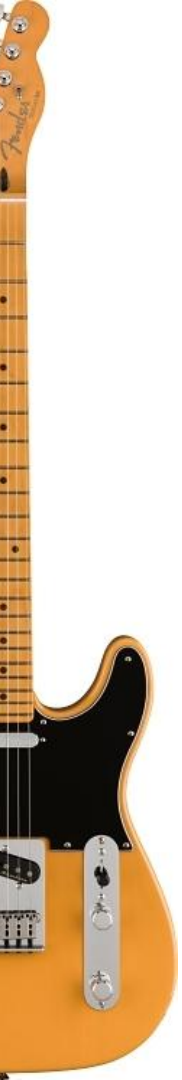


Capacitors in Guitars

And other music technologies

Guitar: Reverb.com Capacitor: Technology Student

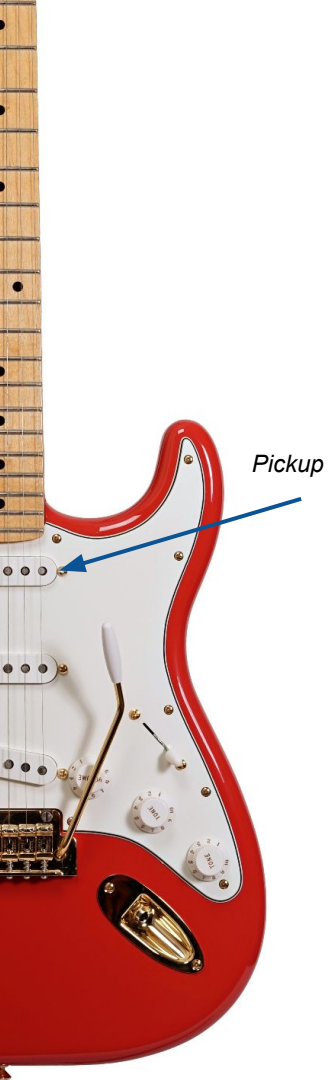
Capacitors Basic Uses

Capacitors, in their most basic use form, capacitors do three things in an audio environment:

- Smooth current
- Filter frequencies
- Time effects

They do one or multiple of these for all these use cases, and are used in varying locations in the circuit

How does an Electric Guitar Work?



When the strings on the guitar are plucked, they vibrate over magnets held within a coil of copper wire, known as a pickup.

This vibrating creates a small amount of current, at whatever notes are hit frequencies.

The current then goes into an amplifier, which makes this signal louder and easier to work with.

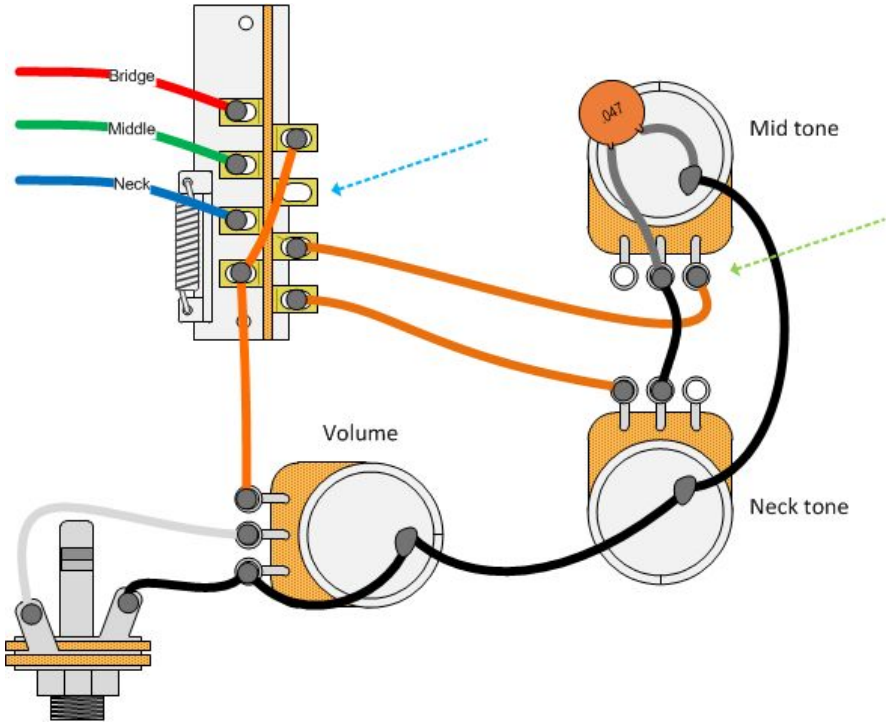
A combination of different potentiometers, resistors and capacitors shape this signal into the sound we all know.

