

## 1. WELCOME

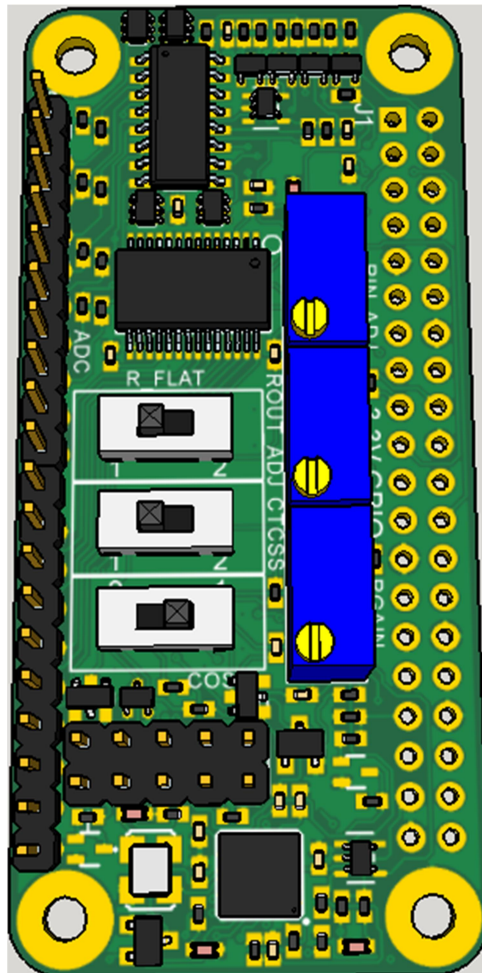
Thank you for purchasing the PI-REPEATER-1X, the first repeater controller board designed to be powered by the ubiquitous Raspberry Pi computer systems.

This little piece of hardware mates to the Raspberry Pi just like any other daughter card you may have used for the Raspberry Pi, Arduino, or other development platform.

This system enables you to have a variety of control options for your station, including simplex, duplex, echo-link, etc.

We use multiturn potentiometers for fine adjustment of the audio, offer hardware pre-emphasis filtering, active high / active low selects for each COS / CTCSS input signal, and have inputs tolerant to 18Vdc for the signals coming from the radio.

This board will work with any software that is capable of interacting with the sound card (I2S), and GPIO (I2C required)) for radio interfaces. We recommend getting started with SVXlink, but the choice is ultimately yours! Feel free to experiment and decide which system best fits your requirements.



## 2. CONTENTS

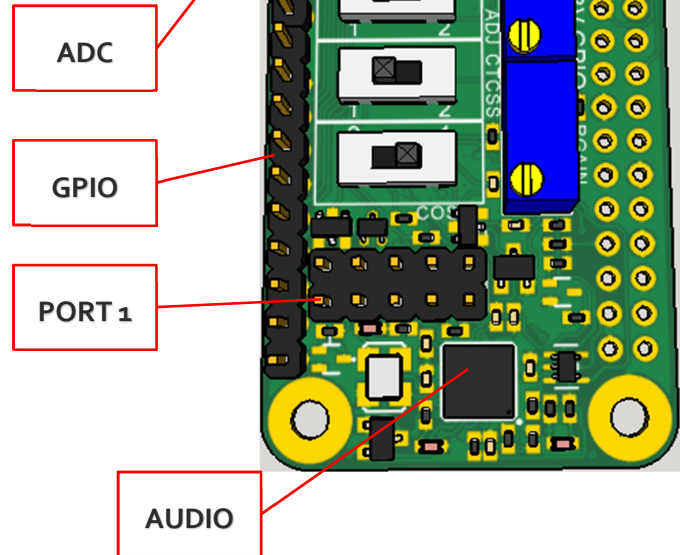
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### 3. HARDWARE INTRODUCTION

There are several features built into this little board that you should be aware of as they can easily be missed when setting up the hardware for the first time. Your software selection may or may not support all the features right out of the gate.

