A Fully Functional Audio FX Processor with Distortion and 6-Band Equalisation Compact Pedal Board STOMP BOX V6

(Adaptive Design Audio FX processor)

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ABSTRACT: *As we see that the world of music is a mixture of different trends and fashions the most popular of all is the ROCK culture and its fashion of music, the main element in this Rock music is the Distorted sound style of the guitar called as DISTORTION. This is nothing but an external effect layered to the sound of the guitar hence results in this Distortion which completely makes the Rock genre of Music.*

Due to the advancements in the technology these sound effects are being layered to the instruments Digitally though Digital audio processors – which are stored electronics sound designs saved and are externally layered to the Instrument through a digital interface. This problem is partially met through using keen and high-quality sound effects designs and they are integrated to the Digital processor which somehow convenes the users to adapt and start using them. The Stomp Box V6 is a strong solution to this problem which lies on opposite contrast to the Digital processors, Stomp box is a Analog pedal which is constructed in a standard procedure of building effect pedals, unlike the digital processors which include built in Sound design layers the Stomp box in built with a fully electrical circuit with the perfect audio processing techniques. It produces the best sound and a very quality depth in the Distortion effect which gives the musician the best performance and sound while playing. The output of the Stomp Box v6 is a clean Distortion sound with good quality without any feedback noises, clean filtered effect which sits exactly right on the original guitar signal without any overlapping or crunch.

Keywords: *Audio processing, Distortion, Equalisation, Analog pedal board, 6-band Equalisation, Analog potentiometers, Amplifier.*

OBJECTIVE:

Stomp Box v6 is a bundle of Audio processing FX controller with two important segments including Distortion effect and an Equalization section, it is mainly used for musical instruments such as Guitars where it can be connected and through the Stomp Box v6 we can add

- Distortion effect to the Guitar signal,
- Adjust or control the Bandwidth and Frequency

range of the Guitar audio signal and can be equalized according to the user's choice, This Equalization section consists of a 6-Band EQ channel where we can alter the Frequency range of the guitar signal in 6 diff channels and ranges and can be adjusted.

1. INTRODUCTION

Distortion effects in an electric guitar is an additional sound effect which is a modulation technique [1]. Such as Delay, Echo, Flagger, Phaser, Chorus, etc. where in the sound waves of the instruments are altered accordingly. The peaks of the sound waves generated by the guitar audio signal are compressed during distortion effect, which results in a procedure of adding more over tones to the system signal [2]. Over-driving of the tube appliers results in the production of the distorted guitar sounds, and hence the name gain is also given to the distortion effects which enable us to increase and decrease the distortion effect, this gain control is altered by deflection of the gain-potentiometer. Distortion effects are most commonly produced by effects pedal and processors, also known as the distortion pedal [3].which usually uses a digital embedded circuitry to modify the electric guitar signals such as clipping and harmonic multiplication and other wide range of audio processing modulations to result in a wide range of sounds [4]. Modifying of the waveforms are generally are termed as effects, in our cause termed as Distortion effect [5]. Which is usually associated with having a negative consequence. But, in the context of music and audio processing, distortion would refer to addition of newer frequencies or overtones by clipping of the amplifier circuits. Clipping is a non-linear process such that the sound waves which are clipped would have varied values of amplitude and hence the newer frequencies are added to the signal system which were not present originally [6]. There are two different ways to achieve the required clipping in an audio signal.

1. **Hard clipping and**
2. **Soft clipping [7].**

Hard clippings are Used to clip the peak values of the amplitude, to abruptly flatten out the waveform resulting in harsh sounding at higher amplitudes [8], while the soft clippings are used to flatten the peaks gradually taking care of not including the harshness in sound and hence the name [9]. The stereo speakers are technically designed manufactured differently due to their specific mode of application [10]. As compared to the guitar speakers and others may include usage such as loud sound bass boosters or as live stage monitoring and etc. The stereo speaker, including the public address speaker systems are required to produce the sound as clearly and sharp as possible, or in other words, with as little distortion as possible [11]. On the other hand, the guitar speakers would want to only highlight few specific ranges of frequencies to bring in the effects and the tone of the distortion of the electric guitar, by enhancing those frequencies while the other unwanted frequencies naturally generated or added by amplification of the audio signal are attenuated [12].As the power delivered to the guitar speaker system usually tends towards the maximum rated power of the system, interference of noise and other ambient signals and fading of the tones are observed [13]. A distortion pedal not only generates the effect but also circumvents these problems by the application of modifying the signal before it reaches the amplifier as the distortion, the circuit is placed before the main amplifier, hence subduing and fulfilling the job of a pre-amp [14].

