Cosmic controller and OLED

If using the IQaudIO Cosmic controller it is necessary to configure it as shown in the section *Configuring the IQaudIO Cosmic controller and OLED* on page 182.

Construction using the Pimoroni Pirate radio

A full set of instruction for building the Pimoroni Pirate radio with pHat BEAT can be found here: <https://learn.pimoroni.com/tutorial/sandyj/assembling-pirate-radio>

Soldering skills are required.

Construction using the PiFace CAD

Fortunately, no soldering or construction is required with the PiFace CAD. Just plug it in and install and run the software. The PiFace CAD also has an IR sensor which means that it can be used with a remote control. It is however more sluggish in its operation when compared to other variants of the radio as the SPI interface on the Raspberry Pi is fairly slow. It also has the disadvantage that the push buttons are on the bottom of the unit.



Figure 109 PiFace CAD and Raspberry PI



Figure 110 PiFace CAD in a case

Various ready-made cases are available from various suppliers. Warning: not all fit properly and might require some modification.

The PiFace CAD uses the SPI interface (from Motorola)

See http://en.wikipedia.org/wiki/Serial_Peripheral_Interface_Bus and the section called *Installing PiFace CAD software* on page 127 for further information on SPI.

Installing the FLIRC USB remote control



Note: This installation procedure is only for the HDMI or Touchscreen display of the radio. If using an LCD display see *Installing an IR sensor and remote control* on page 61.

FLIRC USB Remote Control dongle



The FLIRC USB dongle allows the use of any remote control with your Raspberry Pi. In this design it is intended for use with the graphical version of the radio (Touch-screen or HDMI displays). It allows button presses on a remote control to be mapped to the keyboard input of the Raspberry Pi. For example, pressing the volume up button on the remote control will act just like pressing the + key on keyboard (if so mapped). The graphical version of the radio accepts key presses. The LCD versions of the program don't so FLIRC will not work with the LCD versions. This may however change in a later version.

More can be found at the FLIRC Web site: <https://flirc.tv>

Installation documentation can be found at: <https://flirc.tv/ubuntu-software-installation-guide>



Note: This installation procedure is only for the HDMI or Touchscreen display of the radio. If using an LCD display see *Installing the Infra-Red sensor software* on page 145.

It is first necessary to install FLIRC. First install the necessary libraries.

```
$ sudo apt install libhidapi-hidraw0 libqt5xmlpatterns5
```

Install the FLIRC software by running the following:

```
$ curl apt.flirc.tv/install.sh | sudo bash
```

The following will be displayed:

```
% Total    % Received % Xferd  Average Speed   Time    Time     Time
Current
                        Dload  Upload  Total  Spent  Left
Speed
100 8266 100 8266    0    0 17185    0  --:--:--  --:--:--  --:--:--
17149
:
:
Distribution: debian
Checking for curl...
Detected curl...
Installing flirc deb-repo...
Running apt update... done.
Installing apt-transport-https... done.
Installing /etc/apt/sources.list.d/flirc_fury.list...done.
Running apt update... done.
```

Answer Y to the following question:

```
Do you want to install the flirc utilities? [Y/n]
```

Reboot the Raspberry pi in Desktop mode (Important).

On the desktop open **Programs** → **Accessories** → **Flirc**



Note: At this stage you may see a pop-up window offering a Firmware Upgrade. Answer Yes to upgrade the firmware in the FLIRC dongle. Failure to do so may result in the Dongle not connecting.

Now see *Configuration of the FLIRC USB dongle* on page 190.

Construction Tips and Tricks

This section contains some construction tips which may be useful. It goes without saying that having the correct tools such as a good fine tipped soldering iron, wire strippers and the like will greatly help constructing the radio.

Wiring up rotary encoders and switches



Figure 111 Rotary encoder wiring components

Purchase prototype board jumper wires with at least one end fitted with female connectors. The best type is the ribbon type particularly in the case of rotary encoders. Strip off five wires for the rotary encoder or two for push buttons. Also, it is better to use shrink wrap to cover the wires after they have been soldered onto the switch or rotary encoder. This improves both insulation and strength.



Figure 112 Using wire strippers

Cut the plugs off the end that is to be soldered to the rotary encoder or switch. Leave the other end with *female* connectors. Using good wire strippers, strip a few millimetres off the wires. Separate the wires for about 30 millimetres.

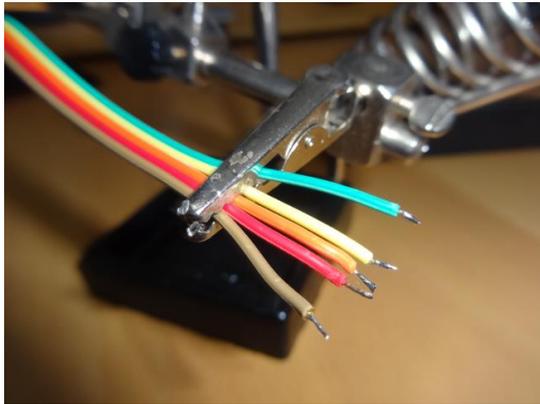


Figure 113 Tinning the wires with solder

Twist the copper strands together as tightly as possible and tin the wires with a little solder. A so called “Extra pair of hands” is very useful for gripping the wires using crocodile clips.

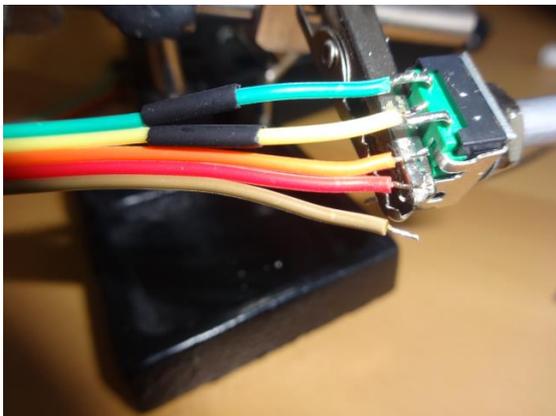


Figure 114 Soldering up the switch

Tin the switch connections with solder. Cut a few millimetres of shrink wrap and slide onto the wires to be soldered. Make sure that the shrink wrap sleeves are well away from the heat of soldering iron as these will shrink easily with the slightest bit of heat. Tack the wire onto the top of the switch connector. Don't attempt to twist the wire around the connector. Just tack it on top with a little bit of heat from the soldering iron.



Figure 115 Shrink shrink-wrap with a hair dryer

After soldering on all wires push the shrink wrap over the newly soldered wires. Using a hair dryer heat the shrink wrap until it has completely shrunk tightly over the wires.

The finished switch can either be connected directly to the Raspberry Pi or to an interface board.

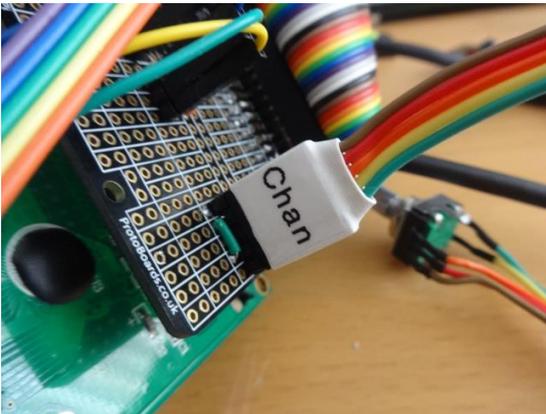


Figure 116 Connecting the rotary encoder an interface board

If using an interface board, the female connectors can be bound together to form a plug using a larger piece of shrink-wrap. Slip the shrink wrap over the female pins and heat with a hair dryer. This can then be labelled up using Dymo tape machine or a CD marker pen. Push the newly created plug onto the male pins on the interface board.

Selecting an audio amplifier

There is a wide range of amplifiers that can be used with the radio which fall into five main categories:

1. A set of PC speakers with amplifier (Logitech or similar) – the simplest option
2. A dedicated AB or Class D stereo amplifier (Velleman or similar)
3. A combined DAC (I2S) and amplifier from manufacturers such as **IQaudio** or **HiFiBerry**
4. The audio stage of an existing (vintage) radio. Use the PA or record player input (Usually mono only)
5. Bluetooth speakers or headset



Figure 117 PC speakers

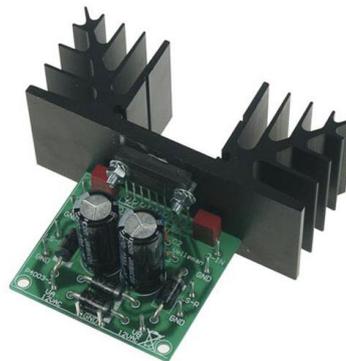


Figure 118 Velleman 30W stereo amplifier



Figure 119 IQaudIO DAC and 20W Amplifier



Figure 120 Vintage radio PA input



Figure 121 JVC Bluetooth Speakers



Figure 122 Audio output jack amplifier



The above manufacturer's products are examples only and do not imply any specific recommendations. There are an enormous number of solutions available. The choice is determined by, amongst other things, price, mono/stereo, power output and quality.

Preventing electrical interference

One of the most irritating faults that one can have is the LCD screen occasionally either going blank or displaying hieroglyphics especially when switching on and off other apparatus or lights on the same circuit. This is due to Electromagnetic Interference (EMI).

See https://en.wikipedia.org/wiki/Electromagnetic_interference for more information.

EMI can be caused by any number of sources such as fluorescent lighting, switching on and off equipment on the same circuit as the radio or even electrical storms. If you are using a standard Raspberry Pi USB power supply then you will probably not experience this problem as nearly all are fitted with a ferrite core (This is the big lump in the cable or may be built in). If you do experience this problem then try the following solutions one at a time in the order shown below. They can all be used together if required.

Using a clip-on ferrite core on the +5 volt cable



Figure 123 Clip on ferrite core

One of the most effective solutions is to put a clip on ferrite core on the +5V cable going to both the Raspberry Pi and USB hub. Loop the wire through at least once. Even a single loop seems to be enough. Try this first!



Figure 124 Loop +5V supply around the core

Fit a mains filter



Figure 125 Various mains filters

Try using a mains filter. This has the advantage that it can prevent spikes coming in from the mains and protect against electrical storms. The picture on the right shows an integrated filter and panel mount mains socket.



Figure 126 Integrated mains socket and filter

Use an I2C LCD backpack

If all else fails replace the directly wired LCD wiring with an I2C backpack. See the section called *Construction using an I2C LCD backpack* on page 58 for further information.

Preventing ground loops



Figure 127 3.5mm Jack Ground Loop Isolator

Avoid creating ground loops in the first place during construction. Ground loop issues usually cause a humming or electronic noise. Trying to tap off the Raspberry power supply from the power supply for the amplifier (if used) is one sure way to create a ground loop. If you experience such a problem then a 3.5mm Jack Ground Loop Isolator available from suppliers such as Kenable (<http://www.kenable.co.uk>) can prevent unwanted hum on the audio system. Place the isolator between the Audio output of the Raspberry Pi or sound card and the amplifier input.

For further information on ground loops: [https://en.wikipedia.org/wiki/Ground_loop_\(electricity\)](https://en.wikipedia.org/wiki/Ground_loop_(electricity))

Connecting up a USB power adapter



Figure 128 Connecting up a USB power adapter

It is convenient to connect all power supply components for the Raspberry Pi, amplifier and USB hub etc via a single mains switch. USB 240V AC to +5V power adapters are designed to connect directly to the mains and not via a mains switch. One idea is to purchase a European round pin adapter and use standard electrical connector blocks to connect the incoming AC power cable to the two pins of the power adapter. AC cables to other components such as the amplifier can also be connected to the connector blocks. Use electrical tape or shrink-wrap to isolate the connector blocks.

Cooling the Raspberry Pi

The Raspberry Pi is built from commercial chips which are qualified to different temperature ranges; the LAN9512 is specified by the manufacturers being qualified from 0°C to 70°C, while the Application Processor (AP) is qualified from -40°C to 85°C. Operation outside these temperatures is not guaranteed. The temperature of the CPU should not really go above 80°C. If it does the CPU will throttle back its processor clock speed to reduce the temperature. The official line from the Raspberry Pi is that does not require cooling even though you can get temperature warnings when using the Raspberry Pi 7-inch touch screen.

The **vcgencmd** command can be used to check the CPU temperature.

```
$ /opt/vc/bin/vcgencmd measure_temp  
temp=67.1'C
```

For most of the radio designs in this document no specific cooling is required. If you need to cool the Raspberry Pi (Those with touchscreens in particular) then a variety of heat sinks and cooling fans are available as shown in Figure 129 below. Even with a heat sink good ventilation is necessary.



Figure 129 Heat sink kit

A variety of heat sink and cooling fan kits are available for the Raspberry Pi. Fans are a less good idea as they will produce a background hum. Also, as the CPU gets hot and the RPi is mounted vertically the adhesive softens and the fan and its heat sink tend to fall off unless secured in some way. Try to using a heat sink first.



Figure 130 Cooling fans

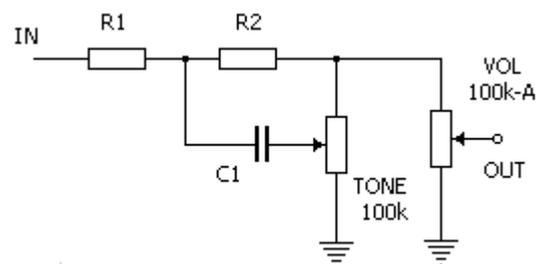
Miscellaneous

Simple tone regulator

It may be that you wish to fit a tone regulator to the radio. Below is one option.

The following diagram and modified text came from Jack Orman at:

<http://www.muzique.com/lab/swtc.htm>



muzique.com

Figure 131 Simple tone control circuit

This tone control circuit that has a response that can be altered from high cut to high boost as the knob is turned. The output resistance is constant so the volume does not vary as the tone control is adjusted.

Suggested values for beginning experimentation with, are $R1=10k$, $R2=47k$, $C1=0.022\mu F$ and $100k$ for the tone and volume pots.



Note that the above circuit has a lot of attenuation of the audio output so using the onboard audio output of the Raspberry Pi might result in a disappointing level of volume. It is recommended to use a sound output DAC or USB sound dongle.

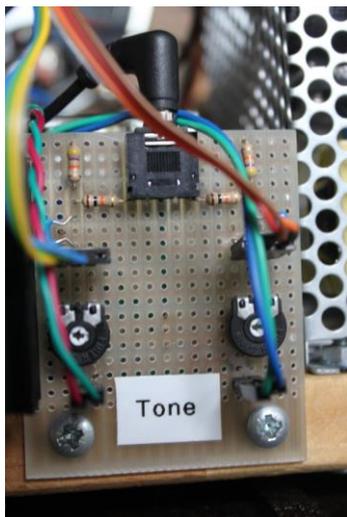


Figure 132 Tone control board

The illustration on the left shows a simple passive tone regulator board using the above circuit.

The audio output from the Raspberry Pi or DAC is fed into the board via a standard Audio socket.

Below the input are the connections to the tone regulator potentiometer mounted on the front panel of the radio. Below the potentiometer connections are the two $100K$ presets for adjusting the output level to the Audio Amplifier.

Below these the Left and Right audio outputs connect to the Amplifier.

Using the Adafruit backlit RGB LCD display

The Adafruit backlit RGB LCD has three LED backlights (Red, Blue and Green) which can either be switched on individually or in various combinations together as shown in the table below:

Table 14 Adafruit backlit RGB display wiring

Switch pin	Red (Pin 16)	Green (Pin 17)	Blue (Pin 18)	Colour	Diodes required
1	0	0	0	Off	0
2	0	0	1	Blue	0
3	0	1	0	Green	0
4	0	1	1	Light Blue	2
5	1	0	0	Red	0
6	1	0	1	Purple	2
7	1	1	0	Yellow	2
8	1	1	1	White	3
Common	GND			Total diodes	9



The diodes used are any low voltage low current diodes such as the IN4148. So to use all of the above combinations would require a single pole 8 way rotary switch and logic and nine diodes. The first switch position is off.

Figure 133 IN4148 diode

- Do not wire anything to position 1.
- Wire pin 16 (Blue) of the LCD backlight to switch position 2.
- Wire pin 17 (Green) of the LCD to switch position 3
- Wire pin 18 (Red) of the LCD to switch position 5
- Wire pin 17 and 18 via two diodes to pin 4 to give the colour light blue
- Do the same for the other two-colour combinations
- Wire pin 16, 17 and 18 to pin 8 via three diodes to give the colour white
- Wire the centre pin of the switch to 0v (GND)

Chapter 5 – System Software Installation

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Editing configuration files	78
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Conventions used in this tutorial

Installation of the radio program requires you to enter lines at the command line prompt. This requires you to log into the Raspberry PI as user '**pi**'. The default password is **raspberrypi**.



Note: Don't carry out any of the following commands just yet. They are just examples.

```
Raspberrypi login: pi
Password: raspberrypi
pi@raspberrypi:~$ Last login: Sun Apr  6 10:18:18 2014 from 192.168.2.100
pi@raspberrypi:~$
```

The prompt line is displayed ending with a \$ sign. The **pi@raspberrypi:~** string means user 'pi' on host machine called 'raspberrypi'. The ~ character means the user 'pi' home directory **/home/pi**. In this tutorial if you are required to do something as user **pi** then only the \$ sign will be shown followed by the command as shown in the example below:

```
$ mpc status
```

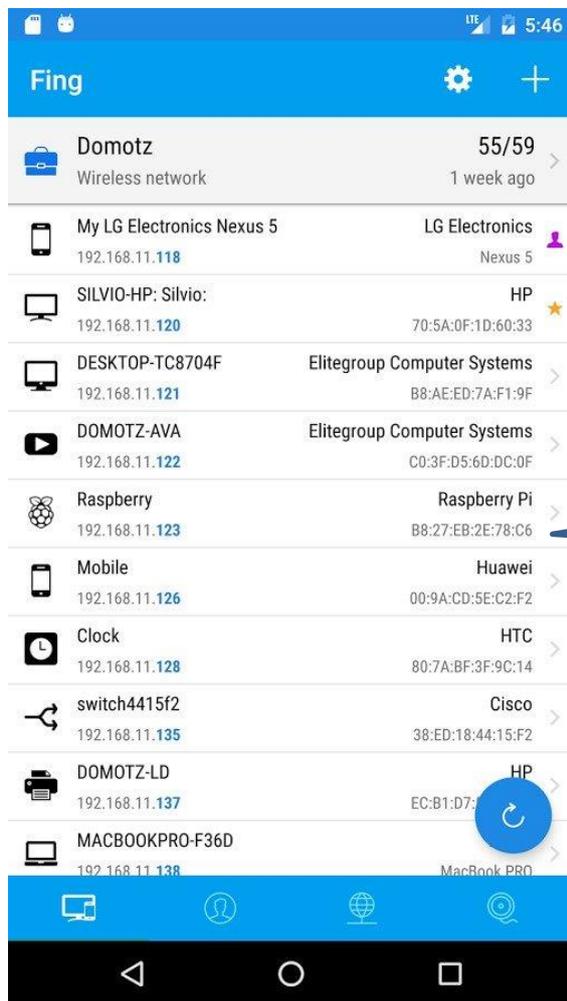
Some commands produce output which does not need to be shown. In such a case a ':' is used to indicate that some output has been omitted.

```
$ aplay -l
**** List of PLAYBACK Hardware Devices ****
: {Omitted output}
card 0: ALSA [bcm2835 ALSA], device 1: bcm2835 ALSA [bcm2835 IEC958/HDMI]
  Subdevices: 1/1
  Subdevice #0: subdevice #0
card 1: Device [USB PnP Sound Device], device 0: USB Audio [USB Audio]
  Subdevices: 0/1
  Subdevice #0: subdevice #0
```

END OF EXAMPLE COMMANDS.

Useful installation tools

Finding the Raspberry Pi on a network using Fing



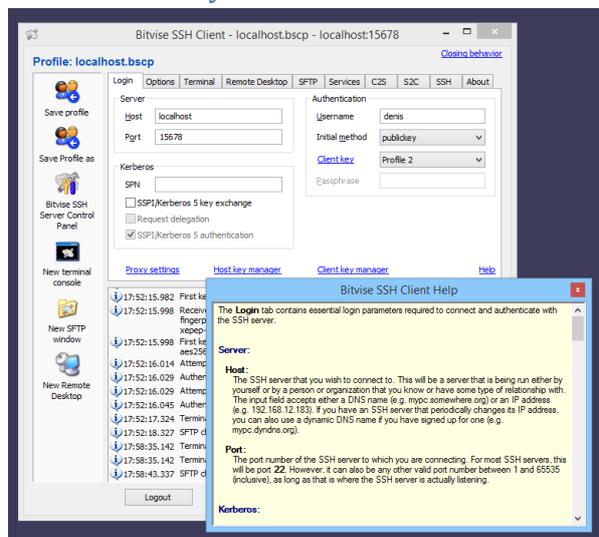
The **Fing** App is a free network toolkit and scanner for iOS (Apple) and Android. It will discover all the devices on your network, identify intruders and can also run Internet speed tests.

In this context it is very useful for finding out the IP address of any Raspberry Pi connected to the network. It will only see it of course once the Raspberry Pi has been set up first on the Wireless Network or hard-wired in. It scans both Wireless and hard-wired Ethernet devices.

Once detected it is possible to SSH to the Raspberry Pi using **Bitvise** or **Putty**.

See <https://www.fing.com/products/fing-app> for further information.

Bitvise and Putty



Bitvise is a free SSH client available for Windows or Mac to connect SSH server enabled Unix or Linux operating systems. It is a graphical based SSH client just like Putty with more features. It supports the File Transfer using SFTP (Secure File Transfer Protocol). Once installed you can easily make a terminal connection to the Raspberry Pi using the IP address discovered by Fing above as well as easily transferring files.

See <https://www.bitvise.com/ssh-client> for more information.

Entering system commands

If you are new to Linux there are a couple of things that may cause confusion.

1. Entering program names on the command line
2. File path names
3. File permissions

Take the following examples:

```
$ raspi-config
```

The following command fails

```
$ configure_radio.sh  
$ -bash: configure_radio.sh: command not found
```

The following two commands both work.

```
$ cd /usr/share/radio  
$ ./configure_radio.sh
```

```
$ /usr/share/radio/configure_radio.sh
```

The third command has a `./` in front of it, the first one doesn't. Why?

The reason is that the **raspi-config** program is in the **/usr/bin** directory which is in the **PATH** environment directive. This can be seen with the following command.

```
$ echo $PATH  
/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/local/game  
s:/usr/games
```

The second program is located in the **/usr/share/radio** directory which is not in the **PATH** directive. The `./` in front of the command means that the program or script will be found the current directory.

So, this means for programs not in directories specified in the **PATH** environment directive, you must either specify the full path name to the command or change to its directory and then enter the command with a `./` in front of it.

In the system prompt for user pi you will see a `~` character. The `~` character means the home directory for the current user, this case pi. So `~` is the same as **/home/pi**.

```
pi@raspberrypi3:~ $
```

For information on file permissions see the following link:

https://wiki.archlinux.org/index.php/File_permissions_and_attributes

Editing configuration files

At various points during the installation procedures in this manual you will be asked to edit certain configuration files such as `/etc/radiod.conf` (The radio configuration file) or `/boot/config.txt` (The boot configuration file). There are various text editors that can be used but the main ones in the case of the Raspberry Pi are:

1. Nano - **nano** is a small, free and friendly editor particularly suited for use by beginners.
2. Vi – **vi** is usually the professional user’s choice of editor. It is very powerful but a lot harder to use for someone unfamiliar with it.

Usage:

```
nano <filename>
```

or

```
vi <filename>
```

Where *<filename>* is the name of the file to be edited.

See <https://www.raspberrypi.org/documentation/linux/usage/text-editors.md> for an overview of available text editors.

It is important to know that most configuration files are owned by root so you may be able to read them but not write them. For example:

```
$ nano /etc/radiod.conf
```

This will allow you to read the file but not change it. To give user **pi** temporary root user permissions so that you can save changes to the file use the **sudo** command in front of the editor command:

```
$ sudo nano /etc/radiod.conf
```

Or

```
$ sudo vi /etc/radiod.conf
```



Note: Make sure that you edit the file `/etc/radiod.conf` and not `/usr/share/radio/radiod.conf` which is the distribution file. The latter is copied to the `/etc` directory during installation and configuration.

Using the Vi editor

This is too big a subject to cover here. Type “Using vi” into a search engine such as Google or Bing to display various tutorials on how to use **vi**.

Using Nano

When **nano** is started it will display the contents of the file being edited. For example, `/etc/radiod.conf`. In this example the following screen will be displayed.

```

64.tlp - pi@192.168.2.21:22 - Bitvise xterm - pi@pitest: ~/develop/pi/radio6
GNU nano 2.7.4 File: /etc/radiod.conf
# Raspberry Pi Internet Radio Configuration File (40 Pin version)
# $Id: radiod.conf,v 1.15 2017/11/13 12:27:27 bob Exp $

# Configuration file for version 6.0 onwards
# 40 pin version to support IQ Audio and other sound cards

[RADIOD]

# LogLevel is CRITICAL,ERROR,WARNING,INFO,DEBUG or NONE
LogLevel=DEBUG

# Startup option either RADIO or MEDIA (USB stick)
startup=RADIO

# Set date format, US format = %H:%M %m/%d/%Y
#dateformat=%H:%M:%S %d/%m/%Y
dateformat=%H:%M:%S %A %e %B %Y

# Volume range 10, 20, 25, 50 or 100
volume_range=20

# Volume display text or blocks
volume_display=blocks

# MPD port number (Do not change unless MPD reconfigured)
mpdport=6600

# Remote control communication host and port Default localhost 5100
remote_control_host=localhost
remote_control_port=5100

^G Get Help ^O Write Out ^W Where Is ^K Cut Text ^J Justify ^C Cur Pos ^Y Prev Page
^X Exit ^R Read File ^\ Replace ^U Uncut Text ^T To Spell ^_ Go To Line ^V Next Page

```

Figure 134 The nano file editor

Hold down the Ctrl key and press the letter G on the keyboard to display the help text. The following screen will be displayed:

```

64.tlp - pi@192.168.2.21:22 - Bitvise xterm - pi@pitest: ~/develop/pi/radio6
GNU nano 2.7.4 File: /etc/radiod.conf
Main nano help text

The nano editor is designed to emulate the functionality and ease-of-use
of the UW Pico text editor. There are four main sections of the editor.
The top line shows the program version, the current filename being
edited, and whether or not the file has been modified. Next is the main
editor window showing the file being edited. The status line is the
third line from the bottom and shows important messages. The bottom two
lines show the most commonly used shortcuts in the editor.

Shortcuts are written as follows: Control-key sequences are notated with
a '^' and can be entered either by using the Ctrl key or pressing the Esc
key twice. Meta-key sequences are notated with 'M-' and can be entered
using either the Alt, Cmd, or Esc key, depending on your keyboard setup.
Also, pressing Esc twice and then typing a three-digit decimal number
from 000 to 255 will enter the character with the corresponding value.
The following keystrokes are available in the main editor window.
Alternative keys are shown in parentheses:

^G (F1) Display this help text
^X (F2) Close the current file buffer / Exit from nano
^O (F3) Write the current file to disk
^R (F5) Insert another file into the current one

^W (F6) Search for a string or a regular expression
^_ (M-R) Replace a string or a regular expression
^K (F9) Cut the current line and store it in the cutbuffer
^U (F10) Uncut from the cutbuffer into the current line

^J (F4) Justify the current paragraph

^X Exit ^P Prev Line ^Y Prev Page M-_ First Line
^L Refresh ^N Next Line ^V Next Page M-/ Last Line

```

Figure 135 The nano editor help screen

The ^ character means the Control-key (Ctrl). So, for example ^O above is Ctrl + O. For more information on nano see <https://www.nano-editor.org/dist/v2.0/nano.html>

System Software installation

Raspberry Pi OS (previously called **Raspbian**) is the Foundation's official supported operating system. The latest version of **Raspberry Pi OS** is called **Bookworm**. Create a new SD card with **Bookworm** or **Bookworm Lite**. There is also a "Full" version of **Bookworm** however this is unnecessary for this project.

A lot of very useful Raspberry Pi documentation will be found at:
<https://www.raspberrypi.org/documentation>



Note: The touch-screen or HDMI TV version of the software requires a desktop version of the operating system so use **Raspberry Pi Bookworm** and not the **Lite** version. Only use **Lite** for LCD versions of the radio.



Warning: Version 7.4 onwards is designed to work primarily on **Raspberry Pi Bookworm** but can run with restrictions on **Buster**. **Bookworm** uses Music Player Daemon (MPD) version 0.23.12.

SD card creation using Raspberry Pi Imager

Use at least a 16 Gigabyte Card for **Bookworm Lite** or 32 Gigabyte for **Bookworm Desktop/Full**. Create an SD card running the latest **32-bit** version of **Raspberry Pi Bookworm** or **Bookworm Lite**.



Note: This version now works on either **32-bit** or **64-bit** architecture of the Raspberry Pi Operating System. Please note that the **64-bit** version is in the Beta testing stage. The software has exactly the same functionality for both architectures.

There are a couple of ways of doing this but in this tutorial, we are using the **Raspberry Pi Imager** software to create the SD card. You will need a Windows PC or Laptop with a SD Card Reader as shown in Figure 136 below.



Figure 136 Windows Laptop with SD card reader



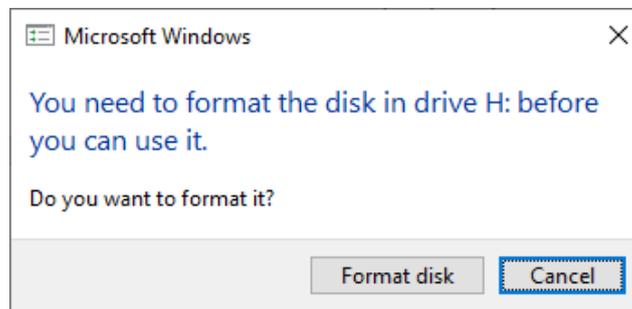
Figure 137 USB SD Card reader

If your PC does not have an SD Card Reader then you can use a USB SD Card reader as shown on the left. The Raspberry Pi Imager software can then be used to write the Raspberry Pi OS to SD Card.

An Apple Mac PC can also be used but will require that you download the Mac OS version of the software.

First insert the SD card into the SD card reader on your PC.

When you insert an SD Card that already has an OS other than Windows you may see the following:



Ignore this message and close the above dialogue box. The above may occur a number of times during this process.



Note: It is possible to boot from a USB 3.0 disk drive or stick instead of from an SD card. This is described in the section called *Booting from a USB drive* on page 326 (Chapter Advanced topics). However, always start with an SD card first.



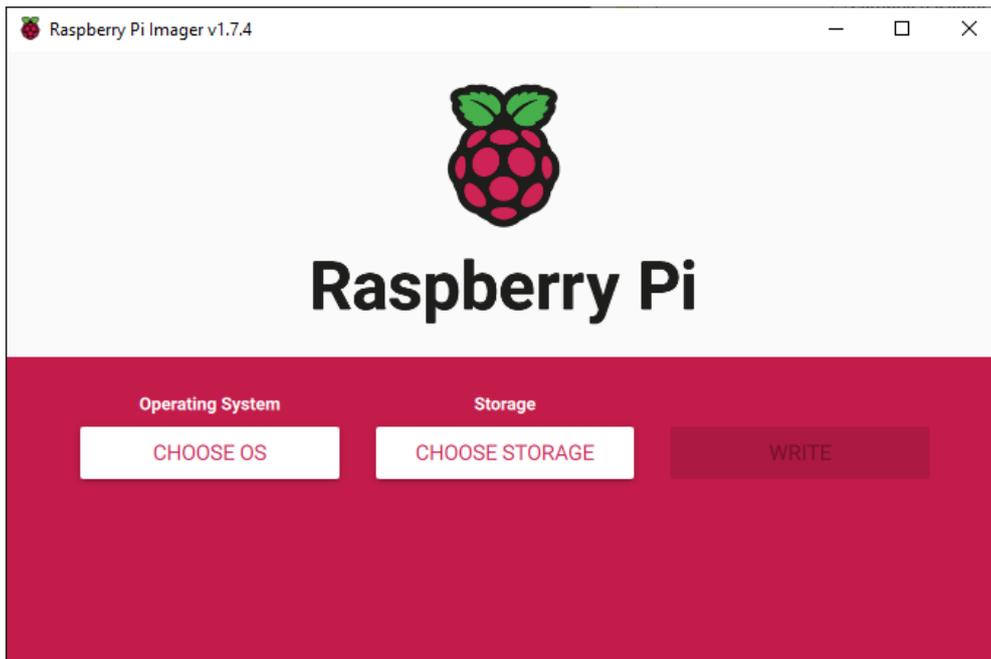
Note: If installing on a very old Raspberry Pi 1B with a 26-pin header this only runs properly on **Buster**. If using a model 1B install **Buster** and not **Bookworm**.

Using a Web browser, go to <https://www.raspberrypi.org/software/>

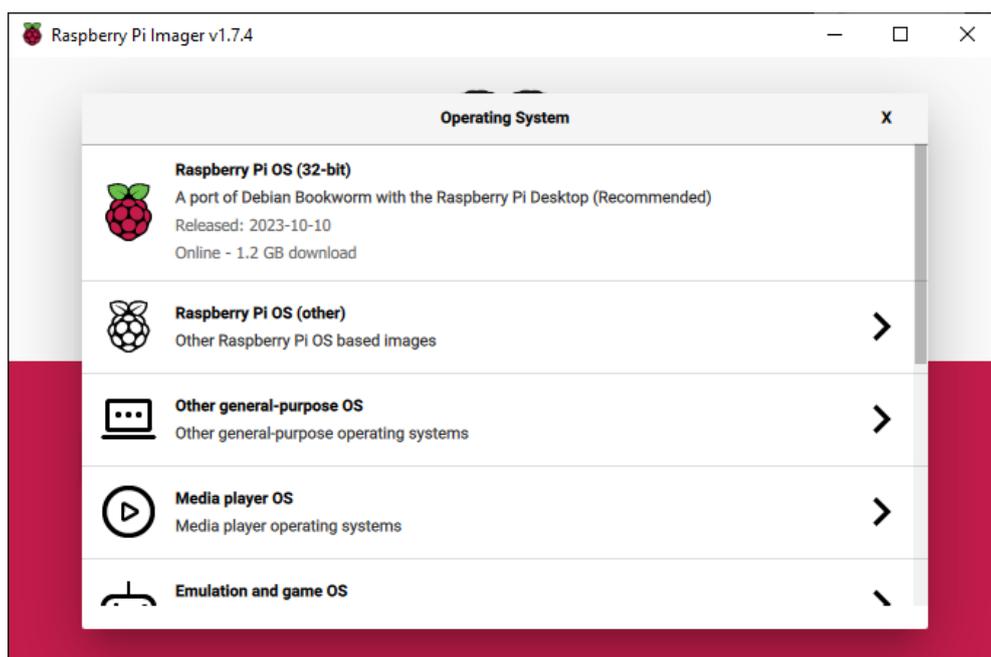
Download and install the **Raspberry Pi Imager** software for your PC Operating System (Normally Windows or Mac OS).

Once installed you will see the Raspberry Pi Imager Icon on your desk-top. Click on the desktop Imager icon.

The following screen will be displayed:



Insert the SD card into your card reader. Ignore any Windows messages to format the card as it isn't necessary. Click on "Choose OS"

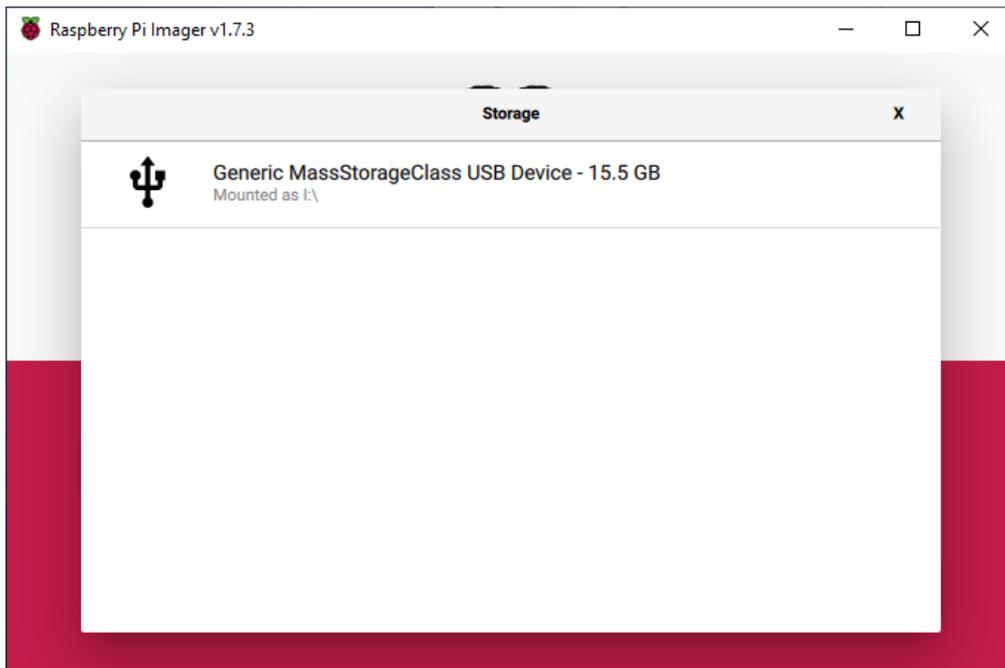


The download options will be displayed. Select the first option **Raspberry Pi OS (32-bit)**. If you want either **Bookworm Lite** the **64-bit** version then select these from **Raspberry Pi OS (other)**.

The program will return to the first screen. Select CHOOSE STORAGE. This will display the available USB devices. The actual drive letter shown will have been assigned by your PC. You should see something like the following. In this example it is drive **H:**

y

Select your SD card. The imager software should only display USB devices.



Note: If there are multiple choices of USB drives make sure that you select the correct one. Do not proceed until you are absolutely sure you are selecting the correct drive and not for example a USB backup drive.

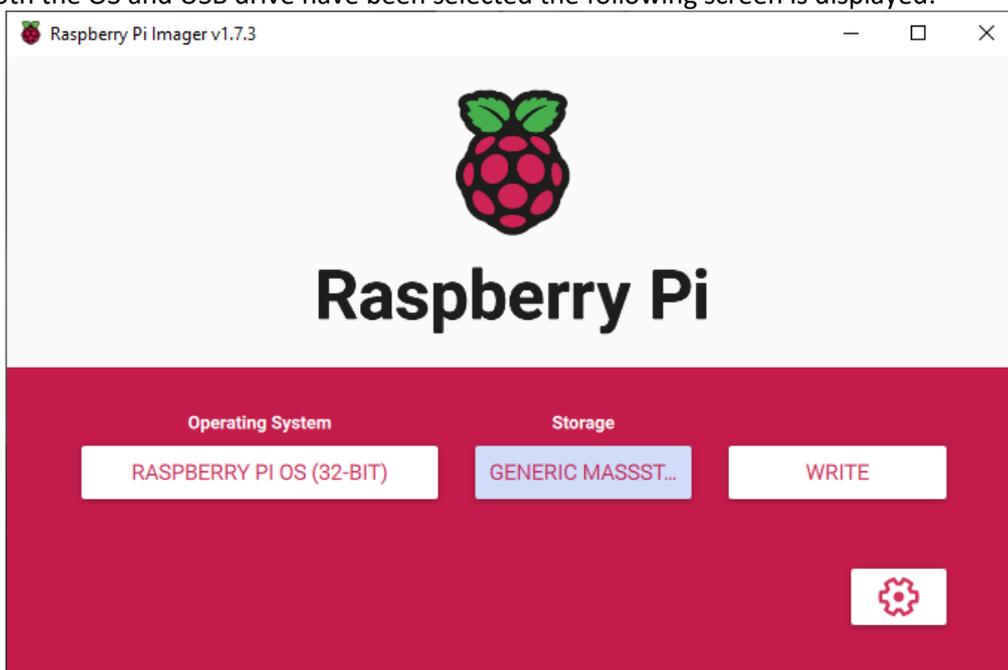


Note: Do **not** press write at this stage as you need to set up SSH (Secure Shell login) and your Wi-Fi identifier (SSID) and password and other optional changes.



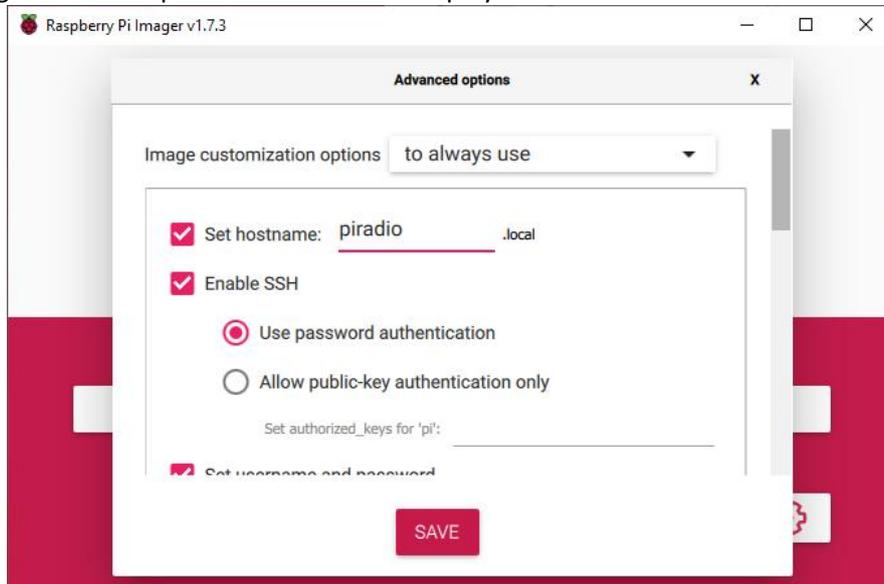
Note: The recommended user name is **pi**. It is possible to use another username other than **pi** when creating the SD card. However only limited testing has been carried out.

Once both the OS and USB drive have been selected the following screen is displayed:



To select the customisation menu press either the configuration icon (Gear wheel) in the bottom right or **CTRL, Shift** and **X** keys together. Clicking on WRITE will ask if you want to edit the parameters.

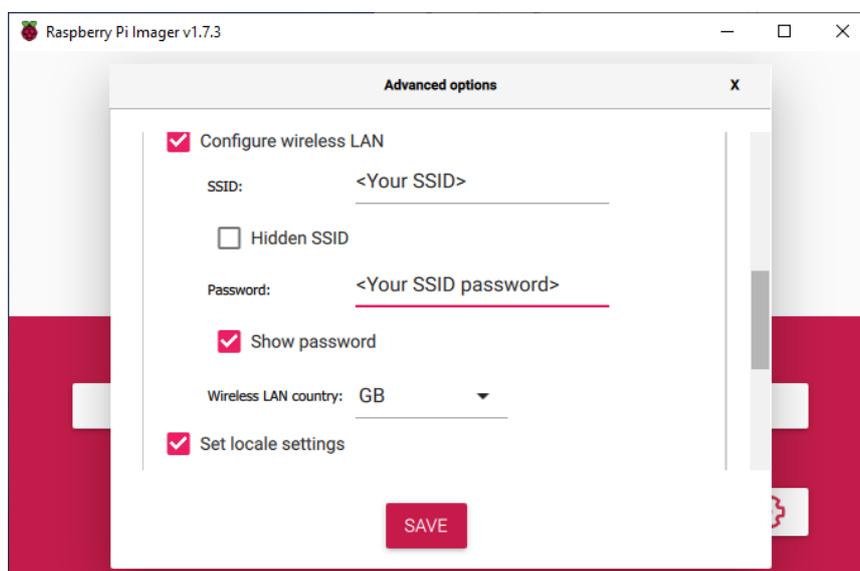
The following Advanced Options screen will be displayed:



Click the “Set hostname” and “Enable SSH” tick boxes. Enter a hostname (such as **piradio**) and a password for user **pi**. You can change the username from **pi** but it is recommended to use user **pi**. Make a note of the username and password.

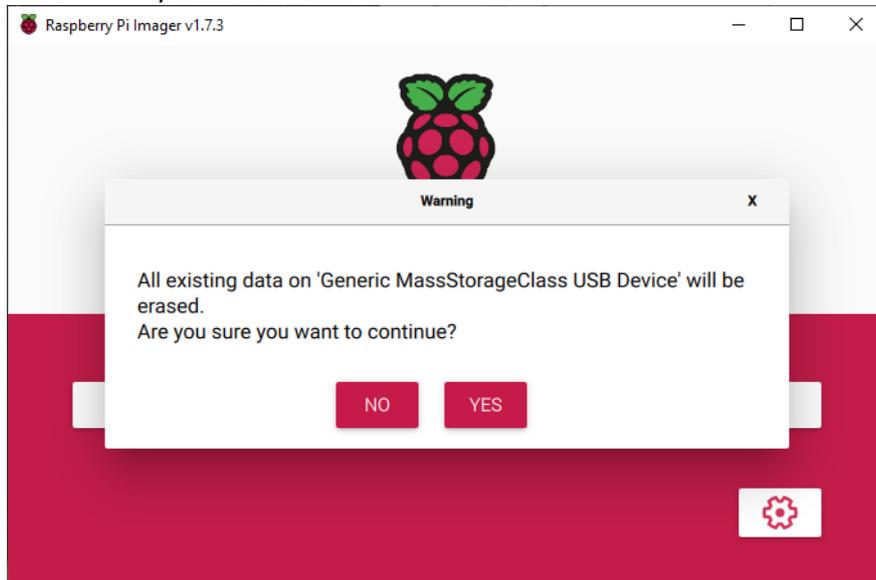
Important: Enable the SSH option “Use password authentication”. If you select “Allow public-key authentication only” you will have to set up SSH keys between the PC and the RPi which is more complicated and not covered yet in this manual.

Do not press SAVE just yet. Ignore “Disable overscan” for now, as this is used to prevent a black border around a HDMI screen. Now scroll down to the “Configure wireless LAN” option using the right-hand scroll bar. Enter the SSID and password for your router. This information is usually given on the router itself or with router documentation.



You must also set the locale using the two-letter country code for your location, for example GB (Great Britain), DE (Germany) or NL(Netherlands). It is required for correct set-up of Wi-Fi. There are other options in this menu but these are not required for this project.

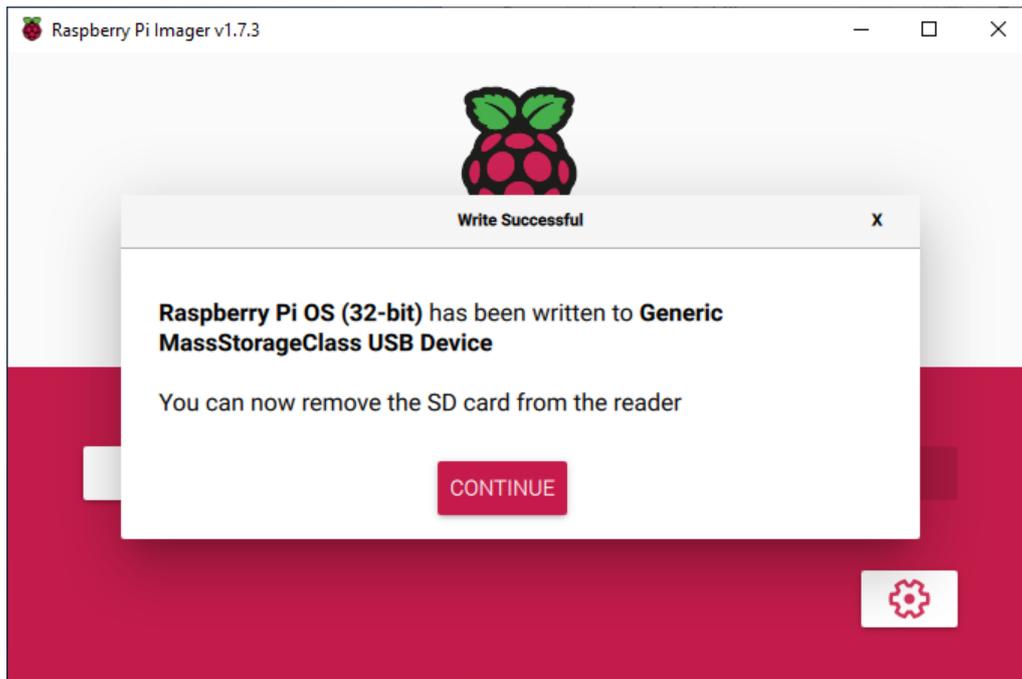
Click on “Save” followed by “Write” to continue.



Click “YES” to continue with writing to the new SD card.



This will take about 10 minutes to complete including the verification stage.



Remove the SD card from your computer and insert it into the Raspberry Pi (Remove power from the Raspberry Pi first).

Booting the Raspberry Pi for the first time

Power up the Raspberry Pi. The first boot will take a little longer as there are a few jobs that the OS must carry out, such as re-sizing the file system on the SD card.



BOOT PROBLEMS: If the Raspberry Pi will not boot up the first time see the section called *Boot problems* on page 244 in *Chapter 9 - Troubleshooting*.

Log into the Raspberry Pi for the first time

There are two ways of logging into the Raspberry Pi:

1. Using the graphical Linux Windows desktop
2. Using SSH to log into the RPi over the network

Logging in with the Raspberry Pi desktop

If you installed the OS with the Linux desktop you will need an HDMI monitor, a USB keyboard and mouse. Boot up the Raspberry Pi with the new SD card with the **Raspberry Pi Buster** Operating System (OS). If you have used **Buster** or **Bookworm** desktop then a graphical desktop will be displayed. Start a terminal session by clicking on the black terminal icon  on the top left of the screen to the left of the "Welcome" message. With **Raspberry Pi Lite** only a log in prompt will be displayed. In such a case log into the Raspberry Pi as user **pi** and using the password **raspberrypi**. Alternatively log in using SSH (See following section).

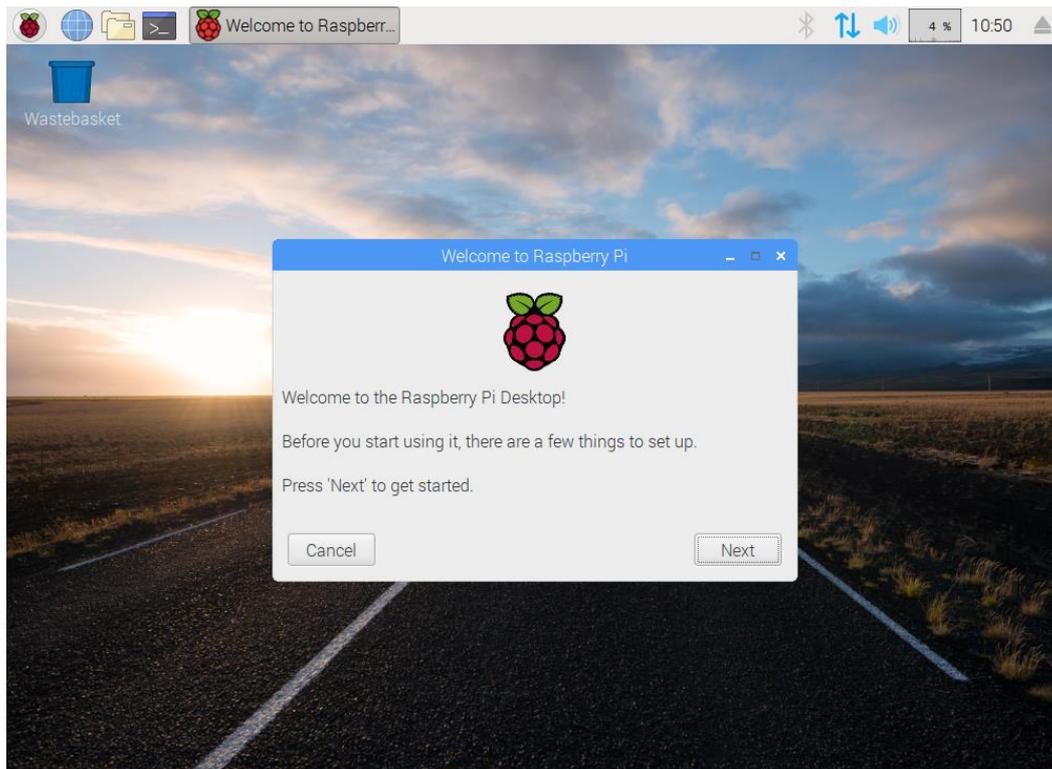


Figure 138 Raspberry Pi desktop

If you created the SD card with the Lite version of the OS then you will not see a desktop. Instead, you will see a terminal session which will allow you to carry out the next steps of the installation.



IMPORTANT: A new screen driver for the Desktop namely the Broadcom VideoCore 4 driver (**vc4-kms-vc3**) has been recently introduced. However, the **vc4-kms-vc3** driver (dtoverlay) is not compatible with all HDMI displays. If the system fails to display a Desktop, then see *Disabling the DRM VC4 V3D driver* on page 90.

Logging in with SSH (Bitwise)

If you don't have a USB keyboard, mouse and screen then you can log into the RPi using the Bitwise or Putty utility running on a Personal Computer. Run the **Bitwise** interface and using **Fing** to find the IP address of the Raspberry Pi as shown in the section *Finding the Raspberry Pi on a network using Fing* on page 76. Enter the IP address from Fing into the Host field (192.168.1.36 in this example). Also enter the user name **pi** and the password you set up.

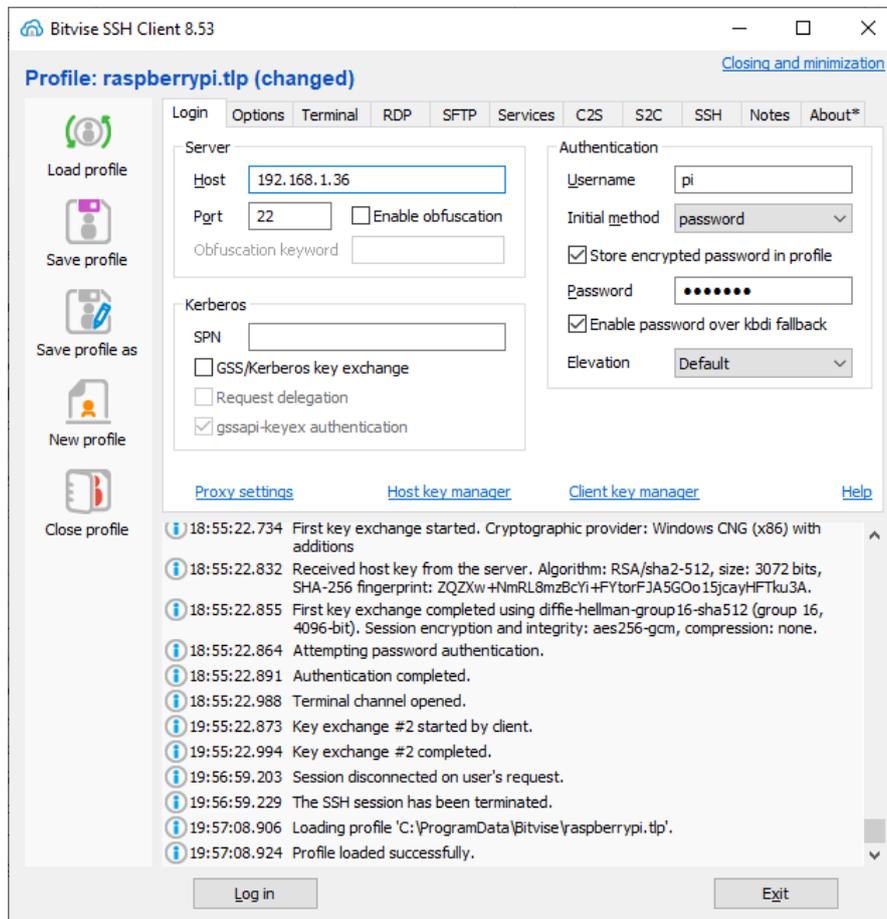


Figure 139 Bitwise connection dialogue



Note: You can also use the host name of the Raspberry Pi instead of its IP address. If you set the SD card up according to the instructions shown earlier. For example if the hostname was “raspberrypi” then try the name **raspberrypi** first. If that doesn't work then try **raspberrypi.lan**, **raspberrypi.local** or **raspberrypi.home** in the host field. If the hostname was “piradio” then try the names **piradio**, **piradio.lan**, **piradio.local** or **piradio.home**. If none of these work just use the IP address.

Enabling SSH using raspi-config

If SSH was enabled when creating the SD card this step should not be necessary. You will need a USB keyboard, mouse and HDMI display screen. Once logged in run **raspi-config**.

```
$ sudo raspi-config
```

Select option 3 – Interface options. The following screen will be displayed

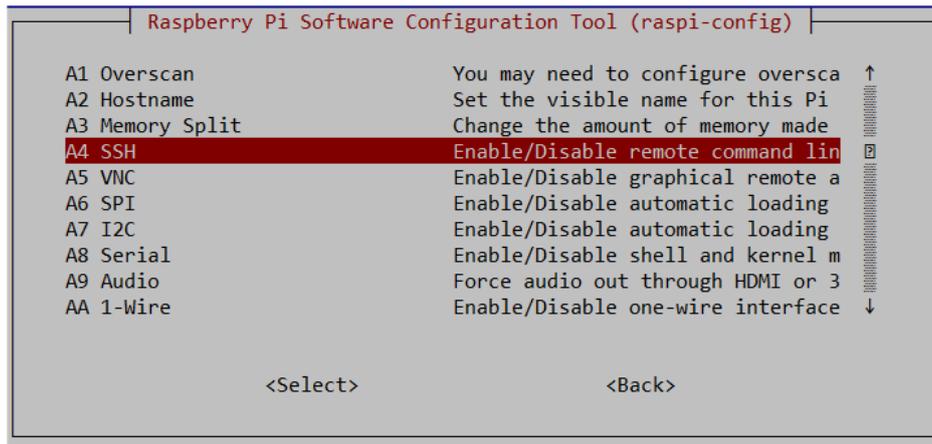


Figure 140 Enabling SSH

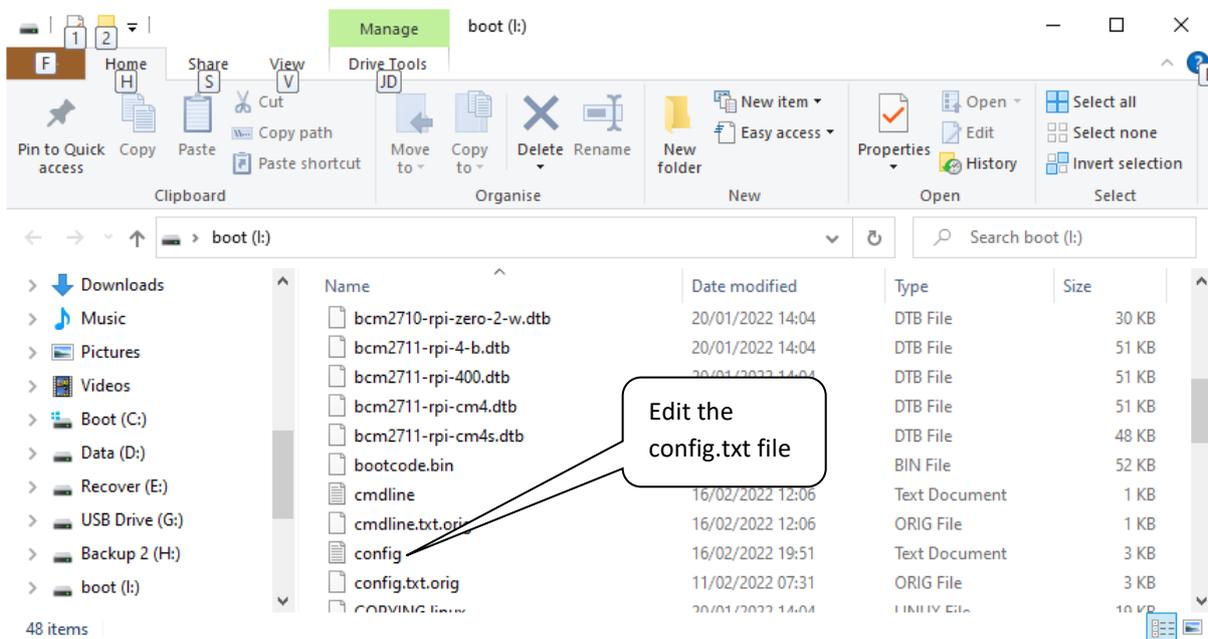
Reboot the Raspberry Pi after which it will be possible to log into the Raspberry Pi using SSH.

```
$ sudo reboot
```

Now log into the Raspberry Pi using SSH.

HDMI Screen not available

If the HDMI display is not available or not working due to the **vc4-kms-vc3** overlay it is necessary to disable the **vc4-kms-vc3** overlay or use the previous **vc4-fkms-vc3** overlay. Put the SD card into a PC. A new drive will be seen called **boot**. In the following example this is drive (i:). This will vary with each system. Look for the text file **config.txt**.



Open the **config.txt** file using notepad. Carry out the edit shown in *Disabling the DRM VC4 V3D driver* on page 90. Once the **config.txt** file has been edited and saved, put the SD card back into the Raspberry Pi and reboot the system.

```
$ sudo reboot
```

Disabling the DRM VC4 V3D driver

By default, the **vc4-kms-v3d** HDMI screen driver is enabled in **/boot/config.txt** configuration file. Regrettably this driver gives rise to several problems including audio problems and unreliable touch screen problems.

To disable the **vc4-kms-v3d** driver (dtoverlay) first log into the Raspberry Pi using SSH or by using the method described in *HDMI Screen not* on page 89.

Edit the **/boot/config.txt** file either using **sudo nano** or **vi**.

```
$ sudo nano /boot/config.txt
```

Disable the VC4 driver as shown below. Comment out the **dtoverlay** statement for the VC4 driver.

```
# Enable DRM VC4 V3D driver
#dtoverlay=vc4-kms-v3d
```

Reboot the system.

```
$ sudo reboot
```

After logging back in the following message may be displayed if a new password wasn't set.

```
SSH is enabled and the default password for the 'pi' user has not been
changed. This is a security risk - please login as the 'pi' user and type
'passwd' to set a new password.
```



Note: Security is becoming more and more of an issue for devices connected to the internet. If SSH has been enabled then please change the user password at the first opportunity. See the section called *Chapter 13 - Internet Security* page 305 for further information on security issues.

Preparing the Operating System for software installation

Update to the latest the packages

Run the following command to update the library list.

```
$ sudo apt update
```

The above command will take some time! If you see a message similar to the following.

```
E: Repository 'http://raspbian.raspberrypi.org/raspbian Bookworm InRelease'
changed its 'Suite' value from 'testing' to 'stable'
```

Run the following command

```
$ sudo apt update --allow-releaseinfo-change
```

Now re-run the update.

```
$ sudo apt update
```

Run the following command to upgrade to the latest packages for this release.

```
$ sudo apt full-upgrade
```



Note: The **update/full-upgrade** commands will also automatically update the Raspberry Pi with the latest stable firmware. Older Raspbian versions such as Stretch required a separate command called **rpi-update** to update the firmware. Do not use **rpi-update** with **Bookworm** or **Buster** unless specifically advised to do so by an official source.

Reboot the Raspberry Pi.

```
$ sudo reboot
```



Important: After upgrading the system the repository locations may no longer be valid. Re-run **apt update** to refresh the package list. Failing to do this may result in packages failing to install.

Re-run the update command to update the library list.

```
$ sudo apt update
```

Once you have updated the operating system login to the system and run **raspi-config**.

```
$ sudo raspi-config
```



Warning: If you are intending to run the touch-screen/HDMI version of the radio, do not be tempted to start removing components of the **pygame** software such as games as this may unfortunately remove graphic libraries used by the radio software.

Disable booting to the desktop environment

If you are planning to use a touch-screen or HDMI display skip this section.

The desktop environment is not required for the LCD, TFT or OLED versions of the Radio and takes a lot of processing power. It is enabled by default in **Bookworm** but is not installed with **Bookworm Lite**. If you are not planning to use the touch-screen or HDMI version of the radio or you don't otherwise plan to use it then disable it.

Run **raspi-config**:

```
$ sudo raspi-config
```

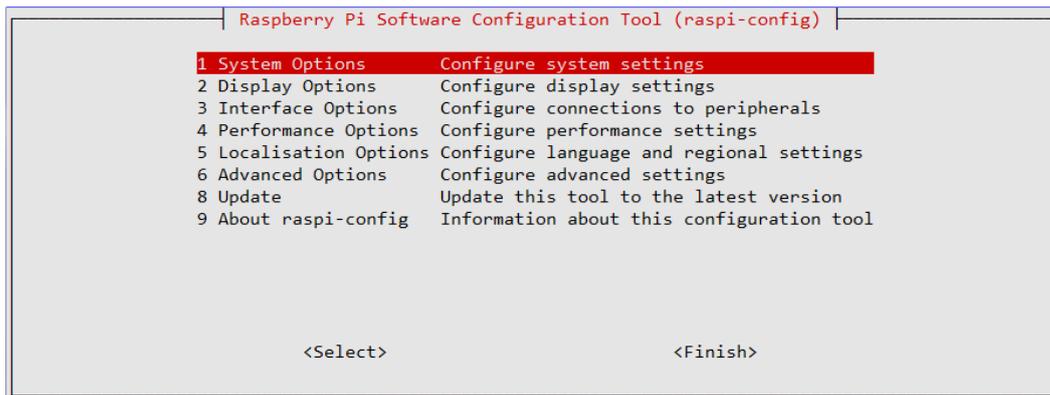


Figure 141 raspi-config main screen

Select option **1 System options**

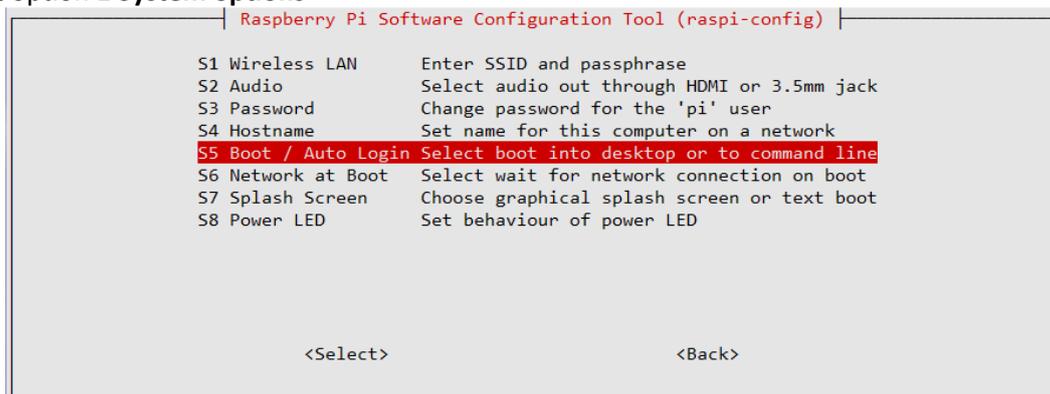


Figure 142 Disabling the graphical desktop

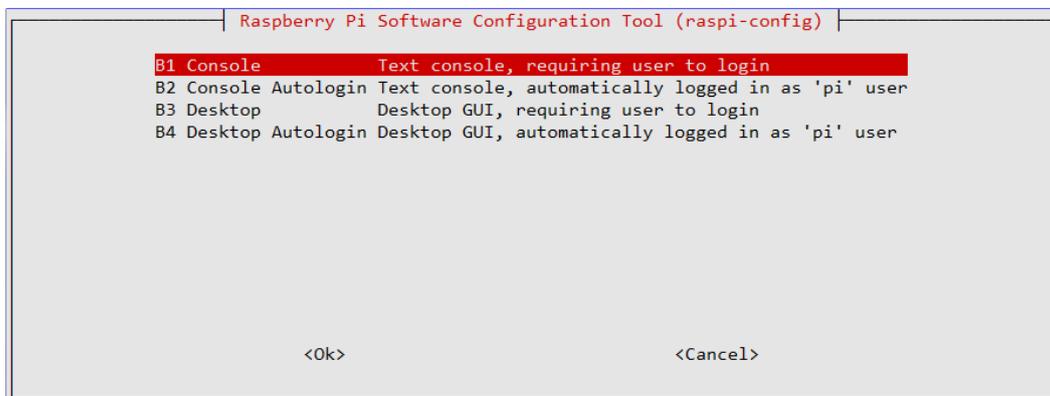


Figure 143 Desktop enable/disable selection

Select option **B1**(secure) or **B2**(insecure) to disable the desktop and select OK

Setting the time zone

The **Raspberry Pi Buster** operating system is usually set to UK time or the time zone that you set with the **Raspberry Pi OS imager** settings. If you still need to set the time zone then the easiest way to set the time zone for your country if you are in a different time zone is to use the **raspi-config** program and select option 5 “Localisation Options”:

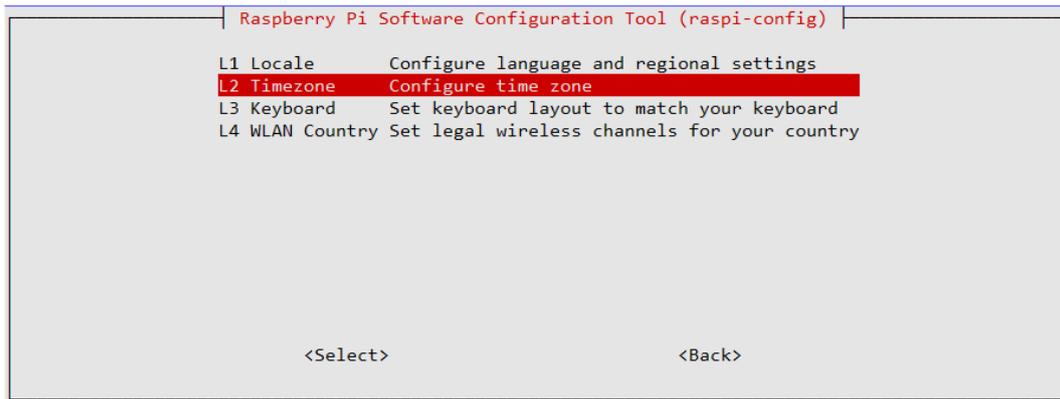


Figure 144 Setting the time zone

Select option L2 “Timezone”:



Figure 145 Saving the time zone

Select the region your country is in, Europe for example. Use the tab key to move to <OK> and press enter. The program will then display a list of time zones for the selected region.

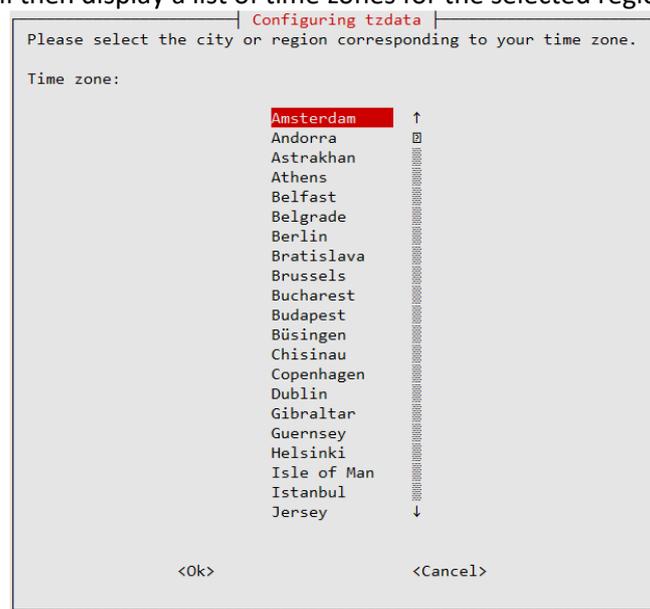


Figure 146 Time zone country selection

Select the correct one and save it by tabbing to <ok> and pressing the enter key. The time zone will be updated. Exit the program once finished.

Changing the system hostname and password



If the **RaspberryPi** Imager was used to create the SD card it may be that the hostname and password may have already been set, in which case this option can be skipped.

It is a good idea to change the system password for security reasons especially if your raspberry PI is connected to a network with a wireless (WI-FI) network. Changing the hostname is also a good idea as it makes identifying your radio on the network much easier. If you wish to do this, change the default hostname from 'raspberrypi' to something like 'piradio' or 'myradio'.

Both the password and hostname can be changed using the **raspi-config** program. Select option **1 System options**

```
Raspberry Pi Software Configuration Tool (raspi-config)

S1 Wireless LAN      Enter SSID and passphrase
S2 Audio             Select audio out through HDMI or 3.5mm jack
S3 Password          Change password for the 'pi' user
S4 Hostname          Set name for this computer on a network
S5 Boot / Auto Login Select boot into desktop or to command line
S6 Network at Boot  Select wait for network connection on boot
S7 Splash Screen    Choose graphical splash screen or text boot
S8 Power LED        Set behaviour of power LED

<Select>                <Back>
```

Figure 147 Changing the Raspberry PI password

Option **S3** is used to change the password. Make sure you record your new password somewhere safe (It is easy to forget it).

The hostname is changed in option **S4** Hostname:

```
Enter new UNIX password:
Retype new UNIX password:
```

As the password is entered nothing is displayed. This is normal. You will be asked if you wish to reboot the system. After you reboot the system you will see the new hostname at the login prompt.

```
pi@piradio:~$
```

In the above example the new hostname is **piradio**. Once the hostname has been changed the program will ask if you wish to reboot. Answer "yes" to reboot.

Configuring the Wi-fi Connection via raspi-config



If the **RaspberryPi** Imager was used to create the SD card it may be that the Wi-Fi interface has already been configured, in which case this option can be skipped.

Select the country you are in for legal Wi-Fi channel selection. From the first **raspi-config** screen select **1 System Options** followed by option S1 Wireless LAN:

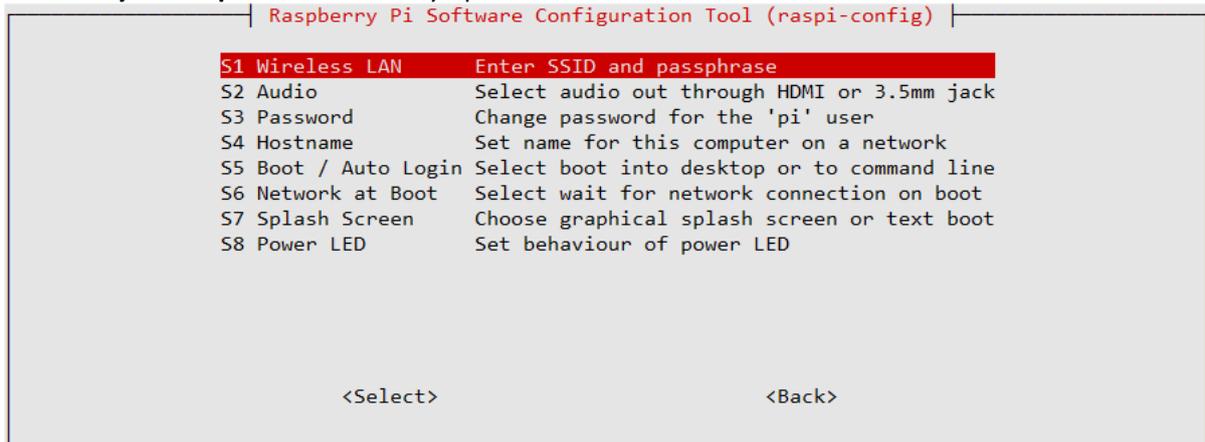


Figure 148 Setting up the Wi-Fi in raspi-config

Now enter the SSID and passphrase for your network. Save the settings and reboot the Raspberry PI. If this option is not available then use the procedure

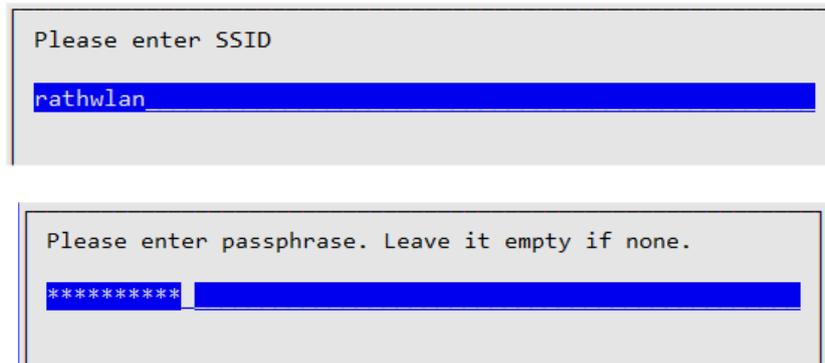
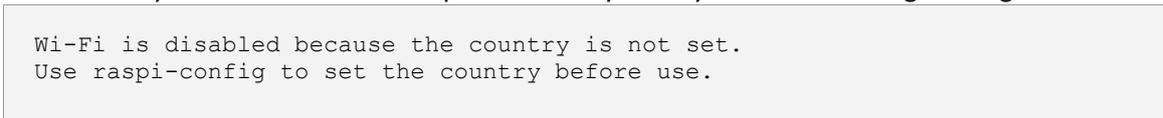


Figure 149 Entering Wi-Fi credentials

Reboot the system. After reboot it is possible that you may see the following message:



In such a case re-run **raspi-config**. Select localisation options and select I4 to set Wi-Fi country:

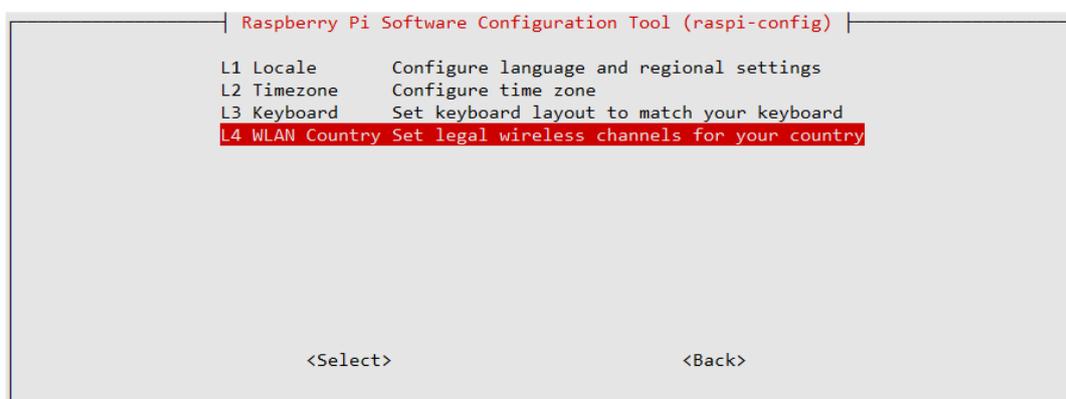


Figure 150 Setting up the Wi-fi country

Select your country from the dropdown menu and exit the **raspi-config** to save the setting.

Setting up the locale

As default the language used by Raspbian is English. To change this in Advanced options select option I1 Change Locale.

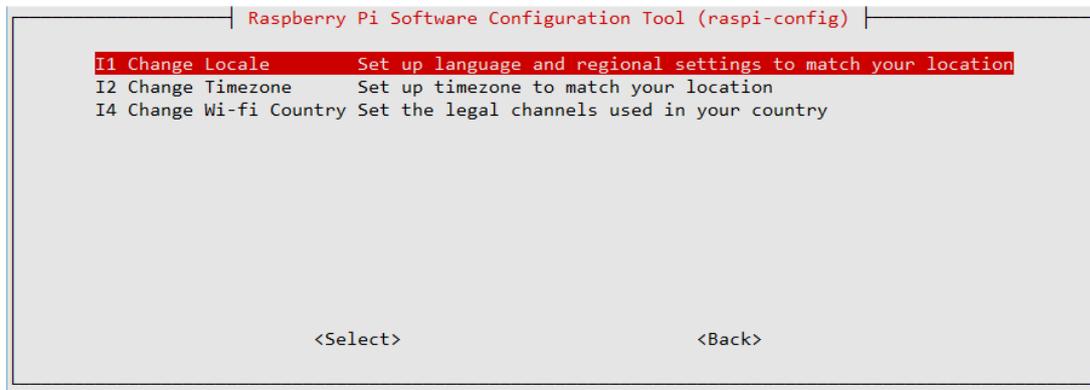


Figure 151 Selecting change locale

Select a locale beginning with the two-letter international code for your country and language.

Usually this will be a locale containing the string ISO or UTF-8.

- fi_FI.ISO-8859-1 (Try this one first)
- fi_FI.ISO-8859-15@euro
- fi_FI.UTF-8

In the following example for the Netherlands the locale is this **nl_AW UTF-8** for the Netherlands (nl).

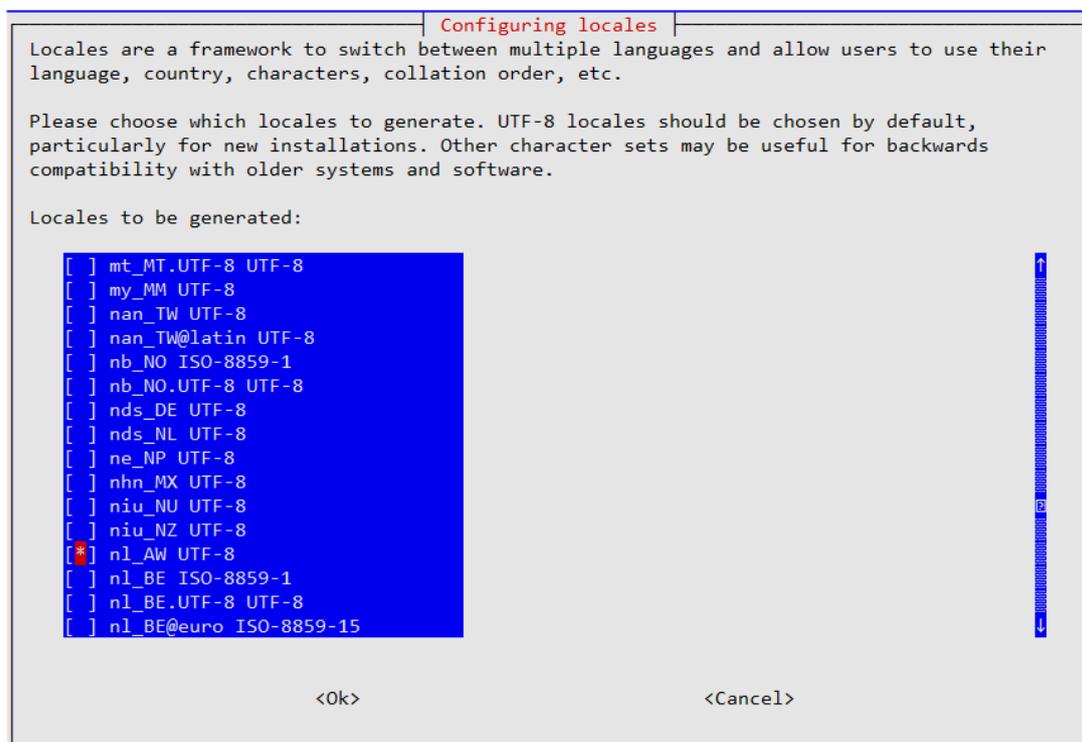


Figure 152 Generating the locale.



Warning: Do not be tempted to generate “All locales” as this is not only unnecessary and futile and will take a very long time.

Press OK to continue. The program will now generate the selected locales.

```
Generating locales (this might take a while)...
  en_GB.UTF-8... done
  nl_AW.UTF-8... done
Generation complete.
```

The following screen is displayed:

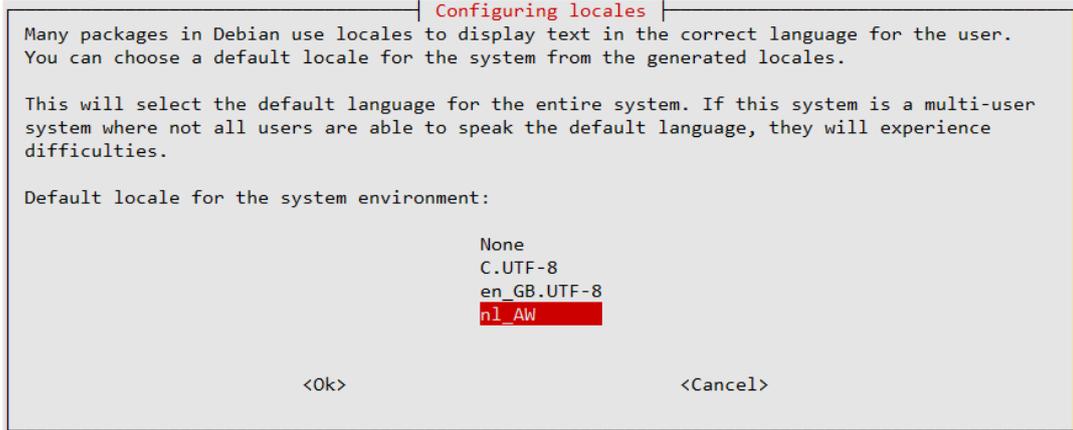


Figure 153 Selecting the locale

Select the required locale **nl_AW** in this example and press OK to save. The new locale will become active after the next reboot.

Install other required packages

The table below shows additional packages which are required depending upon the design.

Table 15 Additional system packages

Package	Grove	HDMI/ Touchscreen	Olimex	Shoutcast	RGB I2C Rotary Encoder	Page
ffmpeg	No	Yes	n/a	n/a	No	97
python-requests	No	n/a	n/a	Yes	No	98
libffi-dev build-essential libi2c-dev i2c-tools python3-dev	No	No	Yes	n/a	No	
python3-pil	Yes	No	Yes	n/a	No	98
scratch	No	Optional	No	No	No	98
rpd-wallpaper	No	yes	No	No	No	98
ioe-python	No	No	No	No	Yes	99

Install the ffmpeg video converter

This section is only applicable if the HDMI/Touchscreen version of the radio is to be used. If using an LCD version of the radio then skip this section. The **ffmpeg** video converter is required to extract

artwork (if included) from music files mpeg files. Install **ffmpeg** video converter with the following command (Note that it may already be installed):

```
$ sudo apt install ffmpeg
```

```
Reading package lists... Done
:

The following packages have unmet dependencies:
ffmpeg : Depends: libavdevice57 (>= 7:3.2.10) but it is not going to be
installed
          Depends: libsdl2-2.0-0 (>= 2.0.4) but it is not installable
E: Unable to correct problems, you have held broken packages.
```

If the installation fails with the above message re-run the **apt update** command to update the library list and retry installing **ffmpeg**.

```
$ sudo apt update
```

Run the following for further information about **ffmpeg**.

```
$ man ffmpeg
```

Install libraries for the Olimex OLED or SSD1306 OLED

If using the IQaudio Cosmic controller or SSD1306 OLED is also necessary to install **libffi-dev** plus other necessary libraries. If you are not using the IQaudio controller then skip this section. Carry out the following instructions.

```
$ sudo apt -y install libffi-dev
$ sudo apt -y install build-essential libi2c-dev i2c-tools python3-dev
```

If using **Raspbian Lite** also install the **python3-pil** package:

```
$ sudo apt -y install python3-pil
```

Install the anacron package

The **anacron** package is required to run the **/etc/cron.weekly/radiod** and **/etc/cron.daily/radiod** scripts. These scripts are required to run the **create_stations.py** and **/etc/cron.daily/radiod** playlist maintenance programs.

Install it with the following command.

```
$ sudo apt -y install anacron
```

Install the Scratch and rpd-wallpaper packages

This section is only applicable if the HDMI/Touchscreen version of the radio is to be used. There is an option to provide extra backgrounds. If using an LCD or OLED versions of the radio then skip this section. Scratch and rpd-wallpaper used to be installed by default, however, in the latest versions of

Raspberry Pi OS Desktop they may not be. Extra backgrounds can be used by installing **Scratch**. Scratch is a visual programming tool for children.