This board contains the following features which will be discussed in more detail in the following sections

- 1 Duplex Channel
  - Selectable High/Low COS/COR
  - Selectable High/Low CTCSS
  - Selectable Flat Audio
  - Adjustable audio input level
  - Adjustable audio output level
- Built in audio (input/output)
- Analog to Digital Converter
- GPIO expansion

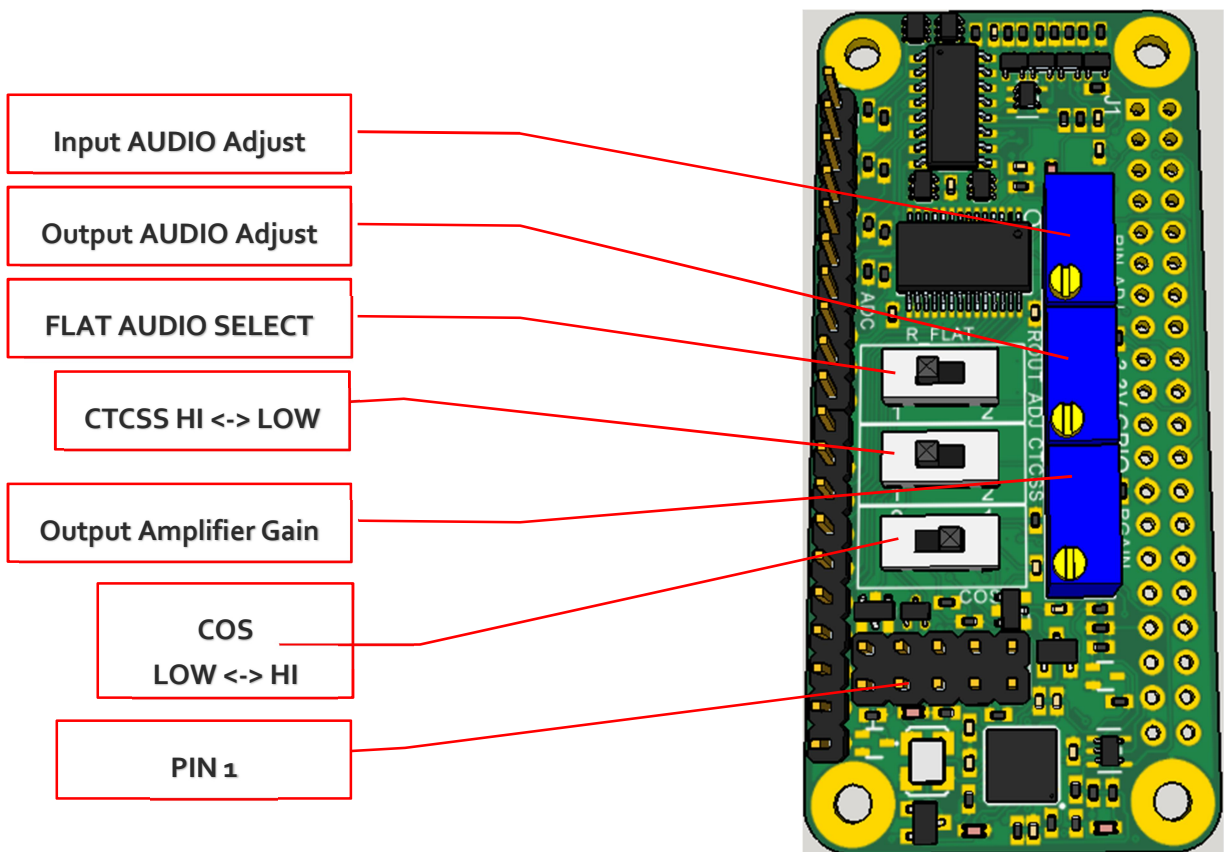


### 3.1 DUPLEX PORT CONFIGURABLE FEATURES

The board supports 1 full duplex channel.

