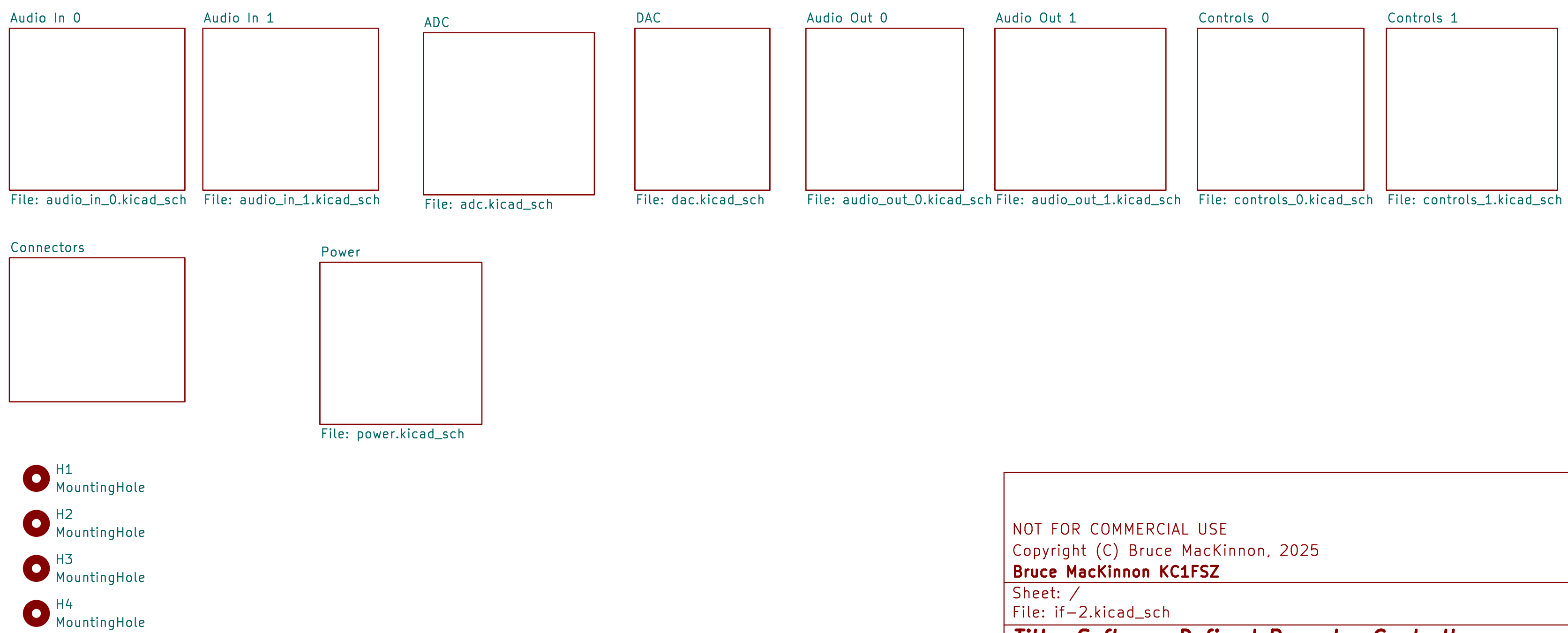
Software Defined Repeater Controller - Radio Interface Board

NOTES:
* This is an analog board that interfaces with two radios. A separate digital board based on the RP2040 is also required. A ribbon cable connects the two boards.
* The goal of this design is to do as little as possible in hardware.
* Many things that usually happen in hardware (or FPGA) will happen in software:
  - Audio routing between the two radios will happen in software.
  - Audio pre-emphasis/de-emphasis (if needed) will happen using DSP using digital filters.
  - CTCSS decoding (if needed) will happen in DSP.
  - CTCSS encoding (if needed) will happen in DSP.
  - DTMF decoding will happen in DSP.
  - CWID and other tone prompts will happen in DSP/software.
  - Voice IDs will happen in DSP/software.
  - Other digital audio interfaces like EchoLink (or DMR/D-Star in the future) will be directly integrated.