All Images: Reverb.com

Capacitors within the guitar

In the most basic circuit, the guitar is just a coil connected to the output jack.

The capacitor shown here is used to ground any buzz that the pickup coils detect from the background ‘noise’

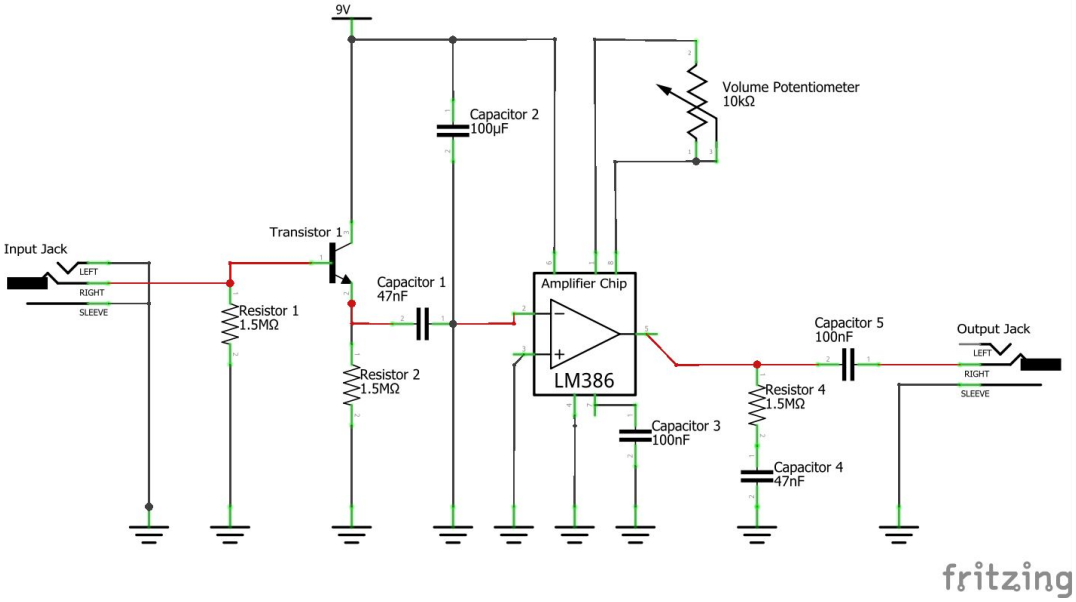


How do Capacitors come into this?

Here is a diagram of a over simplified diagram of a guitar amp.

Each capacitor is used in a different way to make the signal nicer to ears, to edit the signal in some way.

The guitar's signal follows the red line.

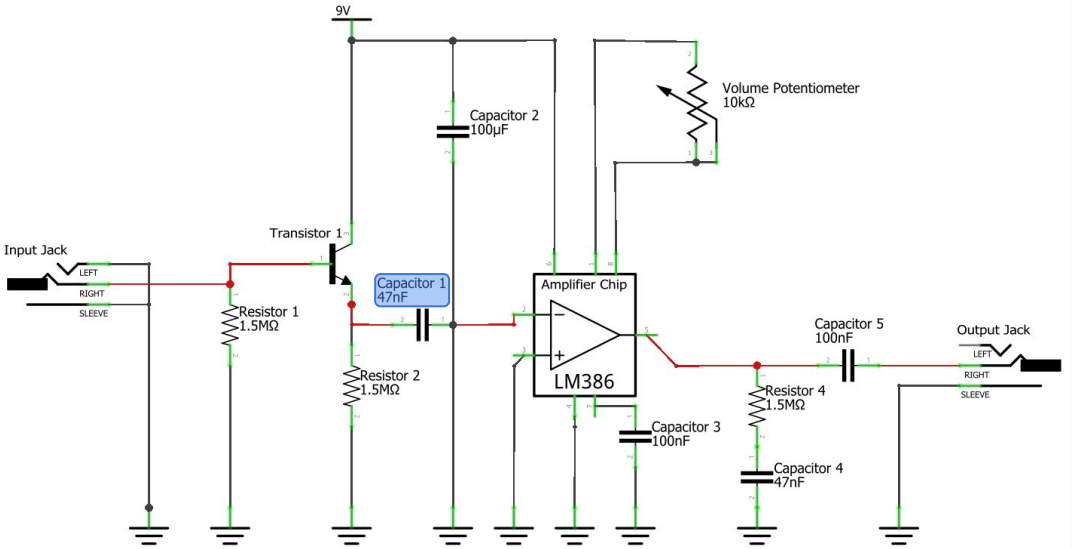


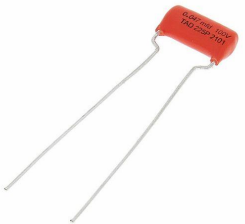
How do Capacitors come into this?