- Selectable High/Low COS/COR
  - Select the switch setting as shown in the following sections to select the polarity of active signaling for your radio (typically active low)
- Selectable High/Low CTCSS
  - Select the switch setting as shown in the following sections to select the polarity of active signaling for your radio (typically active low)
- Selectable Flat Audio
- Adjustable audio input level
- Adjustable audio output level

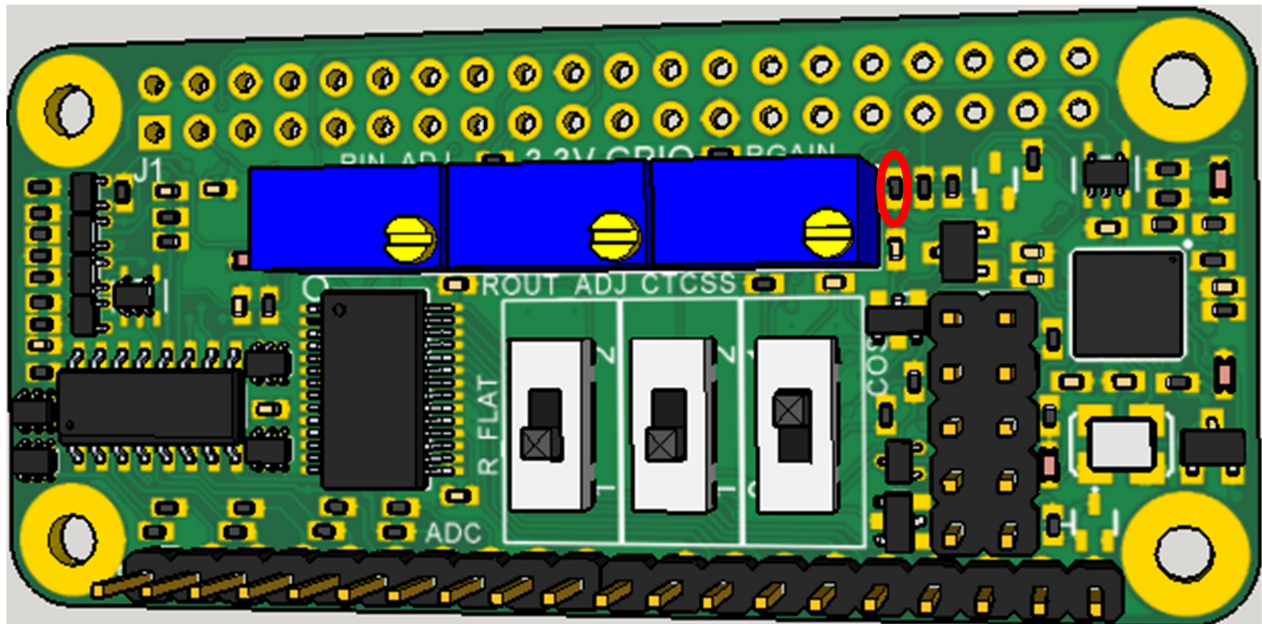
#### 3.1.1 DUPLEX CHANNEL



### 3.1.2 INPUT AUDIO ADJUST

The input audio adjust is used to adjust the amplitude of the volume coming from the receiver. This is an 18 turn, 10k $\Omega$  potentiometer, multiple turns are required to effect a large change in amplitude, while fractional turns yield fine resolution adjustments.

The input audio should be approximately 0.4 volts peak to peak as measured at R2.



### 3.1.3 FLAT AUDIO SELECT

This is used to select if the audio coming in requires the addition of a flat-audio filter (removes pre-emphasis).

To learn more about "Flat Audio" we recommend starting here:

<http://www.repeater-builder.com/tech-info/flat-audio.html>

### 3.1.4 OUTPUT AUDIO ADJUST

The output audio adjust is used to adjust the amplitude of the volume coming from the repeater board. This is an multi turn, 10k $\Omega$  potentiometer, multiple turns are required to effect a large change in amplitude, while fractional turns yield fine resolution adjustments.

