Digital Audio with Teensy - workshop

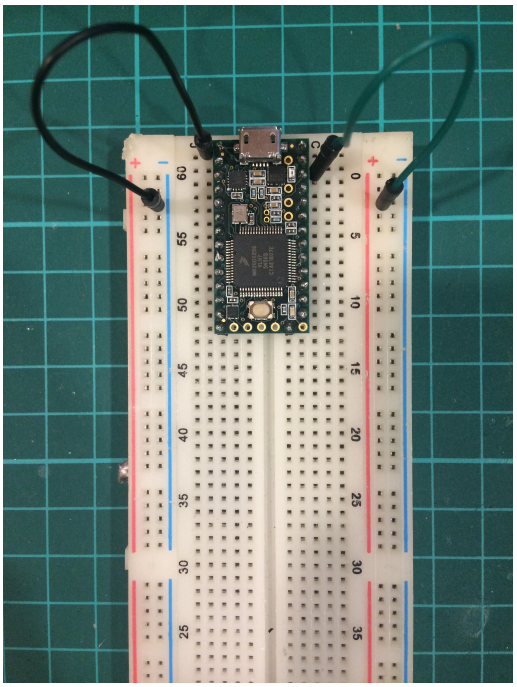
1. Bits

- Teensy board + spec sheet
- Breadboard
- Patch cables
- USB cable
- Audio cable
- Switch
- 2 potentiometers

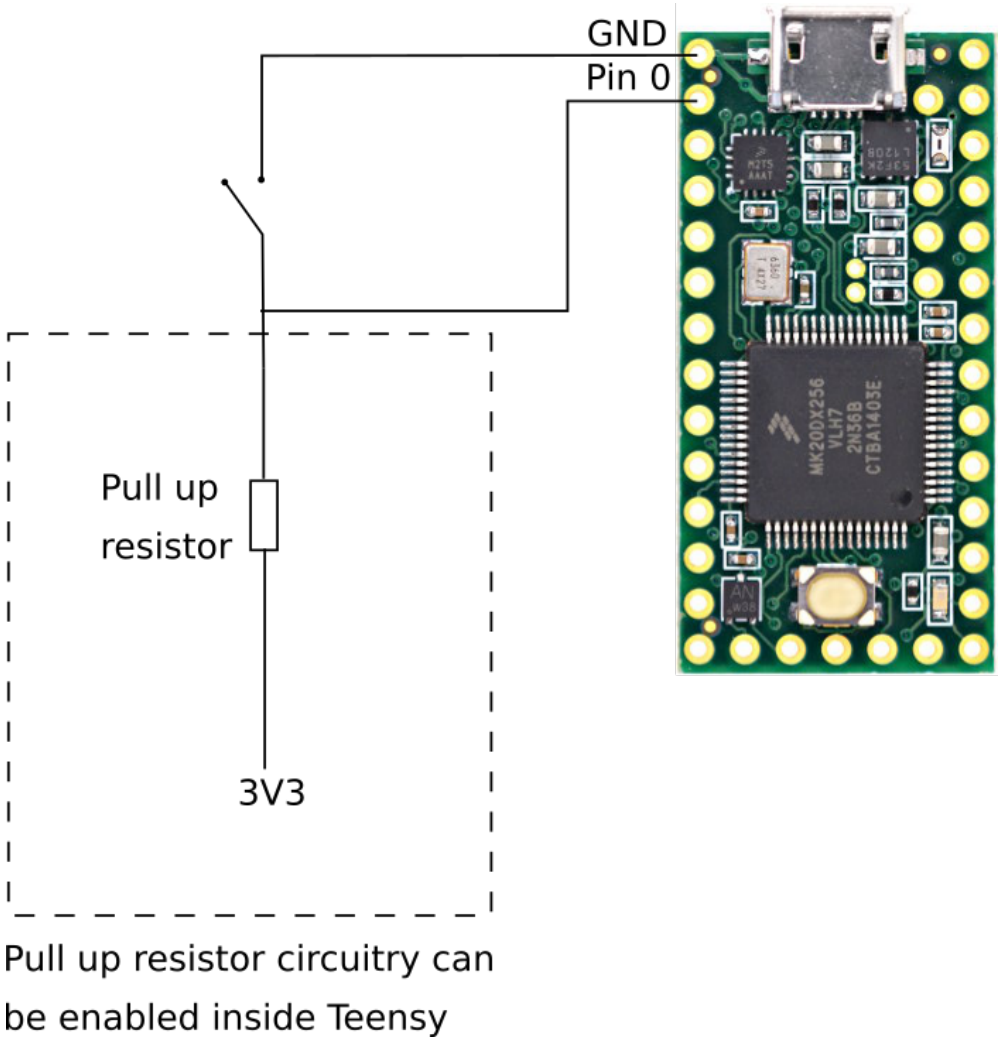
2. Installation

- Install Arduino https://www.arduino.cc/en/Main/Software
- Install Teensyduino https://www.pjrc.com/teensy/teensyduino.html