Scratch is not actually used by the radio software but the graphic files in the **/usr/share/scratch/Media/Backgrounds** directory provide additional background wallpaper for the full feature graphical radio (gradiod.py).

The background wallpaper is set by the following parameter in **/etc/radiod.conf** and can be amended to use a different background. This can only be done after installing the radio software in the next section.

The default wallpapers are available in the **/usr/share/rpd-wallpaper** directory. Amend the wallpaper command once you have installed the radio software.

To install **rpd-wallpaper** run the following:

```
$ sudo apt install rpd-wallpaper
```

The default wallpaper is **aurora.jpg**

```
wallpaper=/usr/share/rpd-wallpaper/aurora.jpg
```

If **scratch** is installed other additional wallpapers can be used:

```
wallpaper=/usr/share/scratch/Media/Backgrounds/Nature/beach-malibu.jpg
```

To install **scratch** run the following:

```
$ sudo apt install scratch
```

Install Pimoroni ioe-python

The **ioe-python** python package is required for RGB I2C Rotary Encoders.

```
$ git clone https://github.com/pimoroni/ioe-python
$ cd ioe-python/
$ sudo ./install.sh --unstable
```

The following message will be displayed.

```
Would you like to copy examples to /home/pi/Pimoroni/pimoroni-ioexpander?
[y/N]
```

Unless you particularly want the example code answer **N**.

Reboot

```
$ sudo reboot
```

Extra packages required for Raspberry OS Lite

If you are running **Raspberry OS Lite** then not all required packages are installed. Run the following commands.

```
$ sudo apt install python-configparser
$ sudo apt install python3-pip
```

The following are required for any displays that are using **I2C**.

```
$ sudo apt install -y i2c-tools
```

Disable PiWiz screen reader (Buster only)

Since December 2020 release of Buster, the developers have installed the PiWiz screen reader. As a result, every 15 seconds a computerized voice says "To install the screen reader press control alt space".

This feature is normally disabled during installation using the desktop interface. However, if you are using a headless installation procedure it may not be disabled. The message is not only very annoying, but hogs the sound system meaning that the radio (MPD) cannot play audio content. To disable PiWiz run the following:

```
$ sudo rm /etc/xdg/autostart/piwiz.desktop
```

On some later versions of Bookworm this file has already been removed so if it isn't found this step can be ignored.

Chapter 6 - Installing the radio Software

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Radio software pre-requisites

Upgrading from previous versions

If upgrading from version 6.x or earlier it is necessary to replace your existing configuration file with the new one supplied in the upgrade. First take a note of any specific configuration items that are not standard or make a copy of your existing `/etc/radiod.conf` configuration file.



Important: The name format of Radio playlists has changed from version 7.3 onwards. See *Creating and Maintaining Playlist files* on page 218. Also, in this release, it is now possible to add, move and delete entries in the play list using any MPD client that is capable of doing so. See *Maintaining playlists using external MPD clients* on page 226.



Note: The location of the log file has changed from `/var/log/radio.log` to `/var/log/radiod/radio.log`. Also, its ownership has been changed from `root` to user `pi`. This has been done to reduce the number of programs that need to run with `sudo`.

Installing the Music player daemon

If you haven't already done so upgrade the system packages as shown in *Update to the latest the packages* on page 90.

After reboot install the [Music Player Daemon](#) (mpd) and its client (mpc) along with the Python3, MPD and `python3-rpi.gpio` libraries. Note that you must install `python3-mpd` and not `python.mpd`.

```
$ sudo apt install mpd mpc python3-mpd python3-rpi.gpio
```

Answer yes 'y' when asked to continue.

Install the client library needed by the radio software (It may be already installed).

```
$ sudo apt install libmpdclient2
```

If the installation says it cannot find the above packages, then re-run the update command to update the library list and retry installing the above packages.

```
$ sudo apt update
```



IMPORTANT: Unfortunately, the configuration file (`/etc/mpd.conf`) supplied with MPD version 0.22.6 on **Bookworm** is corrupt. It is necessary to correct this as show below.

Find the following entries in `/etc/mpd.conf` somewhere around line 232.

Corrupt `/etc/mpd.conf` file

```
#audio_output {
#   type           "alsa"
#   name           "My ALSA device"
#   device         "hw:0,0"
#   mixer_type     "software"
##   mixer_device   "default"       # optional
##   mixer_control  "PCM"           # optional
##   mixer_index    "0"             # optional
```

```
# }
```

Change the above entries to the following:

Corrected /etc/mpd.conf file

```
audio_output {  
    type "alsa"  
    name "My ALSA Device"  
    device "hw:0,0"  
    mixer_type "software"  
    # mixer_device "default" # optional  
    # mixer_control "PCM" # optional  
    # mixer_index "0" # optional  
}
```



If installing on **Bookworm Lite** this will take quite a long time as there are a lot of software libraries to be installed.



At this stage there are no playlists configured so the music daemon won't play anything. The play lists are created when the **radiod** Debian Package is installed in the next section.



The version of **MPD** released with **Bookworm** is **0.22.6** which is reasonably up-to-date. You should install MPD version **0.22.6** first. When it is all working if you are having problems playing certain stations, it is well worth installing the latest version of MPD as shown in the section called *Compiling and installing the latest Music Player Daemon* on page 172.

Installing pulseaudio

The **pulseaudio** package may or may not needed to be installed. This has been different between various releases of the operating system. Currently the **pulseaudio** package causes a lot of problems with the radio software, in particular **espeak** and the Alsa sound system. If you do not intend to use **espeak** and need **pulseaudio**, for example, for blue-tooth devices or pHat BEAT then install it. The following table shows the options:

Table 16 PulseAudio installation options

Type of radio installation	Install pulseaudio
Using espeak	No
Pimoroni Pirate Radio with pHat BEAT	Yes (Installed by phatbeat)
Pimoroni Pirate Audio/mini-speaker	No
Adafruit speaker bonnet	No
LCD display radio	No unless using above DACs
HDMI or touch-screen displays	No unless using above DACs
IQaudIO, HiFiBerry or JustBoom DACs	No
Bluetooth sound devices	Yes

To install **pulseaudio**:

```
$ sudo apt install pulseaudio
```

To remove **pulseaudio**:

```
$ sudo apt remove pulseaudio
```

If installing on Bookworm disable the `pulseaudio-enable-autospawn.service`.

```
$ sudo systemctl stop pulseaudio-enable-autospawn.service
```



At the time of writing there was a fault with the **lxplug-volumepulse** package which stops any of the menus on the Raspberry Pi desktop from being displayed. Remove the **lxplug-volumepulse** package with the following command:

```
$ sudo apt remove lxplug-volumepulse
```

Install display drivers



Note: If you are installing the software for any of the products listed below then first carry out the instructions in the appropriate section. Do this before installing the radio software.

Table 17 Display driver software installation

Device	Section/Devices	Page
Pirate Radio	Installing Pimoroni Pirate Radio (pHat BEAT)	119
Pirate Audio	Installing the Pimoroni Pirate Audio	120
SSD1306 0.9-inch OLED	Installing OLED driver software and libraries Installing the SSD1306 OLED driver	121
SH1106 SPI (joystick)	Installing the SH1106 SPI OLED driver libraries	122
MHS RPi displays	MHS 3.5-inch RPi display installation	126
SH1106 1.3-inch OLED	Installing LUMA monochrome OLEDs	124
LUMA OLED devices	SSD1306, SSD1309, SSD1325, SSD1331, SH1106, WS0010	124
Waveshare TFTs	Waveshare TFT device installation	125
Grove LCD RGB	Installing the Grove LCD RGB	127
Adafruit TFT	Installing the Adafruit 2.5 and 3.5-inch TFT touchscreen	122
PiFace CAD	Installing PiFace CAD software	127
Waveshare SH1106 SPI	Installing the SH1106 SPI OLED driver libraries	122

Installing the Radio Daemon

First install the **python-configparser** package:

```
$ sudo apt install python-configparser
```

The Raspberry PI Internet Radio software is distributed as a Debian package. This can be downloaded from http://www.bobrathbone.com/raspberrypi/pi_internet_radio.html

Either download it to your PC or Macintosh and copy it to the **/home/pi** directory or get it directly using the **wget** facility.

To use the **wget** facility first copy the download link from the above page (Right click on the link). Log into the Raspberry PI. Now use **wget** to the software package.

For 32-bit systems:

```
$ wget http://www.bobrathbone.com/raspberrypi/packages/radiod_7.6_armhf.deb
```

Run **dpkg** to install the package.

```
$ sudo dpkg -i radiod_7.6_armhf.deb
```

For 64-bit systems:

```
$ wget http://www.bobrathbone.com/raspberrypi/packages/radiod_7.6_arm64.deb
```

Run **dpkg** to install the package.

```
$ sudo dpkg -i radiod_7.6_armhf.deb
```

If upgrading or re-installing the radio software use the following to overwrite the existing package download file (Substitute correct file name):

```
$ curl -L -O http://bobrathbone.com/raspberrypi/packages/radiod_7.6_arm64.deb
```

The **dpkg** program will install the files.

```
(Reading database ... 131542 files and directories currently
installed.Preparing to unpack radiod_6.14_armhf.deb ...
Raspberry PI internet radio installation
Stopping radiod service
Unpacking radiod (7.6)
```

If updating from an earlier version of the radio software you may see the following message. Enter 'I' or 'Y' to install the new version.

```
Configuration file '/etc/logrotate.d/radiod'
==> Deleted (by you or by a script) since installation.
==> Package distributor has shipped an updated version.
What would you like to do about it ? Your options are:
  Y or I : install the package maintainer's version
  N or O : keep your currently-installed version
  D      : show the differences between the versions
  Z      : start a shell to examine the situation
The default action is to keep your current version.
*** radiod (Y/I/N/O/D/Z) [default=N] ? I
```

Configuring the radio

Once that is done the installation will automatically run the **configure_radio.sh** script. This updates the configuration settings in **/etc/radiod.conf**.



Note: This configuration program does the basic configuration to get the radio going with the hardware you are using. More complex configuration options are explained in *Chapter 7 – Configuration* on page 177.

The configuration program is automatically run when installing the radio package but can safely be run at any time using the following commands:

```
$ cd /usr/share/radio
$ sudo ./configure_radio.sh
```

The installation script detects if this is a software upgrade and if that is the case displays the following screen. Normally select option 2 if upgrading the software. This means that the configuration will not be changed.

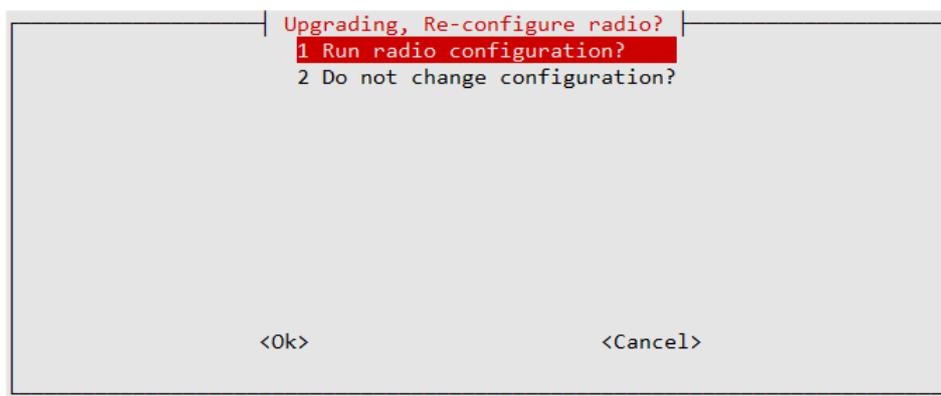


Figure 154 Configure radio – Upgrade

If you selected option 1 above and you are upgrading the software from a previous version, the program will ask if you wish to overwrite the existing configuration. Unless you have a heavily modified configuration you may safely overwrite the configuration file:

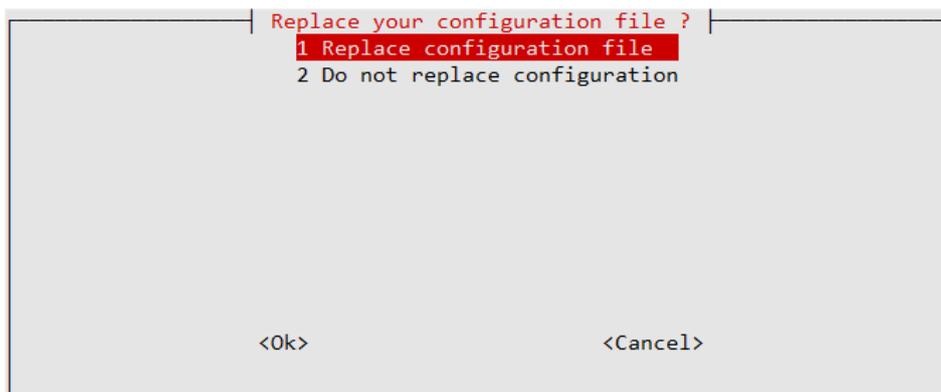


Figure 155 Replace configuration file

If option 1 is selected the existing configuration will be replaced. A backup copy of the original configuration is written to **/etc/radiod.conf.save**. The following screen will then be displayed:

```

Select user interface
1 Push button directly connected to GPIO pins
2 Radio with Rotary Encoders
3 Mouse or touch screen only
4 IQAudio Cosmic Controller
5 Pimoroni pHat BEAT with own push buttons
6 Adafruit RGB plate with own push buttons
7 PiFace CAD with own push buttons
8 Pimoroni Audio with four push buttons
9 Do not change configuration

<Ok>                                <Cancel>

```

Figure 156 Configure radio – User interface selection



Note: This configuration program can be re-run at any time in the future. Change directory to `/usr/share/radio` and run `configure_radio.sh`. To do this run the following:

```

$ cd /usr/share/radio
$ sudo ./configure_radio.sh

```

Select option 1 if push buttons are being used or option 2 if using rotary encoders. Otherwise select the type of user interface being used in option 3 onwards.

This screen and all following screens have the option to not change the configuration. The program will always ask you if your choice is correct and give you the opportunity to change the selection.

```

Push buttons selected
Is this correct?

<Yes>                                <No>

```

Figure 157 Configure radio - Confirmation screen

If the push-button interface is selected, the program will ask how they have been wired. The push-buttons can be wired to either +3.3V (The original scheme) or GND(0V).

```

How are the push buttons wired?
1 GPIO --> Button --> +3.3V - Original wiring scheme
2 GPIO --> Button --> GND(0V) - Alternative wiring scheme
3 Do not change configuration

<Ok>                                <Cancel>

```

Figure 158 Push-button voltage selection

If option 2 Rotary Encoders was selected then the following screen will be seen:

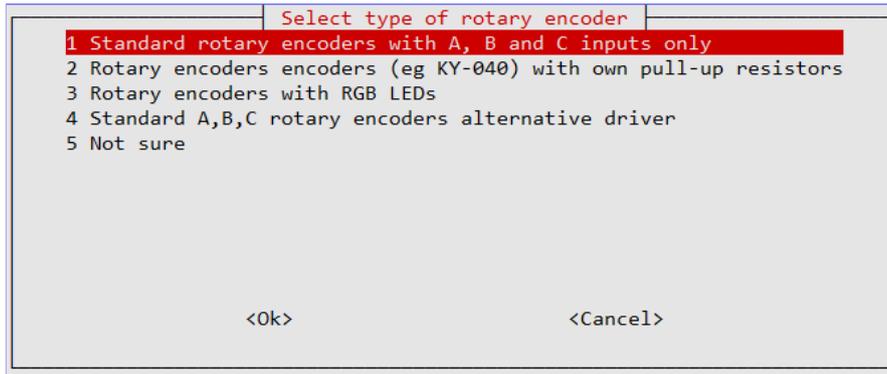


Figure 159 Rotary encoder type selection

Traditional rotary encoders have three connections called A, B and C. They usually also have two connections to a switch (See Rotary encoder wiring on page 40). If these rotary encoders are being used the select option 1 as shown above.

If rotary encoders such as the KY040 (See *Using KY040 Rotary encoders* on page 41) are being used, these have their own 10K pull-up resistors and so do not need the internal GPIO pull-up resistors as well. If the internal GPIO pull-up resistors are also enabled then they are paralleled across the rotary encoders pull-up resistor giving a value of 5K for the pull-up which is half the recommended 10K value. Select option 2 KY040 encoders to disable the internal GPIO pull-up resistors. Select option 2. This can also be done by setting `rotary_gpio_pullup=none` in `/etc/radiod.conf`.



If you are missing the push-button 10K resistor as shown in *Figure 77 KY040 Missing 10K resistor* on page 41 then select option 1 (Standard A, B and C inputs).

If using rotary encoders with RGB LEDs select option 3.

If there are problems with the standard A, B, C rotary encoders try option 4 - Alternative driver.



Note: Option 2 will not work with traditional A, B and C encoders. If unsure select option 3 and the internal pull-up resistors will be enabled and will work with both types of encoders.

Next select the GPIO header wiring. This is either 26-pin (Older RPi models) or 40-pin wiring. Note that the 26-pin wiring scheme can also be used on 40-pin headers if so wished.

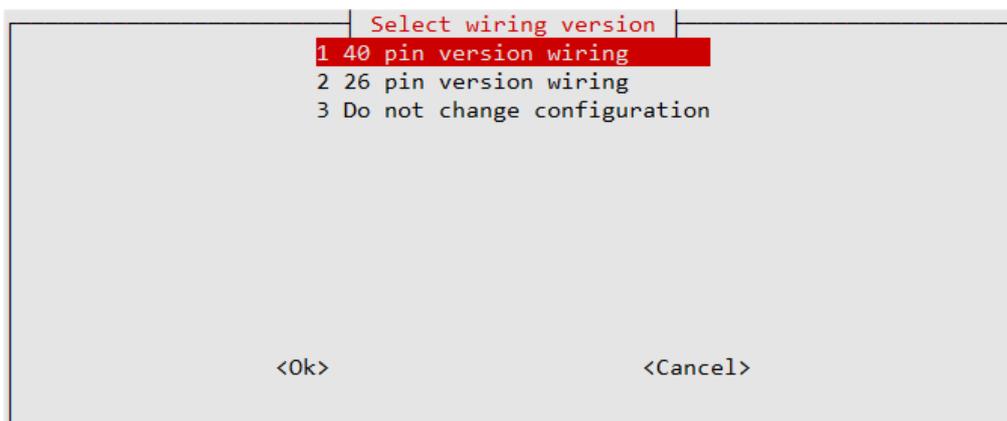


Figure 160 Configure radio - wiring selection

Normally select the 40-pin option unless you have used the 26-pin wiring scheme. See *Table 4 Controls and LCD wiring 26 pin version* and *Table 5 Radio and DAC devices 40-pin wiring*.

Confirm selection and continue to the next screen:

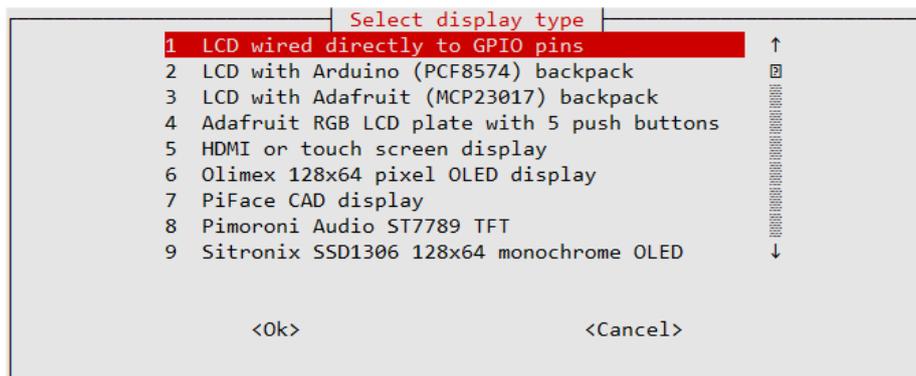


Figure 161 Configure radio - Display interface selection 1

Notice that there is a scroll bar to the right of the options. Use the Up/Down keys to scroll down to the remaining options. Select the option which matches the display you are using.

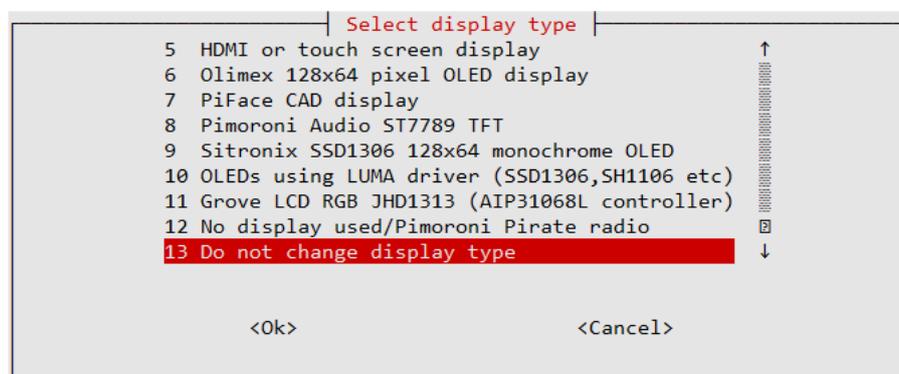


Figure 162 Configure radio - Display selection 2

Select the correct option for the display interface and confirm selection. Again, it is possible leave the configuration unchanged. There is also an option 10 (Scroll down) called “Do not change display type”.

If option 5 – ‘HDMI or touch screen display’ was selected the go to the section called *Configuring HDMI monitor and Touchscreen* on page 124.

If options 6, 8, 9 or 10 were selected go to *Configuring OLEDs* on page 112.

If option 2, 3, 4 or 6 was selected then this will require the hex address to be configured. Otherwise, the program will skip the screens in the next section and go to the section called *Select the type of LCD display* on page 111.

If option 6 (Olimex OLED) was selected then the following will be displayed:

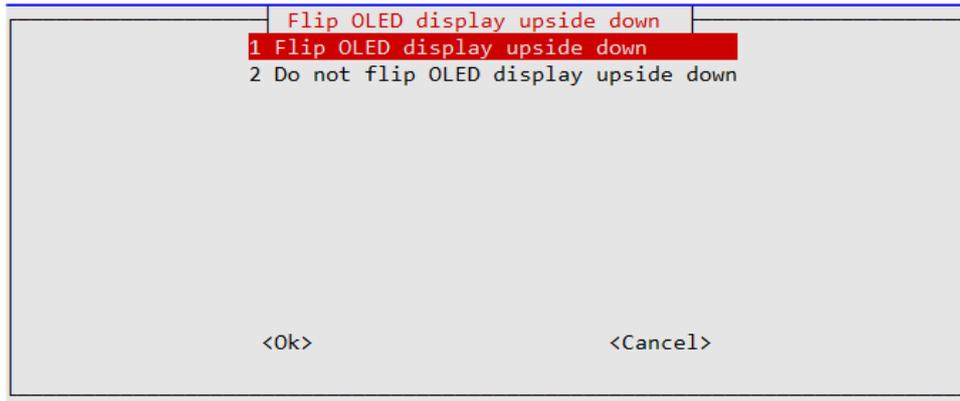


Figure 163 Olimex OLED flip display

This option sets the `flip_display_vertically` parameter in `/etc/radiod.conf` to `yes` or `no` and allows the Olimex OLED display to be flipped vertically. This option doesn't work with the ST7789TFT.

Configure the SPI Kernel Module

Skip this section unless installing PiFace CAD or devices using the ST7789 OLED display.

If installing the radio on PiFace CAD or the ST7789 OLED display it is necessary to enable the SPI interface. For example, if PiFace CAD was selected the following message will be seen:

```
The chosen display PiFace CAD requires the
SPI kernel module to be loaded at boot time.
The program will call the raspi-config program
Select the following options on the next screens:
  5 Interfacing options
  P4 Enable/Disable automatic loading of SPI kernel module

Press enter to continue:
```

Press enter and select option 1:

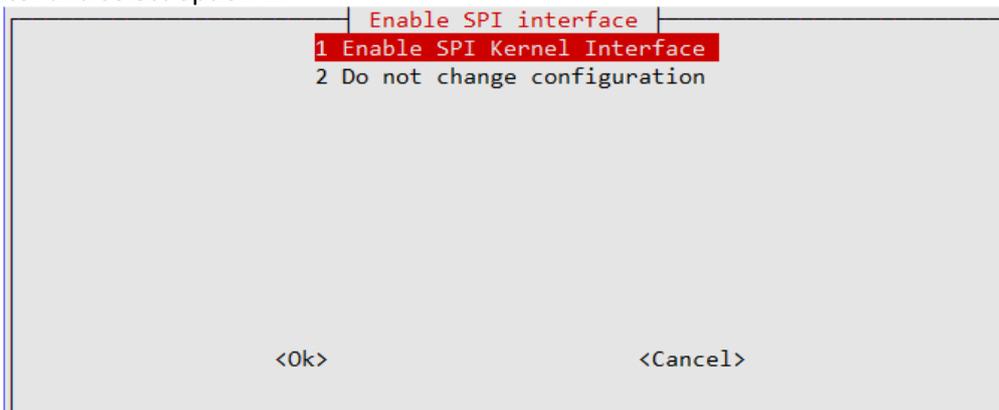


Figure 164 Enable SPI Kernel Module

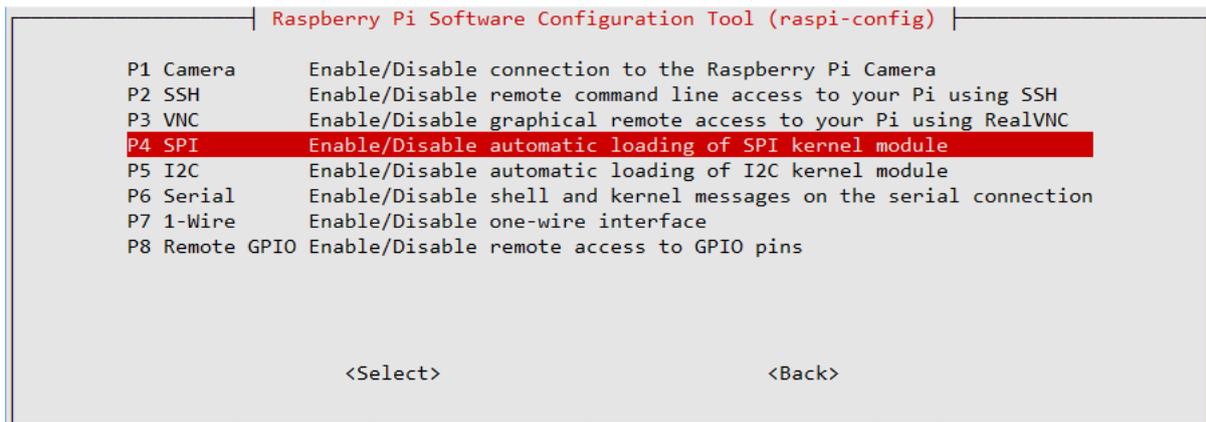
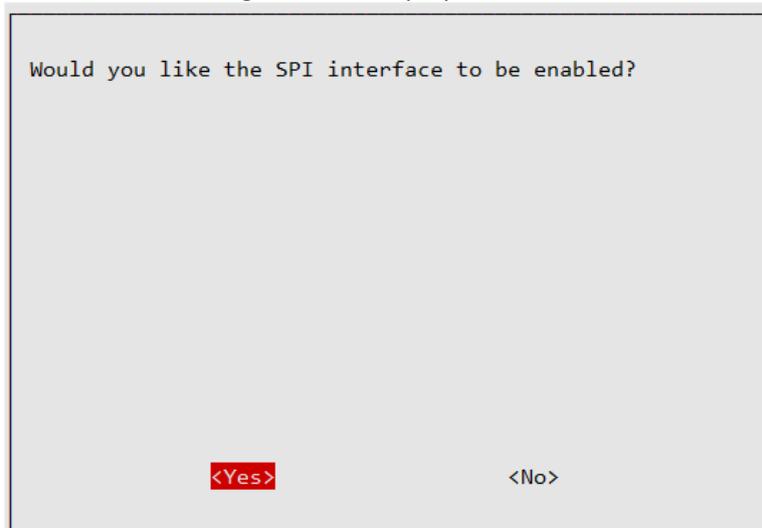
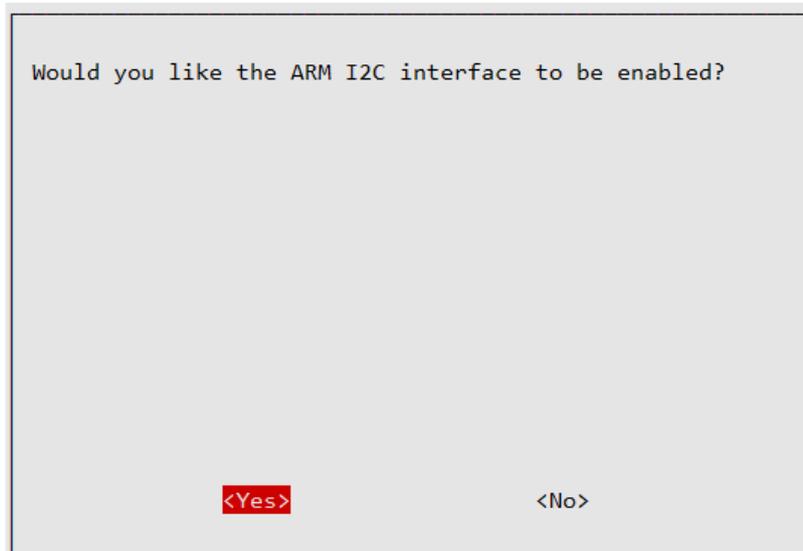


Figure 165 Enable SPI kernel module option

Select the option P4 SPI. The following screen is displayed:



Select Yes to enable the SPI kernel module. Select "Finish" to exit.



Select the type of LCD display

Skip this section if you are not using an LCD display directly connected to the GPIO pins. Confirm the selection and continue to the next screen to select the type of LCD display. This section is not relevant for a HDMI or touch screen.

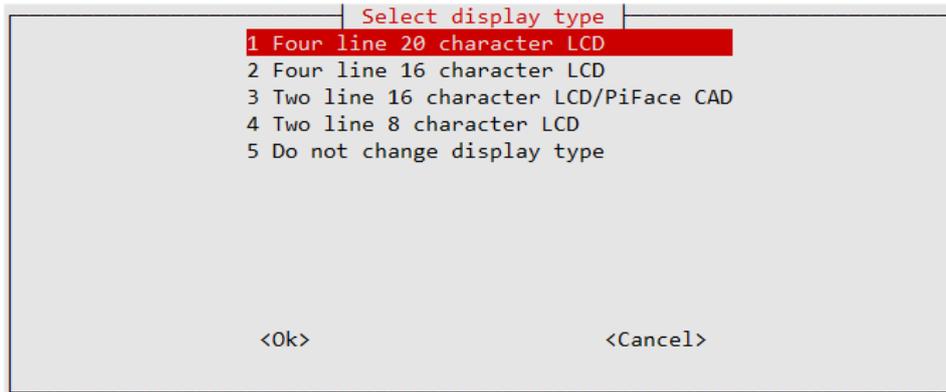


Figure 166 Configure radio - Display type selection

Select the type of display to be used and confirm the selection. The installation script asks if you wish to configure the audio device:

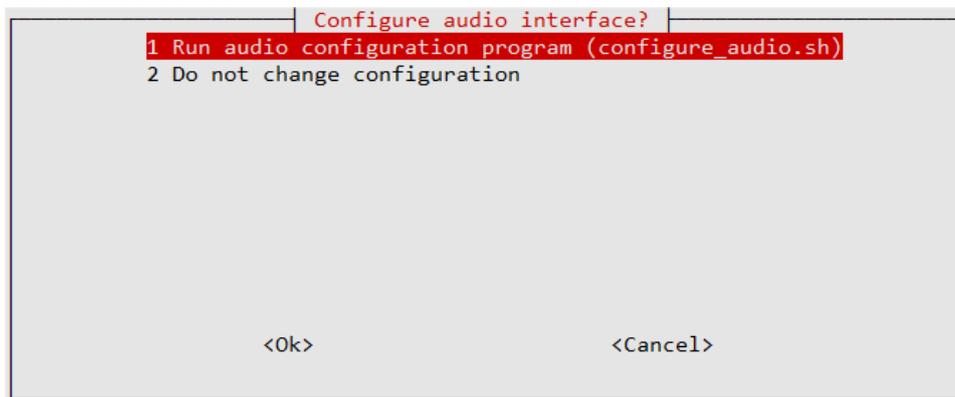


Figure 167 Configure radio audio output option

You should select option 1 to run the audio device configuration program. If you selected option 1 then go to the section *Configuring the audio output* on page 116.

Configuring OLEDs

If not using an OLED display, then go to the section *Configuring the audio output* on page 116.

There are five drivers available for OLED displays. These can have either the 2-wire **I2C** interface (+5v, GND, Data and Clock) or the 4-wire **SPI** interface. They are selected by the **display_type** parameter in `/etc/radiod.conf`. This is setup by the `configure_radio.sh` configuration program.

Table 18 OLED rivers

display_type	Interface	Lines	Driver	Option	Notes
ST7789TFT	SPI	5	st7789tft_class.py	8	Used by the Pimoroni Pirate Audio hat
OLED_128x64	I2C/SPI	5	oled_class.py	6	The driver automatically detects I2C or SPI
SSD1306	I2C	4	ssd1306_class.py	9	From version 7.2 onwards
LUMA	I2C	4	luma_class.py	10	From version 7.3 onwards
SH1106_SPI	SPI	4	sh1106_class.py	11	From version 7.6 onwards

The Luma device supports multiple devices namely devices using SSD1306, SSD1309, SSD1325, SSD1331, SH1106 or WS0010 hardware driver chips. Only SSD1306 and SH1106 devices have been tested.

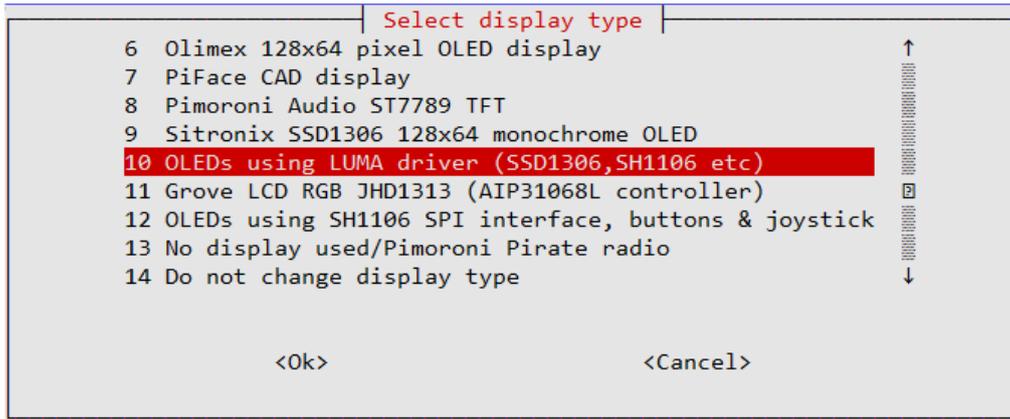


Figure 168 Selecting an OLED display

Select option 6, 8, 9, 10 or 11 depending upon the type of OLED being configured.

If option 10 (Luma device driver) was selected the following screen will be displayed:

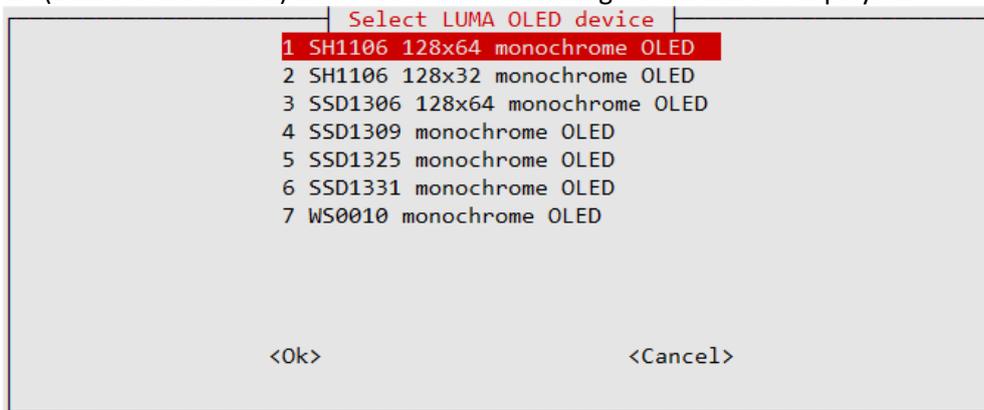


Figure 169 Luma devices

Select the device that your OLED is using.

If using devices with an I2C interface then select the appropriate I2C device address. OLED devices usually use address **0x3C** but check your device specification or run **i2c_detect.py -y 1** to display it.

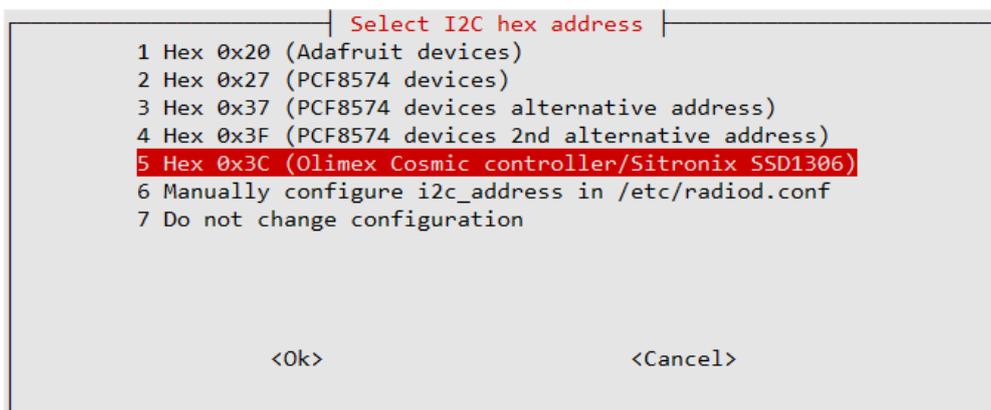


Figure 170 Selecting the OLED I2C address

After configuring I2C address go to the section *Configuring the audio output* on page 116.

Installing the HDMI or touch screen software

This section is only relevant if configuring an HDMI or touchscreen interface. If using an LCD display then skip this section. The following screen is displayed:

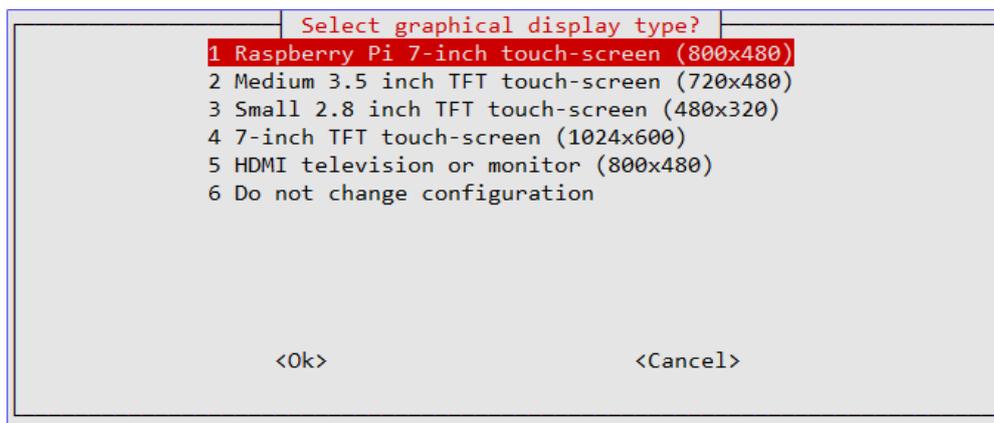


Figure 171 Touchscreen selection

Select the type of screen that is connected to the Raspberry Pi.

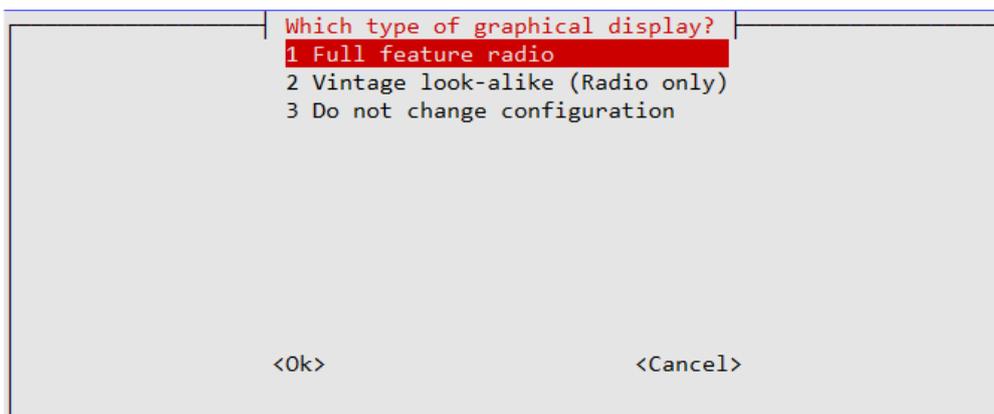


Figure 172 Selecting the type of radio display

Select which radio program to start-up. . See *Figure 2 Raspberry pi 7-inch touchscreen radio* and *Figure 4 Vintage tuning touch-screen radio* on page 4.

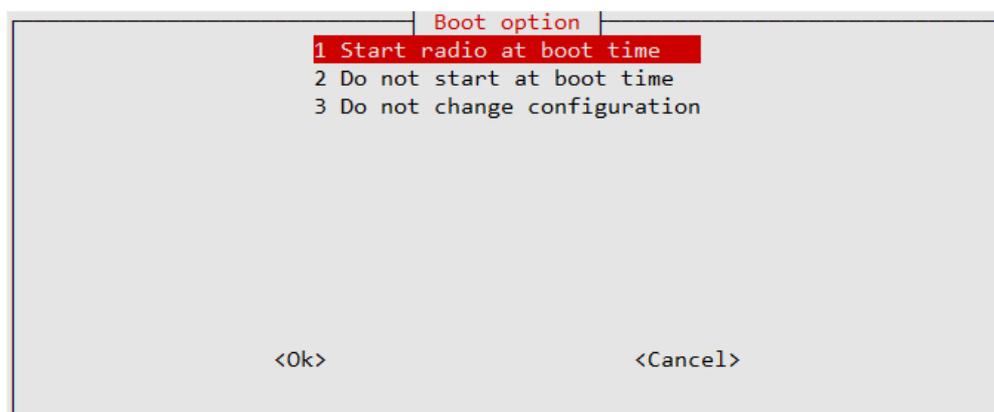


Figure 173 Configuring the HDMI or touch screen display startup

Normally select option 1 to automatically start the gradio.py program when the Graphical Desktop is loaded. This copies a desktop configuration to the file `/home/pi/Desktop/gradio.desktop` file.

There is also a similar file created called **vgradio.desktop** for the vintage graphical radio. For more information see the Appendix *A.3 X-Windows radio desktop* files on page 367367.

The installation script also copies the graphic screen configuration to **/etc/radiod.conf**. It also disables start-up of the **radiod** service which is only used for the LCD versions of the radio. Now select the option to display the radio full screen (7-inch touchscreen) or in a desktop window (Large HDMI monitor or TV).

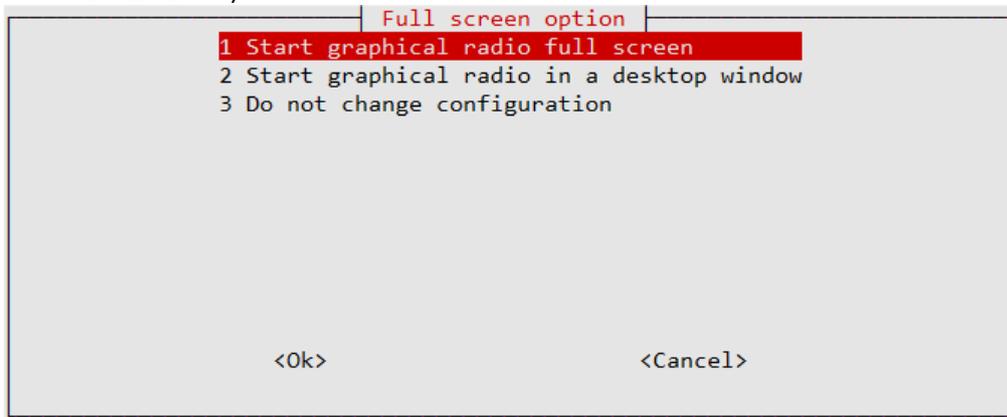


Figure 174 Configuring the graphical radio full screen

Configuration of the HDMI/Touch screen is shown in the section *Configuring the HDMI or Touch Screen* on page 178. Operation of the HDMI/Touch screen is shown in the section called *Operation of HDMI and touch screen displays* on page 203.

At the end of the radio configuration process the radio installation calls the **configure_audio.sh** script which then displays the screen shown below in Figure 175.



Currently it is not possible to configure anything but the onboard audio jack or HDMI when the **configure_audio.sh** script is called directly from the initial installation script.

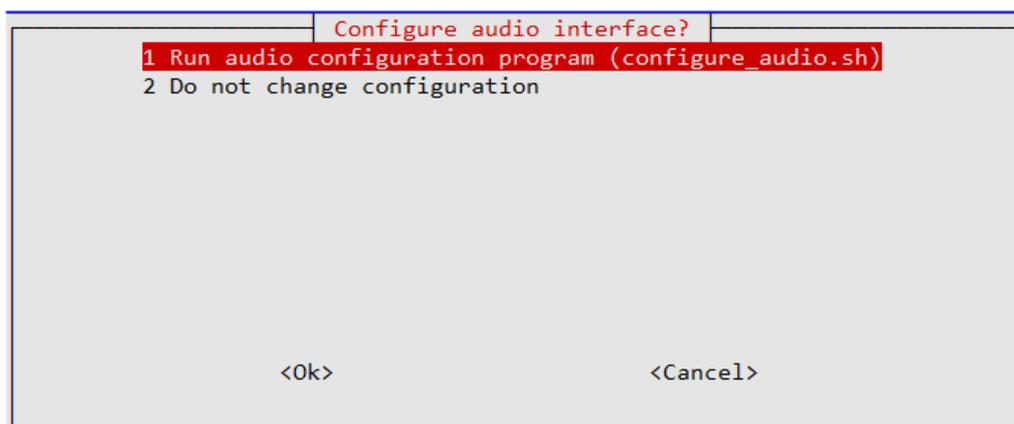


Figure 175 Audio configuration selection

If you wish to configure the on-board audio select option 1. If you wish to configure DAC, USB or Bluetooth devices then select option 2 to exit the program, then run the following command:

```
$ cd /usr/share/radio
$ ./configure_audio.sh
```

Configuring the audio output

If building a new radio start by using the Raspberry Pi on-board audio output jack. Leave configuring a digital audio card such as HiFiBerry or IQaudIO until later unless you are using a Raspberry Pi Zero which doesn't have an on-board audio jack. In that case there is no choice but to configure the sound card. The package installation `configure_radio.sh` script will automatically run the `configure_audio.sh` script.

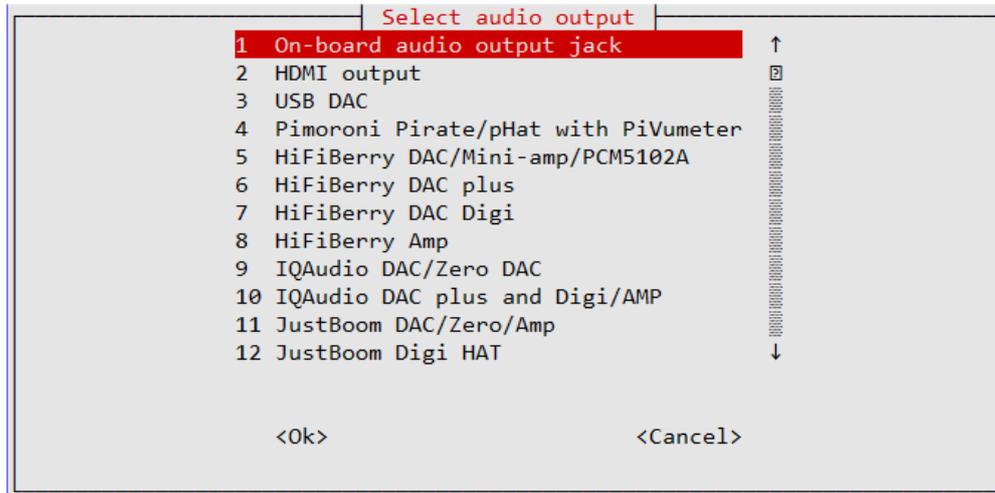
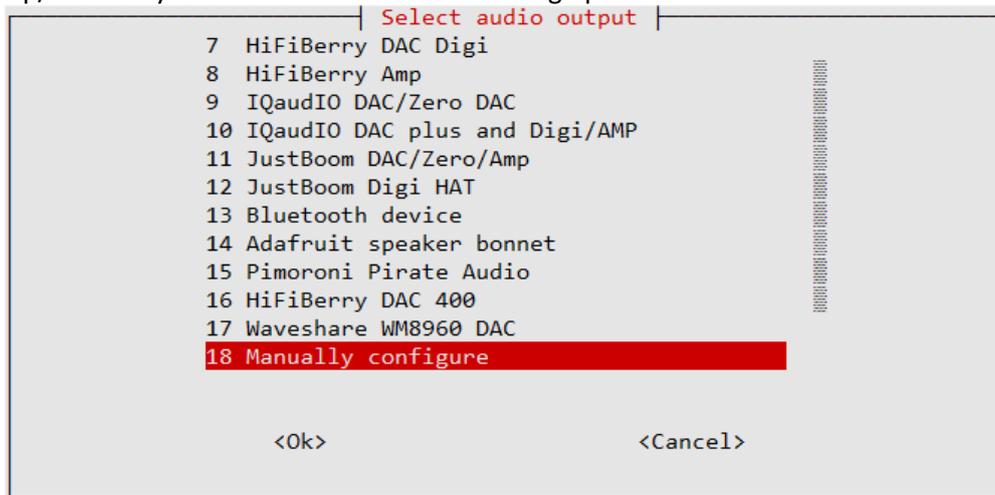


Figure 176 Selecting the audio output device

Use the Up/Down keys to scroll down to the remaining options:



Please note the scroll bar on the right side of the above screen. There are more options after option 12 (Bluetooth device). Use the Up/Down keys to scroll up and down.



This configuration program can be safely re-run at any time in the future. Change directory to `/usr/share/radio` and run `configure_audio.sh`. To do this run the following:

```
$ cd /usr/share/radio
$ ./configure_audio.sh
```

Installation logs

A log of the changes made by the radio configuration program will be written to the `/usr/share/radio/logs/install.log` file. For the audio configuration program changes will be written to the `/usr/share/radio/logs/audio.log` file.

Reboot to enable the software

The software is installed in the `/usr/share/radio` directory. Now reboot the Raspberry Pi.

```
$ sudo reboot
```

Once rebooted the software should run and music should be heard out of the on-board audio jack. If not go to the section called *Chapter 9 -Troubleshooting* on page 243.

The radio daemon (LCD versions only) can be started and stopped with the **systemctl** command:

```
$ sudo systemctl start radiod
$ sudo systemctl stop radiod
```

This will also stop and start the MPD daemon.

To prevent automatic start-up of the radio at boot time run the following command:

```
$ sudo systemctl disable radiod
```

To re-enable it:

```
$ sudo systemctl enable radiod
```

Testing the I2C interface.



Version 6.13 onwards comes with its own **SMBus** library (`smbus2`) in the `smbus2` sub-directory of the radio package.

The I2C interface should have already been enabled by the installation program. To test the I2C interface, carry out the following:

If you are using a revision 2 Raspberry Pi (Newer boards) carry out the following:

```
$ sudo i2cdetect -y 1
```

If you are using a revision 1 Raspberry Pi (Very old V1 boards) carry out the following:

```
$ sudo i2cdetect -y 0
```

This will search `/dev/i2c-0` (Very old v1 RPIs) or `/dev/i2c-1` (Later RPI versions) for all address, and if correctly connected, it should show up at **0x20** for the Adafruit LCD Plate or normally **0x27** for the Arduino PCF8574 backpack but might be another address such as **0x3F**. The OLED 128x64 pixel display uses address **0x3C**. See Figure 177 *The I2C bus display using the i2cdetect program*.

```

pi@raspberrypi ~ $ sudo i2cdetect -y 0
   0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f
00: -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
10: -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
20: 20 -- -- -- -- -- -- -- -- -- -- -- -- -- --
30: -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
40: -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
50: -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
60: -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
70: -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
pi@raspberrypi ~ $

```

Figure 177 The I2C bus display using the i2cdetect program

If the following is seen instead then it is necessary to run enable the I2C module at boot time using **raspi-config**.

```

Error: Could not open file `/dev/i2c-1' or `/dev/i2c/1': No such file or
directory

```

If problems with **i2cdetect** are still encountered, then edit the **/boot/config.txt** file using **sudo nano** and change the following line:

```

#dtparam=i2c_arm=on

```

Change to:

```

dtparam=i2c_arm=on

```

Also, the **i2c-dev** module must be added to the **/etc/modules** file.

```

i2c-dev

```

Reboot and retry the **i2cdetect** program.



Note: If the Arduino **PCF8574** backpack is using another address other than **0x27**, **0x37** or **0x3F** then you must modify the **i2c_address** parameter in **/etc/radiod.conf**. For example, if the backpack is using the address **0x2F** then modify the **i2c_address** parameter to match this as shown in the example below:

```

# The i2c_address parameter overrides the default i2c address. 0x00 = use default
# Some backpacks use other addresses such as 0x3F, then set i2c_address=0x3F
i2c_address=0x2F

```

Once both of these packages have been installed, you have everything you need to get started accessing I2C and SMBus devices in Python. Now reboot the Raspberry PI.

```
$ sudo reboot
```

The Radio should start automatically. If not then go to the section called *Chapter 9 -Troubleshooting* on page 243.

Installing Pimoroni Pirate Radio (pHat BEAT)

If not using the Pimoroni Pirate Radio then skip this section

To use the Pimoroni Pirate radio with **pHat BEAT** it is necessary to install the Pimoroni software pHat BEAT first. Do this before installing the Rathbone radio software.

Once the Pimoroni software is installed and tested it is then necessary to install the Rathbone radio software as shown in *Chapter 6 - Installing the radio Software* on page 101. Only the VU meter and pHat audio software is used by the Rathbone software. pHat uses the VLC radio not MPD.

The following instructions are based on the following link:

<https://github.com/pimoroni/phat-beat#full-install-recommended>

Run the following commands from the pi user home directory:

```
$ cd
$ curl https://get.pimoroni.com/phatbeat | bash
```

This displays the following:

```
% Total      % Received % Xferd  Average Speed   Time    Time     Time
Current
                        Dload  Upload  Total  Spent  Left
Speed
100 35982  100 35982    0    0  113k      0  --:--:--  --:--:--  --:--:--
114k

This script will install everything needed to use
pHAT Beat

Always be careful when running scripts and commands copied
from the internet. Ensure they are from a trusted source.

This script should -- only be run on a Raspberry Pi with RPi OS --
other systems and SBCs are not supported and may explode!

If you want to see what this script does before running it,
you should run: 'curl https://get.pimoroni.com/phatbeat'

Note: pHAT Beat uses the I2S interface
bash: line 494: [: !=: unary operator expected

Do you wish to continue? [y/N] y
```

Answer yes (y).

The following is displayed:

```
pHAT Beat comes with examples and documentation that you may wish to
install.
```

```
Performing a full install will ensure those resources are installed,
along with all required dependencies. It may however take a while!
Do you wish to perform a full install? [y/N] y
```

Again, answer yes(y).

The installation will take quite some time as it does a system upgrade and then builds the software as well as installing any other required packages so be patient.

Eventually the installation program displays:

```
All done!
```

Install the Rathbone Internet radio software

Do the following:

1. Now carry out the instructions shown in section *Installing the Radio Daemon* on page 104.
 - a. Select option 5 Pimoroni pHat BEAT with own push buttons
 - b. Select option 1 40-pin wiring
 - c. No display used/Pimoroni Pirate radio
 - d. Audio configuration – Select 4 Pimoroni Pirate/pHat with PiVumeter
2. Since the Pirate Radio does not have a screen, you can optionally install **espeak** as shown in the section called *Installing the speech facility* on page 170 to hear choices when using the menu button.

Finally reboot the Raspberry Pi to start the radio.

```
$ sudo reboot
```



If no sound is heard from the Pirate radio, then use the volume up (+) button to increase the volume until sound is heard.

Installing the Pimoroni Pirate Audio

If you are not using either the Pimoroni Pirate Audio; skip this section.

Install the packages required by the Pimoroni Pirate Audio .

```
$ sudo apt -y install python3-rpi.gpio python3-spidev python3-pip python3-
pil python3-numpy python3-pip git
```

Install setup tools

```
$ sudo pip3 install setuptools
```

Install the st7789 library if using the Pimoroni Pirate Audio. Not needed for the SSD1306 OLED.

```
$ sudo pip3 install st7789
```

Now carry out the instructions shown in *Chapter 6 - Installing the radio Software* on page 101. Select the following.

1. User interface - Select option 8 Pimoroni Audio with four push buttons
2. Select option 1 40-pin wiring
3. Display type - Select Pimoroni Audio ST7789 TFT

When configuring the audio output, select option 14 *Pimoroni Pirate Audio (HiFiBerry DAC)*. This will configure **/boot/config.txt** with the following lines.

```
dtoverlay=hifiberry-dac
```

and

```
dtparam=audio=off
```

More details about the configuration for the Pirate Audio are found in section *C.5 Pimoroni Pirate Audio wiring* on page 376.

Note 1: Button Y (Volume up) can be GPIO 24 instead of 20 on versions of the Pirate Audio card produced before January 2020.

The new settings in **/etc/radiod.conf** are normally:

```
up_switch=16
down_switch=5
left_switch=6
right_switch=20
```

or on some variants.

```
right_switch=24
```

Manually edit **/etc/radiod.conf** if your Pirate Audio is using GPIO24.

Now carry out the instructions shown in section *Installing the Radio Daemon* on page 104.

Installing OLED driver software and libraries

Installing the SSD1306 OLED driver libraries

SSD1306 devices can either use the **ssd1306_class** driver or the **luma_class** driver configured for SSD1306 (The Luma driver supports multiple devices). The 0.9-inch SSD1306 OLED display works with either the **ssd1306_class** or **luma_class** driver.

To use the *Luma driver* see *Installing LUMA monochrome OLEDs* on page 124.

Otherwise follow the instructions below to use the SSD1306 driver. These install the `Adafruit_Python_SSD1306` driver software.

```
$ sudo apt install git
$ git clone https://github.com/adafruit/Adafruit_Python_SSD1306.git
$ cd Adafruit_Python_SSD1306
$ sudo python3 setup.py install
```

Now carry out the instructions shown in section *Installing the Radio Daemon* on page 104.

Installing the SH1106 SPI OLED driver libraries

The SH1106 SPI driver used by the 1.3" OLED with joystick and 3-button interface requires the following commands to install the prerequisite libraries. The following instructions are only for the SPI interface and not the I2C interface.

```
$ sudo apt-get install python3-pip
$ sudo pip3 install RPi.GPIO
$ sudo apt-get install python3-smbus
$ sudo pip3 install spidev
```

When you run the radio configuration program later on it will configure `/etc/radiod.conf` with the following switch settings.

```
menu_switch=13
mute_switch=21
up_switch=6
down_switch=19
left_switch=5
right_switch=26
```

Installing the Adafruit 2.5 and 3.5-inch TFT touchscreen

If not using the Adafruit TFT then skip this section.



If using the Adafruit TFT display this procedure needs to be carried out before attempting to install the Radio software. This procedure requires the desktop version of the Raspberry Pi OS



Note: There are two types of TFT touch-screen available screen available from Adafruit namely Capacitive or Resistive. The one used in this project is the Resistive type.

Plug the TFT screen into the Raspberry Pi 40 pin header. Depending upon the type of display the TFT screen will have either a 26-pin or 40-pin female header which plugs into the GPIO header.

The basic installation instructions can be found on the Adafruit Web site:

<https://cdn-learn.adafruit.com/downloads/pdf/adafruit-pitft-3-dot-5-touch-screen-for-raspberry-pi.pdf>

Or from the Bob Rathbone Web site:

<http://bobrathbone.com/raspberrypi/documents/Adafruit/adafruit-pitft-3-dot-5-touch-screen-for-raspberry-pi.pdf>

Software installation is also covered in the above manual.

Look at the section called *FBCP Install Commands* (HDMI Mirroring).

Below is the easy installation for the Adafruit TFT displays:
Install pre-requisite python3-pip (May already be installed)

```
$ cd ~  
$ sudo apt install -y git python3-pip
```

Download the Adafruit installer scripts:

```
$ sudo pip3 install --upgrade adafruit-python-shell click  
$ git clone https://github.com/adafruit/Raspberry-Pi-Installer-Scripts.git
```

Now run the setup scripts.

```
$ cd Raspberry-Pi-Installer-Scripts/  
$ sudo python3 adafruit-pitft.py --display=35r --rotation=90 --install-  
type=fbcp
```

Replace 35r with 28r for the 2.8-inch TFT. To flip the display, change the rotation from 90 to 270 and re-run the python3 script.

The above command adds the following to **/boot/config.txt** (may vary).

```
# --- added by adafruit-pitft-helper Sun Jul 11 11:15:00 2021 ---  
hdmi_force_hotplug=1  
dtparam=spi=on  
dtparam=i2c1=on  
dtparam=i2c_arm=on  
dtoverlay=pitft35-resistive,rotate=90,speed=20000000,fps=20  
# --- end adafruit-pitft-helper Sun Jul 11 11:15:00 2021 ---  
hdmi_cvt=720 480 60 1 0 0 0
```

Make sure that the resolution specified matches your device. This is 720x480 in the above example. The supported resolutions are 480x320 or 720x480 pixels for the 2.8-inch and 3.5-inch TFT respectively. Smaller resolutions are not supported.

Edit **/boot/config.txt** and force the console to the same size with the same values.

```
framebuffer_width=720  
framebuffer_height=480
```



It is very important that the resolution set in the above instructions matches your device and that they have been set to the same value. If not, the results will be unpredictable.

The TFT screen should already be calibrated but if calibration required refer to the section called *Resistive Touchscreen Manual Install & Calibrate* in the Adafruit in the Adafruit manual.

There is also an interactive installation script:

```
sudo python3 adafruit-pitft.py
```

See the Adafruit manual for the full procedure.

Reboot the Raspberry Pi.

```
$ sudo reboot
```

If everything has been correctly configured the Raspberry Pi desktop should be seen on the TFT display. If a HDMI monitor is also plugged in then the RPi desktop should also be seen mirrored on it.

Now carry out the instructions shown in section *Installing* the Radio Daemon on page 104.

Installing LUMA monochrome OLEDs

The LUMA device driver (**luma_class.py**) interfaces monochrome OLEDs which are using SSD1306, SSD1309, SSD1325, SSD1331, SH1106 or WS0010 interface chips. In this release only SSD1206 and SH1106 OLEDs have been tested.

The devices test used 64x64 or 128x64 pixels resolution. Other resolutions may also work.

If using any of the above devices then first install the necessary dependencies.

Install dependencies:

```
$ sudo apt install python3-pip
$ sudo -H pip3 install --upgrade luma.oled
$ sudo apt install python3 python3-pil libjpeg-dev zlib1g-dev libfreetype6-
dev liblcms2-dev libopenjp2-7 libtiff5 -y
$ sudo pip3 install pathlib
$ sudo pip3 install luma.core
```

For more information on the Luma driver see:

<https://luma-oled.readthedocs.io/en/latest/install.html>

<https://luma-oled.readthedocs.io/en/latest/api-documentation.html>

When the **configure_radio.py** program is run and the LUMA OLED driver is selected the **display_type** parameter in **/etc/radiod.conf** is set to **LUMA.<DEVICE>** where **<DEVICE>** is the chip being used.

For example, LUMA.SH1106 for OLEDs using the sh1106 chip

```
display_type=LUMA.SH1106
```

Now carry out the instructions shown in section *Installing* the Radio Daemon on page 104.

Configuring HDMI monitor and Touchscreens

Configuring an HDMI monitor or TV screen

If using a touch-screen or HDM TV/Monitor add the following lines to **/boot/config.txt**.

```
hdmi_group=2
hdmi_mode=4
hdmi_cvt 800 480 60 6 0 0 0
max_usb_current=1
```

If the screen upside-down then add the following line. Note: you must disable the *DRM VC4 V3D driver* as shown on page 90 for this to work.

```
# Rotate screen 180
lcd_rotate=2
```

Now carry out the instructions shown in section *Installing the Radio Daemon* on page 104.

Waveshare TFT device installation

If not using Waveshare devices skip this section.

Full instructions for installing and configuring the Waveshare TFTs will be found at:

https://www.waveshare.com/wiki/RPi_LCD_User_Guides

Below are the basic installation instructions extracted from the above site. First clone the Waveshare installation software.

```
$ cd
$ git clone https://github.com/waveshare/LCD-show.git
```

It is now necessary to change to the LCD-show directory and run the correct installer for the type of Waveshare screen being installed. For example:

LCD28-show Waveshare TFT 2.8"
LCD35-show Waveshare TFT 3.5"
LCD35B-show Waveshare TFT 3.5" type B
LCD35C-show Waveshare TFT 3.5" type C

There are other installation scripts for different Waveshare LCD models in the

Below is an example of the installation for the Waveshare TFT 3.5" type C.

```
$ cd LCD-show/
$ ./LCD35C-show
```

This command to rotate the screen 180 degrees and can be run at any time (reboot required)

```
$ ./LCD35C-show 180
```

However, do refer to the Waveshare documents as the above are only very basic instructions.

Edit **/boot/config.txt** and force the console to 720 x 480.

```
framebuffer_width=720
framebuffer_height=480
```



Warning: The Waveshare installation script currently copies its own **boot.config** to **/boot/config.txt** and will overwrite any previous settings. For example, Bluetooth settings. The file it copies to config.txt (config-32c.txt-retropie) is also in **DOS** format. Use **dos2unix** to convert it back to Unix format. See below

```
$ sudo apt install dos2unix
$ sudo dos2unix /boot/config.txt
```

If you are using Bluetooth then after running the Waveshare configurator and correcting the DOS format add the following two lines to the **/boot/config.txt** configuration file.

```
dtoverlay=pi3-miniuart-bt
core_freq=250
```

Below is an example of Waveshare driver code added to the **/boot/config.txt** configuration file.

```
dtoverlay=waveshare35b:rotate=270
hdmi_force_hotplug=1
hdmi_group=2
hdmi_mode=1
hdmi_mode=87
hdmi_cvt 480 320 60 6 0 0 0
hdmi_drive=2
display_rotate=0
```

Now carry out the instructions shown in section *Installing the Radio Daemon* on page 104.

MHS 3.5-inch RPi display installation

If not using MHS devices skip this section.

Full instructions for installing and configuring the MHS devices will be found at:

http://www.lcdwiki.com/MHS-3.5inch_RPi_Display

Below are the basic installation instructions extracted from the above site. First clone the Waveshare installation software.

```
$ cd
$ git clone https://github.com/goodtft/LCD-show.git
```

It is now necessary to change to the **LCD-show** directory and run the correct installer for the type of MHS screen being installed. For example:

MHS35-show MHS 3.5-inch RPi display

MHS55-show MHS 5.5-inch RPi display

MHS35B-show MHS 3.5-inch RPi display

LCD7B-show MHS 7-inch RPi display

There are other installation scripts for different MHS LCD models in the

Below is an example of the installation for the MHS TFT 3.5" RPi display

```
$ cd LCD-show/
$ ./MHS35-show
```

This command to rotate the screen 180 degrees and can be run at any time (reboot required)

```
$ ./MHS35-show 180
```

However, do refer to the MHS documents as the above are only very basic instructions.

Edit **/boot/config.txt** and force the console to 720 x 480.

```
framebuffer_width=720  
framebuffer_height=480
```

Now carry out the instructions shown in section *Installing the Radio Daemon* on page 104.

Using other touch screens

There are various other touch screens on the market but this version of the software does not support screen sizes of less the 480 x 320 pixels. There is a **screen_size** parameter in **/etc/radiod.conf** configuration file.

```
# Size is in pixels. Supported is 800x480 (7" screen) or 720x480(3.5"  
screen)  
# or 480x320 (2.8" or 3.5" screen)  
screen_size=800x480
```

Another important aspect of screen size are the following parameters in **/boot/config.txt**.

```
framebuffer_width=1280  
framebuffer_height=720
```

Changing the above can force a console size. By default, it will be display's size minus overscan settings in **/boot/config.txt**.

If using the Elecrow 7-inch TFT Capacitive touch screen display then see *B.2 -Elecrow 7-inch touch-screen* notes on page 369.

Now carry out the instructions shown in section *Installing the Radio Daemon* on page 104.

Installing the Grove LCD RGB

The **Grove LCD** with RGB backlight is capable of displaying any colour wanted. For instance, the colour AQUA would be RGB (5,195,221). To turn the word "AQUA" into its RGB value the PIL (Python Image Library) package is required. Install it with the following command.

```
$ sudo apt install python3-pil
```

Now carry out the instructions shown in section *Installing the Radio Daemon* on page 104.

Installing PiFace CAD software

Version 7.4 onwards re-introduces **PiFace CAD**. The PiFace CAD software is no longer supplied as a package but as source which has to be compiled into a library (egg). It also requires the **SPI** interface to be enabled and also needs the **lirc** package to be installed.

First install git which is required to download the software from <https://github.com/piface>

```
$ sudo apt install git
```

Install **pifacecommon**

```
$ cd
$ git clone https://github.com/piface/pifacecommon.git
$ cd pifacecommon/
$ sudo python setup.py install
$ sudo python3 setup.py install
```

Install pifacecad:

```
$ cd
$ git clone https://github.com/piface/pifacecad.git
$ cd pifacecad/
$ sudo python setup.py install
$ sudo python3 setup.py install
```

Now install the IR remote control software as shown in the section called *Install the IR remote control software* on page 145. Put the settings for the IR Sensor to use GPIO25 and 0 for the IR remote Led (No LED available).

If you configured the IR sensor to use LIRC for **Buster** also carry out the instructions below. Amend the LIRC import in the pifacecad **ir.py** Python script

```
$ cd /usr/local/lib/python3.9/dist-packages/pifacecad/
$ cp ir.py ir.py.lirc
```

Edit **ir.py** using `sudo nano` or `sudo vi` and change:

```
import lirc
```

to

```
import pylirc
```

Run the Hello World demo using Python3:

```
$ python3
>>> import pifacecad
>>> cad = pifacecad.PiFaceCAD() # create PiFace Control and Display
object
>>> cad.lcd.backlight_on() # turns the backlight on
>>> cad.lcd.write("Hello, world!") # writes hello world on to the LCD
```

A full test can be run with the following:

```
$ cd /usr/share/radio
$ ./lcd_piface_class.py
```

Configuring sound devices

Other sound devices can be used with the radio. Currently supported are the following devices:

- CMedia USB speakers or devices (See page 129)
- Sound cards such as **HiFiBerry**, **IQaudio**, **JustBoom** and **Pimoroni pHat** DAC and DAC+ products (See page 130)
- Bluetooth speakers or headphones (See page 138).

To check if the audio device is present run the **aplay** command.

```
$ aplay -l
**** List of PLAYBACK Hardware Devices ****
card 0: ALSA [bcm2835 ALSA], device 0: bcm2835 ALSA [bcm2835 ALSA]
  Subdevices: 8/8
  Subdevice #0: subdevice #0
  Subdevice #1: subdevice #1
  Subdevice #2: subdevice #2
  Subdevice #3: subdevice #3
  Subdevice #4: subdevice #4
  Subdevice #5: subdevice #5
  Subdevice #6: subdevice #6
  Subdevice #7: subdevice #7
card 0: ALSA [bcm2835 ALSA], device 1: bcm2835 ALSA [bcm2835 IEC958/HDMI]
  Subdevices: 1/1
  Subdevice #0: subdevice #0
card 1: Device [USB PnP Sound Device], device 0: USB Audio [USB Audio]
  Subdevices: 0/1
  Subdevice #0: subdevice #0
```

In the above example **Card 0** is the on-board devices namely the audio output jack and HDMI. **Card 1** is a USB PnP sound device.

To configure other sound devices run the **configure_audio.sh** utility.

```
$ cd /usr/share/radio
$ ./configure_audio.sh
```

Configuring a USB sound device

To configure a USB DAC sound devices such as CMedia speakers or sound dongles run the **configure_audio.sh** utility.

To configure USB audio devices run the Run the **configure_audio.sh** utility.

```
$ cd /usr/share/radio
$ ./configure_audio.sh
```

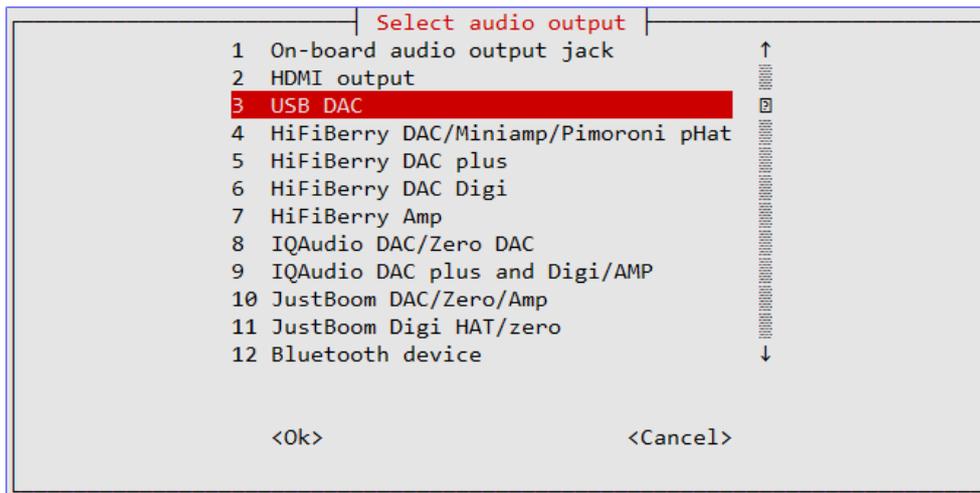


Figure 178 Configure USB DAC

Reboot when prompted. After rebooting the Raspberry Pi run the **alsamixer** program.

```
$ alsamixer
```

The following screen is displayed:

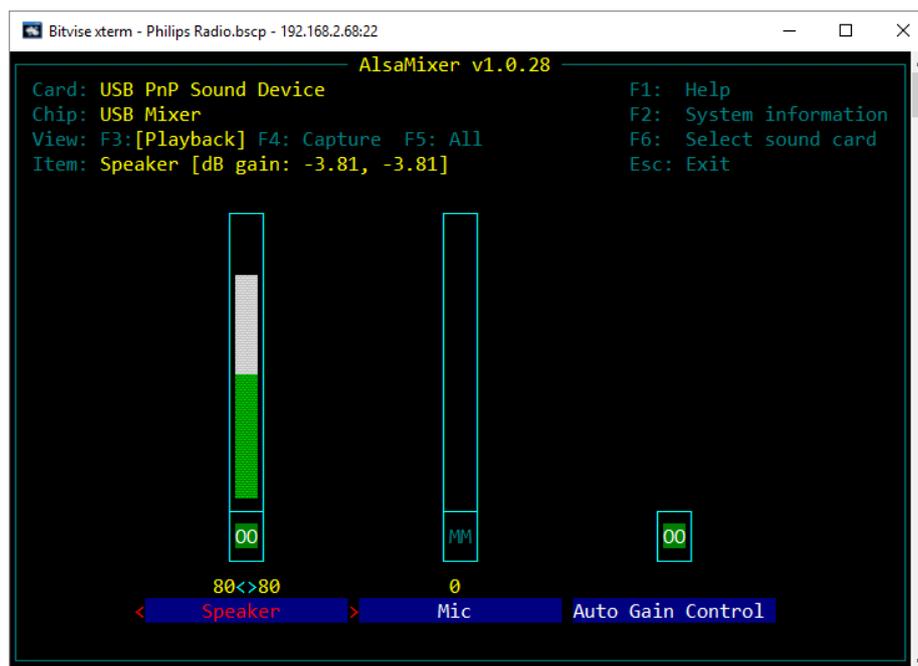


Figure 179 The USB PnP Alsa Mixer

Use the Left and Right keys to position on the 'Speaker field'. Adjust the sound level using the Up and Down keys (80% in the above example). Pres **Esc key** or **Ctl Z** key to exit.

Configuring a Sound Card

This section covers configuration of add on DAC boards such as **HiFiBerry**, **IQaudio** and **JustBoom DAC**, **DAC+** and Amplifier products. Older versions of the **HiFiBerry DAC** that used the 26-pin GPIO header are not supported.

To configure add on audio cards run the Run the **configure_audio.sh** utility:

```
$ cd /usr/share/radio
$ ./configure_audio.sh
```

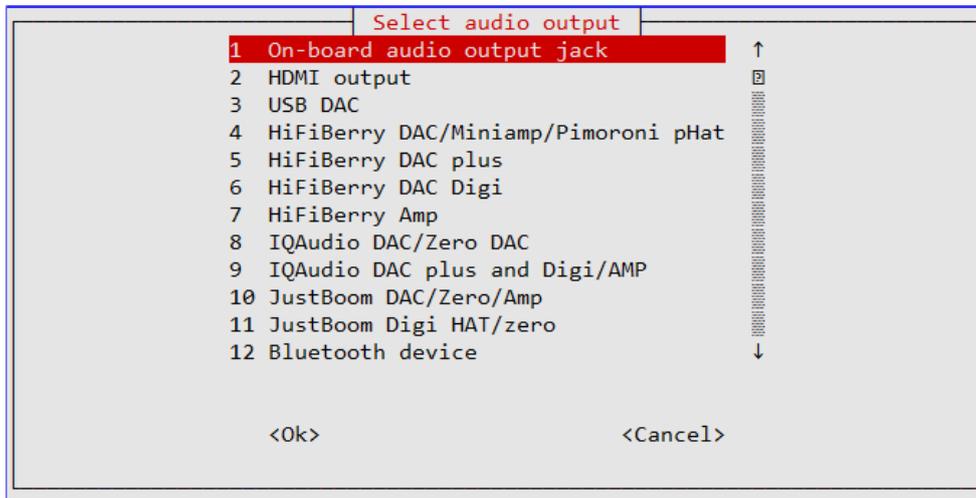
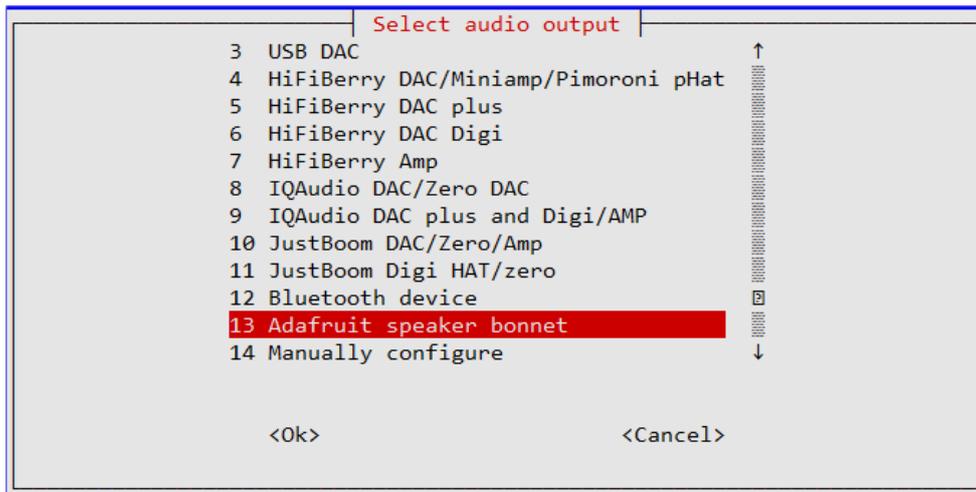


Figure 180 Configuring add-on DAC sound cards

More options are available by scrolling down with the down arrow key:



Select option for the DAC being used and press OK. Reboot when prompted by the next screen. If using Bluetooth devices such as speakers or headphones then select option 12 Bluetooth device.

The Pimoroni pHat is compatible with HiFiBerry DAC (Not DAC+) and uses the same Device Tree (DT) overlay so select HiFiBerry DAC if using the pHat.

After rebooting run the **alsamixer** program.

```
$ alsamixer
```

Use the left and right keys to select the mixer control (Analogue) and use the up down keys to change the volume to 100%.

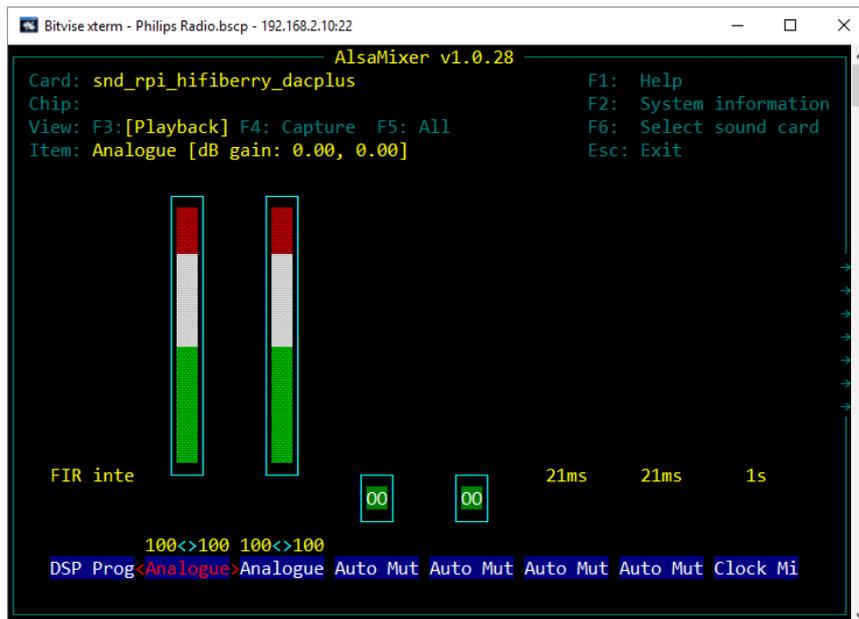


Figure 181 Set mixer analogue volume

Next use the right key to position on the “Digital” mixer control and use the up down keys to change the mixer volume:

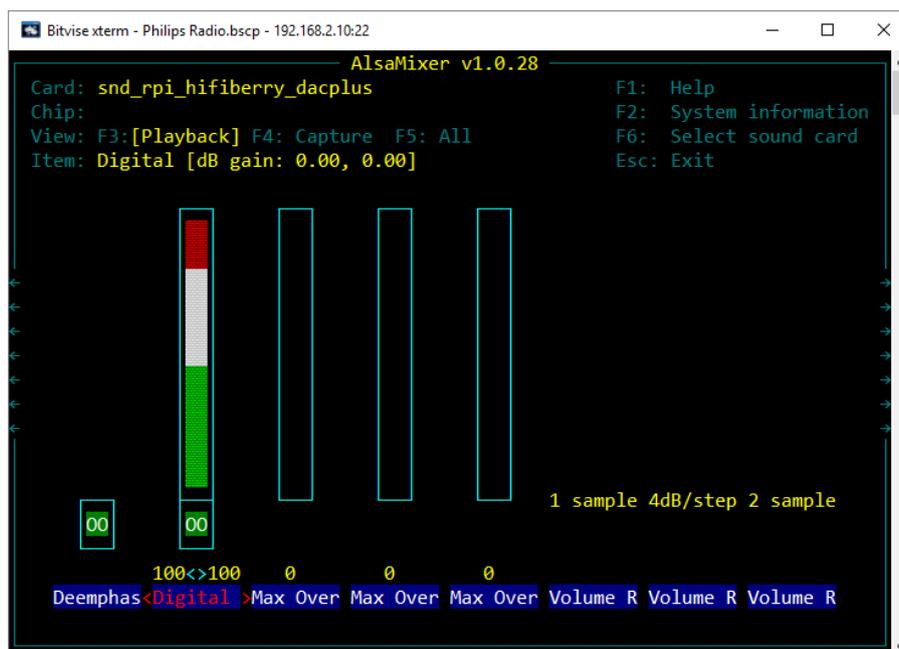


Figure 182 Set mixer digital volume

Configuring Allo Sound Cards

The Allo Piano, in particular, has two outputs, one for normal sound ranges and one for a sound woofer. The board comes pre-programmed as 2.1 for the Raspberry Pi. The subwoofer has a right and left output but is mono only.

However, it uses a second I2S channel on GPIO5 and mute signal on GPIO6 both used to control the woofer amplifier. This conflicts with the LCD signals **lcd_data4** and **lcd_data5** pins. Other Allo products are not affected as they only use one I2S channel. There are two ways to correct this.

Method 1

Edit `/etc/radiod.conf` and locate the LCD GPIO connection definitions.

```
# LCD GPIO connections for 40 pin version of the radio
lcd_select=7
lcd_enable=8
lcd_data4=5
lcd_data5=6
lcd_data6=12
lcd_data7=13
```

Change the `lcd_data4/5` assignments in `/etc/radiod.conf` to:

```
lcd_data4=26
lcd_data5=27
```

Wire LCD `data4/5` to GPIO 26 (physical pin 37) and GPIO 27 (physical pin 13).

Method 2

Configure the LCD to use an I2C backpack. This frees up 6 GPIOs including GPIO5 and 6. See *Construction using an I2C LCD backpack* on page 58.

Configuring Allo driver dtoverlay

Allo manufacture several audio products as well as the Piano 2.1 with woofer. Currently these cannot be configured via the radio installation program. It is necessary to load the correct **device tree overlay (dtoverlay)** by adding the following line for the corresponding **Allo** audio card the end of the `/boot/config.txt` file.