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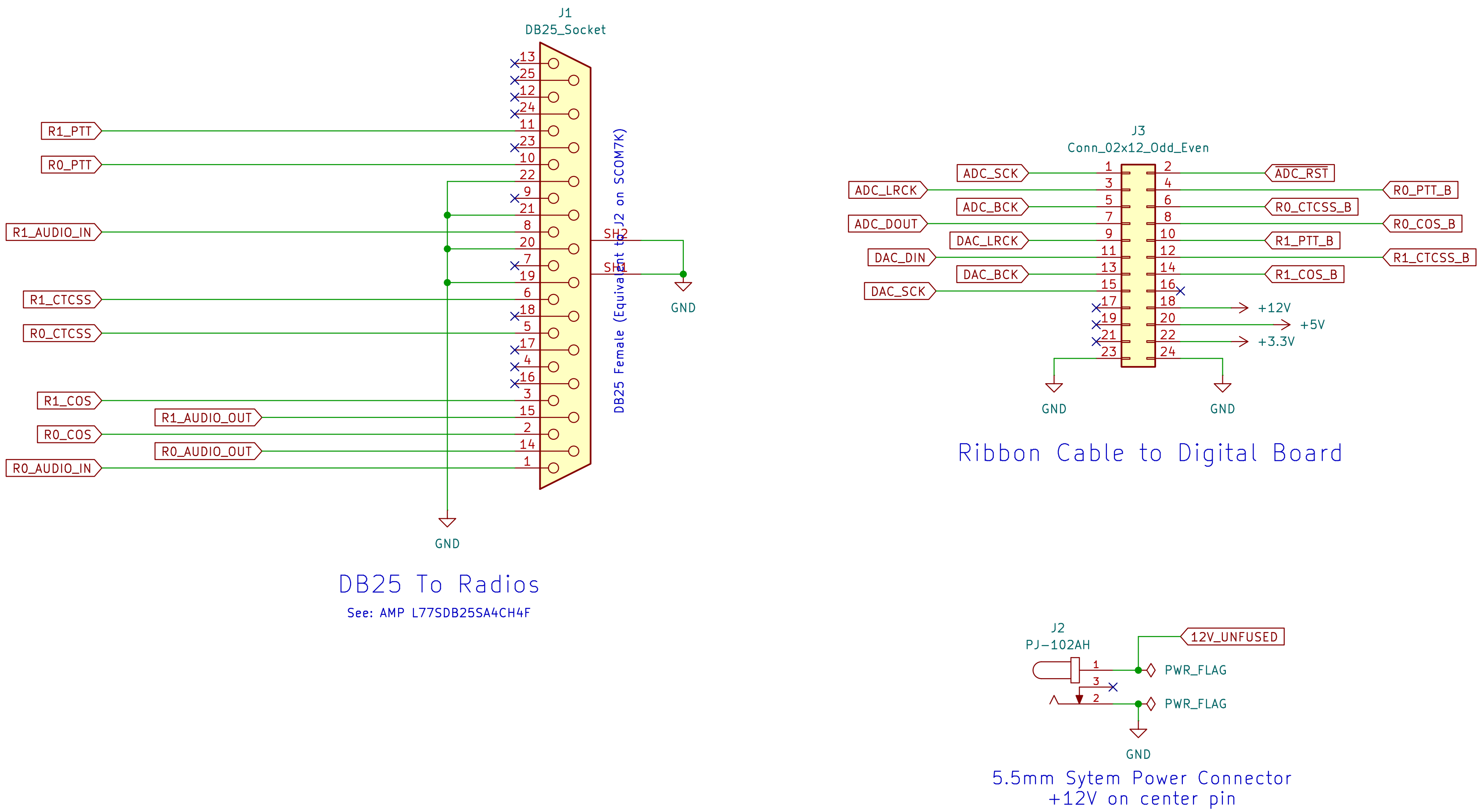
Sheet: /
File: if-2.kicad_sch

Title: Software Defined Repeater Controller

Size: USLetter	Date: 2025-06-25	**Rev: 3**
KiCad E.D.A. 9.0.0		Id: 1/11



This page shows all of the external connectors to the radio interface board.

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Sheet: /Connectors/
File: connectors.kicad_sch

Title: Connectors

Size: USLetter	Date: 2025-06-25	**Rev: 3**
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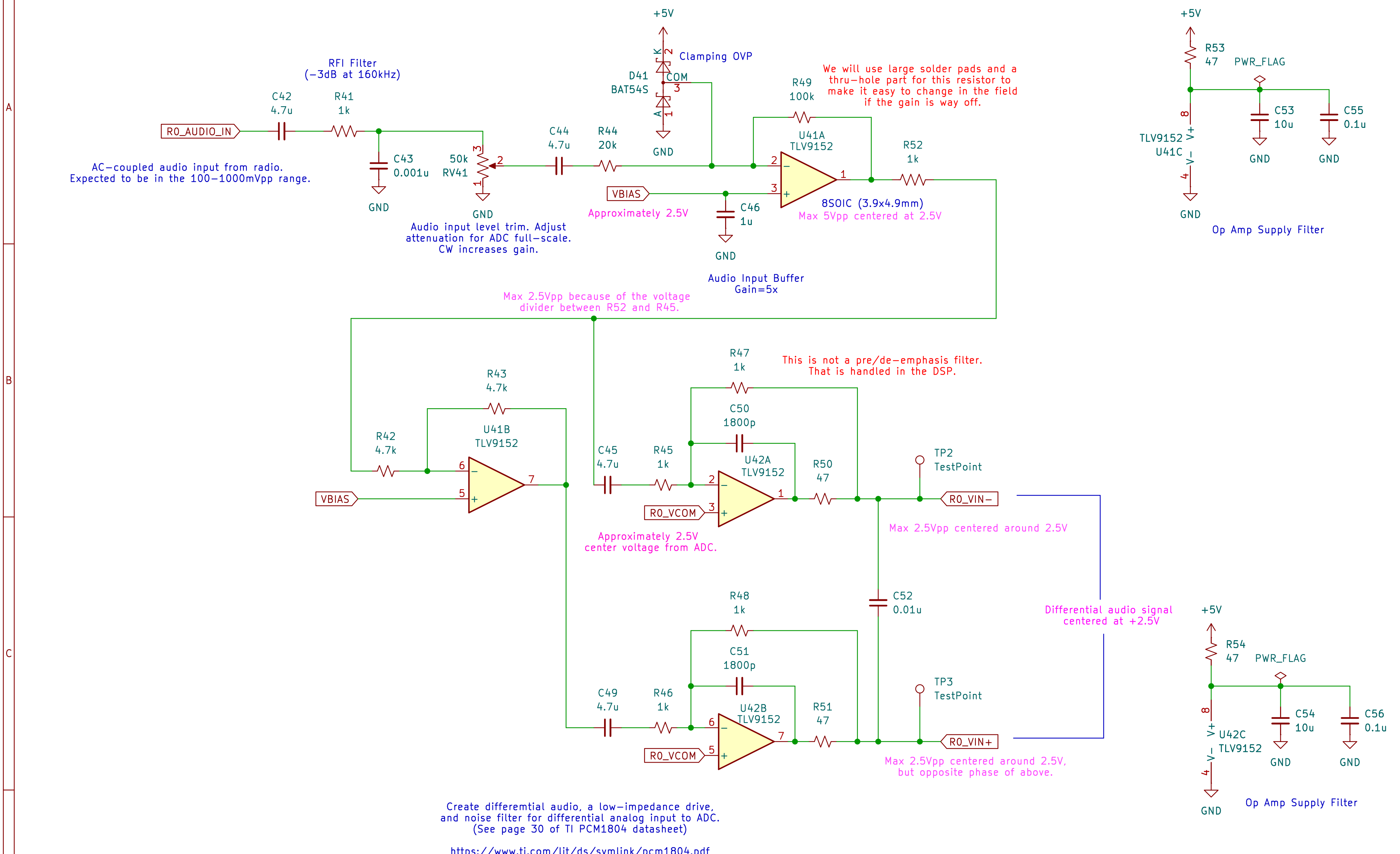