This function is used to adjust the amplitude of the repeated audio being sent to your transmitter radio. This output amplitude should be adjusted per the transmitter radio specifications.

### 3.1.5 CTCSS ACTIVE HIGH/LOW

This switch is used to select the active on state for the CTCSS signal from the receiver radio. Typically this will be active low, but some radios output an active high signal. This input can be used for 3-18Vdc signal levels.

### 3.1.6 PORT CONNECTOR & PIN 1

The duplex port comes out to a 2x5 male header. This header is typically connected 1:1 into a DB9 Female connector, but the user may also make a custom cable/adaptor for their own equipment if desired.

Connector Selection: Due to the tight spacing of the board, it is important to select mating connectors that do not exceed the width of the male pin alignment blocks, or you risk mechanical interference with the port 2 header. For custom cables we suggest using connector block [952-2033-ND from Digikey](#), or a similar variant. **STANDARD IDC RIBBON CABLE CONNECTORS WILL NOT FIT.**

Pin 1 is located in the bottom left corner as shown above in section 3.1. When using ICS-CTRL provided DB9 connectors, will correspond with the brown wire.

#### CONNECTOR PINOUT:

- 1- CTCSS ENCODE OUTPUT
- 2- CTCSS INPUT FROM RX RADIO
- 3- PUSH TO TALK (OPEN COLLECTOR)
- 4- AUDIO OUTPUT
- 5- AUDIO INPUT
- 6- GROUND
- 7- COS INPUT FROM RX RADIO
- 8- GROUND
- 9- GROUND
- 10- GROUND (DB9 SHELL)

### 3.2 OUTPUT AMPLIFIER GAIN

This is a multi-turn, 10k $\Omega$  potentiometer that can be used to further adjust the output audio amplitude. It is recommended to leave this potentiometer at the midpoint value for normal operations.

### 3.3 BUILT-IN AUDIO

The system contains a [SGTL5000 Audio codec chip](#) which provides stereo input and output capability so you won't require a USB sound card to have receive audio capability.

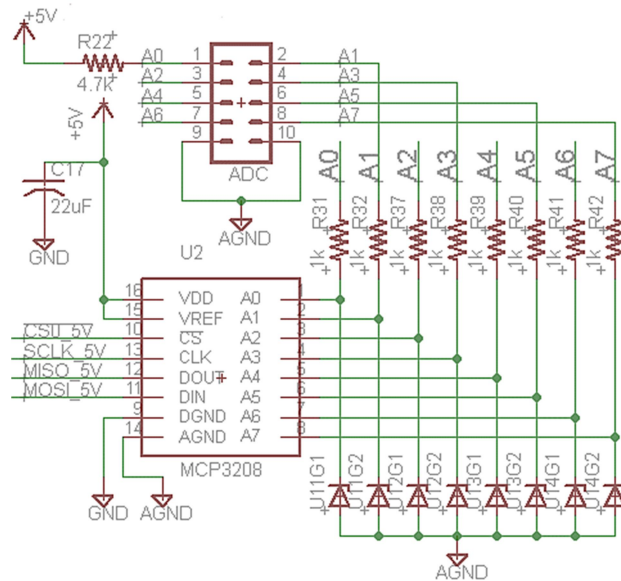
The stereo audio is split into 2 mono channels, this board uses 1 uses the RIGHT audio channel only.

### 3.4 ANALOG TO DIGITAL CONVERTER

A MCP3208 is built into the system to provide analog input capabilities with support for 8 channels with 12-bit resolution per channel.

Each channel is provided with some input protection through a current limiting resistor and a Zener diode. It is the user's responsibility to ensure the inputs are not over driven beyond a 5V maximum input voltage to prevent damage to the ADC unit.