As we have natural selection of similar substances, Distortion also has a similar effect called as overdrive [15]. People think both are similar but they are quite different from each other and render opposite output, the audio signal generated are pretty different and unique in their own effect processed [16].

Overdrive circuits are also used to obtain the distortion effects in an electric guitar. The overdrive circuits amplifies the signals to such an extent of a high level that they exceed the ordinary standard input signal amplitude. Overdriving of the amplifier, results in major clipping of the wave forms of the Guitar audio signal at the peak values and thus flattening them. The one main difference observed between the distortion circuit and the overdrive circuit is that, irrespective of the level of volume which is set, the distortion circuit clips, generates overtones as read from above and distorts the signal, whereas, the overdrive circuit gives clean sound for quieter volumes, and more harsh and cringy and distorted sound when set on higher volumes. Fig. 1, shows the classic distortion pedal, with the capabilities of reproducing the dynamics of playing and the performance, from soft to hard distortions, and level and tone control to tailor the overall sound and generate a good thick effect and a high-quality distortion is desired.

Fig 1: Existing Distortion pedal by Boss Referred from official Boss-website.

2. Boss DS1 Distortion System

The Boss DS1 circuit can be broken down into 5 big blocks: Input Stage, Transistor Booster, Op-Amp Gain Stage, Tone Control, Output Buffer and Power Supply .

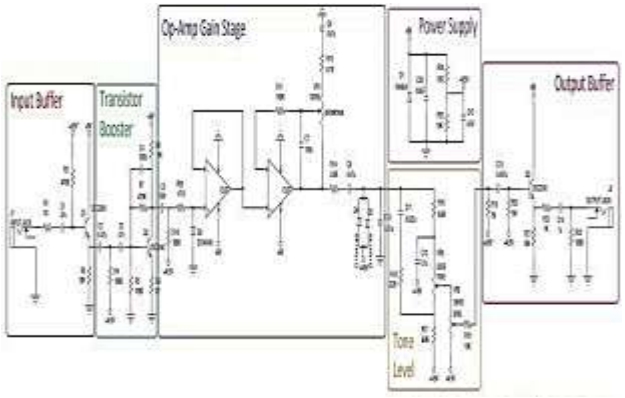


Fig 2. Boss DS-1 Distortion Pedal Circuit.