This page (and the next) shows the circuits that handle the audio input from the radio receivers. The main flow is (1) RF filtering (2) adjustable gain control (3) biasing to a 2.5V center (4) creation of a differential pair of signals needed to drive the ADC.

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Sheet: /Audio In 0/
File: audio_in_0.kicad_sch

Title: Audio Input (Radio 0)

Size: USLetter	Date: 2025-06-25	**Rev: 3**
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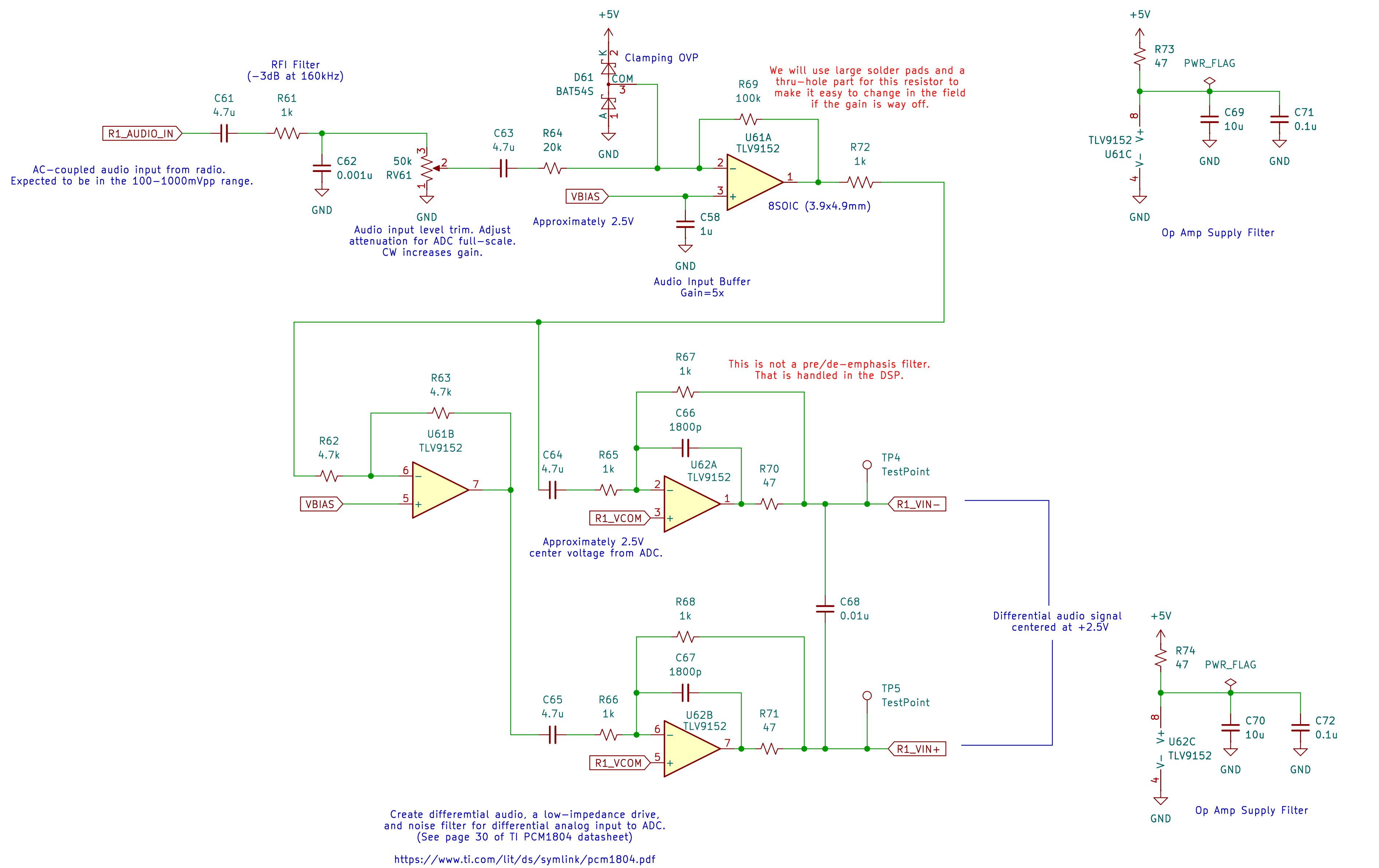

(Should be a copy of R0 audio input)

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Sheet: /Audio In 1/
File: audio_in_1.kicad_sch

Title: Audio Input (Radio 1)

