

**DESIGN AND DEVELOPMENT A GADGET OF MULTI EFFECT
FOR MUSICAL INSTRUMNET**

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This Report Is Submitted In Partial Fulfillment of Requirements for the Bachelor
Degree Of Electronic Engineering (Industrial Electronic)

**Faculty of Electronics and Computer Engineering
Universiti Teknikal Malaysia Melaka**

MAY 2007



UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : Design and Development a Gadget of Multi Effect for Musical Instrument

Sesi Pengajian : 2006/2007

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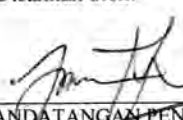
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ACKNOWLEDGEMENT

I would like to extend my sincere gratitude to my supervisor, Pn. Maisarah bt. Abu for her assistance and guidance towards the progress of this thesis project. Throughout the year, Pn. Maisarah has been patiently monitoring my progress and guided me in the right direction and offering encouragement. Obviously the progress I had now will be uncertain without her assistance. Special thanks must also to all the lecturer of Faculty of Electronics and Computer Engineering for his/her advice and help on the software/hardware development.

ABSTRACT

Every guitarist has an intuitive sense as to where basic effects should go in their signal chain. If they have two pedals, a distortion unit and a digital delay, it would naturally put the distortion before the delay and the guitar goes into the distortion, the distortion into the delay, and the delay into the amp. But the more pedals you use, the trickier it gets. The purpose of this multi-effect is to provide a convenient way for a musician to instantaneously change the sound of his instrument without a stoppage in play according to the stored sound set before the play. The unit rests on the floor and the effect can be activated or bypassed via a 'footswitch', a durable switch the user steps on to activate. Overall, through all the design of this multi-effect, the main key of manipulates the electronic study is to create an effect gadget that will boost up the quality in type of sound produced and convenient to the guitarist.

ABSTRAK

Setiap pemain gitar berkeinginan mempunyai rangkaian efek-efek gitar dan kesemuanya rangkaian efek-efek gitar itu dirangkumkan dalam satu rangkaian sahaja. Contohnya, apabila mereka mempunyai 2 injak, satu herotan dan satu lengah digital, secara semulajadi pemain gitar tersebut akan menyambungkan herotan sebelum lengah dan gitar disambungkan pada herotan, herotan tersebut pula akan disambungkan pada lengah dan lengah disambungkan pada penguat. Tetapi apabila banyak injak digunakan, semakin merumitkan keadaan. Tujuan multi-efek adalah untuk keselesaan kepada pemain gitar untuk menukar serta-merta bunyi dari gitar tanpa memberhentikan permainan ketika sedang merekod. Multi-efek tersebut senang digunakan memandangkan ianya terletak di atas lantai dan diaktifkan menggunakan suis kaki. Secara keseluruhannya, untuk mereka efek ini adalah kunci kepada kecenderungan untuk mempelajari kesan-kesan elektronik di dalam membentuk kualiti kepada penghasilan bunyi dan memudahkan penggunaannya kepada pemain gitar.

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LIST OF ABBREVIATIONS

EQ – Equalizer
IC – Integrated circuit
DPDT - Double Pole Double Throw
PCB – Printed Circuit Board
CD – Compact Disc
DSP – Digital Signal Processing
LED – Light Emitting Diode

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CHAPTER I

INTRODUCTION

1.1 Introduction of the Project

The use of electronics to manipulate signals produced by electrical stringed instruments is presently becoming more and more popular among musicians. ‘Effects’ as they are called in the music industry, alter audio signals in different ways and can come in various shapes and sizes from simple stomp boxes to intricate digital processors. In this project, the use of electronic study to manipulate the signal waveform from musical instrument (guitar) into several types of effect sounds that come out from guitar amplifiers is the main reference for how this project will progress. Guitar effects are electronic devices that modify the tone, pitch, or sound of an electric guitar. Effects can be housed in effects pedals, guitar amplifiers, guitar amplifier simulation software, and rack mount preamplifiers or processors. Electronic effects and signal processing form an important part of the electric guitar tone used in many genres, such as rock, pop, blues, and metal. Guitar effects are also used with other instruments in rock, pop, blues, and metal, such as electronic keyboards or electric bass.

For more details on how a multi-effect connection between guitar and amplifier, Figure 1.1 shows how this multi-effect will connect between guitar and amplifier as a signal processor for guitar sound before it goes into amplifier as an output.