Allo Piano HIFI DAC

```
dtoverlay=allo-piano-dac-pcm512x-audio
```

Allo Piano 2.1 HIFI DAC with woofer

```
dtoverlay=allo-piano-dac-plus-pcm512x-audio
```

Allo Boss HIFI DAC / MINI BOSS HIFI DAC

```
dtoverlay=allo-boss-dac-pcm512x-audio
```

Allo DIGIONE

```
dtoverlay=allo-digione
```

Also disable the on-board output jack by amending it in the `/boot/config.txt` file.

```
dtparam=audio=off
```

Reboot the Raspberry Pi to load the Allo dtoverlay.

```
$ sudo reboot
```

Verification

Check, if the sound card is enabled with “aplay”. The output below will vary depending upon which Allo DAC has been selected:

```
$ aplay -l
**** List of PLAYBACK Hardware Devices ****
card 0: PianoDAC [PianoDAC], device 0: PianoDAC multicodec-0 []
  Subdevices: 0/1
  Subdevice #0: subdevice #0
```

Installing the Waveshare WM8960 DAC

Install the WM8960 DAC Driver software. This procedure is based upon the following:

https://www.waveshare.com/wiki/WM8960_Audio_HAT

First update system:

```
$ sudo apt-get update
$ sudo apt-get upgrade
```

Clone the WM8960 driver from GitHub. Install **git** if required:

```
$ git clone https://github.com/waveshare/WM8960-Audio-HAT
```

Install WM8960 driver:

```
$ cd WM8960-Audio-HAT
$ sudo ./install.sh
$ sudo reboot
```

Check if the driver is installed.

```
$ sudo dkms status
wm8960-soundcard, 1.0, 4.19.58-v7l+, armv7l: installed
```

Note: If the WM8960 Audio HAT has a noise problem, please reinstall the driver and test it again. If the 3.5mm jack has no audio output, please run the following command to restart the service:

```
$ sudo systemctl restart wm8960-soundcard.service
```

Check the Soundcard. On a system with no HDMI devices connected only one audio card should be seen:

```
$ aplay -l
pi@raspberrypi:~ $ aplay -l
**** List of PLAYBACK Hardware Devices ****
card 0: wm8960soundcard [wm8960-soundcard], device 0: bcm2835-i2s-wm8960-
hifi wm8960-hifi-0 []
  Subdevices: 1/1
```

```
Subdevice #0: subdevice #0
```

Configuration of MPD

Either run the **configure_audio.sh** program or edit the **/etc/mpd.conf** configuration file

```
audio_output {
    type      "alsa"
    name      "WM8960-Audio-DAC"
    command   "aplay -f cd 2>/dev/null"
    mixer_type "software"
    # mixer_device "default" # optional
    # mixer_control "PCM" # optional
    # mixer_index "0" # optional
}
```

Reboot the Raspberry Pi to restart the radio.

```
$ sudo reboot
```

The installation of the WM8960 sound card needs a special configuration of **/etc/asound.conf**. A copy of **/etc/asound.conf** for reference for the WM8960 HAT is stored in: **/usr/share/radio/asound/asound.conf.dist.wm8960**

Setting the Headphone Volume

Using **aplay -l** command find out the card number of the WM8960 sound card:

```
$ aplay -l
**** List of PLAYBACK Hardware Devices ****
card 0: vc4hdmi0 [vc4-hdmi-0], device 0: MAI PCM i2s-hifi-0 [MAI PCM i2s-hifi-0]
  Subdevices: 1/1
    Subdevice #0: subdevice #0
card 1: vc4hdmi1 [vc4-hdmi-1], device 0: MAI PCM i2s-hifi-0 [MAI PCM i2s-hifi-0]
  Subdevices: 1/1
    Subdevice #0: subdevice #0
card 2: Headphones [bcm2835 Headphones], device 0: bcm2835 Headphones [bcm2835 Headphones]
  Subdevices: 8/8
    Subdevice #0: subdevice #0
    Subdevice #1: subdevice #1
    Subdevice #2: subdevice #2
    Subdevice #3: subdevice #3
    Subdevice #4: subdevice #4
    Subdevice #5: subdevice #5
    Subdevice #6: subdevice #6
    Subdevice #7: subdevice #7
card 3: wm8960soundcard [wm8960-soundcard], device 0: bcm2835-i2s-wm8960-hifi wm8960-hifi-0 [bcm2835-i2s-wm8960-hifi wm8960-hifi-0]
  Subdevices: 0/1
    Subdevice #0: subdevice #0
```

The WM8960 sound card has separate controls for the speaker volume and the headphone volume. However, the headphone volume is set to 0db. To set the headphone volume, run **alsamixer** using the correct card number:

```
$ alsamixer -c 3
```

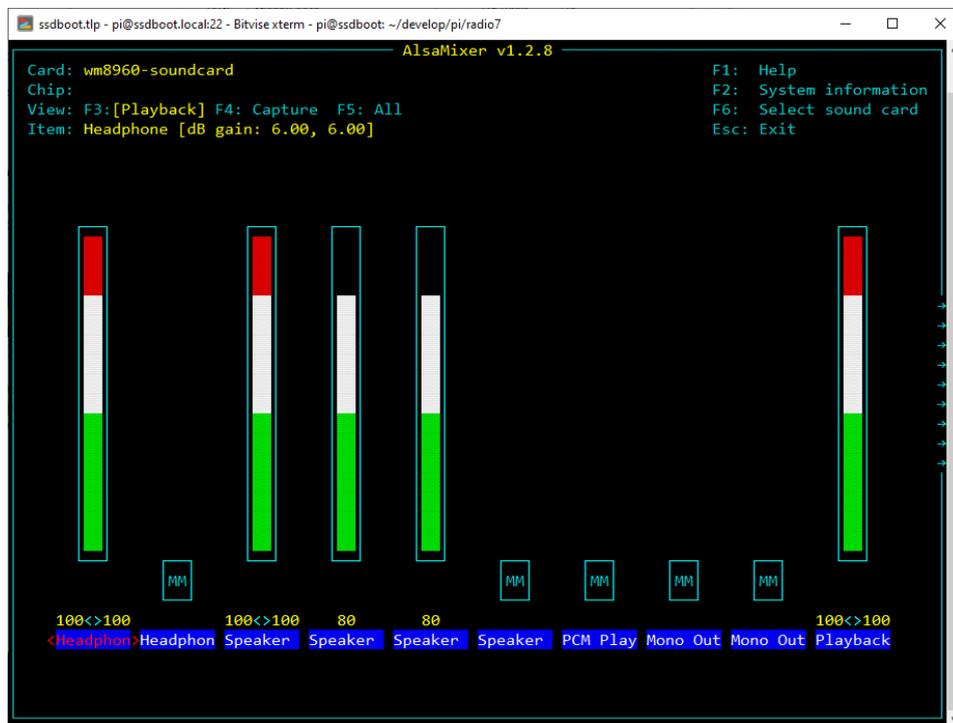


Figure 183 Alsamixer setting the Headphone Volume

Set the headphone volume to maximum, press Esc to exit, then store the settings with the following command.

```
$ sudo alsactl --file /etc/wm8960-soundcard/wm8960_asound.state store:
```

Uninstalling the Waveshare WM8960 sound card

```
$ cd /home/pi/WM8960-Audio-HAT  
$ sudo ./uninstall.sh
```

Now run the **configure_audio.sh** configuration script as shown in *Configuring the audio output* on page 116.

Manually configuring sound cards

Unless you have a need to manually configure some other sound card or need to troubleshoot a non-working card you can skip this section. Configuring a HiFiBerry DAC is shown in this example Edit the **/boot/config.txt** and add the following line to the end of the file depending upon the version you are using.

```
dtoverlay=hifiberry-dacplus
```

See <https://www.hifiberry.com/guides/configuring-linux-3-18-x/> for other devices.

Modify the **audio_output** section in **/etc/mpd.conf** to support the HiFiBerry DAC and software mixer.

```
audio_output {
    type      "alsa"
    name      "HiFiBerry DAC"
    device    "hw:0,0"
    # mixer_type "hardware"
    mixer_type "software"
}
```

Reboot the Raspberry Pi.

```
$ sudo reboot
```

If no music is heard run the **alsamixer** program and set the volume to at least 80% as shown in the previous section on **HiFiBerry** devices.

Configuring MPD to use pulseaudio

In this version **pulseaudio** is removed due to the fact that for some unknown reason MPD has problems if **pulseaudio** is installed and MPD is configured to use the default ALSA system. Some DACs such as the Adafruit Bonnet require **pulseaudio**. MPD can be configured to use either the default **Alsa** sound system or the Pulse audio server. If you want to use **pulseaudio**, stop the radio and install **pulseaudio**:

```
$ sudo systemctl stop radiod
$ sudo apt install pulseaudio
```

Either re-run the **configure_radio.sh** program or manually change the **audio_output** type statement in **/etc/mpd.conf** to **pulse**. The **‘:’** character means output not shown.

```
audio_output {
    type      "pulse"
    name      "IQAudio DAC+"
    device    "hw:0,0"
    mixer_type "software"
    :
}
```

Reboot the Raspberry Pi to restart the radio.

```
$ sudo reboot
```

See section *B.3 Sound card DT Overlays* on page 370 for supported/tested overlays.

Setting the mixer volume

All sound output goes through a mixer. After rebooting the Raspberry Pi, for the on-board output jack, run the **alsamixer** program:

```
$ alsamixer
```

The following screen is displayed:

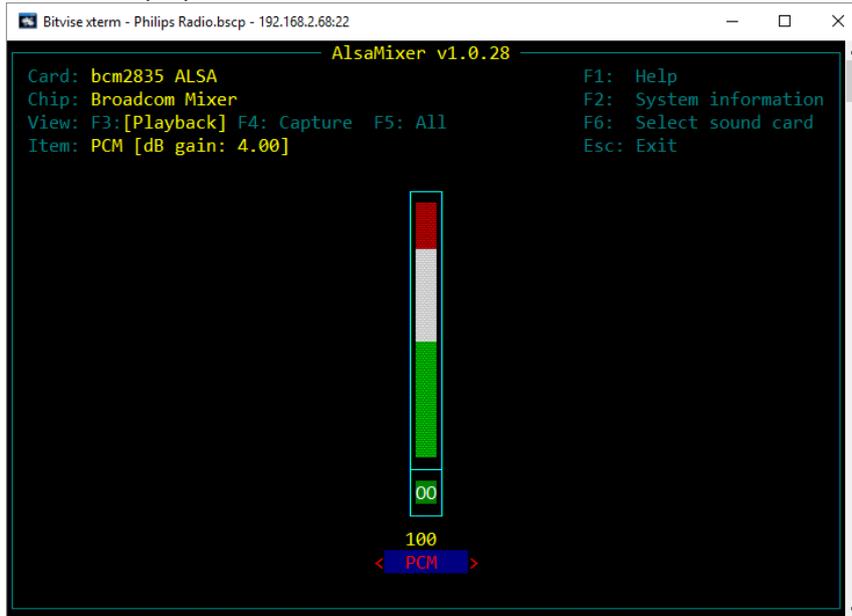


Figure 184 Basic Alsa sound mixer

The above illustration shows the **bcm2835** Alsa Mixer. There is only one mixer control called PCM (Pulse Code Modulated). Adjust the volume to 100% if not already set by using the Up and Down keys on the keyboard. Press the **Esc** key or **Ctl-Z** to exit the program.

It is also possible to set the volume for the on-board mixer volume with the **amixer** program.

```
$ amixer cset numid=1 100%
numid=1,iface=MIXER,name='PCM Playback Volume'
; type=INTEGER,access=rw---R--,values=1,min=-10239,max=400,step=0
: values=400
| dBscale-min=-102.39dB,step=0.01dB,mute=1
```

Connecting a Bluetooth audio device

Install the Bluetooth software

Usually, all necessary Bluetooth is installed for the full versions of Raspbian but may be missing for the Lite version. To make sure all required software is installed run the following:

```
$ sudo apt-get install pulseaudio pulseaudio-module-bluetooth
```

Add user pi (or the user you have configured) to the Bluetooth group:

```
$ sudo usermod -G bluetooth -a pi
```

Reboot the Raspberry Pi.

```
$ sudo reboot
```

Pairing a Bluetooth device

Switch on the Bluetooth speakers or headphones. Reboot the Raspberry Pi. To pair your Bluetooth device run **bluetoothctl**. This will enter its own shell.

```
$ bluetoothctl
Agent registered
[bluetooth]#
```

Do not mistake the # prompt for the root (super-user) prompt. Put scanning on.

If you see the following message:

```
$ bluetoothctl
[bluetooth]# scan on
No default controller available
```

See *Cannot start Bluetooth control program* on page 275.

For the bookworm version of the OS display the Bluetooth address of the controller.

```
Agent registered
[CHG] Controller B8:27:EB:A3:E4:52 Pairable: yes
```

Switch on the Bluetooth agent and set as default

```
[bluetooth]# agent on
Agent registered
[bluetooth]# default-agent
Default agent request successful
```

Switch on scanning.

```
[bluetooth]# scan on
Discovery started
[CHG] Controller DC:A6:32:05:36:9D Discovering: yes
[NEW] Device C0:48:E6:73:3D:FA [TV] Samsung Q7 Series (65)
[NEW] Device 00:75:58:41:B1:25 SP-AD70-B
```

When you see your Bluetooth speaker or headphones switch scan back off.

```
[bluetooth]# scan off
:
[CHG] Controller DC:A6:32:05:36:9D Discovering: no
Discovery stopped
```

In this example the device name is **SP-AD70-B** and has a Bluetooth ID of **00:75:58:41:B1:25**. Now pair the device using its ID:

```
[bluetooth]# pair 00:75:58:41:B1:25
Attempting to pair with 00:75:58:41:B1:25
[CHG] Device 00:75:58:41:B1:25 Connected: yes
[CHG] Device 00:75:58:41:B1:25 UUIDs: 0000110b-0000-1000-8000-00805f9b34fb
[CHG] Device 00:75:58:41:B1:25 UUIDs: 0000110e-0000-1000-8000-00805f9b34fb
[CHG] Device 00:75:58:41:B1:25 UUIDs: 0000111e-0000-1000-8000-00805f9b34fb
```

```
[CHG] Device 00:75:58:41:B1:25 ServicesResolved: yes
[CHG] Device 00:75:58:41:B1:25 Paired: yes
Pairing successful
[CHG] Device 00:75:58:41:B1:25 ServicesResolved: no
[CHG] Device 00:75:58:41:B1:25 Connected: no
```

Now connect and trust the device:

```
[bluetooth]# connect 00:75:58:41:B1:25
Attempting to connect to 00:75:58:41:B1:25
[CHG] Device 00:75:58:41:B1:25 Connected: yes
Connection successful
[CHG] Device 00:75:58:41:B1:25 ServicesResolved: yes
```

Trust the new Bluetooth device

```
[SP-AD70-B]#trust 00:75:58:41:B1:25
[CHG] Device 00:75:58:41:B1:25 Trusted: yes
Changing 00:75:58:41:B1:25 trust succeeded
```

Connect the device

```
[SP-AD70-B] # connect 00:75:58:41:B1:25
Attempting to connect to 00:75:58:41:B1:25
[CHG] Device 00:75:58:41:B1:25 Connected: yes
Connection successful
```

Note that the Bluetooth prompt displays the name of the connected device. Now exit **bluetoothctl**.

```
[SP-AD70-B]# exit
$
```

You can also use **bluetoothctl** with commands following it from the normal pi user prompt.

For Bullseye and earlier:

```
$ bluetoothctl paired-devices
Device 00:75:58:41:B1:25 SP-AD70-B
```

For bookworm run

```
$ bluetoothctl devices
Device 00:75:58:41:B1:25 SP-AD70-B
```

The info command displays the state of the paired Bluetooth device.

```
[SP-AD70-B]# info 00:75:58:41:B1:25
Device 00:75:58:41:B1:25 (public)
    Name: SP-AD70-B
    Alias: SP-AD70-B
    Class: 0x00240404
    Icon: audio-card
    Paired: yes
    Trusted: yes
```

```
Blocked: no
Connected: yes
LegacyPairing: no
UUID: Audio Sink (0000110b-0000-1000-8000-00805f9b34fb)
UUID: A/V Remote Control (0000110e-0000-1000-8000-00805f9b34fb)
UUID: Handsfree (0000111e-0000-1000-8000-00805f9b34fb)
```

The following displays all available commands:

```
$ bluetoothctl help
```

Testing Bluetooth

Once Bluetooth is running switch on the Bluetooth Speaker or device. The Bluetooth device should indicate that it is connected to the Raspberry Pi by some means (See your device manual). Now run the following:

```
$ aplay /usr/share/sounds/alsa/Rear_Right.wav
```

If things are working correctly, a spoken “Rear right” should be heard from the Bluetooth device. If not see *Bluetooth device no sound* on page 243 in Chapter 9 -Troubleshooting.

Configuring the radio and MPD software to use Bluetooth

Now re-run the **configure_audio.sh** configuration script and select Bluetooth.

```
$ cd /usr/share/radio/  
$ ./configure_audio.sh
```

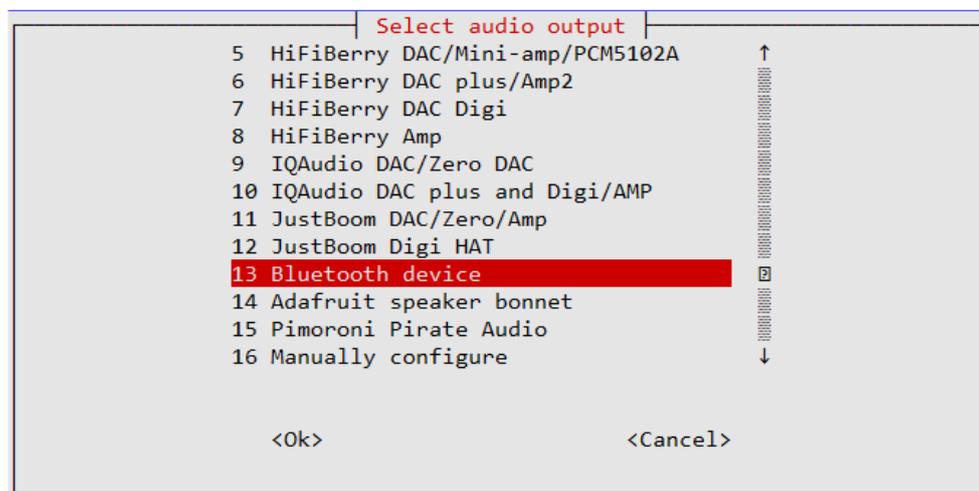


Figure 185 Configuring bluetooth devices

Reboot the Raspberry Pi.

```
$ sudo reboot
```

Using the alsamixer with Bluetooth devices

If using the Bluetooth speakers or headphones using **bluealsa**, use the following command to invoke the **alsamixer**.

```
$ alsamixer -D bluealsa
```

The following screen will be displayed:

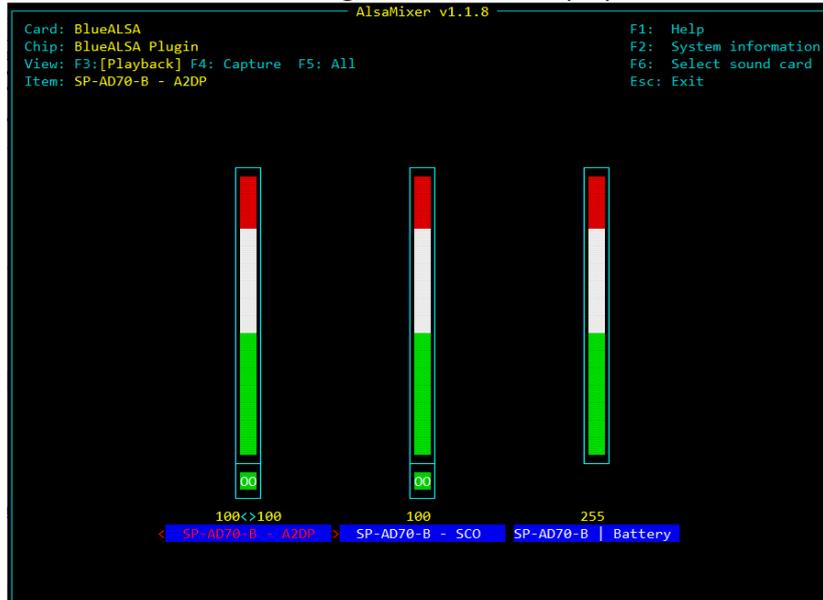


Figure 186 Alsamixer using Bluetooth devices

Controls from left to right, A2DP=Master volume, SCO=Messages volume (“Waiting for connection”, “connected”), Battery=Battery state messages (“low Battery”)

Testing the Music Player Daemon MPD

This section provides useful information on the operation of the Music Player Daemon (MPD) and its client (MPC) or diagnostics if no music is heard when the Radio is started.

If no music is being heard check the status of MPD:

```
$ sudo systemctl status mpd
● mpd.service - Music Player Daemon
   Loaded: loaded (/lib/systemd/system/mpd.service; disabled; vendor preset:
   enabled)
   Active: active (running) since Mon 2019-11-04 11:22:03 GMT; 6min ago
     Docs: man:mpd(1)
           man:mpd.conf(5)
           file:///usr/share/doc/mpd/user-manual.html
   Main PID: 1056 (mpd)
     Tasks: 7 (limit: 2061)
    Memory: 10.6M
    CGroup: /system.slice/mpd.service
           └─1056 /usr/bin/mpd --no-daemon
```

If the following is seen:

```
$ sudo systemctl status mpd
mpd is not running ... failed!
```

Start the MPD daemon.

```
$ sudo systemctl start mpd
Starting Music Player Daemon: mpd.
```

If no music is heard check that there are playlists configured using the music player client **mpc playlist** command (sudo isn't necessary):

```
$ mpc playlist
Nashville FM
RAI Radio Uno
RAI Radio Duo
Prima Radio Napoli
Radio 1 Nederland
:
```

If no playlists are shown run the **create_stations.py** program as shown in the section called Creating new playlists on page 218.

Installing the Infra-Red sensor software

Before starting, the IR sensor needs to be wired to the correct GPIO pin. The following table shows the correct GPIO pin assignment for the IR receiver depending upon the hardware being used. Configuration commands shown later use the GPIO number shown in bold in the table below.

Table 19 IR Sensor Pin outs

Radio Type	Pin	GPIO	Type of Raspberry PI
Two- or Four-line LCD with Push Buttons	21	9	Any (No DAC)
Two- or Four-line LCD with Rotary encoders	21	9	Any (No DAC)
Two- or Four-line LCD with I2C backpack	21	9	Any (No DAC)
Adafruit RGB plate with push buttons	36	16	40-pin version only
All versions using DAC sound cards	22	25	40-pin version only
IQaudIO Cosmic Controller and OLED display	22	25	40-pin version only



Note: If you have wired your IR sensor to a different IR sensor other than shown in the above table, simply use any of the above GPIO numbers and then later amend the **dtoverlay=gpio-ir,gpio_pin=x** in **/boot/config.txt** where **x** is the GPIO number you have used.

Install the IR remote control software

If you haven't already done so update the operating system first.

```
$ sudo apt update
$ sudo apt upgrade
```

Run the IR remote installation program:

```
$ cd /usr/share/radio
$ ./configure_ir_remote.sh
```

The following screen will be displayed. Select option 1 – Run IR Remote Control Configuration.

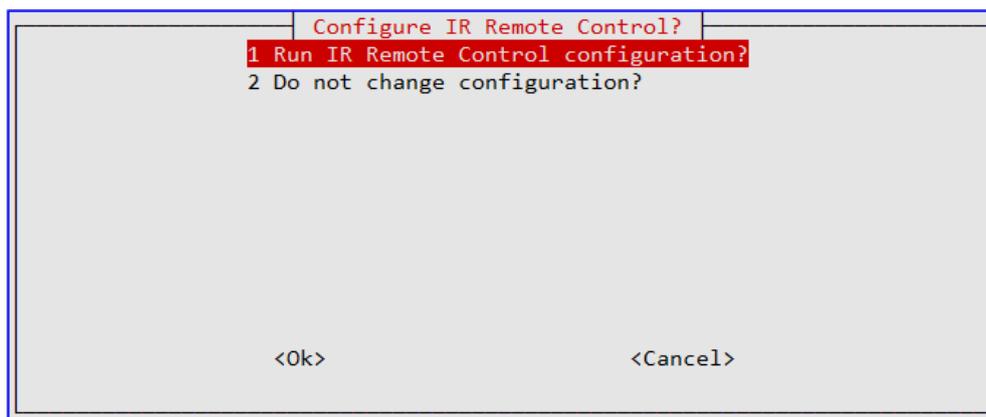


Figure 187 IR Remote Installation program

It is now necessary to select which GPIO is to be used for the IR sensor. This is either 9, 16 or 25.

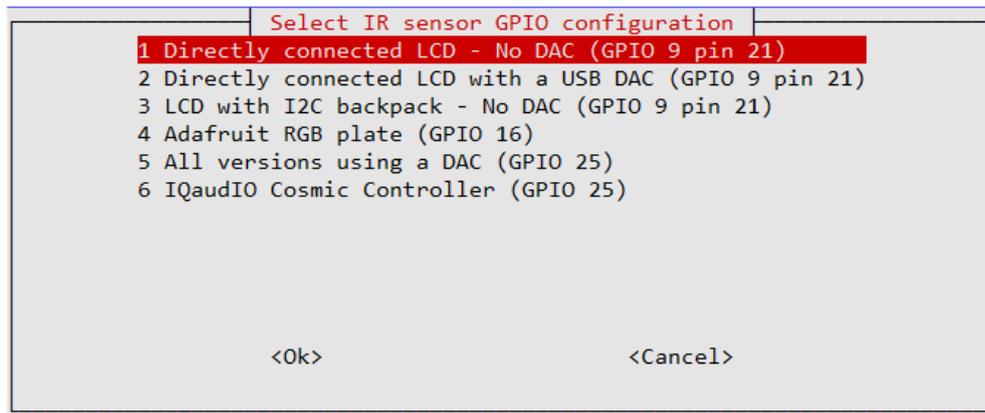


Figure 188 IR configuration IR sensor GPIO selection

Now select the Remote Activity LED GPIO. This is either GPIO 11, 13, 14 or 16.

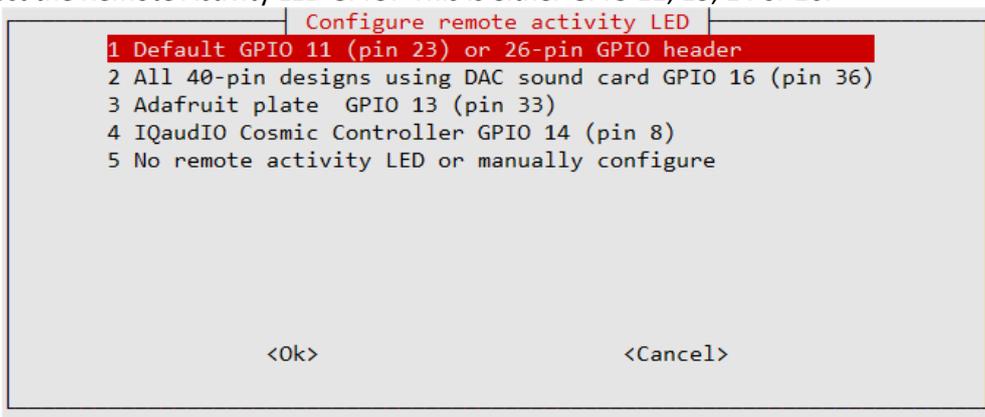


Figure 189 IR configuration Activity LED GPIO selection

Once the Activity LED selection has been made the program will install the Kernel Event components and configure the `/boot/config.txt` file. It installs `ir-keytable` and `python3-evdev` packages.

The program will display the following instructions to complete the set-up process. In the following it gives the example for the Kernel events service.

```
Configuration of Kernel Event completed OK
Reboot the system and then run the following
to configure your IR remote control
    sudo ir-keytable -v -t -p rc-5,rc-5-sz,jvc,sony,nec,sanyo,mce_kbd,rc-
6,sharp,xmpir-keytable

Create myremote.toml using the scan codes from the ir-keytable program
output
See the example in /usr/share/radio/myremote.mytoml
Then copy your configuration file (myremote.toml) to /etc/rc_keymaps
    sudo cp myremote.toml /etc/rc_keymaps/.

Reboot the Raspberry Pi

A log of this run will be found in /usr/share/radio/install_ir.log
```

The program adds the `gpio-ir` dtoverlay to the `/boot/config.txt` file for Buster. The `gpio_pin` varies with the selection you made.

```
dtoverlay=gpio-ir,gpio_pin=25
```

Reboot the radio:

```
$ sudo reboot
```

After reboot check that the correct IR daemon is running. Use Ctrl-C to exit

If the Kernel Events interface was configured check **ireventd**.

```
$ systemctl status ireventd.service
● ireventd.service - Radio remote control daemon
   Loaded: loaded (/lib/systemd/system/ireventd.service; enabled; vendor
  preset: enabled)
   Active: active (running) since Sat 2023-06-24 12:22:28 BST; 1h 51min
  ago
     Main PID: 3055 (python3)
        Tasks: 1 (limit: 1599)
             CPU: 336ms
        CGroup: /system.slice/ireventd.service
                └─3055 python3 /usr/share/radio/ireventd.py nodaemon
:
```



Note that some remote such as the Samsung remote have a select button or buttons (for example VCR and TV) which change the protocol or coding or both of the IR signal transmitted. Make sure that you use the same mode when setting up the remote control and using it avoid confusion.

Configuring the IR remote control

The Radio software uses the **ir-keytable** program to handle IR remote control events.

You should also have already installed the general IR software as shown in *Installing the Infra-Red sensor software* on page 145.

The configuration files for **ir-keytable** have the **toml** extension. These can be listed with the following command:

```
$ ls /lib/udev/rc_keymaps/
adstech_dvb_t_pci.toml  encore_enlvtv.toml  pixelview_002t.toml
af9005.toml            evga_indtube.toml  pixelview_mk12.toml
alink_dtu_m.toml      eztv.toml          pixelview_new.toml
:
```

This will list over 430 different remote controls and if you are lucky, it may find one that matches the one you are using. If not, create one using the following method.

```
$ sudo ir-keytable
```

This will list the available input devices of which there are several. The one that is of interest is **gpio_ir_recv**.

The **gpio_ir_recv** driver

```
Found /sys/class/rc/rc0/ with:
  Name: gpio_ir_recv
  Driver: gpio_ir_recv
  Default keymap: rc-rc6-mce
  Input device: /dev/input/event0
  LIRC device: /dev/lirc0
  Attached BPF protocols:
  Supported kernel protocols: lirc rc-5 rc-5-sz jvc sony nec sanyo
mce_kbd rc-6 sharp xmp imon
  Enabled kernel protocols: lirc rc-6
  bus: 25, vendor/product: 0001:0001, version: 0x0100
  Repeat delay = 500 ms, repeat period = 125 ms
```

Now run:

```
$ sudo ir-keytable -v -t -p rc-5,rc-5-sz,jvc,sony,nec,sanyo,mce_kbd,rc-6,sharp,xmp
```

Note the above is all one line. This will display the protocols available.

```
Found device /sys/class/rc/rc0/
:
Opening /dev/input/event0
Input Protocol version: 0x00010001
Protocols changed to rc-5 rc-5-sz jvc sony nec sanyo mce_kbd rc-6 sharp xmp
```

Now press a button on the remote control such as Volume Up. This will display the **scancode** for that button.

```
Testing events. Please, press CTRL-C to abort.
7800.012059: lirc protocol(necx): scancode = 0x833356
7800.012097: event type EV_MSC(0x04): scancode = 0x833356
7800.012097: event type EV_KEY(0x01) key_down: KEY_VOLUMEUP(0x0073)
7800.012097: event type EV_SYN(0x00).
7800.188028: event type EV_KEY(0x01) key_up: KEY_VOLUMEUP(0x0073)
7800.188028: event type EV_SYN(0x00).
```

Now create file called **myremote.toml** as shown in the example below. The name can be anything you wish, but it must end in the **toml** extension. The name field should be **myremote**. The protocol should be that shown above (**necx** in this example). Assign the scan code for each key as show in the above event. The variant field is normally the same as the protocol field but this will be indicated in the event output if it is different. There is an example **myremote.toml** file in the **/usr/share/radio/remotes** directory.



Note: There wasn't a **necx** protocol. The nearest one was **nec** so this was used.

```
[[protocols]]
name = "myremote"
protocol = "nec"
variant = "nec"
[protocols.scancodes]
0x833356 = "KEY_VOLUMEUP"
```

```

0x8333357 = "KEY_VOLUMEDOWN"
0x8333395 = "KEY_MUTE"
0x8333358 = "KEY_CHANNELUP"
0x8333359 = "KEY_CHANNELDOWN"
0x8333396 = "KEY_MENU"
0x8333342 = "KEY_UP"
0x8333343 = "KEY_DOWN"
0x8333344 = "KEY_LEFT"
0x8333345 = "KEY_RIGHT"
0x8333341 = "KEY_OK"
0x8333360 = "KEY_NUMERIC_0"
0x8333361 = "KEY_NUMERIC_1"
0x8333362 = "KEY_NUMERIC_2"
0x8333363 = "KEY_NUMERIC_3"
0x8333364 = "KEY_NUMERIC_4"
0x8333365 = "KEY_NUMERIC_5"
0x8333366 = "KEY_NUMERIC_6"
0x8333367 = "KEY_NUMERIC_7"
0x8333368 = "KEY_NUMERIC_8"
0x8333369 = "KEY_NUMERIC_9"
0x8333373 = "KEY_EXIT"

```



Note: The remote-control power on/off button must be called **KEY_EXIT** and not **KEY_POWER**. If **KEY_POWER** is used the event system issues its own system shutdown command instead of letting the radio decide the exit action, either system shutdown or stop radio. See the **exit_action** parameter in **/etc/radiod.conf** file.

Now write the new remote-control definition (myremote.toml) to the key table:

```

$ sudo ir-keytable -c -w myremote.toml
Read myremote table
Old keytable cleared
Wrote 11 keycode(s) to driver
Protocols changed to rc-5

```

Display the new table:

```

$ sudo ir-keytable -r
scancode 0x8333341 = KEY_OK (0x160)
scancode 0x8333342 = KEY_UP (0x67)
scancode 0x8333343 = KEY_DOWN (0x6c)
scancode 0x8333344 = KEY_LEFT (0x69)
scancode 0x8333345 = KEY_RIGHT (0x6a)
scancode 0x8333356 = KEY_VOLUMEUP (0x73)
scancode 0x8333357 = KEY_VOLUMEDOWN (0x72)
scancode 0x8333358 = KEY_CHANNELUP (0x192)
scancode 0x8333359 = KEY_CHANNELDOWN (0x193)
scancode 0x8333360 = KEY_NUMERIC_0 (0x200)
scancode 0x8333361 = KEY_NUMERIC_1 (0x201)
scancode 0x8333362 = KEY_NUMERIC_2 (0x202)
scancode 0x8333363 = KEY_NUMERIC_3 (0x203)
scancode 0x8333364 = KEY_NUMERIC_4 (0x204)
scancode 0x8333365 = KEY_NUMERIC_5 (0x205)
scancode 0x8333366 = KEY_NUMERIC_6 (0x206)
scancode 0x8333367 = KEY_NUMERIC_7 (0x207)
scancode 0x8333368 = KEY_NUMERIC_8 (0x208)
scancode 0x8333369 = KEY_NUMERIC_9 (0x209)
scancode 0x8333373 = KEY_EXIT (0x74)
scancode 0x8333395 = KEY_MUTE (0x71)
scancode 0x8333396 = KEY_MENU (0x8b)
Enabled kernel protocols: lirc nec

```

Now test it:

```
$ ir-keytable -t
7427.808043: lirc protocol(necx): scancode = 0x833356
7427.808079: event type EV_MSC(0x04): scancode = 0x833356
7427.808079: event type EV_KEY(0x01) key_down: KEY_VOLUMEUP(0x0073)
7427.808079: event type EV_SYN(0x00).
7427.864040: lirc protocol(necx): scancode = 0x833356 repeat
7427.864075: event type EV_MSC(0x04): scancode = 0x833356
7427.864075: event type EV_SYN(0x00).
```



Note: If you press a key that you did not previously configure, it will display the scan code but it will not have a key name such as KEY_VOLUMEUP.

If all is OK it is now necessary to make the changes permanent when the RPi is rebooted.

Copy the newly created **myremote.toml** to **/etc/rc_keymaps/**

```
$ sudo cp myremote.toml /etc/rc_keymaps/myremote.toml
```

Reboot the Raspberry pi

```
$ sudo reboot
```

After reboot check that the IR key table is OK

```
$ ir-keytable -r
scancode 0x833341 = KEY_OK (0x160)
scancode 0x833342 = KEY_UP (0x67)
scancode 0x833343 = KEY_DOWN (0x6c)
scancode 0x833344 = KEY_LEFT (0x69)
scancode 0x833345 = KEY_RIGHT (0x6a)
scancode 0x833356 = KEY_VOLUMEUP (0x73)
scancode 0x833357 = KEY_VOLUMEDOWN (0x72)
scancode 0x833358 = KEY_CHANNELUP (0x192)
scancode 0x833359 = KEY_CHANNELDOWN (0x193)
scancode 0x833395 = KEY_MUTE (0x71)
scancode 0x833396 = KEY_MENU (0x8b)
: {Rest of output not shown}
```



Note: If you called your configuration anything else other than **myremote.toml** you not only need to change the previous instructions to use that name but also edit it in **/etc/radiod.conf** and change the **keytable** parameter to match the name you chose.

Edit **/etc/radiod.conf** and find the keytable entry and change the name to match the name you used.

```
# ireventd daemon keytable name
keytable=myremote.toml
```

This is necessary as the **ireventd.service (ireventd.py)** reads this entry to load they key table at the start of its run.

Now reboot the system and test the remote control:

```
$ reboot
```

Operation

The keys should work as expected, for example, Volume Up/Down, Mute and Channel Up/down. Pressing any of the numeric keys will cause the radio to play the station or track number entered. For example, press 5 and the 5th station in the playlist will play. Press 128 within two seconds and the radio will jump to the 128th station or track (if it exists). If it doesn't exist it will jump to station 1.

You can check the status of the **ireventd.service** using **systemctl**.

```
$ systemctl status ireventd.service
● ireventd.service - Radio remote control daemon
   Loaded: loaded (/lib/systemd/system/ireventd.service; enabled; vendor
  preset: enabled)
   Active: active (running) since Wed 2023-06-14 10:44:28 BST; 4h 43min
  ago
     Main PID: 541 (python3)
        Tasks: 1 (limit: 1599)
           CPU: 686ms
      CGroup: /system.slice/ireventd.service
             └─541 python3 /usr/share/radio/ireventd.py nodaemon

Jun 14 10:44:28 bobrath systemd[1]: Started Radio remote control daemon.
:
```

Testing the ireventd daemon

If the **ireventd.service** isn't running then it is possible to test it as follows:

First stop the service.

```
$ sudo systemctl stop ireventd.service
```

Run the **ireventd.py** software from the command line. For example:

```
$ cd /usr/share/radio
$ sudo ./irreventd.py
```

This will display the usage instructions:

```
This program must be run with sudo or root permissions!
Usage: sudo ./irreventd.py start|stop|status|nodaemon|flash|config|send
<KEY>
```

The following command flashes the activity LED six times if fitted.

```
$ sudo ./irreventd.py flash
```

If the service is crashing you can test it using the following command to run it as a foreground process:

```
$ sudo ./ireventd.py nodaemon
```

If you see the following:

```
pidfile /var/run/ireventd.pid already exist. Daemon already running?
```

Run

```
$ sudo ./ireventd.py stop
```

If the program is running normally, it displays the following (pid and GPIO number will vary):

```
IR Remote control listener running pid 1847
Using IR events architecture
Flashing LED on GPIO 16
Read myremote table
Old keytable cleared
Wrote 22 keycode(s) to driver
Protocols changed to nec
:
/dev/input/event0 gpio_ir_rcv gpio_ir_rcv/input0
Listening for IR events:
```

Pressing a key on the remote-control will display the key that was pressed. The radio program will respond with 'OK'. For example, the following will be displayed if the Channel UP key is pressed.

```
KEY_CHANNELUP
OK
```

It can also be used to send a valid test key or command to the radio program.

```
$ sudo ./ireventd.py send
Usage: ./ireventd.py send <KEY>
Where <KEY> is a valid IR_KEY
KEY_VOLUMEUP,KEY_VOLUMEDOWN,KEY_CHANNELUP,KEY_CHANNELDOWN,KEY_MENU
KEY_UP,KEY_DOWN,KEY_LEFT,KEY_RIGHT,KEY_OK,KEY_INFO,KEY_MUTE,KEY_EXIT
PLAY_<n> Where <n> is 1 to 999, play station/track n
```

For example, to play station 12.

```
$ sudo ./ireventd.py send PLAY_12
```

The status command:

```
$ sudo ./ireventd.py status
Remote control running pid 1975
```

Finally, the IR configuration can be displayed.

```
$ sudo ./ireventd.py config
Remote Control daemon configuration
```

```
-----  
LED = GPIO 16  
HOST = localhost  
PORT = 5100  
LISTEN = 5100  
dtoverlay=gpio-ir,gpio_pin=25  
Key map: /etc/rc_keymaps/myremote.toml
```

Comitup Wi-Fi roaming

Comitup works by configuring a Wi-Fi Hot-Spot on the Raspberry Pi which can be connected to using either a Mobile Phone, tablet or PC via a Web Interface. The web interface then allows selection of any available Wi-Fi network. More information on **comitup** can be found at:

<https://davesteele.github.io/comitup>

There are two ways of installing comitup:

- Download the ready-made image from <https://davesteele.github.io/comitup>
- Install the comitup Rasbian package using **apt install**

Installation from the Comitup Image

To burn onto an SD card for the Raspberry Pi, first download the image from the above web site. There are currently two versions namely **Bookworm Desktop** and **Bookworm Lite**. Download the zip file to your PC (Not the torrent or Magnet versions). You should find the file in your **Downloads** folder:

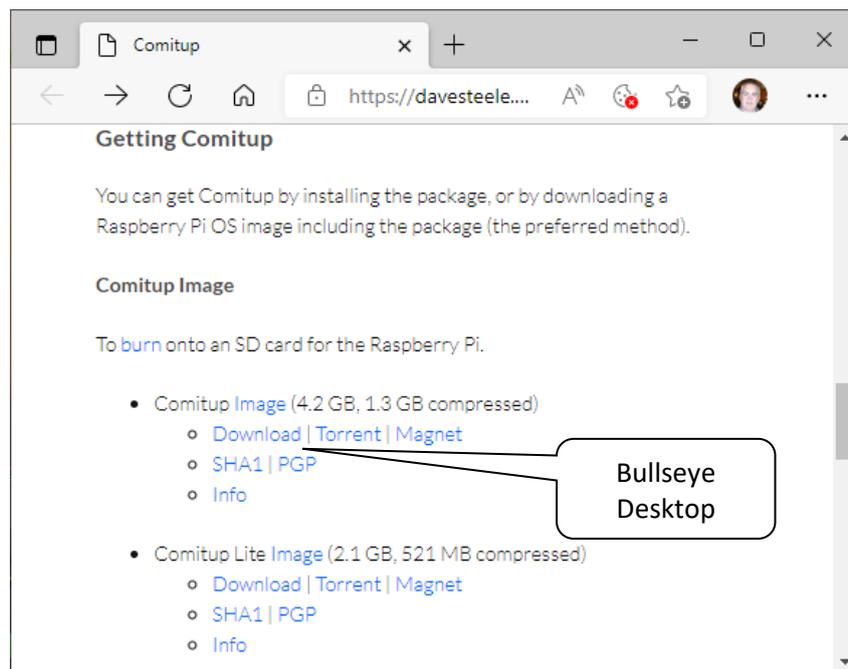
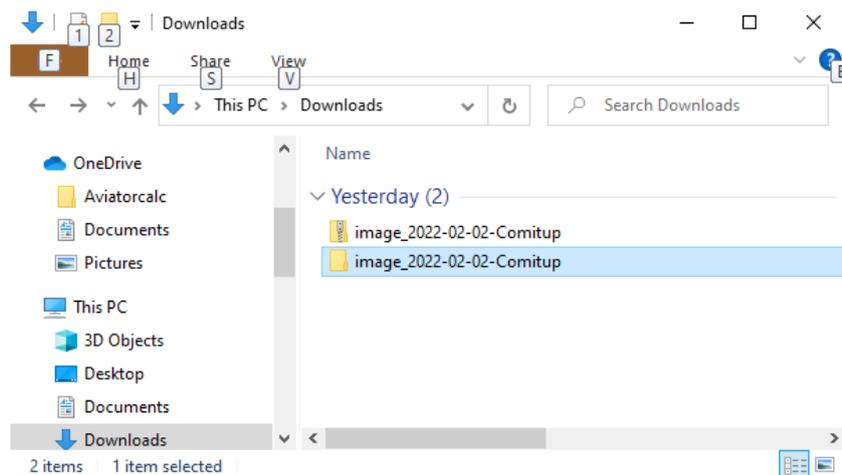
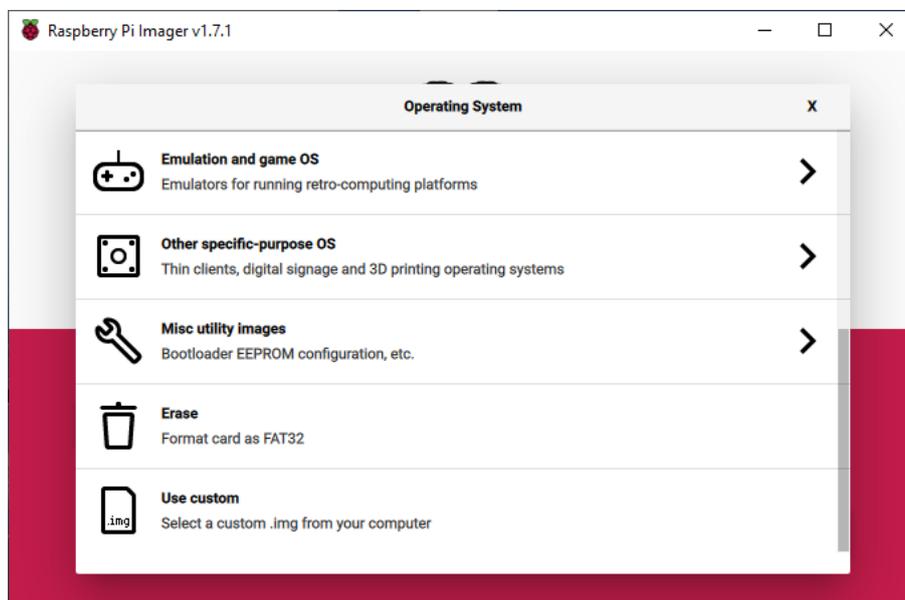


Figure 190 Downloading the comitup image

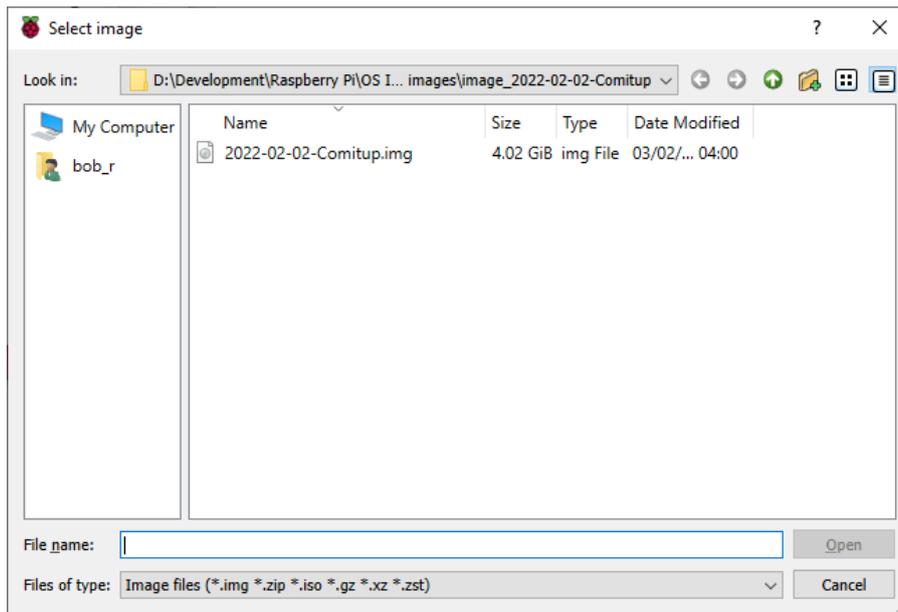
Using **Winzip** or **7Zip** unzip the image file:, Typically this will unzip the compressed image to a directory with the same name as the zip file:



Now open the Raspberry Pi Imager software (See SD card creation using Raspberry Pi Imager on page 80 for more detail). Select “CHOOSE OS” and then scroll down to “Use custom”.



This will open a browser window. Go to your downloads browser and select the img file that was just unzipped.



Click and open the image file. Next select “CHOOSE STORAGE” and select your USB device. Finally select “WRITE”. Don’t change the hostname at this stage. It will have already been set to comitup-xxx where xxx is a three-digit number and will vary for example, comitup-123.

Installing from a Raspbian package



At the moment this procedure does not seem to produce a working comitup service. It used to work and is being investigated. Please use the procedure described in *Installation from the Comitup Image* on page 153.

Install required libraries

```
$ sudo apt install python3-tabulate firewallld libteam-utils
```

Install the Comitup package:

```
$ sudo apt install comitup
```

The current `/etc/wpa_supplicant/wpa_supplicant.conf` must be moved out of the way and control handed over to comitup. Rename

```
$ cd /etc/wpa_supplicant
$ sudo mv wpa_supplicant.conf wpa_supplicant.conf.save
```

Comitup requires access to port TCP 53 however the system-resolved service uses that port so must be disabled.

```
$ sudo systemctl disable systemd-resolved
```

The current Web interface (If installed) must be placed under comitup control. In this case it is the Apache web interface that must be disabled and configure to be controlled by comitup.

```
$ sudo systemctl disable apache2.service
```

Add the following line to the **/etc/comitup.conf** file

```
web_service: apache2.service
```

Enable comitup and associated web service.

```
$ sudo systemctl enable comitup comitup-web
```

Reboot the Raspberry Pi

```
$ sudo reboot
```

After reboot there will no longer be a connection via the normal Wi-Fi Interface. Use a mobile phone or PC and use the Wi-Fi configuration screen to select the comitup

Once logged back in it is possible to check the status of the comitup and comitup-web services.

```
$ sudo systemctl status comitup
● comitup.service - Comitup Wi-Fi Management
   Loaded: loaded (/lib/systemd/system/comitup.service; enabled; vendor
   preset: enabled)
   Active: active (running) since Wed 2020-06-10 19:43:15 BST; 11min ago
     Docs: man:comitup(8)
  Main PID: 493 (comitup)
    Tasks: 2 (limit: 2061)
   Memory: 26.3M
   CGroup: /system.slice/comitup.service
           └─493 /usr/bin/python3 /usr/sbin/comitup
             └─731 dnsmasq --conf-file=/usr/share/comitup/dns/dns-hotspot.conf
--interface=wlan0
```

```
$ sudo systemctl status comitup-web
● comitup-web.service - Comitup Web Service
   Loaded: loaded (/lib/systemd/system/comitup-web.service; static; vendor
   preset: enabled)
   Active: active (running) since Wed 2020-06-10 19:54:22 BST; 3s ago
     Docs: man:comitup-web(8)
  Main PID: 2389 (comitup-web)
    Tasks: 1 (limit: 2061)
   Memory: 12.8M
   CGroup: /system.slice/comitup-web.service
           └─2389 /usr/bin/python3 /usr/sbin/comitup-web
```

To use comitup enter <http://10.41.0.1> into a web browser running on a PC, tablet or mobile telephone.

Notes:

The IP address is defined in `/usr/share/comitup/comitup/nm.py`

Disabling comitup

If for any reason comitup is a problem then it can be disabled and the standard Wi-Fi configuration restored with the following instructions.

Disable comitup and associated web service.

```
$ sudo systemctl disable comitup comitup-web
```

Restore `/etc/wpa_supplicant/wpa_supplicant.conf` (This assumes that this was previously a working configuration)

```
$ cd /etc/wpa_supplicant
$ sudo mv wpa_supplicant.conf.save wpa_supplicant.conf
```

Re-enable the **system-resolved** service.

```
$ sudo systemctl enable systemd-resolved
```

Re-enable the **apache2** service.

```
$ sudo systemctl enable apache2.service
```

Reboot the Raspberry Pi

```
$ sudo reboot
```

Installing the Web interface

MPD has several Web clients. See the following link: <https://www.musicpd.org/clients/>. There are three versions of the Web interface used by the radio software:

1. Version 1.10 **Snoopy** Web interface (Optional)
2. Version 2.0 **Snoopy** and **O!MPD** Web interface for Buster
3. Version 2.2 **Snoopy** and **O!MPD** Web interface (The ! character is not a spelling mistake).

All three options use the Apache Web server.

It is recommended to install **O!MPD** as it provides a much more sophisticated user interface but it does require setting up a **MySQL** database. The Snoopy interface is much simpler but also more limited. You can also install the **Snoopy** interface and install and **O!MPD** at a later date.

Install the Apache Web Server

Install Apache the Web server. Make sure that the system is up to date with the following commands otherwise installation of Apache may fail.

Re-run the update to refresh package lists.

```
$ sudo apt update
```

Now upgrade the packages

```
$ sudo apt upgrade
```

Re-run the update to refresh package lists.

```
$ sudo apt update
```

Now install Apache and the PHP libraries for Apache as user root.

Run the following command:

```
$ sudo apt install apache2 php libapache2-mod-php php7.4-gd php7.4-mbstring
```

This will take some time. If the above fails run the following command and re-run the installation:

```
$ sudo apt -f install
```

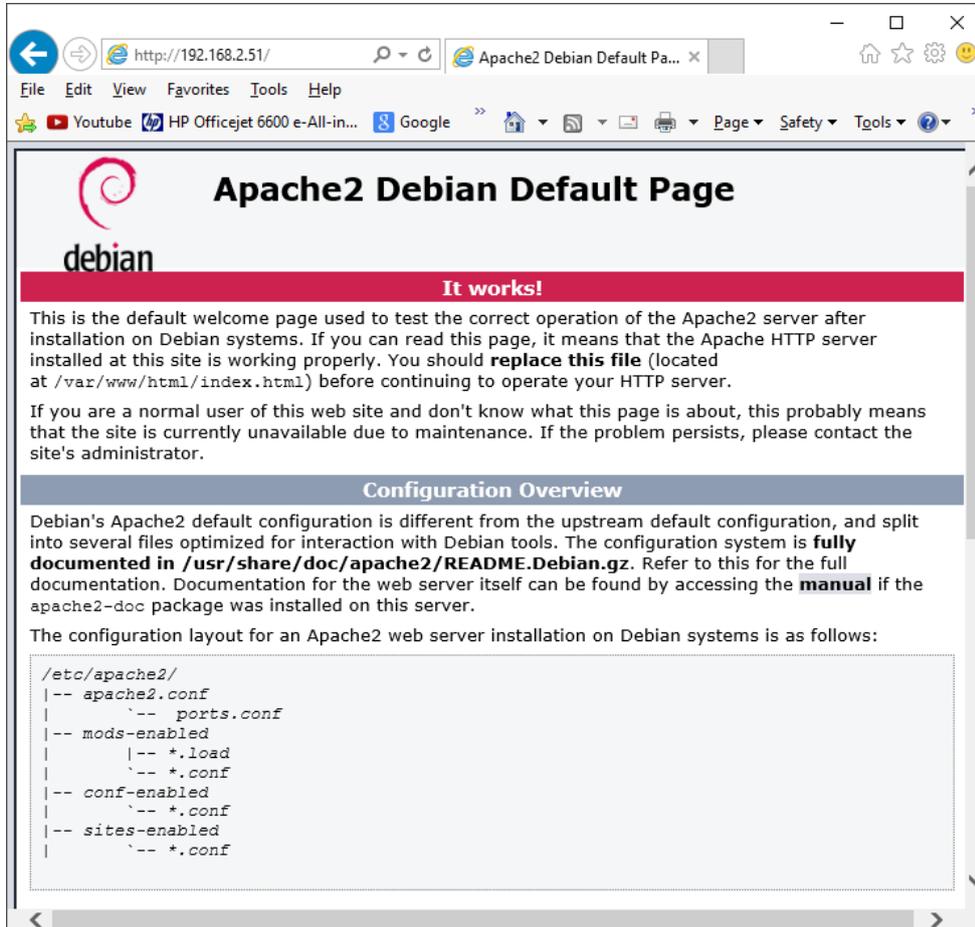
Test the Apache Web browser

Point your Web browser at the IP address or network name of the Raspberry PI. For example:
<http://192.168.2.51>.



Note: Make sure that you specify **http** and not **https** as the protocol. So <https://192.168.2.51> will not work as the Apache Web server is listening on port 80 (**http**) and not port 443 (**https**)

You should see the following display.



If it is not running check the `apache2.service`. The following display should be displayed. If not, there should be the appropriate error message.

```
$ systemctl status apache2
● apache2.service - The Apache HTTP Server
   Loaded: loaded (/lib/systemd/system/apache2.service; enabled; vendor preset: enabled)
   Active: active (running) since Fri 2022-02-18 07:50:11 GMT; 9s ago
     Docs: https://httpd.apache.org/docs/2.4/
   Process: 11481 ExecStart=/usr/sbin/apachectl start (code=exited, status=0/SUCCESS)
   Main PID: 11485 (apache2)
     Tasks: 6 (limit: 2054)
        CPU: 139ms
   CGroup: /system.slice/apache2.service
           └─11485 /usr/sbin/apache2 -k start
             └─11486 /usr/sbin/apache2 -k start
               └─11487 /usr/sbin/apache2 -k start
                 └─11488 /usr/sbin/apache2 -k start
                   └─11489 /usr/sbin/apache2 -k start
                     └─11490 /usr/sbin/apache2 -k start
```

```
Feb 18 07:50:11 Bookworm2 systemd[1]: Starting The Apache HTTP Server...
Feb 18 07:50:11 Bookworm2 systemd[1]: Started The Apache HTTP Server.
```

Install the Web Browser server pages



Note: This procedure describes the simpler more limited **Snoopy** interface. If you wish to directly install version 2.x with **O!MPD** there is no need to install version 1.10 first. If you wish to install the **O!MPD** Web interface, go to the section called *Install version 2.x of the Web interface* on page 163.

Download the **Snoopy** radio Web pages Debian package from the Bob Rathbone Web site.

Run the following to install the version 1.10 Snoopy Web interface:

```
$ wget http://www.bobrathbone.com/raspberrypi/packages/radiodweb_1.10_armhf.deb
```

Now run:

```
$ sudo dpkg -i radiodweb_1.10_armhf.deb
```

This package will install the radio Web pages in the `/var/www/html` directory and the CGI scripts in `/usr/lib/cgi-bin` directory. It will also enable the CGI scripts module.

The following error message may appear:

```
apache2: Could not reliably determine the server's fully qualified domain
name, using 127.0.1.1. Set the 'ServerName' directive globally to suppress
this message
```

The message may be ignored or it can be suppressed by editing the `/etc/apache2/apache2.conf` file and adding a **ServerName** directive.

Edit `/etc/apache2/apache2.conf` file.

Add the following line anywhere in the `apache2.conf` file.

```
ServerName localhost
```

Start the radio Web interface

Point your web browser at the IP address of the Raspberry Pi. For example: <http://192.168.1.168> you should see the following display:



Figure 191 Radio Web interface

Now click on the 'Radio' tab. If the radio software is running you will see the following:

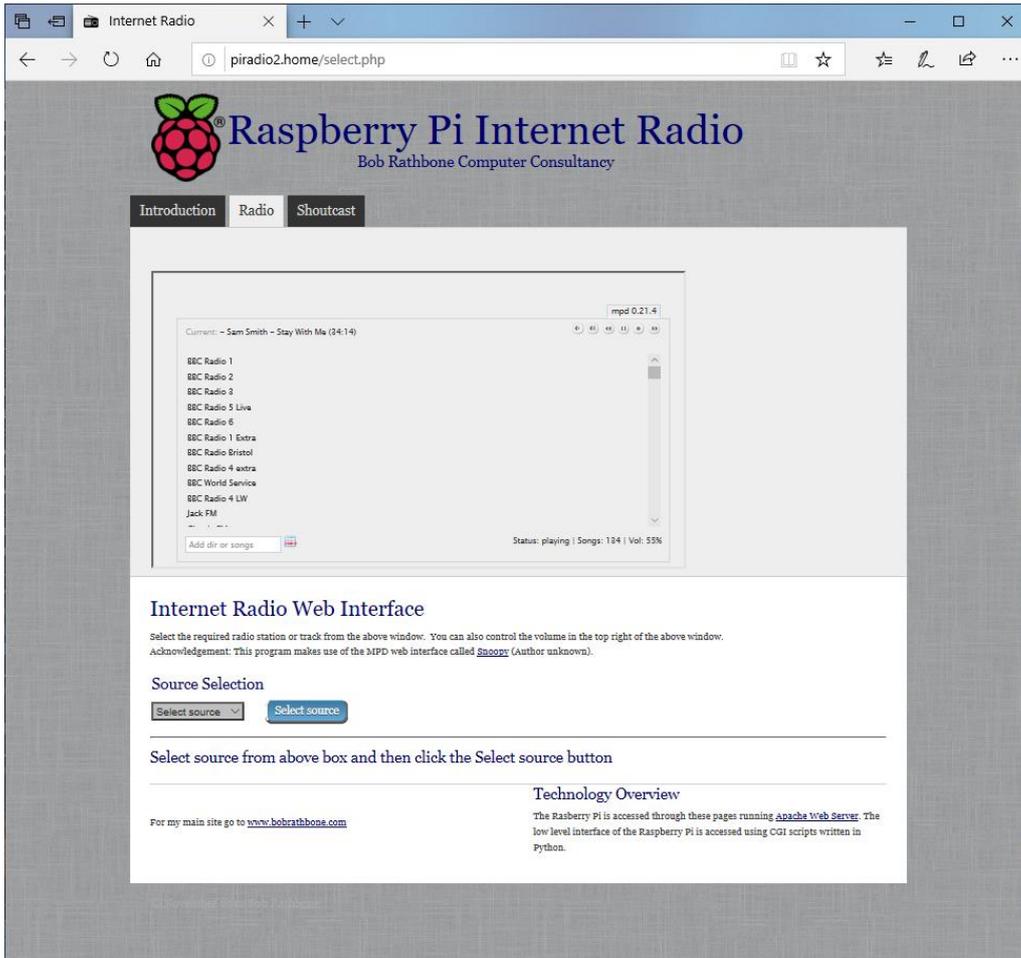
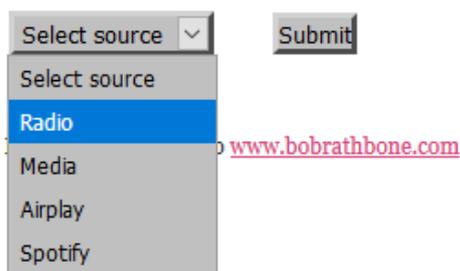


Figure 192 Snoopy Web interface

Click on any station in the list to select a station. After a short pause the station should start playing if it is online.

Source Selection



The example on the left shows four music sources that can be selected namely Radio, Media, Airplay and Spotify. Version 1.8 onwards also displays Shoutcast

The desired source can be selected from the source drop-down selection box. Click on the required source then click on 'Submit' button to load the selected source in the radio. If you have more than one Media or Radio playlist, then repeatedly clicking on the appropriate source and Submit button will cycle through the playlists for that source. The name of the new playlist, however, is not displayed.

The Shoutcast tab is explained in *Using the Shoutcast Web Interface* on page 229.



Note: The radio tab only displays radio stations or media tracks from MPD. It is not currently capable of displaying Spotify or Airplay details which can only be seen on the radio itself.

Install version 2.x of the Web interface

Install Apache as described in the section called *Install the Apache* on page 158. Once done install required packages.

Install version 2.x of the Web interface

For Bookworm

Install PHP4 and the MariaDB database.

```
$ sudo apt install php7.4-gd php7.4-mbstring mariadb-server php-mysql
```

Install the Radio Web pages.

```
$ wget http://www.bobrathbone.com/raspberrypi/packages/radiodweb_2.2_armhf.deb
```

Install the **radiodweb** package:

```
$ sudo dpkg -i radiodweb_2.2_armhf.deb
```

For Buster

Install PHP3 and the MariaDB database.

```
$ sudo apt install php7.3-gd php7.-mbstring mariadb-server php-mysql
```

Download the **radiodweb** package:

```
$ wget http://www.bobrathbone.com/raspberrypi/packages/radiodweb_2.0_armhf.deb
```

Install it

```
$ sudo dpkg -i radiodweb_2.0_armhf.deb
```

For both Buster and Bookworm

If any of the previous commands fail for any reason run the following command:

```
sudo apt --fix-broken install
```

Enable the new PHP modules:

```
$ sudo phpenmod gd mbstring
```

Restart Apache:

```
$ sudo apachectl restart
```

Create **MySql** user and password

```
$ sudo mysql
Welcome to the MariaDB monitor.  Commands end with ; or \g.
:
MariaDB [(none)]>
```

Enter the following commands at the **MariaDB [(none)]>** prompt to create a password hash. All commands end with a semicolon (;).

```
SELECT PASSWORD('raspberry');
+-----+
| PASSWORD('raspberry') |
+-----+
| *1844F2B11CCAEF3B31F573A1384F608BB6DE3DF9 |
+-----+
1 row in set (0.008 sec)
```

Now grant permissions to user 'pi'. Note that the command in bold below is all one line.

```
GRANT USAGE ON *.* TO 'pi'@'localhost' IDENTIFIED BY PASSWORD
'*1844F2B11CCAEF3B31F573A1384F608BB6DE3DF9';
Query OK, 0 rows affected (0.001 sec)
```

Grant permissions to user pi to create the OMPD database with the following two commands.

```
GRANT ALL PRIVILEGES ON ompd.* TO 'pi'@'localhost';
FLUSH PRIVILEGES;
```

Exit mysql.

```
exit
```

Restart Apache2

```
$ sudo apachectl restart
```

Enter the address of your Raspberry Pi into the browser. In this example that would be **http://192.168.1.249**. The following should be seen:



Figure 193 Version 2.x Web interface with O!MPD

Note that there is an extra tab called **O!MPD** when compared to the **Snoopy** interface. No, the ! character is not a spelling mistake. Now click on the **O!MPD** tab. The following should be seen:

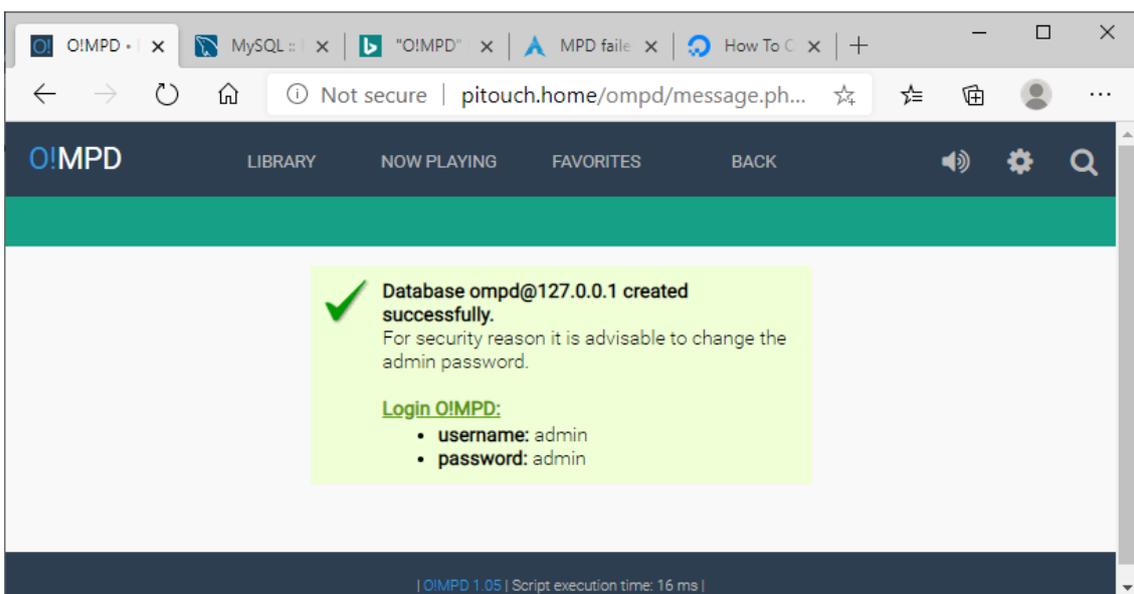
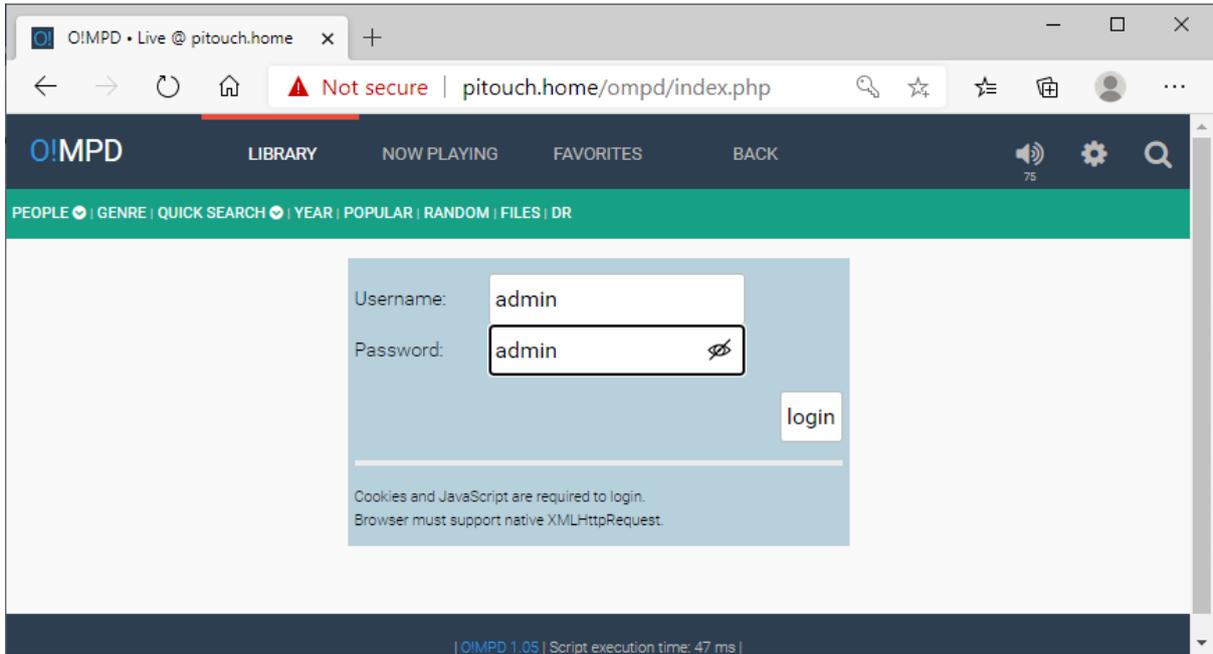
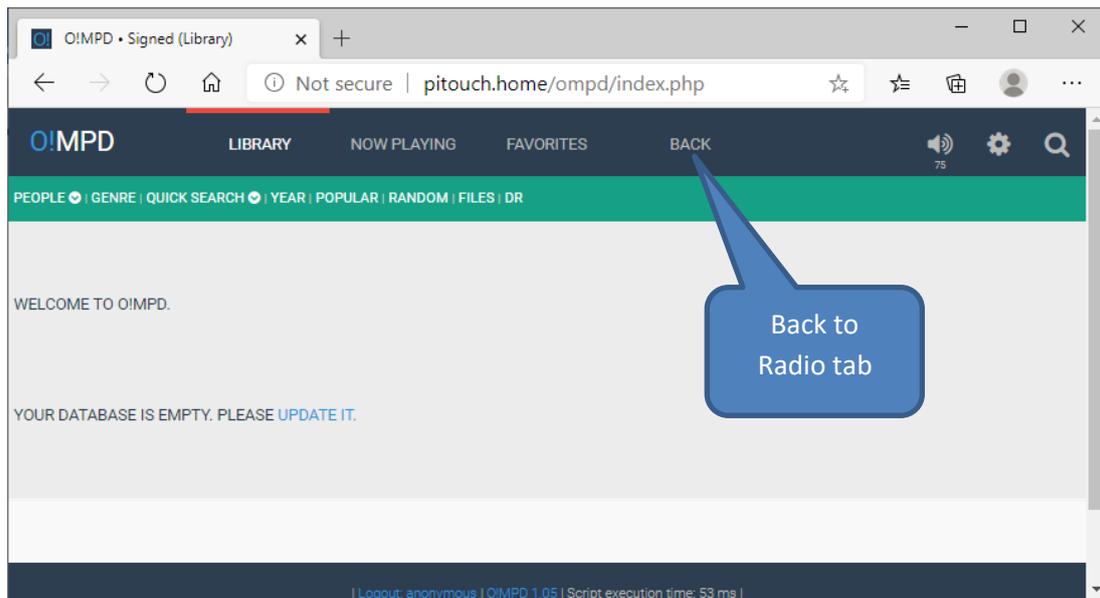


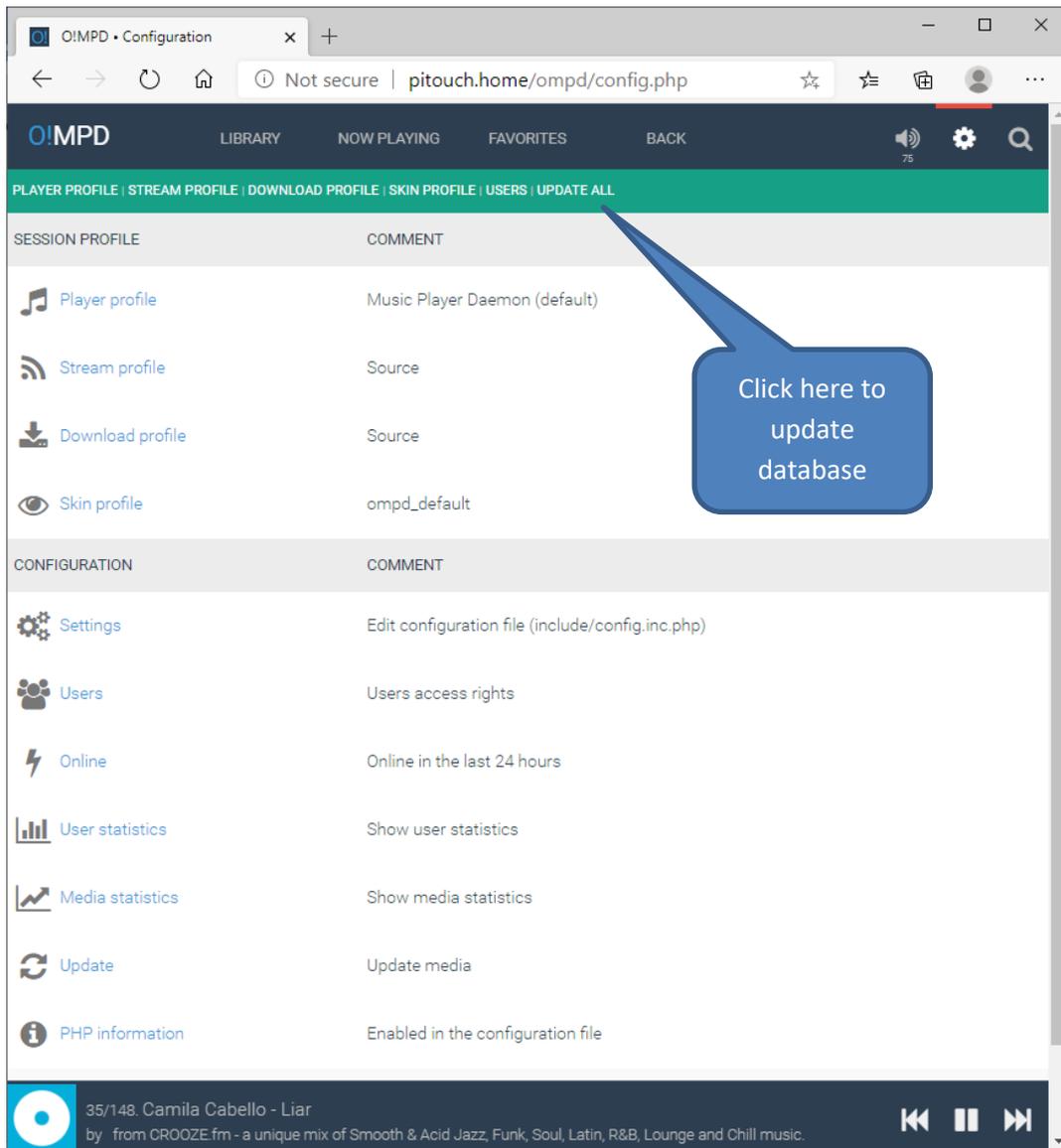
Figure 194 OMPD database creation



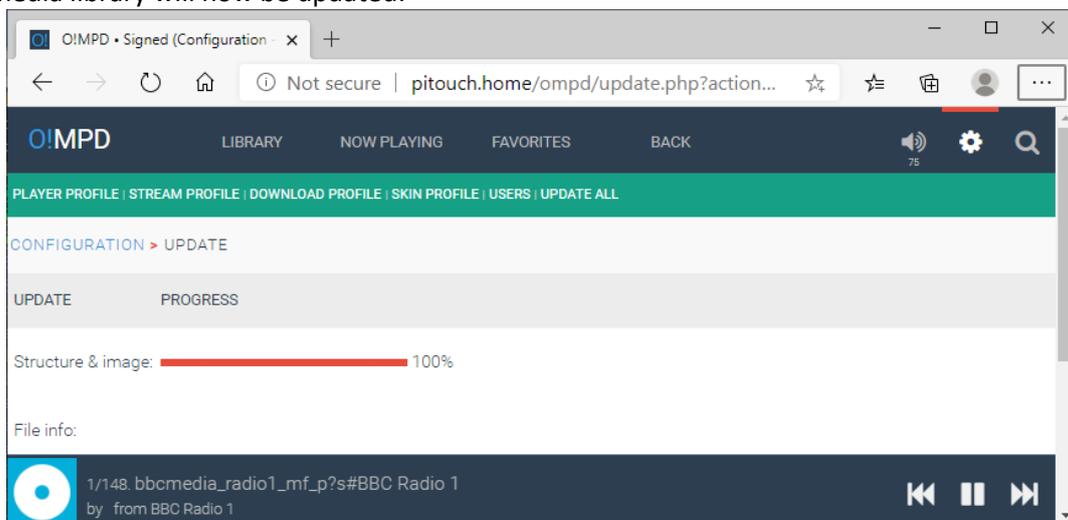
If you have already created a music library by running the `create_playlist.sh` program then it is necessary to update the **O!MPD MySQL** database. Otherwise skip these instructions.



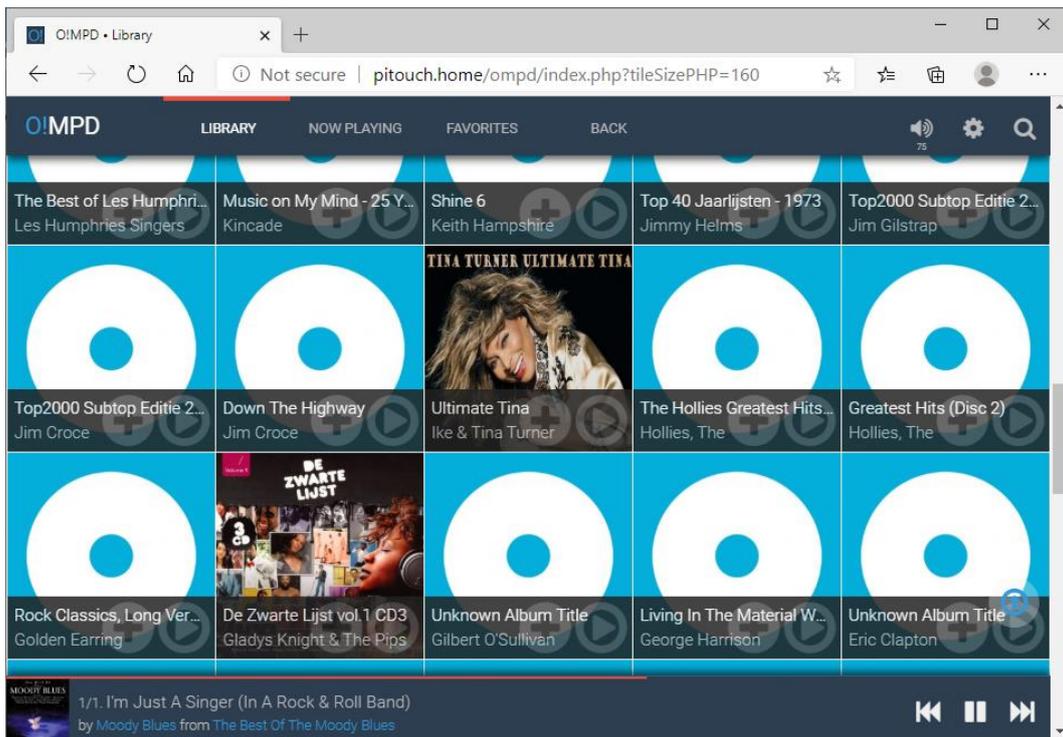
Note: The “(i) Not secure” message in the above screens can be ignored. It is because the web pages do not have a security certificate to verify that the pages come from a legitimate source and also are not using the HTTPS protocol. Since these pages are not coming from a source on the Internet and are locally installed, they do not pose a security risk and come from a reliable source namely the **Bob Rathbone radioweb** package.



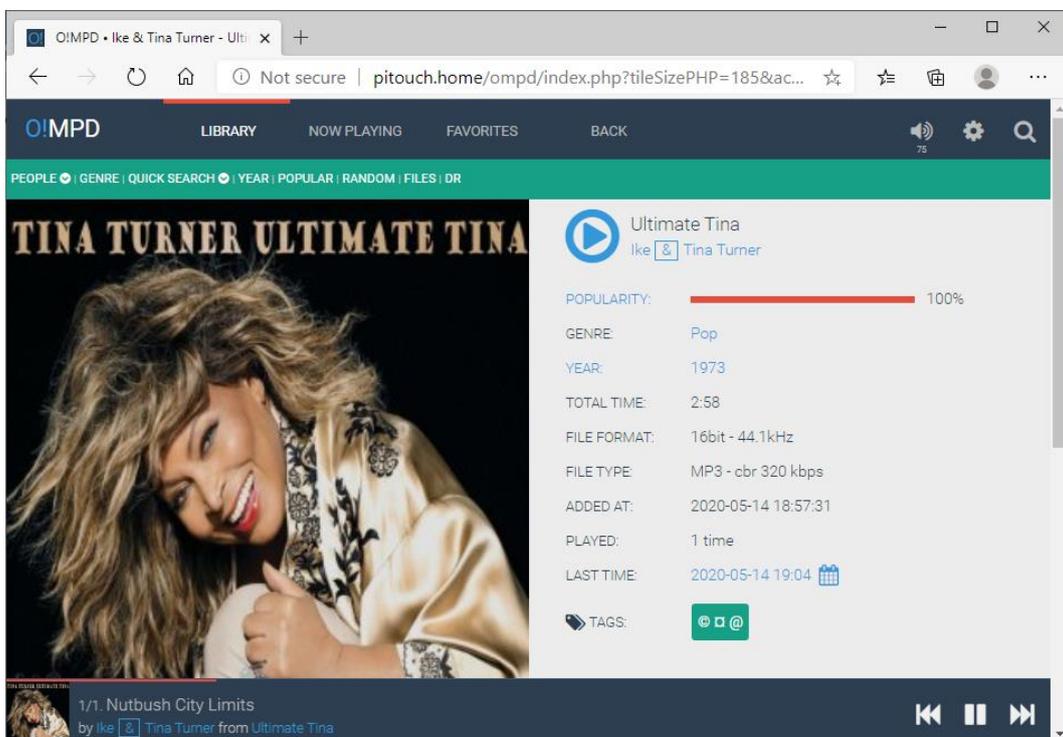
The media library will now be updated:



The Web interface will now display the contents of the media library.

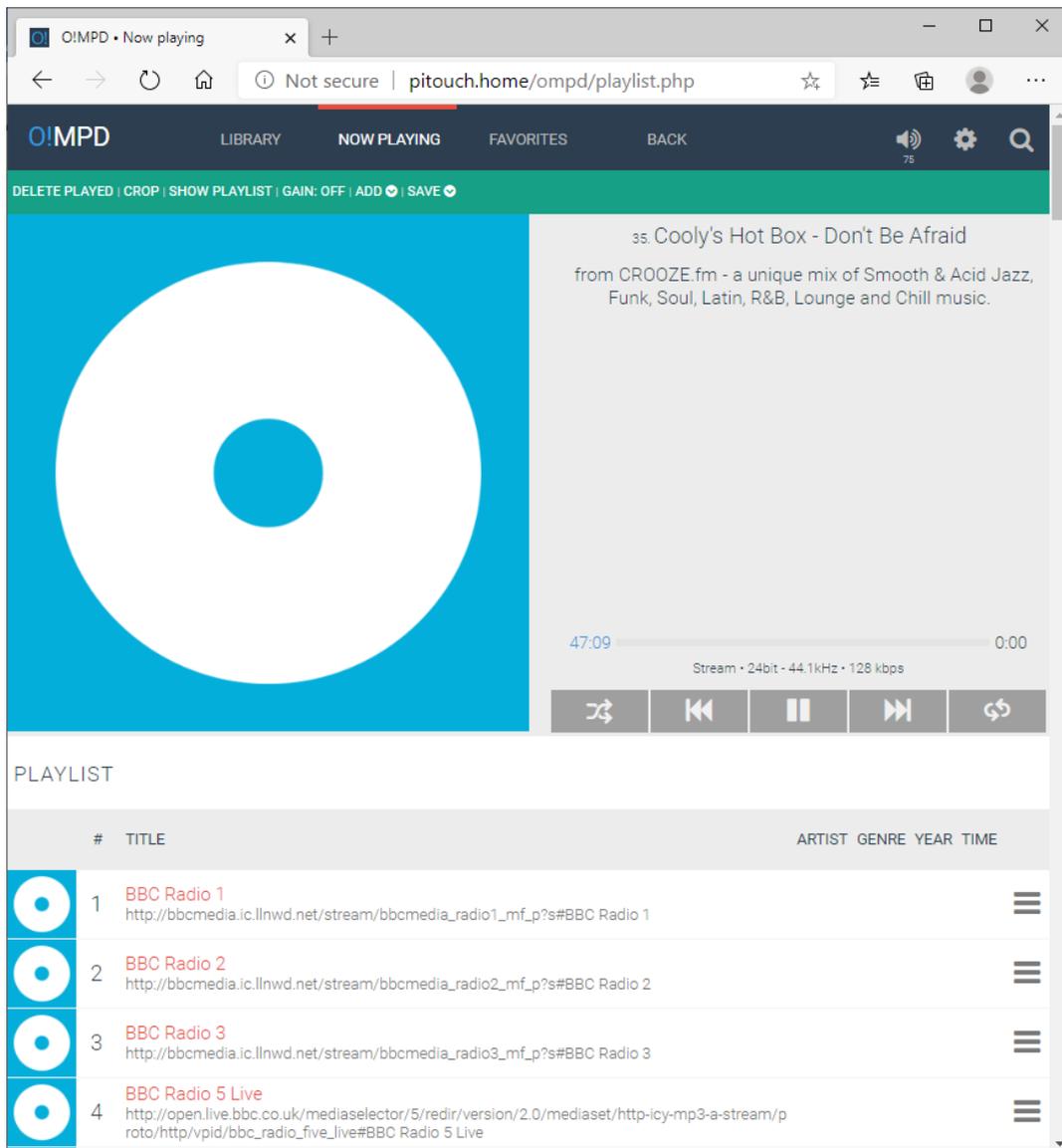


Clicking on one of the tracks will display its details along with the album artwork.



Clicking on the blue play icon will play the track.

To play a radio station click on the "NOW PLAYING" top menu item. Select the required radio station to start playing the stream.



Changing the Web Interface Radio photo

If you want to change the photo displayed by the Web interface on the first page, then replace the **jpeg** photo file at **/var/www/html/images/radio.jpg**. Try to adjust the size on disk to about 50K using a suitable photo editor such as Photo Shop. Copy the new jpeg photo to the pi home directory with any ftp program.

Now copy it to the Web pages image directory using **sudo**.

```
$ sudo cp radio.jpg /var/www/html/images/.
```

If the new image looks stretched then it may also be necessary to change image proportions in the `<img.>` statement in **/var/www/html/index.html** file. Find the following line in the index file and adjust the width/height values to display the photo with the correct proportions.

```
</td>
```

Upgrading the Music Player Daemon

The Raspberry Pi usually is installed with the **Raspberry Pi OS** (Formerly **Raspbian**) operating system. At the time of writing the latest version of **Raspbian** is called **Bookworm** which uses version **5.10.17** of the Linux kernel or later.



Note: The **MPD** version described in this procedure is **0.23.8** whilst the version released with Bookworm is **0.22.6** and is already fairly out-of-date. The version released with **Buster** is **0.21.5** which is even worse as it is years out of date. The latest version of MPD is much more stable. Due to their age, it is impossible to get support on the older versions of MPD.