Size: USLetter | Date: 2025-06-25 | **Rev: 3**

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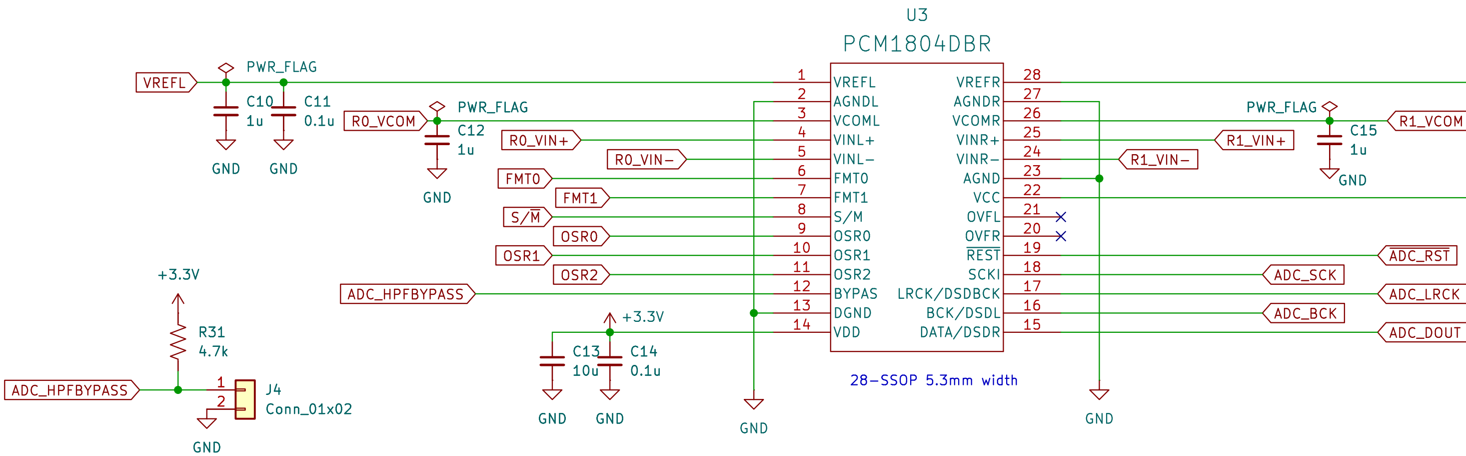
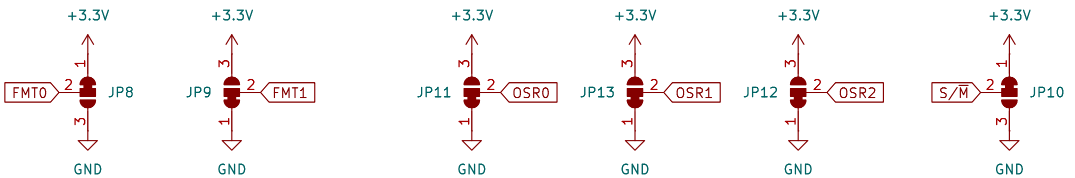
The TI PCM1804 is a 24-bit stereo analog to digital converter designed for audio applications. It contains an integrated low-pass anti-aliasing filter on the front-end with a cut-off around 20 kHz. Sample rate (fs) will be 32,000 samples/second. Narrower filtering will be achieved in DSP.



HPF enabled by default, can be disabled for testing using this jumper block. NOTE: When HPF is enabled it's not possible to test the ADC with DC levels.

Configuration Solder Bridges (unlikely to change)



FMT=I2S by default

Slave Mode: OSR=000 (single rate x128 fs) by default
Master Mode: OSR=010, 384*fs

Slave by default

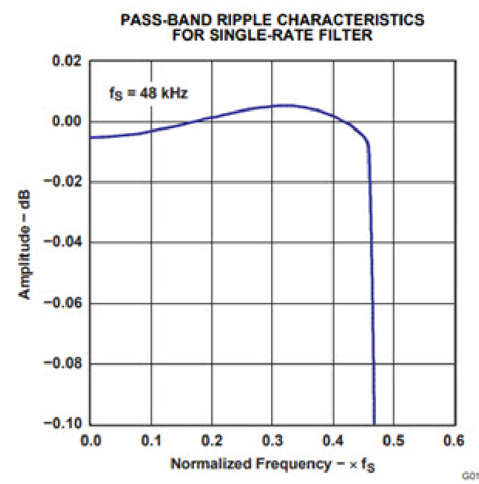


Figure 18.

This page shows the analog to digital converter (ADC). This part has two channels because it is intended for use in stereo audio systems. We use the left channel for radio 0 and the right channel for radio 1. Most of the setup here is copied from the PCM1804 application circuits shown in the datasheet.

This ADC has a narrow high pass filter to "notch out" the DC component of the input, so the digital values are perfectly centered. However, this HPF filter doesn't seem to negatively impact the low frequencies that need to be detected for CTCSS decode.

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Sheet: /ADC/
File: adc.kicad_sch