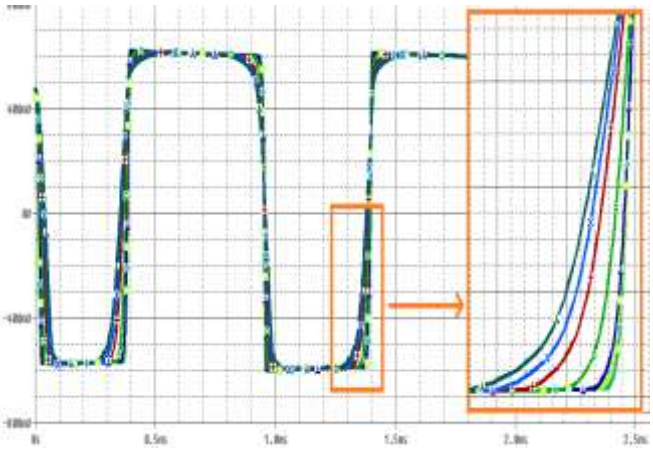


Fig 3. Boss DS-1 Distortion waveform after the op-amp stage

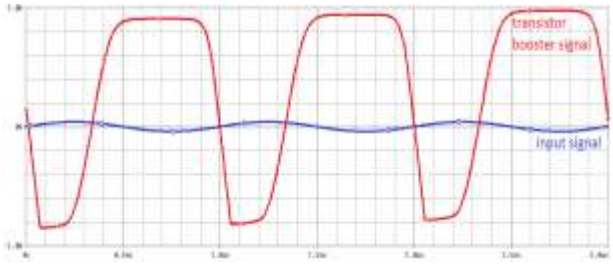


Fig 4. Boss DS-1 Distortion waveform after Transistor Booster stage

3. WORKING OF THE PRESENT SYSTEM

As we see the evolution of music from late 80s music to our brand new EDM culture of DJ- electronic music. but is we go back to the late authentic music culture of 80s the Rock and Jazz music were the revolutionary musical sensations and this genera of music was well known for introduction of the 'Distortion' in their compositions, Most of the guitar players were influenced by this great sound effect and started taking place in every song and live performances. The early massive concerts greatly gained the attentions towards this Distorted Guitar performances. They prefer to obtain this particular distortion sound effect by turning the power section pitch hard by setting the amplifiers at their peak levels. When the power section valves are driven to such an extent of high value ranges, setting the amplifiers at their peak levels, it renders the intensity of the volume rises considerably. This high intensity volume was difficult to manage in the place of recording and post production and studio sessions. An alternative solution was required to lower the volume without any changes on the distortion being produced in the guitar signal. Some alternative solutions figured out the option of diverting of the power valve section from the speaker in order to keep the volume within a low limit zone. Such diverting of the power valve from the speakers required the use of built-in or separate power attenuators and power-supply-based power attenuation in Realtime. These components would help to subside the effect of loud volume coming right out of the speakers. These components are used in a system called Voltage Variable Regulator (VVR), which intern drops the voltage across the valve's plates in order to reduce the volume while still maintaining and sustaining the same level of distortion. Another alternative method used to reduce the volume was the modular rack mount setup. The modular rack mount setup consists of a rack mount preamp, a rack mount valve power amplifier, and a rack mount dummy load which is used to attenuate the output to desired volume levels by the choice of the user.

The distortion pedal for an electric guitar was based on the following circuit diagram with the following components on the circuit board:

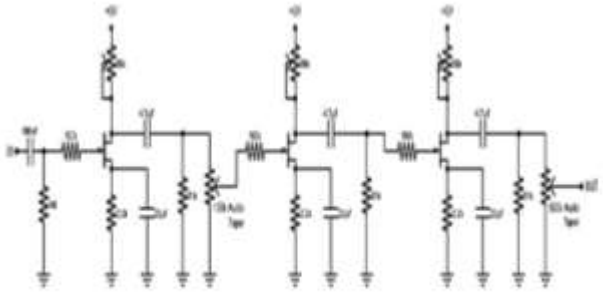
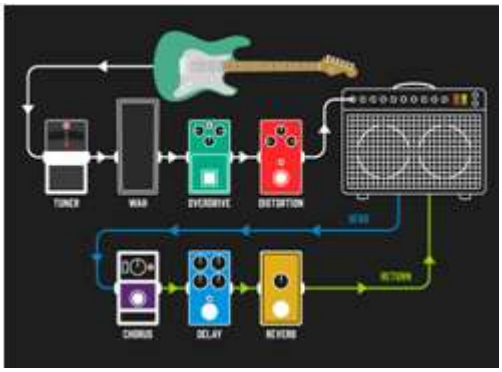


Fig 5. The basic stage of the distortion circuit (Photo courtesy: General Gadgets, JFET based distortion pedal).

4. Working Model Block Diagram:



Block Diagram: A guitar audio signal sent into different effect pedals is given into a Amplifier (sends and returns are mentioned between guitar to amplifier and Amplifier to other effects Pedals.

5. Components Used:

Resistors:

- R1 4M7 (4.7M) yellow-violet-green yellow-violet-black-yellow
- R2 2M2 (2.2 M) red-red-green red-red-black-yellow
- R3 none
- R4 1kbrown-black-red brown-black-black-brown
- R5 4k7 (4.7k) yellow-violet-red yellow-violet-black-brown
- R6 470k yellow-violet-yellow yellow-violet-black-orange
- R7 68kblue-gray-orange blue-grey-black-red
- R8 1M5 (1.5M) brown-green-green brown-green-black-yellow
- R9 4k7 (4.7k) yellow-violet-red yellow-violet-black-brown
- R10 6k8 (6.8k) blue-grey-red blue-grey-black-brown
- R11 22k red-red-orange red-red-black-red