There are two methods of updating MPD.

1. Download a ready-made Debian package **mpd_0.23.8_armhf.deb** (or latest version)
2. Download the latest MPD source, then compile and install it.

Installing the MPD upgrade from a Debian package

Two versions of the Raspberry Pi OS are supported in this tutorial.

- **Bookworm** – Install version **0.23.13** (mpd_0.23.13_armhf.deb)
- **Buster** – Install version **0.23.5** (mpd_0.23.5_armhf.deb)

Version **0.23.8** will not run on Buster as it requires the **libc67** library which is not available in **Buster**. If using **Buster** substitute all commands using **0.23.13** with **0.23.5**. For example:

```
$ wget https://bobrathbone.com/raspberrypi/packages/mpd_0.23.13_armhf.deb
```

For **Buster**:

```
$ wget https://bobrathbone.com/raspberrypi/packages/mpd_0.23.5_armhf.deb
```

The **mpd_0.23.13_armhf.deb** (or **mpd_0.23.5_armhf.deb**) upgrade package is currently available from the **package's** directory on the Bob Rathbone Web site. This is an upgrade; **mpd** and **mpc** as supplied with the OS must be installed first.

```
$ sudo apt install mpc
```

Answer yes 'y' when asked to continue.

Install the required libraries. Some of these may already be installed if using the desktop version. Execute all three lines below. Do not copy the \$ sign in the commands below.

```
$ sudo apt install libsidutils0 libresid-builder0c2a libcurl3-gnutls
$ sudo apt install libaudiofile1 libyajl2
$ sudo apt install libiso9660-11 libzip-0-13 libao4
```

Now install the **libadplug** library. There are two versions depending upon the OS version being used. **For Bullseye** and above (It may already be installed)

```
$ sudo apt install libadplug-2.3.3-0
```

```
$ wget https://bobrathbone.com/raspberrypi/packages/mpd_0.23.13_armhf.deb
```

For Buster

```
$ sudo apt install libadplug-2.2.1-0v5
```

Download the MPD update software.

```
$ wget https://bobrathbone.com/raspberrypi/packages/mpd_0.23.13_armhf.deb
```

Now install with **dpkg**.

```
$ sudo dpkg -i mpd_0.23.13_armhf.deb
```

Ignore the warnings for existing **/var/log/mpd** and **/var/lib/mpd** directories.

Reboot the Raspberry Pi to enable the new version.

```
$ sudo reboot
```



Note: For some unknown reason when **mpd.socket** is run from this package it changes the ownership of the **/var/run/mpd** directory from **mpd:audio** to **root:root** which causes **mpd.service** to fail with a permissions error. To correct this problem the following line has been added to **mpd.service** just before the **ExecStart** statement.

```
ExecStartPre=--/bin/chown mpd:audio /var/run/mpd
```

There is no need to add this line yourself as it is already added by the installation script. If the Radio/MPD service fails to start see the section called *Music Player Daemon won't start* on page 255.

Installing the latest MPC client

The **mpc_0.34_armhf.deb** upgrade package is currently available from the **packages** directory on the Bob Rathbone Web site. The latest version of **mpd** must be installed first as shown in the previous section.

Download the MPC software upgrade package.

```
$ wget https://bobrathbone.com/raspberrypi/packages/mpc_0.34_armhf.deb
```

Now install with **dpkg**.

```
$ sudo dpkg -i mpc_0.34_armhf.deb
```

Ignore the warnings for existing **/var/log/mpd** and **/var/lib/mpd** directories.

Reboot the Raspberry Pi.

Compiling and installing the latest Music Player Daemon

How to download and compile the latest version of Music Player daemon is described in the following document:

<https://bobrathbone.com/raspberrypi/documents/Compiling%20and%20installing%20MPD.pdf>

Installing the speech facility

It is possible to configure speech for visually impaired and blind persons who cannot read the display. As channels are changed or stepping through the menu the radio will “speak” to you. This excellent idea came from one of the project contributors, see *Acknowledgements* on page 351). This facility requires installation of the **espeak** package.

See [http://elinux.org/RPi_Text_to_Speech_\(Speech_Synthesis\)](http://elinux.org/RPi_Text_to_Speech_(Speech_Synthesis))

The speech facility makes use of the **/var/lib/radiod/language** file as already described in the section called *Creating a new language file* on page 185

Install the **espeak** package:

```
$ sudo apt install espeak
```

Enable the speech facility in **/etc/radiod.conf** and restart the radio.

```
# Speech for visually impaired or blind listeners, yes or no
speech=yes
```

The verbose setting speaks the station or track details every time it is changed. However, it can take a long time to move through the tracks or stations whilst speaking. Usually set this to no.

```
verbose=no
```

To get the right balance between speech volume and the normal radio volume adjust the **speech_volume** parameter percentage (10-100%)

```
speech_volume=30
```

Speak hostname and IP address when in the Information Menu.

```
speak_info=no
```

The **/var/lib/radiod/voice** file

The **/var/lib/radiod/voice** file contains the **espeak** command (or part of it).

```
$ espeak -ven+f2 -k5 -s130 -a
```

Where **-v** is the voice (en+f2 = English female voice 2), **-k** is capitals emphasis, **-s** is the voice speed and **-a** is amplitude (0-200), the **-a** parameter is filled in by the radio program.

Testing espeak

You can test **espeak** with the following command (Stop the radio first).

```
$ espeak -ven+f2 -k5 -s130 -a20 "Hello Bob" --stdout | aplay
```

To see the capabilities of **espeak** see the Web site <http://espeak.sourceforge.net/> or run:

```
$ espeak -h
```

If no sound is heard then then test using the **aplay** program. The **espeak** system will not work if **aplay** is not working. Test with **aplay** and a suitable wav file.

```
$ sudo mpc pause
$ $ aplay /usr/share/sounds/alsa/Noise.wav
```

Or if Scratch is installed

```
$ aplay /usr/share/scratch/Media/Sounds/Vocals/Singer2.wav
```

If still no sound check what devices are configured using **aplay**.

```
# aplay -l
**** List of PLAYBACK Hardware Devices ****
card 0: ALSA [bcm2835 ALSA], device 0: bcm2835 ALSA [bcm2835 ALSA]
  Subdevices: 8/8
    Subdevice #0: subdevice #0
    Subdevice #1: subdevice #1
    Subdevice #2: subdevice #2
    Subdevice #3: subdevice #3
    Subdevice #4: subdevice #4
    Subdevice #5: subdevice #5
    Subdevice #6: subdevice #6
    Subdevice #7: subdevice #7
card 0: ALSA [bcm2835 ALSA], device 1: bcm2835 ALSA [bcm2835 IEC958/HDMI]
  Subdevices: 1/1
    Subdevice #0: subdevice #0
card 1: Device [Generic USB Audio Device], device 0: USB Audio [USB Audio]
  Subdevices: 0/1
    Subdevice #0: subdevice #0
```

In the above example there are two devices namely *bcm2835 ALSA* (normal audio jack output) and *Generic USB Audio Device*. If using either a HiFiBerry DAC or IQaudio device then create the **/etc/asound.conf** file using nano:

```
$ sudo nano /etc/asound.conf
```

Add the following lines:

```
ctl.!default {
    type hw
    card 1
}

pcm.!default {
    type plug
```

```
slave {
    pcm "plughw:0,0"
    format S32_LE
}
```

The format S16_LE is an alternative format but does not work with HiFiBerry DAC. The above statements set up the default mixer and PCM sound device respectively to use card 1.

If using the USB (Card 2 device 1) then change the device definition in the above file.

```
pcm "plughw:1,0"
```

Retest with **aplay** (No need to reboot).



Note: This author does not provide support for **espeak**.

See: <https://sourceforge.net/p/espeak/discussion/> for general support issues.

Speech Operation

At the moment the speech function is highly experimental and will be developed further if there is the demand. The best use is with the remote control which includes a button for toggling sound on and off and another button to speak information about the station or track as well as speaking the time. These buttons are set up in the section called *Installing the Infra-Red sensor software* on page 145.

The Rotary encoder version of the radio is the best implemented. The MUTE switch is now the “Speak information” switch. To mute the radio, hold the button in for two seconds and release.

Suppressing an individual message

It is possible to suppress speech of an individual message by adding an exclamation mark (!) to the beginning of the message string in the language file. For example if you do not wish to hear the time when speaking information then change **the_time** parameter by adding an ! character to the beginning of the text to be spoken as shown in the example below:

```
the_time: !The time is
```

The exclamation message is removed if the message is displayed on a display. Only speech is affected.

Software maintenance

Apply patches to the radio software

DO NOT SKIP THIS SECTION.

Patches will be announced on Twitter at: https://twitter.com/bob_rathbone and should always be applied to the current software release.

Follow this Twitter feed for announcements about new patches. Patches can be viewed at http://www.bobrathbone.com/raspberrypi/pi_internet_radio.html

Patches take the form:

radiod-patch-<version>-<patch-number>.tar.gz

Where; <version> is the package version number, 7.6 in this case.

<patch-number> is the patch number from 1 onwards.

For example:

radiod-patch-7.6-1.tar.gz



Always check for the latest patches on the Web site. They will not be listed in this document.

To apply this patch (if it exists) run the following commands:

```
$ cd /usr/share/radio
$ wget http://www.bobrathbone.com/raspberrypi/packages/radiod-patch-7.6-1.tar.gz
$ tar -xvf radiod-patch-7.6-1.tar.gz
```

Modify the above command as necessary.

To see the details of the patch run the following command:

```
$ cat README.patch
```

Restart the radio software to activate the patches.



Any patch greater than 1 will also include all previous patches where relevant so it is not necessary to install previous patches. So for example patch 3 will include patches 1 and 2.



Do not apply any patches from a previous version of the software to the current version. This will most likely cause the current software to malfunction.

All relevant patches in a particular version will normally be included in the next version of the software.

Keeping the radio software up-to-date



The Radio software may be updated from time to time especially if a new version of the operating system is released or a new feature is added to the software. To keep up to date follow the author on Twitter at: https://twitter.com/bob_rathbone
(https://twitter.com/bob_rathbone)

Backing up the SD card

Having spent a lot of time and effort installing and configuring the Radio software it is a very good idea to create a backup of the SD card should it ever become corrupted. There are various ways of doing this. For backing up under Linux see:

<https://www.raspberrypi.org/documentation/linux/filesystem/backup.md>

One of the easiest ways of backing up the SD card on a Windows machine using Windows Disk Imager (Win32DiskImager) described in the following link.

<https://www.raspberrypi.org/forums/viewtopic.php?t=26463>

This allows you to create a copy of the SD card in an image (.img) file. This can then be compressed using **winzip/Zzip** or any other zip utility to reduce the space on disk.

Chapter 7 – Configuration

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Configuration basics

This section covers manual configuration of the radio. A number of programs are provided to help with configuration. These are:

1. **configure_radio.sh** – Configure the basic radio interfaces.
2. **configure_audio.sh** – Configure the audio output.
3. **set_mixer_id.sh** – Configure the Alsa mixer volume control ID (normally called by the radio program)

The above programs are found in the **/usr/share/radio** directory and are normally used to configure the radio and audio output. The following descriptions cover manual configuration and those configuration parameters not set by the above programs.

Configuring the HDMI or Touch Screen

In the **/etc/radiod.conf** file there is a section called [SCREEN] as shown below. This is the HDMI/Touch Screen default configuration.

```
# Graphics (touch screen) screen settings
[SCREEN]
# Size is in pixels. Supported is 800x480 (7" screen) or 720x480(3.5" screen)
# or 480x320 (2.8" or 3.5" screen) or 1024x600 (Maximum)
# Also see framebuffer_width and framebuffer_height parameters in /boot/config.txt
screen_size=800x480
fullscreen=yes

# Screen save time in minutes, 0 is no screen saver
screen_saver=0

# Title %V = version %H = hostname
window_title=Bob Rathbone Internet Radio Version %V - %H
window_color=turquoise
banner_color=white
labels_color=white
display_window_color=lightblue
display_window_labels_color=black
slider_color=darkgreen
display_mouse=yes

# Wallpaper backgrounds. See /usr/share/scratch/Media/Backgrounds
wallpaper=/usr/share/scratch/Media/Backgrounds/Nature/beach-malibu.jpg

# Set date format for graphic screen
dateformat=%H:%M:%S %A %e %B %Y

# Allow switching between vgradio and gradio
switch_programs=yes

# The following is specific to the vintage graphical radio
scale_labels_color=white
stations_per_page=40
display_date=yes
display_title=yes
```

Parameter	Explanation
fullscreen	Set to yes or no . If using a large HDMI monitor or TV set to no .
window_title	Title to display in the desktop window if fullscreen=no
window_color	Window background colour if wallpaper (See below) not specified.
banner_color	This is the colour of the time and date banner.
labels_color	This is the colour of the radio and MPD option labels.
display_window_color	This is the background colour of the station/track display window.
display_window_labels_color	Colour of the display window text.
slider_color	The color of the slider in the slider window next to the search window.

display_mouse	Future use – hide mouse yes/no .
wallpaper	Background wall paper. Any jpeg or gif file can be specified. See directory <code>=/usr/share/scratch/Media/Backgrounds</code> .
dateformat	The format for displaying the time and date banner.

The following settings are specific to the vintage graphical radio:

scale_labels_color	This sets the color of the station names on the tuning scale
stations_per_page	This is the maximum number of stations that will be displayed on each page.
display_date	Display the date at the top of the screen yes/no
display_title	Display the station title at the bottom of the screen yes/no



All parameters use the American spelling for color and not the British spelling.
The **wallpaper** parameter overrides the **window_color** parameter.

The parameters allow any theme to be configured for the HDMI or Touch Screen window.

Configuring GPIO outputs

Apart from changing the **down_switch** GPIO setting to be compatible with the **HiFiBerry DAC** it is not normally necessary to change the GPIO settings for the switches, rotary encoders or LCD display connections. The default settings match the wiring configuration shown in Table 4 on page 37.

Unless here is a need to change the GPIO configuration skip this section.

All switches, rotary encoders and LCD display settings are configurable in the `/etc/radiod.conf` file.



If the **GPIO** assignments are changed in the `/etc/radiod.conf` file then these must match the actual physical wiring for your radio project. The configuration in `/etc/radiod.conf` uses **GPIO** numbers and not physical pin numbers. For example, **menu_switch=17** is using **GPIO 17** (Physical pin 11).

Switches and rotary encoders GPIO assignments

The default switch settings including the rotary encoders are shown below. Normally there is no need to change these as they are set by the `configure_radio.sh` program.

```
# Switch settings for 40 pin version (support for IQaudIO)
menu_switch=17
mute_switch=4
up_switch=24
down_switch=23
left_switch=14
right_switch=15
```

Disabling button or rotary encoder GPIOs

It is possible to disable a button or rotary encoder GPIO configuration. For example, if you are building a radio with an amplifier with its own volume control you may not need the music player daemon volume control as well. In this case set these to 0 to disable them.

```
menu_switch=17
up_switch=24
down_switch=23
mute_switch=0
left_switch=0
right_switch=0
```

This will free the GPIOs originally configured for the volume control for other uses (4, 14 and 15 in this example).

LCD display GPIO assignments

The default LCD settings for a 40-pin Raspberry Pi are shown below. Again, there is no need to change these unless your wiring is different. Again, setting these to 0 disables the outputs. Again, the numbers below refer to **GPIO** number assignments and not physical pin numbers.

```
# LCD GPIO connections for 40 pin version of the radio
lcd_select=7
lcd_enable=8
lcd_data4=5
lcd_data5=6
lcd_data6=12
lcd_data7=13
```

Configuring button interface with pull up resistors

This applies to the radio with push buttons only. The original design of the radio wires the push buttons from low to high (GND 0V to 3.3V). It is now more usual to configure the buttons to operate from high to low (3.3V to GND 0V). This is the case for rotary encoders. It may be easier to wire up the buttons to GND 0V. In such a case it is necessary to configure the **pull_up_down** parameter in **/etc/radiod.conf** to 'up' as shown below.

```
# Pull GPIO up/down internal resistors (Applies button interface only).
# Default:down
pull_up_down=up
```

Configuring the remote control activity LED

It is useful to have an activity LED which flashes every time the remote control is pressed. How to wire the activity LED is shown on page 62. Which pins you connect to will depend on the type of radio you are building. Table 13 on page 62 shows the required LED connections. Boards such as the the **AdaFruit RGB plate** will need a 40-pin Raspberry Pi as all the first 26-pins are occupied but the plug in card.

Configure the LED in **/etc/radiod.conf** for to pin 11 GPIO 23 for all versions except AdaFruit plate or Vintage radio. For Adafruit RGB plate configure either **remote_led=0** (No LED) or GPIO 13 (pin 33). For the vintage radio use GPIO 23 (Pin 16). See the section called *Remote Control Activity LED* on page 62.

```
# Output LED for remote control, default GPIO 11 (pin 23) or
# GPIO 13 (pin 33) for AdaFruit plate
# remote_led=0 is no output LED
remote_led=11
```

Testing the remote control activity LED

It is possible to test the activity LED with the **irreventd.py** program.

```
$ cd /usr/share/radio/
$ ./irreventd.py flash
```

The activity LED should flash about six times. If not then check that the **remote_led** parameter in the **/etc/radiod.conf** configuration file is correctly set and that the activity LED is correctly wired (See LED wiring on page 62).

Specifying the action for exit/shutdown action

The radio can be exited by holding the menu button in for three seconds. The action depends upon the **exit_action** parameter. This is either set to **stop_radio** or **shutdown**.

```
# Action on exiting radio. Stop radio only or shutdown the system
# exit_action=stop_radio
exit_action=shutdown
```



From version 7.3 onwards the graphic versions of the radio have an exit/shutdown button (as shown on the left). The exit/shutdown button is displayed by default. This can be changed by changing it to no.

```
display_shutdown_button=no
```

If the exit button is enabled and clicked, the radio program will either exit to the operating system (handy during testing) or it will perform a system shutdown.

It is also possible to specify the shutdown command with the **shutdown_command** parameter in **/etc/radiod.conf**. The default command is shown below.

```
shutdown_command="sudo shutdown -h now"
```

This can be replaced with required command for example "x735off" for a X735 V2.5 shield. Put the command between apostrophes for example "x735off".

Changing the date format

The date is configured in the **/etc/radiod.conf** file using the **dateformat** parameter:

```
dateformat=%H:%M %d/%m/%Y
```

The default configuration is: **%H:%M %d/%m/%Y**

Where: %H = Hours, %M=Minutes, %d= Day of the month, %m=month, %Y=Year

It is possible to change the date format (for example for the United States) by changing the format. Some valid formats are:

%H:%M %m/%d/%Y	US format
%H:%M %d-%m-%Y	Minus sign as date separator
%d/%m/%Y %H:%M	Reverse date and time
%H:%M %m%d	Short date display for Olimex OLED

Seconds can also be displayed:

%H:%M:%S %d/%m/%Y	Display seconds (%S) on 20 character displays <u>only</u>
-------------------	---

Configuring the IQaudio Cosmic controller and OLED

The `configure_radio.sh` program can be used to set the configuration to use the 128 by 64 pixel OLED supplied with the Cosmic controller. This sets the `display_type` parameter to `OLED_128x64`.

```
display_type=OLED_128x64
```

When running with the Cosmic controller OLED screen there are two relevant settings in the `/etc/radiod.conf` file which are not set by the `configure_radio.sh` program.

The OLED display can be flipped vertically by setting the `flip_display_vertically` parameter to yes.

```
flip_display_vertically=yes
```

Note: If upgrading you will need to add this parameter to the `[RADIO]` section of the `/etc/radiod.conf` file.

The three LEDs on the Cosmic Controller board are driven by the `status_led_class.py` program. This class was originally written for the Vintage radio but is now also used with this board. Configure the following parameters in `/etc/radiod.conf` as shown below:

```
rgb_red=14
rgb_green=15
rgb_blue=16
```

The left LED means an ERROR, the middle LED means NORMAL operation and the right-most is BUSY.

If you want to switch off the status LEDs then set them to 0. However, GPIO 15 is switched on automatically at boot time. To switch it off add the following two lines to `/etc/rc.local`.

```
gpio -g mode 15 out
gpio -g write 15 0
```

Set the date format so that it displays fits the display.

```
dateformat=%H:%M %d%m
```

Configuring the Adafruit LCD backlight colours

Some Adafruit displays such as the **rgb-negative Adafruit LCD** allow changing the colour of the backlight. This is configurable in the `/etc/radiod.conf` file. The colours that can be used are RED, GREEN, BLUE, YELLOW, TEAL, VIOLET and WHITE or OFF (No backlight).

The colour settings in the `/etc/radiod.conf` file

```
# Background colours (If supported) See Adafruit RGB plate
# options OFF, RED, GREEN, BLUE, YELLOW, TEAL, VIOLET, WHITE
bg_color=WHITE
mute_color=VIOLET
shutdown_color=TEAL
error_color=RED
search_color=GREEN
info_color=BLUE
menu_color=YELLOW
```

```
source_color=TEAL
sleep_color=OFF
```



Note: Always use the American spelling ‘color’ in all commands and not the British spelling ‘colour’.

Configuring startup mode for Radio or Media player

The radio can be configured to start in **RADIO**, **MEDIA**, **LAST** modes or a **playlist** name. The default is **_Radio**. To change this, edit `/etc/radiod.conf` and change the `startup=_Radio` parameter to **RADIO**, **MEDIA** or **LAST** to start the radio with the last playlist used in the previous run. For example:

```
# Startup option either RADIO,MEDIA or LAST a playlist name
startup=MEDIA
#startup=Radio
```

Alternatively, the radio can be configured to load a specific playlist. To display the available playlists run the following command:

```
$ mpc lsplaylists
USB_Stick
UK_stations
Beatles
Radio
:
```

To configure the radio to start with a specific playlist change the `startup=` statement.

```
#startup=RADIO
startup=USB_Stick
```

If you configure `startup=RADIO` the program will load the first available Radio playlist. Likewise if you configure `startup=MEDIA` the program will load the first available Media playlist.

Configuring the volume display

The volume can be displayed as either text or as a series of blocks. This is configured in `/etc/radiod.conf` using the `volume_display` parameter. The default is text.

```
# Volume display text or blocks
volume_display=text
```

```
12:01 30/08/2017
WPJR Country
Lonestar - Mr. Mom
Volume 75
```

To display the volume as a series of blocks change this to ‘blocks’:

```
volume_display=blocks
```

```
12:01 30/08/2017
WPJR Country
Lonestar - Mr. Mom
```



If the timer or alarm functions are being used then the volume display reverts back to text display so as to allow display of the alarm or timer values.

Configuring the volume range

This setting affects the volume control sensitivity.

The MPD daemon has a volume range from 0 to 100. The volume is incremented or decremented by one each time the volume button is pressed or rotary encoder is turned a notch. This means a lot of turns of the knob or pushes of the button to change the volume the full range. Also, different devices are more sensitive than others.

For example, the Adafruit plate version allows very rapid change of the volume and the default range of 0 to 100 is not a problem. The rotary encoder version of the radio requires a lot of twisting of the volume knob to get from 0 to 100.

This **volume_range** parameter allows you to set the volume range to increase the sensitivity of the volume control as shown below. For example, if the volume range is set to 20 you will see the volume displayed from 0 to 20 however the MPD volume is incremented by 5.

Increment = 100 / Volume range. For example, $100/20 = 5$

So, if the volume displayed on the LCD is 10 and the range is 20, then the MPD volume is $10 \times 5 = 50\%$.

The volume range is configured in **/etc/radiod.conf** configuration file using the **volume_range** parameter:

```
# Volume range 10, 20, 25, 50 or 100
volume_range=20
```

Ideally you should choose a volume range number that divides into 100 equally as shown above however other values will work.

Configuring the MPD client timeout

When the radio program tries to connect to radio stream it will time out after so many seconds. In all previous versions this timeout was hard set to ten seconds. This is configurable from three to fifteen seconds using the **client_timeout** parameter in **/etc/radiod.conf**. The default is ten seconds.

```
# MPD client timeout from 2 to 15 seconds default 10
client_timeout=10
```

Changing the display language

The language file is stored in `/home/pi/radio/language` directory. This contains the text that will be either displayed or spoken. The default language is English. The `language.en` file is copied to `/var/lib/radiod/language`. The language file (if present) file is loaded during start-up of the radio. If not present the default English text is used.

The format of each entry in the language file is:

`<label>:<text>`

For example:

`select_source: Select source`

It is possible to display all the labels and text by running `language_class.py`.

```
$ cd /usr/share/radio
$ ./language_class.py
airplay: Airplay
alarm: Alarm
alarmhours: Alarm hours
alarmminutes: Alarm minutes
colour: Colour
consume: Consume
current_station: Current station
information: Information display
loading: Loading
loading_media: Loading media library
loading_radio: Loading radio stations
main_display: Main
media_library: Media library
menu_find: Find
menu_option: Menu option:
menu_search: Search
:
```

Creating a new language file

To create a new language file by running the `language_class.py` program and redirecting the output to a file called `language.<new>` where `<new>` is the country code. For example, to create a language file in Dutch, the country code is `nl`.

```
$ cd /usr/share/radio
$ sudo ./language_class.py > language/language.nl
```

Now edit the text (Not the labels) in the `language/language.nl` file. It isn't necessary to change every message. Lines beginning with `#` are for any comments.

```
# Nederlands text for uitspraak
main_display: Hoofd menu
search_menu: Zoek menu
select_source: Media selecteren
options_menu: Opties menu
rss_display: RSS beeld
information: Informatie beeld
the_time: De tijd is
loading_radio: Radio zenders laden
loading_media: Media laden
search: Zoek
source_radio: Internet Radio
```

```
source_media: Muziek selectie
sleeping: Slaapen
```

Finally copy the new language file to **/var/lib/radiod/language** (Omit the country code) and restart the radio.

```
$ sudo cp language/language.nl /var/lib/radiod/language
$ sudo systemctl restart radiod
```

Configuring Music Player Daemon CODECs

It is possible to configure the Music Player Daemon CODECs list in **/etc/radiod.conf**. There is a parameter called CODECS with the CODECs list between quotes.

```
# Codecs list for media playlist creation (Run 'mpd -V' to display others)
CODECS="mp3 ogg flac wav"
```

To see what CODECs are available in MPD run the following command.

```
$ mpd -V
```

A CODEC defines the method for encoding and decoding a digital stream. CODEC is a portmanteau of Coder-Decoder. See Wikipedia article <https://en.wikipedia.org/wiki/Codec> for more information on CODECS.

Configuring an RSS feed

To display an RSS feed it is necessary to create the **/var/lib/radiod/rss** file with a valid RSS URL. For example:

```
http://feeds.bbci.co.uk/news/uk/rss.xml?edition=int
```

The above is the RSS for the BBC news feed however any valid RSS feed may be used. If the **/var/lib/radiod/rss** is missing or contains an invalid RSS URL then this mode is skipped when stepping through the menu. The software comes with a valid BBC RSS feed file in the **/var/lib/radio/rss** file. You can test the feed first by pasting it into your PC's Web browser URL and pressing enter.

If configured, the RSS feed will be automatically displayed by stepping through the menus.

Configuration of the mute button action

When the mute button is pressed the volume is reduced to zero and the stream is either paused or stopped depending upon the setting of the **mute_action** parameter in **/etc/radiod.conf**.

```
# Action when muting MPD. Options: pause(Stream continues but not processed)
or stop(stream is stopped)
# mute_action=stop
mute_action=pause
```

pause – The radio stream continues to be downloaded but is not processed (default)

stop – The radio stream is stopped altogether.

Both have their own characteristics. When the radio is un-muted using the **stop** option it will play the old remaining stream in its buffer for about 30 seconds before jumping to the new live stream. It does have the advantage that no Internet bandwidth is being consumed.

The **pause** option continues to download the radio stream, but not processing it and consuming Internet bandwidth. When the radio starts playing again MPD simply starts processing the live stream again. There is no buffer to empty so no “jumping” to the new stream. The behaviour of pause and stop is controlled by the Music Player daemon over which the author has no control.

Configuring the Alsa Equalizer



Note: The author of the radio software does not currently have a configuration that is compatible with either **Pulseaudio** or **Bluetooth** audio. Devices. If you wish to use any of these then you cannot currently use the Alsa equalizer. This may change in a future release.

Install the Alsa plugin with **apt**:

```
$ sudo apt install -y libasound2-plugin-equal
```

Amend the “device” parameter in the **audio_output** block in **/etc/mpd.conf** configuration file.

```
audio_output {
    type          "alsa"
    name          "IQAudio DAC+"
    device        "plug:plugequal"
    mixer_type    "software"
}
```

In the above example we are using an IQaudio card but may be any sound card.

Save the existing **asound.conf** file just in case you need to restore the original file

```
$ sudo cp /etc/asound.conf /etc/asound.conf.save
```

Copy the **asound.conf.dist.equalizer** to **/etc/asound.conf**

```
$ cd /usr/share/radio/asound/
$ sudo cp asound.conf.dist.equalizer /etc/asound.conf
```

The new **/etc/asound.conf** file should look as shown below:

```
pcm.!default {
    type plug
    slave.pcm plugequal;
}
ctl.!default {
    type hw card 0
}
ctl.equal {
    type equal;
}
pcm.plugequal {
```

```
type equal;
slave.pcm "plughw:0,0";
}
pcm.equal {
type plug;
slave.pcm plugequal;
}
```

If your sound system is using card 1 (for example a USB audio device) then change the hardware settings in the above configuration to use card 1.

```
:
type hw card 1
:
slave.pcm "plughw:1,0";
```

It is also necessary to amend the card number in the **equalizer.cmd** file in the **/var/lib/radiod** directory

```
#!/bin/bash
# Change -c 0 to your alsa device number
lxterminal --command="/bin/bash -c 'sudo -H -u mpd alsamixer -c 1 -D equal'"
```

Reboot the Raspberry Pi.

```
$ sudo reboot
```

After reboot run the ALSA Equalizer as user **mpd**.

```
$ sudo -H -u mpd alsamixer -c 0 -D equal
```

If using card 1 change the **-c 0** parameter above to **-c 1**. The following screen will be displayed:

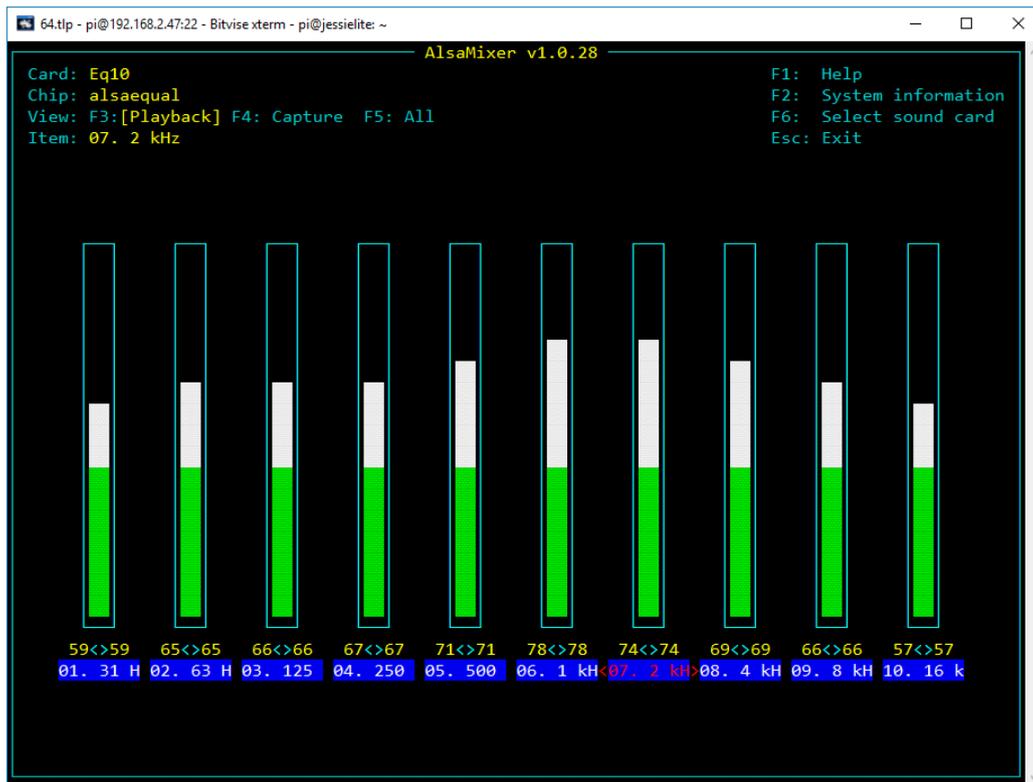


Figure 195 The Alsa

Use the Tab key to move along to the desired frequency to be changed. In this example, it is the <2KHz> block. Use the up and down arrows to adjust the level. The settings are saved in the `/var/lib/mpd/.alsaequal.bin` file. Changes to the sound should be heard.



Note: If you set a particular frequency value too high you will cause unpleasant distortion to the sound output.

Disabling the Alsa equalizer

Restore the original `asound.conf` file:

```
$ cd /usr/share/radio/asound/
$ sudo asound.conf /etc/asound.conf
```

Restore the original “device” parameter in the `audio_output` block in `/etc/mpd.conf` configuration file.

```
audio_output {
    type          "alsa"
    name          "IQAudio DAC+"
    device        "hw:0,0"
    #device       "plug:plugequal"
    mixer_type    "software"
}
```

Reboot the Raspberry Pi to restore the original sound configuration.

Configuration of the FLIRC USB dongle



Note: This configuration procedure is only for the HDMI or Touchscreen display of the radio. If using an LCD display see *Installing the Infra-Red sensor software* on page 145.

First of all, install the **FLIRC** software as shown in the section called *Installing the FLIRC USB remote control* on page 65.

Click on the left-hand program icon (A Raspberry) and select Accessories. In Accessories select **Flirc**. The following screen will be displayed. However, on a 7-inch touchscreen you may not be able to see the whole FLIRC window. In this case use the procedure called *Configuring FLIRC* from the command line on page 191. The first time you run this program it may ask you if you want to upgrade the firmware. Always upgrade the firmware:

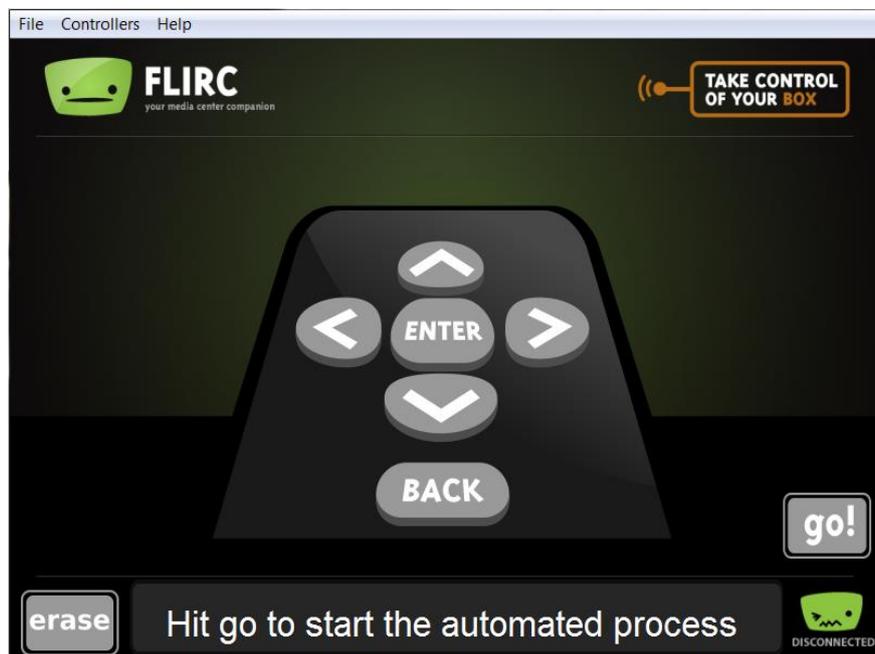


Figure 196 FLIRC setup program

On the **Controllers** drop down menu select the **Full Keyboard** controller.



Figure 197 FLIRC keyboard controller

Now map the buttons on the remote control to the keys shown in Table 22 Graphic screen keyboard command on page 210. For example, press the letter **m** on the above keyboard and then press the Mute button on the Remote Control. For volume control **up** press Shift key followed by the + key on the keyboard, then press the volume up button on the remote control. Do the same with the – key for volume down. Full instructions for configuring FLIRC are to be found at:

<https://flirc.gitbooks.io/flirc-instructions/>

Configuring FLIRC from the command line

If using a small touchscreen there may not be enough room to see the Flirc screen. If so, do the following:

- 1) Amend the **fullscreen=yes** parameter to **fullscreen=no** in **/etc/radiod.conf**
- 2) Reboot the Raspberry PI
- 3) When rebooted open a terminal session on the desktop (Don't use remote SSH).
- 4) In the terminal window on the command line run the following:

```
$ flirc_util format
```

Now record the buttons:

```
$ flirc_util record up  
Press any button on the remote to link it with '+'
```

'up' is the name of the key. Now press the Channel Up key. The following will be displayed:

```
Successfully recorded button.
```

Repeat the command for each key name.

They are:

```
pageup, pagedown,  
+, -,  
left, right,  
up, down,  
return,  
l (small letter L), p, a,  
r, t, c, s, m and d.
```

In the case of the + and – keys press shift first, followed by the + or – key.

Test and if necessary, repeat key-mapping. If configuring on an HDMI Television do not configure volume (+-) or mute (m) keys as the TV will provide these functions.

The configured keys can be displayed with the `flirc_util keys` command, however this command may be missing from the latest version of `flirc_util`.

```
$ flirc_util keys

Recorded Keys:
Index  hash          key
-----  -
  0    7D14E297      down
  1    ED385097      up
  2    58C86297      right
  3    41787497      left
  4    BF8F6297      return
  5    AB616762      r
  6    2676D097      t
  7    B6536297      c
  8    9206E297      s
  9    590C3E97      l
 10    E8E8D097      p
 11    C49C5097      a
 12    F1EFD097      e
 13    B9F03963      escape
 14    D1F15097      pageup
 15    53DA6297      pagedown
 16    9F5BE297      escape
 17    A8DDF497      left_ctrl Q
 18    66FFBE97      d
```

Saving the configuration:

```
flirc_util saveconfig my_flirc_config

Saving Configuration File 'my_flirc_config.fcfg' to Disk
[=====>] 100%

Configuration File saved
```

There is also a `loadconfig` command.

What if a key does not work after configuring it.

First delete the key by its index. In this example the key d (Display Window) command isn't working.

```
$ flirc_util delete_index 18
```

Re-record the key

```
$ flirc_util record d
Press any button on the remote to link it with '+'
Successfully recorded button.
```

Re-test and repeat until a reliable 'hash' is received from the remote control.
If a key is multiply defined delete the first one you see by its index.

```
13 B9F03963 escape
14 D1F15097 pageup
15 53DA6297 pagedown
16 9F5BE297 escape
```

```
$ flirc_util delete_index 13
```

Re-test and if necessary, re-record.

There is a help facility for the flirc_utility.

```
$ flirc_util help
```

Configuring the display scroll speed

This option applies to LCDs only. It does not apply to PiFace CAD, touch screens or OLED devices.

The parameter **scroll_speed** in **/etc/radiod.conf** can be changed to speed up or slow down the scroll speed of longer display lines. The **scroll_speed** parameter is actually the inter-character delay in seconds. The smaller the value the faster the display scrolls.

The human eye can only discern 10 to 12 images a second limiting the lower range to approximately 0.08 seconds. The optimum speed is 0.2 to 0.3 seconds.

```
# Display Scroll speed 0.08 to 0.6 seconds
scroll_speed = 0.2
```

It is only possible to set the scroll speed between 0.08 and 0.6 seconds.
It may be necessary to adjust the contrast top get a good scrolling display.

Configuring Russian/Cyrillic text

The radio program can display the Russian language either in **Cyrillic** or **Romanized** (convert to Latin) characters. For example, **Радио Пятница** when Romanized becomes **Radio Pyatnica**.

First purchase a character LCD/OLED with a Russian/Cyrillic character ROM. These devices also will display English characters.

To display Russian/Cyrillic text Romanized it is not necessary to change the configuration as this is the default. To display Russian/Cyrillic change the following parameters in **/etc/radiod.conf**.

Change the language to Russian

```
language=Russian
```

Switch off Romanization

```
romanize=off
```

Unless using a HD44780U compatible controller leave the controller setting as it is

```
controller=HD44780U
```

If using an older LCD with an HD44780 (No U at the end) controller set it to HD44780

```
controller=HD44780
```

Leave the codepage setting as 0. This will pick up the correct code page from the language translation file in the **/usr/share/radio/codes** directory.

```
codepage=0
```



The **translate_lcd** parameter must also be set to **on** for Romanization or Cyrillic translation routines to work. Translation is disabled if using an OLED as OLEDs use system fonts.

Configuring European languages

First purchase a character LCD/OLED with a Western European character ROM. These devices also will display English characters. To display Western European text Romanized it is not necessary to change the configuration as this is the default. Any LCD/character OLED can be used for this.

Change the language to European and carry out the same instructions, except for language, as shown in *Configuring Russian/Cyrillic text* on page 193.

```
language=European
```

There is a detailed explanation of LCD code pages and program settings in Appendix B.5 *Cyrillic/European character LCDs/OLEDs* on page 372.

Configuring the Internet Check URL and port

Version 7.0 onwards now regularly checks to see if there is an Internet connection when playing radio streams. It is disabled when playing a USB stick or share which do not require an Internet connection.

This feature it is checking to see if there is a connection to a reliable URL and port number across the Internet which can be contacted such as **google.com** on port number 80 (HTTP). There is a distinction between a network connection and an Internet connection. A network connection is local such as Wi-Fi or a wired network switch. An Internet connection is to a network provider via an Internet router which gives access to Internet resources, in this case, radio streams.

Without it, if the radio fails to load a radio stream because it has no network interruption it attempts to switch to another stream but this is pointless if there is no Internet connection.

This is configured in **/etc/radiod.conf**.

```
internet_check_url=google.com
internet_check_port=80
```

If Google ever change the **internet_check_url** a new one can be configured.

This feature can be disabled by removing the URL in the configuration

```
internet_check_url=
```

Configuring MPD interface

The Music Daemon listens on port 6600, and this has not changed since the introduction of the Raspbian OS (Now RaspberryPi OS) in 2013. There is therefore no need change it unless the port setting in **/etc/mpd.conf** changes (port "6600").

```
mpdport=6600
```

Configuring the remote-control parameters

The remote-control software has three parameters in **/etc/radiod.conf**:

The first parameter is for the remote control UDP server listen host, either 0.0.0.0 (All interfaces) or localhost.

The second parameter is the remote control communication port Default localhost 5100.

```
remote_control_host=localhost
remote_control_port=5100
remote_led=11
```

For information about the remote indicator LED see *Table 13 Remote Control Activity LED* on page 62.

Configuring the radio software UDP server listening port

This allows another host to send UDP messages to the **radiod** UDP server (not the remote control **irreventd** daemon). It is either 'localhost' or the IP address of the remote **radiod** server.

```
remote_listen_host=localhost
```

You should normally never need to change this from the default **localhost**. This parameter is only intended for any new software used to controll the radio from another host using the commands shown in *Table 30 UDP messages* on page 371. For example:

```
Remote UDP-Client → UDP network → Radio software UDP-receiver
(IP 192.168.1.66)   Commands      (192.168.1.203)
```

```
remote_listen_host=192.168.1.203
```

The remote client would send commands such as 'KEY_VOLUMEUP', 'KEY_CHANNELDOWN' etc. as shown in Table 30 to the **radiod** daemon running on host IP 192.168.1.203 (example).

Configure the I2C bus number

```
i2c_bus=1
```

This only needs to be changed to '0' for the original Model A raspberry Pi's

Configuring character LCD lines and width.

Display width, 0 use program default. Usual settings 16 or 20. Lines are normally 2 or 4.

```
display_width=20  
display_lines=4
```

These parameters are normally set by the **configure_radio.sh** program. However, there may be cases where you might want to change these. They do not affect OLED displays.

Configuring Rotary Encoders

Rotary encoders are configured by the **configure_radio.sh** script.

The settings for the **rotary_class** parameter are **standard**, **alternative**, **rgb_rotary** or **rgb_i2c_rotary**. Some rotary switches do not work well with the standard rotary class so set to "alternative" to use the alternative rotary encoder class.

For rotary encoders with RGB LEDs in the shaft set to **rgb_rotary**

For rotary I2C encoders with RGB LEDs in the shaft set to **rgb_i2c_rotary**

```
rotary_class=standard
```

KY-040 encoders etc have their own physical 10K pull-up resistors and do not need the internal GPIO pull-up resistors so the **rotary_gpio_pullup** parameter is set to **rotary_gpio_pullup=none** otherwise set to "up".

```
rotary_gpio_pullup=up
```

The **rgb_rotary** or **rgb_i2c_rotary** settings use I2C and RGB Led settings and should be left to the **configure_radio.sh** script to configure.

Configuring the Menu rotary switch

These settings are not used in the standard RPi Internet Radio and can be ignored for this project. They were used in the Vintage Internet radio supplement to select the menu but are more or less redundant with only a few radios using it.

```
# Menu rotary switch (optional) Normal values are 24,8 and 7 respectively.  
Value 0 disables  
menu_switch_value_1=0  
menu_switch_value_2=0
```

```
menu_switch_value_4=0
```

See <http://bobrathbone.com/raspberrypi/documents/Raspberry%20PI%20Vintage%20Radio.pdf> for more information.

Configuring soft volume (SoftVol)

Some less expensive DACs do not have any controls such as volume. This can be seen by running the **alsamixer** program. It displays the following:

This sound device does not have any controls

Being able to control the volume via the mixer controls is needed for volume control of **Airplay** and **Spotify**. However, it is possible to enable a “soft” volume control (SoftVol). First copy the distribution **softvol asound** definition file to **/etc/asound.conf**.

```
$ cp /usr/share/radio/asound.conf.dist.softvol /etc/asound.conf
```

The **/etc/asound.conf** configuration file should look like the following:

```
# Software volume control for card 0
pcm.softvol {
    type                softvol
    slave.pcm           "plughw:0,0"
    control {
        name            "PCM"
        card            0
    }
}

pcm.!default {
    type                plug
    slave.pcm           "softvol"
}
```

Edit **/etc/mpd.conf** file to enable the softvol plugin in and DAC.

```
audio_output {
    type                "alsa"
    name                "My DAC"
    device              "plug:softvol"
    mixer_type          "software"
    mixer_control       "DAC"
    # mixer_device      "default" # optional
    # mixer_index       "0"      # optional
}
```

Note: “Name” can be anything and doesn’t affect the configuration.

The **alsamixer** program should now display the volume control and should allow the volume to be changed via the mixer control.

Chapter 8 – Operation

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Operation of LCD and OLED versions

This section assumes that the LCD screen is working correctly, the MPD daemon is installed and tested and that there is an Internet connection available. This section is for LCD versions only. For graphical radios see *Operation of HDMI and touch screen displays* on page 203.

Starting and stopping the LCD and OLED programs

The program must either be run as root user or using `sudo`.

The basic operation of the program is:

```
$ sudo service radiod start|stop|restart|status|info|version
```

Where `start`: Start the radio program.
`stop`: Stop the radio program.
`restart`: Restart the radio program.
`status`: Show the status of the radio daemon.
`info`: Show program information
`version`: Show the version number of the program

To start the radio:

```
$ sudo systemctl start radiod
```

To stop the radio:

```
$ sudo systemctl start radiod
```

The following System V commands will also work:

```
$ sudo service radiod start  
$ sudo service radiod stop
```

To display the status either use the program directly or use the **`sudo service radiod status`** command:

```
$ sudo service radiod status  
● radiod.service - Radio daemon  
  Loaded: loaded (/lib/systemd/system/radiod.service; enabled; vendor  
  preset: enabled)  
  Active: active (running) since Wed 2017-11-08 10:06:19 CET; 3h 55min ago  
  Main PID: 1619 (python)  
  CGroup: /system.slice/radiod.service  
          └─1619 python /usr/share/radio/radiod.py nodaemon  
:  
{The last relevant log entries will be displayed here}
```

To see what version of the software you are running:

```
$ sudo /usr/share/radio/radiod.py version
Version 7.6
```

To display information about the running program:

```
$ systemctl status radiod
● radiod.service - Radio daemon
  Loaded: loaded (/lib/systemd/system/radiod.service; enabled; vendor
  preset: enabled)
  Active: active (running) since Wed 2020-09-30 12:03:00 BST; 47min ago
  Main PID: 1560 (python)
    Tasks: 3 (limit: 2068)
   CGroup: /system.slice/radiod.service
           └─1560 python /usr/share/radio/radiod.py nodaemon
```

The above shows the process ID of the radio, the Music Player Daemon version and operating system details.

Push buttons or Rotary encoders operations

In the following sections there may be an instruction such as “Press left button”.

If you are using rotary encoders then the following applies:

Rotary-encoder clockwise = button right

Rotary-encoder anti-clockwise = button left

Rest of page deliberately left blank

Radios with push buttons operation

The original radio has five buttons, four function buttons and one menu button. However, the new design can also support a sixth button which is the mute button. The Menu button changes the display mode and the functions of the left and right-hand buttons as shown in the following table. If using rotary encoders please see Table 21 on page 202.

Table 20 Push Button Operation

LCD Display Mode	Volume buttons		Channel buttons	
	Right button	Left button	Up button	Down button
Mode = TIME Line 1: Time Line 2: Station or Track	Volume Up	Volume Down	Station/Track up	Station/Track down
Mode = SEARCH If source = RADIO Line 1: Search: Line2: Radio Station	Volume Up	Volume Down	Scroll up radio station	Scroll down radio station
Mode = SEARCH If source = MEDIA Line 1: Search Line2: MusicTrack/Artist	Scroll up through artists	Scroll down through artists	Scroll up through track	Scroll down through track
Mode = SOURCE Line 1: Input Source: Line2: Radio or Media playlist or Airplay	Volume Up Mute	Volume Down Mute	Cycle up through Airplay, Radio and Media playlists	Cycle down through Airplay, Radio and Media playlists
Mode = OPTIONS Line 1: Menu Selection Line 2: <option> Options are Random, Consume, Repeat, Reload Music, Timer, Alarm ,Alarm Time Set (Hours), Alarm Set (Minutes), Streaming:	Toggle selected mode on or off. Set timer and Alarm	Toggle selected mode on or off. Set timer and Alarm	Cycle through Random, Consume, Repeat, Reload Music, Timer, Alarm , Alarm Time Set and Streaming	Cycle through Random, Consume, Repeat, Reload Music, Timer, Alarm Time Set and Streaming:
Mode = RSS (1) Line 1: Time Line 2: RSS feed	Volume Up Mute	Volume Down Mute	Station/Track up	Station/Track down
MODE = IP address Line 1: IP address Line 2: Station or Track	Volume Up Mute	Volume Down Mute	Scroll up through track or radio station	Scroll down through track or radio station



Note: If the `/var/lib/radiod/rss` file is missing then the RSS mode is skipped. If it contains an invalid RSS URL, this will be displayed on the LCD.

Radios with rotary encoders operation

This option is for a radio with rotary encoders with push buttons. The volume knob when pushed in is the **Mute** sound function. Likewise, the tuner knob when pushed in is the **Menu** switch. The Menu button changes the display mode as shown in the following table.

Table 21 Rotary Encoder Knob Operation

	Volume knob		Tuner knob	
LCD Display Mode	Clockwise	Anti-clockwise	Clockwise	Anti-clockwise
Mode = TIME Line 1: Time Line 2: Station or Track	Volume Up	Volume Down	Station/Track up	Station/Track down
Mode = SEARCH If source = RADIO Line 1: Search: Line2: Radio Station	Volume Up	Volume Down	Scroll up radio station	Scroll down radio station
Mode = SEARCH If source = MUSIC LIBRARY Line 1: Search Line2: MusicTrack/Artist	Scroll up through artists	Scroll down through artists	Scroll up through track	Scroll down through track
Mode = SOURCE Line 1: Input Source: Line2: Radio, Media playlist, Spotify or Airplay	Volume Up Mute	Volume Down Mute	Cycle up through Airplay, Radio and Media playlists	Cycle down through Airplay, Radio and Media playlists
Mode = OPTIONS Line 1: Menu Selection Line 2: <option> Options are Random, Consume, Repeat, Reload Music, Timer, Alarm and Alarm Time(Hours), Alarm Time(Minutes) set and Change colour(1), Streaming on/off.	Toggle selected mode on or off. Set timer and Alarm	Toggle selected mode on or off. Set timer and Alarm	Cycle through Random, Consume, Repeat, Reload Music, Timer, Alarm Time Set, Streaming and Background colour(1)	Cycle through Random, Consume, Repeat, Reload Music, Timer, Alarm , Alarm Time Set, Streaming and Background colour(1)
Mode = RSS (2) Line 1: Time Line 2: RSS feed	Volume Up	Volume Down	Station/Track up	Station/Track down
MODE = IP address Line 1: IP address Line 2: Station or Track	Volume Up	Volume Down	Scroll up through track or radio station	Scroll down through track or radio station



Note 1: The colour change option is only available for the AdaFruit RGB plate (ada_radio.py). Note 2: If the `/var/lib/radiod/rss` file is missing or contains an invalid RSS URL then the RSS mode is skipped.

Mute function

Pressing both volume buttons together or in the case of a rotary encoder with a push button (Volume) will mute the radio. If voice is enabled then then operation is slightly different (See section on espeak). Press either the volume up or down switch to un-mute the radio. If you change channel or use the menu switch the radio will also be un-muted. If the alarm is set then the radio will go into sleep mode.

Operation of HDMI and touch screen displays

The graphical screen

The HDMI and Touch Screen versions of the program can be started in three separate ways.

1. Automatically when starting the desktop
2. By clicking on the radio icon on the desktop
3. By manually starting the program from the command line (From a xterminal)

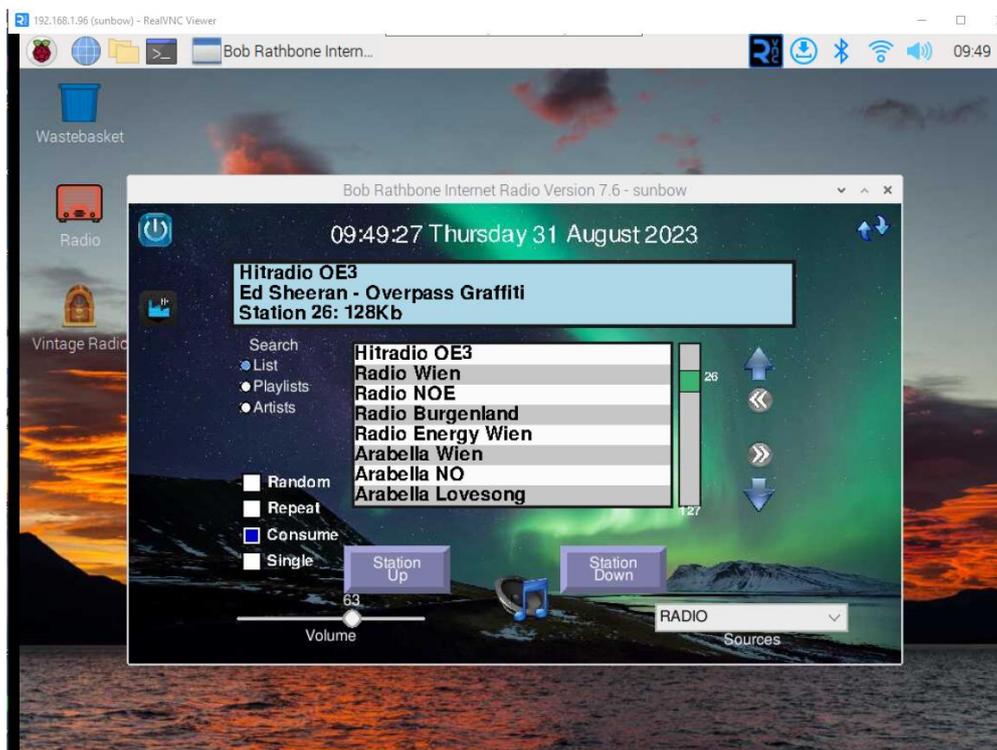
To start the radio from command line run the gradio.py program:

```
$ cd /usr/share/radio
$ sudo ./gradio.py &
```

Starting the radio from the desktop. Click the icon shown here on the desktop.



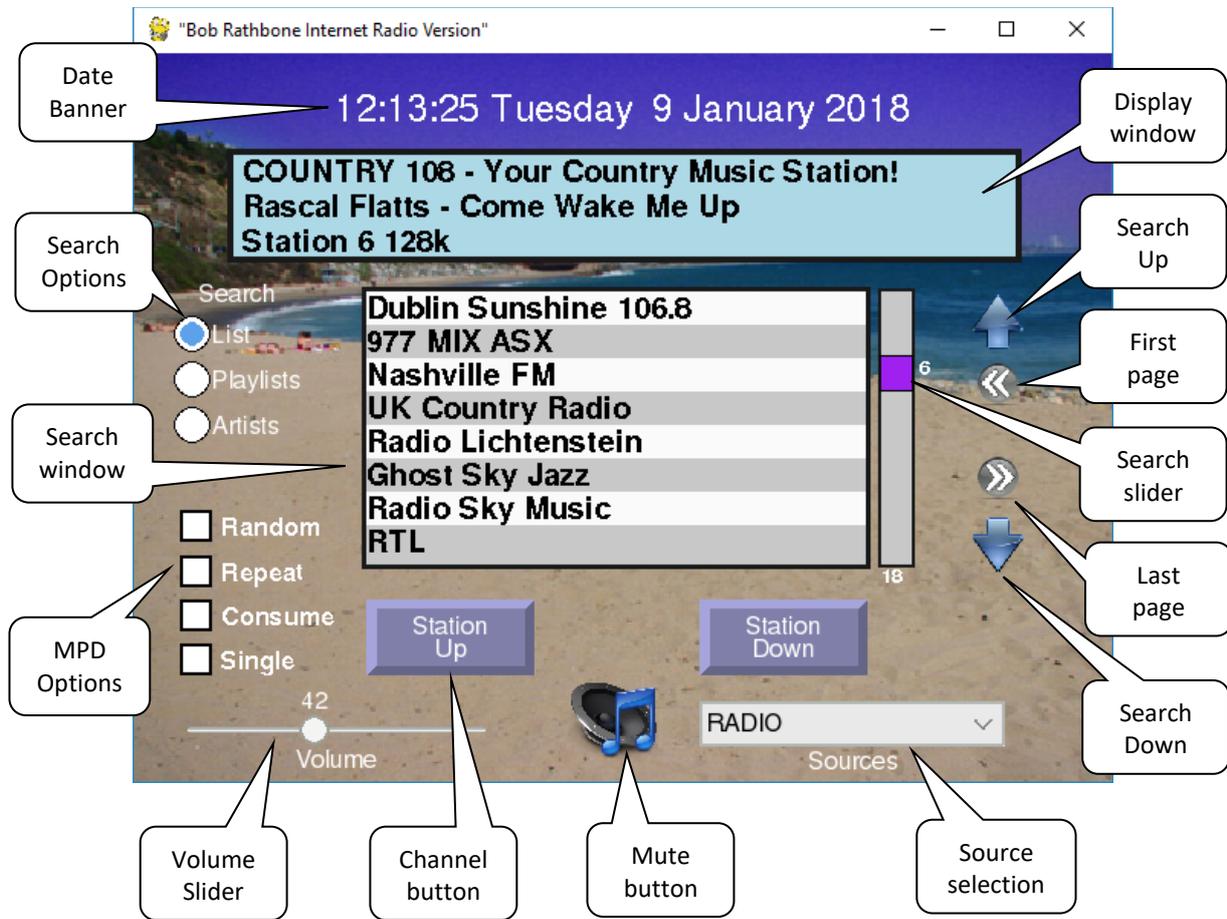
Normally you will need a HDMI monitor or TV with HDMI input and a mouse to operate the graphical radio programs as these programs run on the Raspberry Pi Desktop. However, it is possible to run the RPi desktop on a PC or MAC computer using **VNC** as shown below:



See *Accessing the Raspberry Pi from a PC or MAC using VNC* on page 343 in *Chapter 16 Advanced topics* for more information on VNC.

In all cases a screen similar to the following will be displayed. In this example **fullscreen=no**.

Figure 198 HDMI and Touch Screen Display



Clicking the mouse on a control such as station Up/Down or touching it do the same thing. In the following description we will only refer to "clicking". By this, also touching a control is also meant.

The display window

The display window normally displays the Radio station or Media rack that is currently playing. Clicking in the display window changes the third line to display the RSS feed if configured. A second click in the same window displays version details, IP address and hostname.

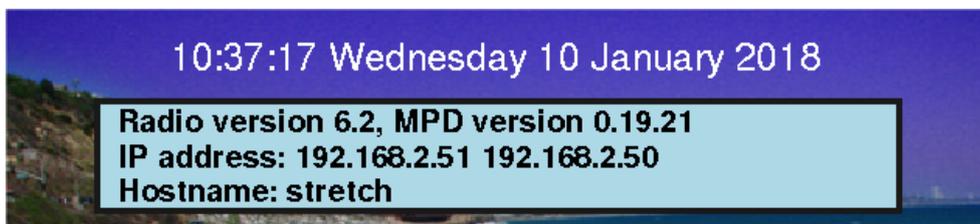


Figure 199 Graphical scree information display

In this example the hostname is 'stretch'. The version number will be different for later releases. Two IP addresses are displayed (Wireless and Ethernet).

The search window

The search window normally displays the contents of the currently selected playlist.



Figure 200 Graphical radio search window

Click on a station in the list selects it. Clicking in the slider window or dragging the slider re-positions the list. The current position, 16 in this example, is displayed next to the slider. The length of the current playlist, 28 for this playlist, is displayed at the bottom of the slider window.

Clicking on the Up and Down arrows travels up and down the list. Clicking on the left double arrow goes to the first page in the list. Clicking on the right double arrow goes to the last page in the list.



Figure 201 Graphical radio search functions

Clicking on the Playlists radio button selects the available playlists. This shows the playlists for radio or media such as the USB stick or Network share. It also shows 'airplay' which is not really a playlist but is a source, but can be selected here. Click on the desired playlist in the search window.



Figure 202 Display playlists

In the following example the USB stick playlist was selected. Once a playlist selected the list is displayed.

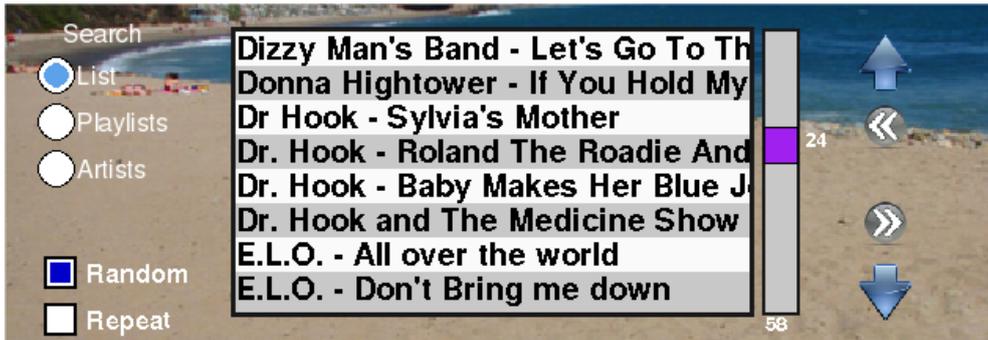


Figure 203 Display of media tracks

Clicking the Artists radio button displays the list of artists in the search window. Once clicked the search window positions on the first song of that artist's tracks.



Figure 204 Displaying artists

Note that if you click on the 'Artists' radio button when displaying Radio stations, it will always be forced back to the 'List' display as Artist selection is not relevant for Radio stations.

Smaller TFT screens

Screens with a resolution equal to or less than 420 x 320 pixels will display slightly different than previously shown. Only one line will be displayed in the search window. There are no options for Random, Repeat or Consume due to lack of space.



The search list type (Playlist, Station/Track list or Artist) is cycled through by clicking on the Search list type button. All other controls work the same as shown in Figure 198 on page 204.

Artwork display

If the music track has artwork and the **ffmpeg** (See *Setting up the locale* on page 95) package has been installed then the artwork will be displayed. Clicking on any of the radio search buttons will re-display the search window. The artwork cannot be displayed until the track is re-selected.

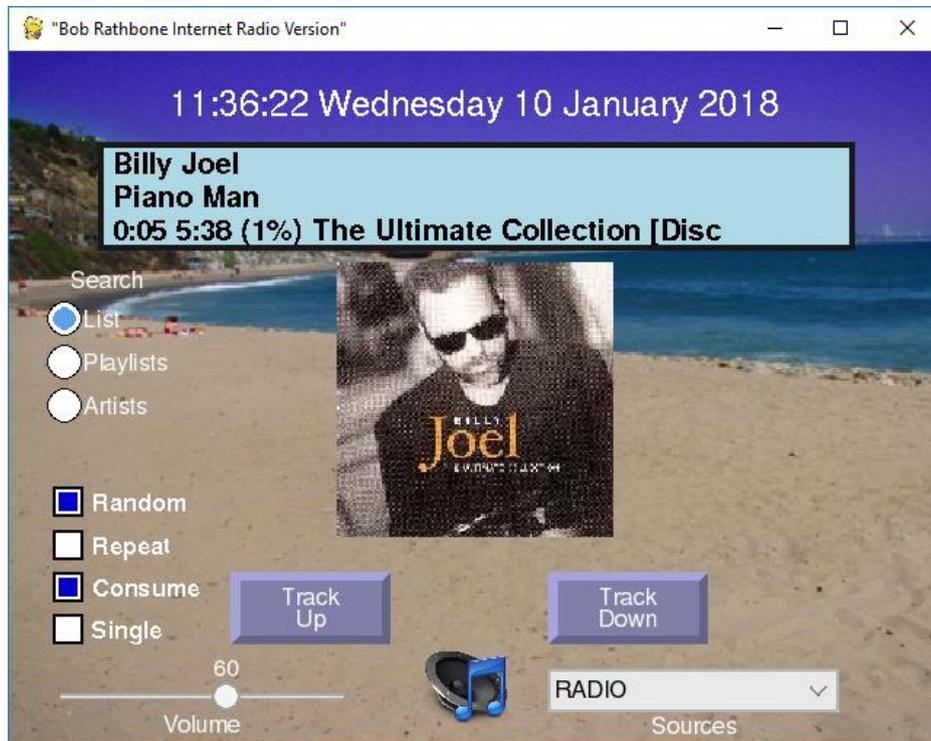


Figure 205 Track artwork display

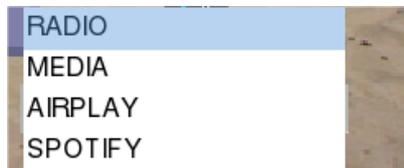
Note that the two grey push buttons now display 'Track Up/Down' instead of 'Station Up/Down'.

Volume and Mute controls



The volume is controlled by a slider at the bottom left of the window. Clicking on the loud-speaker at the bottom of the screen mutes the sound and displays the mute icon as shown on the left. Any volume control change un-mutes the radio.

Source selection



Click on the down arrow on the right of the Source selection to select the Source namely Radio, Media, Airplay or Spotify. The radio will select the first playlist in that source. Re-selecting the same source will select the next playlist for that Source.

Other graphic window controls

Music Player Daemon(MPD) options Random, Repeat, Consume and Single are selected using the square push buttons on the bottom left of the window. Only the Random option is stored for the next time.

Running Airplay on the HDMI touchscreen

Airplay must first of all be installed on the Raspberry Pi. See *Airplay Installation* on page 302 for instructions how to do this. To select Airplay either select it from the Sources drop-down box or from the playlists in the search window.

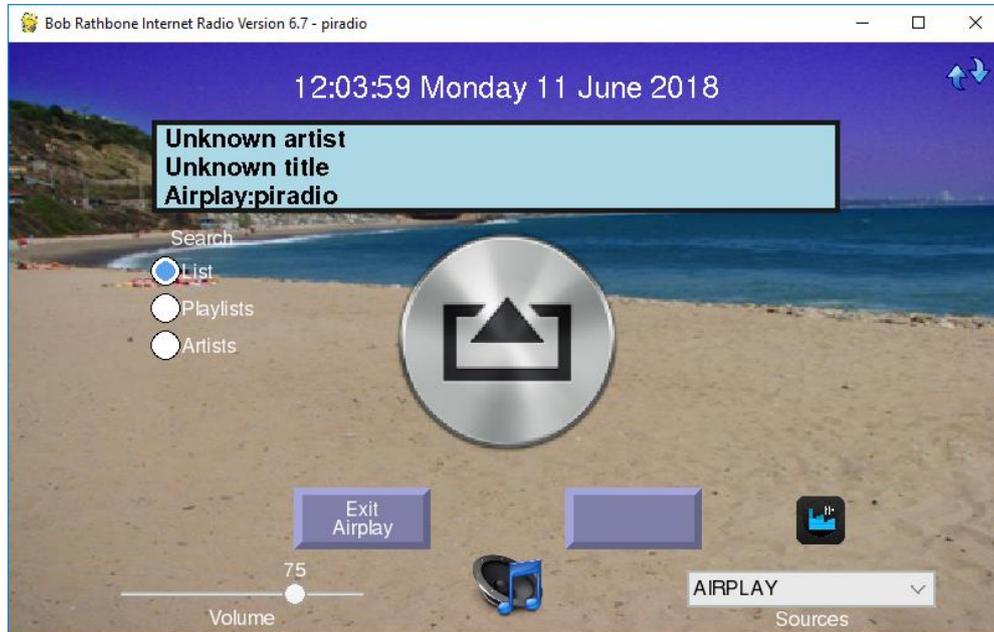


Figure 206 Airplay running on a Graphical screen

Connect to the Raspberry Pi from an Airplay compatible mobile device or run an App such as **CloudBreak**. The hostname to connect to is displayed when Airplay is first opened in the Display Window as shown below:

```
Unknown artist
Unknown title
Airplay:piradio
```

In this case the hostname is 'piradio'. To exit Airplay, press the left button at the bottom of the screen. The other button on the right has no label and doesn't do anything in Airplay mode.

Changing the graphical radio theme

The colour scheme and background are largely configurable in the [SCREEN] section of the `/etc/radiod.conf` configuration file. Button colours cannot be configured.

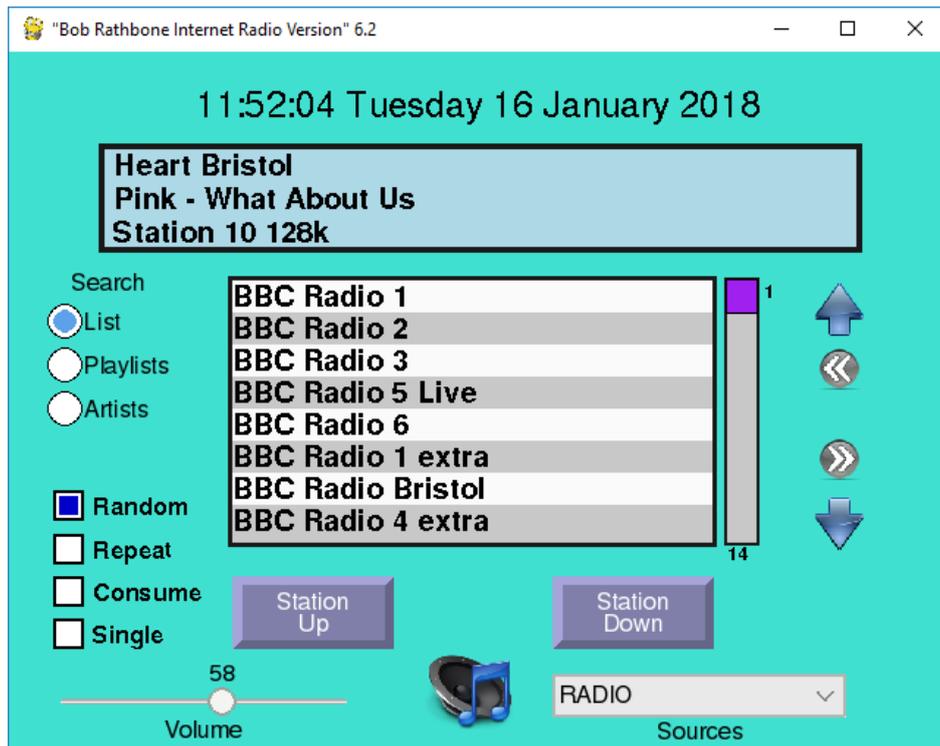


Figure 207 Changing the graphical screen theme

One good personalisation is to use your own favourite holiday picture as the background.

```
wallpaper=<path to your photograph>
```

Window and label colours can be changed to your own preferences. In the above screen the wallpaper option has been disabled, so the **window_color** option is used.

```
# Graphics (touch screen) screen settings
[SCREEN]
fullscreen=yes
window_title="Bob Rathbone Internet Radio Version"
window_color=turquoise
banner_color=black
labels_color=black
display_window_color=lightblue
display_window_labels_color=black
slider_color=purple
display_mouse=yes
switch_programs=yes
screen_saver=0

# Wallpaper backgrounds. See /usr/share/scratch/Media/Backgrounds
#wallpaper=/usr/share/scratch/Media/Backgrounds/Nature/beach-malibu.jpg
# Set date format for graphic screen
dateformat=%H:%M:%S %A %e %B %Y

# The following is specific to the vintage graphical radio
scale_labels_color=white
stations_per_page=40
display_date=yes
display_title=yes
```

Python pygame colour constants

See <https://www.webucator.com/blog/2015/03/python-color-constants-module/>

However, be aware that not all colours are supported on the Raspberry Pi version of pygame.

Graphic screen keyboard controls

The HDMI/Touchscreen version accepts input from the keyboard. It is limited and is only included as a keyboard may be connected to the Raspberry Pi when using an HDMI screen. The normal interface is either touch screen or mouse and not the keyboard.

Table 22 Graphic screen keyboard command

Key	Description	Key	Description
Page Up (PgUp)	Channel/Track Up	Up Arrow	Search Up
Page Down (PgDn)	Channel/Track Down	Down Arrow	Search Down
+ Key	Volume increase	Left arrow	Go to first search page
- Key	Volume decrease	Right arrow	Go to last search page
R	Toggle <u>R</u> andom	L	Select Search <u>L</u> ist
T	Toggle Repeat <u>T</u>	P	Select Search <u>P</u> laylists
C	Toggle <u>C</u> onsume	A	Select Search <u>A</u> rtists
S	Toggle <u>S</u> ingle	M	Toggle <u>M</u> ute on/off
D	Cycle <u>d</u> isplay window	ESC	Exit program
X	Switch between vgradio and gradio		



You may be interested how the screen-shots in this section were created. A Windows based server called **XMinG** was run on the Windows PC. X-Forwarding is then enabled in the SSH program (Putty or Bitwise etc). A SSH terminal session was started and the **gradio.py** program started which is then displayed on the PC desktop. Then clicking on the graphic radio window at pressing **Alt** and **PrtScn** keys together copies the window to the system clip-board where it can be pasted into a document. Operation is however very sluggish so the method is not recommended for normal use.

The Vintage Graphic Radio

As an alternative to the **gradio.py** program there is a touch-screen version of the radio called **vgradio.py**. This radio program only can play radio stations and not other Media (USB stick for example) or Airplay.



Note: This radio program can only play radio stations and not other Media such as a USB stick or Airplay, nor are there currently any plans to change this. If you want to play media you will need the full feature **gradio.py** program previously described.



Figure 208 The vintage graphic radio on a touch-screen

This allows a radio to be constructed to look like a vintage radio with a sliding tuning dial. The pages scroll through the stations so hundreds of stations can be added. When you touch the name of a station on the tuner dial the green slider jumps to that location and plays the selected station.

The double arrows at the top of the screen allow you to page through the stations. At the bottom is the round volume slider. Under that is the title of the currently playing song. The blue arrows are used to step through the stations one at a time. The mute button is on the right-hand side of the screen. This design can also be combined with rotary encoders or switches.

To run this radio, either run the `configure_radio.sh` program or amend the `/home/pi/.config/lxsession/LXDE-pi/autostart` configuration file to run `vgradio.py` instead of `gradio.py`.

```
@lxpanel --profile LXDE-pi
@pcmanfm --desktop --profile LXDE-pi
@xscreensaver -no-splash
@point-rpi
@sudo /usr/share/radio/vgradio.py
```

This radio is designed to work with a single radio playlist. This is normally the `_Radio` playlist. You should configure the radio to start with this playlist by amending the `startup` parameter in `/etc/radiod.conf`.

```
startup=_Radio
```

However, this does not mean that you cannot have multiple radio playlists. If you have more than one radio playlist then by using the page up button (Double right arrow) it is possible to scroll through to the current playlist to the end and then onto the next playlist. In this case the new playlist name will be displayed in the very top-left of the screen.

You cannot currently scroll back to the previous playlist but must continue scrolling through the pages until you reached the desired playlist.

If using the FLIRC remote control dongle then it is only necessary to program the following keys: **pageup, pagedown, left, right, up, down.**

Switching between graphics programs

It is possible to switch between the full feature graphical radio (**gradio.py**) and the vintage graphical radio (**vgradio.py**). First configure the **switch_programs** parameter in the [SCREEN] section of **/etc/radiod.conf**.

```
switch_programs=yes
```



Restart the program. The switch icon on the left will appear towards the top of the right-hand side of the screen. By clicking on it the program will switch between the two versions of the desktop radio programs. There will be a very short pause in the music stream whilst it is doing the switch-over.

Configuring a screen saver



Note: The **xscreensaver** program described here does not appear to work if the radio program is in full screen mode. This will probably be addressed in a later release.

Modern LCD displays are not as susceptible to screen burnout as the old cathode ray tubes of old. However continuous static screen displays will eventually cause shadowing. It is therefore a good idea to install a screen saver. The standard one for **Raspbian** is called **xscreensaver**. To install it run the following:

```
$ sudo apt install xscreensaver
```

After installation of the screen saver it can be configured in the desktop preferences menu. This allows configuration of time, screen saver or a blank screen. Choose a not too busy screen saver or the blank screen option.

There is also a program called **xscreensaver-command** for command line manipulation of the screen saver. However, the advice is not to use it as, at the time of writing, it causes severe problems with both the console and desktop display.

Playing Media

Playing MP3 and WMA files

The radio software also allows you to play music from the following sources:

1. From a USB stick
2. From a music directory on the SD card (Create this yourself)
3. From a Network Attached Storage (NAS)

Playlists for all of the above can be created using the **create_playlist.sh** program.

```
$ cd /usr/share/radio
$ sudo ./create_playlist.sh
```

See the section on Creating Media playlists on page 223 for a detailed description of this program.

Playing music from a USB stick

Put your music tracks on a USB stick (MP3 and WMA files only) and insert it into the USB port of the Raspberry PI. Run the **create_playlist.sh** program as shown above. Reboot the PI. Once the Radio program is running again, push the Menu button until "Input source" is displayed. Press either the left or right button to change the source to "Music Library". Now press the Menu button again. The music on the USB stick will now be loaded.

Playing music from the SD card

With large (32/64GB) SD cards now available music can be stored on the SD card. There is already a directory called **/home/pi/Music** where music can be stored.

Using FTP or any other file transfer program, copy the music from a PC to the **/home/pi/Music** directory and reload the library via the options menu. Now run the **create_playlist.sh** program. Select option 3 (SD card). See the section on *Creating Media playlists* on page 223.

Playing music from a Network Attached Storage (NAS)

This is a bit more involved to set up. See the section called *Mounting a network drive* on page 238. Then goto the section on *Creating Media playlists* on page 223

Organising the music files

The search (find menu) routines get Artist and Track name directly from MPD which in turn get them from the music media file itself. The files should be placed in the top-level directory of the USB stick or in the **/home/pi/Music** directory if using the SD card. Any directory structure can be used. For example:

Elvis Presley/The 50 Greatest Hits Disc 1/That's All Right.mp3

The find menu however will not use the directory structure for Artist/Track names so the directory structure and naming is arbitrary but should relate to the Artist and Track names displayed on the radio display. It is however possible sometimes to change the meta-data ((Artist/Track name) in the media file itself. Search on-line for ways of doing this.



Note: It is possible to create playlists for multiple locations. So, for example you can define one or more playlists for each of the USB Stick, NAS Storage and the SD card and select any of them from the radio or Web interface.

MPD Logging

All logging for the MPD daemon is to the `/var/log/mpd/mpd.log` file by default.

Radio program logging

The running Radio program logs to a file called `/var/log/radiod/radiod.log`. See example log below:

```
2022-03-06 06:44:35,510 INFO ===== Starting radio =====
2022-03-06 06:44:35,511 INFO Initialising radio
2022-03-06 06:44:36,148 INFO Python version 3
2022-03-06 06:44:36,155 INFO Translation code page in radiod.conf = 0
2022-03-06 06:44:36,513 INFO Display code page 0x1
2022-03-06 06:44:36,515 INFO Loaded 'codes.European'
2022-03-06 06:44:36,516 INFO Loaded 'codes.Russian'
2022-03-06 06:44:36,517 INFO Loaded 'codes.English'
2022-03-06 06:44:36,518 INFO Screen LCD Lines=4 Width=20
2022-03-06 06:44:38,293 INFO Romanize True
2022-03-06 06:44:38,811 INFO IP 192.168.1.248
2022-03-06 06:44:40,261 INFO Board revision 2
2022-03-06 06:44:40,286 INFO OS release: Raspbian GNU/Linux 10 (buster)
2022-03-06 06:44:40,299 INFO Linux piboombbox 5.10.63-v7+ #1459 SMP Wed Oct 6
16:41:10 BST 2021 armv7l GNU/Linux
2022-03-06 06:44:41,055 INFO Connected to MPD port 6600
2022-03-06 06:44:41,149 INFO UDP Server listening on localhost port 5100
2022-03-06 06:44:41,156 INFO UDP listen:remote 0.0.0.0 port 5100
2022-03-06 06:44:42,851 INFO Radio ['/usr/share/radio/radiod.py',
'nodaemon'] Version 7.6
2022-03-06 06:44:42,853 INFO Radio running pid 1305
```

There are six levels of logging namely CRITICAL, ERROR, WARNING, INFO, DEBUG or NONE. This is configured in the `/etc/radiod.conf` file. Use DEBUG for more information.

```
# loglevel is CRITICAL,ERROR,WARNING,INFO,DEBUG or NONE
loglevel=INFO
```

Other useful logs

daemon.log A very useful log for various looking at daemon process messages
For instance, if you want to see what a particular daemon is doing use `grep <daemon name>`.

```
grep -i <daemon name> /var/log/daemon.log
```

For example, to look at Bluetooth processes:

```
$ grep -i bluetoothd /var/log/daemon.log
Jul  8 08:59:55 buster02 bluetoothd[808]: Bluetooth management interface
1.18 initialized
:
```

Daemons of interest are **radiod**, **mpd**, **librespot**(Spotify) and **bluetoothd**.

Installation and Configuration Logs

Installation and configuration logs are stored in directory `/usr/share/radio/logs`. These are:

1. **install.log** – Output from the `configure_radio.sh` script
2. **audio.log** - Output from the `configure_audio.sh` script
3. **stations.log** – Output from `crontab` weekly run of `create_stations.py`

These logs are overwritten every time the above programs are run.

Configuration and status files

The main configuration file is `/etc/radiod.conf`. See section *A.1 Files added to the system* on page 358. This file is normally maintained by the `configure_radio.sh` program. This is run at installation time but can be safely run at any time.

There are some other configuration and status files in the `/var/lib/radiod` directory. These are:

alarm	Alarm setting in t:hh:mm where t is the alarm type (t=0=off)
current_station	The current radio station
current_track	The current music track
language	Espeak language definition file
mixer_volume	Used by Airplay to set mixer volume (See page 302)
mixer_volume_id	Mixer volume ID (Used primarily for Airplay volume control)
rss	RSS feed URL
share	The NAS share instruction
stationlist	The user list of radio station URLs
streaming	Icecast2 streaming on or off
timer	Timer (Snooze) value in minutes
voice	The espeak voice file
volume	The volume setting
equalizer.cmd	The ALSA Equalizer command file called from gradio and vgradio

It isn't normally necessary to change most of these files. However, the **stationlist**, **share**, **language** and **rss** file will need to be edited as required. The other files are maintained by the radio or configuration programs. When the radio program starts up it uses the last settings, for example, the **volume**, **current_station** and **current_track** files.

Using the Timer and Alarm functions



Note: The Raspbian operating system synchronizes time over the Internet. It does this using the **timesync** service. This service is a light-weight, client only, time synchronisation service, using the Network Time Protocol (NTP). In Bookworm this is implemented the **systemd-timesyncd** service.

There is a timer (Snooze) and alarm function (LCD and OLED versions only). The timer and alarm can operate individually or together. The timer when set will put the radio into Sleep Mode when the timer expires. The Alarm can be set to either On, Repeat or "Weekdays only".

Setting the Timer (Snooze)

Press the Menu button until the "Menu Selection" is displayed. Press either the channel UP or DOWN control until "Timer off" is displayed on line 2 of the LCD screen. Now push the volume UP button to set the timer. Use volume UP and DOWN to adjust the timer which will be displayed as "Timer hh:mm:ss" where hh=hours, mm=minutes and ss=seconds. The Timer can be set up to 24 hours in increments of one minute. Once the timer is set, press the Menu button; the display will return to TIME mode.

On a four-line LCD display the timer will be seen counting down after the Volume display on line 4. On a two-line LCD display the timer count down will be displayed on line 1 after the time display.

When the timer expires (reaches zero) the radio will enter SLEEP mode. Sleep mode can only be exited by pressing the menu button.

To switch the timer off go back to the timer menu as described above and reduce the timer to 0 using the volume DOWN control. This will switch off the timer.

The timer function uses the `/var/lib/radiod/timer` file which will contain the value of the timer in minutes when it was successfully fired. You do not need to change the contents of this file.

Setting the Alarm

The Alarm menu has three settings:

- The alarm type (On, off, repeat etc)
- The Alarm Hours time (Pressing menu in this mode puts the radio into Sleep mode)
- The Alarm Minutes time (Pressing menu in this mode puts the radio into Sleep mode)

Press the Menu button until the “Menu Selection” is displayed. Press either the channel UP or DOWN (Or rotate rotary encoder) until “Alarm off” is displayed on line 2 of the LCD screen. Using the volume UP control cycle through the options which are

- Alarm off - The Alarm is switched off
- Alarm on – The Alarm is on for one time only. Once the alarm is fired it will return to off.
- Alarm repeat – The Alarm will be repeated every day and not switched off.
- Alarm weekdays only – The Alarm will only fire Monday through Friday. It is not reset.

Now move to “Set alarm time:” using the channel UP control. The current alarm time will be displayed on line 2 of the display. Using the volume UP and DOWN control adjust the alarm time (Hours or Minutes) to the required setting. If you do not wish to put the radio into sleep mode at this stage then use the channel UP/DOWN control to move away from the “Set alarm time:” option and press the Menu button. If you press the Menu button whilst in the “Set alarm time:” option and the Alarm is set to anything except off then the radio will enter Sleep mode and display the alarm on line 2 for a two-line LCD or on line 4 for a four-line LCD.



Note: Sleep mode can only be exited by pressing the Menu button.

The alarm function uses the `/var/lib/radiod/alarm` file which will contain the current alarm type and time. The format is `t:hh:mm` where t is type (0=off, 1=on, 2=repeat, 3=weekdays only) and hh:mm is hours and minutes (24 hour clock). You do not need to change the contents of this file.