Capacitor 1

Capacitor 1 acts as a DC Blocker.

This protects the speakers from DC current, which could break them - it ‘biases’ the magnet in it it, and pushes the diaphragm out more than it should.



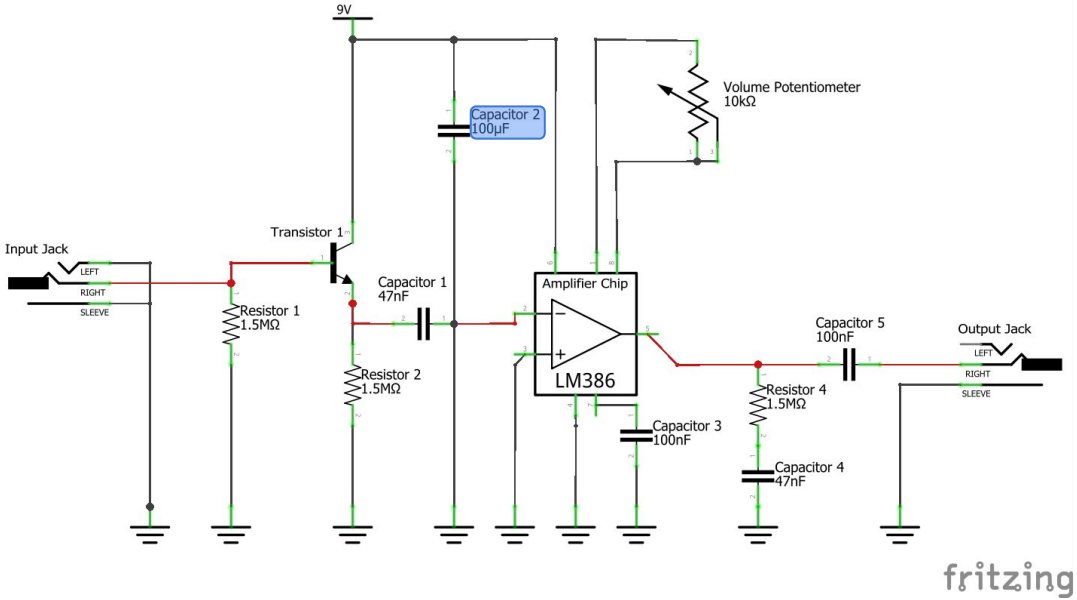


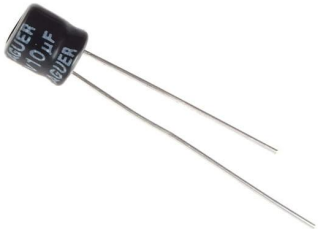
How do Capacitors come into this?

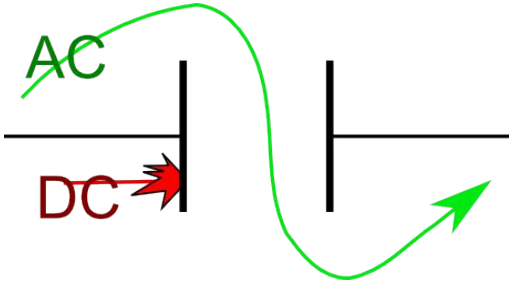
Capacitor 2

Capacitor 2 is a filter cap.

It reduces the buzz from the DC power supply by stopping the DC current from going through the insulator