3. Add the Teensy to the breadboard



4. Connect button as shown



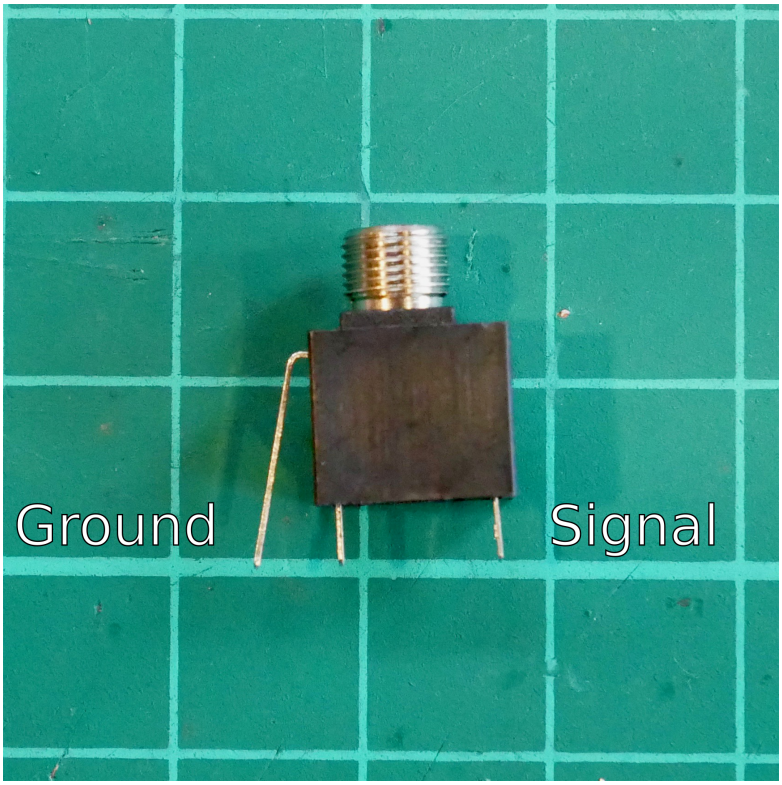
5. Download test code

- Open code in Arduino
- Plug USB cable into Arduino
- Compile and Download to Teensy by clicking the right facing arrow (second button from the left)

- In Arduino select Tools->Port and select Teensy
- Open Tools->Serial Monitor
- Press button, you should see text appearing in the Serial Monitor