PLEASE NOTE THAT THE ALARM RELIES UPON THE SELECTED RADIO STREAM TO BE AVAILABLE WHEN THE ALARM WAKES UP. THIS CANNOT BE GUARANTEED AS THE STATION FEED MAY BE OFF AIR OR THERE IS A PROBLEM WITH THE INTERNET CONNECTION. YOU SHOULD NOT THEREFORE RELY SOLELY ON THIS ALARM FUNCTION IF YOU HAVE AN IMPORTANT APPOINTMENT OR A PLANE OR TRAIN TO CATCH FOR EXAMPLE. ALSO SEE DISCLAIMER ON PAGE 352.

Using the Alarm and Timer functions together

The Alarm and Timer functions can be used together. For example you want to set your radio to a 30 minute snooze time before going to sleep and to sound the alarm in the morning. Simple set the Timer to the required elapse time and then set the alarm as described in the previous section. Press

the Menu button and the timer will be seen counting down followed by the alarm time on line 4 or line 1 for the four-line and two-line LCD respectively.

Music Player Clients

MPD is designed around a client/server architecture, where the clients and server (MPD is the server) interact over a network. A large number of graphical and Web-based clients are available for MPD and are too numerous to mention here. Please see the following link for further information on MPD clients: <http://mpd.wikia.com/wiki/Clients>. The main client used in this project is MPC.

Using the MPC client

Everything you should normally wish to do can be done using the radio. However, there may be occasions that you wish to test or control music selection, volume etc. using MPC. It is also useful for diagnosing Music Player Daemon problems.

Log into the Raspberry PI using the console or SSH login. To start playing music run:

```
$ mpc play
```

If the following is seen start **mpd** using the **systemctl** command and retry:

```
mpd error: Connection refused
$ sudo systemctl start mpd
```

To see a list of all available commands, run:

```
$ mpc help
```

Here are some frequently used **mpc** commands:

Table 23 Common MPC commands

MPC command	Description
mpc	Displays status (mpc status also does the same)
mpc current	Displays currently playing station or track
mpc next	Play next song
mpc prev	Play previous song
mpc play n	Play station or track where n is the track or station number
mpc volume 75	Set volume to 75%
mpc stop	Stop playing
mpc random <on off>	Toggle shuffling of songs on or off
mpc repeat <on off>	Toggle repeating of the playlist
mpc clear	Clear the playlist
mpc consume <on off>	When playing tracks remove from the playlist once played
mpc playlist	List loaded radio stations or streams
mpc listall	List all songs in the music directory

Adafruit RGB Plate changing colours

This section is only relevant for the Adafruit RGB plate. When running the radio with an Adafruit RGB plate, it is an option to change the colour of the display. Push the menu button until “Menu selection”. Push the channel button until “Select color” is displayed. Now push the volume button to

cycle through the colours. The available colours are red, green, blue, yellow, teal, violet, white or Off (No backlight). Note that the program uses the American spelling 'color'

Shutting down the radio

You can simply switch the power off. This doesn't normally harm the PI at all. However, if you want a more orderly shutdown then press the menu button for at least three seconds. This will stop the MPD daemon and issue a shutdown request to the Raspberry PI. Wait at least another ten seconds and then power off the Radio.

Creating and Maintaining Playlist files



Note: The creation of playlists has completely changed from earlier 5.x versions of the program. Read the following carefully for an understanding of the new playlists structure. To use old format play-lists, see the section called *Using old 5.x Radio playlists* on page 224.

Previous 5.x versions of the radio only allowed three playlists namely Radio, USB stick or Network share. This has completely changed in version 6.0 onwards. It is now possible to define as many playlists as you wish. For example:

Table 24 Example playlists

Playlist Name	Type	File name	Description
Radio	Radio	Radio.m3u	Playlist with radio stations
BBC stations	Radio	BBC_stations.m3u	Playlist with only BBC radio stations
German stations	Radio	German_stations.m3u	Playlist with only German radio stations
USB stick	Media	USB_Stick.m3u	Playlist with the contents of the USB stick
Network	Media	Network.m3u	Playlist with the contents from a network share
Country	Media	Country.m3u	Playlist with just country music
Rock and Roll	Media	Rock_and_Roll.m3u	Playlist with just Rock and Roll music

You may have as many or few playlists as you like. All playlists are stored in `/var/lib/mpd/playlists` and must have a `.m3u` file extension.



Previous to version 7.3, `radio` station names began with an underscore "`_`". This was to distinguish between RADIO and MEDIA playlists. However, from version 7.3 onwards Radio playlists will be created without an underscore for example `Radio.m3u` instead of `_Radio.m3u`. Old playlists beginning with an underscore will be left untouched.

Creating new playlists

There are four ways to create playlists:

1. Create Radio station playlists with the `create_stations.py` program
2. Create Media playlists from either USB stick or Network share using `create_playlist.sh`
3. Use the Shoutcast (`get_shoutcast.py`) program or Web interface
4. Manual creation of your own Media playlists

The create stations program

The `create_stations.py` program is used to create playlists in the `/var/lib/mpd/playlists` directory. If you wish to understand more about playlist files see the section called *Overview of media stream URLs* on page 232. If you have installed the `anacron` package this program will be run on a regular basis in the background in an attempt to filter out any bad or missing stations. The directories and files used by the `create_stations.py` program are shown in the following table:

Table 25 Playlist files and directories

Name	Type	Description
<code>/var/lib/radiod/stationlist</code>	File	The file containing the users list of radio stations
<code>/usr/share/radio/station.urls</code>	File	Initial distribution Radio playlist. This is copied to <code>/var/lib/radiod/stationlist</code> directory during program installation.
<code>/var/lib/mpd/playlists</code>	Directory	Location of MPD playlists
<code>/var/lib/mpd/music</code>	Directory	Location of media files for either a USB stick or a Network share

The `/var/lib/radiod/stationlist` file is the file that should be maintained by you to create [Radio](#) playlists. When this `create_stations.py` program is first run it copies the distribution file `station.urls` to the `/var/lib/radiod/stationlist` file. You may then modify the `/var/lib/radiod/stationlist` file.

The format is: **(<playlist name>)**

Example: **(Radio)**

The above will create a playlist called **Radio.m3u** (not `_Radio.m3u` as previously) and will contain the title and URLs for each station. Now add or remove radio station definitions in the `stationlist` file. The first statement in the station definition is the name of the playlist in brackets:

The format is: **[<title>] http://<url>**

Example: **[BBC Radio 4 extra] http://www.bbc.co.uk/radio/listen/live/r4x.asx**

After modifying the `stationlist` file run the `create_stations.py` program to create the Music Player Daemon playlists.



Note: When installing the radio software for the first time a file called `station.urls` will be copied to the `stationlist` file. It will not be overwritten when upgrading or re-installing the software. The [user](#) is totally responsible for maintaining the `stationlist` file from then on.

Below is an example of part of a `stationlist` file stored in `/var/lib/radiod` directory. This file is the source of [all](#) radio playlists.

```
# Radio stations
(Radio)
# United Kingdom
# The following links are iPhone streams (m3u files)
[BBC Radio 1] http://www.radiofeeds.co.uk/bbcradio1.pls
[BBC Radio 2] http://www.radiofeeds.co.uk/bbcradio2.pls
[BBC Radio 3] http://www.radiofeeds.co.uk/bbcradio3.pls
:
# Dutch stations
(Dutch radio)
[NPO Radio 1] http://icecast.omroep.nl/radio1-bb-mp3
[NPO Radio 2] http://icecast.omroep.nl/radio2-bb-mp3
[NPO Radio 3fm] http://icecast.omroep.nl/3fm-bb-mp3
```

In the above example two Radio playlists are defined by the names in round brackets namely; (Radio) and (Dutch radio). Options can be displayed by entering the program name only.

```
$ ./create_stations.py
This program can only be run as root user or using sudo
Usage: sudo ./create_stations.py [--delete_old] [--no_delete] [--
input_file=<input file>] [--help]
Where: --delete_old Delete old playlists
```

```
--force          Force update of MPD playlists
--no_delete     Don't delete old playlists
--input_file=<input_file> Use alternative input file
--help         Display help message
```

The `create_stations.py` program itself is very easy to use. Just run it with **sudo** in the `/usr/share/radio` directory:

```
$ cd /usr/share/radio
$ sudo ./create_stations.py
```

You may see the following message:

```
Warning: The radio is configured to allow playlist updates by external
clients so overwriting them with this program is disabled.
See update_playlists=yes in /etc/radiod.conf (Add it if it is missing)
Use the --force flag to override this restriction (Current playlists will be
overwritten)
Exiting program!
```

This is because the **update_playlists** parameter in `/etc/radiod.conf` has been set to **yes** to allow external clients such as the Web interface to add, delete and move playlist items. To force playlist creation run the program with the force flag.

```
sudo --force ./create_stations.py
```

Either command will create the playlist files in the `/var/lib/mpd/playlists` directory. Using the example shown above this will produce two files called **Radio.m3u** and **Dutch_radio.m3u** in the MPD playlists directory. To create a log file of the program run the following:

```
$ sudo ./create_stations.py | tee playlist.log
```

You can examine the `playlist.log` file to see what actions the `create_stations.py` program carried out and if there were any errors.

The program will ask if you wish to delete any old playlists:

```
Processed 46 station URLs from /var/lib/radiod/stationlist
There are 2 old playlist files in the /var/lib/mpd/playlists/ directory.
Do you wish to remove the old files y/n: y
```

Normally answer 'y' unless you don't wish to remove the old files. Note that old playlists files with the same name as the new ones will always be overwritten.

If you want to avoid the above prompt then there are two other parameters that you may use.

```
--delete_old   Delete old playlist files in the MPD playlist directory
--no_delete    Don't delete old playlist files in the MPD playlist directory
```

Example:

```
$ sudo ./create_stations.py --no_delete
```

It is also possible to specify a different file than `/var/lib/radiod/stationlist` using the `--input_file` parameter.

```
--input_file=<station list>
```

Where `<stationlist list>` is exactly the same format as `/var/lib/radiod/stationlist`.

For example:

```
$ sudo ./create_stations.py --no_delete --input_file=mystation.urls
```

In the above example the stations list is in the `mystation.urls` file.

Finally, there is a help parameter:

```
$ sudo ./create_stations.py --help
```

Changing the character set

The default character set (charset) used by the Music Player Daemon is called UTF-8 and is defined by the following parameter in `/etc/mpd.conf`.

```
filesystem_charset "UTF-8"
```

This can be changed to LATIN-1 for example for Western European languages.

```
filesystem_charset "LATIN-1"
```

More information can be found in the man page for charsets.

<https://man7.org/linux/man-pages/man7/charsets.7.html>

However, there is a global change which affects all radio stations. To tell MPD to assume a different character set for one or more specific radio stations, specify it in the charset URL fragment parameter, e.g.:

```
http://radio.example.com/stream#charset=latin-2
```

To set this up define the radio station in the `/var/lib/radiod/stationlist` file with a `charset` definition for your region as shown in the following example:

```
[Espace 2] http://stream.srg-ssr.ch/m/espace-2/aacp_96#charset=latin-1
```

When the `create_stations.py` program is run it will create the following entry in the `/var/lib/mpd/playlists/Radio.m3u` file:

```
#EXTM3U
#EXTINF:-1, Espace 2
http://stream.srg-ssr.ch/m/espace-2/aacp_96#charset=latin-1
```

As many different charsets can be defined as required by the individual radio stations. For example, a German radio station would use **latin-1** and a Polish station would use **latin-2**. If most of your radio stations are in a particular region then it is probably better to set this globally in the `/etc/mpd.conf` configuration file by changing the `filesystem_charset` parameter. For example `LATIN-1`.

```
filesystem_charset "LATIN-1"
```

Directly creating the Radio.m3u playlist

There is nothing wrong if you chose to directly create your own MPD radio playlist instead of using the `create_stations.py` program. The correct format for a radio playlist is as shown in the following example:

```
#EXTM3U
#EXTINF:-1,BBC - Radio 1
http://stream.live.vc.bbcmedia.co.uk/bbc_radio_one
#EXTM3U
#EXTINF:-1,BBC - Radio 2
http://stream.live.vc.bbcmedia.co.uk/bbc_radio_two
```

Each entry must begin with **#EXTM3U** followed by **#EXTINF:-1,<Title>** on the next line. The third entry must be a valid URL to the radio stream.

You can choose not to use the `stationlist` file and `create_stations.py` playlist generator but there are quite a few advantages and other considerations to using the playlist generator program.

1. The syntax of the `stationlist` file is much simpler than the resulting `Radio.m3u` file.
2. The `create_stations.py` program checks the syntax of the `stationlist` entries and creates a list of errors
3. The `create_stations.py` program checks that the station definitions are valid and that a URL can be accessed over the Internet before adding it to the `Radio.m3u` file
4. A so-called cronjob called `/etc/cron.daily/radiod` runs daily to re-check the `stationlist` entries and overwrites the `Radio.m3u` file with a verified list. If you don't want your `Radio.m3u` file to be overwritten you need to remove `/etc/cron.daily/radiod` file
5. When you come to use the Web Interface you will see that if configured new entries can be added via the **O!MPD** interface and these update the `stationlist` directly and then re-runs the `create_stations.py` program

So, the advice is always to create your playlists in the `/var/lib/radio/stationlist` file and to use the `create_stations.py` playlist generator program.

If you want to define a specific character set (charset) for a station this can be done as shown in the following example below:

```
#EXTM3U
#EXTINF:-1, Espace 2
```

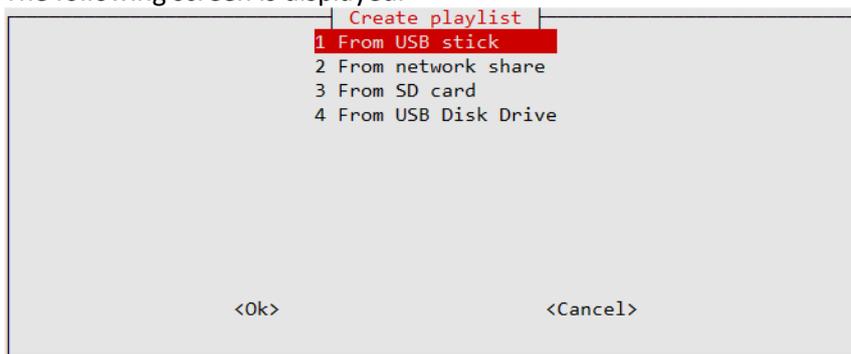
```
http://stream.srg-ssr.ch/m/espace-2/aacp_96#charset=latin-1
```

Creating Media playlists

The radio program comes with a program called **create_playlist.sh**. This creates a single playlist for a USB stick, SD card location or a network share. It can produce as many playlists as required.

```
$ cd /usr/share/radio  
$ sudo ./create_playlist.sh
```

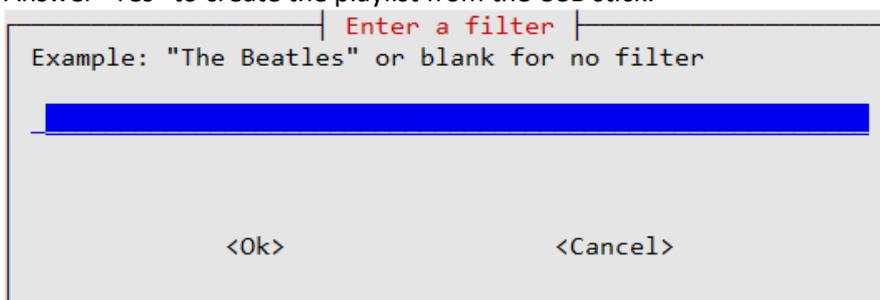
The following screen is displayed.



Select option 1 initially.



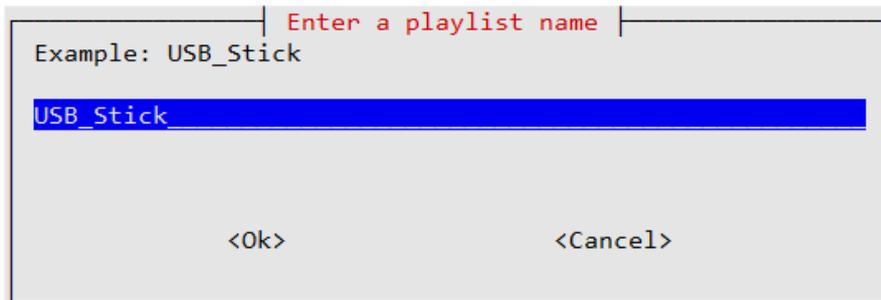
Answer "Yes" to create the playlist from the USB stick.



Enter a filter name or enter for no filter.



Select Yes to continue.



The program will suggest a name for the playlist but you may choose any name (But do not make it too long).

The program continues by creating a playlist called **USB_stick.m3u** in **/var/lib/mpd/playlists**.

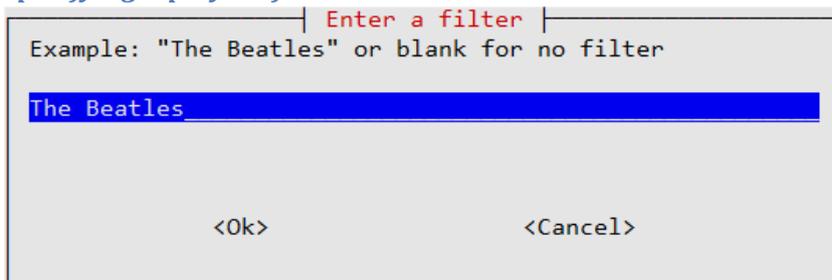
```

sudo service radio stop
sudo service mpd stop
Mounted /dev/sda1 on /media
cd /var/lib/mpd/music/
/var/lib/mpd/music
sudo find -L media -type f -name *.mp3 -or -name *.ogg -or -name *.flac >
/tmp/list29073
sudo mv /tmp/list29073 /tmp/USB_Stick

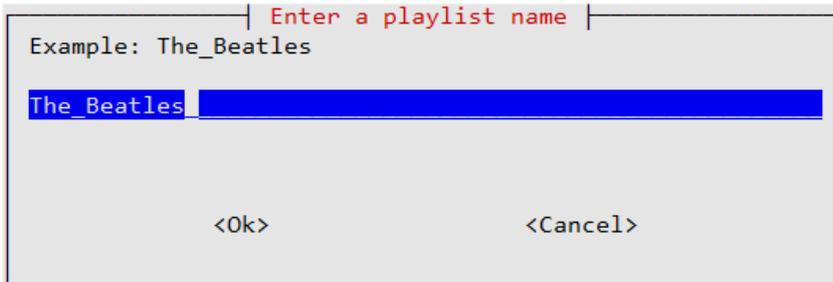
=====
58 tracks found in directory media (No filter)
mv /tmp/USB_Stick.m3u /var/lib/mpd/playlists/USB_Stick.m3u
sudo service mpd start
mpc stop
volume: 58%  repeat: off  random: off  single: off  consume: off
mpc update media
Updating DB (#1) ...
volume: 58%  repeat: off  random: off  single: off  consume: off

```

Specifying a playlist filter



The program will then suggest the playlist name **The_Beatles**.



You will note that spaces in the playlist name have been replaced with underscores(_). This is just for the file name. When the playlist is displayed in the radio program the underscores will be converted back to spaces. The program will now create a playlist with the name **The_Beatles.m3u** (or whatever name was given).

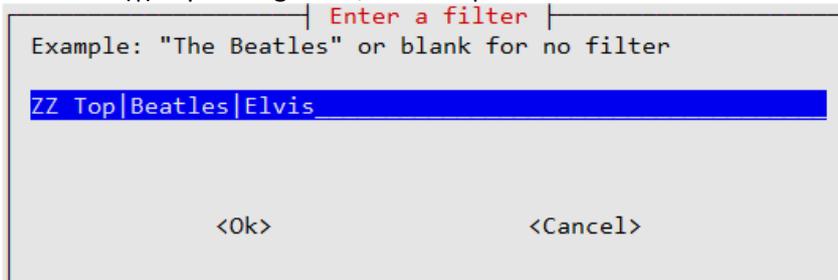
```

sudo service radio stop
:
29 tracks found in directory share matching "The Beatles"
mv /tmp/The_Beatles.m3u /var/lib/mpd/playlists/The_Beatles.m3u
:
Updating DB (#1) ...
volume: 58%  repeat: off  random: off  single: off  consume: off

```

Specifying multiple filters

More than one string may be specified in a filter. To do this specify the filter strings with a pipe character (|) separating them, for example:

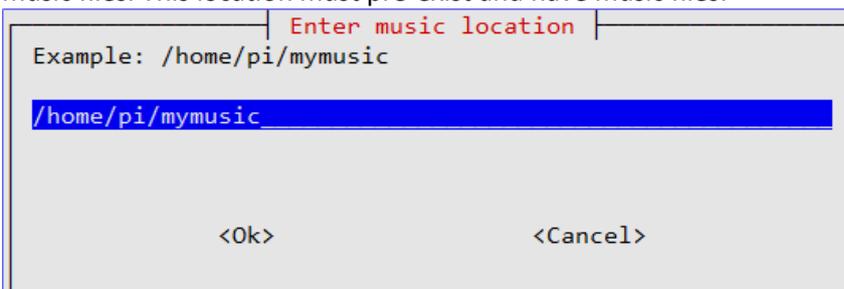


This will filter all songs from ZZ Top, The Beatles and Elvis or any other titles that contain these names. However this may not be what is wanted. Maybe songs by Elvis are wanted and not songs with 'Elvis' in the title. For example *Dire Straits – Calling Elvis*. In such a case use the / character to only look for directory names beginning with 'Elvis' . The above filter becomes:

ZZ Top|Beatles|/Elvis

Restart the radio to reload all new playlists. Using the / character gives a more accurate playlist. Please note that filters are not case sensitive. Filter 'Elvis' and 'elvis' will return the same result.

If you selected option 3 (SD card) you will be prompted for the location where you have installed your music files. This location must pre-exist and have music files.



Maintaining playlists using external MPD clients

From version 7.3 onwards it is possible to add, delete and move playlist items using any external MPD clients capable of doing so. For example the **Snoopy** or **O!MPD** Web clients supplied with the **radiod** Web package. See <https://www.musicpd.org/clients> for a list of MPD clients from the Music Player Daemon Web site.

Before it is possible to do this it is necessary to set the **update_playlists** to **yes** in the **/etc/radiod.conf** configuration file and restart the radio.

```
# Allow updating of playlists by external clients yes/no (Experimental)
update_playlists=yes
```

The current default is set to **no** to maintain backward compatibility with older versions.

The following is an example of adding a new station via the **O!MPD** Web interface.

The recommended format for a new station URL is as follows:

<url>#<name>

For example

http://relay.181.fm:8098#181.FM Salsa

In O!MPD select the NOW PLAYING tab and at the top of the page click on add. Enter the URL in the format shown above.

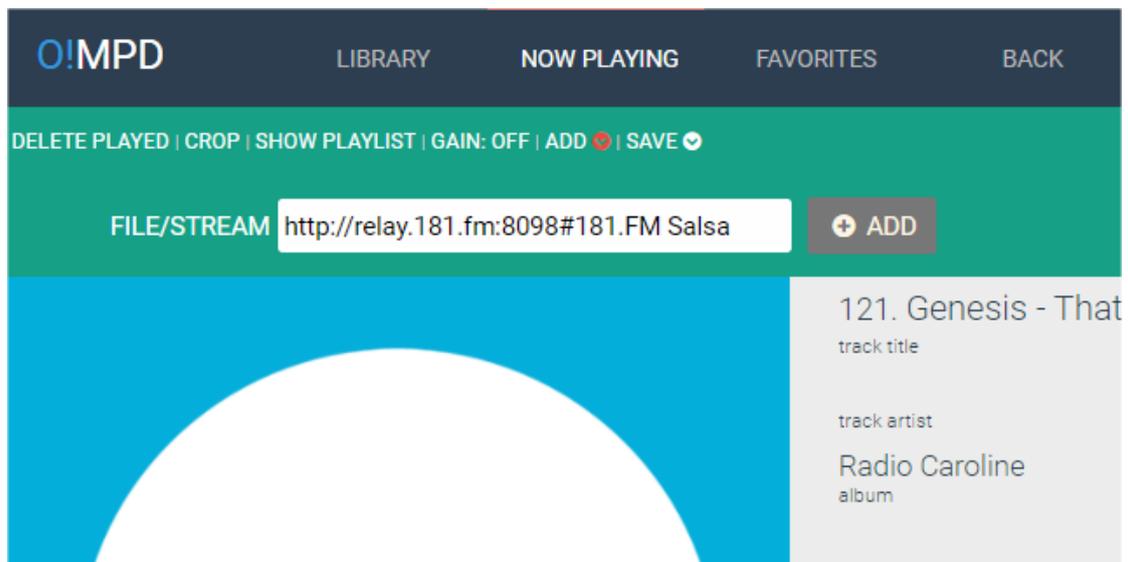


Figure 209 Adding a new station to MPD

Press the ADD button on the right of the URL entry box. The new station will be added to the end of the playlist.

It is possible to add the new station without the **#<name>** part.

For example

http://relay.181.fm:8098

In such a case the station will be added with the format **New Station <n>** where **<n>** is the position in the playlist. For example **New station 22**.



Figure 210 Adding new station URL in the Web interface

By clicking on the right-hand menu for the new station it is possible to move or delete a URL.

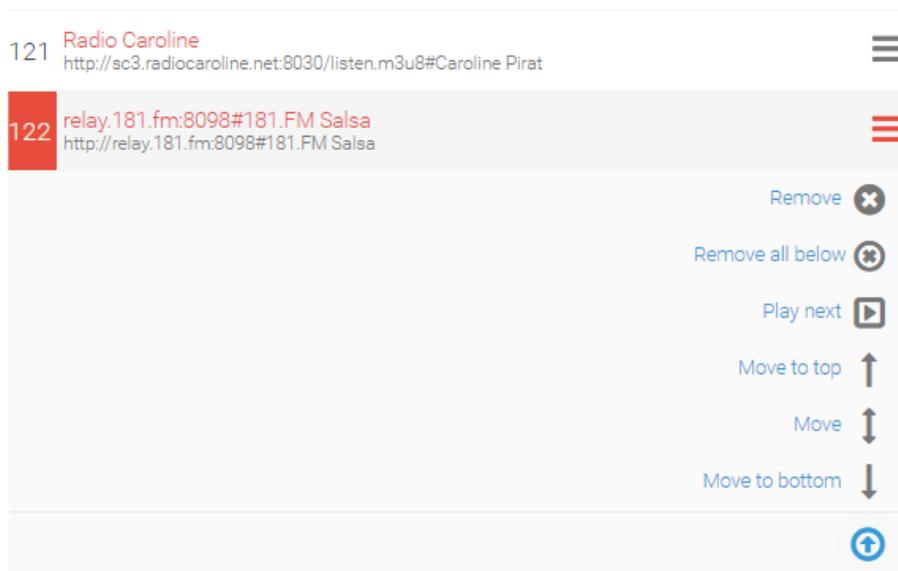


Figure 211 Moving and deleting entries in the Web Interface



Note: The author has been unable to make the double arrow **Move** icon work. Any feedback on this would be appreciated.

There is an important setting in `/etc/radiod.conf` which affects the way the station name is displayed namely `station_names`.

```
# Station names source, list or stream
station_names=list
```

This is normally set to `list` which means that the names displayed by the radio come from the entries contained in the `/var/lib/radiod/stationlist` file as shown below.

```
[181.FM Salsa] http://relay.181.fm:8098
```

In this case station URLs in the playlist use the `<url>#<name>` format as previously explained. By setting `station_names=stream` the station name will come from the radio stream itself.

In the above case new URLs can be added without the `#<name>` part as the name will come from the stream.

Accessing Shoutcast

It is possible to create playlists from the Shoutcast database. See <http://www.shoutcast.com>. Shoutcast provide what can best be described as “fringe” radio stations. They do have a few stations by country but not many. If you are hoping, for example, to get all the United Kingdom BBC radio stations you will be disappointed. However their support for radio stations by genre is very good, for example: rock, jazz, country or classical. This version of software provides two methods of creating playlists from the Shoutcast database:

1. Using the `get_shoutcast.py` program
2. Using the shoutcast tab in the radio Web interface.

Using the `get_shoutcast.py` program

Running the program with no parameters will produce the following usage message:

```
$ ./get_shoutcast.py
Shoutcast UDP connect host localhost port 5100
This program must be run with sudo or root permissions!

Usage: sudo ./get_shoutcast.py id=<id> limit=<limit>
search="<string>"|genre="<genre>" install
    Where: <id> is a valid shoutcast ID.
           <limit> is the maximum stations that will be returned
           (default 100).
           <string> is the string to search the shoutcast database.
           <genre> is the genre search string.
           install - Install playlist to MPD without prompting.

See http://www.shoutcast.com for availble genres.
```

If you see the following message then install python-requests as shown below.

```
Traceback (most recent call last):
  File "./get_shoutcast.py", line 19, in <module>
    import requests
ImportError: No module named requests
```

```
$ sudo apt install python-requests
```

The program must be run with `sudo`. In the following example we want to get fifty jazz stations.

```
$ sudo ./get_shoutcast.py genre="jazz" limit=50
Extracting shoutcast stations: genresearch
Processing URL:
http://api.shoutcast.com/legacy/genresearch?k=anCLSEDQODrElkx1&limit=50&genre=jazz
Abc Lounge
Smoothjazz.com Global
:
:
Created 50 records in /usr/share/radio/playlists/_jazz.m3u
Do you wish to copy this playlist to /var/lib/mpd/playlists [y/n]: y
```

Answer 'y' to install the new playlist.

```
Copied /usr/share/radio/playlists/_jazz.m3u to /var/lib/mpd/playlists
Reload playlists: OK
```

This will copy the new **_jazz.m3u** playlist to the **/var/lib/mpd/playlists** directory. The program will also signal the radio program to reload its playlists so that the new playlist can be accessed straight away.

If you answer 'n' to the above question your new playlist will be saved in **/usr/share/radio/playlists** repository. You can copy it later, if so wished, to the MPD playlists directory.

```
$ cd /usr/share/radio/playlists
$ sudo cp _jazz.m3u to /var/lib/mpd/playlists
```

You must use **sudo** to do this.

The program requires an authorisation key. This is embedded in the program and it is not necessary to specify it. If it ever changes or expires a new authorisation key must be configured in **/etc/radiod.conf**.

```
shoutcast_key=anCLSEdQODrElkx1
```

You need to get this key directly from <http://www.shoutcast.com>.



Note: Access to the Shoutcast is a free service made available through the goodwill of the folks at Shoutcast. It can be withdrawn at any time if over-used or abused so please do not set up any facility, such as scripting, which will stress their servers.

Using the Shoutcast Web Interface

The radio Web interface now has a Shoutcast tab. Click on Shoutcast tab to open the interface. Fill in the search form and press the Submit button once and wait until the summary page is displayed.

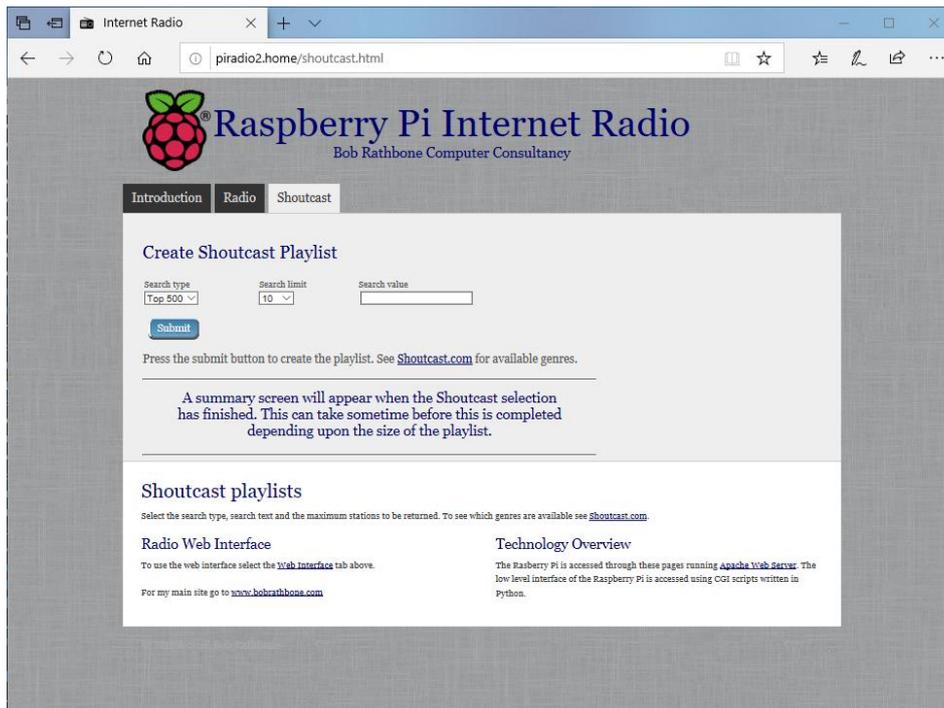


Figure 212 Shoutcast playlist Web page

Select the search type Top 500, Genre or Search from the “search type” drop down box. Select a “limit” for the search then click the “Submit” button. Normally the message “Please wait for selection” is displayed along with a rotating circle wait gif graphic. However, this does not work with **Microsoft Edge** and it is recommended you use the **Firefox** browser.



Figure 213 Shoutcast search selection

The summary page will be displayed. You should see the **Reload playlists: OK** message which means that the new playlist is available in the radio.

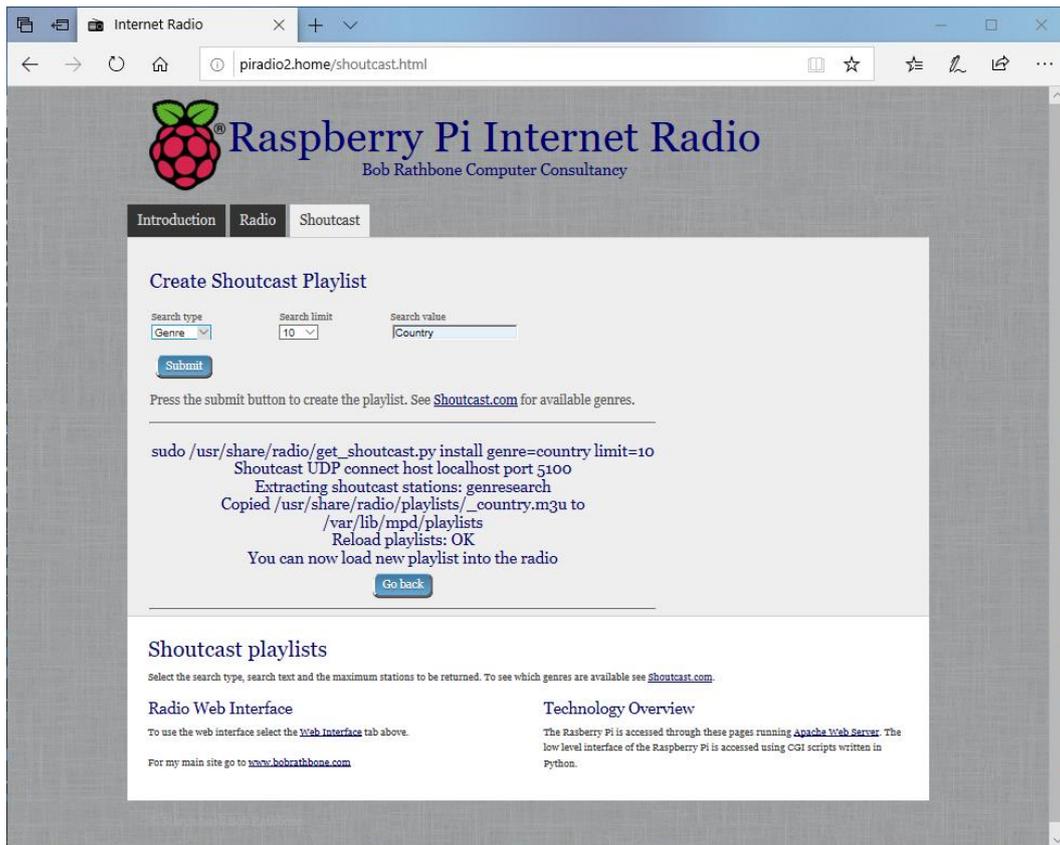


Figure 214 Shoutcast playlist summary

Using old 5.x Radio playlists

Old 5.x playlists are not compatible with this version of the radio. However, the `/var/lib/radiod/stationlist` file can still be used. Do the following:

1. Stop the radio
2. Copy the old **stationlist** file to `/var/lib/radiod/stationlist`
3. Remove most of the (title) statements from the `/var/lib/radiod/stationlist` file
4. Remove all old playlists from `/var/lib/mpd/playlists` directory

```
$ sudo rm /var/lib/mpd/playlists/*
```

5. Run the **create_stations.py** program as previously described.

If you find upon running the Radio that you have a lot of radio playlists. Reduce the number by removing title statements in the **stationlist** file as previously mentioned. These are the names in brackets – for example (BBC Radio). Re-run the **create_stations.py** program.

Radio stream resources on the Internet

There are a lot of resources on the Internet how to find PLS and M3U files so simply search for “PLS or M3U files” through the search machine of your choice. Below are some good sources of radio streams around the world.

<http://radiomap.eu/>

<http://www.publicradiofan.com>

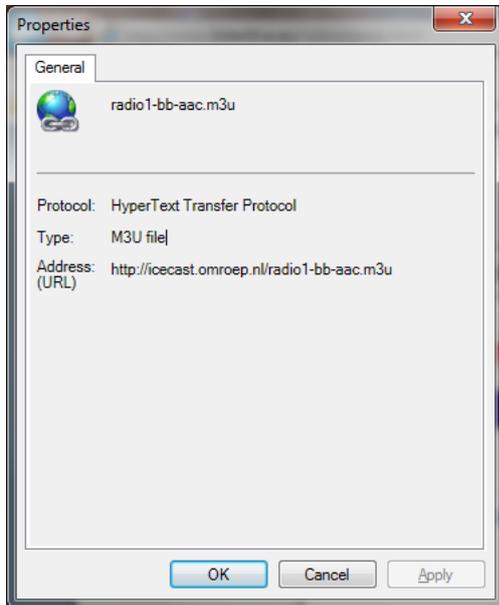
<http://www.radio-locator.com>

<https://www.internet-radio.com/>

<http://bbcstreams.com/>

<http://www.radiofeeds.co.uk/>

Getting a radio stream from a Web browser



To copy a URL open the Web page in any browser on a PC and right click on the URL. Select properties from the drop-down list. For internet explorer will show a window similar to the illustration on the left will be displayed:

Copy and paste the URL into the `/var/lib/radiod/stationlist` file. Add the title in square brackets as shown in the previous section. Other browsers may provide options such as 'copy link' or 'save link as'. This is browser dependant.

Overview of media stream URLs

A deep understanding of this section is not necessary but can be useful when creating playlists. This section is provided for background information only. At first the whole business of how music streams are provided can be quite confusing. The URLs on a radio station Web page can be of different types, for example:

1. A URL pointing to a M3U playlist file (MPEG3 URL). This format is used by MPD.
2. A URL pointing to an HLS (HTTP Live Streaming HLS - M3U8) playlist file
3. A URL pointing to a PLS playlist file (Shoutcast Play List)
4. A URL pointing to an ASX playlist file (Advanced Stream Redirector)
5. A URL which is an actual stream such as MP3 (MPEG 3) or AAC (Advanced Audio Coding)

1, 2 and 3 are so called redirector URLs and point to a playlist file containing one or more URLs to the radio stream(s) itself. The `create_stations.py` program tries to figure out what type of URL that it is and create a playlist from it. This is the facility you should use rather than trying to create your own playlists which can be quite time consuming.

M3U and M3U8 Files

M3U stands for MPEG3 URL. This is the format that MPD itself uses. The following Wikipedia article explains the M3U and M3U8 file formats:

<http://en.wikipedia.org/wiki/M3U>

The Music Player Daemon uses m3u files. An example [M3U](#) file is shown below:
[radio10.m3u playlist file](#)

```
#EXTM3U
#EXTINF:-1, Radio 10 Gold NL
http://icecast.streaming.castor.nl:80/radio10
```

These playlist files have the **m3u** or **m3u8** (UTF-8 encoding) file extension. i.e. **<filename>.m3u**. The first line is the header and must be **#EXTM3U**. The second line is **#EXTINF:** and is information about the radio stream. The **-1** means unlimited play length. This is followed by a comma and then the name of the radio station (*Radio 10 Gold* in this case). The third line is the URL (icecast in this case) for the radio stream. More than one radio stream may be defined in the m3u file. You do not need to create this type of file yourself. Modify the **stationlist** file and run **create_stations.py**.

M3U files may also contain a simple list of file paths to media files. For example:

```
media/Steve Miller Band/Album onbekend/0726 Steve Miller Band - The
Joker.mp3
media/Stories/Album onbekend/Stories - Brother Louie.mp3
:
```

In this version of the radio the program knows that these are media files as opposed to radio playlists because they do not start with an underscore **'_'** which is the convention that the radio program uses for a radio playlist (It is not a general convention).

Note that in the above example **media** is a directory (or a link to it) in the **/var/lib/mpd/music** directory and that the **'/'** character is omitted.

PLS file format

A good place to start is the following Wikipedia article:

[http://en.wikipedia.org/wiki/PLS_\(file_format\)](http://en.wikipedia.org/wiki/PLS_(file_format))

A PLS playlist file does not contain any music files itself, but rather points to music files stored elsewhere. The PLS file format is often used to play Internet radio streams, for example, if you want to play a radio stream from Shoutcast, you can copy the PLS file URL of the station from the site and play it in a desktop media player like Winamp. A PLS file will be similar to below

```
[playlist]
NumberOfEntries=2
Version=2
File1=http://206.217.213.16:8430
Title1=Blues Radio UK
Length1=-1
File2=http://205.164.62.13:8030
Title2=Absolute Blues Hits
Length2=-1
```

The PLS file always starts with the **[playlist]** statement. The **NumberOfEntries** statement must match the number of streams defined in the PLS file (Two in the above example). Set the **Version** number always to 2. There is a **File_n**, **Title_n** and **Length_n** where **n** is the entry number.

ASX file

The Advanced Stream Redirector (ASX) format is a type of XML metafile designed to store a playlist of Windows Media files for a multimedia presentation. An example ASX file is shown below.

```

<ASX version="3.0">

<ABSTRACT>http://www.bbc.co.uk/iplayer/radio/bbc_radio_bristol/</ABSTRACT>
  <TITLE>BBC Bristol</TITLE>
  <AUTHOR>BBC</AUTHOR>
  <COPYRIGHT>(c) British Broadcasting Corporation</COPYRIGHT>
  <MOREINFO
  HREF="http://www.bbc.co.uk/iplayer/radio/bbc_radio_bristol/" />
  <PARAM NAME="HTMLView"
  VALUE="http://www.bbc.co.uk/iplayer/radio/bbc_radio_bristol/" />
  <Entry>
    <ref href="mms://wmlive-
  nonacl.bbc.net.uk/wms/england/lrbristol?BBC-
  UID=1523a2f20f858eb0ba0a4385918e6433df886bb650e021b4446ff486f8204e3a&SSO
  2-UID=" />
  </Entry>
</ASX>

```

Direct stream URLs

These URLs tend to end with .mp3 or _SC or AAC etc. However, there are others. For example:

```

http://mp3.streampower.be/radio1-high.mp3
http://7639.live.streamtheworld.com:80/977_MIX_SC

```

You can determine if a URL is a direct radio stream by using the **wget** program.

```

# cd /tmp
# wget http://mp3.streampower.be/radio1-high.mp3
--2014-03-14 13:08:10-- http://mp3.streampower.be/radio1-high.mp3
Resolving mp3.streampower.be (mp3.streampower.be)... 80.200.255.61
Connecting to mp3.streampower.be (mp3.streampower.be)|80.200.255.61|:80...
connected.
HTTP request sent, awaiting response... 200 OK
Length: unspecified [audio/mpeg]
Saving to: `radio1-high.mp3'

[          ]
365,281    15.8K/s

```

If **wget** doesn't exit and you see the <=> characters moving backwards and forwards then it is a URL to the radio stream itself. You will also see *Length: unspecified* in the output. Press control -C to exit **wget**. Remove the file that **wget** created (/tmp/radio-high.mp3 in this case).

Listening to live Air Traffic Control (ATC)

For those interested in aviation this is a fascinating use of the radio. Live ATC net provide streaming of live ATC transmissions from airports the world over. Their Web site is <http://www.liveatc.net/>

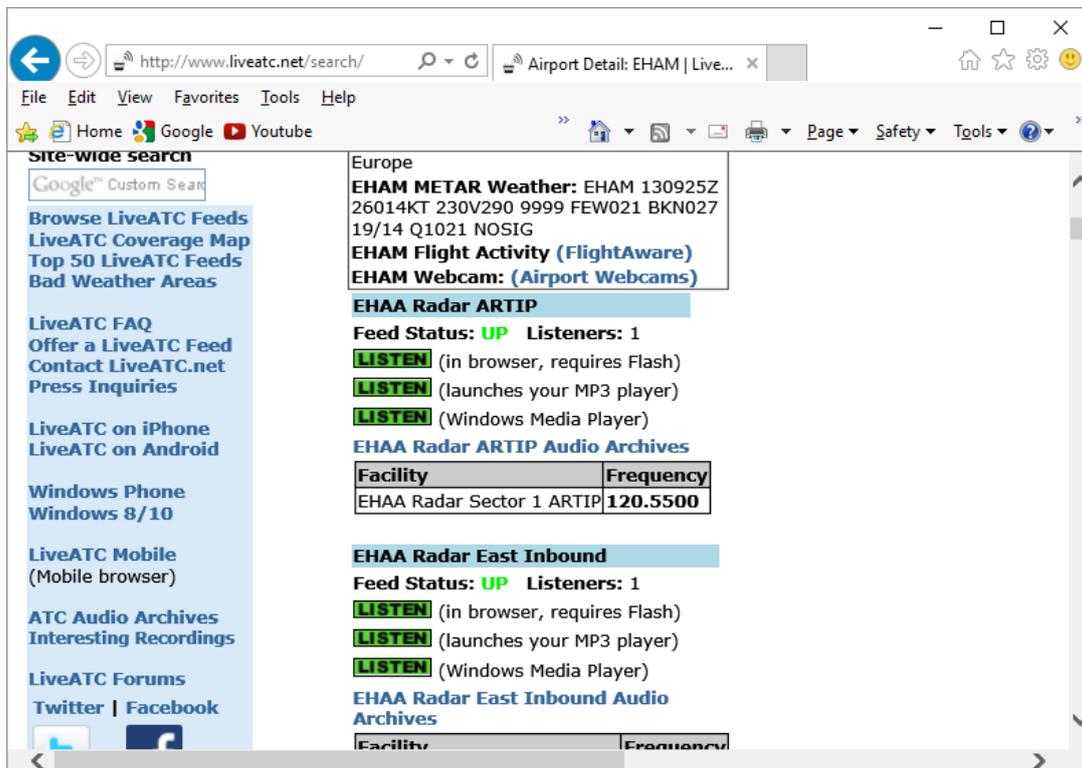


Figure 215 Live ATC Web page

Not only do these streams provide the live ATC conversations but also the in the station information ATIS (Aerodrome Terminal Information Service). This consists of coded weather information which all pilots can understand.

One way to add these stations to a radio playlist is to install **WinAmp** on a PC. Enter either the **ICAO** or **IATA** code of the station in the search box on the Live **ATC** Web site, for example **EHAM** or **AMS** (Schiphol, Amsterdam, the Netherlands) .

Click on the MP3 player **LISTEN** option. The station will be loaded and shortly **WinAmp** will start playing the stream.

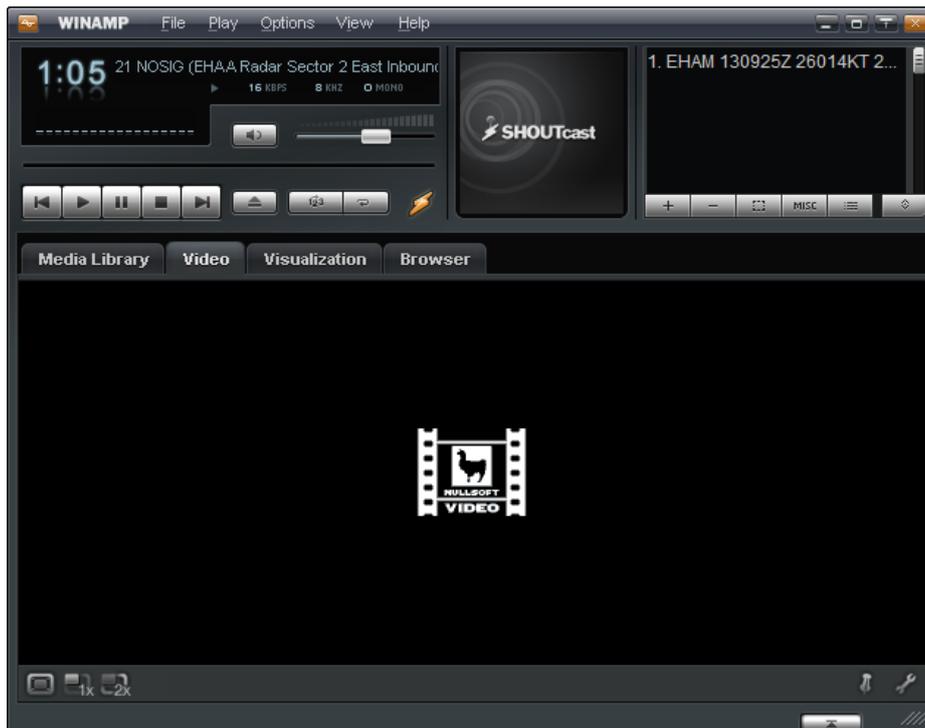


Figure 216 WinAmp playing ATC live feed

Right click in the top left box (Display elapsed time of 1:05 in this example). The station information will be displayed.

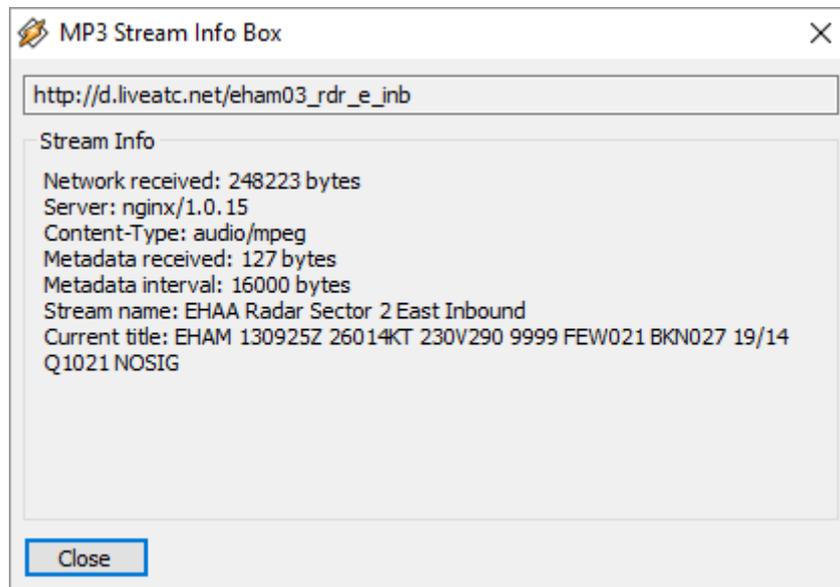


Figure 217 WinAmp station information

The URL for the stream is shown in the top box. **http://d.liveatc.net/eham03_rdr_e_inb**

The stream name is: EHAA Radar Sector 2 East Inbound

The station Title shows the ATIS information.

EHAM 130955Z 25016KT 9999 FEW020 BKN024 19/14 Q1021 NOSIG

Using the URL shown create a playlist to **`/var/lib/radiod/stationlist`** for the live traffic ATC as shown in the following example.

```
(Air traffic)
[EHAA Approach Departures] http://d.liveatc.net/eham4
[EHAA Radar Sector 2 East Inbound] http://d.liveatc.net/eham03_rdr_e_inb
[EHAA Radar SW] http://d.liveatc.net/eham02_rdr_sw
[EHAA Radar 3 South] http://d.liveatc.net/eham02_rdr_s
[EHEH Approach] http://d.liveatc.net/eheh2_app
[CYYT] http://d.liveatc.net/cyyt
[KJFK Gnd Tower] http://d.liveatc.net/kjfk_gnd_twr
[CYYZ Tower] http://d.liveatc.net/cyyz7
```

Now run the **create_stations.py** program to create the playlists.

```
$ cd /usr/share/radio
$ sudo ./create_stations.py
```

Now restart the radio or use the menu to reload the radio stations (Select source option):

```
$ sudo service radiod restart
```

Finally select the new ATC station(s).

Finding out ICAO and IATA airport codes

Try sites such as https://en.wikipedia.org/wiki/List_of_airports_by_ICAO_code:A

Decoding ATIS information

See site <http://www.dixwx.com/wxdecoding.htm> or search for ATIS/TAF/METAR decode.

In the following example:

EHAM 130955Z 25016KT 9999 FEW020 BKN024 19/14 Q1021 NOSIG

EHAM	Amsterdam Schiphol, the Netherlands
130955Z	13 th of the current month. Time 09:55 Zulu (UTC)
25016KT	Wind 250 degrees at 16 Knots
9999	Visibility 10 Kilometres or greater
FEW020	Few clouds at 2000 feet
BKN024	Broken cloud at 2400 feet
19/14	Temperature 19 degrees Celsius. Dew point 14 degrees Celsius
Q1021	Barometric pressure 1021 Millibars (Will be given in Inches Mg in US airports)
NOSIG	No significant weather.

Mounting a network drive

It is very likely that you may have your music on a shared network drive and want to play the music through the radio. There are two main types of network drive protocols used by Raspbian Buster on the Raspberry Pi namely:

- CIFS – Common Internet File System
- NFS – Network File System

The protocol used for CIFS is SMB (Server Message Block – Microsoft). Previously connections to SMB were via a product called SAMBA but has been largely replaced by the mount using the CIFS option in the Linux. The steps to mount the network drive are as follows:

1. Find out the IP address or network name of your network drive.
2. Create and test the mount command using either NFS or CIFS.
3. Copy the mount command to `/var/lib/radiod/share` file.
4. In the Radio menu select “Music Library” as the source and press “Menu” again to load
5. Update the playlists to include the files on the new share (Network drive).

This procedure assumes that you already have your Network Drive configured and working with your PC and can play music via the PC. In the examples below a Synology Network Drive was used with a volume called Volume1 with a directory called “music”. The IP address for the Synology Network drive used was 192.168.2.6.

First stop the Radio software when creating and testing the mount command.

Don't configure `/etc/fstab` to do the mount of the network drive. Although this is the usual way of mounting shares however the radio program needs total control of the mount and un-mount process.

The general syntax for the mount command is as follows:

```
mount -t <type> -o option1,option2,... <remote IP address and directory>
<mount point>
```

Where: `<type>` is either **nfs** or **cifs**.

-o option1,option2 are the mount options.

<remote IP address and directory> Is the IP address and music directory path

<mount point> This will always be `/share` for this program

Finding the IP address of the network drive

Only general guidance can be given here. Nearly all network drives have a Web interface. The IP address was almost certainly provided from DHCP in your home router. The IP address will be the IP address of the Web Interface. Look at your network drive documentation for further information.

The CIFS mount command

The following example mount command assumes that you have a guest user configured with password 'guest'. Adapt the command as required.

```
mount -t cifs -o username=guest,password=guest,uid=pi,gid=pi,vers=1.0
//192.168.1.6/music /share
```

The above command is all on one line. The **uid** and **gid** parameters set the ownership of the music files to user **pi**. The **vers** statement is the CIFS version and can be 1.0, 2.0 or 3.0 depending upon the NAS storage. The share directory is created when you first run the Radio program so there is no need to create it. If the command was successful you should be able to display the music from the network drive. Go to section called *Display the share directory* on page 239.

Older NAS drives sec security option

Older NAS drives may also require the **sec=ntlm** option to the **-o** line. The **sec** option is the authentication protocol and determines how passwords are encrypted between the server and client. Security mode **ntlm** used to be the default authentication method but that is now become **ntlmssp**. If you are accessing a network drive which doesn't support **ntlmssp** you have to add **sec=ntlm** to the options as shown below:

```
-o username=guest,password=guest,uid=pi,gid=pi,sec=ntlm
```

Many NAS devices use older technology so they often only use **ntlm** authentication. There are other authentication methods such as **ntlmv2** but most are not currently supported with the Raspberry Pi OS.

The NFS mount command

The following NFS mount example assumes the NFS protocol has been configured for the music directory.

```
mount -t nfs -o ro,noexec,nolock 192.168.1.6:/volume1/music /share
```

A few things to note here; the NFS mount command uses the volume name (volume1 – can vary), The CIFS mount command doesn't. The second thing is that the IP address and remote directory are separated by a colon (:). If the command was successful, you should be able to display the music from the network drive.

Display the share directory

If the mount was successful using either CIFS or NFS you should be able to display the **/share** directory with the **ls** command.

```
# ls -la /share
total 4
drwxrwxrwx 85 pi pi 0 May 10 14:18 .
drwxr-xr-x 23 root root 4096 Jul 15 17:57 ..
drwxrwxrwx 4 pi pi 0 May 10 14:16 Albert Hammond
drwxrwxrwx 3 pi pi 0 May 10 14:16 Alexander Curly
drwxrwxrwx 3 pi pi 0 May 10 14:16 Allen Price & Georgie Fame
drwxrwxrwx 3 pi pi 0 May 10 14:16 Al Martino
drwxrwxrwx 3 pi pi 0 May 10 14:16 Animals
drwxrwxrwx 4 pi pi 0 May 10 14:16 Aretha Franklin
drwxrwxrwx 3 pi pi 0 May 10 14:16 Armand
```

The important thing apart from seeing the files is that you should see that the files are owned by pi and group pi or whatever login name that you are using.

Un-mounting the /share directory

To un-mount the share directory use the **umount** command (not unmount).

```
# umount /share
```

Copy the mount command to the configuration

Once the mount command is working copy it to the **/var/lib/radiod/share** file.

For example for the CIFS mount command:

```
# echo "mount -t cifs -o username=guest,password=guest,uid=pi,gid=pi  
//192.168.1.6/music /share" > /var/lib/radiod/share
```

The above command is all on one line.



Note: If you decide to directly edit the **/var/lib/radiod/share** file instead of using the above command then do not include quotations marks around the command.

Loading the media playlists

Now run the radio program. The radio stations will normally be loaded. Cycle through the menu by pressing the menu button until **Input Source:** is displayed. Press the channel up or down buttons or rotate the Channel knob to select one of the media playlists previously created using the **create_playlist.sh** program as shown in the section *Creating Media playlists* on page 223.

Once the desired playlist has been selected, press the **Menu** button. The radio program loads the selected playlist and starts playing a track from it. The program does not know the last track number that was played previously for the selected playlist and will select the track number that it finds in the **/var/lib/radiod/current_track** file. If this track number is bigger than the newly selected playlist length it will reset the track number to 1.

Update the playlists for the new share

Select Music Library Now cycle through the menu until **Menu Selection:** is displayed. Press the channel up or down buttons until the **Update list:No** is displayed. Use the Volume buttons to toggle the display to **Update list:Yes**.

Now press the Menu button. This will cause the MPD database to be cleared and updated from all the files loaded in the **/var/lib/mpd/music** directory including the new share. This can take some time (Several minutes) if the Network Drive contains a large amount of music files. During this process the Radio program will ignore any button depressions and you will see the first **Initialising** (Library) and then **Updating** (Library).

Create a Playlist for the share

Now create a playlist for the new network share. See *Creating and Maintaining Playlist files* on page 218. DO NOT FORGET TO DO THIS.

Disabling the share

To disable the share simply put a hash character (#) at the beginning of the line in the **/var/lib/radiod/share** file as shown in the example below. Alternatively remove the share file altogether.

```
# mount -t cifs -o username=guest,password=guest,vers=1.0
//192.168.1.6/music /share
```

Further information

Mount points

For your information if you display the `/var/lib/mpd/music` directory you will see two soft links to the `/share` and `/media` directories for the network drive and USB stick respectively. You may also see a link called `sdcard` to the location of the music library on the SD card.

```
$ ls -la /var/lib/mpd/music/total 8
drwxr-xr-x 2 root root 4096 Jul 7 12:37 .
drwxr-xr-x 4 mpd audio 4096 Apr 7 11:02 ..
lrwxrwxrwx 1 root root 6 Jul 7 12:17 media -> /media
lrwxrwxrwx 1 root root 16 Jul 7 12:37 sdcard -> /home/pi/mymusic
lrwxrwxrwx 1 root root 6 Jul 7 12:17 share -> /share
```

These links are created automatically by the Radio program. If these are missing they can be re-created with the `ln -s` command.

```
$ cd /var/lib/mpd/music
$ sudo ln -s /media
$ sudo ln -s /share
$ sudo ln -s /home/pi/mymusic sdcard
```

This shouldn't normally be necessary as the links are created by the program when it creates the media and share mount points.

Troubleshooting mount problems

See section called *Cannot mount remote network drive* on 262.

Controlling the Music Player daemon from Mobile devices

Android devices

There are a number of Android Apps capable controlling the Music Player Daemon from an Android such as a smart-phone or tablet. One of the most popular seems to be **MPDdroid** See the following link: <https://github.com/abarisain/dmix/releases> or download from the Android Play Store.

MPDdroid allows you to control a MPD server (Music Player Daemon) and stream from it. It is a fork from an earlier program called **Pmix** and adds various new features and streaming support. The radio daemon is completely integrated with MPD clients such as **mpc** and **MPDdroid**

Load the MPDdroid App use the Google Play Store on your device. Go to the settings menu and select **WLAN based connection**. Select **Host** and fill in the IP address of the radio and press OK. Set up the **Streaming url suffix** to **mpd.mp3**.

All other settings can be left at their defaults.

Keep pressing the back button to exit and then restart the MPDdroid App. The play screen should be displayed as shown below. Volume, pause, fast forward/back can all be controlled from this screen.

To switch to the playlist, drag the play screen to the left. The current station list or play list will be displayed. Tap on the desired station or track to play it. Drag the play screen to the right to return to the play screen.

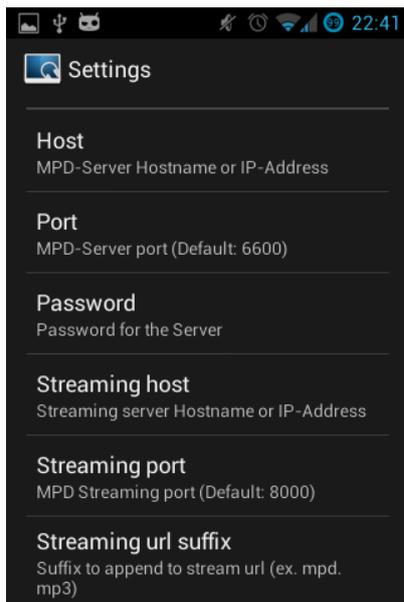


Figure 218 MPDdroid set-up screen

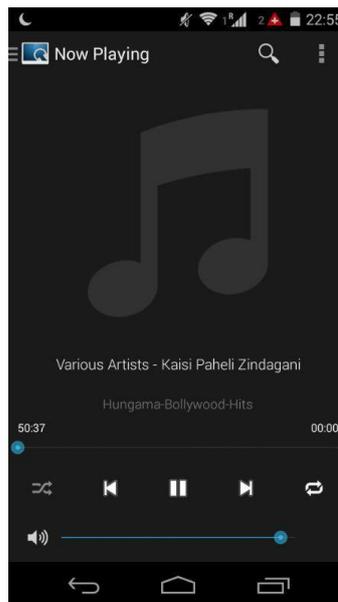


Figure 219 MPDdroid play screen

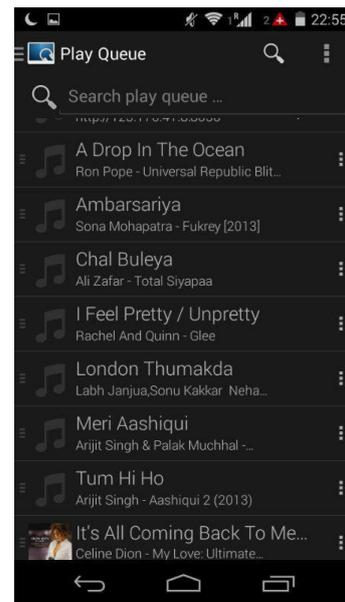


Figure 220 MPDdroid play queue



Note: MPDdroid is third party software and no support can be provided by bobrathbone.com.

Apple devices

Download **mPod – MPD Remote Control Software** from the Apple store or at following link: <http://antipodesaudio.com/mpd.html> . Run **mPod**, it will automatically find the Raspberry Pi running the Music Player daemon.

Chapter 9 -Troubleshooting

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Also see the section called *Using the diagnostic programs* on page 274. If you need to create a log file in DEBUG mode, see the procedure for doing this on page 282.

Boot problems

Newly created desktop version of Raspberry Pi OS will not boot

This is a very recent problem. After creating a new SD card using Raspberry Pi OS (32 bit) dated 1st January 2022 the Raspberry Pi will not boot.

This appears to have started in March 2022. It even seems to be trying to reboot several times. This has been experienced on the Raspberry Pi 4B. Other models may also be affected. This appears to be a problem with new DRM VC4 V3D screen driver (**vc4-kms-v3d**).

Insert the SD card into a PC. The PC will display a boot partition as shown in the example below:

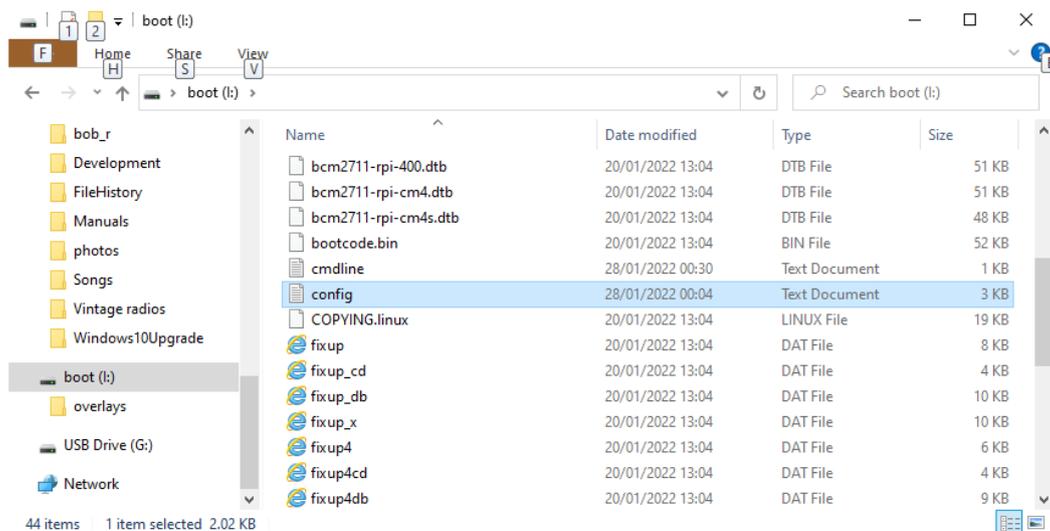


Figure 221 SD card boot partition

In the above example this is on drive I: but will most likely be different on your PC. Find the config file (config.txt) on the boot drive and open it with **Notepad** or any other text editor. Find the entry **dtoverlay=vc4-kms-v3d**.

```
# Enable DRM VC4 V3D driver
#dtoverlay=vc4-kms-v3d
max_framebuffers=2
```

Either disable the driver by putting a # character at the beginning of the line or use the older **vc4-fkms-v3d** dtoverlay as shown below

Using the older **vc4-fkms-v3d** dtoverlay:

```
dtoverlay=vc4-fkms-v3d
```

Save the file and try booting off the modified SD card. All being well it should reboot OK. If not look for other causes as shown in the rest of this section.

The Raspberry Pi will not boot from a previously good SD card

This is always worrying if this happens but doesn't always mean that the situation is irrecoverable. It often indicates a SD card corruption problem. Connect the HDMI output of the Raspberry Pi to the HDMI input of a TV set and attach a USB keyboard. Reboot the Pi. If you see the following:

```
[...] An automatic file system check (fsck) of the root filesystem failed.
A manual fsck must be performed, then the system restarted. The fsck should
be performed in maintenance mode with the root filesystem mounted in read-on
[FAIL] ... failed!
[warn] The root filesystem is currently mounted in read-only mode. A
maintenance shell will now be started. After performing system maintenance,
please CONTROL-D to terminate the maintenance shell and restart the system.
... (warning).
sologin: root account is locked, starting shell
root@raspberrypi:~#
```

You are asked to press enter which brings up the dollar \$ prompt

```
Cannot access console, press enter to continue
$
```

Enter a root password that you can remember.

```
$ sudo passwd root
Enter new UNIX password:
Retype new UNIX password:
Password successfully changed
$ sudo reboot
```

When reboot has finished you will be asked to enter the root password you just entered which will take you to the # prompt. Then run the following commands:

```
# umount /
# fsck -y /dev/mmcblk0p2
```

This will, with luck, correct the file system. When **fsck** has finished reboot the system. Once rebooted use **vi** or **nano** to modify **/etc/default/rcS**. Add the following line to **/etc/default/rcS**.

```
# automatically repair filesystems with inconsistencies during boot
FSCKFIX=yes
```

Finally reboot the Raspberry Pi.

```
$ sudo reboot
```

Corrupt SD card

If experiencing boot problems, a corrupt SD card cannot be ruled out. See Advanced topics - *Repairing a non-bootable SD card* on page 336. If all of the above efforts fail to resolve the problem try installing the **Raspberry Pi OS** on a different SD card.

Installation problems

Missing package dependency problems

If an attempt is made to install the radio software without first installing **mpd** and **python3-mpd** the following maybe be seen:

```
dpkg: dependency problems prevent configuration of radiod:
radiod depends on python-mpd; however:
  Package python3-mpd is not installed.
radiod depends on mpc; however:
  Package mpc is not installed.
radiod depends on mpd; however:
  Package mpc is not installed.
```

The following may also be seen:

```
radiod depends on python2; however:
  Package python2 is not installed.
radiod depends on python-configparser; however:
  Package python-configparser is not installed.
```

To correct this run:

```
$ sudo apt install python3-mpd
$ sudo apt install python-configparser python2
```

Then run

```
$ sudo apt install --fix-broken
```

Confused or unsure of wiring

All wiring is configurable in **/etc/radiod.conf**. The physical wiring must match the configuration in the configuration file. Run the **wiring.py** program (See page 279). Adapt either the configuration or wiring to match each other. The configuration in **/etc/radiod.conf** uses GPIO numbers and not physical pin numbers. If you are unsure how you have wired a button or rotary encoder this can be confirmed by running the **test_gpios.py** program. See *The test_gpios program* on page 280.

Unexpected message during an upgrade

It is possible one of the files has been changed in a new package. For example:

```
Configuration file `/etc/logrotate.d/radiod'
==> Deleted (by you or by a script) since installation.
==> Package distributor has shipped an updated version.
What would you like to do about it ? Your options are:
  Y or I : install the package maintainer's version
  N or O : keep your currently-installed version
  D      : show the differences between the versions
  Z      : start a shell to examine the situation
The default action is to keep your current version.
*** radiod (Y/I/N/O/D/Z) [default=N] ? Y
Installing new version of config file /etc/logrotate.d/radiod ...
:
```

If you see this enter a Y to install the new file unless you have a good reason not to do so.

Network problems

Checking the network quality

Connect a screen or a TV and keyboard to the Raspberry Pi. Check the network with the **ip** tool. Run **ip addr** or press the menu button until the information screen is displayed with the IP address(es).

```
$ ip addr
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group
default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc mq state UP group
default qlen 1000
    link/ether dc:a6:32:05:36:9b brd ff:ff:ff:ff:ff:ff
    inet 192.168.1.152/24 brd 192.168.1.255 scope global noprefixroute eth0
        valid_lft forever preferred_lft forever
    inet6 fe80::fe6a:9f30:4326:57d1/64 scope link
        valid_lft forever preferred_lft forever
3: wlan0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state
UP group default qlen 1000
    link/ether dc:a6:32:05:36:9c brd ff:ff:ff:ff:ff:ff
    inet 192.168.1.153/24 brd 192.168.1.255 scope global noprefixroute wlan0
        valid_lft forever preferred_lft forever
    inet6 fe80::4c8b:8a00:e1d1:cd27/64 scope link
        valid_lft forever preferred_lft forever
```

The above example shows the Wi-Fi and Ethernet IP addresses.

Display the route to the Router using **ip route**.

```
$ ip route
default via 192.168.1.254 dev eth0 proto dhcp src 192.168.1.152 metric 202
default via 192.168.1.254 dev wlan0 proto dhcp src 192.168.1.153 metric 303
192.168.1.0/24 dev eth0 proto dhcp scope link src 192.168.1.152 metric 202
192.168.1.0/24 dev wlan0 proto dhcp scope link src 192.168.1.153 metric 303
```

The above example shows the route between Wi-Fi and Ethernet interfaces and the IP address of the Router (192.168.1.254).

If the problem is with Wi-Fi check the **/etc/wpa_supplicant/wpa_supplicant.conf** configuration file.

```
$ cat /etc/wpa_supplicant/wpa_supplicant.conf
ctrl_interface=DIR=/var/run/wpa_supplicant GROUP=netdev
update_config=1
country=GB

network={
    ssid="<Your-SSID>"
    psk="<Your-Router-Password>"
    key_mgmt=WPA-PSK
}
```

Checking the Wi-Fi signal strength

If using the Wi-Fi interface, the signal strength received by the Raspberry Pi can be checked either one of the readily available mobile Wi-Fi signal apps or with the `display_wifi.sh` program supplied with the radio software. Good Wi-Fi signal strength is required for the operation of the radio. Run the following commands:

```
$ cd /usr/share/radio/  
$ ./display_wifi.sh
```

This will display the main information about the Wi-Fi signal.

```
Wi-Fi network information  
-----  
Hostname: pizen  
Wi-Fi: wlan0 ESSID:"EE-Hub-4qM4"  
IP address wlan0: 192.168.1.95  
wlan0 Protocol Name:"IEEE 802.11"  
Current Frequency:2.437 GHz (Channel 6)  
Bit Rate=72.2 Mb/s Tx-Power=31 dBm  
Link Quality=70/70 Signal level=-26 dBm  
Power save: on  
0: phy0: Wireless LAN  
    Soft blocked: no  
    Hard blocked: no  
1: hci0: Bluetooth  
    Soft blocked: no  
    Hard blocked: no
```

In the above example the name of the router (ESSID: TP-Link), the Wi-Fi interface (wlan0) IP address, protocol, frequency and channel are displayed. Lastly the really important information is the Tx-Power value in Decibels (dBm). If phy0 is blocked use “rfkill unblock 0” to enable it.

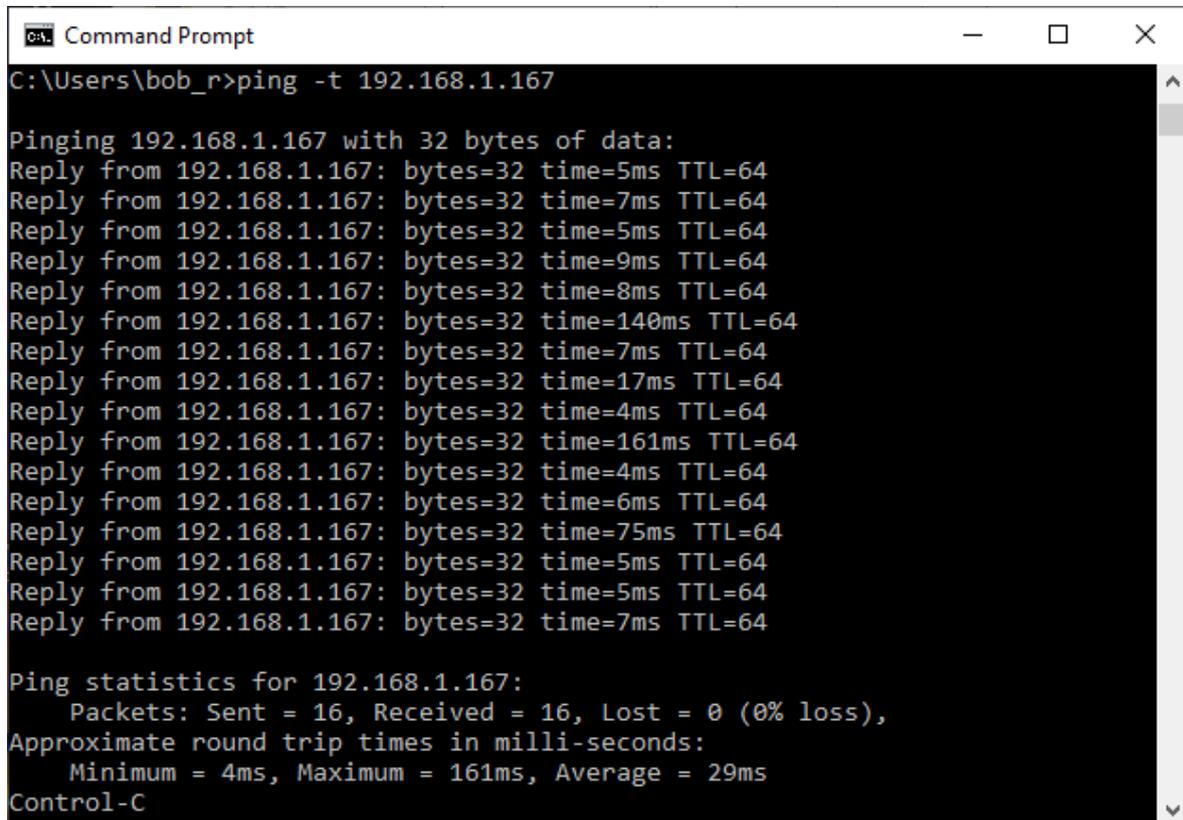
Table 26 Wi-Fi signal strength

Signal strength	Signal quality	Notes
-30 dBm	Maximum signal strength, usually attained if the RPi is very close to the Wi-Fi access point	Excellent for all services
-50 dBm	Anything down to this level can be regarded as excellent signal strength	Excellent for all services
-60 dBm	This is still a good, reliable signal strength	Good for all services
-67 dBm	This is the minimum value for all services that require smooth and reliable data traffic.	Minimum required for streaming services including for the radio
-70 dBm	The signal is not very strong, but mostly sufficient.	Only good for Web browsing, email, and the like
-80 dBm	Minimum value required to make a connection. You cannot count on a reliable connection or sufficient signal strength to use services at this level	The radio will not work reliably at this level
-90 dBm	It is very unlikely that you will be able to connect or make use of any services with this signal strength.	The radio cannot operate reliably at this level.

If the signal strength is poor, try re-positioning the radio nearer the router or use a repeater (TP-Link or similar). Position away from radiators or other large metal objects such as fridges and freezers.

Checking response times with ping

Check the response times using the ping command from a PC or another Raspberry Pi. If possible, connect the PC/RPi via an Ethernet cable to the router rather than via Wi-Fi.



```
ca. Command Prompt
C:\Users\bob_r>ping -t 192.168.1.167

Pinging 192.168.1.167 with 32 bytes of data:
Reply from 192.168.1.167: bytes=32 time=5ms TTL=64
Reply from 192.168.1.167: bytes=32 time=7ms TTL=64
Reply from 192.168.1.167: bytes=32 time=5ms TTL=64
Reply from 192.168.1.167: bytes=32 time=9ms TTL=64
Reply from 192.168.1.167: bytes=32 time=8ms TTL=64
Reply from 192.168.1.167: bytes=32 time=140ms TTL=64
Reply from 192.168.1.167: bytes=32 time=7ms TTL=64
Reply from 192.168.1.167: bytes=32 time=17ms TTL=64
Reply from 192.168.1.167: bytes=32 time=4ms TTL=64
Reply from 192.168.1.167: bytes=32 time=161ms TTL=64
Reply from 192.168.1.167: bytes=32 time=4ms TTL=64
Reply from 192.168.1.167: bytes=32 time=6ms TTL=64
Reply from 192.168.1.167: bytes=32 time=75ms TTL=64
Reply from 192.168.1.167: bytes=32 time=5ms TTL=64
Reply from 192.168.1.167: bytes=32 time=5ms TTL=64
Reply from 192.168.1.167: bytes=32 time=7ms TTL=64

Ping statistics for 192.168.1.167:
    Packets: Sent = 16, Received = 16, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 4ms, Maximum = 161ms, Average = 29ms
Control-C
```

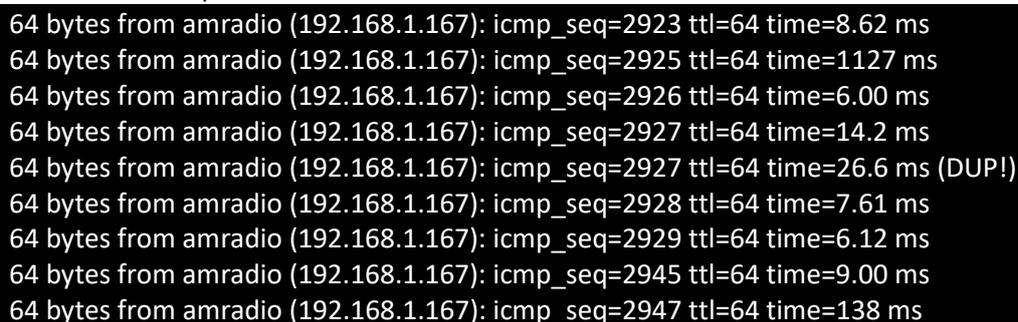
Figure 222 The ping command

Typical response times are:

Via Ethernet cable - < 1 ms

Via Wi-Fi - 5 to 12 ms with occasional responses < 300 ms

Below is an example of a **bad** network connection.



```
64 bytes from amradio (192.168.1.167): icmp_seq=2923 ttl=64 time=8.62 ms
64 bytes from amradio (192.168.1.167): icmp_seq=2925 ttl=64 time=1127 ms
64 bytes from amradio (192.168.1.167): icmp_seq=2926 ttl=64 time=6.00 ms
64 bytes from amradio (192.168.1.167): icmp_seq=2927 ttl=64 time=14.2 ms
64 bytes from amradio (192.168.1.167): icmp_seq=2927 ttl=64 time=26.6 ms (DUP!)
64 bytes from amradio (192.168.1.167): icmp_seq=2928 ttl=64 time=7.61 ms
64 bytes from amradio (192.168.1.167): icmp_seq=2929 ttl=64 time=6.12 ms
64 bytes from amradio (192.168.1.167): icmp_seq=2945 ttl=64 time=9.00 ms
64 bytes from amradio (192.168.1.167): icmp_seq=2947 ttl=64 time=138 ms
```

A DUP can be seen (packet resent as no response the first one received). Also, the 2nd packet sent took 1.127 seconds to respond.

The above network will give nothing but problems and needs correction. Wired Ethernet connections are very unlikely to give a problem. For a bad Wi-Fi connection consider using a Wi-Fi repeater, such as TP-Link or Netgear, for blind spots in your premises. Put the repeater close to the

Raspberry Pi. Search “bad wi-fi” on the Internet for further advice on how to solve this type of problem.

Reboot your router

If you are getting poor ping responses on a Wi-Fi network it is worth re-setting your Wi-Fi router. Switch off your router for at least a minute and then power up the router again. This has been known to cure poor ping responses and problems with the radio.

If you are using Wi-Fi repeaters then also do a power reset on these devices as well.

Checking the Internet connection

The previous section shows if there is a network connection or not. But this only shows connectivity to the Local Area Network (LAN) which is just the Internet Router and local devices and does not mean there is connection across the Internet itself. This can be easily checked with the **host** command as shown below.

```
$ host google.com
google.com has address 216.58.206.142
google.com has IPv6 address 2a00:1450:4009:811::200e
google.com mail is handled by 20 alt1.aspmx.l.google.com.
google.com mail is handled by 10 aspmx.l.google.com.
:
```

The radio software contains a more sophisticated check which is configured in **/etc/radiod.config**.

```
# Internet check URL. This must be a reliable URL and port number
# which can be contacted such as google.com
# The port number is normally 80 (HTTP).
# The internet_timeout in in seconds
# Disable by removing the URL from internet_check_url= parameter
internet_check_url=google.com
internet_check_port=80
internet_timeout=10
```

The radio program regularly checks for a good Internet connection when playing a radio stream across the network. If you find this check is a problem it can be disabled by removing the URL (google.com)

```
internet_check_url=
```

Wi-Fi is currently blocked by rfkill.

No Wi-Fi network is available and the following message is shown during login:

```
Wi-Fi is currently blocked by rfkill.
Use raspi-config to set the country before use.
```

Running the **raspi-config** network set-up doesn't cure the problem. Run the **rfkill** utility to confirm the problem.

```
$ sudo rfkill list all
0: phy0: Wireless LAN
   Soft blocked: yes
   Hard blocked: no
```

```
1: hci0: Bluetooth
    Soft blocked: no
    Hard blocked: no
```

The above display confirms that the Wi-Fi network is blocked. Unblock it with **rfkill**:

```
$ sudo rfkill unblock 0
```

Wireless network keeps dropping out

The Raspberry Pi powers off the Wi-Fi adapter if it has been idle for some time. Normally the Wi-Fi adapter is in constant use when streaming a radio station but can become idle when muted.

You may see on-line documentation which asks you to add the following line to **/etc/network/interfaces**. However, this does not work for **Buster** or later.

```
wireless-power off
```

To disable Wi-Fi power management, add the following line to the end of **/etc/rc.local** just before the **exit 0** statement.

```
:
sudo iw dev wlan0 set power_save off
exit 0
```

After reboot the Wi-Fi power save state can be displayed with the following command.

```
$ iw dev wlan0 get power_save
Power save: off
```

Cannot find my Raspberry Pi

A very handy tool for checking devices connected to your network is the **Fing** App. This runs on both Android and Apple devices. See section *Finding the Raspberry Pi on a network using Fing* on page 76. More information on Fing can be found at <https://www.fing.com/products/fing-app>.

HDMI/Touchscreen problems

Screen size error

The following may be seen in the logging when running the graphics version of the radio (gradio or vgradio).

```
gradio screen size error: No video mode large enough for 1024x600
```

The problem is that the screen size for the display being used has not been correctly set. There are three places this must be set. In the following example the graphics screen has a resolution of 720 x 480 pixels.

Edit the **hdmi_cvt** parameter in **/boot/config.txt** (may vary).

```
hdmi_cvt=720 480 60 1 0 0 0
```

Make sure that the resolution specified matches your device. This is 720x480 in the above example.

Set the console to the same size.

```
framebuffer_width=720
framebuffer_height=480
```

Finally edit `screen_size` parameter in the [SCREEN] section of `/etc/radiod.conf`.

```
screen_size=720x480
```

HDMI/Touchscreen radio does not start

Make sure that the LCD/TFT version of the radio isn't running. Stop and disable it with the following commands:

```
$ sudo systemctl stop radiod
$ sudo systemctl disable radiod
$ sudo reboot
```

If it is not starting on reboot then re-run the `configure_radio.sh` program as shown in the section *Configuring the radio* on page 105. Select the option to start the program at boot time.

There is a file called `/home/pi/.config/lxsession/LXDE-pi/autostart`. This is where desktop applications are started from.

```
@lxpanel --profile LXDE-pi
@pcmanfm --desktop --profile LXDE-pi
@xscreensaver-no-splash@point-rpi
@sudo /usr/share/radio/gradio.py
```

The last line starts `gradiod.py` at boot time. It has been known for the above file to disappear. Re-create it as shown above.