Title: Analog to Digital Converter

Size: USLetter	Date: 2025-06-25	**Rev: 3**
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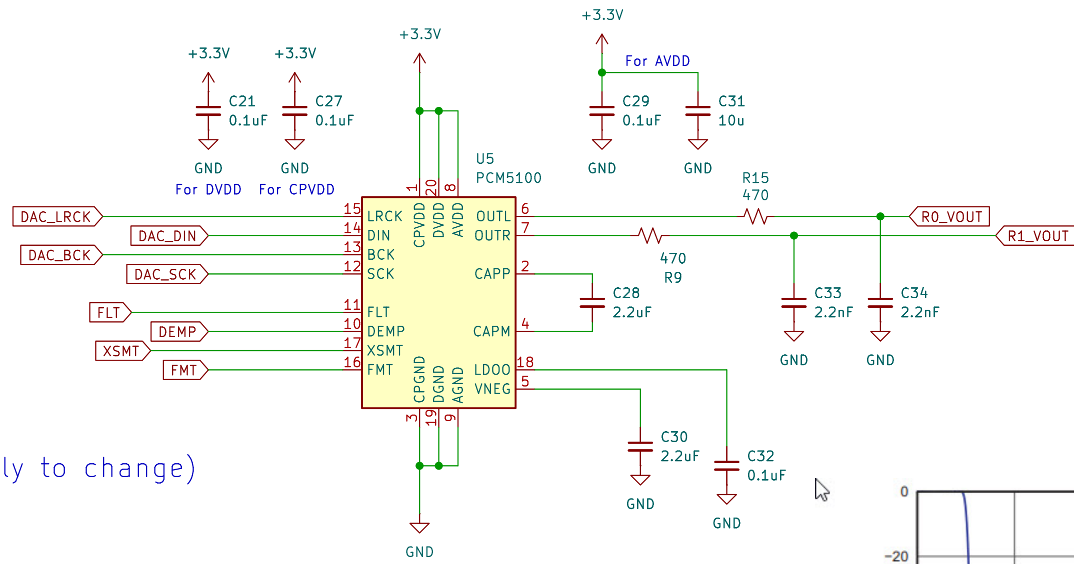
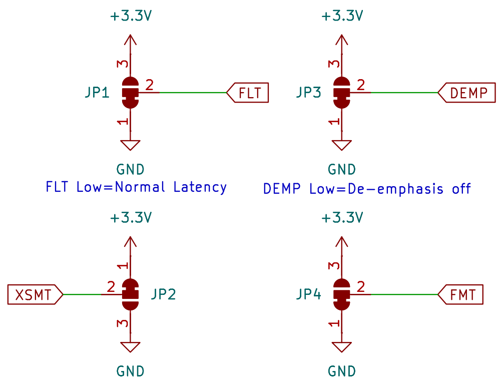
The TI PCM5100 is a 24-bit stereo digital to analog converter designed for audio applications. It contains an integrated low-pass interpolation filter on the back-end with a cut-off around 20 kHz. Sample rate (fs) will be 32,000 samples/second. Narrower filtering will be achieved in DSP.



Configuration Solder Bridges (unlikely to change)



FLT Low=Normal Latency

DEMP Low=De-emphasis off

XSMT High=Soft Unmute

FMT Low=I2S Format

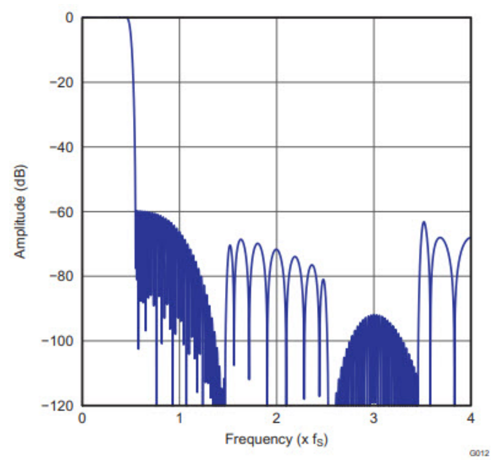


Figure 16. Normal x8 Interpolation Filter Frequency Response

This page shows the digital to analog converter (DAC). This part has two channels because it is intended for use in stereo audio systems. We use the left channel for radio 0 and the right channel for radio 1. Most of the setup here is copied from the PCM5100 application circuits shown in the datasheet.

The DAC has the ability to generate low frequencies needed for CTCSS encoding.

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Sheet: /DAC/

File: dac.kicad_sch

Title: Digital to Analog Converter

Size: USLetter	Date: 2025-06-25	**Rev: 3**
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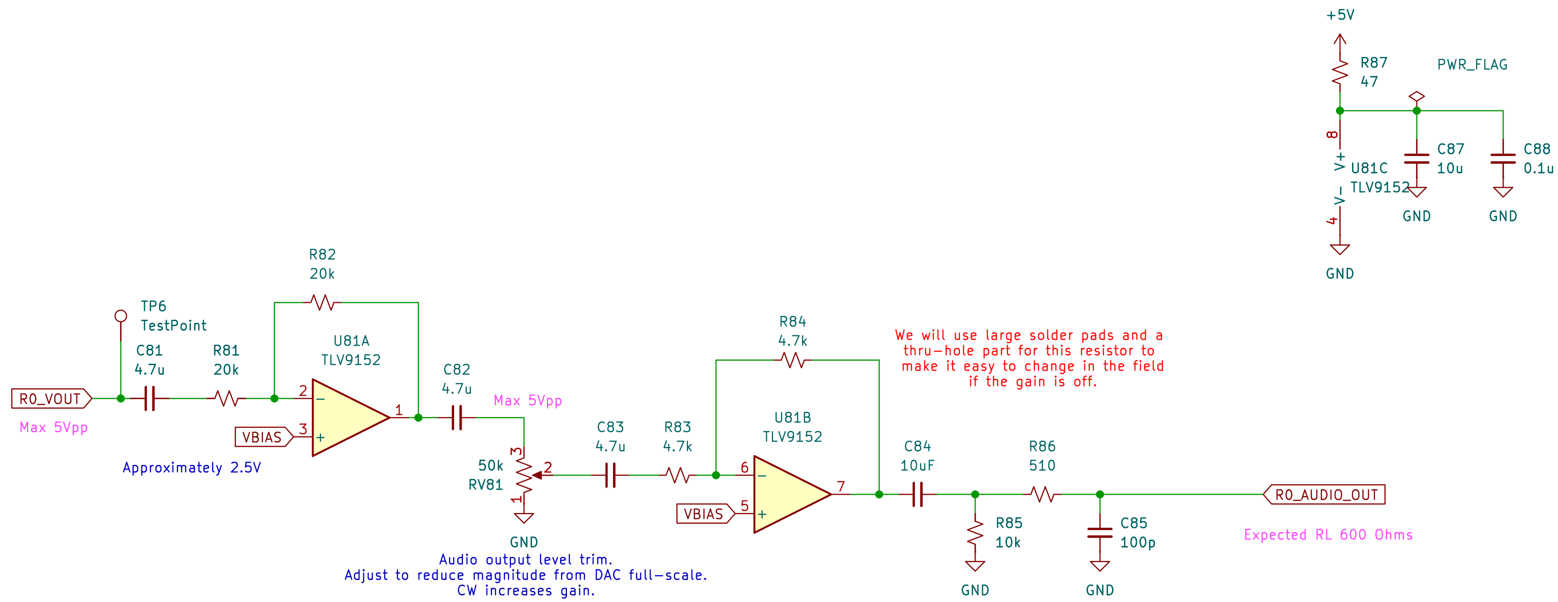

This page (and the next) shows the circuits that handle the audio output to the radio transmitters. The flow is (1) buffer stage (2) adjustable gain control (3) buffer (4) low pass filter.