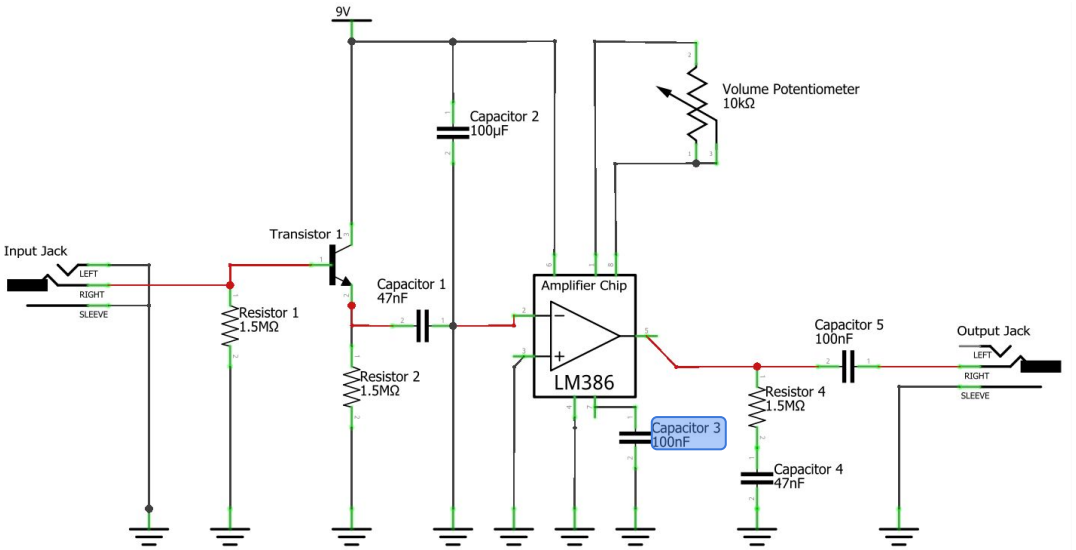
Capacitor AC/DC Diagram: audiojudgement.com
Capacitor: guitar-electronics.eu

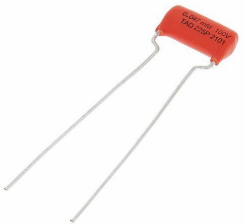
How do Capacitors come into this?

Capacitor 3

Capacitor 3 acts as a frequency filter.

By using a specific capacitance it allows frequencies above a certain level through to ground, and the rest gets blocked

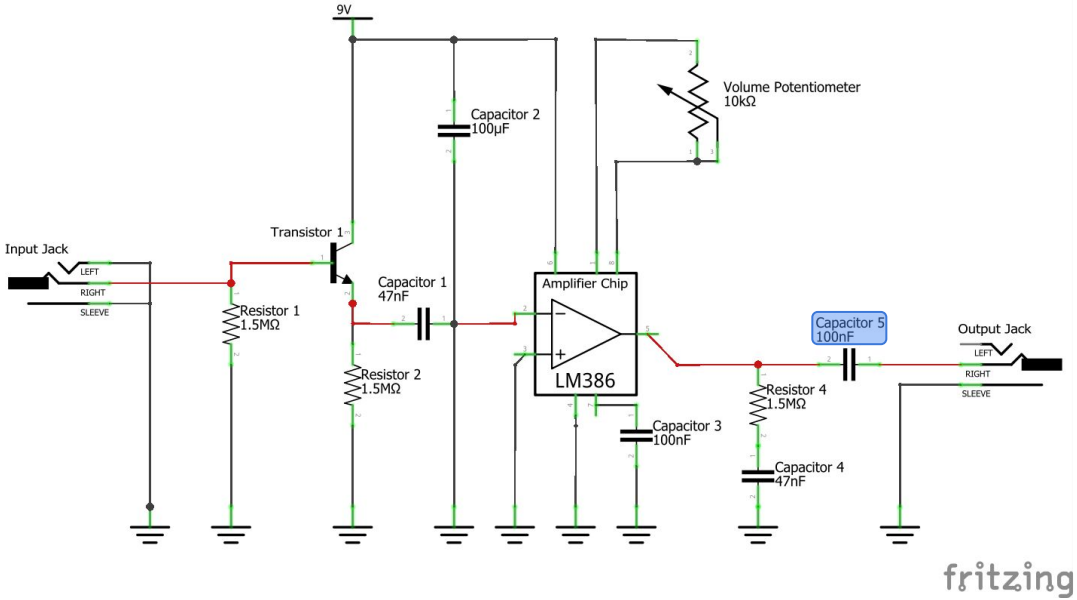


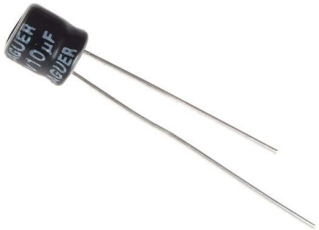


How do Capacitors come into this?

Capacitor 4

Cap 4 is part of what's known as a Zorbel Network – it cancels out the loss of current from the impedance of the speaker.