Test the graphic version of the radio

Open a terminal window. The pi user prompt should be displayed. Now run the following

```
$ cd /usr/share/radio
$ sudo ./gradio.py
```

The graphical version of the radio should start. If it doesn't, it should display the problem.

```
Traceback (most recent call last):
  File "./gradio.py", line 46, in <module>
    from gcontrols_class import *
  File "/usr/share/radio/gcontrols_class.py", line 22, in <module>
    from sgc.widgets.base_widget import Simple
  File "/usr/share/radio/sgc/__init__.py", line 19, in <module>
    import surface
  File "/usr/share/radio/sgc/surface.py", line 10, in <module>
    import pygame.display
ImportError: No module named pygame.display
```

In the above example the `python-pygame` package is missing. The solution is to install it.

```
$ sudo apt install python-pygame
```

Re-test gradio.py

HDMI/Touchscreen is displaying upside-down

The standard orientation is with the connectors for power and HDMI at the bottom of the screen. However, with the official Raspberry case, it has the cables at the top. If the screen is displaying upside-down then edit the **/boot/config.txt** configuration file and add the following line.

```
lcd_rotate=2
```

Note: you must disable the *DRM VC4 V3D driver* as shown on page 90 for this to work. Reboot the Raspberry Pi for the changes to take effect.

See the following guide:

<https://www.modmypi.com/blog/raspberry-pi-7-touch-screen-assembly-guide>

The touch screen displays a lightning symbol

This is an under-voltage warning. See:

<https://www.raspberrypi.org/documentation/configuration/warning-icons.md>

Use at least a 1.5 ampere (1500 mA) power supply.

The touch screen displays a thermometer symbol

The Raspberry Pi is getting too hot. Improve airflow to the Raspberry Pi. Do not ignore this warning.

Sound is heard but the graphical radio program will not start

This is almost certainly due to the fact that the **radiod** service is running. Either re-run the **configure_radio.sh** program to reconfigure or run the following commands.

```
$ sudo systemctl stop radiod  
$ sudo systemctl disable radiod
```

The HDMI/Touchscreen program only displays a blue screen

This is due to missing scratch files in **/usr/share/scratch/Media** directory. To correct this install scratch as shown in the section called *Install the Scratch and rpd-* on page 98 or change the .

Cannot launch Graphical radio by clicking on the Desktop Icon

This is almost certainly because the gradio.desktop vgradio.desktop files in the home Desktop folder are not executable. To correct this do the following

```
$ cd /home/pi/Desktop  
$ sudo chmod +x gradio.desktop vgradio.desktop
```

It should now be possible to launch the radio from either desktop icon by double-clicking it.

Clicking on one of the radio desktop icon asks for an execution option

When attempting to launch the graphical radio programs the following is seen.

```
This text file seems to be an executable script "what do you want to do with it"
```

This is a minor irritation. To run the program just click on Execute.

To disable this behaviour, do the following:

1. On the Windows desktop click on File manager (Folder Icon top left)
2. Move to the home **Desktop** folder by double clicking it
3. Highlight **gradio.desktop** file
4. Select Edit on the top left of the screen then *Preferences* → *General*
5. Un-tick the option "Don't ask options on launch executable file"
6. Close the *Preferences* window
7. Highlight **vgradio.desktop** file and repeat the above steps 4 through 7

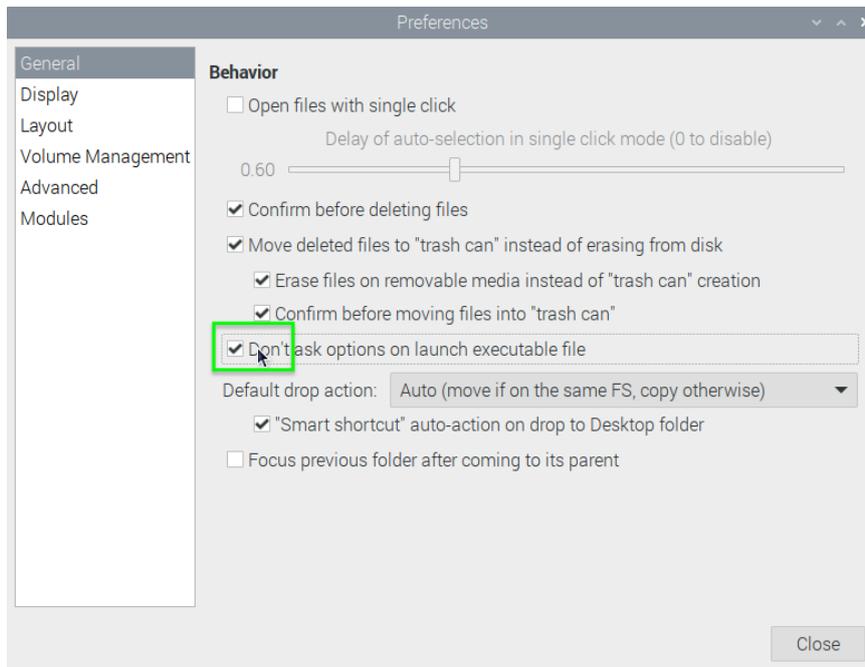


Figure 223 Desktop gradio/vgradio startup options

You may also want to click on "Open files with a single click". Close the window. Retry clicking on either of the Radio desktop icons. The program should be executed straight away.

Touch-screen unreliable operation

When clicking on the various controls of the graphical radio or desktop either the button clicked doesn't work at all or is unreliable.

This is most likely due to the **vc4-kms-v3d** driver (dtoverlay) configured in **/boot/config.txt** configuration file.

Disable the **vc4-kms-v3d** driver as shown in the section called *Disabling the DRM VC4 V3D driver* on page 90.

Trouble shooting problems with MPD

Most problems are due to the following:

- Incompatibility with the **pulseaudio** package
- Sound mixer volume set to zero or very low volume
- Incorrect setup of the **/etc/mpd/mpd.conf** file
- Incorrect setup of the **/etc/asound.conf**
- If using a sound card, no driver loaded in **/boot/config.txt**
- The Raspberry Pi audio is configured to use the **HDMI** output instead of the output jack or sound card.

Check the audio jack cable first before doing anything else.

The **/var/log/mpd/mpd.log** file is the place to look first if all other things seem normal.

Remove the **pulseaudio** package unless required for Bluetooth audio devices.

```
$ sudo apt remove pulseaudio
```

Re-run the **configure_audio.sh** program as shown in the section *Configuring the audio output* on page 116. You must do this to configure MPD to work with pulseaudio.

If using the onboard audio output there should not be a problem. The standard **/etc/mpd.conf** settings should be OK. Only if pulse audio is not removed or the Alsa mixer volume is not set can it lead to lack of sound. See *Installing pulseaudio* on page 103 .

If using a USB or HiFiBerry DAC:

1. Check to see if the DAC is visible using **aplay -l** command
2. Check that the **/etc/mpd.conf** is correctly configured.
3. Check that the mixer volume is correctly set.
4. For HiFiBerry DAC ensure **/boot/config.txt** contains the correct **dtoverlay** statement.

See *Configuring sound devices* on page 128.

MPD fails to install

During installation of MPD some files return a 404 error (Not found) the following message is seen.

```
Unable to fetch some archives, maybe run apt update or try with -fix-missing?
```

This is due to that an update was not previously carried out as shown in the section called *Update to the latest the packages* on page 90. Perform the update and upgrade as shown and re-install MPD and MPC.

Music Player Daemon won't start

The MPD daemon logs to the **/var/log/mpd/mpd.log** file. Examine this file for errors. The MPD daemon is dependent on good M3U files so check that these are correct as described in the section called *Creating and Maintaining Playlist files* on page 218.

Missing configuration file in mpd.service file

This is normally only a problem with the upgraded version (0.22.x onwards) of MPD.

```
$ sudo systemctl start mpd
Job for mpd.service failed because the control process exited with error
code.
See "systemctl status mpd.service" and "journalctl -xe" for details.
```

Check the status

```
$ systemctl status mpd.service
● mpd.service - Music Player Daemon
   Loaded: loaded (/usr/local/lib/systemd/system/mpd.service; disabled;
 vendor preset: enabled)
   Active: failed (Result: exit-code) since Fri 2020-05-29 19:30:19 BST;
 1min 41s ago
     Docs: man:mpd(1)
           man:mpd.conf(5)
   Process: 1060 ExecStart=/usr/local/bin/mpd --no-daemon (code=exited,
 status=1/FAILURE)
   Main PID: 1060 (code=exited, status=1/FAILURE)

May 29 19:30:19 buster03 systemd[1]: Starting Music Player Daemon...
May 29 19:30:19 buster03 mpd[1060]: exception: No configuration file found
May 29 19:30:19 buster03 systemd[1]: mpd.service: Main process exited,
code=exited, status=1/FAILURE
May 29 19:30:19 buster03 systemd[1]: mpd.service: Failed with result 'exit-
code'.
May 29 19:30:19 buster03 systemd[1]: Failed to start Music Player Daemon.
```

In this case `/usr/local/bin/mpd` cannot find `/etc/mpd.conf`. Check that the `ExecStart` statement in `/usr/local/lib/systemd/system/mpd.service` contains the configuration file name.

```
ExecStart=/usr/local/bin/mpd --no-daemon /etc/mpd.conf
```

Missing Libraries cause service start to fail

This is normally only a problem with the upgraded version (0.22.x) of MPD.

A message similar to the following shows that one or more required libraries are missing.

```
$ sudo systemctl status mpd.service
● mpd.service - Music Player Daemon
  :
Apr 12 01:54:59 buster04 mpd[3460]: /usr/local/bin/mpd: error while loading
shared libraries: libao.
Apr 12 01:54:59 buster04 systemd[1]: mpd.service: Main process exited,
code=exited, status=127/n/a
Apr 12 01:54:59 buster04 systemd[1]: mpd.service: Failed with result 'exit-
code'.
Apr 12 01:54:59 buster04 systemd[1]: Failed to start Music Player Daemon.
```

Solution: Install the pre-requisite libraries as shown in the section called *Installing the MPD upgrade from a Debian package* on page 170.

Reset failed units mpd service units. and recheck.

```
$ sudo systemctl reset-failed mpd.socket mpd.service
```

Restart mpd service.

```
$ sudo systemctl start mpd.service
```

Re-check the mpd service.

```
$ sudo systemctl status mpd.service
● mpd.service - Music Player Daemon
   Loaded: loaded (/usr/local/lib/systemd/system/mpd.service; enabled;
   vendor preset: enabled)
   Active: active (running) since Mon 2021-04-12 02:06:32 HDT; 2min 29s ago
   :
 Apr 12 02:06:32 buster04 systemd[1]: Started Music Player Daemon.
```

Finally remove any redundant libraries

```
$ sudo apt autoremove
```

The MPD program may display a socket error

When starting the MPD daemon the following message is seen:

```
Starting Music Player Daemon: mpdlisten: bind to '[:,:1]:6600' failed: Failed
to create socket: Address family not supported by protocol (continuing
anyway, because binding to '127.0.0.1:6600' succeeded)
```

If this message is seen in the MPD log file this is simply because IP version 6 (IPv6) isn't installed so the message doesn't affect operation of the MPD. To prevent it from happening configure the *bind_to_address* parameter in the **/etc/mpd.conf** file to "any". The installation procedure should normally set this anyhow.

The MPD daemon complains about the avahi daemon

The following message is seen in the **/var/log/mpd/mpd.log** file

```
Apr 10 15:37 : avahi: Failed to create client: Daemon not running.
```

It would be normal to change the **zeroconf_enabled** parameter in the **/etc/mpd.conf** file to "yes" to overcome this. The Avahi daemon is used in small local networks (such as a home LAN). The avahi-daemon process handles **mDNS** (Multicast DNS), which is used for name resolution and service discovery within the local network. The default for MPD is to disable

Since version 7.1 onwards the following will be seen in **/var/log/mpd.log**:

```
zeroconf: No global port, disabling zeroconf
```

This is not an error. This is because the radio is now using **mpd.socket** in addition to **mpd.service**. The **mpd.socket** service starts the **mpd.service** as required so that multiple applications can access MPD. In the case of the radio this is either **radiod** or the Web service for the radio.

Radiod → mpd.socket → mpd.service

Changing `zeroconf_enabled` to “yes” will have no effect as it will be automatically disabled as `mpd.socket` is being used. By the way zeroconf is the generic term for any service providing mDNS such as Avahi (Linux) or Bonjour (Apple) etc.

LCD Problems

LCD screen not showing anything

Check that the wiring conforms to the *wiring list* on page 31. Make sure that pin 3 is grounded (0V) to give maximum contrast or if a contrast potentiometer is fitted then make sure it is at the maximum setting. Make sure the correct Radio variant has been selected. Re-run the `configure_radio.sh` program as shown in the section *Configuring the radio* on page 105.

Run the `test_lcd.py` program to see if the LCD displays anything. This runs independently of any other software and can be used stand alone. Run the `wiring.py` program (See page 279).

The LCD only displays hieroglyphics

This can be caused by incorrect wiring of the LCD. This problem has also been experienced with faulty LCD hardware particularly when re-booting the Raspberry PI.

Check the wiring conforms to the *wiring list* on page 31. In particular check the data lines to pins 11, 12, 13 and 14 (See LCD wiring on page 40). Retest the LCD using the `test_lcd.py` program. If the wiring is correct run the `configure_radio.sh` script to select the correct revision of the board and restart the program. Run the `wiring.py` program (See page 279).

The LCD displays hieroglyphics or goes blank occasionally

If the LCD is normally working OK but goes wrong when switching on and off lights this is due to Electromagnetic Interference (EMI). See the section *Preventing electrical interference* on page 70.

LCD backlight not working

Check that pins 15 and 16 of the LCD display have +5V and 0V (GND) respectively. See section called *Using KY040 Rotary encoders* on page 41

LCD only displays dark blocks on the first line

This is normal when the raspberry PI starts up. The display should work with the `test_lcd.py` program. If the `test_lcd.py` program still doesn't display anything then check that the wiring conforms to the *wiring list* on page 37. If you are using the Adafruit LCD plate the make sure that you are running the `ada_radio.py` program and not one of the other programs (See Table 2 on page 33). `configure_radio.sh` script to select the correct radio daemon. Run the `wiring.py` program (See page 279).

Constant alternate display of Station Name and Volume

Problem: The LCD screen continually switches between displaying station name and volume. Also the radio log file displays "ERROR radio._setVolume error vol=nn" where nn is the volume level. This is due an incompatibility with the `pulseaudio` package.

Solution: Remove the `pulseaudio` package.

```
$ sudo apt remove pulseaudio
```

Display scrolling too fast or too slow

Adjust the **scroll_speed** parameter in **/etc/radiod.conf**. Adjust between 0.001 and 0.5 seconds.

```
scroll_speed = 0.2
```

Adafruit LCD backlight problems

When using an AdaFruit Blue/White 2x16 character display, if stepping through the menus the backlight goes off and on. This is because with this type of display the backlight is only using one of the RGB inputs. To solve this problem, set all backlight colours except **sleep_color** to **WHITE**.

```
bg_color=WHITE
mute_color=WHITE
shutdown_color=WHITE
error_color=WHITE
search_color=WHITE
info_color=WHITE
menu_color=WHITE
source_color=WHITE
sleep_color=OFF
```

Grove JHD1313 LCD with RGB backlight

When using the Grove JHD1313 LCD the following output is seen from the **systemctl status radiod** command:

```
Sep 18 16:32:57 piradio systemd[1]: Started Radio daemon.
Sep 18 16:32:59 piradio radiod.py[502]: Traceback (most recent call last):
Sep 18 16:32:59 piradio radiod.py[502]:   File "/usr/share/radio/radiod.py",
line 29, in <module>
Sep 18 16:32:59 piradio radiod.py[502]:     from display_class import
Display
Sep 18 16:32:59 piradio radiod.py[502]:   File
"/usr/share/radio/display_class.py", line 22, in <module>
Sep 18 16:32:59 piradio radiod.py[502]:     from PIL import ImageColor
Sep 18 16:32:59 piradio radiod.py[502]: ModuleNotFoundError: No module named
'PIL'
Sep 18 16:32:59 piradio systemd[1]: radiod.service: Main process exited,
code=exited, status=1/FAILURE
Sep 18 16:32:59 piradio systemd[1]: radiod.service: Failed with result
'exit-code'.
```

Install **PIL** as shown in the section called *Installing the Grove LCD RGB* on page 127.

Pimoroni Pirate Radio problems

Volume UP button (Y button) not working.

Pimoroni are using either GPIO 20 or 24 for button Y (Volume UP). By default, the setting for **volume_up** in **/etc/radiod.conf** is GPIO 20. For boards produced before January 2020 this is GPIO 24:

```
right_switch=24
```

See section *C.5 Pimoroni Pirate Audio wiring* on page 376 for more details. If your card is using GPIO 24 then manually edit the `/etc/radiod.conf` file as shown above.

Playlist problems

The display shows the message “No playlists”

Cause: There are no playlists found in `/var/lib/mpd/playlists`.

Check to see if there are any playlists in `/var/lib/mpd/playlists`. You should see files with the `m3u` extension.

Solution: Create playlists by running the `create_playlists.py` program as shown in the section called *Creating and Maintaining Playlist files* on page 218.

Restart the radio.

Cannot play newly mounted network share

Cause: Although the share may have been created, there are no playlists found in `/var/lib/mpd/playlists`.

Solution: Create playlists by running the `create_playlists.py` program as shown in the section called *Creating and Maintaining Playlist files* on page 218. Select network share from the menu.

I2C and SMBUS problems

Import errors

The following is seen:

```
$ sudo ./radiod.py nodaemon
Radio running pid 825
:
ImportError: No module named PIL
```

The `python3-pil` package has not been installed as shown in the section *Install libraries for the Olimex OLED* on page 98.

PiFace CAD and SPI problems

PiFace CAD not detected

When running the radio configured for PiFace CAD the following is seen when running the radio in `nodaemon` mode.

```
pifacecad.core.NoPiFaceCADDetectedError: No PiFace Control and Display board
detected (hardware_addr=0, bus=0, chip_select=1).
```

This is due to the Raspberry Pi being unable to operate with the default speed of the SPI bus. Edit `spi.py` program file as shown in the section *Installing PiFace CAD software* on page 127.

Olimex OLED problems

Radio does not start with Olimex screen

Run the program in no daemon mode as shown in the section called *Running the radio program in nodaemon mode* on page 282.

```
Traceback (most recent call last):
```

```
:
 ImportError: No module named PIL
```

If the above is seen then the libraries for the Olimex display have not been installed. Carry out the instructions as shown in the section called *Install libraries for the Olimex OLED* on page 98.

If the problem is not missing libraries check wiring and connections to the OLED as these can be easily damaged.

OLED Screen is displaying upside down

This can be changed by setting the **flip_vertical** setting in **/etc/radiod.conf** to yes or no.

```
flip_display_vertically=yes
```

Note that this setting only works with OLEDs and not LCDs. Also it does not work with SSD1306 driver. If you need to flip the screen on an SSD1306 device then use the LUMA.SSD1306 driver.

Pimoroni Pirate Audio crashes

Cause 1 SPI not enabled

These devices use an ST7789 OLED display. This requires the SPI interface to be enabled.

A typical crash is seen below when a status check is run.

```
$ sudo systemctl status radiod
● radiod.service - Radio daemon
   Loaded: loaded (/lib/systemd/system/radiod.service; enabled; vendor
   :
   :
   "/usr/local/lib/python2.7/dist-packages/ST7789/__init__.py", line 124, in
   __init__
Oct 23 18:09:58 raspberrypi radiod.py[356]:      self._spi =
   spidev.SpiDev(port, cs)
Oct 23 18:09:58 raspberrypi radiod.py[356]: IOError: [Errno 2] No such file
   or directory
Oct 23 18:09:58 raspberrypi systemd[1]: radiod.service: Main process exited,
   code=exited, status=1/FAILURE
Oct 23 18:09:58 raspberrypi systemd[1]: radiod.service: Failed with result
   'exit-code'.
```

Solution: Using **raspi-config** to enable the SPI interface. See the section called *Configure the SPI Kernel Module* on page 110.

Cause 2 Memory pointer error

There is a suspected issue with the **PIL** library (Python Imaging Library) also called Pillow which gets a memory fault (Invalid pointer) after about three to four hours of running. It is hoped to fix this in a later release. In the meantime, edit the **/lib/systemd/system/radiod.service** file and un-comment the Restart options as shown below. This will restart the program on failure although it may skip a station.

```
Restart=on-failure
RestartSec=5s
```

Rotary encoder problems

Testing rotary encoders

Run the test programs shown in the section called *Testing rotary encoders* on page 277.

These programs display the configuration found in **/etc/radiod.conf**.

Use the **wiring.py** program to display your configured wiring. Does this match the actual wiring? If not, either correct the wiring or amend the switch settings in **/etc/radiod.conf**.

Check wiring in particular the common pin must be connected to ground (and not 3.3 volts).

Also, you can use the **test_gpios.py** program to confirm how you have wire a specific button or rotary encoder. See *The test_gpios program* on page 280.

Keep getting erroneous button-down events

This can happen with KY040 rotary encoders which have their own pull-up resistors and the VCC pin has not been connected to +3V.

Without the connection to VCC +3V the A, B and switch are all connected together via the 10K resistors and will interfere with each other (crosstalk). Connect the VCC to 3.3V as shown in See *Figure 78 KY-040 Circuit Diagram*.

RGB I2C rotary encoder - Missing module ioeexpander

The following message is displayed when using RGB I2C rotary encoders:
ImportError: No module named ioeexpander.

It is necessary to install ioe-python. See section called *Install Pimoroni ioe-python* on page 99.

Stream decode problems

The radio may display a message similar to the following:

```
ERROR: problems decoding http://173.244.194.212:8078
```

This is due to an invalid URL (In the above example this is <http://173.244.194.212:8078>) in one of the M3U files. Locate the offending URL in the play list file in the **/var/lib/radiod/stationlist** file.

Either correct the radio stream URL or remove it all together. Re-run the **create_stations.py** program. Also check that the file URL is not the pointer to the playlist file (See section *Creating and Maintaining Playlist files* on page 218).

Cannot mount remote network drive

There are just too many possibilities to cover all of these here. However, a few common problems are covered here:

Error: mount error(112): Host is down

Cause: Missing or incorrect **vers** statement.

The **vers** parameter can be 1.0, 2.0 or 3.0. The **mount.cifs** man page incorrectly states that version 1.0 is the default. This is correct for the Buster OS. Try adding **vers=1.0** to the mount statement in **/var/lib/radiod/share**.

```
...uid=pi,gid=pi,vers=1.0 ...
```

Error: mount error(115): Operation now in progress

Cause: Most likely an incorrect IP address

Error: NFS mount hangs

Cause: Most likely an incorrect IP address

Error: mount.nfs: access denied by server while mounting <ip address>:/music

Cause: The volume name is missing – for example /volume1/music

Error: mount error(16): Device or resource busy

Cause: The share mount directory is in use because a mount has already been done. Run the umount command.

Error: mount error(2): No such file or directory

Cause: The path specified in the mount doesn't exist

Error:

mount.nfs: rpc.statd is not running but is required for remote locking.

mount.nfs: Either use '-o nolock' to keep locks local, or start statd.

mount.nfs: an incorrect mount option was specified

Cause:

You need to include the “-o noclock” option.

If the error isn't in the above list then search the Web for suggestions.

Sound problems (including Bluetooth)

Re-run the audio configurator program

If experiencing any problems with sound, always re-run the audio configuration program and select the correct option for your sound system, for example Hedphones, HDMI or DAC etc.

```
$ cd /usr/share/radio
$ ./configure_audio.sh
```

Select the correct sound configuration as shown the section called *Configuring the audio output* on page 116. Reboot the Raspberry Pi.

Check to see if any sound cards are configured

Check first if the card is visible using the **aplay** command. The DAC card should be visible.

```
$ aplay -l
**** List of PLAYBACK Hardware Devices ****
card 0: sndrpihifiberry [snd_rpi_hifiberry_dacplus], device 0: HiFiBerry
DAC+ HiFi pcm512x-hifi-0 []
  Subdevices: 0/1
  Subdevice #0: subdevice #0
```

Re-run the `configure_audio.sh` program as shown in the section *Configuring the audio output* on page 116.



Note: If you have configured Bluetooth speakers then you will not see any cards. This is because Bluetooth devices do not use **alsa** but use **bluealsa** instead. Use the **bluetoothctl info** command instead. If using Bluetooth devices see the section called *Bluetooth device no sound* on page 265.

HiFiBerry or other types of DAC no sound

If the **DAC** card is still not visible check the following:

Check that the B output of the channel rotary encoder is wired to GPIO 10 (pin 19) and not GPIO 18 (pin 12). GPIO18 is used by the DAC plus. Also check that the **down_switch** parameter in **/etc/radiod.conf** is set to 10 (Comment out `down_switch=18`) to reflect the actual wiring.

```
#down_switch=18
down_switch=10
```

Make sure that the `/boot/config.txt` file contains the correct **dtoverlay** command as shown in *Table 29 Sound card Device Tree overlays* on page 370. The following example is for a HiFiBerry DAC plus.

```
dtoverlay=hifiberry-dacplus
```

Finally modify the **audio_output** section in **/etc/mpd.conf**. The Device parameter should point to the correct card.

```
audio_output {
    type      "alsa"
    name      "DAC"
    device    "hw:0,0"
    #format   "44100:16:2" # optional
```

```
    mixer_device    "PCM"
    mixer_control   "PCM"
    mixer_type      "software"
}
```

Reboot the Raspberry Pi and retest.

Bluetooth device no sound

Check Bluetooth device connected

The following commands are useful for checking that the Bluetooth device is connected. The actual address of your Bluetooth device should be used

```
$ bluetoothctl devices
Device 00:75:58:41:B1:25 SP-AD70-B
```

If no device is seen then rescan and pair your device using the instructions in the section *Connecting a Bluetooth audio device* on page 138.

Ping the Bluetooth device:

```
$ sudo l2ping 00:75:58:41:B1:25
Ping: 00:75:58:41:B1:25 from DC:A6:32:05:36:9D (data size 44) ...
44 bytes from 00:75:58:41:B1:25 id 0 time 5.72ms
44 bytes from 00:75:58:41:B1:25 id 1 time 4.89ms
44 bytes from 00:75:58:41:B1:25 id 2 time 4.83ms
44 bytes from 00:75:58:41:B1:25 id 3 time 4.91ms
```

Try connecting to it:

```
$ bluetoothctl connect 00:75:58:41:B1:25
Attempting to connect to 00:75:58:41:B1:25
Connection successful
```

Check the HCI UART controller

```
$ dmesg | grep -i Bluetooth
[ 28.274746] Bluetooth: Core ver 2.22
[ 28.274837] Bluetooth: HCI device and connection manager initialized
[ 28.274860] Bluetooth: HCI socket layer initialized
[ 28.274878] Bluetooth: L2CAP socket layer initialized
[ 28.274904] Bluetooth: SCO socket layer initialized
[ 28.285231] Bluetooth: HCI UART driver ver 2.3
[ 28.285249] Bluetooth: HCI UART protocol H4 registered
[ 28.285335] Bluetooth: HCI UART protocol Three-wire (H5) registered
[ 28.285601] Bluetooth: HCI UART protocol Broadcom registered
[ 28.534358] Bluetooth: BNEP (Ethernet Emulation) ver 1.3
[ 28.534367] Bluetooth: BNEP filters: protocol multicast
[ 28.534383] Bluetooth: BNEP socket layer initialized
```

Check Bluetooth powered on

Run the following command

```
$ bluetoothctl show | grep -i powered
Powered: yes
```

If the above check shows “Powered: no” switch power back on with:

```
$ bluetoothctl power on
Changing power on succeeded
```

Check MPD and radio configuration for the Bluetooth device

The `configure_audio.sh` program should have amended the **name**, **device** and **format** fields in `/etc/mpd.conf`. The name can be anything. The device definition takes the following format:

```
name <Your bluetooth device name>
device "bluealsa:DEV=<Your Bluetooth device ID>,PROFILE=a2dp"
```

```
audio_output {
    type "pipe"
    name "SP-AD70-B"
    # device "bluetooth"
    mixer_type "software"
    command "aplay -D bluealsa -f cd"
    format "44100:16:2"
    # mixer_device "default" # optional
    # mixer_control "PCM" # optional
    # mixer_index "0" # optional
}
```

All being well the configuration should match your device if not correct it.

Check that the **bluetooth_device** parameter in the **[RADIOID]** section of `/etc/radiod.conf` has been configured with the Bluetooth device ID of your device.

```
# Bluetooth device ID - Replace with the ID of your bluetooth
speakers/headphones
# Example: bluetooth_device=00:75:58:41:B1:25
# Use the following command to display paired devices
# bluetoothctl paired-devices
bluetooth_device=00:75:58:41:B1:25
```

Amend it if not correct.

Restart the radio or reboot. Music should be heard from the Bluetooth device.

The `/etc/asound.conf` file should look like this except the device address will be different.

```
# asound.conf for Bluetooth device used with MPD type pipe
defaults.bluealsa.service "org.bluealsa"
defaults.bluealsa.device "00:75:58:41:B1:25"
defaults.bluealsa.profile "a2dp"

# Set default mixer controls
ctl.!default {
    type hw
    card 1
}

# Set default PCM device
pcm.!default {
    type plug
    slave {
        pcm "plughw:1,0"
        format S32_LE
    }
}
```

```

}

# Bluetooth speakers
pcm.btdevice {
    type plug
    slave {
        pcm {
            type bluealsa
            service org.bluealsa
            device "00:75:58:41:B1:25"
            profile "a2dp"
        }
    }
    hint {
        show on
        description "Bluetooth device"
    }
}

ctl.btdevice {
    type bluetooth
}

```

Problems pairing the bluetooth device

If you selected a Bluetooth device then reboot the Raspberry Pi. Check that all the Bluetooth daemon is running:

```
$ sudo systemctl status blue*
```

You should see the **bluetooth** daemons and one **bluealsa** daemon running.

```

• bluetooth.service - Bluetooth service
  Loaded: loaded (/lib/systemd/system/bluetooth.service; enabled; vendor
  preset: enabled)
  Active: active (running) since Mon 2019-11-04 10:04:54 GMT; 1h 10min ago
  Docs: man:bluetoothd(8)
  Main PID: 888 (bluetoothd)
  Status: "Running"
  Tasks: 1 (limit: 2061)
  Memory: 2.1M
  CGroup: /system.slice/bluetooth.service
          └─888 /usr/lib/bluetooth/bluetoothd --noplugin=sap

:

• bluetooth.target - Bluetooth
  Loaded: loaded (/lib/systemd/system/bluetooth.target; static; vendor
  preset: enabled)
  Active: active since Mon 2019-11-04 11:21:55 GMT; 1min 18s ago
  Docs: man:systemd.special(7)

Nov 04 11:21:55 buster8 systemd[1]: Reached target Bluetooth.

• bluetooth.service - Bluetooth service
  Loaded: loaded (/lib/systemd/system/bluetooth.service; enabled; vendor
  preset: enabled)
  Active: active (running) since Mon 2019-11-04 11:21:55 GMT; 1min 18s ago
  Docs: man:bluetoothd(8)
  Main PID: 838 (bluetoothd)
  Status: "Running"
  Tasks: 1 (limit: 2061)
  Memory: 2.1M
  CGroup: /system.slice/bluetooth.service

```

```

└─838 /usr/lib/bluetooth/bluetoothd --noplugin=sap
:
• bluealsa.service - BluezALSA proxy
  Loaded: loaded (/lib/systemd/system/bluealsa.service; static; vendor
  preset: enabled)
  Active: active (running) since Mon 2019-11-04 11:21:55 GMT; 1min 18s ago
  Main PID: 841 (bluealsa)
  Tasks: 6 (limit: 2061)
  Memory: 1.2M
  CGroup: /system.slice/bluealsa.service
          └─841 /usr/bin/bluealsa
:

```

Ignore any warnings about the Sap driver. These should disappear once the audio configuration program has been run.

Check the hciuart daemon.

```

$ systemctl status hciuart
• hciuart.service - Configure Bluetooth Modems connected by UART
  Loaded: loaded (/lib/systemd/system/hciuart.service; enabled; vendor
  preset: enabled)
  Active: active (running) since Tue 2019-11-05 16:17:11 GMT; 16h ago
  Process: 330 ExecStart=/usr/bin/btuart (code=exited, status=0/SUCCESS)
  Main PID: 818 (hciattach)
  Tasks: 1 (limit: 1599)
  Memory: 1000.0K
  CGroup: /system.slice/hciuart.service
          └─818 /usr/bin/hciattach /dev/serial11 bcm43xx 3000000 flow -

```

Connection problems

Sometimes a paired device may fail to connect.

```

[bluetooth]# paired-devices
Device 00:75:58:41:B1:25 SP-AD70-B
[bluetooth]# connect 00:75:58:41:B1:25
Attempting to connect to 00:75:58:41:B1:25
Failed to connect: org.bluez.Error.Failed

```

If you have problems connecting to your Bluetooth device try removing it and re-pairing it.

```

[bluetooth]# remove 00:75:58:41:B1:25

```

Repeat the procedure *Connecting a Bluetooth audio device* on page 138.

No music heard from Bluetooth device

Check that all of the above instructions have been correctly followed.

Check the status of the device using **bluetoothctl info**. Check that it is paired, connected and trusted.

The following is an example using device ID 00:75:58:41:B1:25. The ‘:’ character means output not shown.

```

$ bluetoothctl info 00:75:58:41:B1:25
Device 00:75:58:41:B1:25 (public)
  Name: SP-AD70-B
  Alias: SP-AD70-B

```

```
Class: 0x00240404
Icon: audio-card
Paired: yes
Trusted: yes
Blocked: no
Connected: yes
LegacyPairing: no
UUID: Audio Sink (0000110b-0000-1000-8000-
```

Try changing channels on radio. This causes MPD to retry connecting. Check the Alsamixer.

Run the following:

```
$ bluetoothctl connect <Your Bluetooth Device>
```

Noisy interference on the radio

If there is noise interference when playing the radio and this is still present even when the radio is muted this can be for several reasons. This can happen with a wired Ethernet connection and a Wi-Fi dongle are connected to the Raspberry Pi and the Ethernet activity is being picked up by the Wi-Fi dongle. This can be cured by using either a wireless adapter or the Ethernet connection and not both. Another common cause can be an inadequate power supply.

See on page 49. Unfortunately, the later 40-pin versions of the Raspberry Pi seem to be more prone to interference. The recommendation is to use a USB DAC or a suitable DAC card.

Humming sound on the radio

This is usually due to a ground loop somewhere in the design. See the section called Preventing ground loops on page 70.

Speaker Tests

There are a number of diagnostics available for testing speakers.

Simple white noise speaker test

Run `speaker-test -c2` to generate white noise out of the speaker, alternating left and right. If you have a mono output amplifier, the I2S amp merges left and right channels, so you'll hear continuous white noise:

```
$ speaker-test -c2
```

Simple WAV speaker test

Once you've got something coming out, try to play an audio file with `speaker-test` (for WAV files, not MP3). Note that the following does not work with Bluetooth devices.

```
$ speaker-test -c2 --test=wav -w /usr/share/sounds/alsa/Front_Center.wav
```

You'll hear audio coming from left and right alternating speakers

Simple MP3 speaker test

If you want to play a stream of music, you can install the `mpg123` program and use it to test a live stream. To install `mpg123` run:

```
$ sudo apt install -y mpg123
```

To test a stream.

```
$ mpg123 http://ice1.somafm.com/u80s-128-mp3
```

Any online mp3 can be used if the above is not working.

Cannot change volume when running Airplay

This is most likely caused by the wrong mixer volume ID. In normal radio operation is controlled by MPD. As Airplay is nothing to do with MPD, the volume when using Airplay is controlled through the Alsa mixer. Run the following **amixer controls** command to identify the mixer volume ID.

The mixer volume ID can be identified as shown in the following command example.

```
$ amixer controls | grep -i volume
:
numid=4,iface=MIXER,name='Mic Playback Volume'
numid=8,iface=MIXER,name='Mic Capture Volume'
numid=6,iface=MIXER,name='Speaker Playback Volume'
```

Run the `set_mixer_id.sh` program to set the mixer volume id in `/var/lib/radiod/mixer_volume_id` file.

```
$ cd /usr/share/radio
$ sudo ./set_mixer_id.sh
```

Volume control errors

The following error or similar is seen in the log file:

```
ERROR volume._setVolume error vol=50: [52@0] {setvol} problems setting
volume
```

Set the **mixer_type** to “software” in `/etc/mpd.conf`. The ‘:’ character means output not shown.

```
audio_output {
:
    mixer_type      "software"
:
}
```

Operational problems

When selecting the source, the USB stick isn't shown

You need to create the playlist for the USB stick first. See the section called *Creating and Maintaining Playlist files* on page 218.

Radio daemon doesn't start or hangs

This is almost certainly a problem with either the MPD daemon or failed internet connection. Check the network connection and run installation tests on the MPD daemon. Occasionally a bad playlist file can also cause this problem. You can check that your Raspberry PI has an internet connection with the `ip addr` command.

The example below shows interface `eth0` connected as IP 192.168.2.22.

```
# ip addr
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 16436 qdisc noqueue state UNKNOWN
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state
UP qlen 1000
    link/ether b8:27:eb:fc:46:15 brd ff:ff:ff:ff:ff:ff
    inet 192.168.2.22/24 brd 192.168.2.255 scope global eth0
```

Volume control not working with DAC or USB speakers

This is hardware dependant. Not all USB hardware and drivers work with mixer type "hardware". If this problem is being experienced try setting the `mixer_type` parameter to "software". Edit the `/etc/mpd.conf` file and change the mixer type to software.

```
mixer_type      "software"
```

Remove the # at the beginning of the line to enable software mixing and save the file. Restart the radio software.



Note: This solution was provided by one of the constructors and is untested by the author.

The radio keeps skipping radio stations

MPD will automatically skip bad stations. Remove any bad URLs from `/var/lib/radiod/stationlist` and re-run `create_stations.py`.

Source selection only shows the radio playlist

When attempting to play music from a USB stick, source selection only shows the radio playlist. This is usually because you have forgotten to run the `create_playlist.sh` program.

See the section *Creating and Maintaining Playlist files* on page 218.

Shoutcast playlist not created

Test the `get_shoutcast.py` program.

```
$ ./get_shoutcast.py
Traceback (most recent call last):
  File "./get_shoutcast.py", line 20, in <module>
    import requests
ImportError: No module named requests
```

If you see the above message, install `python-requests`.

```
$ sudo apt install python-requests
```

A station plays for a few seconds then skips to the next one

This is a known problem with the Music Player Daemon version 0.19.1 on Raspbian Jessie.

There is only one solution and that is to create a new SD card with the latest Raspbian operating system (At the time of writing this was Raspbian Buster) and install the latest version of the radio. This will install Music Player Daemon version 0.19.21 which will cure this particular problem.

The volume keeps getting reset to a 100% when the radio is restarted

This is almost certainly that the mixer volume id is incorrectly set. This is used by the ALSA mixer to set the volume. The radio software stores the mixer volume id in `/var/lib/radiod/mixer_volume_id`. The `mixer_volume_id` is normally set to the correct value by the `configure_audio.sh` program during installation. Check the setting:

```
$ cat /var/lib/radiod/mixer_volume_id
1
```

Now run the `amixer` program to determine the `numid` of the 'Master Playback Volume'.

```
$ amixer controls
numid=4,iface=MIXER,name='Master Playback Switch'
numid=3,iface=MIXER,name='Master Playback Volume'
numid=2,iface=MIXER,name='Capture Switch'
numid=1,iface=MIXER,name='Capture Volume'
```

Note the `numid` of the mixer volume and update the correct mixer id. In the above example it is 3. Now write the `numid` number to `/var/lib/radiod/mixer_volume_id` and check it.

```
$ sudo echo 3 > /var/lib/radiod/mixer_volume_id
$ cat /var/lib/radiod/mixer_volume_id
3
```

Edit the `/etc/radiod.conf` file and set the desired mixer pre-set volume as required.

```
mixer_preset=70
```

Now restart the radio.

Raspberry Pi shuts down when the Menu button is pressed

The radio by default is designed to shut down the Raspberry if the Menu button is pressed for more than 3-seconds. If this happens immediately upon pressing the Menu button then this is because the incorrect rotary class driver has been selected. Correct this by re-running the configurator and select the correct rotary class driver.

Incorrect clock time displayed

If the time date and time displayed is incorrect for a short while after switch on, this is normal. The Raspberry Pi is not the same as a full featured PC motherboard at misses some of the features that are found on such boards. For example, it does not have a Real Time Clock (RTC). A RTC is a chip with battery back-up which maintains the system time when the device is switched off.

As there is no RTC the only time that the RPi has is the last time the device was used. Shortly after the network becomes active the system synchronises its time with one or more NTP time servers on

the Internet using the Network Time Protocol (NTP). This used to be done with the NTP daemon **ntpd**. However, in more recent times this is done with a feature of **systemd** called **systemd-timesyncd**. This should synchronise the time within about 10 to 15 seconds although this can take a minute or more.

If the time is synchronising OK but you want to have the correct time immediately upon switch on see *Adding a Real Time Clock (RTC)* on page 342

IR remote control problems

Remote control software does not start up

Check that there are no problems with the `remote_contol.py` program (Called by service **ireventd**)

```
$ cd /usr/share/radio/
```

```
$ sudo ./ireventd.py nodaemon
IR Remote control listener running pid 2305
Using IR kernel events architecture
Flashing LED on GPIO 16
Read myremote table
Old keytable cleared
Wrote 21 keycode(s) to driver
Protocols changed to nec
/dev/input/event2 vc4-hdmi-1 vc4-hdmi-1/input0
/dev/input/event1 vc4-hdmi-0 vc4-hdmi-0/input0
/dev/input/event0 gpio_ir_recv gpio_ir_recv/input0
Listening for IR events:
```

Make a note of the pid (in this example it is 2305). Operate the volume up and down. The following should be displayed:

```
KEY_VOLUMEUP
KEY_VOLUMEDOWN
```

To stop the program run using the previously noted pid (2305).

```
$ sudo kill -9 2305
```

If the **ireventd.py** program is working OK make sure that the **irevent** service is enabled to start at boot time. Enable using **systemctl**.

```
$ sudo systemctl enable ireventd
```

Reboot the Raspberry Pi

```
$ sudo reboot
```

Check that the UDP server program is listening on port 5100

```
$ netstat -an | grep 5100
udp 0 0 127.0.0.1:5100 0.0.0.0:*
```

If not running stop the radio and check the UDP server software

```
$ cd /usr/share/radio/
$ sudo ./udp_server_class.py
Starting UDP server on port 5100
```

From another terminal run the following command

```
$ sudo ./ireventd.py send TEST
OK
```

On the server side you should see

```
Data = TEST
```

Stop the `udp_server.py` program with Ctrl-C. Restart the radio and retry.

Cannot select source through the Web interface

Make sure that the radiod is running or the vgradio or gradio programs on the desktop.

```
$ sudo systemctl status radiod
```

Run the checks or the UDP server as shown in the previous server. Run the UDP server software. Select a source from the Web interface. In the following example the Radio playlist has been selected.

```
$ sudo ./udp_server_class.py
Starting UDP server on port 5100
Data = PLAYLIST: Radio
```

Using the diagnostic programs

The diagnostic code for testing various components of the radio is contained in the various class code files themselves. For example, `lcd_class.py` (Test LCD display). First stop the radio and then run the relevant class code.

The classes that contain diagnostic code are as follows:

- `lcd_class.py` Test the LCD screen (Directly wired to the GPIO)
- `lcd_adafruit_class.py` Test the Adafruit LCD plate and buttons
- `lcd_i2c_adafruit.py` Test the Adafruit I2C backpack
- `lcd_i2c_pcf8574.py` Test LCD with a PCF8574 I2C backpack
- `lcd_i2c_jhd1313.py` Test Grove JHD1313 LCD RGB I2C
- `lcd_piface_class.py` Test PiFace CAD display and buttons
- `button_class.py` Test push button switches (Directly wired to the GPIO)
- `rotary_class.py` Test rotary encoders (Directly wired to the GPIO)

- **rotary_class_alternative.py** Test rotary encoders using alternative driver
- **rotary_class_rgb_i2c.py** Test RGB I2C Rotary Encoders

A number of other programs are supplied and can also be used for diagnostics.

- **display_model.py** Display Raspberry Pi model information
- **display_current.py** Display current station or track details
- **wiring.py** Display wiring as configured in **/etc/radiod.conf**
- **test_gpios.py** Test state of all GPIOs and connected buttons or rotary encoders
- **display_config.sh** Display the current configuration.
- **display_wifi.sh** Display current Wi-Fi connection details

All diagnostic programs are supplied in the **/usr/share/radio** directory. Change to this directory first!

```
$ cd /usr/share/radio
```

All programs require the **./** characters in front of the name to execute unless called by their full pathname.

Cannot start Bluetooth control program

If you see the following message:

```
$ bluetoothctl
[bluetooth]# scan on
No default controller available
```

Run the following:

```
$ sudo hciconfig scan
hci0:    Type: Primary    Bus: UART
      BD Address: DC:A6:32:E0:50:69    ACL MTU: 1021:8    SCO MTU: 64:1
      UP RUNNING
      RX bytes:77809    acl:38    sco:0    events:9464    errors:0
      TX bytes:11743815    acl:18667    sco:0    commands:122    errors:0
```

If instead of 'UP RUNNING' you see 'DOWN' check the **hciuart** service.

```
$ systemctl status hciuart.service
● hciuart.service - Configure Bluetooth Modems connected by UART
   Loaded: loaded (/lib/systemd/system/hciuart.service; enabled; vendor preset: enabled)
   Active: active (running) since Wed 2021-10-13 22:17:07 BST; 2 days ago
     Main PID: 424 (hciattach)
       Tasks: 1 (limit: 2059)
    CGroup: /system.slice/hciuart.service
           └─424 /usr/bin/hciattach /dev/serial11 bcm43xx 3000000 flow -
             b8:27:eb:73:99:d5

Oct 13 22:17:06 pitouch systemd[1]: Starting Configure Bluetooth Modems connected by UART...
Oct 13 22:17:07 pitouch btuart[341]: Cannot open directory '/etc/firmware':
No such file or director
Oct 13 22:17:07 pitouch btuart[341]: Patch not found, continue anyway
Oct 13 22:17:07 pitouch btuart[341]: bcm43xx_init
Oct 13 22:17:07 pitouch btuart[341]: Set BDADDR UART: b8:27:eb:73:99:d5
```

```
Oct 13 22:17:07 pitouch btuart[341]: Set Controller UART speed to 3000000
bit/s
Oct 13 22:17:07 pitouch btuart[341]: Device setup complete
Oct 13 22:17:07 pitouch systemd[1]: Started Configure Bluetooth Modems
connected by UART.
First switch on your Bluetooth device, then switch on scanning. In the
following example this is JVC SP-AD70-B Bluetooth speakers.
```

In the above example it would appear that hciuart cannot find the firmware patches. Check to see if it is present.

```
$ locate BCM4345C0.hcd
/usr/lib/firmware/brcm/BCM4345C0.hcd
```

Now link the above `/usr/lib/firmware` directory to `/etc/firmware`.

```
$ cd /etc/
$ sudo ln -s /usr/lib/firmware
```

Reboot the Raspberry Pi and retry running.

Running test programs

Running the radio program in diagnostic mode

This is one of the first things you should learn to do. Running the `radiod.py` program in `nodaemon` mode will display any errors it encounters. Use Ctrl-C to exit the program.

```
$ sudo ./radiod.py nodaemon
```

Using the LCD test code

```
$ ./lcd_class.py
```

The above program will display the following text on the LCD:

```
Bob Rathbone
Line 2: abcdefghi
```

Line 2 scrolls the alphabet followed by 0 through 9.

The `lcd_adafruit_lcd.py` program does the same except it also prints a message on the console screen when a button is pressed.

Testing push buttons program

Test push buttons directly wired to the GPIO pins.

```
$ ./button_class.py
down_switch
up_switch
right_switch
left_switch
menu_switch
Pull Up/Down resistors DOWN
```

```
Button pressed on GPIO 17
:
```

Pressing the switches should show on the screen as shown in the above example.

Testing rotary encoders

This program does a simple test of the rotary encoders.

```
$ ./rotary_class.py
Test rotary encoder Class
Left switch GPIO 14
Right switch GPIO 15
Up switch GPIO 24
Down switch GPIO 23
Mute switch GPIO 4
Menu switch GPIO 17
Tuner event 1 CLOCKWISE
Tuner event 2 ANTICLOCKWISE
Volume event 1 CLOCKWISE
Volume event 2 ANTICLOCKWISE
Tuner event 4 BUTTON UP
Tuner event 3 BUTTON_DOWN
Volume event 4 BUTTON_UP
Volume event 3 BUTTON_DOWN
Volume event 1 CLOCKWISE
Volume event 2 ANTICLOCKWISE
```

You can also try

```
$ ./rotary_class_alternative.py
```

Testing RGB I2C rotary encoders

Run the `rotary_class_rgb_i2c.py` program

```
$ ./rotary_class_rgb_i2c.py
You must specify at least one encoder to be tested!

Usage: sudo ./rotary_class_rgb_i2c.py --help
        --test_volume
        --test_channel
        --test_both
        --volume_i2c=<volume_i2c_address>
        --channel_i2c=<channel_i2c_address>

Recommended values for volume and channel I2C addresses are 0x0F and 0x1F
(defaults)
Run "i2cdetect -y 1" to check I2C address
```

You can test either one of the rotary encoders individually or both together. For example:

```
$ sudo ./rotary_class_rgb_i2c.py --test_both
RGB I2C Dual Rotary Encoder Test
Volume rotary encoder I2C address=0xf
Mute switch GPIO 27
Channel rotary encoder I2C address=0x1f
Menu switch GPIO 17
Started
Channel rotary encoder event ANTICLOCKWISE
```

```
Channel rotary encoder event ANTICLOCKWISE
Channel rotary encoder event CLOCKWISE
Channel rotary encoder event CLOCKWISE
Channel rotary encoder event BUTTONDOWN
Volume rotary encoder event CLOCKWISE
Volume rotary encoder event CLOCKWISE
Volume rotary encoder event CLOCKWISE
Volume rotary encoder event ANTICLOCKWISE
Volume rotary encoder event ANTICLOCKWISE
Volume rotary encoder event BUTTONDOWN
```

The RGB I2C Hex addresses are configured in **/etc/radiod.conf**.

```
# I2C addresses for RGB I2C Rotary Encoders
volume_rgb_i2c=0x0F
channel_rgb_i2c=0x1F
```

However, the encoders themselves are delivered with the default I2C hex address of **0x0F**. One of the encoders must be set to hex **0x1F** (Channel Rotary Encoder) using the **rgb_set_i2c_address.py** program.

```
$ ./rgb_set_i2c_address.py --new_i2c_address=0x1F
```

The display_current program

This is a useful diagnostic that prints out the raw information available from the MPD daemon. The radio daemon uses the same libraries as this test program.

```
$ ./display_current.py

file: http://airspectrum.cdnstream1.com:8116/1649_192#Easy hits Florida HD
title: Lou Rawls - You'll Never Find Another Love Like Mine
name: Easy Hits Florida
time: 0
duration: 0.000
pos: 69
id: 181
current_id 70

Status
volume: 35
repeat: 0
random: 0
single: 0
consume: 0
partition: default
playlist: 20
playlistlength: 111
mixrampdb: 0.000000
state: play
song: 69
songid: 181
time: 3002:0
elapsed: 3001.688
bitrate: 192
duration: 0.000
audio: 44100:24:2
nextsong: 70
nextsongid: 182

uptime: 3002
```

```

playtime: 3002
artists: 0
albums: 0
songs: 0
db_playtime: 0
db_update: 1644564447
Bit rate 192

```

To find out the exact meaning of all these fields please refer to the standard **python-mpd** documentation at <https://pypi.python.org/pypi/python-mpd/> or <http://pythonhosted.org/python-mpd2/topics/getting-started.html>.

The wiring program

The **wiring.py** program displays a wiring list based upon the configuration that it finds in **/etc/radiod.conf**. In the following example the 40-pin wiring (See Table 5 on page 38) has been selected during installation. The first column shows the GPIO setting in **/etc/radiod.conf**. The second column (Pin) shows the physical pin for that GPIO. For example, in the **left_switch** parameter in **/etc/radiod.conf** has been set to GPIO 23 which is physical pin 16 on the 40-pin GPIO header.

The program displays three wiring sections namely:

1. SWITCHES – Rotary encoder and push button wiring
2. LCD – Directly connected LCD wiring
3. OTHER – Remote control and activity LED, I2C backpacks

```

$ cd /usr/share/radio
$ sudo ./wiring.py
Radio wiring scheme based upon configuration in /etc/radiod.conf

----- SWITCHES -----
GPIO   Pin           Switch           Rotary
=====
23     16 <-----> Left switch     A
24     18 <-----> Right switch   B
        6 <-----> Gnd 0v         C
4      7 <-----> Mute switch    < GND 0V
14     8 <-----> Down switch    A
15     10 <-----> Up switch      B
        6 <-----> Gnd 0v         C
17     11 <-----> Menu switch    < GND 0V

Pull Up/Down resistors DOWN

Push button switches must be wired to +3.3V
Rotary push switches must always be wired to GND 0V

----- LCD -----
GPIO   Pin           Function         LCD pin
=====
5      29 <-----> Lcd data4      11
6      31 <-----> Lcd data5      12
12     32 <-----> Lcd data6      13
13     33 <-----> Lcd data7      14
8      24 <-----> Lcd enable     6
7      26 <-----> Lcd select     4
        2 <-----> VCC +5V       2,15
        6 <-----> GND 0V        1,16
10K Pot <-----> Contrast       3

----- OTHER -----

```

```

GPIO      Pin      Function
====      ==      =====
16        36 <-----> Remote led
3         5 <-----> I2C Data
2         3 <-----> I2C Clock
25        22 <-----> IR Remote      (See /boot/config.txt)

```

Currently the wiring for the vintage radio RGB Led and Menu switch are not shown.

In the above output the connections are descriptive. The parameters found in `/etc/radiod.conf` can be displayed with the `-p` option:

```

$ ./wiring.py -p
Radio wiring scheme based upon configuration in /etc/radiod.conf

----- SWITCHES -----
GPIO      Pin      Switch      Rotary
====      ==      =====      =====
23        16 <-----> left_switch  A
24        18 <-----> right_switch B
          6 <-----> GND_0V      C
4         7 <-----> mute_switch  < GND 0V
14        8 <-----> down_switch  A
15        10 <-----> up_switch    B
          6 <-----> GND_0V      C
17        11 <-----> menu_switch  < GND 0V
:

```

In the above display the `left_switch` label is the parameter found in `/etc/radiod.conf`.

If the wiring shown in the `wiring.py` program then either amend the wiring to match the wiring list shown in the output of the wiring program or amend `/etc/radiod.conf` to match the actual wiring. The program also has a help function (`-h` option).

```

$ ./wiring.py -h
Usage: ./wiring.py -p -h
Where -p print parameters, -h this help text

```

The test_gpios program

Sometime you may not be sure how you have wired a particular button or rotary encoder or you may have a conflict with another program or a setting in the `/boot/config.txt` configuration file. The `test_gpios.py` program allows both situations to be tested. Running the program with no parameters display the help message.

```

$ ./test_gpios.py
Usage: ./test_gpios.py <--help> <--pull_up> <--pull_down> <--none>
Where --help this help text
      --pull_up Set pull-up-down internal resistors high (+3.3V)
      --pull_down Set pull-up-down internal resistors low (0V GND)
      --pull_off No pull-up-down internal resistors (Use external resistors)

```

The other options set the internal pull up/down resistors to UP, DOWN or OFF.

`--pull_up` Is the normal parameter for most situations. Use this option if unsure.

--pull_down should be used for older radios with push buttons wired to 0V GND.
--pull_off is used mainly for KY-040 rotary encoders which have their own pull-up resistors.

The following example is for a radio with two normal rotary encoders and an IR receiver configured on GPIO 9.

In this case the program reports that it cannot configure GPIO 9 for testing as it is already configured in `/boot/config.txt` for use by the IR receiver. It attempts to display the conflict.

```
$ ./test_gpios.py --pull_up
GPIO: 2 State:High
GPIO: 3 State:High
GPIO: 4 State:High
GPIO: 5 State:High
GPIO: 6 State:High
GPIO: 7 State:High
GPIO: 8 State:High
GPIO: 9 State:High
Error: GPIO 9 Failed to add edge detection
Check conflict with GPIO 9 in other programs or in /boot/config.txt
dtoverlay=gpio-ir,gpio_pin=9
GPIO: 10 State:High
GPIO: 11 State:High
GPIO: 12 State:High
GPIO: 13 State:High
GPIO: 14 State:High
GPIO: 15 State:Low
GPIO: 17 State:High
GPIO: 18 State:High
GPIO: 19 State:High
GPIO: 20 State:High
GPIO: 21 State:High
GPIO: 22 State:High
GPIO: 23 State:High
GPIO: 24 State:High
GPIO: 25 State:High
GPIO: 26 State:High
GPIO: 27 State:High
Waiting for input events:
```

Note that GPIO 15 is a rotary encoder input and may be high or low depending upon its position. Same for GPIO 14.

The program waits for events. The Mute button is configured on GPIO 4. The volume rotary encoder A and B inputs are wired to GPIO 14 and 15 respectfully. Pressing the Menu button or turning the volume knob should produce an output similar to the following:

```
GPIO 4 falling
GPIO 4 rising
GPIO 4 falling
GPIO 4 falling
GPIO 11 rising
GPIO 14 falling
GPIO 15 falling
GPIO 14 falling
GPIO 15 rising
```

The display_model program

This program displays the Raspberry PI model details.

```
$ ./display_model.py
000e: Model B, Revision 2.0, RAM: 512 MB, Maker: Sony
```

In this example 000e=Manufacturer's revision, B=Model, 2.0=Revision, 512MB RAM, Maker=Sony. If you are unsure of the model or revision of the Raspberry PI use this program to find this out.

The display configuration program

The `display_config.sh` provides diagnostic information how the radio, drivers and MPD have been configured. It also produces a compressed tar file called `/usr/share/radio/config.log.tar.gz` with this information. Send this file to bob@bobrathbone.com.

```
$ ./display_config.sh
Configuration log for pi Tue Jul  4 20:38:27 BST 2023
Release 24th June 2023 - Build 6
IP address: 192.168.1.251

OS Configuration
-----
PRETTY_NAME="Raspbian GNU/Linux 12 (bookworm)"
NAME="Raspbian GNU/Linux"
VERSION_ID="12"
:
===== End of run =====
This configuration has been recored in /usr/share/radio/config.log
A compressed tar file has been saved in /usr/share/radio/config.log.tar.gz
Send /usr/share/radio/config.log.tar.gz to bobrathbone.com if required
```

Running the radio program in nodaemon mode

If for some reason the radio program stops or crashes without explanation (particularly if you have modified the code), it can be extremely difficult to see what is happening as the radio software runs as a so-called system daemon.

There is a way to run the software in foreground mode. In this case stop the radio and change to `/usr/share/radio` directory and run the radio program with the `nodaemon` option.

```
$ cd /usr/share/radio
$ sudo ./radiod.py nodaemon
```

If the program crashes it will display a stack trace which will give the file name and line numbers where the program crashed. Use **Control-C** to exit `nodaemon` mode (This will also display a stack trace which is normal and is not an error).

In the case of `gradio.py` and `vgradio.py`, these are not daemons and can be run as shown in the example for `gradio.py` below:

```
$ sudo ./gradio.py
```

Creating a log file in DEBUG mode

You may be asked to supply a log file in DEBUG mode for support purposes. Stop the radio and remote control if running:

```
$ sudo systemctl stop radiod
$ sudo systemctl stop irreventd
```

Edit the `/etc/radiod.conf` file and switch on DEBUG mode as shown below.

```
# loglevel is CRITICAL,ERROR,WARNING,INFO,DEBUG or NONE
loglevel=DEBUG
```

Remove the old log file or in `/etc/radiod.conf` change `log_creation_mode=truncate`:

```
$ sudo rm /var/log/radiod/radio.log
```

Start the radio and remote control if required:

```
$ sudo systemctl start radiod
$ sudo systemctl start irreventd
```

Operate the radio including the operation you are having with.

Send the `/var/log/radiod/radio.log` file to bob@bobrathbone.com

Switch off DEBUG mode by editing the `/etc/radiod.conf` file and as shown below.

```
loglevel=INFO
```

Display the kernel details

Display the kernel version using `uname`.

```
$ uname -a
Linux raspberrypi 5.10.63-v7+ #1459 SMP Wed Oct 6 16:41:10 BST 2021 armv7l
GNU/Linux
```

Displaying information about the Raspberry Pi

There are a number of standard facilities to provide information about the Raspberry Pi which may be useful when diagnosing a problem.

Displaying the GPIO information

There are two standard programs for reading from and writing to GPIO Pins.

The `gpio readall` command can be used to display the GPIO configuration. Stop the radio first!

BCM	wPi	Name	Mode	V	Physical	V	Mode	Name	wPi	BCM	Switch
		3.3v			1	2		5v			
2	8	SDA.1	IN	1	3	4		5V			
3	9	SCL.1	IN	1	5	6		0v			
4	7	GPIO. 7	IN	1	7	8	0	IN	15	14	Left
		0v			9	10	0	IN	16	15	Right
17	0	GPIO. 0	IN	0	11	12	0	IN	1	18	Up/Down
27	2	GPIO. 2	OUT	0	13	14		0v			
22	3	GPIO. 3	OUT	0	15	16	0	OUT	4	23	
		3.3v			17	18	0	OUT	5	24	
10	12	MOSI	IN	0	19	20		0v			Down*
9	13	MISO	IN	0	21	22	0	IN	6	25	Menu
11	14	SCLK	IN	0	23	24	0	OUT	10	8	

			0v			25	26	1	OUT	CE1		11	7	
28	17	GPIO.17	ALT2	0	51	52	0	ALT2	GPIO.18	18	29			
30	19	GPIO.19	ALT2	0	53	54	0	ALT2	GPIO.20	20	31			
BCM	wPi	Name	Mode	V	Physical	V	Mode	Name	wPi	BCM				
					Model B2									

* Alternative down switch for HiFiBerry DAC+ compatibility.

The physical pins are shown in the center numbered 1 to 26 and 51 through 54 (for a model B2) in this example. The above output is for a radio using a directly wired LCD and push buttons. For example:

Physical pin 8 is BCM GPIO 14 and mode is configured as an input for the left switch and is currently low (Column V is 0).

The second program that can be used is **raspi-gpio**.

```

$ raspi-gpio get
BANK0 (GPIO 0 to 27):
GPIO 0: level=1 fsel=0 func=INPUT
GPIO 1: level=1 fsel=0 func=INPUT
GPIO 2: level=1 fsel=0 func=INPUT
GPIO 3: level=1 fsel=0 func=INPUT
GPIO 4: level=0 fsel=0 func=INPUT
GPIO 5: level=0 fsel=0 func=INPUT
GPIO 6: level=0 fsel=0 func=INPUT
GPIO 7: level=0 fsel=0 func=INPUT
GPIO 8: level=0 fsel=0 func=INPUT
GPIO 9: level=0 fsel=0 func=INPUT
GPIO 10: level=0 fsel=0 func=INPUT
GPIO 11: level=0 fsel=0 func=INPUT
GPIO 12: level=0 fsel=0 func=INPUT
GPIO 13: level=0 fsel=0 func=INPUT
GPIO 14: level=0 fsel=0 func=INPUT
GPIO 15: level=0 fsel=0 func=INPUT
GPIO 16: level=0 fsel=0 func=INPUT
GPIO 17: level=0 fsel=0 func=INPUT
GPIO 18: level=0 fsel=0 func=INPUT
GPIO 19: level=0 fsel=0 func=INPUT
GPIO 20: level=0 fsel=0 func=INPUT
GPIO 21: level=0 fsel=0 func=INPUT
GPIO 22: level=0 fsel=0 func=INPUT
GPIO 23: level=0 fsel=0 func=INPUT
GPIO 24: level=0 fsel=0 func=INPUT
GPIO 25: level=1 fsel=1 func=OUTPUT
GPIO 26: level=0 fsel=0 func=INPUT
GPIO 27: level=0 fsel=0 func=INPUT
BANK1 (GPIO 28 to 45):
GPIO 28: level=1 fsel=0 func=INPUT
GPIO 29: level=1 fsel=0 func=INPUT
GPIO 30: level=0 fsel=7 alt=3 func=CTS0
:

```

Run the following for a full help menu

```

$ raspi-gpio help

```

Examples:

```

raspi-gpio get          Prints state of all GPIOs one per line
raspi-gpio get 20      Prints state of GPIO20
raspi-gpio get 20,21   Prints state of GPIO20 and GPIO21
raspi-gpio set 20 a5   Set GPIO20 to ALT5 function (GPCLK0)
raspi-gpio set 20 pu   Enable GPIO20 ~50k in-pad pull up
raspi-gpio set 20 pd   Enable GPIO20 ~50k in-pad pull down
raspi-gpio set 20 op   Set GPIO20 to be an output
raspi-gpio set 20 dl   Set GPIO20 to output low/zero (must already be
set as an output)
raspi-gpio set 20 ip pd Set GPIO20 to input with pull down
raspi-gpio set 35 a0 pu Set GPIO35 to ALT0 function (SPI_CE1_N) with
pull up
raspi-gpio set 20 op pn dh Set GPIO20 to ouput with no pull and driving
high

```

Displaying information about the Operating system

Display `/etc/os.release` using the `cat` command. Likewise the Debian version

```

$ cat /etc/os-release
PRETTY_NAME="Raspbian GNU/Linux 12 (bookworm)"
NAME="Raspbian GNU/Linux"
VERSION_ID="12"
VERSION="12 (bookworm)"
VERSION_CODENAME=bookworm
ID=raspbian
ID_LIKE=debian
HOME_URL="http://www.raspbian.org/"
SUPPORT_URL="http://www.raspbian.org/RaspbianForums"
BUG_REPORT_URL="http://www.raspbian.org/RaspbianBugs"

```

```

$ cat /etc/debian_version
11.1

```

Chapter 10 - Streaming to other devices using Icecast2

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Inbuilt MPD HTTP streamer

The MPD daemon can be configured to use its own inbuilt streamer. However, this requires a special MPD client such as **gmmpc** on the PC. It cannot be easily accessed from a Web browser. If you wish to use the inbuilt streamer see the following URL:

http://mpd.wikia.com/wiki/Built-in_HTTP_streaming_part_2

Introduction to Icecast

You may wish to play the output of the Radio through your PC speakers or a mobile device such as a tablet or telephone. This is possible to do this using **Icecast**. For more information on **Icecast** see the following Wikipedia article: <http://en.wikipedia.org/wiki/Icecast> .

Please also refer to *Intellectual Property, Copyright, and Streaming Media* on page 349.

Installing Icecast

Install **icecast2** using the **install_streaming.sh** script.

```
$ cd /usr/share/radio
$ sudo ./install_streaming.sh
Starting Icecast2 integration with the Music Player Daemon
The Icecast2 installation progra will ask if you wish to configure Icecast2.
Answer 'yes' to this. Configure Icecast as follows:
Icecast2 hostname: localhost
Icecast2 source password: mympd
Icecast2 relay password: mympd
Icecast2 administration password: mympd
Continue y/n: y
```

Enter 'y' to continue. The Icecast2 installation program will ask if you wish to configure Icecast2:

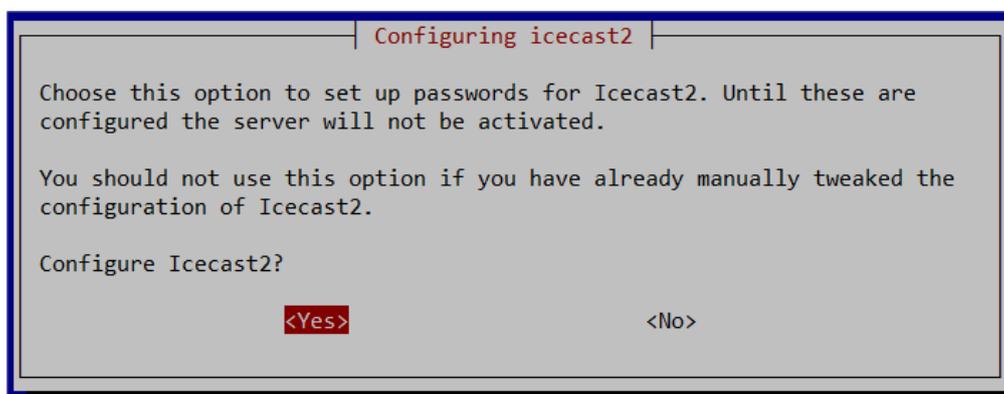


Figure 224 Configuring Icecast2

Answer 'yes' to this. Configure Icecast as follows:

Icecast2 hostname: **localhost** (or the hostname of the Raspberry Pi)

Icecast2 source password: **mympd**

Icecast2 relay password: **mympd**

Icecast2 administration password: **mympd**

It is important that you replace the default password 'hackme' with 'mympd'. The installation program continues configuration. The icecast2 server will be started:

```
Done Configuring icecast2..
```

```
Processing triggers for libc-bin (2.19-18+deb8u6) ...
Processing triggers for systemd (215-17+deb8u5) ...
Configuring Icecast2
Copying /etc/icecast2/icecast.xml to /etc/icecast2/icecast.xml.orig
```

Check that the PI Radio stream (Output 2) is enabled

```
$ mpc outputs
Output 1 (My ALSA Device) is enabled
Output 2 (PI Radio MPD Stream) is enabled
```

If not enable it and restart **mpd** and **icecast2**. In this case it is output 2

```
$ mpc enable 2
$ sudo systemctl restart mpd.service icecast2.service
```

Check that MPD has established a connection with the icecast2 server

```
$ netstat -tn | grep :8000
tcp        0      0 127.0.0.1:59096    127.0.0.1:8000    ESTABLISHED
tcp        0      0 127.0.0.1:8000    127.0.0.1:59096    ESTABLISHED
```

The Icecast2 `install_streaming.sh` script sets the `streaming_on` parameter in `/etc/radiod.conf` to `yes`.

```
streaming_on=yes
```

It also adds the following configuration to `/etc/mpd.conf`.

```
# MPD Radio Stream
audio_output {
    type          "shout"
    name          "PI Radio MPD Stream"
    description   "MPD stream on Raspberry Pi Radio"
    host         "localhost"
    port         "8000"
    mount        "/mpd"
    password     "mympd"
    bitrate      "128"
    format       "44100:16:2"
    encoding     "mp3"
}
```

This completes the installation of Icecast2 however you may need to configure the clock speed if your Raspberry Pi is an earlier version (See *Overclocking older Raspberry PI's* on page 289)

Now go to *Icecast2 Operation* on page 289.

Overclocking older Raspberry PI's

With older versions of the Raspberry Pi it will almost certainly be necessary to over-clock to handle Icecast2 streaming using the **raspi-config** program. Medium over-clocking seems to be sufficient. Note that the later versions of the Raspberry Pi cannot be overclocked and are fast enough anyhow.

Run **raspi-config**. Select option 'Overclock'. After a warning screen about over-clocking has been displayed, the following screen will be displayed:

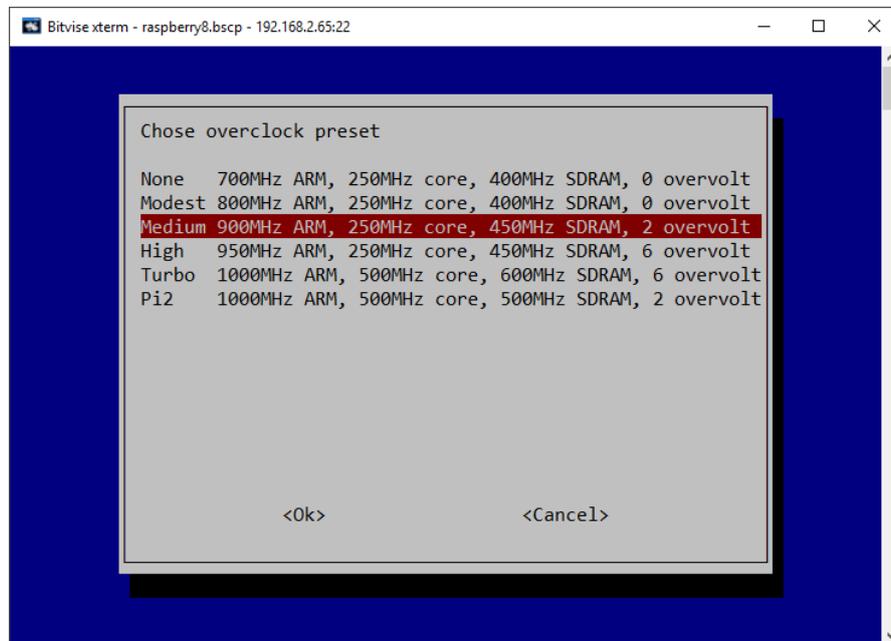


Figure 225 Over-clocking the Raspberry PI

Select 'Medium' to start with. Reboot the Raspberry PI when prompted. Re-test the radio with streaming switched on.

Icecast2 Operation

The **radiod** daemon has full control over the Icecast2 service and stops and starts it as required. When the radio is first switched on the Icecast2 streaming service will normally be enabled. It can be switched on and off in either LCD/OLED versions of the radio and in the full feature graphical version of the radio.

Switching on streaming on and off

Use the options menu (Press menu button three times). Step through the menu option using the Channel up/down buttons until "Streaming off" is displayed in the LCD display (assuming Icecast is installed). Press either Volume button and after a short delay the text should change to "Streaming on" in the LCD display. Press the menu button again to exit the options menu.

This starts the Icecast2 service. It also writes the word "on" or "off" to a file called **/var/lib/radiod/streaming**. This file is used to enable or disable the Icecast streaming function at boot time.

Checking Icecast2 status

Use the following command:

```
$ service icecast2 status
• icecast2.service - LSB: Icecast2 streaming media server
  Loaded: loaded (/etc/init.d/icecast2; generated)
  Active: active (running) since Sat 2021-09-04 07:27:34 BST; 21min ago
    Docs: man:systemd-sysv-generator(8)
   Tasks: 5 (limit: 4915)
  CGroup: /system.slice/icecast2.service
          └─632 /usr/bin/icecast2 -b -c /etc/icecast2/icecast.xml
```

Enabling Icecast2 at reboot time

It isn't necessary to enable the Icecast2 service at boot time as the radio program will start it depending on the contents of the `/var/lib/radiod/streaming` file. Should you wish to enable streaming at boot time then enable it with the following command:

```
$ sudo systemctl enable icecast2
```

Playing the Icecast stream on Windows

To play the Icecast2 radio stream on a PC point your Web browser at the IP address of the radio on port 8000 and the `/mpd` mount point. In the following example the IP address of the radio is 192.168.2.8. So, this would be:

<http://192.168.2.8:8000/mpd>

This will normally open the default media player.

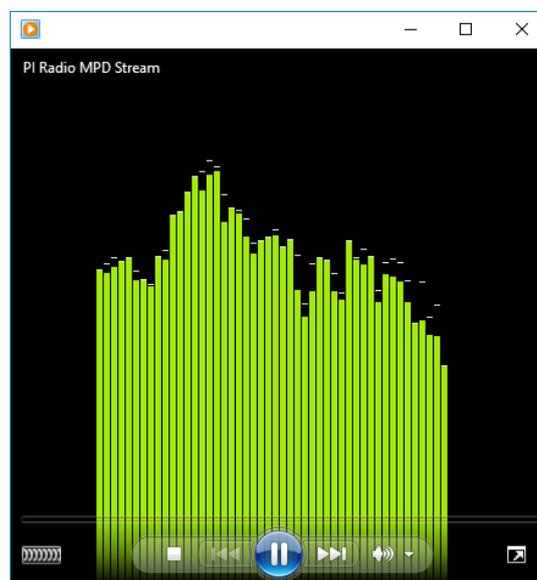


Figure 226 Windows media player

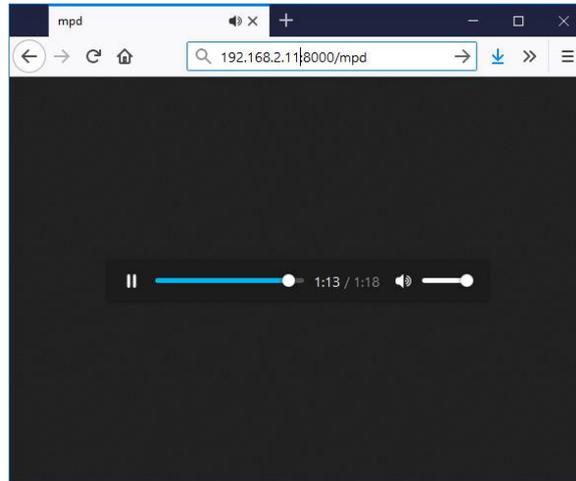


Figure 227 Firefox embedded media player

You will be prompted if you wish to save or open the radio stream. Always select open using the configured media player. The selected radio station or music track should be heard through the PC speakers. At this point you may wish to mute the sound from the radio itself. Simply reduce the volume to almost zero.



Note: It is probably possible to configure Windows 10 Edge or Internet Explorer 11 to use Windows Media player instead of TWIUI. Note: If the mute function is used it will stop the **Icecast** stream.

Running the Icecast Administration Web pages

Using the same IP address as shown in the previous example but without the mount point will bring up the administrator window:

<http://192.168.2.8:8000>

The following screen should be displayed. If not continue to the troubleshooting guide at the end of this chapter:

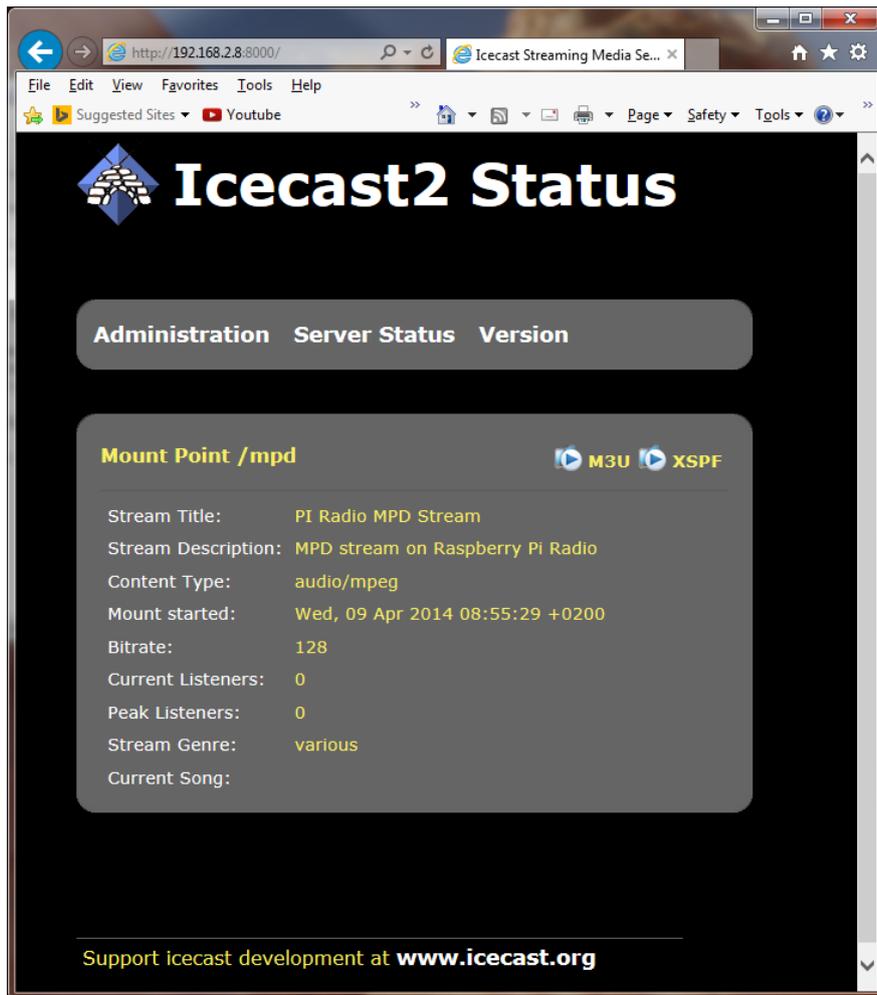
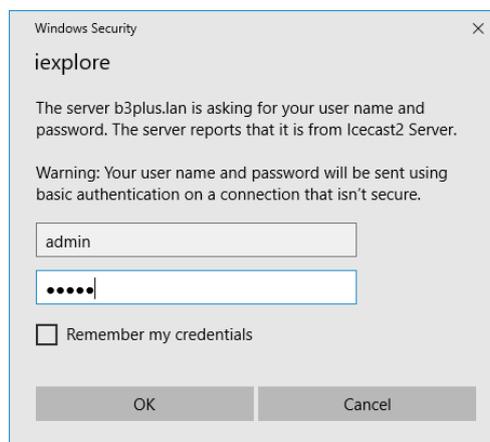


Figure 228 Icecast2 Status

Initially the server status screen is displayed. If you click on the **Administration** tab the you will be prompted for the login credentials.

Log in as admin with user *admin* password *mympd*.



Playing the Icecast2 stream on an Apple iPad

This is exactly the same as playing the Icecast2 stream on a Windows PC.

1. Open the Safari browser.
2. Type in the Icecast2 URL. For example, **http://192.168.2.11:8000/mpd**
3. Click the M3U button

This should open the iTunes Player and after a short time should start playing the radio stream.

Playing the Icecast2 stream on an Android device

1. Open your Web browser
2. Type in the Icecast2 URL. For example, **http://192.168.2.11:8000/mpd** (don't include .m3u)
3. When asked to "Complete action with" select your *Android System* then *Music player*

The Icecast stream should start playing. It is important not to key in **mpd.m3u** at the end of the URL. It must be **mpd** only.

Visual streaming indicator

When streaming is switched on an asterix '*' character is displayed as a visual streaming indicator in the LCD display on the Raspberry PI radio. When the '*' character is displayed this indicates that the Icecast2 streaming is switched on.

For the four line 20 character display the visual indicator is displayed after the time on the first line.

09:26 02/05/2014 *

For the two line by 16 character display there isn't the room to do this so it is displayed after the Volume or Mute message on the second line.

Volume 75 * or Sound muted *

Graphical radio streaming operation



Radio versions prior to version 7.3 could only switch streaming on or off in the LCD/OLED versions of the radio. From 7.3 onwards streaming can be switched on and off in the full featured graphical version of the radio (gradio.py). When Icecast2 is installed the Icecast2 ON icon will appear on the right-hand side of the screen next to the display window. Clicking it once only will switch off streaming and the OFF icon will be shown. It does take a few seconds for this to happen so only click on the icon once.

However, it is necessary to first set the **display_icecast_button** in the **[SCREEN]** section of **/etc/radiod.conf** to 'yes'. Add this parameter if it is missing.

```
# Display Icecast streaming button
display_icecast_button=yes
```

Troubleshooting Icecast2

Help for general problems with icecast2 can be found on the forums at <http://www.icecast.org/>

Icecast2 has two log files in the **/var/log/icecast2** directory namely **access.log** and **error.log**. The error log may give a clue as to the problem.

Below is a simulated error caused by mis-configuring the shoutcast entry in `/etc/mpd.conf` file. Here the hostname 'piradio' has been configured in the `/etc/mpd.conf` shoutcast entry instead of 'localhost'.

```
$ tail -f /var/log/mpd/mpd.log
Apr 07 10:43 : output: Failed to open "PI Radio MPD Stream" [shout]: problem
opening connection to shout server piradio:8000: Couldn't connect
```

Problem - Icecast streaming page says it can't be displayed.

Possible causes:

- The icecast service is not running on the radio.
 - Start it either from the Radio options menu (Streaming on) or run **sudo service icecast2 start** on the Raspberry Pi and retry.
- Incorrect IP address or missing port number in the URL.
 - See Icecast2 Operation on page 289

Problem – No Mount Point displayed

Possible causes:

This is mostly due to a mis-match in the MPD configuration and the Icecast2 configuration.

The icecast configuration file is `/etc/icecast2/icecast.xml`. Make sure that all of the passwords are set to 'mympd'. The password 'hackme' will not work.

Problem - Cannot play the stream on my Android device

There are a number of Icecast players which can be downloaded onto Android and play Icecast2 streams across the network without problem. However, the usual Android System Music player should work. The most likely cause of this problem is keying in an incorrect URL (Maybe adding .m3u to the end). See *Playing the Icecast2 stream on an Android device* on page 293.

Problem – Music keeps stopping or is intermittent

This is difficult to give a definitive answer to this problem. It must be remembered that running MPD and Icecast2 together on a Raspberry Pi is pushing the Raspberry Pi to its limits. It can also depend on your network or the PC you are using. Personal experience showed no problem playing a stream on PC with a wired network connection however a Laptop connected over a wireless network did not work well. Trying to play two or more devices on the MPD/Icast2 stream is also likely to result in poor results.

With older versions of the Raspberry Pi, try over-clocking the Raspberry Pi using the **raspi-config** program. Medium over-clocking seems to be sufficient. See *Overclocking older Raspberry Pi* on page 289.



Note: The Icecast streaming facility is a fun thing to try out but if it doesn't work properly or is causing you stress; switch the streaming facility off.

Chapter 11 - Setting up Spotify and Airplay

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Setting up Spotify



The radio can also be set up as a Spotify receiver. You will still need a Spotify App on your telephone, PC or Tablet. You will also need a Premium Spotify account and not just a free or trial version.

More information at <https://www.spotify.com>

Spotify hardware requirements

Spotify works with the on-board audio output or HDMI audio. However, if using a DAC, the card must be capable of hardware volume control. When the radio is running the volume is software controlled by MPD. When Spotify is running, MPD is stopped and the volume is controlled by the standard **amixer** command. The volume control for Spotify is coded in the **volume_class.py** file. For example, the following command sets the volume to 100%.

```
sudo -u pi amixer cset numid=1 100%
```

The **numid** must match that of the hardware volume control. This is typically numid 1, 2 or 6. The **amixer controls** command will display all the hardware controls for a sound card. To check if your DAC supports Hardware Volume control run the **amixer controls** command.

```
$ amixer controls
:
numid=1,iface=MIXER,name='Digital Playback Volume'
```

DACs using the PCM5122a chip should all support hardware volume control. However, DACs based upon the PCM5102 chip do not have any hardware volume control so the volume cannot be set by **amixer** commands. It is still possible to use these DACs however volume can only be done from the Spotify client App running on a mobile telephone, tablet or PC.

Spotify installation

The radio software also supports **Raspotify** originally from Dave Cooper which is Spotify for Raspberry Pi OS. First carry out a system update and upgrade as shown in *Update to the latest the packages* on page 90.

Install the **apt-transport-https** package and download and install the **Raspotify** software with the **curl** command into the pi home directory.

```
$ cd
$ sudo apt install apt-transport-https
$ curl -sL https://dtcooper.github.io/raspotify/install.sh | sh
```

This will both download and install **Raspotify**. In the **/etc/default/raspotify** configuration file you will see the **OPTIONS** line for Spotify account details. It is not necessary to configure your account details as these will be picked up from the connecting **Spotify** App on your PC or Mobile.

```
#OPTIONS="--username <USERNAME> --password <PASSWORD>"
```

More information on Raspotify can be found at <https://dtcooper.github.io/raspotify>

Using sudo edit `/lib/systemd/system/raspotify.service` and disable the restart options.

```
#Restart=always
#RestartSec=10
```

Set the correct device ID to the **ExecStart** in the same `raspotify.service` file. This must match the **device** setting in the `audio_output` definition in `/etc/mpd.conf`

```
ExecStart=/usr/bin/librespot --device=hw:0,0
```

The configuration in `/etc/mpd.conf` is set up by the `configure_audio.sh` script

```
audio_output {
    type          "alsa"
    name          "IQAudio DAC/Zero DAC"
    device        "hw:0,0"
```

Save the file and update **systemd** with the following command:

```
$ sudo systemctl daemon-reload
```

Finally run the `set_mixer_id.sh` script:

```
$ cd /usr/share/radio
$ sudo ./set_mixer_id.sh
mixer_volume_id=1
```

The above **mixer_volume_id** output may vary.

