Digital Guitar Effects Pedal

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Presentation Outline

- Block Diagram
- Input Signal
- DSP Configuration (Audio Processing)
  - Audio Daughter Card
    - Codec
- MSP Configuration (User Peripheral Control)
  - Pin Connections
  - User Interfaces
  - DSP Connection
- MSP and DSP Connections
- Simulink Modeling
- MSP and DSP Software Flowcharts
Objective \ Statements

- To create a digital guitar effects pedal
- All audio processing will be done with a DSP 6711 DSK board
  - With an audio daughter card
- All user peripherals will be controlled using a MSP430 evaluation board
  - Using the F149 model chip
- User Peripherals include…
  - Floor board switches
  - LCD on main unit
- Most guitar effect hardware that is available on the market is analog.
- Having a digital system would allow the user to update the system with new features without having to buy new hardware.
Block Diagram

- **MSP430F149**
  - Data Bus (8)
  - R/W
  - RS
  - EN
  - LCD Display
  - Footboard Switch

- **TMS320C6711**
  - GPIO (3)
  - Serial 2 RX [16 bit]
  - Serial 2 TX [16 bit]
  - Frame Sync

- **ADC / DAC**
  - Serial Clock

- **Audio Daughter Card**
  - Input from Guitar
  - Data Path

- **DSP 6711 DSK Board**
  - Output to Amplifier

- **Voltage Regulator**
  - Outlet Power Supply
  - +5V
  - +3.3V to MSP
  - +5V to LCD
  - +0.7V to LCD Drive
Guitar Input Signal

- **Voltage Range of Input Signal**
  - Nominal ~ 300 mV peak-to-peak
  - Maximum ~ 3 V

- **Frequency Range**
  - Standard Tuning
  - 500 Hz – 1500 Hz
Hardware: DSP and MSP
**PCM3002 Analog Audio Codec**

- **2 in 1 – ADC and DAC**
- **Sampling**
  - 16/20 bit
  - 8 kHz – 48 kHz
    - Meets 44.1 kHz for CD quality
- **Performance**
  - 20 Hz – 20 kHz range
    - Meets 500 – 1500 Hz guitar range
  - 85 dB ADC
  - 93 dB DAC
  - Built-in Filtering and Anti-Aliasing
- **Serial Output**
- **Applications**
  - Voice/Audio Processing
MSP Controlled Peripherals

- **Liquid Crystal Display (LCD)**
  - Lumex - LCM – S02002
  - 2x20 Character Display
  - Built in Microcontroller (LCD Driver)
  - 16 (8x2) Pin Connection
    - 11 pins to MSP

- **Floor Board**
  - 4 output pins to MSP input pins
    - Effect Selection
  - 4 MSP output pins for LED control
MSP and DSP Connection

MSP430F149

TMS320C6711

Chorus
Reverb
Distortion
Bypass

Floor Board
Input P 6.3:6

Chorus
Reverb
Distortion
Bypass

www.ti.com – slas272f.pdf

http://focus.ti.com/graphics/tool/C6711brd1.gif
Simulink Models for the DSP
Simulink System Diagram

Sample-By-Sample Processing (No Buffering)
There is no audible delay from processing.
Distortion is a music effect that gives a distinct, “heavy” sound.
The signal is amplified to give it a certain gain.
The amplitude of the signal is then limited symmetrically.

http://users.chriot.net.au/~gmarts/fx-desc.htm#Cho
The chorus effect allows a single instrument to be modeled into a sound that replicates a group of instruments playing the same part.

This is achieved by adding a single delayed signal (echo) to the original input.

However, the delay of this echo is varied continuously between a minimum delay and maximum delay at a certain rate.
Reverb Model

- Reverb simulates the acoustical effect of rooms and enclosed buildings.
- The sound heard = source + reflected sound.
- Reverberation time = the time taken for an impulse to decrease by 60dB of its original magnitude.

http://www.geocities.com/gitaarwerk/fxexp/reverb/Reverb.htm
MSP Software Flowchart

Programmed in C
Using IAR Workbench

Input read from floor board

Port Initialization

LCD Initialization

while(1)

if 6.3

Chorus LCD Output
LED/DSP Output

else if 6.4

Reverb LCD Output
LED/DSP Output

else if 6.5

Distortion LCD Output
LED/DSP Output

else if 6.6

Bypass LCD Output
LED/DSP Output

Programmed in C
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else if 6.6

Bypass LCD Output
LED/DSP Output

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**DSP Software Flowchart**

Converted C Code from Matlab’s Simulink Board interfaced using Code Composer Studio v2.1
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