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Sheet: /Audio Out 0/

File: audio_out_0.kicad_sch

Title: Audio Output (Radio 0)

Size: USLetter | Date: 2025-06-25 | **Rev: 3**

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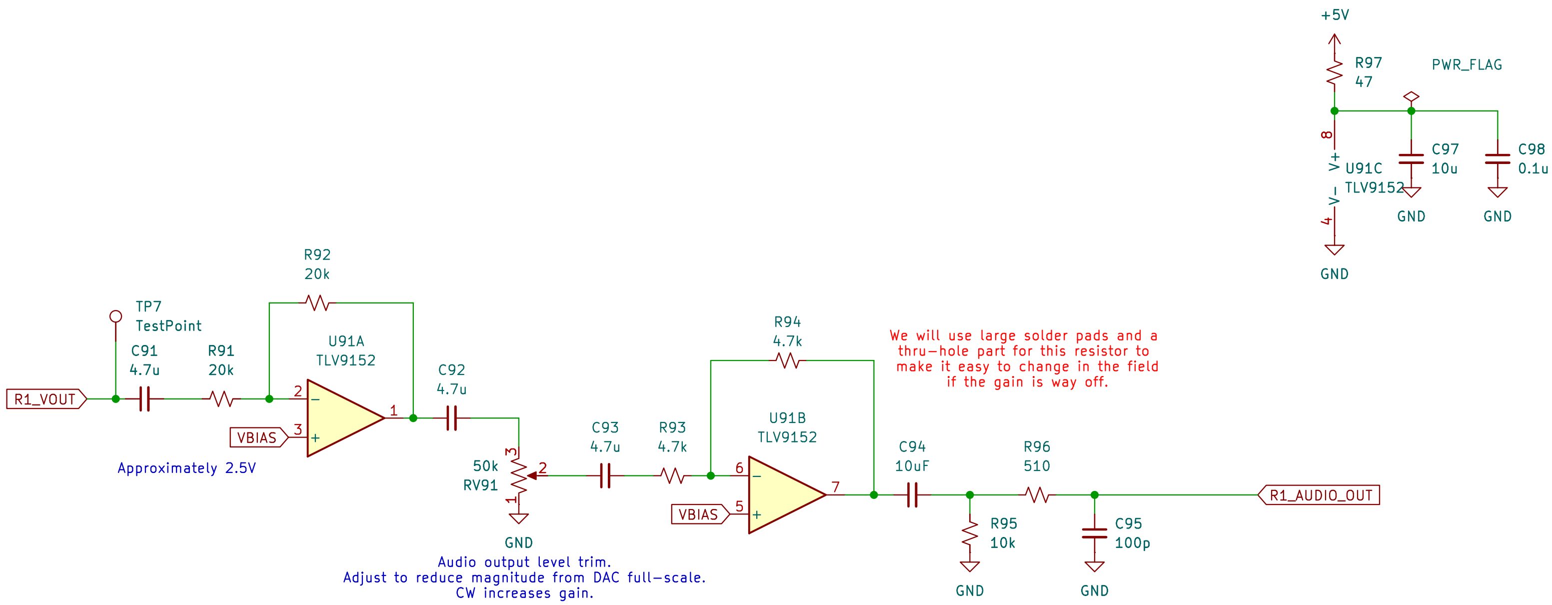

(Should be a copy of R0 audio output)