The radio will automatically stop and start Raspotify but it may be started and with the following commands:

```
$ sudo systemctl start raspotify
$ sudo systemctl stop raspotify
```

You can also check the status of **raspotify** with **systemctl**.

```
$ sudo systemctl status raspotify
● raspotify.service - Raspotify (Spotify Connect Client)
   Loaded: loaded (/lib/systemd/system/raspotify.service; enabled; vendor
  preset: enabled)
   Active: active (running) since Fri 2022-02-18 10:12:25 GMT; 6min ago
     Docs: https://github.com/dtcooper/raspotify
           https://github.com/librespot-org/librespot
           https://github.com/dtcooper/raspotify/wiki
           https://github.com/librespot-org/librespot/wiki/Options
    Main PID: 13033 (librespot)
      Tasks: 1 (limit: 2054)
         CPU: 123ms
    CGroup: /system.slice/raspotify.service
           └─13033 /usr/bin/librespot

Feb 18 10:12:25 bookworm2 systemd[1]: Started Raspotify (Spotify Connect
Client).
```

Disable Raspotify from starting at boot time. Starting and stopping Raspotify is done by the radio.

```
$ sudo systemctl disable raspotify
```

It is necessary to modify **/etc/raspotify/conf** to allow the track title to be displayed.

```
sudo vi /etc/raspotify/conf
```

Comment out the **LIBRESPOT_QUIET** parameter in **/etc/raspotify/conf**. You will need to use your editor with **sudo**. For example, **sudo nano /etc/raspotify/conf**

```
# Only log warning and error messages.  
#LIBRESPOT_QUIET=
```

Failure to do so will mean that track titles will not be displayed.

Raspotify messages during operation can be observed with the following command:

```
$ journalctl --lines 0 --follow _SYSTEMD_UNIT=raspotify.service
```

Finally stop the Raspotify service and restart radiod.

```
$ sudo systemctl stop raspotify  
$ sudo systemctl restart radiod
```



Note: The authors of Raspotify have stated that it is not possible to display the artist's name and never will be. Only the track title can be displayed.

Spotify operation

To start the Radio as a Spotify receiver either select Spotify from the Playlists (LCD or OLED versions) or from the Sources window in the touchscreen version:

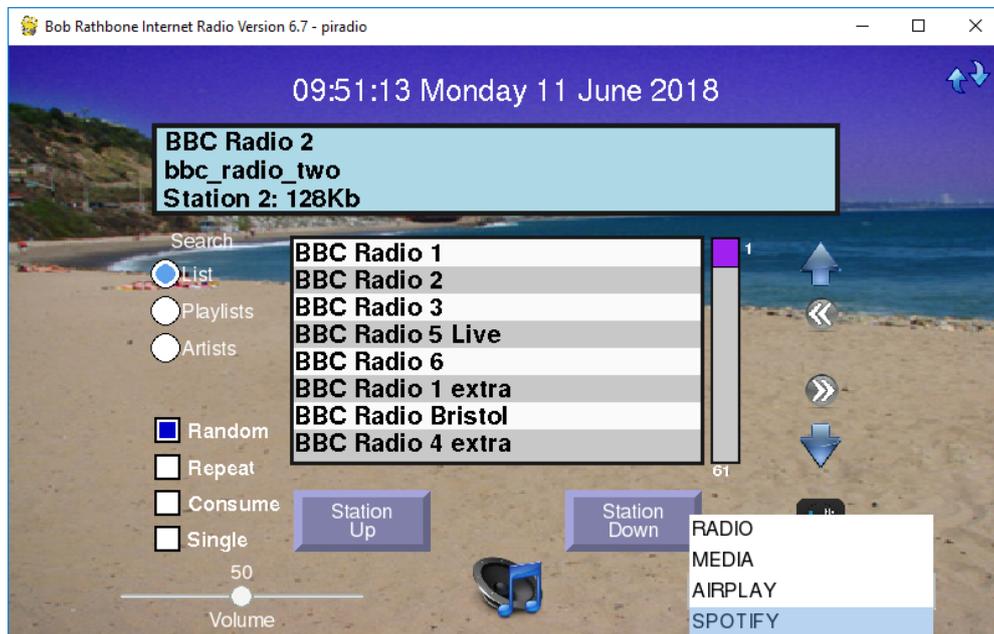


Figure 229 Starting the Spotify Receiver

The following window will appear however a different message may appear on the second line of the display window:



Figure 230 The radio in Spotify mode

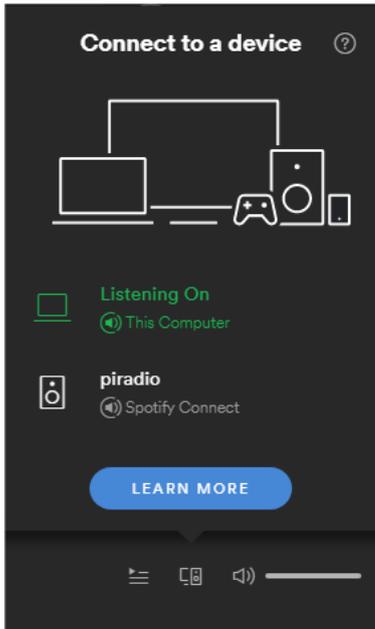


Figure 231 Spotify connecting to the radio

To use Spotify you will need a Spotify App on your telephone, PC or Tablet.

As previously mentioned you will need a Premium Spotify account and not just a free or trial version.

On the radio, press the Menu button until you come to the sources selection. Press channel Up or Down until you see Spotify displayed.

Press the Menu button again and the radio will stop the MPD player and start raspotify.

Now click on *Connect to a device* in the Spotify application. You should see an entry called Spotify Connect with the hostname of your radio.

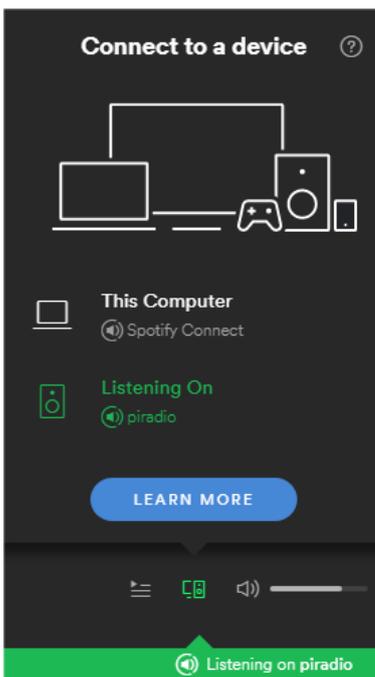


Figure 232 Listening to Spotify on the radio

Click on the *Spotify Connect* device for the radio (*piradio* in this example).

The Spotify application will switch from the current device (PC, mobile phone or tablet) to the Raspberry Pi radio.

You can control the volume either from the Spotify Application or using the volume control on the radio.

To exit Raspotify on the Raspberry Pi press the Menu button and then select another source such as the radio.

The Spotify application will connect the Raspotify application on the Radio.



Note: If you don't hear any sound then turn the volume up to full.

In the case of the touchscreen version of the program the following screen will be displayed:



Figure 233 Spotify playing a music track

In the case of the LCD or OLED version of the radio the title line above will be displayed on the second line of LCD or OLED screen.



Note: Raspotify unfortunately does not supply the Artist information. Only the track name is supplied by **librespot** which is used by Raspotify. There is currently no solution for this.

Exiting Spotify

For the LCD and OLED versions press the Menu button until the Select source: window is displayed. Select any other source (playlist) to exit.

In the case of the touchscreen version of the radio, press the “Exit Spotify” button at the bottom of the screen.

Troubleshooting Raspotify

Installation problems

If the curl command to install the Raspotify software fails then carry out a system update and upgrade as shown in *Update to the latest the packages* on page 90. Retry the curl command.

Raspotify exits with a 101 error code

This is almost certainly an authentication fault. Check your user name and password are correctly set up in **/etc/default/raspotify** and retry. However, it isn't actually necessary to put a username and password in **/etc/default/raspotify** as Raspotify will be using a Raspotify Premium account running on a PC, tablet or mobile phone.

The client connects to Raspotify but no sound heard

Check that the device ID has been added to the **ExecStart** statement in the same **raspotify.service** file.

```
ExecStart=/usr/bin/librespot . . . . . --device=hw:0,0
```



Note: The author does not directly support Raspotify. Report Raspotify issues to <https://github.com/dtcooper/raspotify/issues> Raspotify comes with an MIT licence. See <https://opensource.org/licenses/MIT>

Cannot change Raspotify volume

In some cases, this is normal as many cheaper sound cards (DACs) do not have mixer controls. Mixer controls are required to change the volume on the Raspberry Pi when running Spotify or Airplay. In the case of no mixer controls the sound when running Spotify must be controlled from the App on either your mobile device or from the PC application.

However, it is possible to set up a software mixer (SoftVol).

See section *Configuring soft volume (SoftVol)* on page 197 for further information.

Raspotify initial sound too loud

Edit the `/lib/systemd/system/raspotify.service` file. Locate the following line

```
Environment="VOLUME_ARGS=--enable-volume-normalisation --volume-ctrl linear  
--initial-volume 100"
```

Change to the desired volume setting.

```
--initial-volume 75
```

Airplay Installation

If you have not already done so, carry out a system and firmware upgrade, as shown in *Preparing the Operating System* on page 90. **Airplay** uses a program called **shairport-sync** from Mike Brady.

Airplay is based upon the procedure in the following link:

<http://www.redsilico.com/multiroom-audio-raspberry-pi>



Do not use the procedure in the above link. Use the procedure described below as it has been greatly modified to work with the radio software.

Airplay is installed using an installation script called `install_airplay.sh`.

```
$ cd /usr/share/radio  
$ ./install_airplay.sh
```

This will install both **shairport-sync** and configure the radio to use it.

If the script fails with a dependency error for PHP. Run the following:

```
$ sudo apt -f install
```

Re-run `install_airplay.sh`.

Configuring the Airplay feature

Below are the configuration parameters found in the Airplay section of `/etc/radiod.conf` affecting the Airplay (shairport-sync) function in the radio.

```
[AIRPLAY]
```

```
# Airplay activation yes or no
airplay=no

# Mixer preset volume for radio and media player if using sound card
# Set to 0 if using onboard audio or USB sound dongle.
# If using a sound card set to 100% initially and adjust as necessary
# Old name was mixer_volume
mixer_preset=100
```



If upgrading from an earlier version of the radio and you selected “Do not update existing configuration” during installation then the [AIRPLAY] section will be missing from **/etc/radiod.conf**. If this is the case then copy the above lines to the end of the file.

Check that Airplay is enabled. This should already be configured by **/etc/radiod.conf**

```
airplay=yes
```

Airplay service check

Check that all is well with D-Bus. The following

```
$ sudo systemctl start shairport-sync
Failed to get D-Bus connection: Unknown error -1
```

If the above error message is seen install **systemd-sysv**:

```
$ sudo apt install systemd-sysv
```

Re-start and check status.

```
$ sudo systemctl start shairport-sync
$ sudo systemctl status shairport-sync
● shairport-sync.service - ShairportSync AirTunes receiver
   Loaded: loaded (/lib/systemd/system/shairport-sync.service; disabled;
   vendor preset: enabled)
   Active: active (running) since Sat 2021-03-20 11:25:15 GMT; 15s ago
```

Reboot the Raspberry Pi.

```
$ sudo reboot
```

See the following section on how to use Airplay.

Using Airplay on the radio

Using Airplay on a HDMI/Touchscreen is described in the section called *Running Airplay on the HDMI touchscreen* on page 208. LCD versions of the radio are described here.



Figure 234 Airplay source selection

Press the menu button until **Input Source:** is displayed.

Turn the channel button (or Up/Down switches on a push-button radio) until **Airplay receiver** appears.

Press the menu button one more time. The word Airplay will be displayed on the bottom line along with 'Unknown artist' and 'Unknown title'.

Now use the Airplay device to connect to the raspberry PI (varies according to device software). Start playing the music tracks and this should start being heard on the radio which also displays the Artist, Track and Album on the LCD display. The volume is adjustable if correctly set-up. The mute also works in the normal way but does not pause or stop the Airplay stream as this can only be done from the device running Airplay.



Figure 235 Running an Airplay device on the radio with Cloudbreak

The above example is using an evaluation copy of CloudBreak running on an Android mobile telephone.

Unfortunately, Cloudbreak is no longer available however there are a number of Airplay Apps available for Android telephones such as "Double twist".

Chapter 13 - Internet Security

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This is a section that probably will not concern most people as their Raspberry Pi is not exposed to the internet. However, with more and more cases of such devices such as Web cams and other Internet connected devices being hack by unscrupulous hackers, Internet Security is an aspect of home computing that must be taken seriously. These incursions can be used to mount Phishing (harvesting bank details etc.) or Distributed Denial of Service attacks (**DDOS**) on the wider community as a whole. More and more Internet providers are choosing to block compromised user's systems from access to the Internet until the infection is removed.

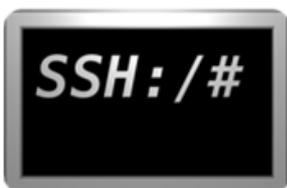
Some golden Internet Security rules



Always change the user **pi** password from the system installation default or use another log in name such as 'bobrath' (Only possible since version 7.5 of the software). When installed the password for user **pi** is 'raspberrypi'. It will be the first password that will be attempted by a hacker. The password can easily be changed using the **raspi-config** program (See *Changing the system hostname and password* on page 94). The user **pi** is very dangerous if hacked as with the command **sudo bash** the hacker then has user root privileges and can do anything they want including installing **Phishing** or **DDOS** software. Don't give them the chance!



Never ever use insecure protocols/programs such as **Telnet**, **Rexec** or **FTP** across the Internet. The problem with all such programs is that the login username and password are un-encrypted and can be discovered by a hacker using eavesdropping software. The use of such software to access the Raspberry Pi will attract hackers like flies around a honey-pot.



If access to the Raspberry Pi across a network is required (for example a headless RPi) then use Secure Shell (**SSH**) for terminal access and Secure Copy (**SCP**) for file transfer. On the latest releases of Raspbian, **SSH** is disabled for security reasons. For extra security use **SSH keys** (explained later)

Fail2Ban



Install **firewall** software such as **fail2ban**. The **Raspbian Buster** operating system has a firewall called **iptables** which can be configured to block or allow access to specific ports from a specific **IP** address or range. The **fail2ban** software is an enhancement to **iptables** which monitors certain ports for hacking attempts and adds a blocking rule to the **iptables** configuration. More on this later. The fail2ban software is a good defence against so-called brute-force dictionary attacks.

SSH keys installation

Raspberry Pi ssh keys

If using **SSH** across the Internet, changing the password for user **pi** will afford some limited protection. However, a hacker can still access the system with SSH and try to log in as user **pi**. They can still try (often using software) to try and guess the password. By using SSH keys a greater level of protection is afforded as person logging in must be in possession of the SSH keys.

Log in as user **pi** and then run the **ssh-keygen** program. Just press enter when asked any questions.

```
$ ssh-keygen -t rsa -C "raspberrypi"
Generating public/private rsa key pair.
Enter file in which to save the key (/home/pi/.ssh/id_rsa):
Created directory '/home/pi/.ssh'.
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /home/pi/.ssh/id_rsa.
Your public key has been saved in /home/pi/.ssh/id_rsa.pub.
The key fingerprint is:
c0:54:96:d9:2d:a5:d0:d0:7c:68:91:8a:5f:e2:a5:9d pi@pixelpi
The key's randomart image is:
+----[RSA 2048]-----+
|      ..=O.*.      |
|      o.o.X.o      |
|      o.o.o        |
|      ..o.o        |
|      oS* .        |
|      + E          |
|                  |
|                  |
|                  |
+-----+

```

Two keys are generated, one public and one private in the **.ssh** directory. The key **id_rsa.pub** is the public key. The **id_rsa** file is the private key.

```
$ ls -la .ssh/
total 16
drwx----- 2 pi pi 4096 Feb 16 12:40 .
drwxr-xr-x 19 pi pi 4096 Feb 16 12:40 ..
-rw----- 1 pi pi 1675 Feb 16 12:40 id_rsa
-rw-r--r-- 1 pi pi 392 Feb 16 12:40 id_rsa.pub

```

Generate a client key

It is also necessary to generate SSH keys on Typically **Putty** and **Bitvise** are a very popular choice for **SSH** clients. There is already so much documentation on the Internet on how to generate SSH keys for both **Putty** and **Bitvise** that it is not repeated here. Search the Internet for instructions.

Add client public key to Raspberry Pi authorised keys

On the Raspberry Pi create or edit the `/home/pi/.ssh/authorized_keys`.

```
$ cd /home/pi/.ssh/  
$ vi authorized_keys
```

Paste or copy the Public key created on the PC to the `authorized_keys` file. (Some output in the following text omitted).

```
ssh-rsa  
AAAAB3NzaC1yc2EAAAABJQAAAQEAAuX+NEQoQECPN2d+Lu+qL2exMT/ICYbrNax6DVWBtKGzTxFOb  
:  
LeiaFbI3tWyi+ZPXg8Swhr1OaPN6l2E/fnAQPbG12S+YMtcIXknNiwVGL8RB3D8N/Q== rsa-  
key-20170216
```

Finally connect to the Raspberry Pi from the PC client using the **publickey** method. If this works OK disable password login method. Edit `vi /etc/ssh/sshd_config` and disable PAM and Password authentication.

```
PasswordAuthentication no  
:  
UsePAM no
```

Firewall set-up

Linux has a firewall facility built-in to the kernel called **iptables**. Rules may be added to **iptables** to allow or deny access to system services as required. However, **iptables** is static and has to be configured with any new rules. The **fail2ban** program enhances **iptables** by dynamically adding rules as required. For example, if a hacker attempts five unsuccessful logins using SSH then **fail2ban** blocks that IP address from connecting to the SSH port by adding a blocking rule to **iptables**. The following commands install and enable **fail2ban**.

```
$ sudo apt install fail2ban  
$ sudo systemctl enable fail2ban
```

Below is an example of a blocked host (195.22.126.242)

```
$ sudo iptables -L  
Chain INPUT (policy ACCEPT)  
:  
Chain FORWARD (policy ACCEPT)  
:  
Chain OUTPUT (policy ACCEPT)  
:  
Chain fail2ban-ssh (2 references)  
target    prot opt source      destination  
REJECT    all  --  195.22.126.242 anywhere reject-with icmp-port-unreachable
```

However, rules added by fail2ban will be lost if the Raspberry Pi is rebooted. An additional package called iptables-**persistent** can be added so that rules added by fail2ban can be made permanent. The following command allows installation.

```
$ sudo apt install iptables-persistent
```

The following command can be used to make the **iptables** rules persistent after a reboot. Run the following command before rebooting.

```
$ iptables-save
```

Search the internet for more information on **iptables** and **fail2ban**.

Chapter 14 - Frequently asked questions (FAQs)

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What is the login name and password?

The default login name is: pi

The default password is: raspberry

You should change this at the earliest opportunity. See *Chapter 13 - Internet Security* on page 305.

How do I change the order of the radio stations?

Playlists are loaded by the radio daemon in alphabetic order using the playlist name.

When loading an individual playlist, MPD loads the stations in the order that they are defined in each individual playlist in the `/var/lib/radiod/stationlist` file.

It helps greatly to group stations of the same type into a single playlist. For example, group all BBC radio stations into a single playlist.

The only way to get all of the radio stations in the order that you define them is to define a single playlist, for example **myplaylist**:

```
(myplaylist)
#
# United Kingdom
[BBC Radio 1] http://bbc.co.uk/radio/listen/live/r1.asx
[BBC Radio 2] http://bbc.co.uk/radio/listen/live/r2.asx
[BBC Radio 3] http://bbc.co.uk/radio/listen/live/r3.asx
:
:
[RAIradio3] http://www.listenlive.eu/rai3.m3u
```

This will produce a single playlist called **myplaylist.m3u** with the stations loading in the order that they have been defined in the `/var/lib/radiod/stationlist` file. Make sure there are no blank lines between station definitions otherwise this terminates the playlist. All remaining stations will end up in their own single playlist file.

Why are some station names not being displayed in the Web interface?

The reason for this is that some stations don't send the name with the stream. If you run the **mpc playlists** command you will see that some radio stations show only the station URL and not the name:

```
$ mpc playlist
RAIradio2
:
BBC Radio 4 extra
http://icestreaming.rai.it/1.mp3
BBC Radio 3
BBC Radio 6
BBC Radio 5 live
```

The only way around this is to complain directly to the radio station to ask them to amend their stream to include the station name and title details. The only way reason that the station name is seen with the radio program is that it picks up the names out of the station list file.

The snoopy Web interface can't do this however.

Why doesn't the Web interface display URLs until a station is selected?

When the Snoopy Web interface is loaded it loads the playlists found in the `/var/lib/mpd/playlists/` directory. Snoopy displays the URLs but doesn't appear to use any titles defined in the playlists. It only displays the radio station information (if present) once it starts streaming from a particular radio station. Snoopy is third party software over which this author has no control.

Why are music tracks played randomly when loaded?

This is the default behaviour when the music library is loaded. Random always defaults to "off" when the radio is selected. However, when the media library is selected the value stored in the `/var/lib/radiod/random` file is used which is either 1 (Random on) or 0 (Random off). This value can be changed in the selection menu by toggling "Random on/off". So, the radio software will remember the desired random setting for the music library when it is restarted.

Can the volume be displayed as Volume nn instead of as blocks?

Yes, it can. Volume is displayed by default as blocks on character LCD's or as a volume ribbon on OLED devices. However, it can also be configured to display as a value "Volume nn" where nn is 1 to 100. This can be changed as shown in section *Configuring the volume display* on page 183

Why do I see a station number on LCD line 3?

If no song information is available then the station playlist number followed by the stream speed. In the following example Radio 1 is not transmitting any song information. It is number 37 in the playlist. The speed from the stream is 96 Kilobit. The displayed stream speed can also continuously change for some radio stations where the stream speed is variable.

```
12:01 23/08/2015
Radio1
Station 37 96K
Volume 75
```

Is it possible to change the date format?

Yes. Please see the section called *Changing the date format* on page 181.

Is there a pause & resume function?

Yes, but it is called mute and un-mute. The mute function also stops or pauses the MPD player. If playing a radio station, a "stop" command is carried out. If playing a media track a "pause" is carried out. The reason these are different is that media may be safely paused but in the case of a radio station pausing causes buffering and jumping to the next station when the radio resumes normal playing.

Is there a reboot or shutdown option?

There is only a shutdown option. Hold the menu button in for at least three seconds. The radio will stop and should display "Radio stopped" on the display. Wait ten seconds and then power off the Raspberry Pi. Powering back on achieves the same effect as a reboot. Also see *Fitting a wake-up button* on page 60.

Why do I see a different station name from the one in the playlist?

The station information displayed comes from the stream itself. The name entered in the playlist definition is only used in the search function. This was a design decision because the station

information is only available once a particular radio station is selected so only the playlist name can be initially used. If the station transmits the station title this is used instead.

Run the `display_current.py` program to see all the information that comes from the stream (It is quite interesting).

What Rotary Encoder can I use for this project?

It is possible to use any so called “Incremental Rotary Encoder” such as the COM-09117 12-step rotary encoders from sparkfun.com or the KY-040 encoder. An incremental rotary encoder provides cyclical outputs (only) when the encoder is rotated. The other type is an “absolute rotary encoder” and maintains position information even when switched off. These do not work with the radio software.

The cheaper smaller rotary encoders are usually incremental encoders. Absolute rotary encoders are usually bigger and more expensive as they house more electronics. If unfortunately, the seller doesn't provide a specification then there is a small risk that they may not run with this software.



Note: Not all manufacturers' rotary encoders will work with this project. If they work then fine if not regrettably you will need to purchase the recommended rotary encoders. You can also try the alternative rotary class which may just work with your encoders.

Can this code or documentation be re-used in other projects?

Yes, it can. You can even use it commercially, provided that you do so under the terms of the licence distributed with this package. The software and documentation for this project is released under the GNU General Public Licence and may be re-used in other projects. See *Licences* on page 348.

You do not need to ask permission to re-use this code or documentation as it is already permitted in the licenses.

Can I use an Electronic Ink display?

The answer is not at the moment. There are a number of electronic ink displays on the market such as the Pimoroni Inky pHat and the Waveshare ink display. These displays appear to only suitable for static display of information and do not handle dynamically changing screens well. However, looking at on-line demo's the Waveshare device, it can handle partial screen updates however continuous updates appeared to damage the screen after a time. Maybe this will improve over time.

Can you make or sell me a radio?

The answer is NO. I regret I do not make any radios for sale nor do I make radios for other people. The whole purpose of this project is to help hobby and enthusiasts to learn computing. If you want one of the radios shown in this manual you need to build it yourself.

Can you recommend the hardware for my project?

No - The author never makes recommendations as to which hardware someone should use for their project. There is a detailed overview, in this manual, of the possible solutions which are supported by the software.

No one can then ever say “well you recommended it” if there is a problem with the hardware selection. The choice of hardware is totally down to the constructor as only they know their exact requirements. Also, the author wishes to remain neutral when it comes to recommending any manufacturer's hardware offering.

Can you make a change to the software for my project?

Many of the ideas and features in this project have come from the community of enthusiast's and constructors. Their ideas and contributions have greatly enhanced both the usability and functionality of the project. These suggestions are always welcome and where possible, sooner or later, find their way into the product but not always.

What seems to be a simple change will mean months of testing of a new release. There are at least twelve basic designs plus variations all of which must be validated before the new software can be released.

However, if a constructor wishes to make software changes, help is available although this does not extend to either debugging their software or teaching Python.

What if I want to try different hardware?

Often a constructor comes across other hardware other than that published in this manual and ask whether or not it can be used. This often because it is cheaper, more locally available or better than the current options. The author will give an opinion as to whether or not it might work in their situation but will not take responsibility for the choice made for any given project. The choice of hardware is ultimately the responsibility of the constructor.

Sometimes there are cheaper versions a popular piece of hardware but prove to be disappointing. One such case was a cheap Chinese version of Adafruit's RGB backplate. This has an RGB backlight. The cheap alternative simply put an RGB LED on the board which did not act as a backlight but rather as an indicator LED. Other cases of cheap alternatives to using the official Raspberry Pi 7-inch touch screen have also displayed start-up problems. So, caution is advised.

Sometimes the suggested hardware would require new or modified software and the author will consider this depending upon the merits of introducing such hardware and has done so many times in the past, thus enhancing the project.

Again, such suggestions and ideas are always welcome but do not guarantee that these suggestions will be supported by the Radio software.

Chapter 15 - Source files

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Introduction to the source code

This section is only of interest if you are considering developing your own version of the software or wish to use one of the classes in your own software.

The source consists of several source modules all written in **Python 3** using Object Orientated techniques. The source will be visible in the `/usr/share/radio` directory once the Radio package has been installed. The radio Debian package is available at http://www.bobrathbone.com/pi_radio_source.htm.

For those who want to develop their own product all source is also available from Github. See *Downloading the source from GitHub* on page 323.

The Radio program

The `radiod.py` program is the top-level radio program for the LCD versions of the radio and provides the logic for operating the radio. It is called from the **systemd radiod.service** script in the `/lib/systemd/system` directory.

The Radio Daemon

The `radio_daemon.py` code allows the LCD radio program to run as a background daemon. It allows start, stop, restart, version and status commands.

The Display Class

The `display_class.py` is the common top-level display used by the radio programs (`radiod`, `gradio` and `vgradio`) and is responsible for displaying messages on the various types of display. It uses the **display_type** parameter in the `/etc/radiod.conf` configuration file to load the correct software for the display being used. Depending upon the actual device configured it will load one of the following display drivers:

Table 27 Display classes

Display class file	Description	display_type
<code>lcd_class.py</code>	LCDs with a directly connected HD44780U	LCD
<code>lcd_i2c_adafruit.py</code>	LCDs with an Adafruit I2C backpack	LCD_I2C_ADAFRUIT
<code>lcd_i2c_pcf8574.py</code>	LCDs with a PCF8574 I2C backpack	LCD_I2C_PCF8574
<code>lcd_i2c_jhd1313.py</code>	Grove JHD1313 LCD RGB with I2C interface	LCD_I2C_JHD1313
<code>lcd_adafruit_class.py</code>	LCDs with an Adafruit RGB plate	LCD_I2C_ADAFRUIT
<code>lcd_adafruit_class.py</code>	Adafruit LCD I2C RGB plate with buttons	LCD_ADAFRUIT_RGB
<code>lcd_pifacecad_class.py</code>	PiFace CAD 2x16 LCD with push buttons	PIFACE_CAD
<code>oled_class.py</code>	Solomon Systech SSD1306 OLED Display - IQaudio	OLED_128x64
<code>st7789tft_class.py</code>	Pimoroni Pirate audio with four push buttons	ST7789TFT
<code>ssd1306_class.py</code>	Sitronix SSD1306 128x64 pixel OLED	SSD1306
<code>no_display.py</code>	No display attached (vintage radio/Pirate Radio)	NO_DISPLAY
<code>luma_class.py</code>	LUMA driver for OLEDs with SSD1306, SSD1309, SSD1325, SSD1331, SH1106 and WS0010 chips	LUMA.<DEVICE>

The above settings are either configured by the `configure_radio.sh` program or by modifying the **display_type** parameter directly in `/etc/radiod.conf`. For example, if the PCF8574 I2C backpack is chosen then then the following will be configured in `/etc/radiod.conf`:
display_type=LCD_I2C_PCF8574

The Graphical Screen radio programs

The *gradio.py* and *vgradio.py* programs are the radio programs for the HDMI/Touchscreen version of the radio and is launched on the graphical desktop of the Raspberry Pi. It is optionally called from the **Desktop/gradio.desktop** script in the **/home/pi** directory. The *vgradio.py* program gives a vintage radio look and feel to the radio display.

In the case of both programs the **display_type** parameter in **/etc/radiod.conf** is set to GRAPHICAL and is set by the **configure_radio.sh** program.

The Graphics display class

The *graphic_display.py* class performs auxiliary display functions such as scrolling and screen mapping for the *gradio.py* and *vgradio.py* programs.

The Graphics controls class

The *gcontrols_class.py* handles the creation of all graphics controls and widgets for the graphic version of the radio. It also uses the SGC widget routines in the **sgc** sub-directory from Sam Bull and Michael Rochester.

The OLED class

The *cosmic_class.py* is the display interface for the SSD1306 128x64 pixel OLED display supplied with the IQaudio Cosmic controller. This class is a wrapper for the routines from **Olimex Limited** in the sub-directory **oled**. It drives the OLED screen although not all functions are used by the radio.

The SH1106 OLED SPI interface (pHat with joystick)

The SH1106 1.3" 128x64 pixel SPI interface uses the following three files:

- **sh1106_class.py** Driver for the 1.3" SH1106 OLED (SPI interface)
- **sh1106_config.py** Configuration file for the above driver
- **sh1106_key_test.py** Graphical test program for the pHat with OLED display, joystick and 3-push buttons

It is also necessary to physically re-wire the OLED pHat (with joystick and push buttons) to use the I2C interface. See Appendix *C.7 SH1106 SPI 1.3" OLED with joystick and 3-buttons* on page 378 for more information.

The button class

The *button_class.py* detects all button presses from the push button radios (Not the Adafruit RGB nor the PiFace CAD which have their own buttons using I2C and SPI interfaces respectively). It passes button press events up to the event class described later.

The rotary class

The *rotary_class.py* and *rotary_class_alternative.py* detect all rotary encoder events from the radios fitted with rotary encoders. It passes rotary encoder events up to the event class described later.

The Cosmic controller Class

The *cosmic_class.py* is used as the user interface for the IQaudio Cosmic controller. This provides the interface for three-button and rotary control interface on the controller board.

The Event class

All user interfaces in the radio software generate a largely common set of events. These are handled by the *event_class.py*. The *event_class.py* program accepts events from the following sources:

- The *gradio.py* and *vgradio.py* graphical radio programs

- The *radiod.py* radio program
- The push button interface user interface (*button_class.py*)
- The rotary encoder user interface (Either *rotary_class.py* or *rotary_class_alternative.py*)
- The IR remote control user interface (*ireventd.py*)
- The radio Web user interface running on an Apache Web server

The Menu class

The *menu_class.py* code provides the logic for stepping through the various menus and their options.

The Message class

All messages are generated from the *message_class.py* program. This uses message labels to load the correct text to be displayed or spoken. By using labels and the *language_class.py* software, the radio can be configured to use any language using a Latin character set. It provides messages to display various menu's, time, station and track information.

The Language class

The *language_class.py* provides the text for both the radio display or the **espeak** package. It reads the **`/var/lib/radiod/language`** file (if present) and passes the text to both the message class and if used. It is used by the message class to deliver messages in the user's own language.

The Log class

The *log_class.py* routine provides logging of events to **`/var/log/radiod/radio.log`** file.

The Volume class

The *volume_class.py* program handles all volume and mixer functions for the radio, Spotify and airplay.

The Configuration Class

The **`config_class.py`** reads and stores the radio configuration from the **`/etc/radiod.conf`** file

The RSS class

The *rss_class.py* routines allow sequential gets from an RSS feed. These feeds are provided from news providers such as the BBC. This class gets the RSS feed defined in the **`/var/lib/radiod/rss`** file.

The Translate class

The *translate_class.py* is used to convert special international character sets (particularly from RSS feeds). It does this by first converting them to escape sequences and then to displayable *ascii* characters (These will show up in DEBUG logging). These *ascii* characters are then passed to the LCD class where they will be converted again to a valid character in the standard LCD character set.

The create_stations program

The *create_stations.py* program creates playlist files in the **`/var/lib/mpd/playlists`** directory using a list of Web links (URLs) with titles as input. This program creates standard playlists for use with with MPD. The operation of the *create_stations.py* program is covered in detail in the section on managing playlist files on page 218.

The `update_stationlist` program

The `update_stationlist.py` program reads each of the RADIO playlist files in the `/var/lib/mpd/playlists` directory and creates a new `/var/lib/radiod/stationlist` file. This is required to add new station URLs dynamically added by any external MPD clients that are capable of doing so. It is run from the `/etc/cron.daily/radiod` crontab script.

The `display_current` program

The `display_current.py` program is a small diagnostic program which displays the information for the current radio station or track. It is only used for trouble-shooting or for gaining an insight into the sort of information provided by the MPD daemon.

The `display_model` script

The `display_model.py` program displays the revision, CPU, memory and maker (If known) of the board. It is only used for trouble-shooting and it will not be used in normal operation.

The `configure_radio.sh` script

The `configure_radio.sh` script is normally called during installation of the Radio Debian package but may be run by the user at any time. It selects the correct board revision and radio program variant. It configures the display to be used and the user interface.

The `playlist creation` program

The `create_playlist.sh` script creates playlists from music directories on either a USB stick or a Network drive such as a NAS. It has the ability to accept filters to make a more selective playlist.

The `configure_audio.sh` script

The `configure_audio.sh` script selects and configures the Audio output. It currently supports selection of the on-board audio jack, HDMI output, USB DAC, HiFiBerry and IQaudio DACs.

The `configure_audio_device.sh` script

The `configure_audio_device.sh` script is called by the radio program when it starts up. It is used to select the sound card to be used. This is because Raspbian have recently changed the way audio devices are numbered and these can vary if an HDMI device is attached or not. It configures `/etc/mpd.conf` and `/etc/asound.conf` with the correct device number depending upon the output of the `aplay -l` command. The script reads the output of the `aplay -l` command and compares each line with the setting of the `audio_out` parameter in `/etc/radiod.conf`. If the above `audio_out` parameter is missing add it to `/etc/radiod.conf`.

The `configure_audio.sh` script sets the `audio_out` parameter when run during setup. Depending on the sound device selected it sets it to **headphones**, **HDMI**, **USB** or **DAC**

To understand this script run the `aplay` command to display available sound cards (The following is an example only).

```
$ aplay -l | grep -i card
card 0: b1 [bcm2835 HDMI 1], device 0: bcm2835 HDMI 1 [bcm2835 HDMI 1]
card 1: Headphones [bcm2835 Headphones], device 0: bcm2835 Headphones [bcm2835 Headphones]
card 2: IQaudIODAC [IQaudIODAC], device 0: IQaudio DAC HiFi pcm512x-hifi-0 [IQaudio DAC HiFi pcm512x-hifi-0]
```

In the above example, three sound cards(devices) are shown. Edit the `/etc/radiod.conf` file and add the following parameter to the `radiod.conf` file.

audio_out=<device>

Where **<device>** is any unique string (when compared with other lines) from the required card definition.

For example:

```
audio_out="Headphones" {Will configure Card 1 On-board audio output jack}
audio_out="IQaudio DAC" {Will configure Card 2 IQaudio DAC}
audio_out="HDMI 1"      {Will configure Card 0 HDMI 1}
audio_out="DAC"         {Will configure Card 2 IQaudio DAC}
```

The `configure_ir_remote` script

The `configure_ir_remote.sh` script sets up and partially configures the Kernel Event driver components for an IR remote control. It sets up the `ireventd.service`.

The `set mixer id` script

The `set_mixer_id.sh` script works out the “Speaker Playback Volume” mixer ID and configures the `mixer_volume_id` in `/var/lib/radiod` directory. This information comes from the `amixer controls` command. This mixer ID (integer) is used to set a default mixer volume for MPD and also is used for volume control when using Airplay. The `set_mixer_id.sh` script is normally called from the radio program (all versions), usually after a reboot, if the `mixer_volume_id` parameter has been removed by the `configure_audio.sh` program. This script also completes configuration of HDMI audio if selected in the `configure_audio.sh` program. It is not normally necessary to run this program separately but can be safely run at any time.

The UDP network communications class

The remote control daemon uses the `udp_server_class.py` program which communicates over the local TCP/IP network using UDP port 5100 as the default; however, the port is configurable in `/etc/radiod.conf`.

When a button is pressed on the remote control this program sends the button identity (See Appendix B.4 *UDP messages* on page 371) to a UDP server running in the radio program. It is also used to send commands from the Web Interface to the radio program.

Button press → IR remote control daemon → UDP message over network → Radio program.

The Status LED class

The `status_led_class.py` is called by the vintage radio software. A Red Blue Green LED is driven to indicate status of the radio as there is no LCD screen. See the Raspberry Pi Vintage Radio supplement.

The Airplay Class

The `airplay_class.py` file contains the routines for stopping and starting the `shairport-sync` daemon and for getting artist, title and album of the playing track. It is used when Airplay is selected as the source.

The Menu Switch class

The `menu_switch_class.py` code supports an 8-position rotary switch (Not encoder) as an alternative method of operating a simple menu system. It is meant to be used with the vintage radio software but can be used with any variant.

The init file

The `__init__.py` file contains a couple of global definitions plus the package version number.

Alsa sound files

The Alsa sound configuration is contained in `/etc/asound.conf` file. You may see mention of the `.asoundrc` file in Alsa documentation but it is not used by the radio project. The `.asoundrc` file does exactly the same as `/etc/asound.conf` file but is specific to one user and is placed in their home directory.

Depending upon the device to be configured a different configuration will be used. These asound files are contained in the `/usr/share/radio/asound` directory. The correct file is copied to the `/etc/asound.conf` file by the `configure_audio.sh` sound configuration script.

Table 28 Asound configuration files

Asound file	Description
<code>asound.conf.dist</code>	Standard asound.conf
<code>asound.conf.dist.bonnet</code>	Adafruit speaker bonnet Alsa configuration file
<code>asound.conf.dist.pivometer</code>	Pimoroni pHat with VU meter configuration file.
<code>asound.conf.dist.blue</code>	Bluetooth devices Alsa configuration file
<code>asound.conf.dist.equalizer</code>	Configuration for the Alsa graphic equalizer
<code>asound.conf.dist.pipe</code>	Bluetooth devices Alsa configuration file using a pipe
<code>asound.conf.dist.bonnet</code>	Configuration file for use with the speaker bonnet
<code>asound.conf.dist.softvol</code>	Configuration file for devices that don't have hardware volume controls.

The IR remote-control `ireventd.service`

This IR service runs on Bookworm or later. Configuration for the IR remote control is done by the `ir-keytable` utility. This is the service that all new users should be using. The command to start the IR `ireventd.service` is:

```
$ sudo systemctl start ireventd.service
```

To stop the IR radio service run:

```
$ sudo systemctl stop ireventd.service
```

When the Remote-Control buttons are pressed it passes the relevant commands to the radio program. The `ireventd.py` program provides complete control of the radio and can change menu options, do searches etc. just as the same as the knobs or buttons. It normally communicates with the radio program using UDP port 5100 on the local network interface.

The weather program

The **weather.py** program has been written for two reasons:

1. To demonstrate how to write your own programs using the display and event classes to use the same hardware as the radio program.
2. To demonstrate how to call your own programs when exiting from the radio program.

weather.py - This is the program which displays the current location weather details

weather_class.py – This class actually gets the weather from <https://openweathermap.org>

wxconfig.py – This contains the configuration details for the weather program

Install the following prerequisite packages

```
$ sudo pip3 install request
$ sudo pip3 install geocoder
$ sudo pip3 install beautifulsoup4
$ sudo apt-get install python3-lxml
```

To run the weather program from the radio program replace the **exit_action** statement in **/etc/radiod.conf** with the following:

```
exit_action=/usr/share/radio/weather.py
```

When the radio program exits, either by pressing the menu button for three seconds or the power button on a remote control, it will call **weather.py** to display the weather details for the location configured in **wxconfig.conf**.

The wxconfig.conf configuration file

```
# Location variable to customise weather display
# Get current weather, For parameters see https://openweathermap.org/current
# Configuration for weather.py

# Location & language
CITY = "London"
COUNTRYCODE = "GB"
LANG = "EN"

# Open weathermap Key (Contact OpenWeatherMap.org directly if you need a new
key)
API_KEY="080535da15e1e2a21f933846b0ba824a"

# Temperature units metric(C) or imperial(F)
# Units standard, metric and imperial units
UNITS = "metric"

# Atmospheric pressure units millibars(M) or inches mercury(I)
PRESSURE_UNITS = "M"

# Set date format, US format = %H:%M %m/%d/%Y
# To display timezone use %Z dateformat=%H:%M %Z %d/%m/%Y
DATE_FORMAT = "%H:%M %d/%m/%Y"

EXIT_COMMAND = "sudo systemctl restart radiod.service"
```

The **API_KEY** worked at the time of writing and allows access to the interface routines at Open Weather Map. If it doesn't work request a new one from <https://openweathermap.org>

Specify your location using the **CITY, COUNTRYCODE** and also the language (**LANG**) you wish to use. **UNITS** are either 'metric' or 'imperial' to display temperature in degrees Centigrade or Fahrenheit respectively.

Likewise, **PRESSURE_UNITS** for atmospheric pressure in millibars or inches mercury. The **DATE_FORMAT** allows the way date and time are displayed.

The above configuration displays the following on a four-line display:

```
10:04 27/08/2023
London GB
14.1C 1011.0mb 89%
Overcast clouds 100%
```

By default, the **EXIT_COMMAND** restarts the radio program. If not required replace it with:

```
EXIT_COMMAND = ""
```

Downloading the source from GitHub

This is only of interest if you wish develop your own version of the Raspberry PI radio based upon the mainstream source code. Otherwise simply install the Installing the Radio Daemon the radio software as shown on page 104. You can view the Raspberry PI source at <https://github.com/bobrathbone/piradio6>



Note: This may be out of date compared to the latest version. All source files, including build files, are included in the **radiod** package anyhow so downloading from GitHub isn't necessary.

Before you can download the source from **GitHub** it is necessary to install **git**. For more information on **git** see [http://en.wikipedia.org/wiki/Git_\(software\)](http://en.wikipedia.org/wiki/Git_(software))

Install **git** with the following command:

```
$ sudo apt install git
```

Make a development directory and change to it:

```
$ mkdir /home/pi/develop
$ cd /home/pi/develop
```

Now clone the github piradio repository:

```
$ git clone git://github.com/bobrathbone/piradio
Cloning into 'piradio'...
remote: Counting objects: 71, done.
remote: Compressing objects: 100% (52/52), done.
remote: Total 71 (delta 13), reused 64 (delta 9)
Receiving objects: 100% (71/71), 185.33 KiB | 334 KiB/s, done.
Resolving deltas: 100% (13/13), done.
```

This will create a sub-directory called 'piradio' which will contain the entire source. Also in the **/home/pi/develop/piradio** directory you will also see a directory called **.git** (dot-git). This is the control directory for **git**.

To find out more about **git** and for general support and documentation see:

<http://git-scm.com>

Chapter 16 Advanced topics

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Booting from a USB drive or stick

The Raspberry Pi is normally booted from an SD card; however, it is also possible to boot from a USB 3.0 disk drive or stick. The drive can be either a USB drive with a spindle or a Solid-State Drive (SSD) or a USB stick. This procedure works with Raspberry Pi's with USB 2.x or 3.x ports such as models 3B, 3B+ or 4B+. The Pi 400 and 4B may already be USB boot enabled and can usually boot from a USB drive without modifying the firmware.

Before starting this procedure, it is important to understand that there are two types of USB drive protocols of importance with respect to the driver software/hardware/firmware:

1. USB drives that support the **USB Attached SCSI (UAS)** protocol
2. USB drives that support USB Mass Storage **Bulk-Only Transport (BOT)** protocol

UAS drivers generally provide faster transfers when compared to the older **BOT** protocol drivers. When used with an SSD, **UAS** is considerably faster than **BOT** for random reads and writes. For UAS to be enabled the USB Drive, hardware controller, USB driver software and firmware must all support **UAS** for it to work.



Regrettably **Bookworm** does not appear to be properly supporting non-UAS drives and this procedure currently only works with **Buster** for these types of USB drive. This may be a configuration issue and is still being investigated by the author.



Figure 236 Raspberry Pi booting from an Intenso USB 3.0 2.5-inch disk drive

The advantages of booting from a USB disk drive are:

- A USB disk drive is a lot less susceptible to corruption than a SD card
- A USB disk drive generally has greater capacity than a SD card for media files and the like
- USB disk drives are a lot faster than a SD card. SSD disks are even faster but limited to USB 3.0 (or 2.x) speeds.

Disadvantages:

- Drives using a spindle are theoretically prone mechanical failure, however modern solid-state drives or USB sticks don't suffer from this problem.

To make a bootable USB disk drive you will need:

1. A Raspberry Pi with USB 3.0 ports or newer RPi's (3B+) with USB 2.0 ports.
2. A spare micro-SD Card
3. A USB disk drive or stick (For example a 2.5-inch USB 3.0 SSD)
4. Raspberry Pi imager software



Note: After carrying out this routine it will still be possible to boot from an SD card. Simply power off, disconnect the USB disk drive, insert a SD card with an OS image and power back on. The Raspberry Pi will now boot from the SD card.



Note: During testing USB sticks were found to be just as vulnerable as SD-cards. It is better to use USB 3.0 2.5-inch SSD drives.

Pi Zero W booting from a USB drive

Booting from a USB drive on a Pi Zero W is not supported. The Pi Zero W uses a BCM2835, which contains the old SD card-only bootloader. Secondly the USB ports have very limited power availability (Standard 600 mA).

USB Disk Drive power consumption

A small USB disk drive with spindle (250 GByte) takes about 260 Milliwatts. The allowed USB power load for the Raspberry Pi is 1.2A across all four USB ports so there is plenty of power available for other USB devices. Solid State Drives (SSD) take significantly less power and do not suffer from mechanical failure. When the Raspberry Pi is shut down, the power is removed from the USB ports and the disk drive is completely powered off.

Enabling the Raspberry Pi to boot from a USB drive

Making a Raspberry Pi boot from a USB drive or stick depends upon the Raspberry Pi model.

- Method 1 - Models with USB 2.0 ports such as the RPi model 3B+
- Method 2 - Models with USB 3.x ports such as the RPi model 4B

Method 1 - Enabling USB booting on models with USB 2.0 ports

This method Raspberry Pi's which have USB 2.0 ports such as the RPi model 3B+.

To enable the Raspberry Pi's USB boot mode, it is necessary to add a configuration option to the **/boot/config.txt** file. When the RPi is rebooted, this will set a bit in the Raspberry Pi's OTP (One Time Programmable) memory, allowing the device to be booted from a USB mass storage device. After that, we won't need the SD card anymore.

To enable USB boot mode, open a terminal session and run the following command:

```
$ echo program_usb_boot_mode=1 | sudo tee -a /boot/config.txt
```

This adds the config option **program_usb_boot_mode=1** to the end of **/boot/config.txt** file. Reboot the Pi with the SD card still inserted.

```
$ sudo reboot
```

After the reboot, check that boot mode has been enabled with the following command:

```
$ vcgencmd otp_dump | grep 17
17:3020000a
```



Note: If you are going to use your microSD card with a different Raspberry Pi later on, you might wish to remove the **program_usb_boot_mode=1** line from **config.txt** file, so that the boot mode won't be programmed to that device as well. Edit the file using the command **sudo nano /boot/config.txt**. and remove the above line.

Now power off and proceed to the section called Now carry out the instructions shown in section *Installing the Radio Daemon* on page 104.

Method 2 - Enabling USB booting on models with USB 3.x ports

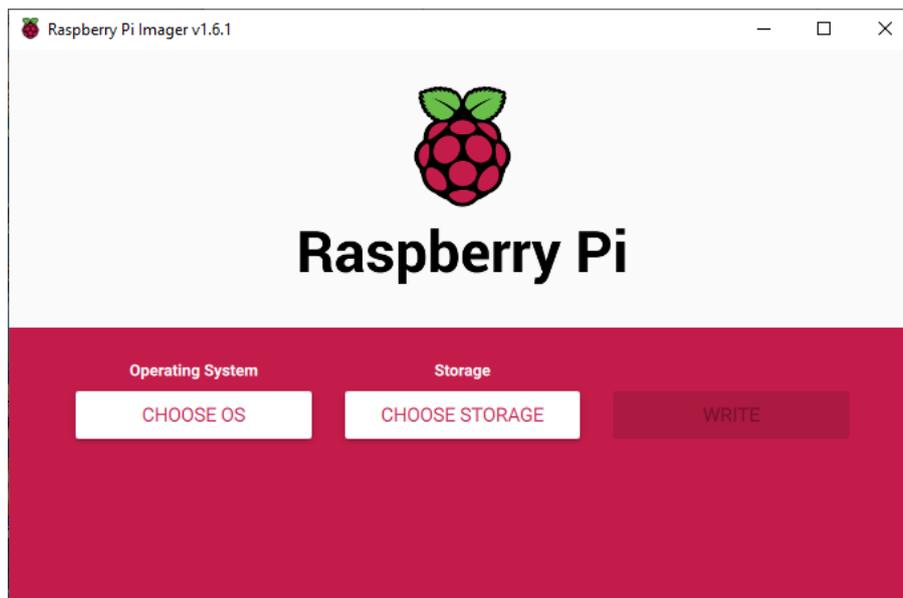
This method Raspberry Pi's which have two USB 3.0 ports and two USB 2.x such as the RPi model 4B or Pi 400. The model 4B and Pi 400 running the latest firmware come already enabled to boot from USB devices. This can be checked with the following command:

```
$ vcgencmd otp_dump | grep 17
17:3020000a
```

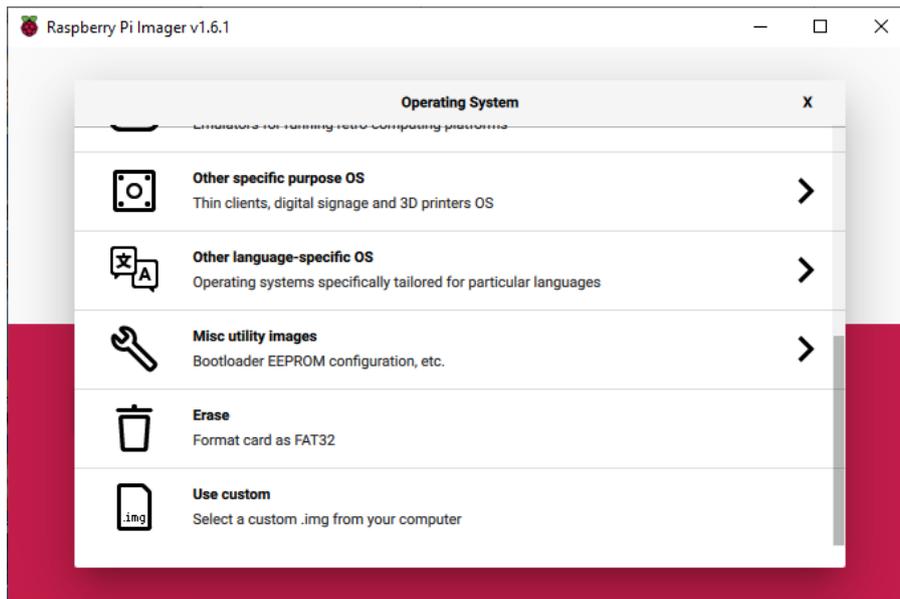
The value shown must be **17:3020000a**. If this is the case then proceed to the section called Now carry out the instructions shown in section *Installing the Radio Daemon* on page 104. If not continue below.

The SD card is loaded with some special software to overwrite the EEPROM code to boot from USB. Download the Raspberry Imager software from <https://www.raspberrypi.org/software/>

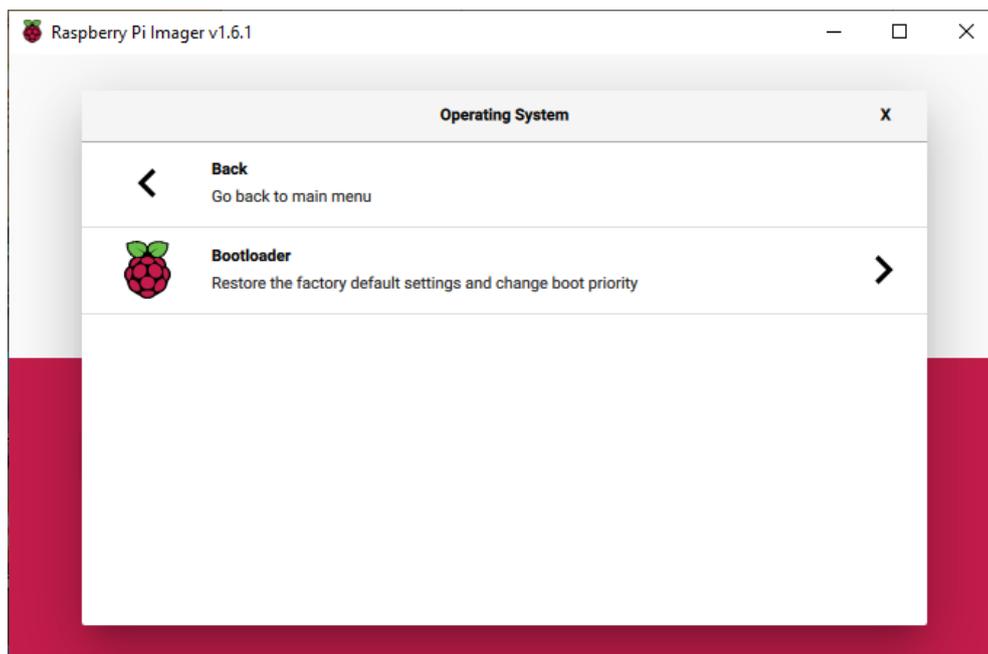
Insert the spare SD card into the PC and start the Raspberry Pi Imager software.



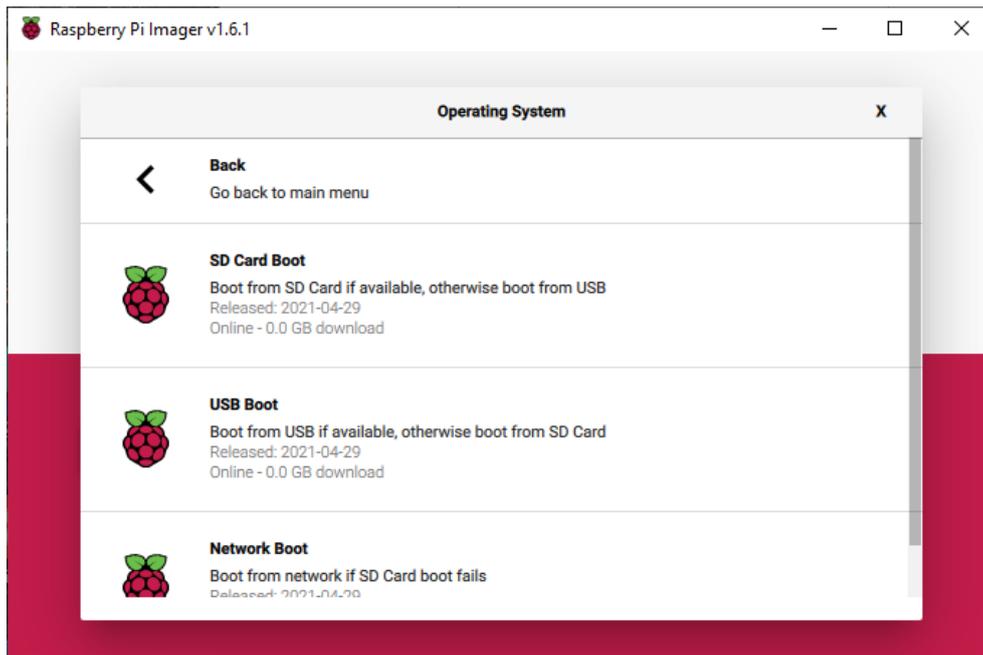
Select "CHOOSE OS"



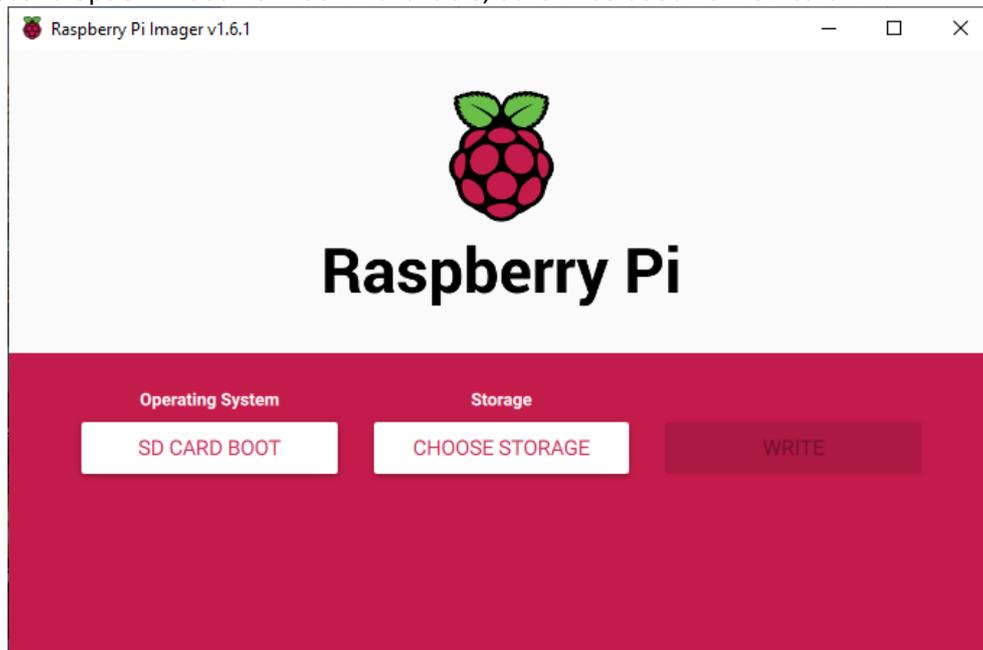
Use the scroll down and select “Misc Images – Bootloader EEPROM configuration”



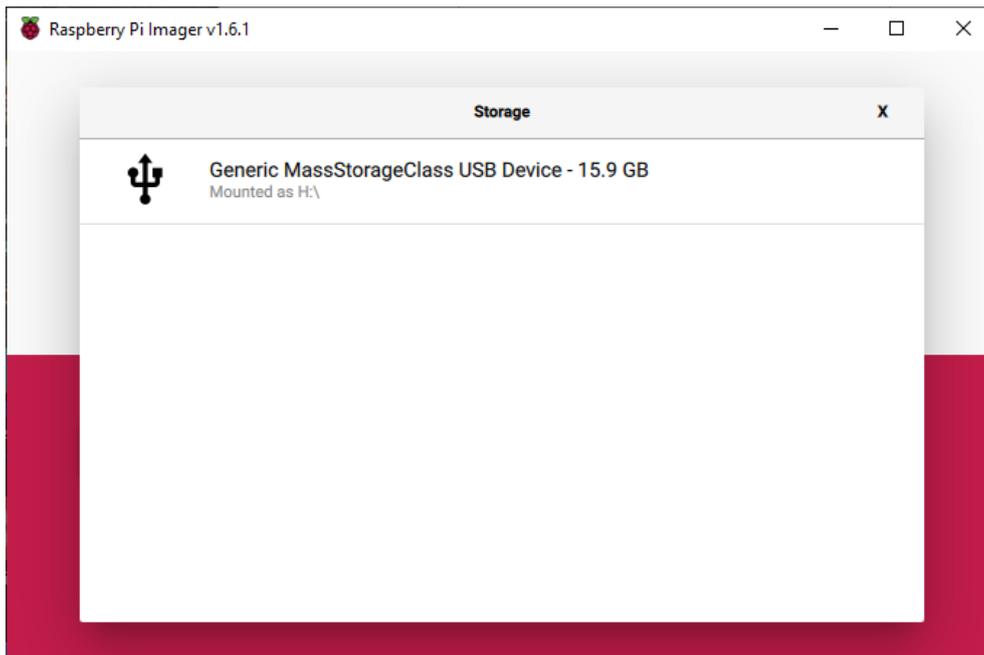
Click the right arrow “>” on “Bootloader” to show the options below.



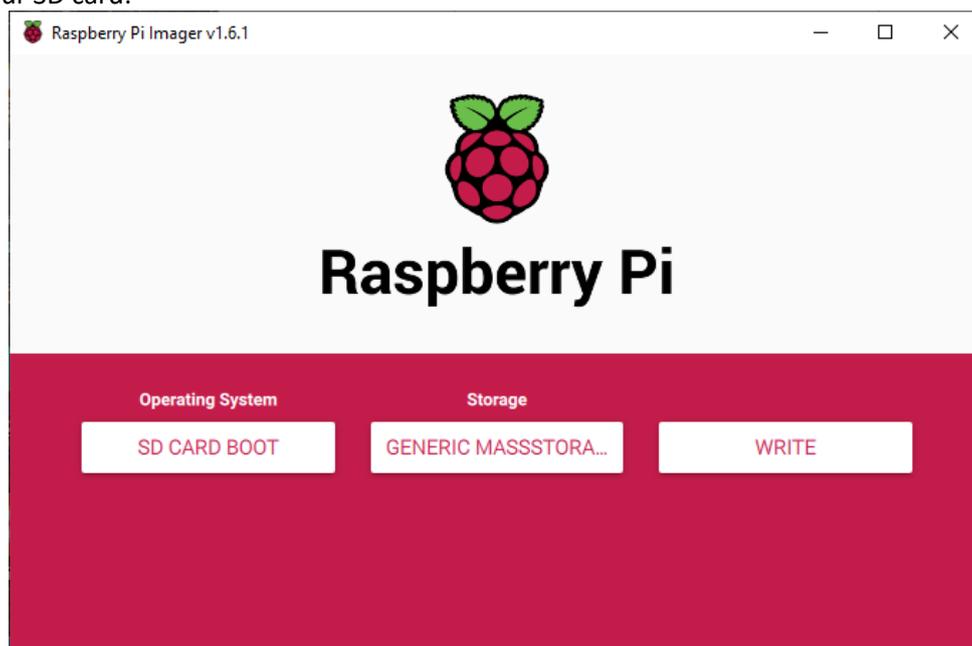
Select the first or second option depending upon your operational requirements. Typically, this will be the second option “Boot from USB if available, otherwise boot from SD card”.



Click on “Choose storage”



Select your SD card:



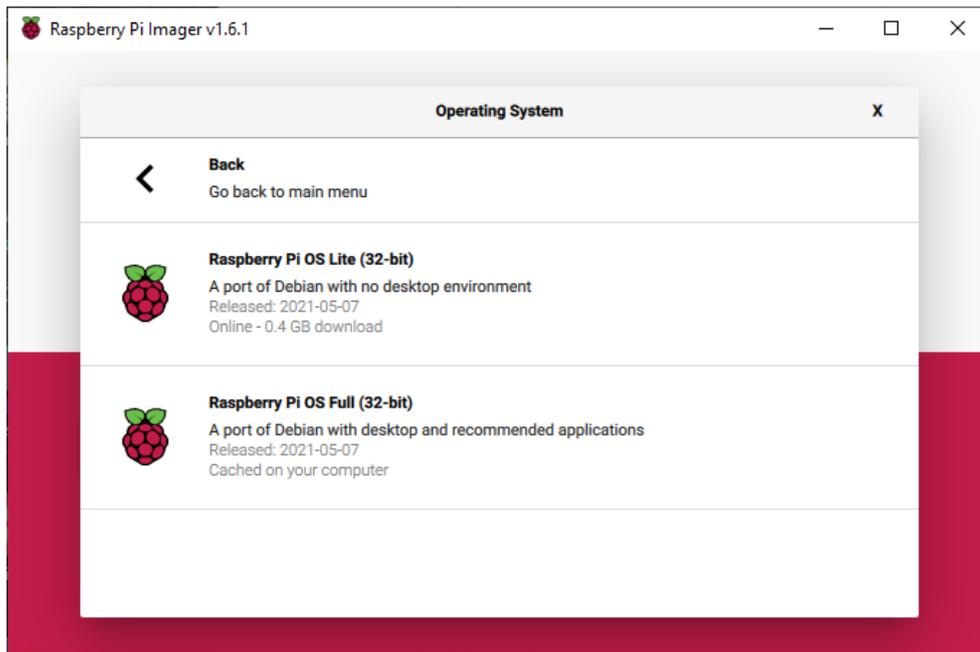
Now press "Write" to create the SD Card image. This will be very quick as there isn't much to write. Once written, remove the SD card from the PC and label it as USB boot. You will need this later.

Creating the bootable USB drive

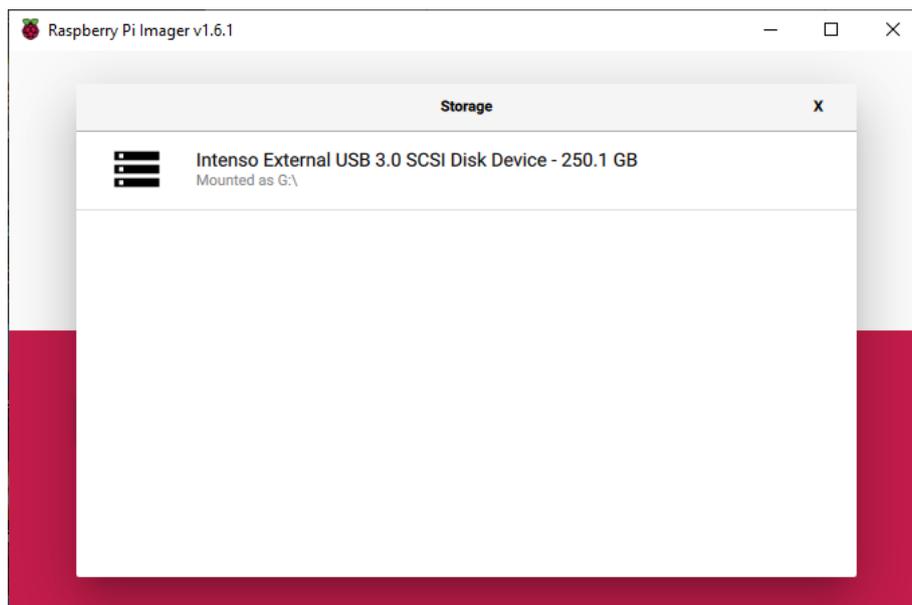
Plug your new USB disk drive into the PC.

Now create the Operating system on the USB disk drive (Not a USB stick). Restart the Raspberry OS imager.

Select the required operating system. Recommended is the "Raspberry Pi OS full (32 bit)"



Now select the USB drive. In the example below this is a USB 3.0 250 Mbyte 2.5-inch disk drive which should be more than enough for most purposes.



Now write to the USB disk as previously shown. Once complete, remove the USB drive from the PC.

Modifying the EEPROM boot order

Take the SD card that you created and labelled as "USB boot" and put it into the Raspberry Pi SD card slot. Power on the Raspberry Pi.

After a few seconds you will see the LED on the Raspberry Pi repeatedly flashing. This means that it has finished writing to the RPi EEPROM. Power off the Raspberry Pi and remove the SD card and put it somewhere safe so that you don't accidentally put it into any other Raspberry Pi.

USB 2.x SDD disk drive not booting

Disable the VC4 DRM driver.

Edit the `/boot/cmdline.txt` file using `sudo`. Disable VC4 driver by commenting it out.

```
#dtoverlay=vc4-kms-v3d
```

Reboot the Raspberry Pi.

USB 3.x SDD disk drive slow booting

Skip this section if you are using a normal disk drive with a spindle.



Note: At the time of writing there is a known problem with some USB 3.0 SDD drives which do not support the UAS protocol and cause them to operate very slowly to a point of being unusable. It is necessary to modify the `/boot/cmdline` file to correct this.

For more information on this problem see the following article:

<https://www.raspberrypi.org/forums/viewtopic.php?f=28&t=245931>

Find the SDD Vendor and Product ID

If using a USB SSD disk drive, it is necessary to first identify the Vendor and Product ID of the USB SDD disk drive and its device. Remove any USB storage devices and boot up the Raspberry Pi from an SD card. Once fully booted up, insert the SDD USB drive into the USB 3.0 port.

Log into the Raspberry Pi and then run the `dmesg` (ring buffer display) program:

```
$ dmesg
```

This should display details of the newly inserted SSD disk. The following example shows the details for an Intenso 250 Gigabyte SDD drive.

Note the Vendor and Product ID. In this example it is **152d** and **0579** respectively. Also note the device name of the first partition (`/boot`) of the SSD drive. This is **sda1** in this case.

```
[ 235.244594] usb 2-1: new SuperSpeed Gen 1 USB device number 3 using
xhci_hcd
[ 235.276190] usb 2-1: New USB device found, idVendor=152d, idProduct=0579,
bcdDevice= 5.06
[ 235.276213] usb 2-1: New USB device strings: Mfr=1, Product=2,
SerialNumber=3
[ 235.276231] usb 2-1: Product: Portable SSD
[ 235.276249] usb 2-1: Manufacturer: Intenso
[ 235.276266] usb 2-1: SerialNumber: 2020090810405
[ 235.315953] scsi host1: uas
[ 235.317600] scsi 1:0:0:0: Direct-Access Intenso Portable SSD
0506 PQ: 0 ANSI: 6
[ 235.319836] sd 1:0:0:0: Attached scsi generic sgl type 0
[ 235.833551] sd 1:0:0:0: [sdb] 500118192 512-byte logical blocks: (256
GB/238 GiB)
[ 235.833561] sd 1:0:0:0: [sdb] 4096-byte physical blocks
[ 235.833760] sd 1:0:0:0: [sdb] Write Protect is off
[ 235.833769] sd 1:0:0:0: [sdb] Mode Sense: 53 00 00 08
[ 235.834181] sd 1:0:0:0: [sdb] Write cache: enabled, read cache: enabled,
doesn't support DPO or FUA
[ 235.834862] sd 1:0:0:0: [sdb] Optimal transfer size 33553920 bytes not a
multiple of physical block size (4096 bytes)
[ 235.876806] sda: sda1 sda2
```

```
[ 235.879360] sd 1:0:0:0: [sdb] Attached SCSI disk
```

Now mount **/dev/sda1** on the **/mnt** partition. This will be very slow, about one minute, so be patient:

```
$ sudo mount /dev/sda1 /mnt
```

Using sudo edit the **cmdline.txt** file.

```
$ cd /mnt
$ sudo nano cmdline.txt
```

Add the following line to the front of all of the other options and save the file. Use the Vendor and Device ID previously identified for your device.

```
usb-storage.quirks=152d:0579:u
```

The **cmdline.txt** file should look like the following

```
usb-storage.quirks=152d:0579:u console=serial0,115200 console=tty1
root=PARTUUID=19de2757-02 rootfstype=ext4 elevator=deadline fsck.repair=yes
rootwait quiet splash plymouth.ignore-serial-consoles
systemd.run=/boot/firstrun.sh systemd.run_success_action=reboot
systemd.unit=kernel-command-line.target
```

Now sync the discs.

```
$ sync;sync
```

Log out and power off and remove the SD card. Leave the drive plugged in and got to the next section.

Boot up the Raspberry Pi from the USB disk drive

Now plug the USB disk drive into one of the USB 3.0 ports and power on. If everything has been correctly done, the Raspberry Pi will boot up from the USB disk drive. If not, check that this procedure has been correctly carried out. This can also be confirmed with the **dmesg** command.

```
$ dmesg | grep -i uas
[ 1.515463] usbcore: registered new interface driver uas
[ 2.161159] usb 2-1: UAS is ignored for this device, using usb-storage instead
[ 2.161289] usb 2-1: UAS is ignored for this device, using usb-storage instead
```

If all is well then continue with installation of the rest of the Operating System as shown *Preparing the Operating System for software installation* on page 90.

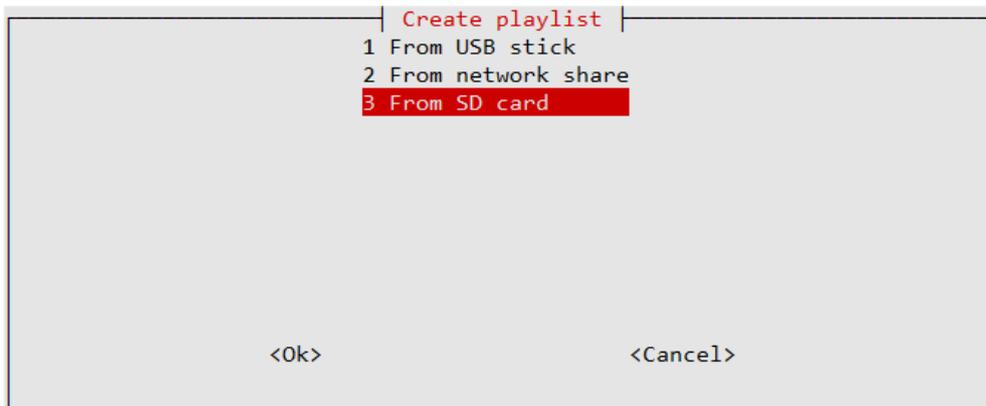
If you wish to boot from an SD card instead of the USB disk drive then remove the USB drive from the USB 3.0 port and insert an SD card configured with the Raspberry Pi OS into the SD card slot and power on. The Raspberry Pi will detect that it does not have a USB drive anymore and will boot from the SD card.

Playing music from the USB disk drive

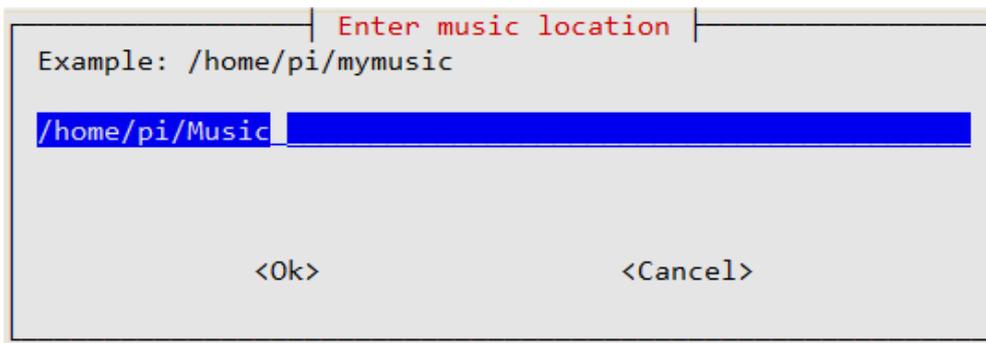
If using a USB disk drive, it makes more sense to play media files from the USB disk drive rather than a separate USB stick.

Using SFTP, copy the music from a PC to the **/home/pi/Music** directory which should already exist and reload the library via the options menu.

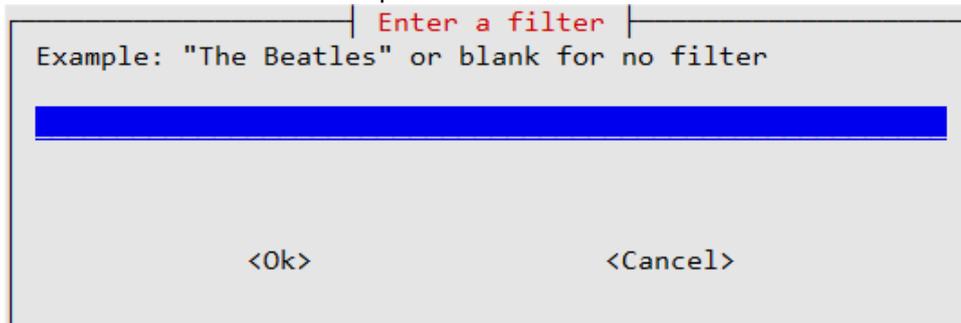
Now run the **create_playlist.sh** program. Select option 3 (SD card).



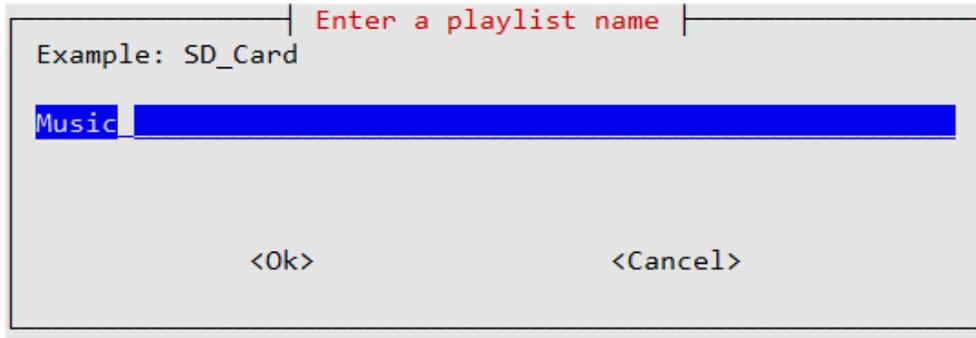
Choose option 3 From SD card even though the music is on your USB drive. Do not select option 1.



Confirm your choice. On the next screen press enter for no filter on the media track names.



Change the default location to **/home/pi/Music**



Press OK. The program will now create the Music playlist. Restart the radio and select the source menu to select the Music playlist.

Repairing a non-bootable SD card

One of the most frustrating things is when your radio which has been working fine and suddenly stops booting up. This is extremely frustrating but all may not be lost. It may be possible to repair an SD Card which has become non-bootable. To do this you will need the following:

- A USB SD card reader
- A spare SD card with Raspberry Pi OS



Figure 237 A USB SD card reader

USB SD card readers are very cheap. You should buy one before you need it in an emergency. Also prepare a spare SD card with the Raspberry Pi OS on it.

It is best to do this before you need it in an emergency. See *SD card creation using Raspberry Pi Imager* on page 80

1. Boot up the Raspberry Pi with the good SD card previously created.
2. Log into the Raspberry Pi as user **pi**.
3. Plug the faulty SD card into the USB SD card reader and plug the card reader into the Raspberry Pi.
4. Run the **dmesg** command. This should show the device number of the SD card at the end, similar to that shown below.

```
$ dmesg
:
[ 700.247477] sd 0:0:0:1: [sdb] Attached SCSI removable disk
[ 700.252572] sda: sda1 sda2
[ 700.260025] sd 0:0:0:0: [sda] Attached SCSI removable disk
```

Now run the following **fsck** commands to attempt to repair the file systems on **sda1** and **sda2**.

```
$ sudo fsck -y /dev/sda1
fsck from util-linux 2.33.1
fsck.fat 4.1 (2017-01-24)
0x41: Dirty bit is set. Fs was not properly unmounted and some data may be corrupt.
Automatically removing dirty bit.
```

```
Performing changes.  
/dev/sda1: 285 files, 98417/516190 clusters
```

/dev/sda2

```
$ sudo fsck -y /dev/sda2  
fsck from util-linux 2.33.1  
e2fsck 1.44.5 (15-Dec-2018)  
rootfs: recovering journal  
Clearing orphaned inode 914 (uid=111, gid=119, mode=0100600, size=0)  
Setting free inodes count to 765822 (was 765872)  
Setting free blocks count to 2122943 (was 2126334)  
rootfs: clean, 149826/915648 files, 1607489/3730432 blocks
```

Run the following to synchronise the disk buffers with the disk.

```
$ sync;sync
```

Now power of the Raspberry Pi and plug the repaired SD card into the Raspberry Pi and power on. The above actions should normally enough to get the RPi to boot. If not carry out the following:

First repeat the above procedure to make sure that the file system on the SD card is OK. Now mount **/dev/sda1** on the **/mnt** directory. Then change to the **/mnt** directory.

```
$ sudo mount /dev/sda1 /mnt  
$ cd /mnt
```

Check the **cmdline.txt** and **config.txt** file sizes look reasonable.

```
$ ls -la cmdline.txt config.txt  
-rwxr-xr-x 1 root root 144 Sep 27 11:45 cmdline.txt  
-rwxr-xr-x 1 root root 1838 Aug 28 14:00 config.txt
```

Check the **cmdline.txt** file looks something like that shown below.

```
$ cat cmdline.txt  
console=tty1 root=PARTUUID=0b18c756-02 rootfstype=ext4 elevator=deadline  
fsck.repair=yes rootwait quiet splash plymouth.ignore-serial-consoles
```

Check that the **config.txt** file looks normal. This will vary from that shown below.

```
$ cat config.txt  
:  
# Enable audio (loads snd_bcm2835)  
dtparam=audio=on  
  
[pi4]  
# Enable DRM VC4 V3D driver on top of the dispmanx display stack  
dtoverlay=vc4-fkms-v3d  
max_framebuffers=2  
  
[all]  
dtoverlay=hifiberry-dac
```

```
dtoverlay=i2s-mmap
```

If the **config.txt** file looks damaged or is missing, copy it from the good **SD** card. It may be necessary to re-configure the audio system (Run **configure_audio.sh** once rebooted).

Faulty **cmdline.txt** example. The file size in this example is zero bytes size.

```
$ ls -la cmdline.txt config.txt
-rwxr-xr-x 1 root root 0 Sep 27 11:45 cmdline.txt
```

First copy a good **cmdline.txt** file from the good SD card to the faulty one.

```
$ sudo cp /boot/cmdline.txt /mnt
```

However, this one will still not work as the root file system UUID is incorrect as it is for the good SD card and not the root UUID of faulty one.

```
$ cat /boot/cmdline.txt
console=tty1 root=PARTUUID=dfde9f91-02 rootfstype=ext4 elevator=deadline
fsck.repair=yes rootwait quiet splash plymouth.ignore-serial-consoles
```

Find out the PARTUUID of **/dev/sda2** with the **blkid** utility.

```
$ sudo blkid /dev/sda2
/dev/sda2: LABEL="rootfs" UUID="3a324232-335f-4617-84c3-d4889840dc93"
TYPE="ext4" PARTUUID="0b18c756-02"
```

Edit the **cmdline.txt** file and insert the correct PARTUUID

```
$ cat /boot/cmdline.txt
console=tty1 root=PARTUUID=0b18c756-02 rootfstype=ext4 elevator=deadline
fsck.repair=yes rootwait quiet splash plymouth.ignore-serial-consoles
```

Run the following to synchronise the disk buffers with the disk.

```
$ sync;sync
```

Try booting using the repaired SD card. If there are still problems, check other files in the boot partition (**/dev/sda1** mounted on **/mnt**) of the faulty SD card. For example, the kernel files:

```
$ ls -la /mnt/kernel*
-rwxr-xr-x 1 root root 6353376 Aug 15 13:46 /mnt/kernel7.img
-rwxr-xr-x 1 root root 6777440 Aug 15 13:46 /mnt/kernel71.img
-rwxr-xr-x 1 root root 7904011 Aug 15 13:47 /mnt/kernel8.img
-rwxr-xr-x 1 root root 6006712 Aug 15 13:47 /mnt/kernel.img
```

On the good SD card. The dates may be different but they otherwise look OK

```
$ ls -la /boot/kernel*
```

```
-rwxr-xr-x 1 root root 6353624 Sep 21 14:16 /boot/kernel7.img
-rwxr-xr-x 1 root root 6779080 Sep 21 14:16 /boot/kernel7l1.img
-rwxr-xr-x 1 root root 7904106 Sep 21 14:16 /boot/kernel8.img
-rwxr-xr-x 1 root root 6006608 Sep 21 14:16 /boot/kernel.img
```

If all of these actions fail to restore the SD card then it is very possible that the SD card is physically damaged, in which case it will be necessary to replace it and install a new OS and Radio software.

Building your own package

If you do modify the code, it may well be that you wish to create your own Raspbian package or create the **radiod** package directly from GitHub. There are several files and scripts required to build the **radiod** package. You need to first download the following files from GitHub.

See <https://github.com/bobrathbone/piradio6>

- **setup.sh** – From 7.2 onwards, script to set-up the build environment and execute **build.sh**
- **build.sh** – Run this to actually build the package (called from **setup.sh**).
- **piradio** – The package definition file which define the executable and other required files.
- **piradio.preinst** – This is the script that runs before the package files are installed.
- **piradio.postinst** – This is the script that runs after the package files are installed.
- **piradio.postrm** – This is the script that runs if the package is removed to run clean-up tasks.

```
$ cd
$ git clone https://github.com/bobrathbone/piradio6
```

From version 7.2 onwards run **setup.sh**. Do not use **sudo**. It only needs to be run once, thereafter it is only necessary to run **build.sh**.

```
$ cd piradio6
$ ./setup.sh
```

If using a version older than 7.2 or building your own package then carry out the following instructions:

Install the build environment packages first:

```
$ sudo apt -y install equivs apt-file lintian
```

The Web interface also has its own build script namely **buildweb.sh** which is a much simpler example.

Study the **piradio** file in particular to glean how to build your own package. Make copies of the package build files and then modify these with your changes. Do not use the original files used to build the **radiod** package as these will be overwritten if the **radiod** package is updated.

To build the package (Example myradio):

```
$ cp -p build.sh mybuild.sh
$ cp -p piradio myradio
```

Modify the mybuild.sh file to use your package files

```
PKGDEF=myradio
PKG=myradiod
```

Modify the package name to match the PKGDEF definition and set the initial version in the **myradio** package definition file.

```
Package: myradiod
Version: 1.0
```

Run the new build script as user **pi**. Do not use **sudo**.

```
$ ./mybuild.sh
```



Note: Most build warnings can be ignored but you should check if these can be easily corrected. Any errors should be corrected.

Start modifying the code with your changes regularly checking the build still runs OK.
Good luck with your build.

Using PWM GPIOs for sound output on a Pi Zero

Another method of creating audio on a Pi Zero or Pi Zero W, is to use a GPIOs 13 and 18, PWM-0 (Left) and PWM-1 (Right) as shown in the following diagram. Note you will still need an amplifier for speakers.