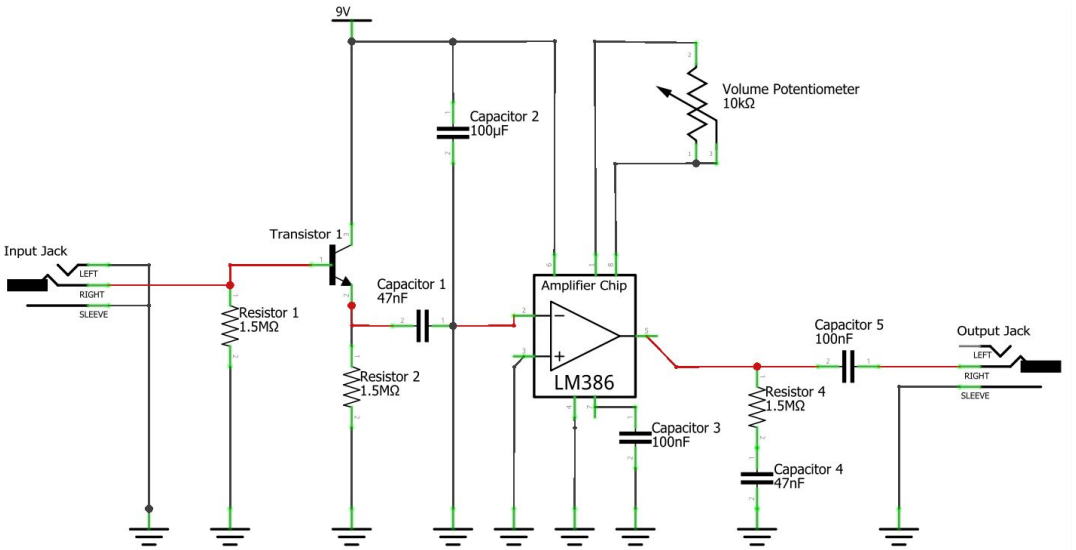


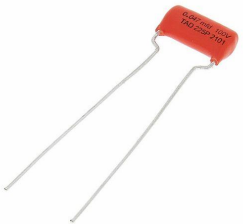
How do Capacitors come into this?

Capacitor 5

Capacitor 5 acts as a decoupling capacitor

This is very similar to cap 1 in that it removes DC current. This one acts as a last-step filter to protect the speakers from current from then DC power input in the chip





Capacitor: Thomann.de
Circuit Diagram: Made on Fritzing

Other Places Capacitors Are Used

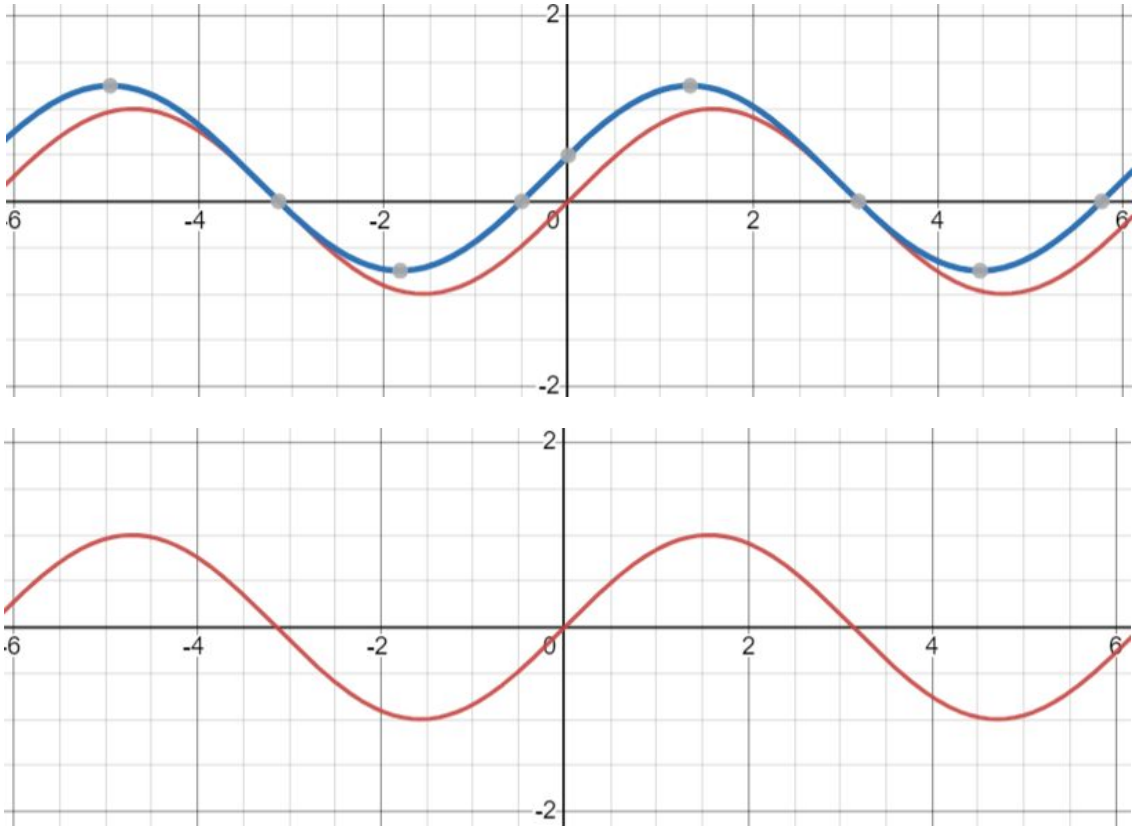
Guitars don’t just require an amp for them to sound good. Lots of other equipment is used to fine tune the sound of the guitar to make it interesting for whoever is listening, whether that be a light reverb on some acoustic guitar, or the crunchy, distorted chorus you’d hear on tracks from the likes of Nirvana or metallica.