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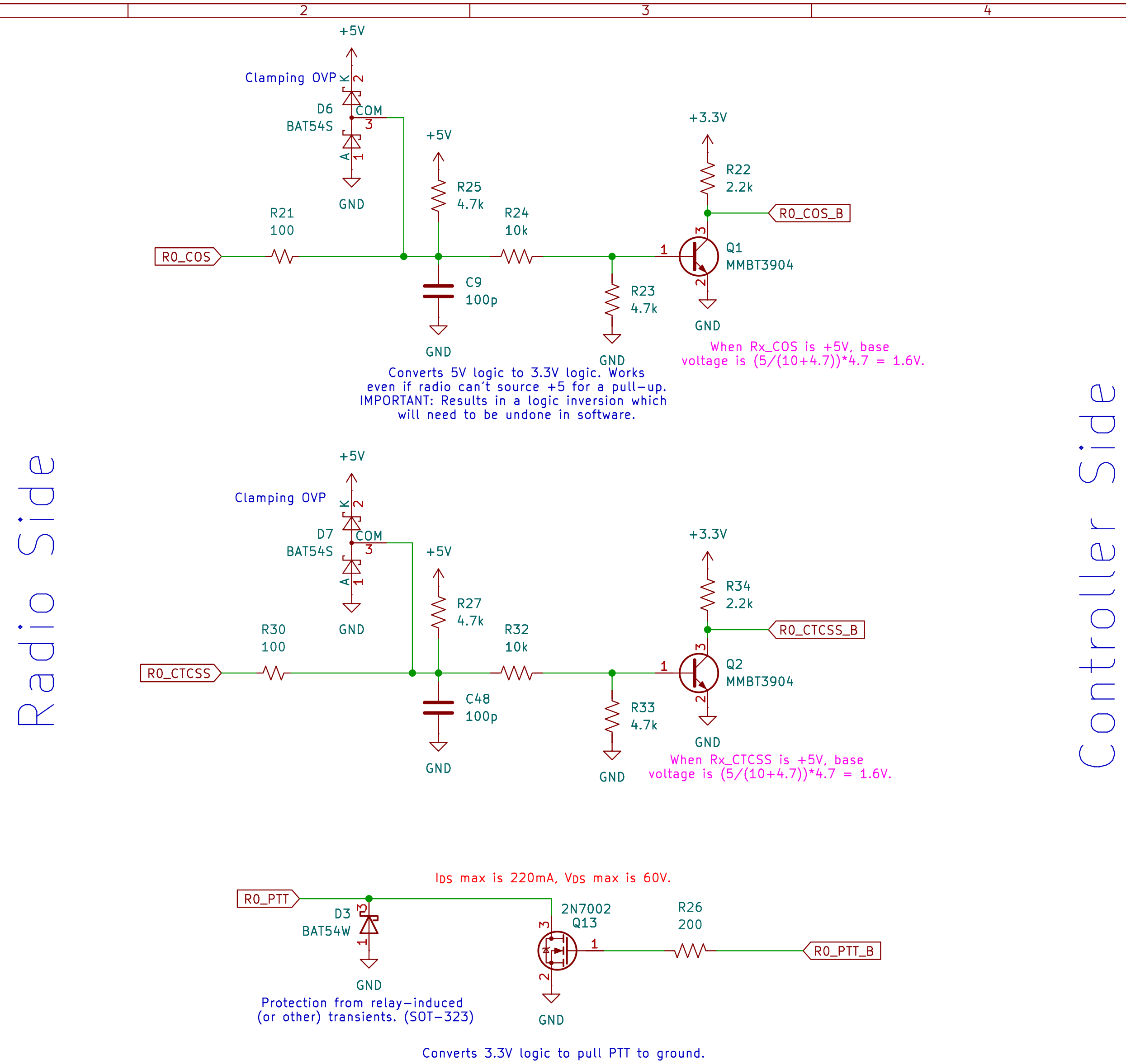
Sheet: /Audio Out 1/
File: audio_out_1.kicad_sch

Title: Audio Output (Radio 1)

Size: USLetter	Date: 2025-06-25	**Rev: 3**
KiCad E.D.A. 9.0.0		Id: 8/11



This page (and the next) shows the circuits that handle the logic inputs/outputs from/to the radios. For the COS and CTSS inputs the radio's 5V logic is converted to 3.3V to be compatible with the Pico GPIO pins.

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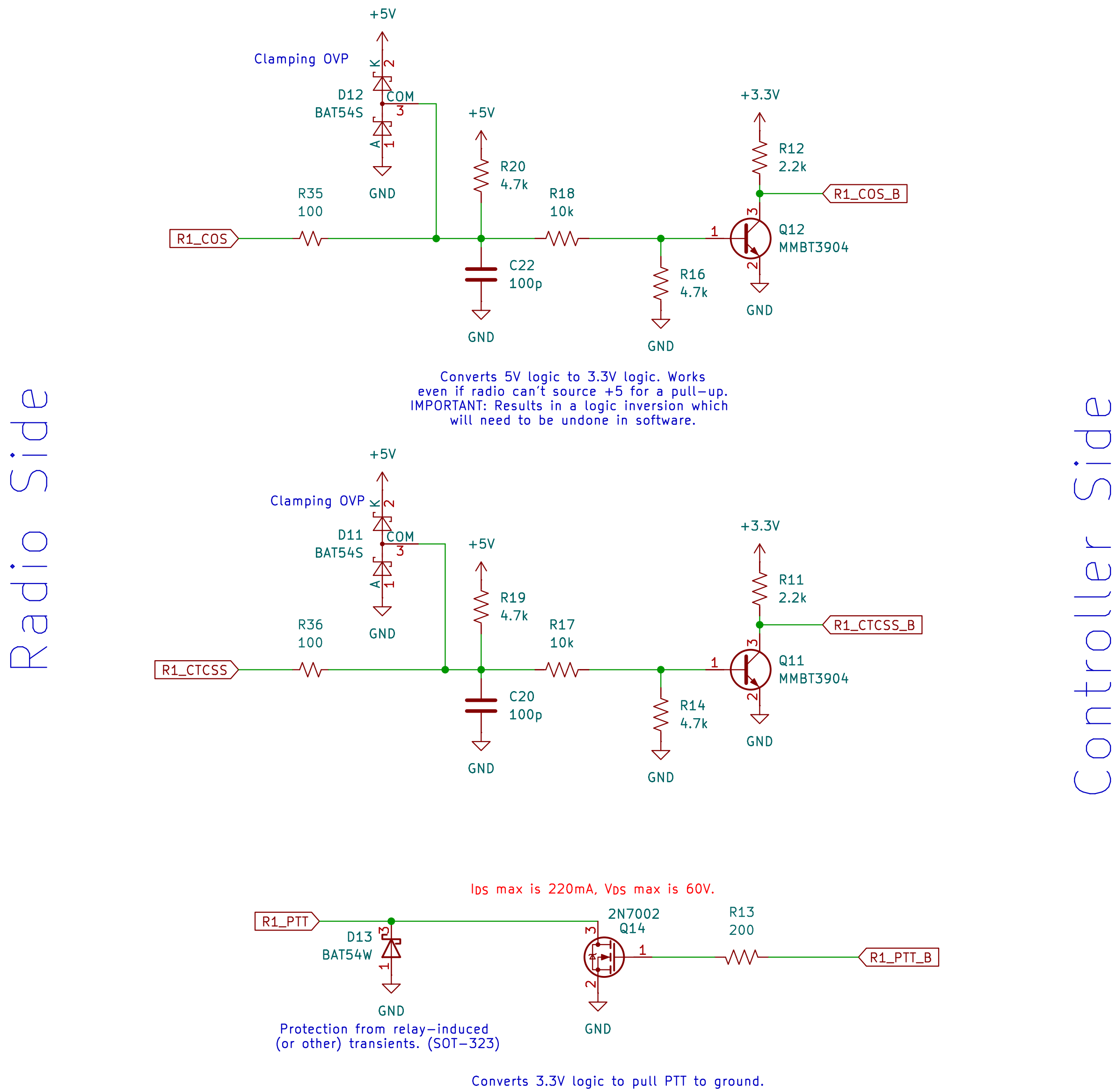
Sheet: /Controls 0/
File: controls_0.kicad_sch