- R12 1M5 (1.5M) brown-green-green brown-green-black-yellow
- R13 (R13T) 50k trimmer
- R14 500k Linear Potentiometer (Drive Control)
- R15 50k Linear Potentiometer (Tone Control)
- R16 100k Log Potentiometer (Volume Control)
- R17 1k brown-black-red brown-black-black-brown

Capacitors:

- C1 0.001µF Ceramic or Film 102 or 1n
- C2a 3.3µF Aluminium Electrolytic 3.3µF
- C2b 3.3µF Aluminium Electrolytic 3.3µF
- C3 10µF Aluminium Electrolytic 10µF
- C4 0.047µF Ceramic or Film 473
- C5 470pF Ceramic 471 or 470
- C6 470pF Ceramic 471 or 470
- C7 0.022µF Film 223
- C8a 10µF Aluminium Electrolytic 10µF
- C8b 0.1µF Film 104
- C9 0.001µF Ceramic or Film 102 or 1n
- C10 0.1µF Film 104
- C11 0.001µF Ceramic or Film 102 or 1n
- C12 0.0047µF Ceramic or Film 472 or 4n7
- C13a 500pF Ceramic 501 or 500
- C13b 30pF Ceramic 30

Potentiometers

- R13 50k Trimmer
- R14 (Drive) 500k linear
- R15 (Tone) 50k linear
- R16 (Volume) 100k log

Other:

- D1 1N914
- D2 12volt Zener
- Q1 BS170 MOSFET Transistor
- Q2 2N5457 (or J201) JFET Transistor
- J1 Stereo quarter-inch jack
- J2 Mono quarter-inch jack
- J3 DC Jack
- B1 9volt battery (not included in the Kit)
- Sw1 Heavy Duty 3PDT footswitch (bypass)
- Sw2 SPST or DPST mini toggle switch
- 9v battery snap, Printed Circuit Board, 24gauge stranded wire, knobs enclosure

The left most part of the circuit shown Fig. 5, is the input stage, this is followed by a 100K resistor, called as the input resistor which limits the forward gate current, protecting the JFET. Since, the JFETs are voltage-controlled devices, this has absolutely no impact on gain, like it would be in a BJT. The centre part of the circuit is the JFET (Junction Field effective transistor), on top of which is a50Ktrimpotentiometerwhich acts as a drain resistor. It sets the bias and gain. The analog potentiometer is a three-terminal resistor with a sliding contact that forms an adjustable voltage divider. Potentiometers is used for: 1) Volume controls on audio equipment. 2) Control the amplifier Gain and offset. 3)amount of Distortion applied on the system. And many other applications. Below the JFET is the 2.2K source resistor, it sets the gain along with drain resistor. Followed by the JFET at the centre of the circuit is a 4.7 µF coupling capacitor which is used to block the DC component of the JFETs output.

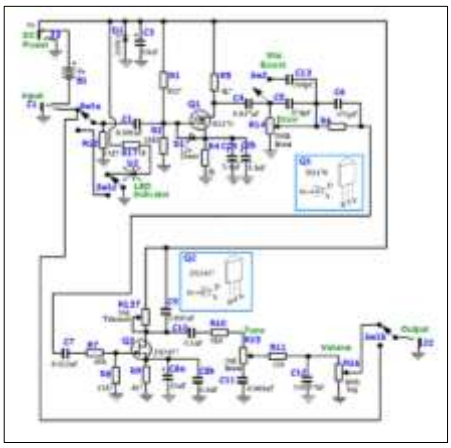


Fig 6.The basic stage of the circuit is cascaded to form a 3-stage distortion circuit to obtain the required tone.

This basic circuit is cascaded (input to output) in stages three times to for a 3 staged is to distortion circuit as show in the Fig. 6. The Fig. 7,8 shown above is the overall circuit with connection to the stereo jack. The battery shown is the 9V battery and the 9V potential is maintained on the overall top side of the circuit, whereas all the grounding of the circuit is shown by the earthing the (grounding) symbol. At the centre of the circuit is the 220 µF capacitor connected to boost the overall gain. The above shown Fig. 8 depicts a bypass switch which enables and disables the effect to pass through the audio signal which basically acts as a switch. The circuit consists of several fairly standard JFET common-source amplifier ‘‘stages’’ cascaded one after the other. JFETs work in depletion mode, in a manner very similar to vacuum tubes. Because of this, by carefully controlling the gain of each stage, asymmetrical, soft clipping can be achieved. Each stage inverts the signal it is fed, so if asymmetrical clipping is required, then cascading of the alternate high gain and low gain stages is required. The overall effect depends on the number of stages used. One stage adds a boost with a mild crunch when driven hard.

