

Senior Design Proposal - Guitar Effects

This document describes the contents of the project proposal that each team should submit. There is no required length for this document; it needs to be long enough to contain the required information.

The PowerPoint presentation that will also be part of the proposal should follow the same outline.

1 Introduction

Guitar pedals are used to modulate and amplify the amplitudes and frequencies of the original input signal that are obtained from the pickups on a guitar. These pedals can be used to produce a variety of sounds that can embellish the tonal palette of a song or recording. Pedals producing effects such as distortion, fuzz, or looping are expensive and can be financially out of reach for musicians who wish to implement these effects in the music they create. Our goal is to integrate these pedal effects into one device that provides the user with the ability to select the pedal effect they wish to use and minimize the cost required to utilize these effects.

2 Problem Description

The problem with using guitar pedals on their own is that they are usually expensive and must be purchased separately to have access to the different effects they provide. The steep price of guitar pedals could prevent someone from being able to utilize these effects for their desired purposes. The pedals also must be activated using your foot, whereas our design aims to provide the user with an interface in which the different pedal effects can be selected without the need to manually activate them on a physical pedalboard. Digitization of the guitar pedals and its effects eliminates the need for physical pedals to be carried around and provides accessibility to those who cannot afford a physical pedal. Our design consolidates different circuits that will be used to produce guitar pedal effects such as distortion, fuzz, and looping where the input signal will be digitally processed and routed to an amplifier.

3 Proposed Solution

The main goal of this project is to emulate the various effects produced by guitar pedals through digital signal processing, and allow the user to be able to incorporate the same effects produced by pedals at a lower cost. We are aiming to develop a user interface which will allow the user to easily select the effect they wish to use through wifi communication with the ESP32 microcontroller. The choice that gets returned will trigger a certain circuit in our device to return the desired effect.

Our solution will consist of three separate circuits. Each circuit is capable of performing one effect: distortion, fuzz, and looping. Our goal is to get these circuits to fit in the most compact container that we can possibly use. This will make the device more convenient to the user. We will use a website similar to the one created for the homework to remotely control the LED. Our site will have a button for each circuit and when pressed, the corresponding LED will light signaling that the circuit is running. We will take the input signal from the guitar and pass it through the desired circuit to the output. We will have open switches on the effects we do not want to run. The circuit should run indefinitely or until the user presses an "off" button. The signal is then passed to an amplifier where we should hear the corresponding effect to the specific circuit chosen. Our design will include the cheapest components that fulfill all of the circuit design specifications. All of these features ensure that our device is: affordable, simple to use, and advantageous compared to using multiple pedals daisy-chained together.

4 Demonstrated Features

Wifi communication with a user interface

- user can choose which guitar effect is applied
- user can choose the intensity of the applied guitar effect

Digital signal processing of audio input on the ESP32

- audio signal can be manipulated to produce the desired effect with low latency

Alteration of the original audio signal to produce an effect while preserving the intended pitches

The ability of our system to emulate multiple possible effects on the audio output

- integration of multiple circuits with the ESP32

The ability to return the audio signal back to the user in a form that is suitable to play through a speaker/amplifier

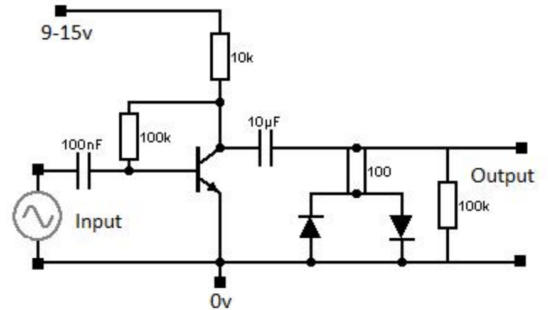
5 Available Technologies

Overall Design:

- Guitar
- Small Amp
- Modified Circuit Housing

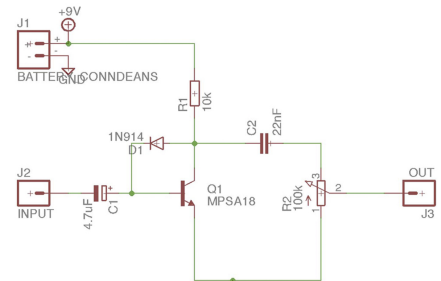
Distortion Pedal Circuit:

- Resistors: 100Ω, 10kΩ, 100kΩ
- Capacitors: 100nF, 10μF
- Transistor: BC337
- Diodes: 1N4001 (2x)
- Potentiometer for 100k biasing resistor



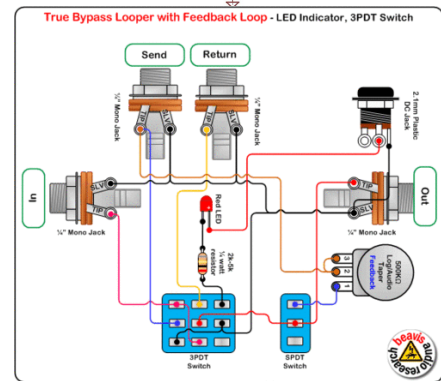
Fuzz Pedal Circuit:

- Resistor: 10kΩ
- Capacitors: 22nF, 4.7μF
- Diode: 1N914
- Transistor: MP5A18
- Potentiometer: 100kΩ



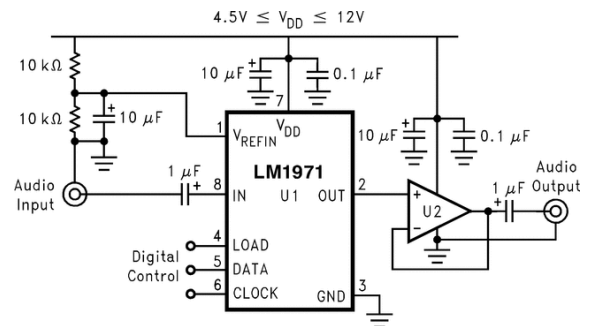
Loop Pedal Circuit:

- 1/4" Mono Jacks (x4)
- 2.1mm Plastic DC Jack
- Potentiometer: 500kΩ
- Resistor: 2kΩ - 5kΩ 1/4 Watt
- 3PDT Switch
- SPDT Switch



Digitally-controlled Audio Attenuator:

- Resistors: 10kΩ
- Capacitors: 0.1 μF, 1 μF, 10 μF
- LM1971, Op-Amp



6 Engineering Content

List the engineering that your team will need to perform to design, build and test the product. You may find it convenient here to think of your overall system in terms of major functional blocks and interfaces either between the functional blocks or between a functional block and the user.

This section should convince me that there is sufficient engineering content to meet the course requirements, relative to the size of the team. There is an expectation that each team member should be working on the project for a minimum of 6 hours per week.

- Assemble circuits shown in schematics for the different effects
- Design bypasses and controls for circuits to allow the ability of adjusting presence of effects
- Build a housing for electronics with necessary inputs and outputs with as compact a design as possible
- Create a user interface (website) using wifi communication with the ESP32 that can enable/disable effects with the ability to control their levels allowing the user to customize the tone produced
- Perform digital signal processing on audio signals to achieve the desired effect without unintentional loss of frequency components
- Maximize the efficiency of the digital signal processing to minimize the latency so the guitar effect is heard “in real time”

7 Conclusions

With our design, we intend to increase both physical and financial accessibility to guitar effects. Our solution will:

- Consist of 3 separate circuits, each capable of performing one effect (distortion, fuzz, and loop)
- Use a website UI for the user to easily choose a guitar effect and adjust its intensity
- Take the input signal from the guitar and pass it through the desired circuit to the output
- Have open switches on the effects we do not want to run
- Pass the modified signal to an amplifier to hear the selected effect

By using basic circuit components and replacing a physical pedal with a website UI, we ensure that our device is: affordable, more physically accessible, simple to use, and advantageous compared to using multiple pedals daisy-chained together.

(links)

Distortion Pedal:

<https://www.instructables.com/Very-simple-and-cheap-GuitarBass-distortion-pedal/>

Fuzz Pedal:

<http://bevisaudio.com/projects/looperswitcher/>

<https://electronics.stackexchange.com/questions/440346/simple-fuzz-pedal-using-bread-board>

<https://fuzzcentral.ssguitar.com/fuzzface/fuzzfacereissueschematic.gif>

Looper Pedal:

<https://diyshoegazer.tumblr.com/post/3042080186/diy-guide-to-feedback-loop-pedals>