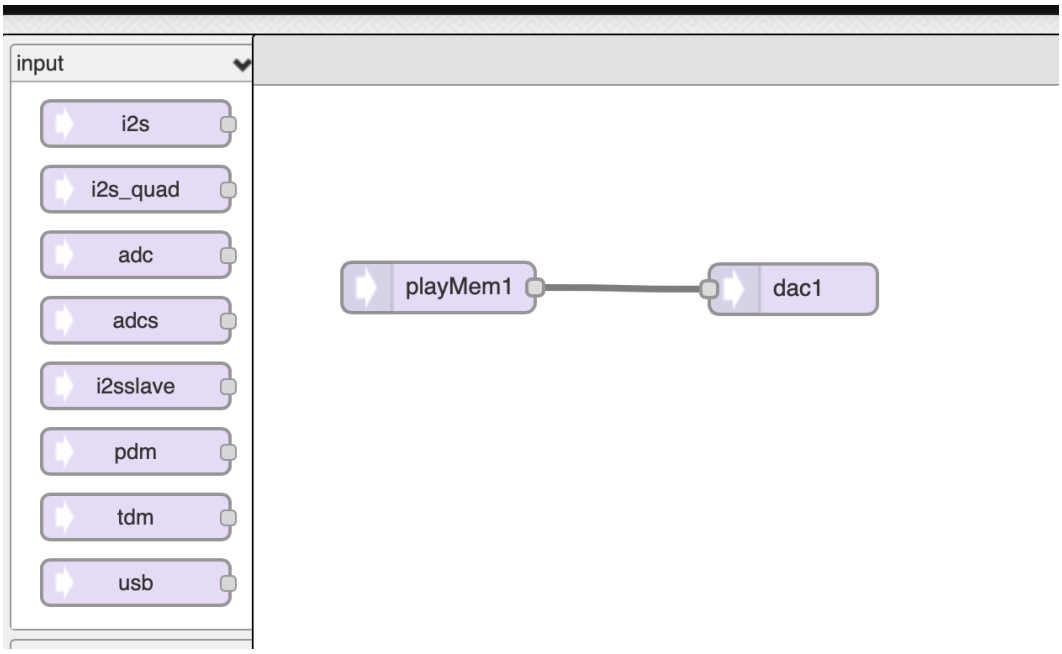
6. Add audio components to breadboard

- Insert jack socket into breadboard
- Connect Signal to DAC pin, and Ground to Ground



7. Use Audio Design Tool to add audio out

- Connect to https://www.pjrc.com/teensy/gui/index.html
- Add the components as shown



- Click Export
- Copy into Arduino Sketch (under #include <Bounce.h>)

8. Add code to trigger sample

At the top of the file add

```
#include "AudioSamplePiano_c3_44k.h"  // include the sample data for the piano sound
```

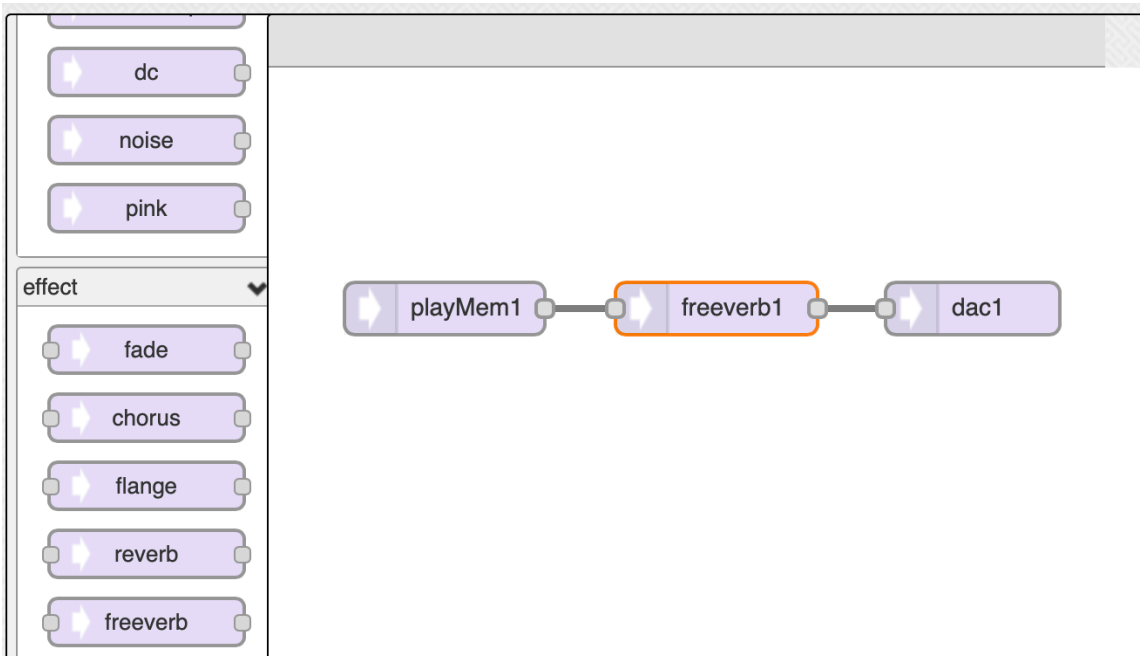
In the button section add

```
// is the button pressed down
if( button_bounce.fallingEdge() )
{
  Serial.println("Button down!");

  playMem1.play( AudioSamplePiano_c3_44k );
}
```