The Advantages based on Fig.6 are as follows:

- The analog potentiometers give a good hand on control on the gain, Distortion Level and Overall effect level
- Single stomp boxes are easy to move around within a pedalboard chain. For example: If you want compression before or after your drive pedals, it’s easy enough to change the order of

your pedals by physically swapping them around.

- Stomp boxes are easy to mount onto a pedalboard.
- The 'single-effect' nature of stomp boxes means that they do what they say on the tin, and you won't suffer from option-paralysis by having too much choice.
- There aren't any small, pesky screens to navigate. You can use the knobs available and your ears to find a sound you like with ease.

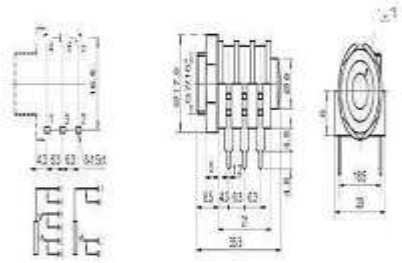


Fig 7. Circuit showing the connection to the stereo jack.

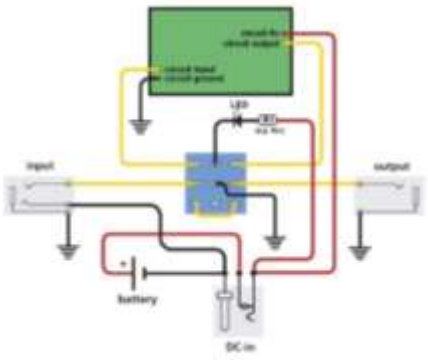


Fig 6. Circuit showing the connection of input and output channels of the pedal.

6. OBJECTIVES

To assemble and construct a varying gated distortion pedal for the electric guitar.

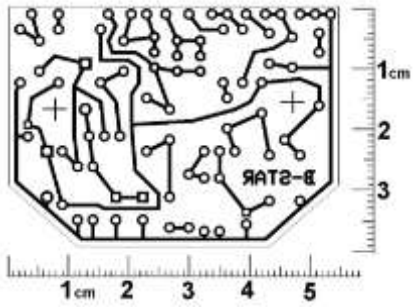


Fig 9. Circuit design for PCB manufacturing.

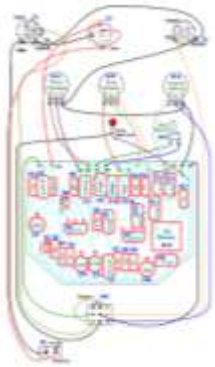


Fig 10. Circuit Design of the PCB in detail with all the Components wired

7. METHODOLOGY

1) Constructing the PCB using toner transfer method. Fig. 10 depicts the circuit design for the PCB manufacturing.

A. MAINTAINING THE INTEGRITY OF THE SPECIFICATIONS

• The Circuit Is Printed by a PCB printer store.

• Crop and align the dust and fingerprints on the board are removed with acetone. The layout is then cut and applied with the printed side on the board. If necessary, the layout is fixed with Scotch Tape.

• Ironing a linen cloth is put on the board. The layout on the board is ironed with circling movements and light pressure. Thereby the correct temperature is important. If it is too high, the toner becomes too liquid and the strip lines become blurred. If it is too low, the toner does not retain on the copper. So, maintaining of the correct temperature while ironing is of the utmost importance.

• Removing the paper

• After Fixing the PCB, all the components are soldiered into the PCB with respect to the Circuit diagram. All the components are carefully solider into the PCB board and all the extra length of the components are removed with a cutter.

• **Earthing** – once all the components are fixed into the Iron case since earthing is requires the earth terminal is attached to the body case, which is the iron chase and is covered with a rubber sleeve to the edge.

