Cristóvão Diniz Trevisan, Victor Volochtchuk de Araujo

Guitar Digitalizer

Brazil

2017, v-0.0.1

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Guitar Digitalizer

Project presented as graduation material for the course of Electronic Engineering at UTFPR

Federal University of Technology - Paraná – UTFPR

Electronic Engineering

Graduation Program

Supervisor: Gustavo Benvenutti Borba

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Cristóvão Diniz Trevisan, Victor Volochtchuk de Araujo
Guitar Digitalizer/ Cristóvão Diniz Trevisan, Victor Volochtchuk de Araujo. – Brazil, 2017, v-0.0.1-
31 p. : il.

Supervisor: Gustavo Benvenutti Borba

Graduation Final Project – Federal University of Technology - Paraná – UTFPR
Electronic Engineering
Graduation Program, 2017, v-0.0.1.

1. Hexaphonic Guitar 2. Digitalizer 3. MIDI 4. Pitch Detection I. Guitar Digitalizer II. Gustavo Benvenutti BorbaIII. Federal University of Technology - Paraná IV. Electronic Engineering

CDU 02:141:005.7

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Project Approved. Brazil, October 8, 2017:

Gustavo Benvenutti Borba
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Invited 1

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Professor
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Brazil
2017, v-0.0.1

This work is dedicated to those who supported our way into through enginnering course, even more when ourselfs tried to give up.

Acknowledgements

We give our special thanks to Eng. Mikhail Anatholy Koslowski, who gave us both intellectual (since he once used an equipament with the same purposed) and physical support (with compenents importation and equipaments). Also to our advisor who was present even in the moment that the initial idea came to life, in a situation nobody else would have stayed.

Abstract

Guitar are one of most popular instruments today, but there is one big disadvantage to use it: there is no good and affordable way to digitalize it's music. The biggest problem with this is the cost to annotate music, as it needs to be done by manually. This project tries to build one such system, building from passive hardware (hexaphonic pickup) to modern signal processing (pitch detection), attempting to produce a cheap and effective equipement for guitar music annotation by means of generating MIDI format data.

Key-words: guitar. digitalizer. MIDI. pitch. detection. hexaphonic.

Resumo

Violões e guitarras estão entre os instrumentos mais populares da atualidade, mas existe uma grande desvantagem em os utilizar: não há um meio barato e eficaz para digitalizar sua música. O grande problema com isso é o alto custo para transcrever partituras, que atualmente é um processo manual. Esse projeto tenta construir um sistema com esse propósito, criando desde sensores passivos (captador hexafonico) até processamento digital de sinais moderno (detecção de nota), visando um produto barato e eficaz para anotação musical através da geração de dados no format MIDI.

Key-words: guitarra. digitalizador. MIDI. nota. detecção. hexafonico.

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List of abbreviations and acronyms

MIDI	Musical Instrument Digital Interface

List of symbols

Ω	Ohm resistance unit

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Introduction

Este documento e seu código-fonte são exemplos de referência de uso da classe abntex2 e do pacote abntex2cite. O documento exemplifica a elaboração de trabalho acadêmico (tese, dissertação e outros do gênero) produzido conforme a ABNT NBR 14724:2011 *Informação e documentação - Trabalhos acadêmicos - Apresentação*.

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Equipe abnTEX2

Lauro César Araujo

[1] <http://www.latex-project.org/lppl.txt>

Part I

Hardware

1 Hardware

1.1 Initial Idea

The project started with the idea of assembly a system which should capture de guitar sound and change the sound to any another instrument. The system should be competitive with other existent devices.
To reach this objective it was verified the features which the project should reach and the methods necessaries to perform the desired actions.

1.2 Pickup Project

After some studies it was decided to assembly a hexaphonic pickup instead buy one already manufactured, which is an expansive device. To reduce the cost of the project it was projected and printed the pickup base on 3D printer as the project showed on figure 1.

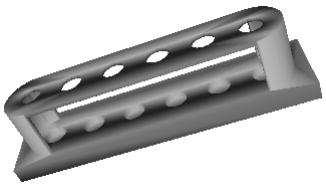

Figure 1 – Pickup Base

After print the pickup base it was assembled the coils, composed by guitar magnets and copper iron (150 revolutions for each magnet), responsible for the transformation of the mechanic vibration of the string to the electric signal which is needed.