These effects often are produced by boxes along the signal chain called “effects pedals”. They're controlled by the musician throughout performance and recording tracks.

All Images from Reverb.com

Chorus Pedals

A Chorus Pedal gives the signal a warmer feel, by creating copies of the wave and moving them slightly out of phase and pitch shifting them.



Images from Desmos.com

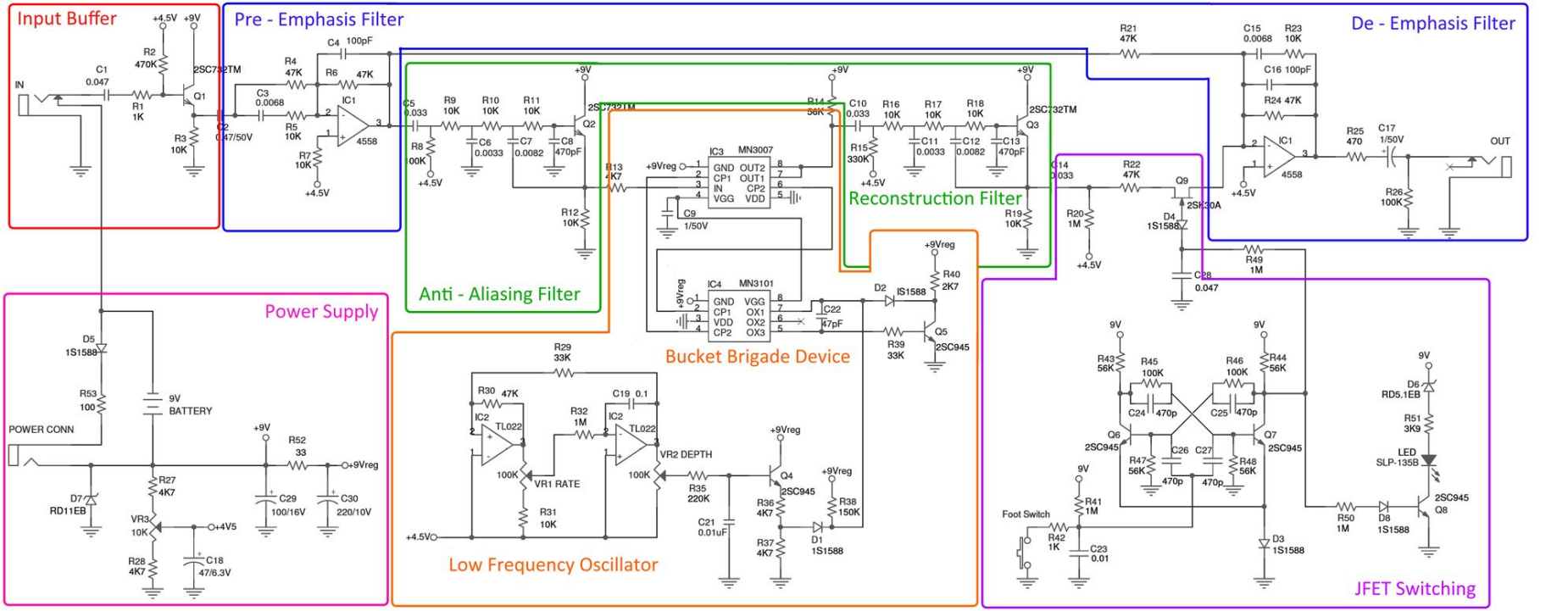
Capacitors in Chorus Pedal

Capacitors do much the same in the pedal as in the amp: It filters signals and blocks current.

The capacitors also perform another crucial role: Timing.