• All the potentiometers are fixed with upper screws and covered on top with Potentiometer heads which give a smooth toggle operation.

• The chase of the case is attached with a glue to the sides to insulate any electrical contact with components and touch of users and is completely fitted in and fixed with screws.

Fig 11. Before casing and fixing PCB, Components include resistors, capacitors, input output jacks, Potentiometers and toggle switches

8. RESULTS

1.Hencewe have observed the Distortion pedal constructed and in Fig 12,13. We can observe the frequency response and output generated by the pedal. The stomp Box V6 had rendered great quality and perfect sharp frequency response and Distorted effect and hence can be notified that it performed better and more detailed than the Digital Audio processors.

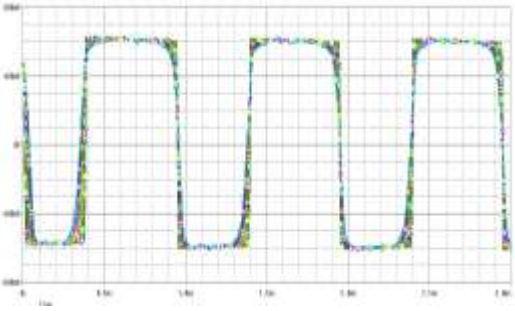
2. In fig 14. We can see the fully constructed stomp Box v6 and in fig we can observe the wave form in the oscilloscope and the wave form response generated by the Output Distortion pedal.

3. To minimize the noise level during distortion a certain threshold level is set as shown in the Fig. 19, and the circuit on the bread board clips the original signal to obtain hard clipping within the threshold region.

4. By varying the potentiometer the threshold levels can be varied.

5. It is economically inexpensive as compared to a full effects pedal board.

6. Maintenance, repair, and debugging of such a circuit is easy because the circuitry is simple, as compared to the circuitry of a full effects pedal board.



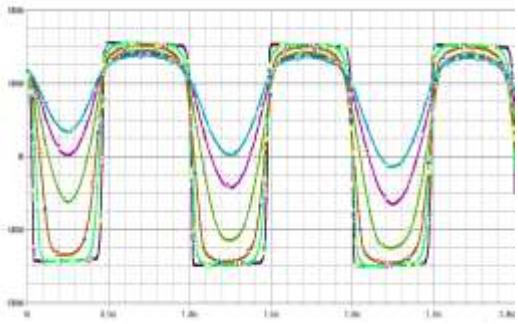


Fig 12. Distortion on Stomp Box V6 at R = 1k,22kohms

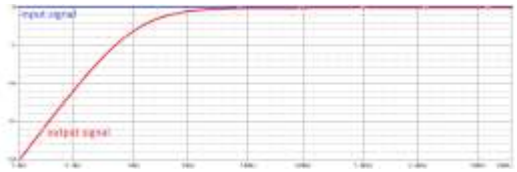


Fig 13. Distortion Input Buffer Frequency Response

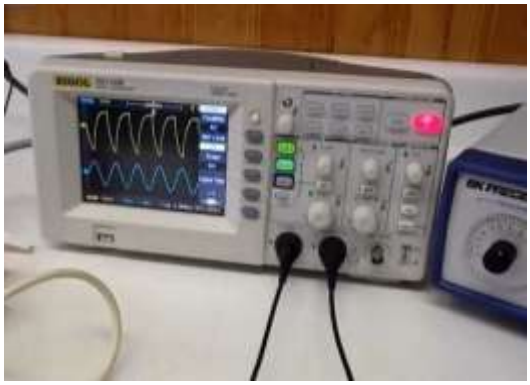


Fig 14. Distortion Input waveform using CRO, Output hard clipped waveform

Fig 15. Distortion Effects Pedal after assembling and testing Stomp Box V6 (photo captured while making PC – self)

Fig 15. Distortion Effects Pedal after assembling and testing Stomp Box V6 (photo captured while making PC – self)

9. CONCLUSION

In this paper, a distortion pedal with a variable gating effect has been described in detail. Available gating distortion effects pedal has the distinct advantage of being able to completely replace a full effects pedal board with a compact device. A full effects pedal board is expensive and heavy, whereas available gating distortion pedal is compact and light, because of the use of general components like the standard electronic integrated components its reliable and has better life in performance and also into further upgradations.

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