Title: COS/CTSS/PTT Controls (Radio 0)

Size: USLetter | Date: 2025-06-25 | **Rev: 3**
KiCad E.D.A. 9.0.0 | Id: 9/11



(Should be a copy of R0 controls)

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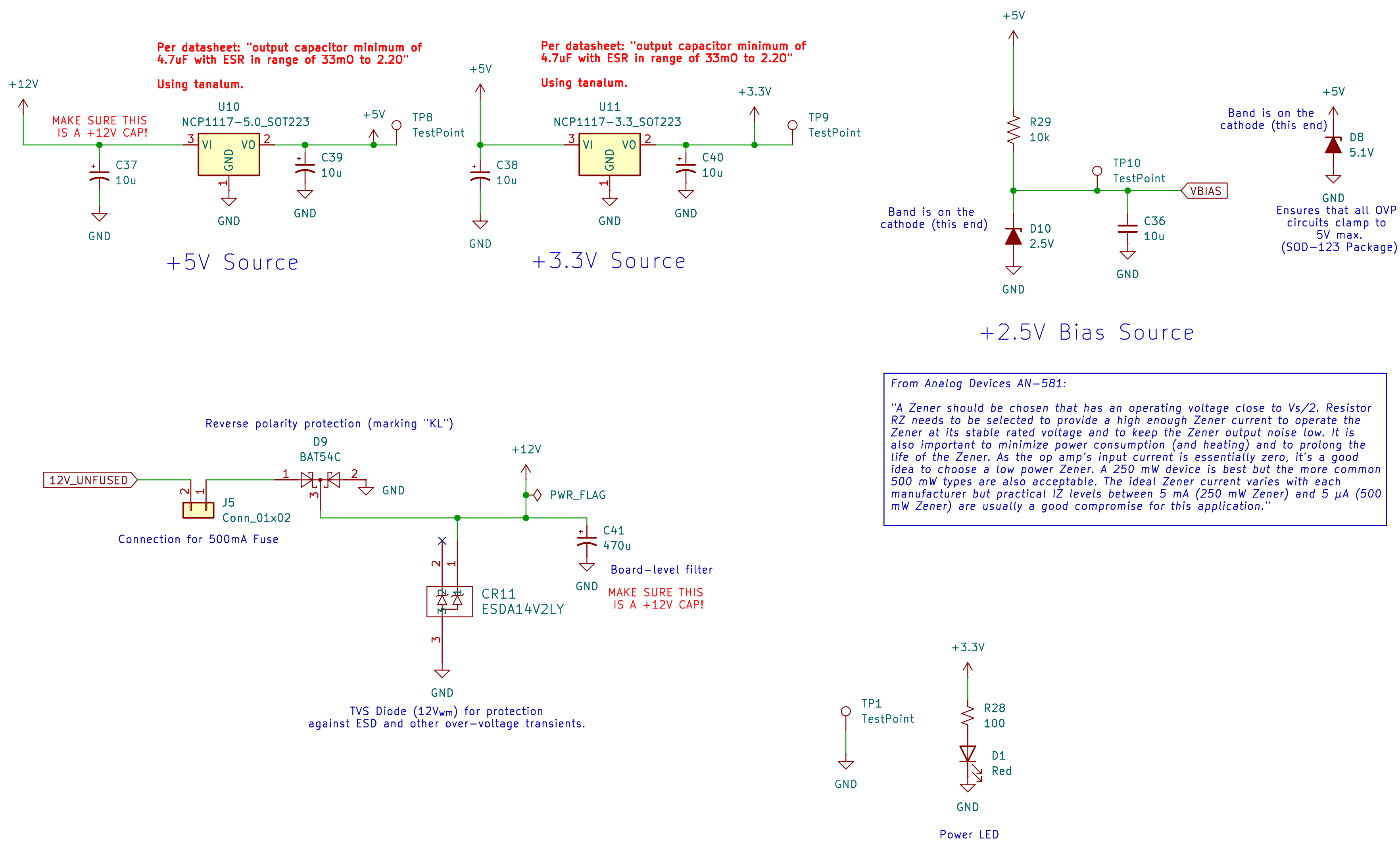
Sheet: /Controls 1/
File: controls_1.kicad_sch

Title: COS/CTCSS/PTT Controls (Radio 1)

Size: USLetter	Date: 2025-06-25	**Rev: 3**
KiCad E.D.A. 9.0.0		Id: 10/11



This page shows the power-related circuits. +12VDC power is converted to +5VDC and +3.3VDC using regulators.

A +2.5VDC bias voltage needed by the single-supply op amps is created using a zener diode.

This page also has some important overvoltage/transient protection circuits.

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Sheet: /Power/
File: power.kicad_sch

Title: Power

Size: USLetter	Date: 2025-06-25	**Rev: 3**
KiCad E.D.A. 9.0.0		Id: 11/11