Because it takes time for a capacitor to “fill up”, it is used to create a clock signal to vary the tuning and phase difference

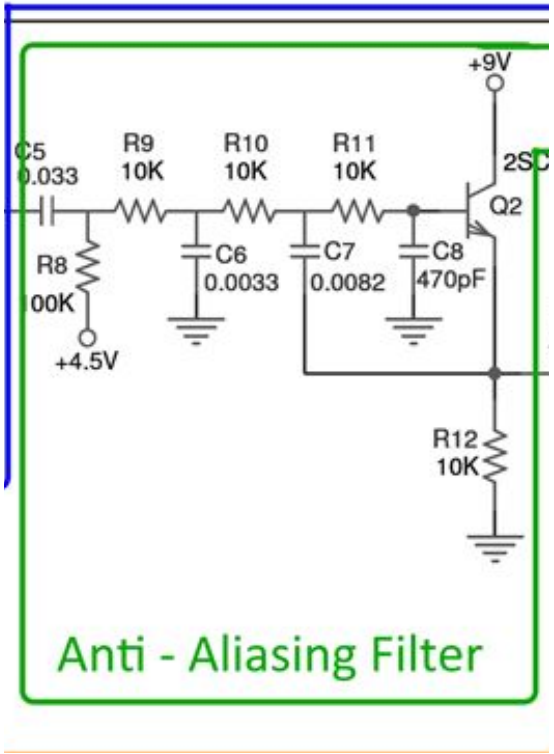
Chorus Diagram



Filters

Anti-Aliasing Filter:

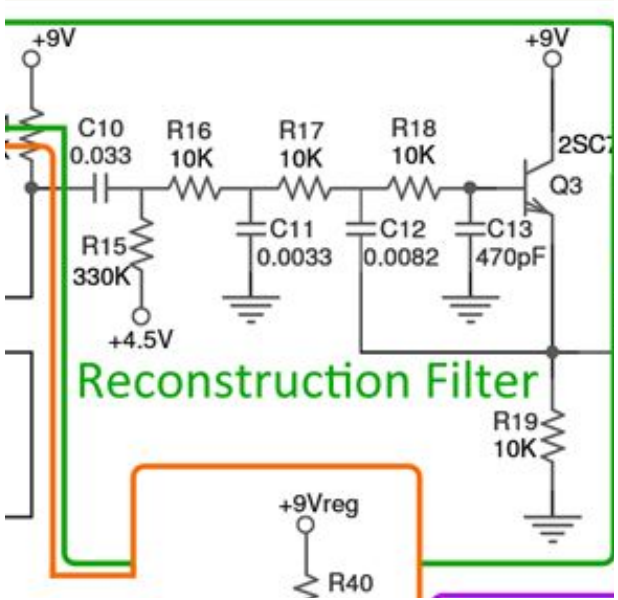
- The anti-aliasing filter is used to remove or reduce frequencies above the ‘Nyquist’ frequency before a signal is sampled.
- According to the Nyquist-Shannon sampling theorem, a continuous signal can be accurately represented in digital form if it is sampled at a rate that is at least twice the highest frequency present in the signal (known as the Nyquist frequency). If frequencies above the Nyquist frequency are not removed before sampling, they can cause aliasing.
- The anti-aliasing filter is a low-pass filter that attenuates (or removes) frequencies above the Nyquist frequency. This ensures that when the analog signal is sampled, no high-frequency components alias back into the frequency range of interest.



Filters Cont.

Reconstruction Filter:

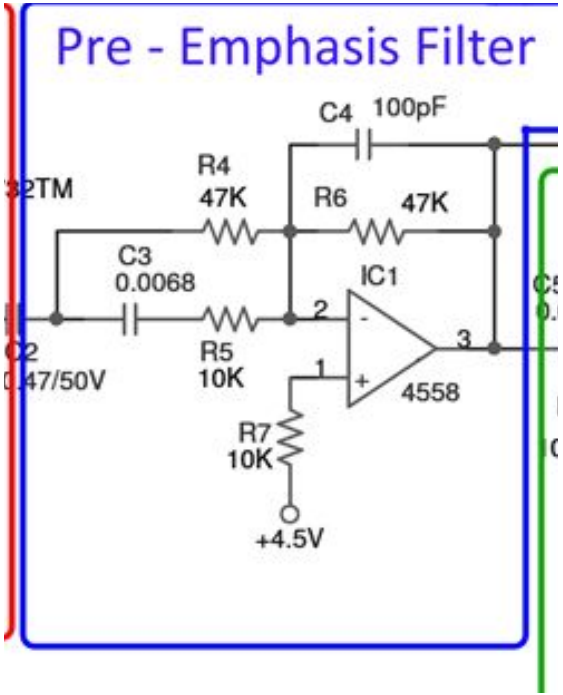
- The reconstruction filter is used to smooth out the stairstep-like output of a digital-to-analog converter (DAC) to reconstruct a continuous signal.
- Explanation: When a digital signal is converted back to analog form, the output is a series of discrete voltage levels (due to the finite resolution of digital representation). The reconstruction filter is a low-pass filter that smooths out these steps to reconstruct a continuous waveform.
- It allows the desired frequency components to pass through and attenuates high-frequency noise and artifacts introduced during the digital-to-analog conversion process.
- Without a reconstruction filter, the output of a DAC would contain unwanted high-frequency components (known as "images") that can distort the reconstructed analog signal.