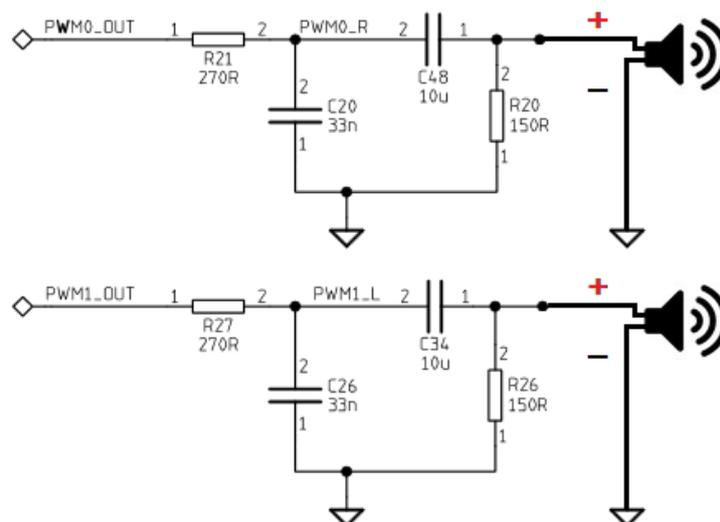


Figure 238 PWM Low band pass filters

This also requires loading the pwm-2chan Device Tree Overlay in **/boot/config.txt**.

```
dtoverlay=pwm-2chan,pin=18,func=2,pin2=13,func2=4
```

See <https://othermod.com/raspberry-pi-zero-audio-circuit/> for the full article how to do this.

Select the internal audio jack to enable audio output.

Fitting a Pimoroni On-Off Shim power switch

Unfortunately, the Raspberry Pi has a tendency to corrupt the SD card if the power is suddenly removed. This risk can be lessened by booting from a USB drive or stick. See *Booting from a USB drive or stick* on page 326. Alternatively, you can use one of the several solutions available on-line such as the Pimoroni power on-off shim.



Figure 239 Pimoroni On-Off shim power switch

The Pimoroni On-Off SHIM plugs into the first twelve GPIO pins of the Raspberry Pi GPIO header. There is a small button in the corner of the board next to USB power connector. This button is the on-off button and connects to GPIO17 (Physical pin 11). This button is also connected to the pins marked **BTN** to allow an external button to be fitted as shown in Figure 240 below.

To operate press the button once to switch on power and boot up the Raspberry Pi. When finished with the RPi simply press and hold the button for one second to initiate a clean shutdown and completely cut the power to the Raspberry Pi.

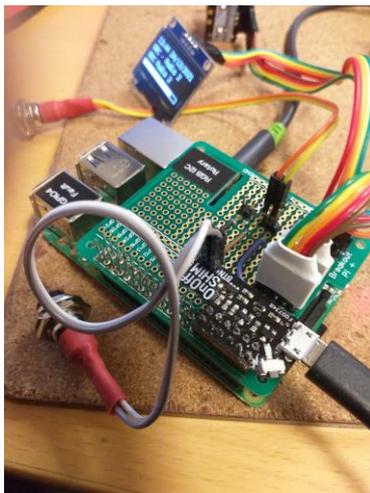


Figure 240 Raspberry Pi Radio with Pimoroni on-off shim

GPIO pin 17 when held low by the button initiates the standard shutdown command. Once this is completed GPIO 4 (Physical pin 7) is lowered by the software to force to completely cut power to the Raspberry Pi.

For more information on the Pimoroni On-Off shim see: <https://shop.pimoroni.com/products/onoff-shim>

However, GPIO4 and 17 are used by the radio to connect the mute and menu switch respectively. This means that the conflicting LCD GPIOs need to be reassigned to different GPIOs, for example, GPIO26 and 27.

First edit `/etc/radiod.conf` and change the following definitions from:

```
menu_switch=17
mute_switch=4
```

to

```
menu_switch=26
mute_switch=27
```

Physically wire the menu switch to physical pin 37 and the mute switch to physical pin 13.

Pimoroni provide special software on their Web site to support the on-off shim. To install the Pimoroni software run:

```
$ curl https://get.pimoroni.com/onoffshim > onoffshim.sh
$ sudo ./onoffshim.sh
```

This software must be installed for the Pimoroni on-off shim to work correctly.



Note that the Pimoroni on-off shim cannot be used with the Allo Piano 2.1 DAC with woofer (See *Allo DAC products* on page 27) as the Woofer channel also makes use of GPIO 4 and 17. There is no way around this. Fortunately, most DACs only use a single channel and do not use GPIO 4 and 17.

Adding a Real Time Clock (RTC)

When the Raspberry Pi is switched off for a while and switched on again it will initially have the system time when the RPi was switched off until the time synchronises with one of the Internet's time servers using the Network Time Protocol (NTP). This is because the RPi does not come with a Real Time Clock (RTC) as standard.



Figure 241 RasClock RTC V4.2 module

A Real Time Clock (RTC) can be added to a Raspberry Pi. There are several solutions available on-line. The illustration on the left shows the RasClock module available from PiHut and which connects to the RPi GPIO Header. The pins used are:

1. 3.3 Volts +
2. Not used (+5V)
3. SDA GPIO 2
4. Not Used (5V+)
5. SCL GPIO 3
6. GND 0V

SDA and SCL are the I2C Data and Clock respectively. The RasClock module needs to be fitted with a CR1220 36mA 3.0 Volt button battery (Bought separately). As the module uses the I2C interface it can be also connected to the above pins using jumper wires. Only pins 1,3,5 and 6 are required.

Installation

Plug the module into the first six pins of the Raspberry Pi. Power on the Raspberry Pi and add the following line to **/boot/config.txt** file after the [all] section.

```
dtoverlay=i2c-rtc,pcf2127
```

Reboot the Raspberry Pi. After reboot run the following command:

```
$ sudo hwclock -r
2022-12-10 12:00:05.664465+00:00
```

This will display the current UTC time. To display local time run **sudo hwclock -l**

Accessing the Raspberry Pi from a PC or MAC using VNC

If running the graphics versions of the radio (**gradio.py** or **vgradio.py**) or any other graphics programs, it is possible to access the Raspberry Pi desktop using VNC (Virtual Network Computing) using either a PC or Apply Mac computer.

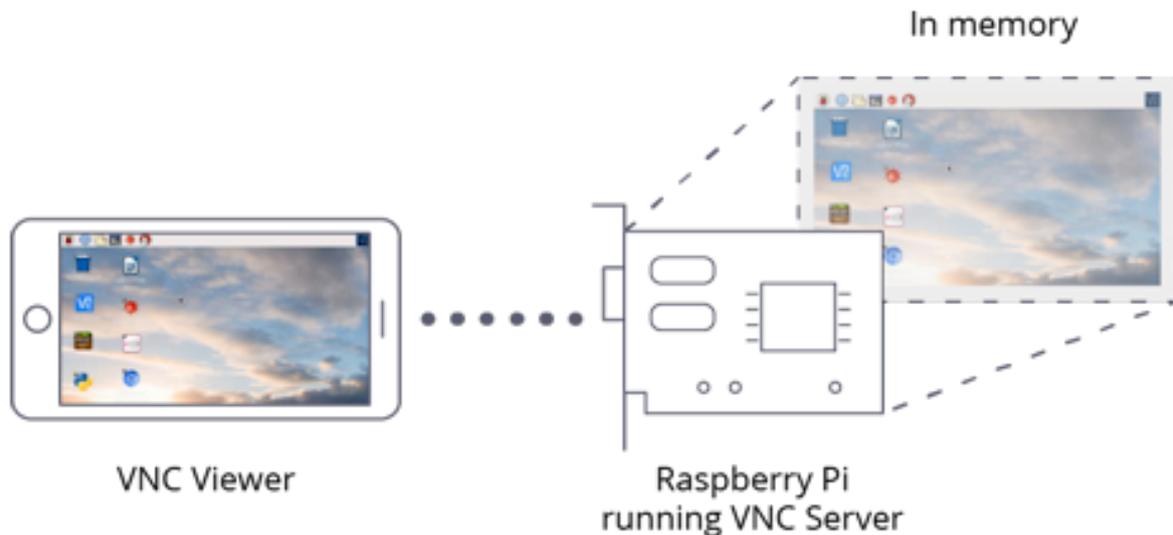


Figure 242 VNC client server architecture

Enable the VNC server on the Raspberry Pi

The VNC server is normally already installed on the Raspberry Pi. If not skip to the next session. Run **sudo raspi-config** and select **3 Interface Options**. The following screen will be displayed:

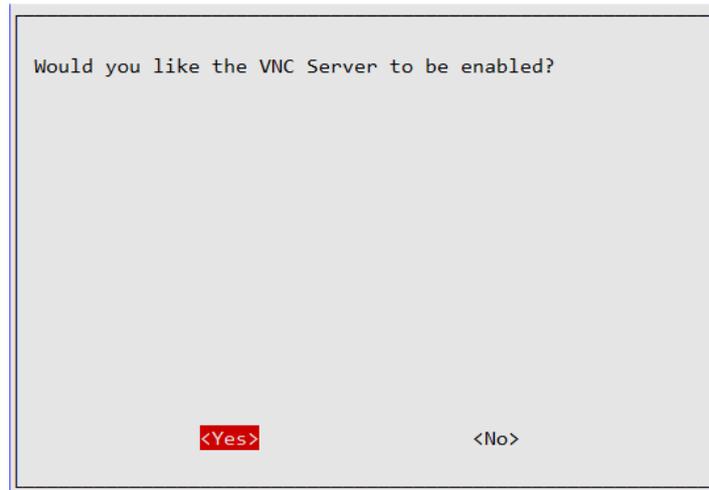
```
Raspberry Pi Software Configuration Tool (raspi-config)

I1 Legacy Camera Enable/disable legacy camera support
I2 SSH           Enable/disable remote command line access using SSH
I3 VNC          Enable/disable graphical remote access using RealVNC
I4 SPI          Enable/disable automatic loading of SPI kernel module
I5 I2C          Enable/disable automatic loading of I2C kernel module
I6 Serial Port  Enable/disable shell messages on the serial connection
I7 1-Wire       Enable/disable one-wire interface
I8 Remote GPIO  Enable/disable remote access to GPIO pins

<Select>                                     <Back>
```

Figure 243 Enabling the VNC server on the Raspberry Pi

Select option **I3 VNC**. The program asks if you wish to enable the VNC server. Answer Yes as shown in the next screen.



There is no need to reboot as raspi-config start the vnc-server.

Install Real VNC server on the Raspberry Pi

Skip this section if the above procedure was successful. First make sure that your Raspberry Pi OS is up to date with:

```
$ sudo apt update
$ sudo apt update -y
```

Next install the VNC server

```
$ sudo apt-get install realvnc-vnc-server
```

Check that it is running

```
$ sudo systemctl status vncserver-x11-serviced.service
```

This should display something similar to the following:

```
● vncserver-x11-serviced.service - VNC Server in Service Mode daemon
   Loaded: loaded (/lib/systemd/system/vncserver-x11-serviced.service;
   enabled; vendor preset: enabled)
   Active: active (running) since Thu 2023-08-31 08:46:49 BST; 1h 19min
   ago
     Main PID: 545 (vncserver-x11-s)
        Tasks: 5 (limit: 1598)
         CPU: 17.982s
    CGroup: /system.slice/vncserver-x11-serviced.service
           └─ 545 /usr/bin/vncserver-x11-serviced -fg
              └─ 569 /usr/bin/vncserver-x11-core -service
                 └─ 1078 /usr/bin/vncagent service 0
                    └─ 1127 /usr/bin/vncserverui service 0
                       └─ 1136 /usr/bin/vncserverui -statusicon 0
:
```

Install the RealVNC viewer on the PC or MAC

There are a number of VNC clients available, both paid for and free. One such client is **RealVNC** and it is free although you will need to create an account using your email address and a password.

The RealVNC viewer is supplied by <https://www.realvnc.com/en/> You can download the viewer from <https://www.realvnc.com/en/connect/download/viewer/>. Do not download **VNC connect** as this is the server version. You need the VNC client viewer. Download the viewer and click on the newly downloaded file and follow the instructions to install it. Once installed open the application.

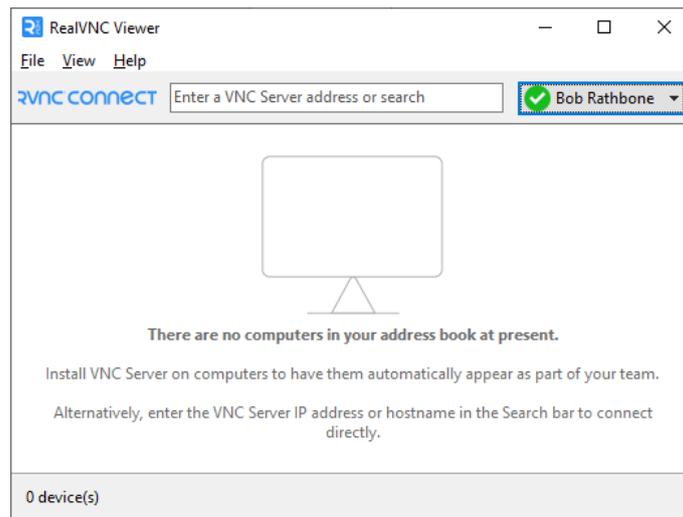


Figure 244 Connecting to the VNC server on the RPi

If you have already created an account this will be displayed (In this case Bob Rathbone) otherwise you will be prompted to create an account when you try to make a connection. First time in you will be prompted for the name of the raspberry pi, thereafter a new connection can be made using the file menu (select new connection).

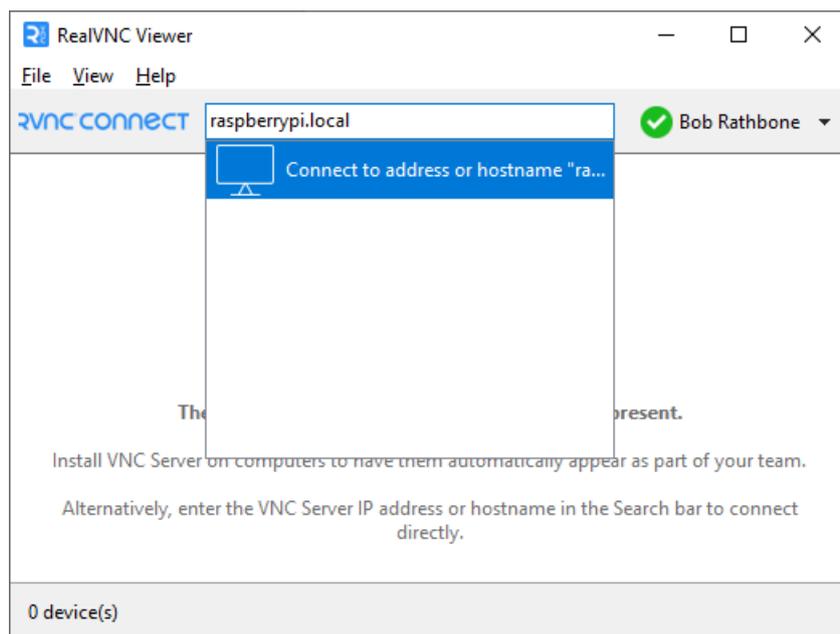
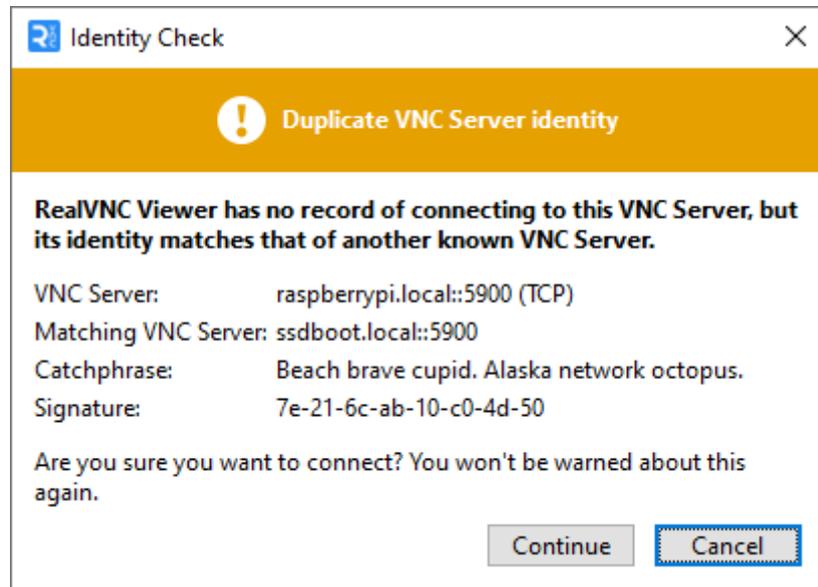


Figure 245 VNC viewer creating a connection

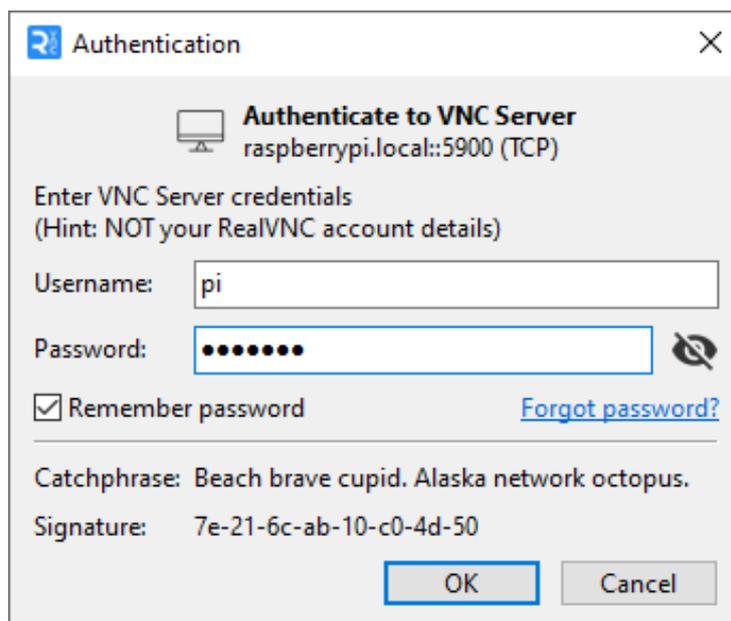
If using the network name of the Raspberry Pi doesn't work then try its IP address (See note on name later in this section).

The following will be displayed. Click on the Continue button:



Note: You can also use the IP address of the Raspberry Pi instead of its host name. If you set the SD card up according to the instructions shown earlier. If using the hostname, the hostname was "raspberrypi" then try the name **raspberrypi** first. If that doesn't work then try **raspberrypi.lan**, **raspberrypi.local** or **raspberrypi.home** in the host field. If the hostname was "piradio" then try the names **piradio**, **piradio.lan**, **piradio.local** or **piradio.home**. If none of these work just use the IP address of the Raspberry Pi.

Now enter the user name (usually pi) and password you are using on the Raspberry Pi.



All being well the Raspberry Pi desktop should be displayed.

The illustration below shows a VNC client running on a PC displaying the graphic version of the radio.

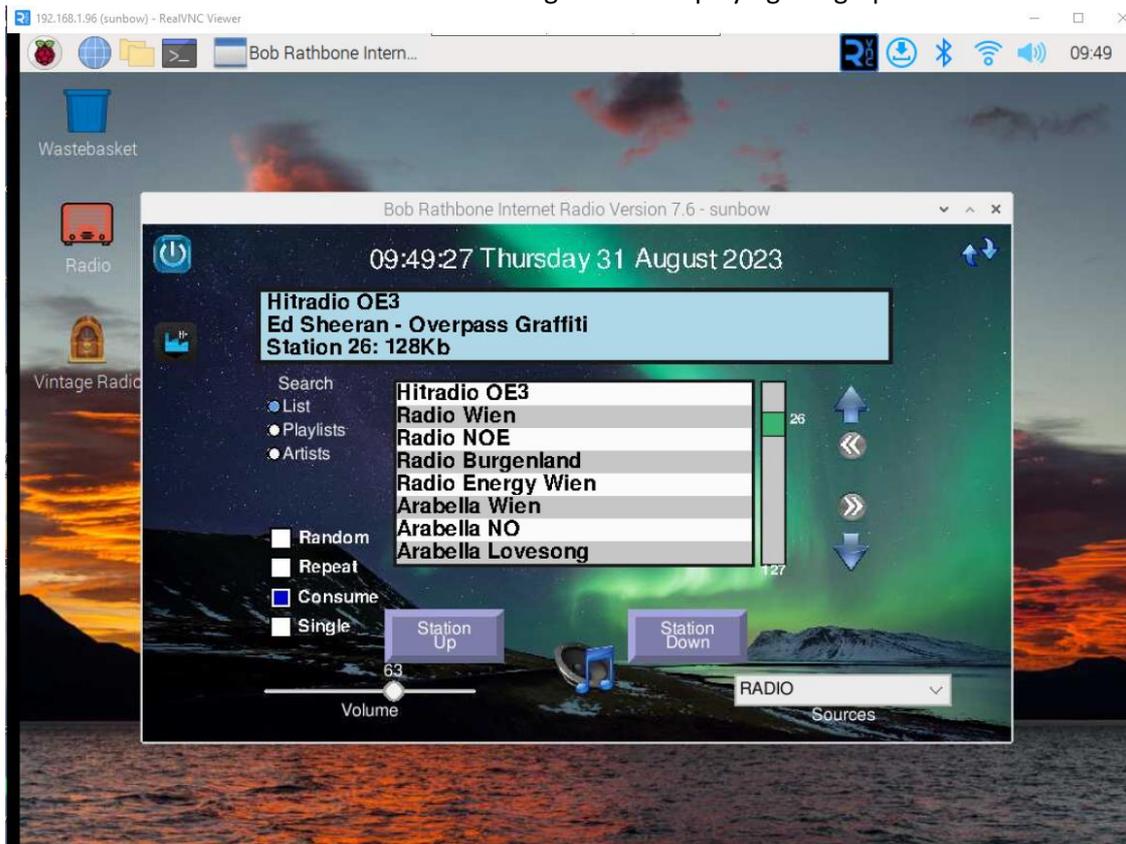


Figure 246 VNC displaying RPi Desktop on a PC



Note: *Bob Rathbone Computer Consultancy* does not directly support VNC components. Help for **Real VNC** can be found at <https://help.realvnc.com/hc/en-us>. They also support **realvnc-vnc-server** on the Raspberry Pi.

You may see the following screen if no HDMI screen is connected to the HDMI ports.

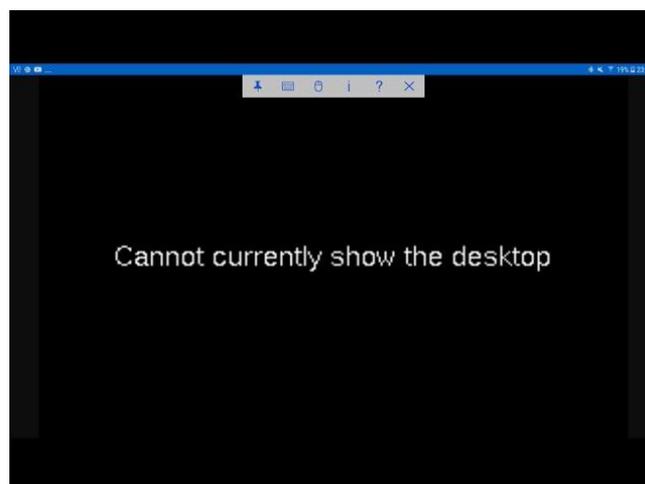


Figure 247 RealVNC display error

Edit the `/boot/config.txt` file and uncomment the following line.

```
# uncomment if hdmi display is not detected and composite is being output
hdmi_force_hotplug=1
```

The next time you use VNC viewer you will see that the Raspberry Pi has been added to the connection dialogue. Just click on it to connect.

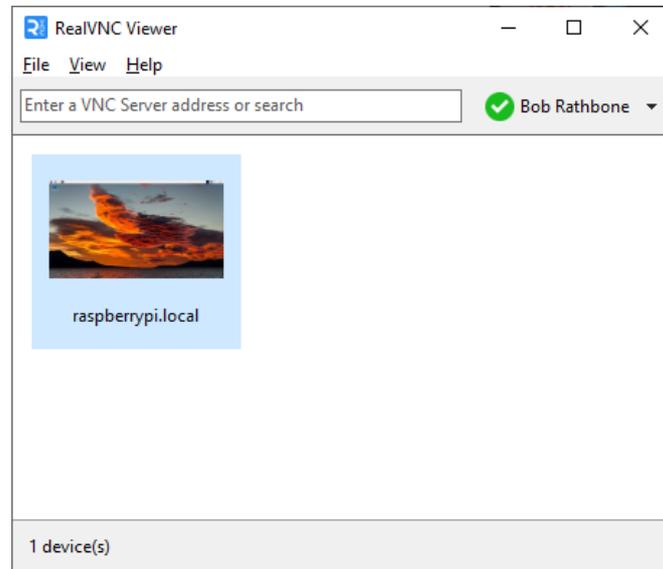
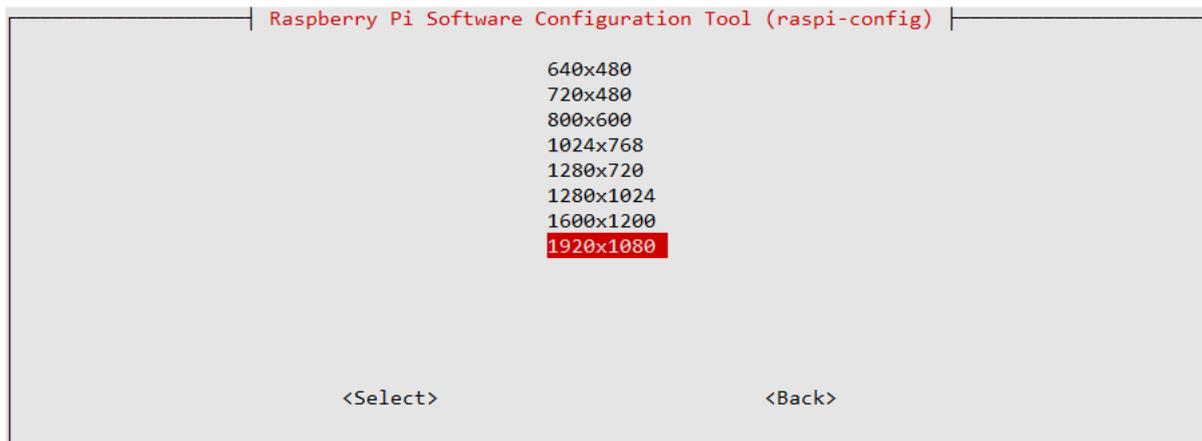


Figure 248 VNC connection dialogue box

It is also possible to alter the VNC screen resolution on the Raspberry Pi. Run `sudo raspi-config` and select:

2 Display Options → D5 VNC Resolution



Select the required resolution (typically the highest 1920 x 1080)

Licences, acknowledgements and support

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Intellectual Property, Copyright, and Streaming Media

This is an unbelievably complex subject. The author is not a lawyer and cannot offer any legal advice on this subject. If you decide to stream your music content or relay a radio station stream back out to the internet or within a public building or space then you should seek legal advice.

See also: http://en.wikipedia.org/wiki/Copyright_aspects_of_downloading_and_streaming

In general Radio stations are providing a stream to promote their radio station. As media providers they should have arrangements in place to make the content that they provide is legally streamed across the Internet but not all do. The question is it legal to listen (or view) such content is a complex one and subject to local and international laws and which vary considerably.

If you implement *Icecast* or any other streaming technology to re-stream content within your own home then provided that this is not streamed back out to the Internet or a public location then one would think that you will not encounter any problems (but you never know).

If you stream music tracks or relay radio stations back out onto the internet or public space then almost certainly you will be infringing a copyright law or intellectual property rights somewhere. The penalties for such an infringement can be severe.

WARNING: YOU USE THE ICECAST STREAMING IN THIS PROJECT AT YOUR OWN RISK ESPECIALLY IF YOU MAKE THE STREAM CONTENT AVAILABLE ACROSS THE INTERNET OR PUBLIC SPACE, EVEN IF YOU ARE JUST RELAYING AN EXISTING MEDIA STREAM, LEGAL OR OTHERWISE.

Also see the Disclaimer on page 352.

Technical support

Technical support is on a voluntary basis by e-mail only at bob@bobrathbone.com. If there are any problems with this email address then also CC r.h.rathbone@gmail.com. Before asking for support, please first consult the troubleshooting section on page 243. I will always respond to e-mails requesting help and will never ignore them. I only ask that you do the same (i.e. Did my suggestions help or not?). Be sure to provide the following information:

- What have you built (Adafruit or normal LCD variants, sound cards etc)?
- Which program and wiring version are you running?
- A clear description of the fault.
- What you have already done to locate the problem?
- Is anything displayed on the LCD or Graphics screen?
- Did you run the test programs and what was the result?
- Switch on DEBUG logging as described on page 214, run the program and include the `/var/log/radiod/radio.log` file.
- Did you vary from the procedure in the manual or add any other software?
- Please do not answer my questions with a question. Please supply the information requested.

Run the configuration display and send the `/usr/share/radio/config.log.tar.gz` that it produces to bob@bobrathbone.com. This will save a lot of questions about your configuration.

```
$ cd /usr/share/radio
$ ./display_config.sh
:
This configuration has been recorded in /usr/share/radio/config.log
A compressed tar file has been saved in /usr/share/radio/config.log.tar.gz
Send /usr/share/radio/config.log.tar.gz to bob@bobrathbone.com if required
```



Please note that support for general Raspberry PI problems is not provided. Only issues relating to the Radio software will be investigated.

For general Raspberry PI support see the following site:

<http://www.raspberrypi.org/forums/>

For support on Music Player Daemon issues see the help pages at the following link:

<http://www.musicpd.org/>

For issues relating to Icecast2 streaming see:

<http://www.icecast.org>

For those of you who want to amend the code to suit your own requirements please note: I am very happy to help people with their projects but my time is limited so I ask that you respect that. Please also appreciate that I cannot engage in long email conversations with every constructor to debug their code or to teach Python.

Acknowledgements

My thanks to [Matt Hawkins](#) for the original LCD screen driver routines. It made the job of writing the `lcd_class.py` much easier.

The original instructions on how to use Rotary Encoders came from an excellent article by [Guy Carpenter](#). See:

<http://guy.carpenter.id.au/gaugette/2013/01/14/rotary-encoder-library-for-the-raspberry-pi/>

To Adafruit Industries for their excellent LCD plate and I2C code. See <http://www.adafruit.com>.

To Steffen Müller for his article on Streaming audio with MPD and Icecast2 on Raspberry Pi.

See <http://www.t3node.com/blog/streaming-audio-with-mpd-and-icecast2-on-raspberry-pi/>

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Gordon Henderson <https://projects.drogon.net/> for the GPIO wiring utility.

To <http://www.allaboutcircuits.com> for Figure 104 Soldering precautions.

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Tomás González, Sevilla, Spain for his changes to `lcd_adafruit_class.py` (Previously `ada_lcd_class.py`) to switch on the Chinese 1602 I2C LCD backlight.

To the authors of the SGC Widget routines. Copyright (c) 2010-2012, Sam Bull and Michael Rochester

To ModMyPi (<https://www.modmypi.com>) for their excellent Pi products and setup guides.

Icons used in the graphic versions of the radio. Clipart library <http://clipart-library.com> and IconSeeker <http://www.iconseeker.com>

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To **Midas Displays**, Great Yarmouth, UK, for their help and sponsorship for the implementation of Russian/Cyrillic OLED character displays. See <https://www.midasdisplays.com>

Thanks to Gordon Garrity at IQaudio <http://iqaudio.co.uk> for his help and sponsorship to develop the radio to support the IQaudio Cosmic Controller and SSD1306 OLED display.

Thanks to **Pimoroni** for their excellent Pirate radio using pHat BEAT software and hardware. See <http://pimoroni.com> for further information.

Thanks to **PiFace UK** for their **PiFace CAD** product. This makes a very easy entry level radio using this software. See <http://www.piface.org.uk/>

Franz-Josef Haffner, from Germany, for his conversion of a Schneider Frères Rondo vintage radio.

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To Syds Post for his work on conversion of the IR Remote Control software from Python2 to Python3 on the Raspberry Pi Bookworm OS. See <https://www.sydspost.nl> (Dutch) in particular his article on the Vintage Internet Radio (Use browser translation facility for English translation).

David Steele for his **comitup** package for configuring Wi-Fi access via a Web Interface. See <https://davesteele.github.io/comitup>

The **ETechnoG Team** <https://www.etechnog.com> for their article on supply voltages.

To all constructors of this project who have sent in photos of their radio's and their ideas for improvement and the many appreciative e-mails that I have received from them.

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Glossary

AC	Alternating Current - In this context 110V or 220V
AP	Application processor (Also see CPU)
API	Application Programming Interface
DC	Direct Current - In this context +5V or +3.3V
A2DP	Advanced Audio Distribution Profile - Bluetooth
AAC	Advanced Audio Coding
ALSA	Advanced Linux Sound Architecture
ARM	Advanced RISC Machine (Type of processor used in Mobile phones and Raspberry Pi)
ASX	Advanced Stream Redirector
ATC	Air Traffic Control
BJT	Bipolar Junction Transistor
BOT	USB Mass Storage Bulk-Only Transport (BOT) – Legacy USB device access (Also see UAS)
CGI	Common Gate Interface – Executable Server-Side scripts
CAD	Control and Display (PiFace) – No longer supported in this version
CD	Compact disc - In this context CD marker pen
CIFS	Common Internet File System
CODECS	Encoder/Decoder for media streams
CPU	Central Processor Unit
DAC	Digital to Analogue Converter (Digital to audio frequency analogue in this case)
DOS	Denial of Service – Attack software aimed at taking down an Internet service (Web etc.)
DOS	Disk Operating System (Microsoft Operating System for PCs)
DDOS	Distributed Denial of Service – DOS attack from hundreds or thousands of computers
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System. Converts a URL such as google.com to an IP address or addresses
DSP	Digital Signal Processing/processor (In this context it is mixer control)
DT	Device Tree (Overlay). Device (Sound cards) configuration in /boot/config.txt in Raspbian

EMI Electromagnetic Interference (For example fluorescent lighting etc.)

EEPROM Electrically Erasable Programable Read Only Memory (Typically a Boot PROM)

FBCP Frame Buffer CoPy – HDMI display mirroring driver

FET Field Effect Transistor

FLIRC A USB device and software which maps an IR remote control to the keyboard

HCI Host Controller Interface. Bluetooth standard for operation with three-wire UART

HLS HTTP Live Streaming. Media streaming protocol for visual and audio media delivery

HDMI High-Definition Multimedia Interface for audio and video plus Ethernet interface.

GPIO General Purpose IO (On the Raspberry PI)

I2C Industry standard serial interface (Philips now NXP) using data and clock signals

I2S Inter-IC Sound (Used in DAC interface) from Philips (Now NXP)

IATA International Air Transport Association

ICAO International Civil Aviation Organization

ID3 Metadata standard for MP3 files which provides title, artist, album, track number, and other information embedded in the currently playing stream

IIC Alternative name used by some manufacturers for I2C

IP Internet Protocol

IPS In-Plane Switching, a type of LED (a form of LCD) display panel technology.

IPv4 Internet Protocol Version 4

IPv6 Internet Protocol Version 6

IR Infra-Red (sensor) for use with infra-red devices such as remote controls

LCD Liquid Crystal Display, also see OLED

LE Low Energy – In this context Bluetooth LE (Bluetooth 4.0 core specification)

LIRC Linux Remote Control software

M3U MPEG3 URL

MAC Media Access Control (address)

MEMS Micro Electro Mechanical Systems (Manufacturing technique, Microphones in this context).

Micro HDMI Miniaturized version of the High-Definition Multimedia Interface specification

MIPI	Mobile Industry Processor Interface (Used for camera and display interfaces)
MMS	Microsoft Media Server Internet protocol
MOSFET	Metal Oxide Semiconductor Field Effect Transistor
MPC	Command line client for MPD
MPD	Music Player Daemon
MPEG	Moving Picture Experts Group
MPEG3	Music encoding standard from MPEG
NAS	Network Attached Storage
NFS	Network File System
NTP	Network Time Protocol
OLED	Organic Light Emitting diode. Also, OLED character displays gradually replacing LCDs
OS	Operating system (Raspbian Buster in this case)
PA	Personal Amplifier (Input to audio stage of a vintage radio)
PC	Personal Computer
PCM	Pulse-Code Modulation is a method used to digitally represent sampled analogue signals
PDF	Portable Document Format
PIL	Python Image Library. Used by Python to manipulate images and colours
PWM	Pulse Width Modulation, is an alternative method for audio circuit design.
PHP	A server-side scripting language designed primarily for Web development
PID	Process ID
PIL	Python Imaging Library – Linux graphics routines – Pillow is a branch of PIL
PLS	MPEG Playlist File (as used by Winamp)
RISC	Reduced Instruction Set Computer – Also see ARM
RPi	Raspberry Pi
RSS	Really Simple Syndication – Web feed usually containing news items
RTC	Real Time Clock – Usually a battery backed up clock chip updating system time
SD	San Disk Memory Card commonly found in cameras and Smartphone's

SPI Serial Peripheral Interface (Motorola) used by PiFace CAD

S/P-DIF Sony/Philips Digital Interface for short distance audio transmissions.

SCO Synchronous Connection Oriented link – Bluetooth

SDK Software development kit

SSH Secure Shell – Encrypted terminal

SSID Service Set Identifier. An SSID is the public name of a wireless network

SSD Solid State Disk Drive

SVI Standard Volume Indicator. Another name for VU meter/indicator

System V Particular version of UNIX, many features of which have found their way into Linux

TCP/IP The common name for network protocols used by the Internet and computer networks.

TFT Thin Film Transistor – Used in display technology and touch-screens

TTS Text-To-Speech (eSpeak in this case)

TV Television (In this case, with one or more HDMI inputs)

UDP Universal Datagram Protocol. A connectionless network protocol over IP

UART Universal Asynchronous Receiver-transmitter for asynchronous serial communication

UAS USB Attached SCSI protocol – Newer faster USB drive access protocol (Also see BOT)

URL Universal Resource Locator (A link to a Web page for example)

USB Universal Serial Bus

USB 2.0 USB with a maximum signalling rate of 480 Mbit/s (60 MB/s)

USB 3.x USB using full duplex communication at speeds up to 5 Gbit/s (625 MByte/s)

USB-C 24-pin USB connector system which can be inserted either way

USB OTG USB On-The-Go, software to support USB devices (Not supported with this radio)

VCC Common Collector Voltage; the positive supply voltage to a device

VDD Voltage Drain Drain Supply; the positive supply voltage to a device

VEE Voltage Emitter. the negative power supply voltage to a device

VLC Media player used by Pimoroni software (Not used by this radio software)

VNC Virtual Network Computing – Used to display a remote screen on a local desktop

- VSS Voltage Source Supply; the negative supply voltage to a device
- VU Volume Unit – Volume meter/indicator also known as SVI (Standard Volume Indicator)
- WEP Wired Equivalent Privacy (WEP) is a security algorithm considered less secure than WPA
- WI-FI Wireless Network typically using the 802.11 Wireless Network protocol
- WPA Wi-Fi Protected Access (WPA) – Also see WPA2
- WPA2 Wi-Fi Protected Access version II, an enhanced, more secure version of WPA.
- XML Extensible Mark-up Language. A Web technology used for transmitting data structures

Appendix A - System Files used by the Radio Program

A.1 Files added to the system

`/etc/radiod.conf`

This is the main configuration file for the radio program. It is mainly configured by the `configure_radio.sh` program.

```
# Raspberry Pi Internet Radio Configuration File
# $Id: radiod.conf,v 1.45 2023/09/23 11:41:04 bob Exp $

# Configuration file for version 7.0 onwards
# Used for both 40 and 26-pin Raspberry Pi versions
#
# Please Note: Configuration of this file, for the most part, is done by
# running the configure_radio.sh and configure_audio.sh programs.

[RADIOD]

# loglevel is CRITICAL,ERROR,WARNING,INFO,DEBUG or NONE
loglevel=INFO

# Logfile creation mode, either truncate or tail
log_creation_mode=truncate

# Startup option either RADIO,MEDIA or LAST a playlist name
#startup=RADIO
startup=Radio

# MPD client timeout from 2 to 15 seconds default 10
client_timeout=10

# Codecs list for media playlist creation (Run 'mpd -V' to display others)
CODECS="mp3 ogg flac wav wma"

# Set date format, US format = %H:%M %m/%d/%Y
# To display timezone use %Z dateformat=%H:%M %Z %d/%m/%Y
dateformat=%H:%M %d/%m/%Y

# Volume range 10, 20, 25, 50 or 100
volume_range=100

# Volume display text or blocks
volume_display=blocks

# MPD port number (Do not change unless MPD reconfigured)
mpdport=6600

# Remote control UDP server listen host either 0.0.0.0 (All interfaces) or
localhost
remote_control_host=localhost

# ireventd daemon keytable name
keytable=myremote.toml

# Remote control communication host and port Default localhost 5100
remote_control_port=5100

# This allows another host to send UDP messages to the UDP server
# It is either localhost or the IP address of the remote server
remote_listen_host=localhost

# Audio output device - Must match an output using the "aplay -l" command
```

```

# The configure_audio.sh program will set this to headphones(default), HDMI,
DAC or USB
# depending upon the audio device/card selection. You can override this
setting
# with your own unique string from the aplay command, for example
"HiFiBerry"
audio_out="headphones"

# Audio config lock stops audio configuration from being dynamically
# changed if HDMI plugged in or out. Default no
audio_config_locked=no

# Output LED for remote control, default GPIO 11 (pin 23) or
# GPIO 13 (pin 33) for AdaFruit plate or PiFace CAD (40 pin RPi needed)
# Use GPIO 16 (pin 36) for designs using IQAudio DAC cards etc.
# Use GPIO 14 (pin 8) for designs using IQAudio Cosmic controller
# remote_led=0 is no output LED
remote_led=0

# Display playlist number in brackets yes or no
display_playlist_number=no

# Background colours (If supported) See Adafruit RGB plate
# options OFF, RED, GREEN, BLUE, YELLOW, TEAL, VIOLET, WHITE
bg_color=WHITE
mute_color=VIOLET
shutdown_color=TEAL
error_color=RED
search_color=GREEN
info_color=BLUE
menu_color=YELLOW
source_color=TEAL
sleep_color=OFF

# Status LED (Typically for vintage radio) Normally 27,22,23 respectively
rgb_red=0
rgb_green=0
rgb_blue=0

# Menu rotary switch (optional) Normal values are 24,8 and 7 respectively.
Value 0 disables
menu_switch_value_1=0
menu_switch_value_2=0
menu_switch_value_4=0

# The i2c_address overrides the default i2c address. 0x00 = use default
# Some backpacks use other addresses such as 0x2F, then set i2c_address=0x2F
i2c_address=0x00

# I2C normally uses bus 1 on the I2C interface. However the very first
Raspberry
# used bus 0. If you are using a very old Pi then set i2c_bus=0
# Run ./display_model.py to see what model Pi you are running
i2c_bus=1

# Set LCD character translation on or off. Graphic and OLED versions
unaffected
# as they do not need language translation and use system fonts
translate_lcd=on

# Language font translation table to be used.
# Current choices are English(Default), European(Western) and Russian
# Translation tables are contained in the /usr/share/radio/codes directory
# Add other translation tables to the above directory
language=English

```

```

# Set LCD/OLED controller being used. HD44780U (default) or HD44780 (Older
LCDs)
controller=HD44780U

# Select LCD code page table 0,1,2 or 3. Default 0
# 0 = Use codepage parameter specified in primary font file (Selected by
language)
# 1, 2 or 3 Override codepage setting in the primary font file
codepage=0

# Romanize characters (eg convert Cyrillic to Latin characters),
# Set to on or off. Default is on
romanize=on

# Speech for visually impaired or blind listeners, yes or no
# Needs espeak package - sudo apt-get install espeak
speech=no
# Speech volume as a percentage of the normal MPD volume
speech volume=75
# Verbose - yes = each station change is spoken
verbose=no
# Speak hostname and IP address
speak_info=no

# Set the user interface to 'buttons' or 'rotary_encoder' or 'graphical'
# These can also be used in conjunction with a graphical/touchscreen display
user_interface=rotary_encoder

# Switch settings for Rotary encoders or buttons
menu_switch=17
mute_switch=4
up_switch=24
down_switch=23
left_switch=14
right_switch=15

# Pull GPIO up/down internal resistors (Applies to button interface only).
# Default:down
pull_up_down=down

# Display types
# NO_DISPLAY = No display connected
# LCD = directly connected LCD via GPIO pins
# LCD_I2C_PCF8574 = Arduino (PCF8574) I2C backpack
# LCD_I2C_ADAFRUIT = Adafruit I2C backpack
# LCD_ADAFRUIT_RGB = LCD I2C RGB plate with buttons
# GRAPHICAL = Graphical or touch screen display
# OLED_128x64 = 128x64 pixel OLED
# PIFACE_CAD = PiFace CAD with six push buttons using the SPI interface
# ST7789TFT = Pimoroni Pirate audio with four push buttons using the SPI
interface
# SSD1306 = Sitronix SSD1306 controller for the 128x64 pixel OLED
# SH1106_SPI = Sino Wealth SH1106 controller for the Waveshare 128x64 pixel
OLED (SPI)
# LUMA = Luma driver for SSD1306, SSD1309, SSD1325, SSD1331, SH1106,
SH1106_128x32, WS0010
# For example LUMA.SH1106 for OLEDs using the sh1106 chip
# LCD_I2C_JHD1313 = Grove RGB 2x16 LCD (AIP31068L controller)
display_type=LCD

# Display width, 0 use program default. Usual settings 16 or 20
display_width=20
display_lines=4

# LCD GPIO connections for 40 pin version of the radio
lcd_select=7
lcd_enable=8

```

```

lcd_data4=5
lcd_data5=6
lcd_data6=12
lcd_data7=13

# Display Scroll speed 0.01 to 0.6 seconds
scroll_speed=0.05

# Settings are standard, alternative, rgb_rotary rgb_i2c_rotary
# Some rotary switches do not work well with the standard rotary class
# Set to "alternative" to use the alternative rotary encoder class
# For rotary encoders with RGB LEDs in the shaft set to rgb_rotary
# For rotary I2C encoders with RGB LEDs in the shaft set to rgb_i2c_rotary
rotary_class=standard

# KY-040 encoders etc have their own physical 10K pull-up resistors and do
not
# need the internal gpio pull-up resistors.
# otherwise set rotary_gpio_pullup=none otherwise set to "up"
rotary_gpio_pullup=up

# Station names source, list or stream
station_names=list

# Action on exiting radio. Stop radio only, shutdown the system or execute
program
# 1) Shutdown system: exit_action=stop_radio
# 2) Exit to operating system: exit_action=stop_radio
# 3) Execute a program: exit_action=<programm name>
# For example: exit_action=/usr/share/radio/weather.sh
exit_action=shutdown

# Bluetooth device ID - Replace with the ID of your bluetooth
speakers/headphones
# Example: bluetooth_device=00:75:58:41:B1:25
# Use the following command to display paired devices
# bluetoothctl paired-devices
bluetooth_device=00:00:00:00:00:00

# Action when muting MPD. Options: pause(Stream continues but not processed)
or stop(stream is stopped)
# mute_action=stop
mute_action=pause

# Shoutcast ID
shoutcast_key=anCLSEDQODrElkx1

# Pimoroni PHat Beat (pivumeter)
pivumeter=no

# Internet check URL. This must be a reliable URL and port number
# which can be contacted such as google.com
# The port number is normally 80 (HTTP).
# The internet_timeout in in seconds
# Disable by removing the URL from internet_check_url= parameter
internet_check_url=google.com
internet_check_port=80
internet_timeout=10

# OLED parameters
# Flip display vertically (yes or no) OLED only at present
flip_display_vertically=no

# Splash screen
splash=bitmaps/raspberry-pi-logo.bmp

# Allow updating of playlists by external clients yes/no (Experimental)

```

```

update_playlists=no

# I2C addresses for RGB I2C Rotary Encoders
volume_rgb_i2c=0x0F
channel_rgb_i2c=0x1F

# Shutdown command (Default "sudo shutdown -h now")
# Replace with required command for example "x735off" for a X735 V2.5 shield
shutdown_command="sudo shutdown -h now"

# Graphics (touch screen) screen settings
[SCREEN]
# Size is in pixels. Supported is 800x480 (7" screen) or 720x480(3.5"
screen)
# or 480x320 (2.8" or 3.5" screen) or 1024x600 (Maximum)
# Also see framebuffer_width and framebuffer_height parameters in
/boot/config.txt
screen_size=800x480
fullscreen=yes

# Screen save time in minutes, 0 is no screen saver
screen_saver=0

# Title %V = version %H = hostname
window_title=Bob Rathbone Internet Radio Version %V - %H

# Colours - See https://htmlcolorcodes.com/color-names/
window_color=turquoise
banner_color=white
labels_color=white
display_window_color=lightblue
display_window_labels_color=black
slider_color=mediumseagreen

# Display or hide mouse
display_mouse=yes

# Display Icecast streaming button
display_icecast_button=no

# Wallpaper backgrounds. See /usr/share/rpd-wallpaper/
# Run: sudo apt install rpd-wallpaper
wallpaper=/usr/share/rpd-wallpaper/aurora.jpg
# More backgrounds in /usr/share/scratch/Media/Backgrounds (Install scratch)
# Run: sudo apt install scratch

# Set date format for graphic screen
dateformat=%H:%M:%S %A %e %B %Y

# Allow switching between vgradio and gradio
switch_programs=yes

# Display shutdown button. The action of this button is dependent
# upon the exit_action parameter setting (shutdown or stop radio
display_shutdown_button=yes

# The following is specific to the vintage graphical radio
scale_labels_color=white
stations_per_page=40
display_date=yes
display_title=yes

[AIRPLAY]

# Airplay activation yes or no
airplay=no

```

```
# Mixer preset volume for radio and media player if using sound card
# Set to 0 if using onboard audio or USB sound dongle.
# If using a sound card set to 100% initially and adjust as necessary
# Old name was mixer_volume
mixer_preset=100
```

[/etc/logrotate.d/radiod](#)

This file causes the `/var/log/radiod/radio.log` to be rotated so that it doesn't continue to grow and fill the disk.

```
/var/log/radiod/radio.log {
    weekly
    missingok
    rotate 4
    compress
    notifempty
    maxsize 150000
    copytruncate
    create 600
}
```

Old log files are compressed and renamed, for example `/var/log/radiod/radio.log.1.gz`.

[/lib/systemd/system/radiod.service](#)

This file is part of the new **systemd** startup services. This file defines the so-called radiod service. It defines how the service will start-up and what services it needs.

```
# Radio systemd script
:
[Unit]
Description=Radio daemon
After=network.target

[Service]
Type=simple
ExecStart=/usr/share/radio/radiod.py nodaemon

[Install]
WantedBy=multi-user.target
```

[/usr/lib/systemd/system/ireventd.service](#)

The **ireventd.service** service definition file is part of the new **systemd** startup services. This file defines the so-called **ireventd** service which starts and stops the IR Remote Control software.

```
# Radio remote control systemd script
# $Id: ireventd.service,v 1.3 2023/07/22 15:58:19 bob Exp

# It uses ireventd.py and ir_daemon.py (Daemon)
# This file is copied to /lib/systemd/system/ireventd.service

[Unit]
Description=Radio remote control daemon
After=network.target

[Service]
Type=simple
ExecStart=/usr/share/radio/ireventd.py nodaemon
ExecStop=/usr/share/radio/ireventd.py stop
```

```
[Install]
WantedBy=multi-user.target
```

/etc/asound.conf

The source of this file is one of the files found in the ***/usr/share/radio/asound*** directory. Which file will be copied depends upon the required configuration for the sound device being used

```
.# Set default mixer controls
ctl.!default {
    type hw
    card 0
}

# Set default PCM device
pcm.!default {
    type plug
    slave {
        pcm "plughw:0,0"
        format S32_LE
    }
}
```

The above example is for the on-board audio jack.

Cronjob scripts

The /etc/cron.weekly/radiod script

This script runs once each week and creates playlist files and copies them to the ***/var/lib/mpd/playlists*** from the stations defined in the ***/var/lib/radiod/stationlist*** file.

```
#!/bin/sh
:
PATH=/sbin:/usr/sbin/;/usr/local/sbin:/bin:/usr/local/bin:/usr/bin

DIR=/usr/share/radio
LOGDIR=${DIR}/logs
LOG=${LOGDIR}/stations.log

mkdir -p ${LOGDIR}
chown pi:pi ${LOGDIR}
sudo ${DIR}/create_stations.py --no_delete 2>&1 >${LOG}
chown pi:pi ${LOG}
```

The /etc/cron.daily/radiod script

Since version 7.3 MPD playlists can be amended by any external MPD client capable of doing so. However, this makes the the ***/var/lib/radiod/stationlist*** file out-of-date. This daily script updates the ***stationlist*** file with all the current entries.

```
PATH=/sbin:/usr/sbin/;/usr/local/sbin:/bin:/usr/local/bin:/usr/bin

DIR=/usr/share/radio
LOGDIR=${DIR}/logs
LOG=${LOGDIR}/update_stationlist.log
CONFIG=/etc/radiod.conf
```

```
mkdir -p ${LOGDIR}
chown pi:pi ${LOGDIR}
grep "update_playlists=yes" ${CONFIG} 2>&1 >${LOG}
if [ $? -eq 0 ]; then
    sudo ${DIR}/update_stationlist.py --update 2>&1 >${LOG}
    sudo ${DIR}/create_stations.py --no_delete --force 2>&1 >${LOG}
fi
chown pi:pi ${LOG}
```



Note: These files require the **anacron** package to be installed to run the above scripts regularly.

A.2 System files modified by the installation

All files to be modified by the installation process are first copied to **<filename>.orig**.

/etc/modules

If the i2C interface is installed then the i2c-dev module definition is added to this file. A reboot is required to load the module.

```
snd-bcm2835
i2c-bcm2708
i2c-dev
# Original file stored as /etc/modules.orig
```

/boot/config.txt

This is amended if installing the IR software by adding the **gpio-ir** dtoverlay. For example:

```
dtoverlay=gpio-ir,gpio_pin=25
```

It may also be modified to support **HiFiBerry DAC** and **DAC+**. For example:

```
dtoverlay=hifiberry-dacplus
```

For **IQaudio** devices the relevant overlay will be specified.

```
dtoverlay=iqaudio-dacplus,unmute_amp
```

The **configure_audio.sh** script configures the audio device to be used in **/boot/config.txt** and sets up the correct **/etc/asound** audio configuration. In the case of DAC configuration, it disables the on-board by changing the **dtparam=audio** parameter from:

```
dtparam=audio=on
```

To:

```
dtparam=audio=off
```

A.3 X-Windows radio desktop files

The lxsession autostart file for the desktop/touchscreen radio

The `/home/pi/.config/lxsession/LXDE-pi/autostart` file is modified to start either `gradio.py` or `vgradio.py` during the desktop start-up if so configured.

```
@lxpanel --profile LXDE-pi
@pcmanfm --desktop --profile LXDE-pi
@xscreensaver -no-splash
@point-rpi
@sudo /usr/share/radio/gradio.py
```

Desktop radio icon files

The configuration files for the two desktop icons for graphic versions of the radio are copied into the `/home/pi/Desktop` directory. This displays two radio icons on the X-windows desktop. Clicking either of these starts the appropriate desktop version of the radio.

The Desktop file `gradio.desktop`

```
[Desktop Entry]
Name=Radio
Comment=Internet radio
Icon=/usr/share/radio/images/radio.png
Exec=sudo /usr/share/radio/gradio.py
Type=Application
Encoding=UTF-8
Terminal=false
Categories=None;
```

The Desktop file `vgradio.desktop`

```
[Desktop Entry]
Name=Vintage Radio
Comment=Vintage Internet radio
Icon=/usr/share/radio/images/Vintage.png
Exec=sudo /usr/share/radio/vgradio.py
Type=Application
Encoding=UTF-8
Terminal=false
Categories=None;
```

Appendix B – Technical specification and other notes

B.1 – Technical specification

The specification of the Raspberry PI internet radio is:

- The software runs on **Raspbian Bookworm** (Debian 11) on all Raspberry Pi's except version 1
- 32-bit and 64-bit software available
- Any sudo enable user can install the software and not just user 'pi'
- Uses the standard Music Player Daemon (MPD)
- The following displays are supported:
 - Raspberry Pi 7-inch touch screen or HDMI screen
 - Most 2.8 and 3.5-inch touch screens
 - 2x16, 2x8, 4x16 or 4x20-character LCD
 - Adafruit LCD plate with 5 push buttons (I2C interface)
 - Adafruit 3.5-inch TFT touch-screen
 - A 128 by 64-pixel OLED display
 - PiFace CAD with 2x16 LCD (Version 1.12 only)
 - Pimoroni Pirate Radio with six buttons and a 3W speaker
 - Pimoroni Pirate Audio radio with a 1W mini-speaker and four push buttons.
 - OLEDs using the Sitronix SSD1306 I2C controller
 - OLEDs supported by the LUMA driver (SH1106, SSD1306 etc)
 - Grove 2x16 LCD with RGB backlight (AIP31068L LCD controller)
 - 1.3" 128x64 pixel with SH1106 SPI interface

The LCD can be directly interfaced via GPIO pins or using an I2C backpack interface

- Optional IR sensor and remote-control using IR-KEYTABLE or FLIRC
- Clock display or IP address display
- Five configurable user interfaces are available:
 - Five push button operation (Menu, Volume Up, Down, Channel Up, Down)
 - As alternative to the above, rotary encoders may be used
 - Touchscreen with Mouse/Keyboard interface
 - IQaudIO Cosmic controller with three push buttons and rotary encoder
 - Pimoroni Pirate radio using pHat BEAT sound card and VU indicator
 - PiFace CAD with six push-buttons (Only five are used). Needs version 6.5.
- Support for Russian/Cyrillic, West European, English (Depending upon LCD capabilities)
- Support for Digital sound cards such as **HiFiBerry, IQaudIO, JustBoom, Waveshre WM8960 or Pimoroni pHat/BEAT**
- Support for Bluetooth speaker or headphones using **pulseaudio-module-bluetooth** software
- Vintage radio conversion to Internet radio supported
- Timer (Snooze) and Alarm functions (Not touch screen version)
- Artist and track scrolling search function
- Plays music from a USB stick, SD card or from a Network drive (NAS)
- Menu option to display a single RSS news feed
- Web interface using Snoopy
- Control the radio from either an Android device or **iPhone** and **iPad**
- Plays Radio streams or MP3 and WMA tracks
- Can function as a **Spotify** receiver (Needs a premium Spotify account)
- Optional support for **Apple Airplay** speaker using **shairport-sync**.

- Play output on PC or on a mobile device using ICECAST streaming
- Playlist creation program using a list of URLs (M3U file)
- Playlist creation from the Shoutcast database via command line or Web interface
- Add and delete stations/tracks via any external MPD client capable of doing so
- Fully integrated with mobile apps such as Android **MPDroid** or Apple **mPod**
- Speech for visually impaired and blind persons using **espeak**
- Support for Russian/Cyrillic and European character sets (Depending upon LCD capabilities)
- Music Player Daemon supports the **ID3** metadata standard. See <https://en.wikipedia.org/wiki/ID3> This provides meta-data such as the title, artist, album, track number, bit-rate, and other information.



Please note that this is not a consumer product. No claims are made to suitability for all users. It is solely intended as a fun construction project. Please also see **Disclaimer** on page 352.

B.2 -Elecrow 7-inch touch-screen notes

Below are some notes on how to set up the Elecrow 7-inch TFT Capacitive touch screen display, with 1024x600 Resolution.



Please note, much of this information was supplied by a third-party and has not been tested by the author. Therefore, any support by the author is limited.

Add the following to **/boot/config.txt** file.

```
hdmi_force_hotplug=1
max_usb_current=1
hdmi_group=2
hdmi_mode=1
hdmi_mode=87
hdmi_cvt 1024 600 60 6 0 0 0
hdmi_drive=1
```

If when running in full screen mode (**fullscreen=yes** in **/etc/radiod.conf**) you see a small window surrounded by a thick black border then in **/boot/config.txt** file amend the following:

```
framebuffer_width=1280
framebuffer_height=720
```

To

```
framebuffer_width=800
framebuffer_height=480
```

Also set the **screen_size** parameter in **/etc/radiod.conf**.

```
screen_size=800x480
```

Both files must be edited using sudo. For example:

```
$ sudo nano /boot/config.txt
```

Further information on the Elecrow touch-screen can be found at:

https://www.elecrow.com/wiki/index.php?title=7_Inch_1024*600_HDMI_LCD_Display_with_Touch_Screen

B.3 Sound card DT Overlays

The following table contains the known Device Tree (DT) overlays for various sound cards. The third column contains the DT overlay statement that needs to be added to the **/boot/config.txt** configuration file. This is either done by running the **configure_audio.sh** program or by directly editing **/boot/config.txt**. Some of the DACs require the **pulseaudio** package to be installed.

Table 29 Sound card Device Tree overlays

Manufacturer	Sound Card	DT Overlay and dtparam	Pulse
Adafruit	3W Stereo Amplifier Bonnet	dtoverlay=hifiberry-dac	Yes
Allo BOSS	384 kHz/32bit DAC PCM5122	dtoverlay=allo-boss-dac-pcm512x-audio	No
HiFiBerry	DAC+ Light/DAC Zero/MiniAmp	dtoverlay=hifiberry-dac dtparam=i2s=on	No
HiFiBerry	DAC+ standard/pro	dtoverlay=hifiberry-dacplus	No
HiFiBerry	Digi/Digi+ all models	dtoverlay=hifiberry-digi	No
HiFiBerry	Amp+	dtoverlay=hifiberry-amp	No
IQaudio	Pi-DAC+	dtoverlay=iqaudio-dacplus	
IQaudio	Pi-DigiAMP+	dtoverlay=iqaudio-dacplus,unmute_amp dtoverlay=iqaudio-dacplus,auto_mute_amp	No
IQaudio	Pi-DACZero	dtoverlay=iqaudio-dacplus	No
IQaudio	Pi-DAC PRO	dtoverlay=iqaudio-dacplus	No
IQaudio	Pi-Digi+	dtoverlay=iqaudio-digi-wm8804-audio	No
JustBoom	Amp, Amp Zero, DAC and DAC Zero	dtoverlay=justboom-dac	No
JustBoom	Digi and Digi Zero	dtoverlay=justboom-digi	No
Pimoroni	pHat Beat or Pirate Audio	dtoverlay=hifiberry-dac dtparam=i2s=on	Yes
Waveshare	DACs using WM8960 DAC chip	dtoverlay=wm8960-soundcard	No
Various	PCM5102A or PCM5100A based	dtoverlay=hifiberry-dac dtparam=i2s=on	No

In all cases, disable the on-board sound system by modifying the **dtparam=audio=on** parameter in the **/boot/config.txt** configuration file to off, or by commenting it out.

```
dtparam=audio=off
```

Or

```
#dtparam=audio=on
```

Configuring other audio devices

For other audio devices, the DT overlays can be found in the **/boot/overlays/** directory. See the **/boot/overlays/README** file. For example, to enable the Cirrus WM5102 you would add the following line to the end of the **/boot/config.txt** configuration file:

```
dtoverlay=rpi-cirrus-wm5102
```

B.4 UDP messages

This section is only of interest to developers wishing to interface with the radio program. These are messages (events) sent to the UDP listener in the `radio_class.py` program. These are sent from the IR remote control program and from the Shoutcast program & Web interface.

Table 30 UDP messages

Message	Source	Description
MUTE_BUTTON_DOWN	Remote control	Mute button held down
KEY_VOLUMEUP	Remote control	Not used, same as KEY_RIGHT
KEY_RIGHT	Remote control	Volume up or menu up function
KEY_VOLUMEDOWN	Remote control	Not used, same as KEY_LEFT
KEY_LEFT	Remote control	Volume down or menu down function
LEFT_SWITCH	Radio class	Left switch pressed
RIGHT_SWITCH	Radio class	Right switch pressed
KEY_CHANNELUP	Remote control	Not used, same as KEY_UP
KEY_UP	Remote control	Channel up or menu up function
KEY_CHANNELDOWN	Remote control	Not used, same as KEY_DOWN
KEY_DOWN	Remote control	Channel down or menu down function
KEY_MENU	Remote control	Menu function on remote control pressed
KEY_OK	Remote control	OK key on remote pressed
KEY_LANGUAGE	Remote control	Toggle speech facility on/off
KEY_INFO	Remote control	Toggle info on/off
PLAY_<n>	Remote control	Play station or track <n> e.g. PLAY_23
MEDIA	select_source.cgi script	Cycle through Media playlists
RADIO	select_source.cgi script	Cycle through Radio playlists
AIRPLAY	select_source.cgi script	Select Airplay as source
SPOTIFY	select_source.cgi script	Select Spotify as source
INTERRUPT	select_source.cgi script	Not used (Test only)
RELOAD_PLAYLISTS	shoutcast.cgi script	Reload (new) playlists

B.5 Cyrillic/European character LCDs/OLEDS

It is possible to purchase LCDs with a Russian/Cyrillic or other languages including Western European character ROMs.



Figure 249 Russian/Cyrillic character LCD

The radio program can display the Russian language either in **Cyrillic** or **Romanized** (convert to Latin) characters. For example, **Радио Пятница** when Romanized becomes **Radio Pyatnica**.

Romanization of Russian characters

For devices that do not currently support Russian/Cyrillic characters, it is possible to Romanize (convert to Latin characters) Russian text as shown in the following example.

This Romanization is achieved by setting the **romanize** parameter in `/etc/radiod.conf` to **on** which is the default.

```
romanize=on
```

For example, the following Russian text:

```
Низкая цена на нефть все больше давит на рубль
```

Converts to:

```
Nizkaja cena na neft' vse bol'she davit na rubl'
```

Translation (just out of interest):

```
Low oil price puts more and more pressure on the ruble
```

For more information on Romanization of Russian characters see:

https://en.wikipedia.org/wiki/Romanization_of_Russian

Displaying Russian/Cyrillic or European characters

To display the Russian language in native Cyrillic alphabet the following are required:

1. An LCD capable of displaying Russian Cyrillic or Western European characters
2. The **romanize** parameter must be set to **off**
3. The correct code page number in the LCD controller must be selected
4. The correct LCD **controller** must be selected.
5. **The translate_lcd** parameter must be set on unless using OLEDs.

The language in this example is selected by setting the language parameter in `/etc/radiod.conf` to the required language. There are currently only three choices. English (Default), European (Western European) and Russian. In this example Russian has been chosen

```
# Language font translation table to be used.
# Current choices are English(Default), European(Western) and Russian
# Translation tables are contained in the /usr/share/radio/codes directory
# Add other translation tables to the above directory
language=Russian
```

Font code page selection is achieved by setting the `codepage` parameter in `/etc/radiod.conf`

```
# Select LCD code page table 0,1,2 or 3. Default 0
# 0 = Use codepage parameter specified in primary font file
# 1, 2 or 3 Override setting in font file
codepage=0
```

Setting codepage to 0 tells the radio program to lookup the default code page setting found in the selected code page translation file in the codes sub-directory. Otherwise, this can be overridden by setting the codepage specifically as shown in the following table.

codepage	LCD code page	Language characters
0		Select code page from translation file
1	0x0	Japanese & English
2	0x1	Western European & English
3	0x2	Russian & English

Table 31 Character font table selection

All LCDs have one or more-character tables in ROM which provide selection of the correct character font for the character to be displayed. There are usually two code/font ROM pages often known as A0 and A2. However, MC0100 controller devices, for example, may have three. Each table can support only 256 characters, so to support say different language character sets a table must be provided for each one. For example, Midas supply an LCD which supports three languages plus English in each case. These code charts will be found in the controller specification (available from the manufacturer) for the character LCD/OLED device.

In the above table, another manufacturer might use table 0x0 for Russian. This can only be established by looking at the specification for your device.

The final setting for the correct language display is the `controller` parameter in `/etc/radiod.conf`.

```
# Set LCD/OLED controller being used. HD44780U (default) or HD44780 (Older LCDs)
controller=HD44780U
```

Along with the language parameter the controller parameter selects the code translation files to be used.

The codes sub-directory contains the character to code page PROM translation tables. There are two code for each file. These are called Romanized (Convert to Latin characters) and codes (Native characters).

The actual tables to be selected are dependent upon the **language** and **controller** parameters.

Table 32 Code page translation files

Controller	English	Russian	European
HD44780U	European.py Russian.py English.py	Russian.py (codes) European.py (romanized) English.py	European.py (codes) Russian.py (romanized) English.py
HD44780	European_HD44780.py Russian_HD44780.py English_HD44780.py	Russian_HD44780.py (native) European_HD44780.py (romanized) English_HD44780.py	European_HD44780.py (native) Russian_HD44780s.py (romanized) English_HD44780.py

You will notice that **English.py** is always loaded and is last. This means that any codes missed in the other translation files will be caught in **English.py**. The file which relates to the language selection is always the first file and its native codes will be used to display text. The above table can be extended in the future for other languages. The exception is English as all codes will be Romanized.

The HTMLcodes.py file found in the **codes** sub-directory is used by the RSS news feeds to translate/strip HTML tags and entities from the RSS feed (in XML). There is also a README file in the **codes** sub-directory.



The **translate_lcd** parameter must also be set to on for Romanization or Cyrillic translation routines to work unless using an OLED display.



The author is not a Russian speaker so testing Russian/Cyrillic character LCDs has relied heavily on Russian and Baltic region constructors to test this and is only able to provide limited support on these types of devices.

Below are the settings for the type of display being used:

Table 33 Russian Cyrillic and Romanization display configurations

Type of Display	translate_lcd	romanize_russian
Non-Russian/Cyrillic Latin LCD	on	on
Russian/Cyrillic LCD	off	off
OLED and HDMI displays	n/a	n/a
Raspberry Pi Touch screen	off	off
HDMI Display	off	off

Character Translation routines

The following is only of interest if you wish to modify the existing translation tables or create your own. The original ASCII code chart for English user only had 256 characters using a single byte. All computers could only use the limited character set at the time and Romanization of character sets such as Cyrillic was the only option. As time went on it was decided to encode these additional characters using two or three bytes. A universal encoding system was invented. The translation routines in the radio software (**translate_class.py**) convert these characters to a specific character font position in the LCD ROM. For example:

Character	Encoding	Character ROM
Д	\xd0\xb4	0xe3 (227)

The actual translation tables are contained in the **/usr/share/radio/codes** directory.

Appendix C – Wiring diagrams and lists

The following tables shows the wiring for the various versions of the radio. These configurations are normally set up by the `configure_radio.sh` program with the exception of the Vintage radio. See *Configuring the radio* on page 105. It is also necessary to set the `pull_up_down` parameter in `/etc/radiod.conf` depending on wiring.

C1 Push Button and Rotary Encoder 40-pin wiring

The following table shows the wiring for the 40-pin push-buttons or rotary encoders.

Table 34 40-PinPush-buttons/Rotary encoder Wiring

Buttons/Encoders	Pin	GPIO	Configuration	Radio function
Menu button	11	17	menu_switch	Menu
Channel down button/Rotary switch A	16	23	down_switch	Channel down
Channel up button/Rotary switch B	18	24	up_switch	Channel up
Mute button	7	4	mute_switch	Mute sound
Volume down button/Rotary switch A	8	14	left_switch	Volume Down
Volume up button/Rotary switch B	10	15	right_switch	Volume Up

C.2 Push Button and Rotary Encoder 26-pin wiring

The following table shows the wiring for the 26-pin push-buttons or rotary encoders.

Table 35 26-PinPush-buttons/Rotary encoder Wiring

Buttons/Encoders	Pin	GPIO	Configuration	Radio function
Menu button	22	25	menu_switch	Menu
Channel down button/Rotary switch A	19	10	down_switch	Channel down
Channel up button/Rotary switch B	11	17	up_switch	Channel up
Mute button	7	4	mute_switch	Mute sound
Volume down button/Rotary switch A	8	14	left_switch	Volume Down
Volume up button/Rotary switch B	10	15	right_switch	Volume Up

Set `pull_up_down=up` in `/etc/radiod.conf` depending on wiring.

C.3 IQaudio Cosmic Controller wiring

The following table shows the wiring for the IQaudio Cosmic controller.

Table 36 IQaudio Cosmic Controller Wiring

Physical control	Pin	GPIO	Configuration	Radio function
Left hand push button	7	6	down_switch	Channel down
Middle push button	29	5	menu_switch	Menu
Right hand push button	31	4	up_switch	Channel up
Rotary encoder A input	16	23	left_switch	Volume control
Rotary encoder B input	18	24	right_switch	“ “
Rotary encoder Switch	13	27	mute_switch	Mute switch
Left status LED	8	14	rgb_red	Error status
Middle status LED	10	15	rgb_blue	Busy status
Right status LED	36	16	rgb_green	Normal status
IR sensor	22	25	In /boot/config.txt	Remote control

C.4 Pimoroni Pirate Radio wiring

The following table shows the wiring for the Pimoroni Pirate radio (pHat BEAT). Orientation is with the basic push buttons on the left-hand side. The menu button is on the top left-hand side.

Table 37 Pimoroni Pirate radio (pHat BEAT) Wiring

Pimoroni buttons	Pin	GPIO	Configuration	Radio function
On Off button	32	12	menu_switch	Menu
Channel Up button	29	5	up_switch	Channel up
Mute button	31	6	mute_switch	Mute sound
Channel Down button	16	13	down_switch	Channel Up
Volume Up button	36	16	right_switch	Volume Up
Volume Down Button	37	26	left_switch	Volume Down

The On/Off button used in the Pimoroni Radio software re-assigned as the menu switch with the Rathbone radio software. All LCD outputs are set to zero (No display).

Set `pull_up_down=up` in `/etc/radiod.conf`

C.5 Pimoroni Pirate Audio wiring

The following table shows the wiring for the Pimoroni Pirate radio (pHat BEAT).

Table 38 Pimoroni Pirate radio Audio Wiring

Radio buttons	Pimoroni	Pin	GPIO	Configuration	Radio function
Channel Up button	X	36	16	up_switch	Channel up
Channel Down button	A	29	5	down_switch	Channel Down
Volume Up button	Y	18	20/24 (1)	right_switch	Volume Up
Volume Down Button	B	31	6	left_switch	Volume Down

Note 1: Button Y (Volume up) can be GPIO 24 on earlier versions of the Pirate Audio card. The new settings in `/etc/radiod.conf` are normally set to the following:

```
up_switch=16
down_switch=5
left_switch=6
right_switch=20
```

For earlier versions of the Pirate Audio this is.

```
right_switch=24
```

The Pimoroni Pirate Audio only has four buttons which means there are no buttons available for **Menu** or **Mute**.

For **Mute** press **Volume UP** and **Volume DOWN** together.

For **Menu** press **Channel UP** and **Channel Down** together.

The menu function currently doesn't work that well at the moment but is good enough to get to the Search menu. There is no shutdown function using menu button long press as with other designs.

Set `pull_up_down=up` in `/etc/radiod.conf`

C.6 Vintage Radio Push-button/Rotary Encoder 40-pin wiring

The following table shows the wiring for the 40-pin push-buttons or rotary encoders. This set-up must be manually configured in `/etc/radiod.conf`. It cannot currently be configured by the `configure_radio.sh` script.

Table 39 40-PinPush-buttons/Rotary encoder Wiring

Buttons/Encoders	Pin	GPIO	Configuration	Radio function
Menu button	22	25	menu_switch	Menu
Channel down button/Rotary switch A	19	10	down_switch	Channel down
Channel up button/Rotary switch B	11	17	up_switch	Channel up
Mute button	7	4	mute_switch	Mute sound
Volume down button/Rotary switch A	8	14	left_switch	Volume Down
Volume up button/Rotary switch B	15	10	right_switch	Volume Up

Table 40 Status LED indications

GPIO	Pin	LED	Function
23	16	Red	Error condition, shutdown in progress, IR activity (If configured)
22	15	Blue	Busy condition such as start-up, loading or changing radio stations or tracks.
27	13	Green	Normal operation such as playing stations or tracks.

Table 41 Rotary menu switch

GPIO	Pin	Switch value
24	18	1
8	24	2
7	26	4

Combining the above switch values gives a composite switch value of 0 through 7.
0=Idle, 1=Speak current station/track, 3=Search mode, 4=Source menu, 5=Options Menu 6,7 unused

C.7 SH1106 SPI 1.3" OLED with joystick and 3-buttons

Table 42 SH1106 1.3" OLED with joystick – GPIO pin assignments

Joystick	Buttons	SPI Interface	Radio Function	GPIO Pin	Configuration
Up			Channel Up	6	/etc/radiod.conf
Down			Channel Down	19	" " "
Left			Volume Down	5	" " "
Right			Volume Up	26	" " "
Push			Menu switch	13	" " "
	KEY1		Mute Switch	21	/etc/radiod.conf
	KEY2		Not used	n/a	" " "
	KEY3		Not used	n/a	" " "
		RST_PIN		25	sh1106_config.py
		DC_PIN		24	" "
		CS_PIN		8	" "
		BL_PIN		18	" "



Please note that none of these pin assignments for the SH1106 1.3" OLED display with joystick can be changed by the user and are documented purely for reference.

The GPIO pin assignments for the joystick and button interface are defined in the **/etc/radiod.conf** configuration file and are configured by the **configure_radio.sh** program. The display settings are also configured in **radiod.conf**.

```
menu_switch=13
mute_switch=21
up_switch=6
down_switch=19
left_switch=5
right_switch=26

display_type=SH1106_SPI

display_width=16
display_lines=4

lcd_select=0
lcd_enable=0
lcd_data4=0
lcd_data5=0
lcd_data6=0
lcd_data7=0
```

The GPIO pin assignments for the SPI configuration are defined in the **sh1106_config.py** configuration file in the **/usr/share/radio program** directory.

```
# Pin definition
RST_PIN      = 25
DC_PIN       = 24
CS_PIN       = 8
BL_PIN       = 18
```

Converting the 1.3" OLED pHat to use the I2C interface



Warning: Do not attempt this procedure unless you possess considerable soldering skills. The risk of damaging both the card and the Raspberry Pi is great if you make a mistake.

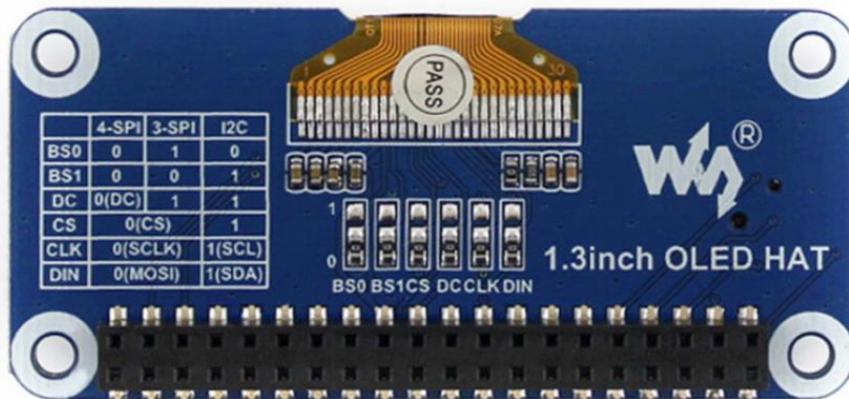


Figure 250 1.3" OLED pHat reverse side

The module uses a 4-wire SPI communication mode by default, that is, BS0, BS1, DC, CS, CLK, and DIN are connected to 0 by default (1 and 0 do not represent the level, but the welding method of connecting or connecting the resistance, the specific hardware link is as follows surface):

Note: The above picture is the welding on the hardware, the following table is the actual hardware connection:

Communication method	BS1/BS0	CS	DC	DIN	CLK
3-wire SPI	0/1	CS	1	MOSI	SCLK
4-wire SPI	0/0	CS	DC	MOSI	SCLK
I2C	1/0	0	1	SDA	SCL

The specific hardware re-wiring for I2C is as follows:

Connect BS0 to 0 to GND, BS1 to 1 to VCC (3.3V), CS to 1 to connect to GND, D/C to 1 to connect to GND, DIN to 1 to connect to Raspberry Pi SDA, CLK to 1 to connect to the tree Raspberry Pi SCL; when using I2C: the high and low states of DC can control the address of the slave device, here is connected to GND, then the 7-bit address of I2C is: 0x3C.

To switch to I2C using the I2C address 0x03 it is necessary to amend the `sh1106_config.py` configuration file. Change the `Device_SPI` and `Device_I2C` definitions in the configuration file to enable the I2C interface instead of I2C.

```
Device_SPI = 1
Device_I2C = 0
```

To

```
Device_SPI = 0
Device_I2C = 1
```

See https://www.waveshare.com/wiki/1.3inch_OLED_HAT for further information.



The author has not tested the above procedure so if any technical support is required, please contact Waveshare directly at <https://support.waveshare.com>

C.8 Raspberry Pi Rotary Encoder version with backlight dimmer

The following wiring diagram was provided by Joaquin Perez, Broadcast Engineer, Leeds. He also shows the circuitry to dim the backlight using a BS170 Mosfet transistor.

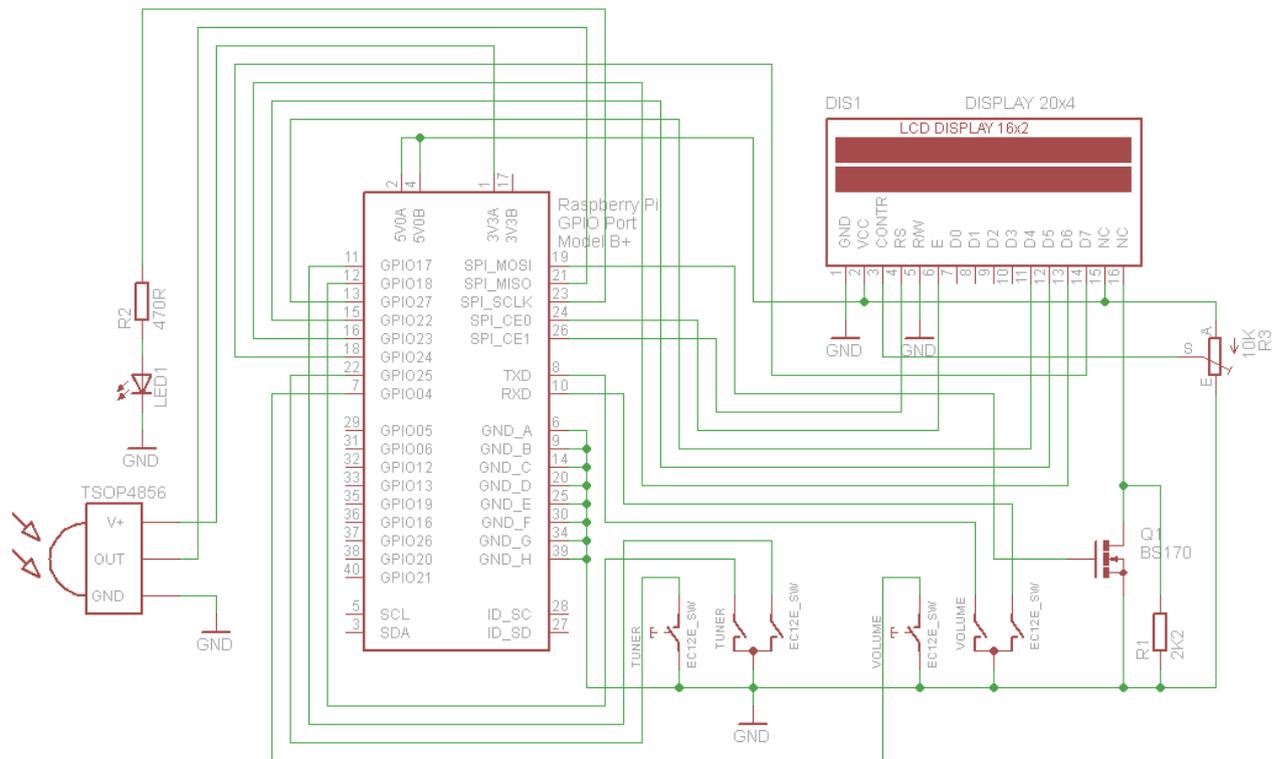


Figure 251 Wiring Raspberry Pi Radio Rotary Encoder version

Appendix D – Using a battery pack

It may be that you wish to make your radio portable. This can be done by using a 5V battery pack.

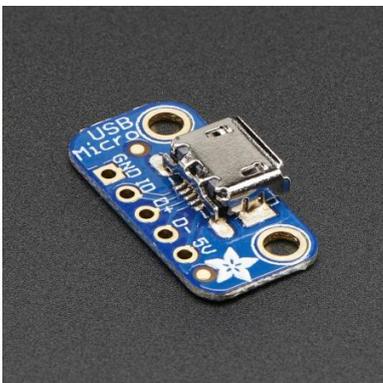


There are various manufacturers who supply a range of battery 5-Volt packs specifically for the Raspberry Pi. These are charged from any normal 5V charger.

Try to use a battery pack that directly connects to the GPIO header rather than connecting via the micro-USB or USB-C port.

The reason is that if connected by the USB port the internal regulator it will drop the voltage to 4.8 Volts which may give problems with the Wi-Fi connection.

Figure 252 Raspberry Pi 5 Volt battery pack



If the battery pack chosen doesn't connect directly to the GPIO header then purchase a micro-USB breakout board. This allows the 5 volt and GND connections to be connected directly to pins 2 and 6 respectively on the GPIO header.

Figure 253 Micro USB breakout board

Appendix E – Explanation of Vcc, Vdd, Vss and Vee

Throughout this guide the terms **Vcc**, **Vss**, **Vdd** and **Vee** may be used. They all apply to the DC voltage applied to a circuit, component or integrated circuit.

Vcc = Voltage Collector Collector

Vdd = Voltage Drain Drain

Vss = Voltage Source Source

Vee = Voltage Emitter Emitter

GND = Ground (0 Volts)

Vcc and **Vdd** are the positive supply voltage to an IC or circuit.

Vss and **Vee** are the negative supply voltage to an IC or electronic circuit.

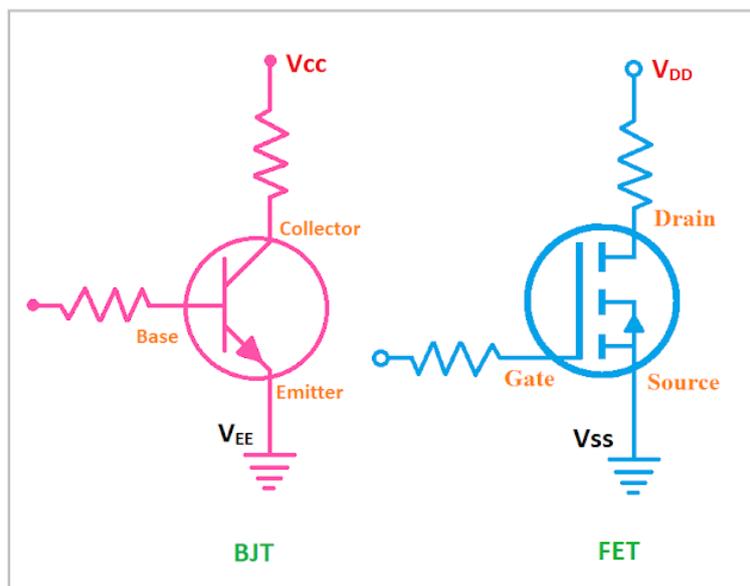


Figure 254 BJT and FET transistors

Which terms are used depends upon the type of circuit being connected to as shown in Figure 254 *BJT and FET transistors*. The terms **Vcc** and **Vee** are invariably used the most. **Vee** and **Vss** are normally tied to the 0v rail but as in the case of some LCDs can actually be a negative voltage.

Table 43 Supply voltage definitions summary

Supply Voltage	BJT (Bipolar Junction Transistor)	FET (Field Effect Transistor)
Positive Supply Voltage	Vcc	Vdd
Negative Supply Voltage	Vee	Vss



The information in this appendix was reproduced from the following article:

<https://www.etechnog.com/2019/06/vcc-vss-vdd-vee-in-electronics.html>

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