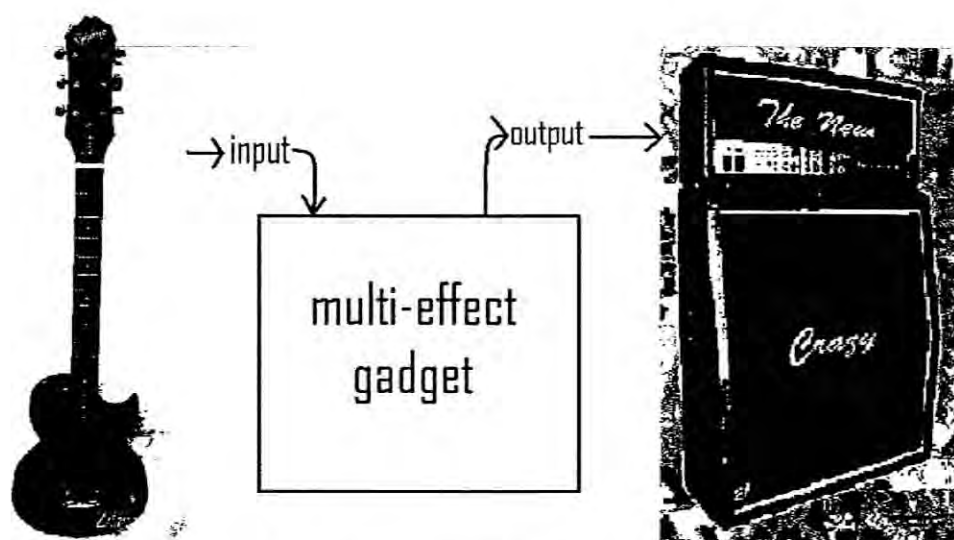


Figure 1.1: The Usage of Multi-effect Gadget

Anything that can affect the sound of a guitar can be considered a guitar effect. Most effects start with the volume and tone controls of your guitar. There are many guitars that now feature active EQ, split coil switches, phase switches, and even MIDI output. The types of pickups and electronics used also very much effect the sound of your guitar.

1.1.1 Kinds of Effects

Effects are usually based on some facet of the human ear's abilities to figure out from amplitude and frequency content variations what a sound source is doing. This was critical when the sound source might be a saber toothed tiger. Now it is a means to express ourselves musically by directly invoking emotion. Where are the examples of effect that used to produce difference sound in guitar.

1.1.1.1 Amplitude Based Effects

These types of effect operate based on the instantaneous loudness of the signal, how it changes, and how quickly it changes. There are:

- i. Volume control
- ii. Tremolo
- iii. Auto tremolo
- iv. Panning/ping-pong
- v. Gating/repeat percussion
- vi. Compression
- vii. Expansion
- viii. Asymmetric comparator / peak comparator
- ix. Noise gating
- x. Attack delay
- xi. Limiting
- xii. Auto swell

1.1.1.2 Waveform Distortion Effects

Generating the distortion type of effect basically base on manipulating the clean signal (sine wave) that produced by guitar by employing this kind of electronic principle such as:

- i. Symmetrical clipping
- ii. Asymmetrical clipping
- iii. Infinite limiting
- iv. Half wave rectification
- v. Full wave rectification
- vi. Arbitrary waveform generation

1.1.1.3 Filter/Frequency Response Effects

The function of this type of effect is to control the frequency and reduce noise that come from the other unwanted sound that had been produced. These types of effect are:

- i. EQ/tone controls
- ii. Treble/mid/bass boost
- iii. Cabinet simulation
- iv. Resonator
- v. Wah
- vi. Auto wah
- vii. Tremolo-wah
- viii. "vibrato"
- ix. Phase shifting

1.1.1.4 Time Delay Effects

A variety of time delay effects are implemented using variable-length delay lines principle which will produced this kind of effect such as:

- i. Reverb
- ii. Echo
- iii. True vibrato
- iv. Flanging
- v. Chorus
- vi. Slap back echo
- vii. Reverse echo/reverb
- viii. Sampling

1.1.1.5 Other Miscellaneous Effects

Beside of those effect that uses the electronic principle, other miscellaneous effects also can be generate by manipulating several audio principle study which basically can be observe by manipulating audio component and applying audio technique that will produced effect such as:

- i. Octave division (octave down)
- ii. Harmony generation
- iii. Phase lock tracking
- iv. Noise addition
- v. Talk box
- vi. Voice tracking (vocoder)
- vii. Ring modulation

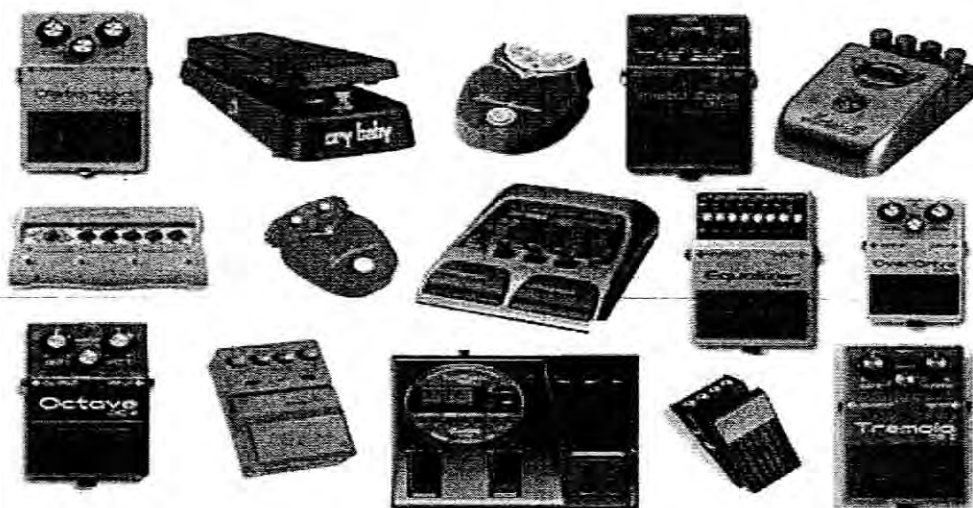


Figure 1.2: Examples of Guitar Effect

Figure 1.2 shows several effect that have been produced using basic electronic and audio principle which have become popular among nowadays musician and also has help most musician to overpowering their creativity on musical performance and music composition. These guitar effects come separately which have various function and produced different type of guitar signal.

1.2 Project Objectives

The purpose of this multi-effect is to provide a convenient way for a musician to instantaneously change the sound of his instrument without a stoppage in play according to the stored sound set before the play. The unit rests on the floor and the effect can be activated or bypassed via a 'footswitch', a durable switch the user steps on to activate. A typical effect has the following features: ¼" input/output plugs, a switch to enable or bypass the effect, and various control knobs. Most effect is either powered by a single 9V battery or an optional AC adapter. So in this project, to design the multi-effect some of this requirement will be notice as a reference. Overall, through all the design of this multi-effect, the main key of manipulates the electronic study is to create an effect gadget that will boost up the quality in type of sound produced.

- i. To design each type of effect including distortion effect, ring modulator effect, tremolo effect and EQ/Tone control circuit which to be develop into a multi-effect circuit.
- ii. To develop and combines those effect types based on electronic theory related to audio signal processing into a gadget of guitar multi-effect.
- iii. So, in this project, along with to design the multi-effect, the noise reduction method will be implemented so the noise that comes out from guitar can be control close into it original range. Noise reduction is the process of removing noise from a signal.

1.3 Scope of Project

In designing and developing this project, the type of signal processing such as amplitude based effect; waveform distortion effect, filter/frequency response effect and time delay effect are to be use as major reference in expecting the result. Working with these signal processing method will be tested firstly by do a simulation on each method and relate it with basic theory of electronic principle also the audio engineering principle which closely bring audio and electronic together in producing expected resulting in varieties of sound by stringed instrument. Some basic circuit that commonly use in audio signal processing are:

1. **Full Wave Rectifier, Common Source MOSFET and JFET, Symmetrical/Asymmetrical Clipping** - generates distortion and overdrive type of effect in basic guitar effect. Commonly an OP amp use by emulating ideal diode produces a full wave signal.
2. **Time Delay** - adjusting time by delaying signal waveform normally in range of maximum 5000ms duration. Some types of effect are reverb, flanger, chorus and vibrato.
3. **Signal/Amplitude Modulation** - tremolo, noise gating and volume control for each type of effect produce in this gadget.
4. **Filter/Frequency Response** - generates equalization and control (Low, Mid, High), phase shifting, resonator and wah type of effect.