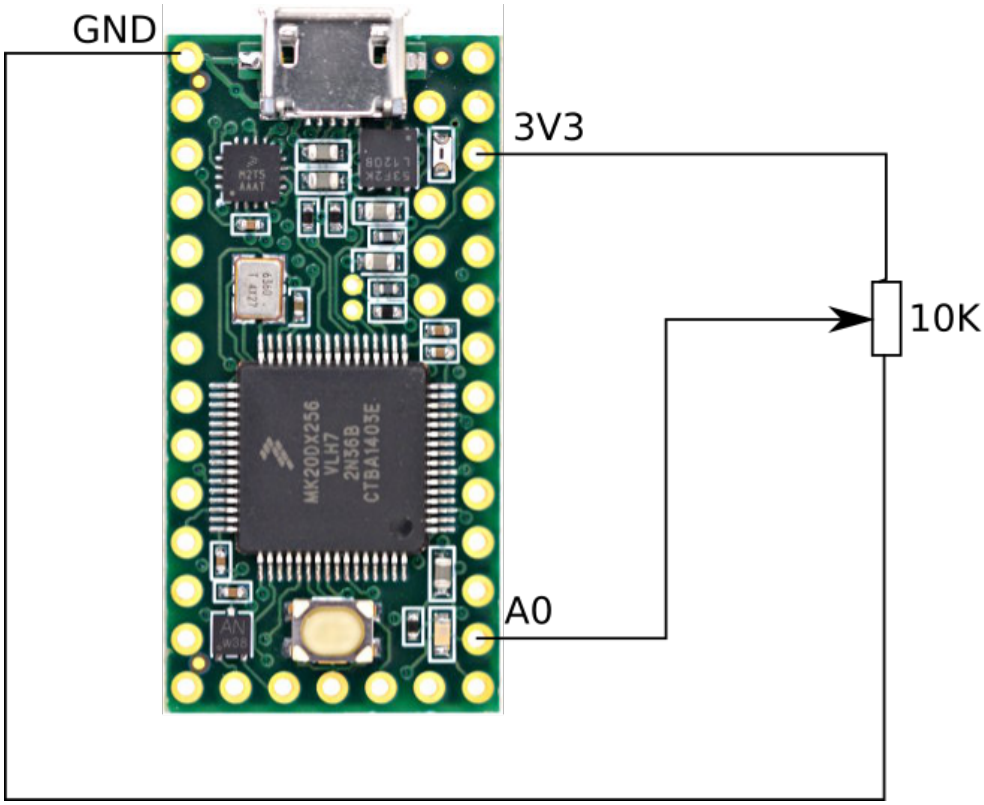
9. Add an audio effect

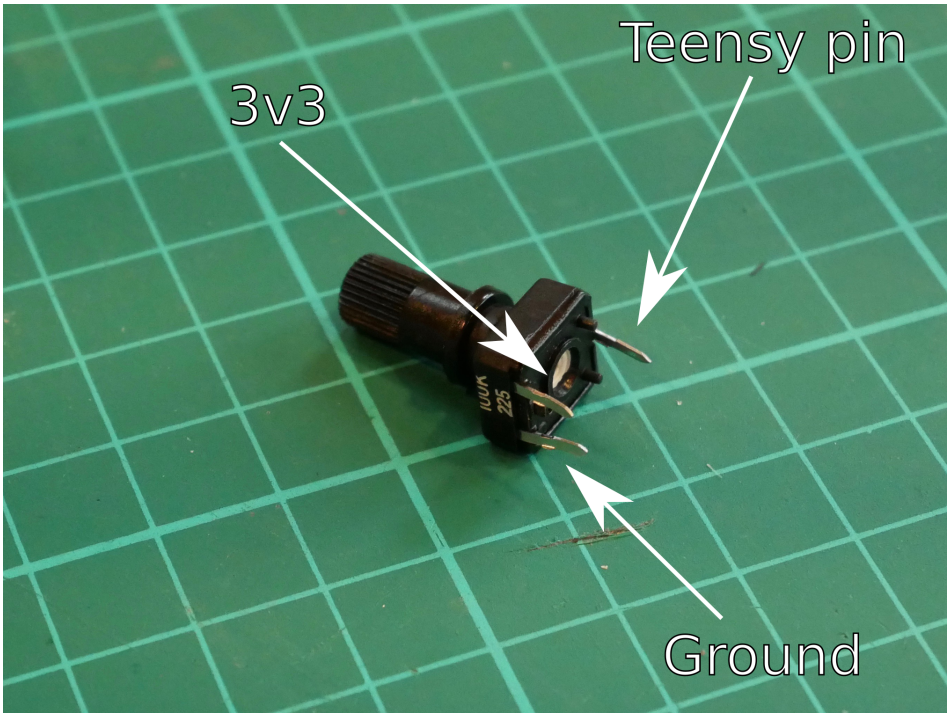
- In the Audio Design Tool add an effect in between playMem1 (which creates the sound) and dac1 (which outputs the sound)
- Export the code and copy over the previous export