Filters Cont.

Pre-emphasis Filter:

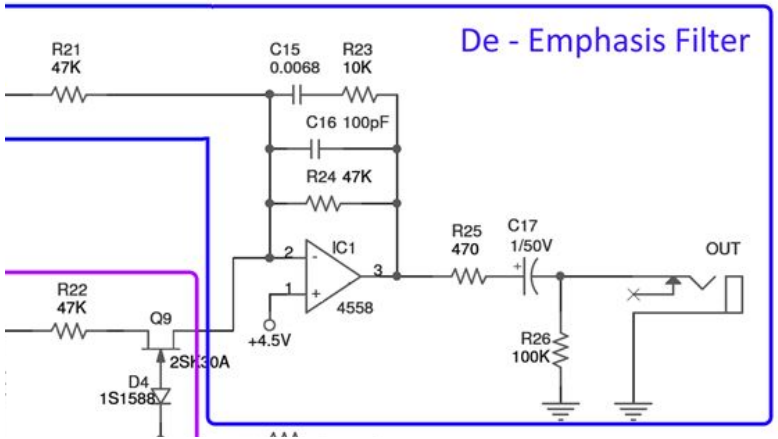
- The pre-emphasis filter is placed at the input stage of the chorus effect.
- It boosts certain frequencies in the input signal, typically the high frequencies.
- This boost helps in emphasizing specific tonal characteristics of the sound before it goes through the modulation process.
- By boosting the high frequencies, the pre-emphasis filter can enhance the clarity and definition of the modulated sound.



Filters Cont.

De-emphasis Filter:

- The de-emphasis filter is placed at the output stage of the chorus effect.
- It attenuates certain frequencies, usually the same frequencies that were boosted by the pre-emphasis filter.
- This process reverses the emphasis applied by the pre-emphasis filter, restoring the original frequency balance of the sound.
- The de-emphasis filter helps in preventing the modulated signal from sounding overly bright or harsh.

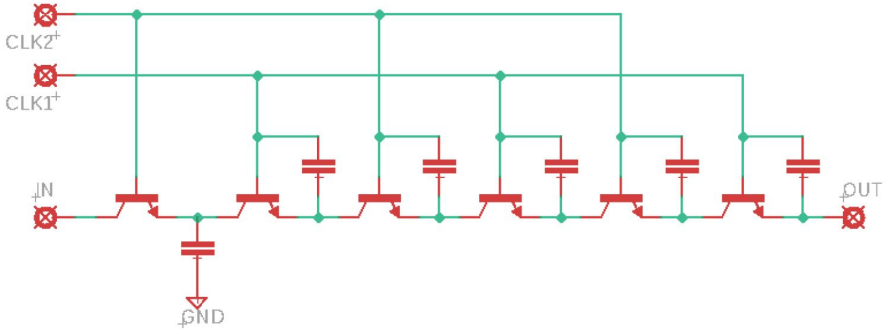


Bucket Brigade Device

This is a common circuit to find in timed effects

The name "Bucket Brigade" comes from the way the signal is passed along the chain of capacitors, similar to passing a bucket of water from one person to the next in a line.

The clock signals how fast the charge is passed from capacitor to capacitor



BBD: Anasounds.com

Thanks!

Info Sources:

Seymour Duncan *slide 4*

https://www.seymourduncan.com/

Rob Robinette *slides 5 - 10*

https://robrobinette.com/

Anasounds *slides 12, 13 & 19*

https://anasounds.com

ElectroSmash *slides 14 - 18*

https://www.electrosmash.com

Image Sources:

Reverb

https://reverb.com

Thomann Musical Instruments

https://thomann.de

Diagrams:

Made with **Fritzing**

https://fritzing.org/