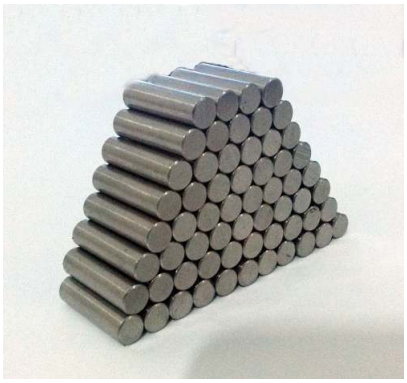

Figure 2 – Magnets

With the pickup already assembled it was verified the output signal. This signal pick was about 0.5 mV and ths value was so weak to send to the Analogic-digital converter present on the microprocessor. With this dungeon it was verified that it is needed a circuit responsible for the signal amplification to be possible to read the signal with quality on the microprocessor.

1.3 Amplifier Circuits

It was researched some types of amplifiers circuits, it was selected the circuits with single supply, because the project was designed to be the maximum embedded on the guitar, without the needing of other supplies except the guitar battery or the USB connection of the microprocessor. After some researches it was decided try two circuit types, with two different operational amplifiers. The first circuit uses the Texas Instruments INA 326 Instrumental Amplifier and the second uses the Texa Instruments TLV 4316 Operational Amplifier.

1.3.1 INA 326

To project the circuit using the INA 326 IC, it was researched the datasheet and it was verified one circuit which provides the desired Gain to the electric signal from the pickup respecting the project's initial requests. The circuit is shown on figure 3.

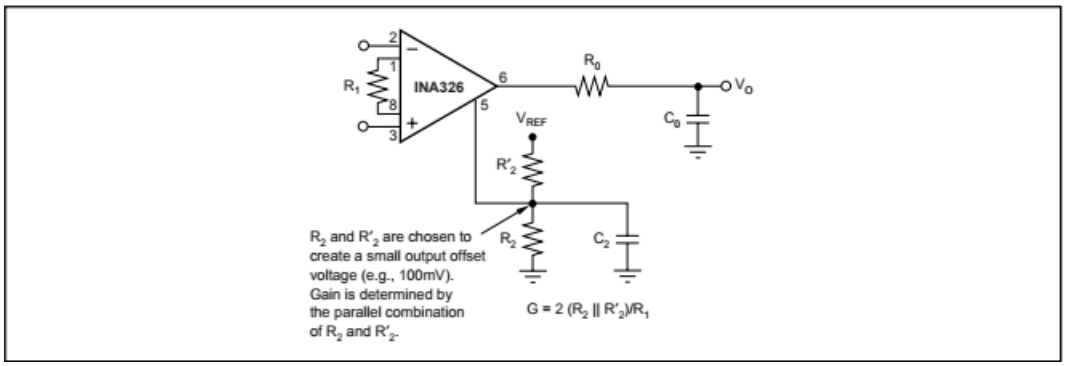

Figure 3 – Amplifier assembly

This circuit amplifies the signal and the gain is obtained by the following equation:

$$G = 2 * \frac{(R_2||R_2')}{R_1}$$

On the project the Resistor R_0 and the Capacitor C_0 was excluded because it was not relevant on the output to this project. After the research it was developed a schematic model to perform some simulation tests to verify and prove the functionalism of the circuit

for the desired application. The schematic circuit it was developed using the software CadSoft Eagle Professional 7.6.0 until the version showed at figure 4.

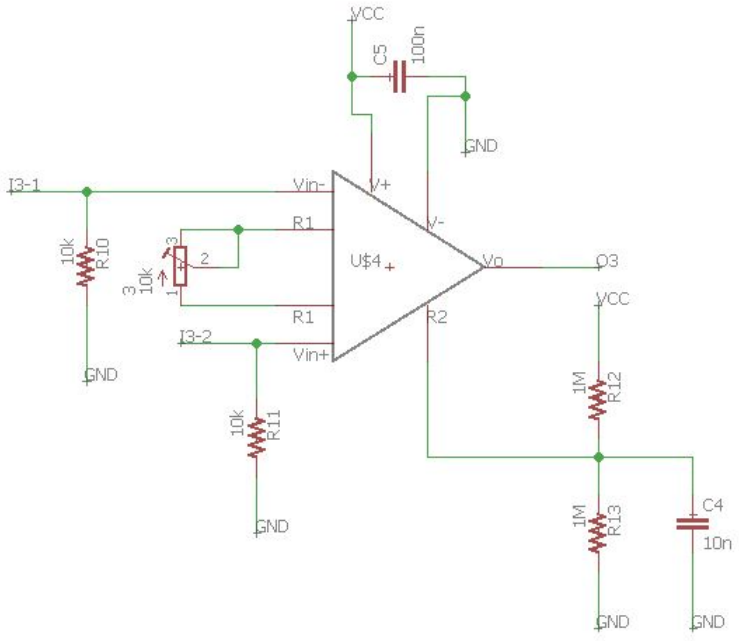

Figure 4 – Schematic for each channel

This circuit as showed on the image provides a Gain of:

$$G = 2 * \frac{(1M\Omega||1M\Omega)}{10k\Omega}$$

$$G = 2 * \frac{500k\Omega}{10k\Omega}$$

$$G = 2 * 50$$

$$G = 100$$

The amplifier circuit was projected to each channel. So the circuit needed 6 IC INA 326 to be complete. The complete schematic is showed on annex 1. After project the schematic circuit to each channel it was developed the PCB project, using the same software described on the schematic modelling. The PCI project is showed on figure 5.

This PCB project was projected on a dual layer board scheme, using 15 mils of minimum width for the conductive tracks. It was assembled on FR4 dual layer copper board, combining the through-hole and surface-mount technologies. This choice was made due the facility of the assembly of the through-hole components. It was sent the files to one person who works with printing PCB boards. After the processes the PCB was like figure 6.

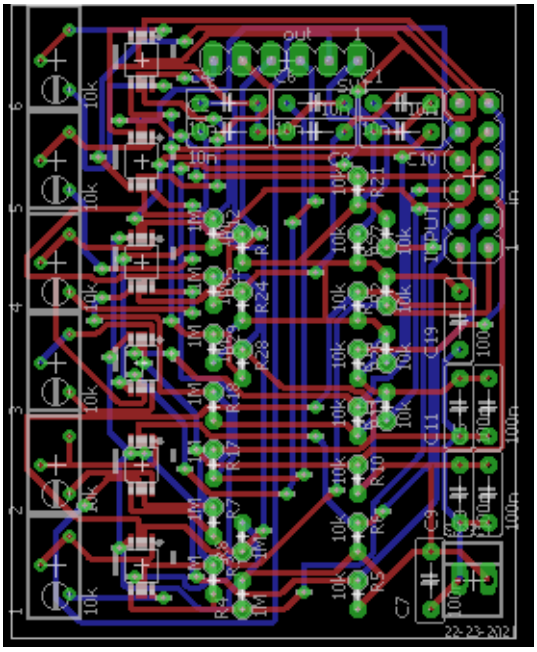

Figure 5 – PCB Project

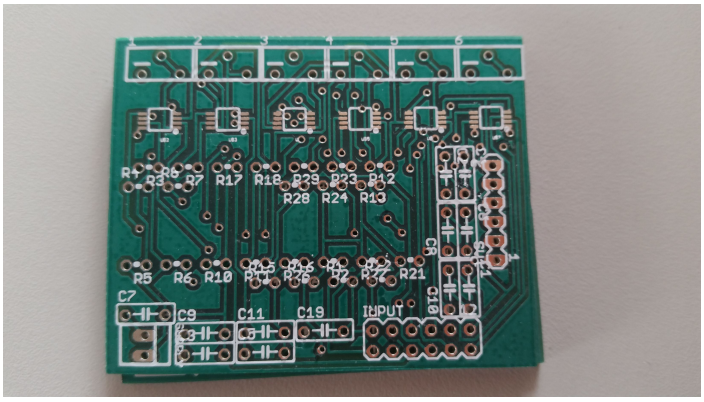

Figure 6 – PCB Project

On this project it was used:

- 6 Instrumental Amplifiers INA 326;
- 6 10kΩ Trimmer Potentiometer;
- 6 10nF Ceramic Capacitor;
- 6 100nF x 50V Electrolitic Capacitor;
- 12 10kΩ 5 Percent Tolerance Resistor;
- 12 1MΩ 5 Percent Tolerance Resistor;
- 1 6 positions Pin bar;

- 1 12 positions dual track Pin bar;
- 1 2 positions Pin bar;

After soldering all the components it was performed some bench tests to verify the functionality of the amplifier circuit. The result showed us that the circuit attends the required function, amplifying the signal from a pick of 10mV to a pick of 1V, proving that the circuit is working perfectly and attending the demand of the project. After the bench test the system was connected to the pickup to verify if the guitar signal would be amplified as needed to the conversion process. The result was satisfactory and attended well the purpose to the project, as showed on image 6.

Figure 7 – INA Project Result

1.3.2 TLV 4316

Part II

Firmware

Part III

Software

Part IV

Results and Dicussions

Conclusion

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Appendix

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Annex

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