10.Add potentiometers

- Connect as shown below to input A0. Your potentiometer will be configured as a potential divider. A0 will read a variable voltage from around 0V to around 3V3, dependent on how far you've turned the potentiometer
- Connect the second potentiometer to A1





11.Link potentiometers to effects chain

- Add the following code after the BUTTON_PIN definition (near the top of the file)

```
const int POT1_PIN(A0);
const int POT2_PIN(A1);
```

- Add the following code at the end of the update() function

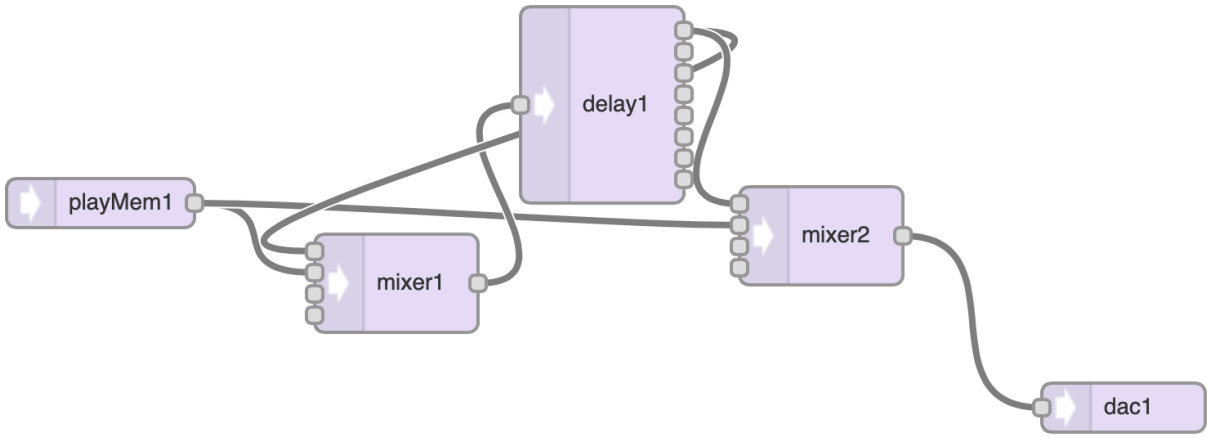
```
float pot1_val = analogRead( POT1_PIN ) / 1024.0f;
freeverb1.roomsize( pot1_val );

float pot2_val = analogRead( POT2_PIN ) / 1024.0f;
freeverb1.damping( pot2_val );
```

12. Experiment

- Create a new effects chain using the Audio Design Tool
- Map the potentiometers to control the effects as above (use the documentation in the design tool for help)

Example - Delay with Feedback



- Increase the audio memory to 128
- Add this to the setup()

```
 // mix dry and wet signal (50% of each)
mixer2.gain( 0, 0.5f ); // wet
mixer2.gain( 1, 0.5f ); // dry
```

- Add this to loop when reading potentiometers

```
const int min_delay_time = 50;
 const int max_delay_time = 300;

 static float old_pot1_val_raw = 0;
 float pot1_val_raw = analogRead( POT1_PIN );

 // is the difference large enough to change the delay time?
 if( abs( old_pot1_val_raw - pot1_val_raw ) > 50 )
 {
   const float pot1_val = pot1_val_raw / 1024.0f;
   const float delay_time = min_delay_time + ( max_delay_time * pot1_val );
   delay1.delay( 0, delay_time );

   // update the old value
   old_pot1_val_raw = pot1_val_raw;
 }

 float pot2_val = analogRead( POT2_PIN ) / 1024.0f;
 mixer1.gain( 0, pot2_val ); // feedback
 mixer1.gain( 1, 1.0f );     // source audio
```

Bonus exercises

- **Add some LEDs**
  - Adding a resistor in series connect an LED to a digital pin
- **Try and create a delay with feedback**
  - Use a mixer object to add feedback into a delay line
- **Convert a different sample and add to code**
  - Download and install wav2sketch
  - Convert a wav file to a header file
  - Import into your Arduino sketch
- **Make a drum machine!**
  - In Arduino select File->Examples->Audio->SamplePlayer
  - Hook up 6 buttons to pins 0-5