Designing the switching system which functionally enable guitarist manually switch from one effect to another effect during live performance. In designing this interference it uses:

1. **Double Pole Double Throw switches** use as gadget footswitch. Also act as _____ switch to turn on the selected effect by guitarist.

Figure 1.3 describes a layout of this multi-effect which shows the switching method using DPDT switches:

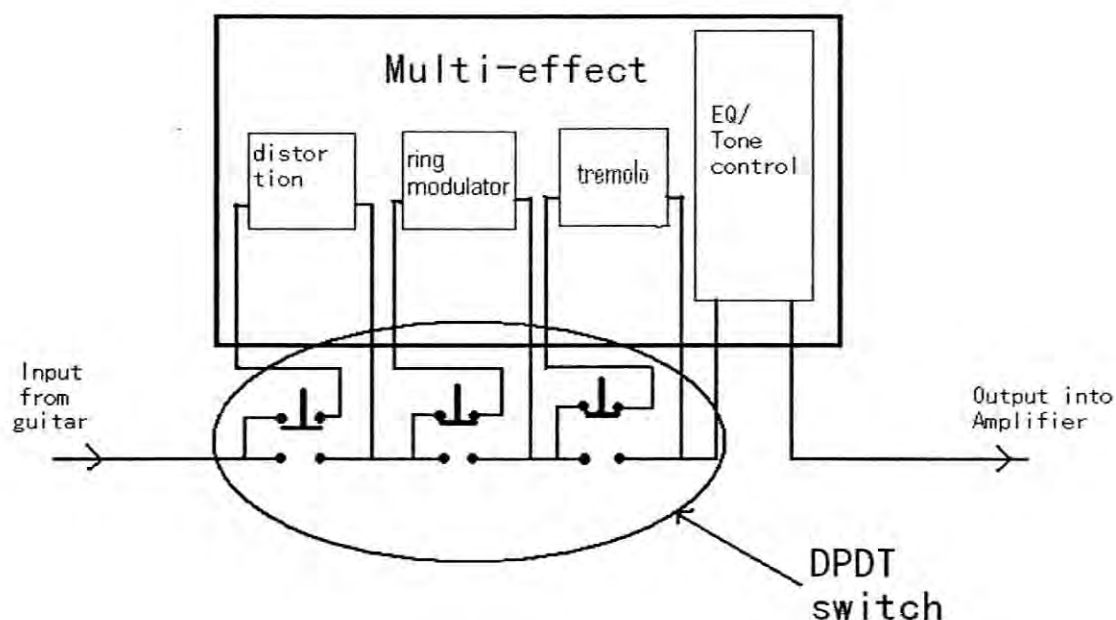


Figure 1.3: Multi-effect by Using DPDT Switches

All of these circuits will be Simulate using **Multisim** determine the expected output waveform signal. Performing Simulation task will be separate according to each or what types of effect are produced. Designing each of relates effect circuit and combines them together in a gadget by using control switches. Enable each effect to be mix or separate in waveform signal form signal processing.

1.4 Problem Statement

State by the author of *Guitar Effect Pedal*, Dave Hunter, most of multi-effect that in market today are quite expensive to buy, so in this project analog audio signal processing still be use because it quite cheaper and can produce original sound that what musician really need to delivered from their guitar. In case that some guitarist are in passion to produce unique and variety of sound in their music composition, they need to afford each of the effect pedal such as distortion, delay, chorus and wah separately together and this are quite expensive to afford.

Digital Projects for Musician's author Craig Anderton also discuss in his book that, most of the guitarist concern during creating and searching for the sound that they really want is the lack of store rage in their effect. Beside ordinary effect does not have memory to store their selected sound? During live performance, this is the major factor for them to give the best performance. If they could have an effect that can store their sound so during live performance it is the best way for them. Craig Anderton also state in his book, *Do-It Yourself for Guitarist* that in audio engineering field the most common problem is to reduce noise that comes out from signal processing gadget. In case that is an electric guitar can produce sound as low as 40 Hz and up to 6 or 8 kHz, the major concern in producing guitar effect is to maintain this signal in producing the original clean frequency as low as 40Hz. That why the noise reduction functions is considerable as the solution of this problem.