Channel A0 has a unique configuration to allow for the use of a LM335 temperature sensor device. It is recommended to use this channel last to minimize potential confusion due to the unique configuration.

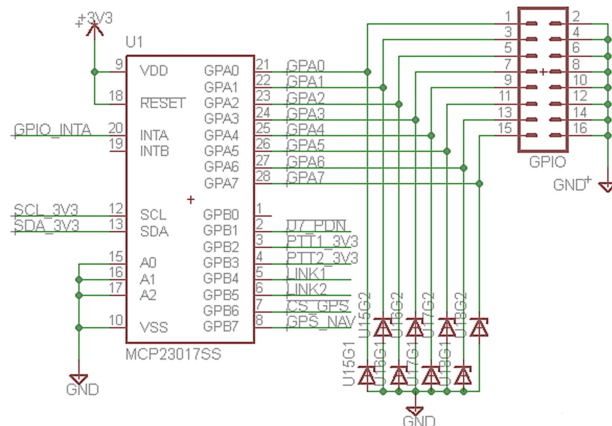


### 3.5 GPIO EXPANSION

As the repeater board consumes some of the signals from the 40 pin header, an additional 8 pins are made available through a 16 pin header. This header connects to PORT A on a MCP23017 IC, and provides input circuit protection through Zener diodes which limit the input voltage to 3.5V maximum.

Caution should be exercised to ensure only **3.3V logic levels** are used to connect to these pins.

The GPIO expander provides the option to include pull-up resistors should your circuit need these, but are not turned on by default, you will be responsible for configuration of these pins if used.



Connector Selection: Due to the tight spacing of the board, it is important to select mating connectors that do not exceed the width of the male pin alignment blocks, or you risk mechanical interference with the port 2 header. For custom cables we suggest using connector block [952-2037-ND from Digikey](#), or a similar variant. **STANDARD IDC RIBBON CABLE CONNECTORS WILL NOT FIT.**

## 4 GETTING STARTED WITH SVXLINK

Introduction: svxlink is a powerful open source controller software that works on many Linux based platforms. This implementation is specific to the ICS-CTRL hardware which includes additional modules that allows you to have access to specific hardware included with your ICS-CTRL PI-Repeater-2X.

Svxlink supports custom code so you can create new features beyond what we have included if your application has specific needs not covered by our base image. We would love to hear about your custom needs, and especially your custom modules. Odds are if you have a specific need, you are not unique and sharing your code will help to support others who follow.

### 4.1 HARDWARE PIN NUMBERS (SVXLINK BASED)

#### Port 1 PINS:

PTT – GPIO506 Active high  
COS – GPIO26 Active Low  
CTCSS – GPIO24 Active Low  
Audio input – FE Pi Right Channel  
Audio output – FE PI Right Channel

#### GPIO PINS:

GPA0 – GPIO496  
GPA1 – GPIO497  
GPA2 – GPIO498  
GPA3 – GPIO499  
GPA4 – GPIO500  
GPA5 – GPIO501  
GPA6 – GPIO502  
GPA7 – GPIO503

### 4.2 ADVANCED CONFIGURATIONS

Svxlink has a lot of features and they are continuously evolving, so be sure to have a recent copy of the manual for svxlink at hand. We will provide some examples for the most common setups encountered as starting points. Sample configurations will be provided on our Yahoo group and our website as we get them created.

If you have a specific hardware need, please make the request to the Yahoo Group for ICS-Controllers or for SVXlink support, at the SVXlink support page respectively. Both pages have a good support community and we monitor the ICS-Controllers group actively.

As the SVXlink software updates frequently, it is best to ask there for software specific issues, but we will do our best to help as well, but may not have the depth of knowledge that you will get from the SVXlink community.

Hardware Support Page: <https://groups.yahoo.com/neo/groups/ICS-Controllers/info>

SVXlink Support Page: <https://github.com/smosvx/svxlink/wiki/GettingSupport>



