

Alex Paige  
Jeff Hanna  
Henry Tang  
Larry Zhao

# *Smart Guitar User Guide*

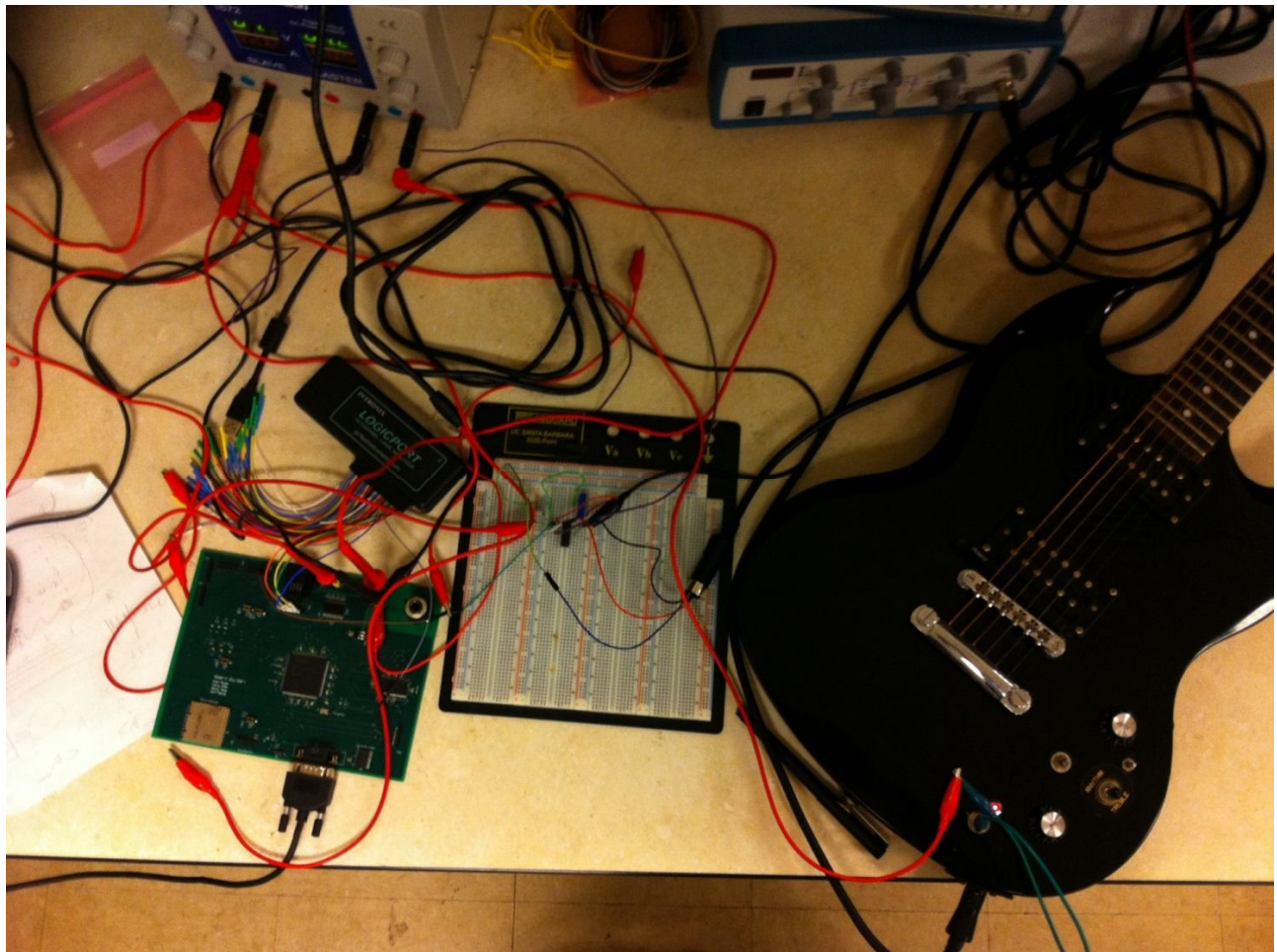
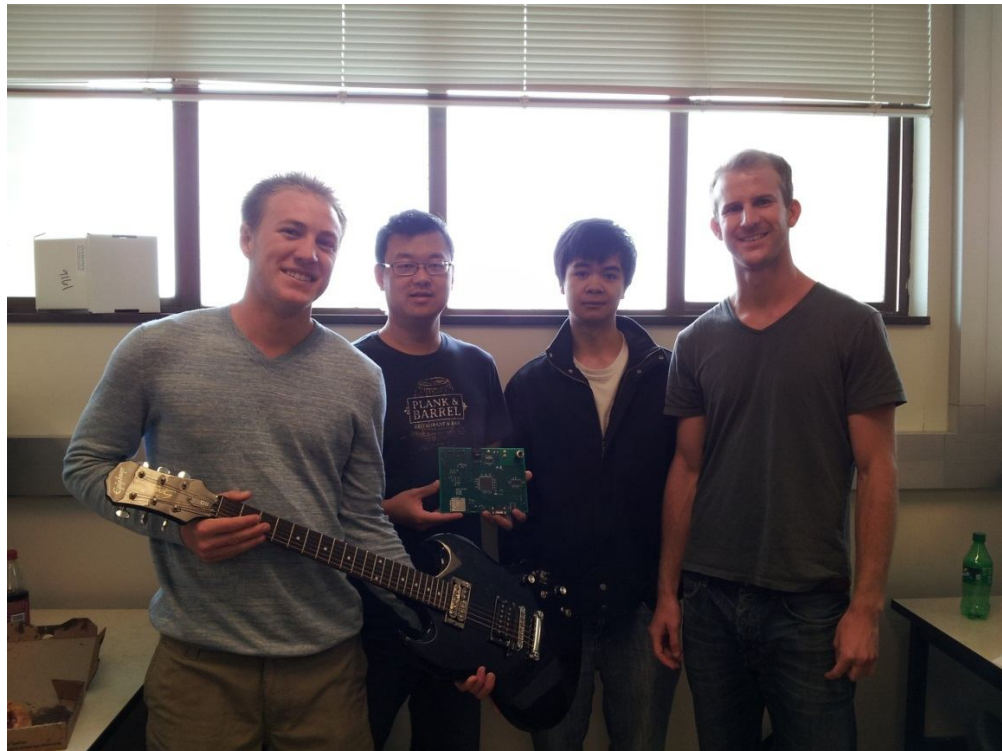


Figure 1.1: Guitar, Op Amp, Circuit and PCB (top view)

# Table of Contents

<i>Understanding Board .....</i>	<i>3</i>
<i>Setup of Parts .....</i>	<i>5</i>
<i>Power Up Board .....</i>	<i>7</i>
<i>Booting Up Code .....</i>	<i>7</i>
<i>Tuning Mode .....</i>	<i>8</i>
<i>Live Streaming Mode .....</i>	<i>9</i>
<i>Guitar Out.....</i>	<i>10</i>



## Understanding the Board

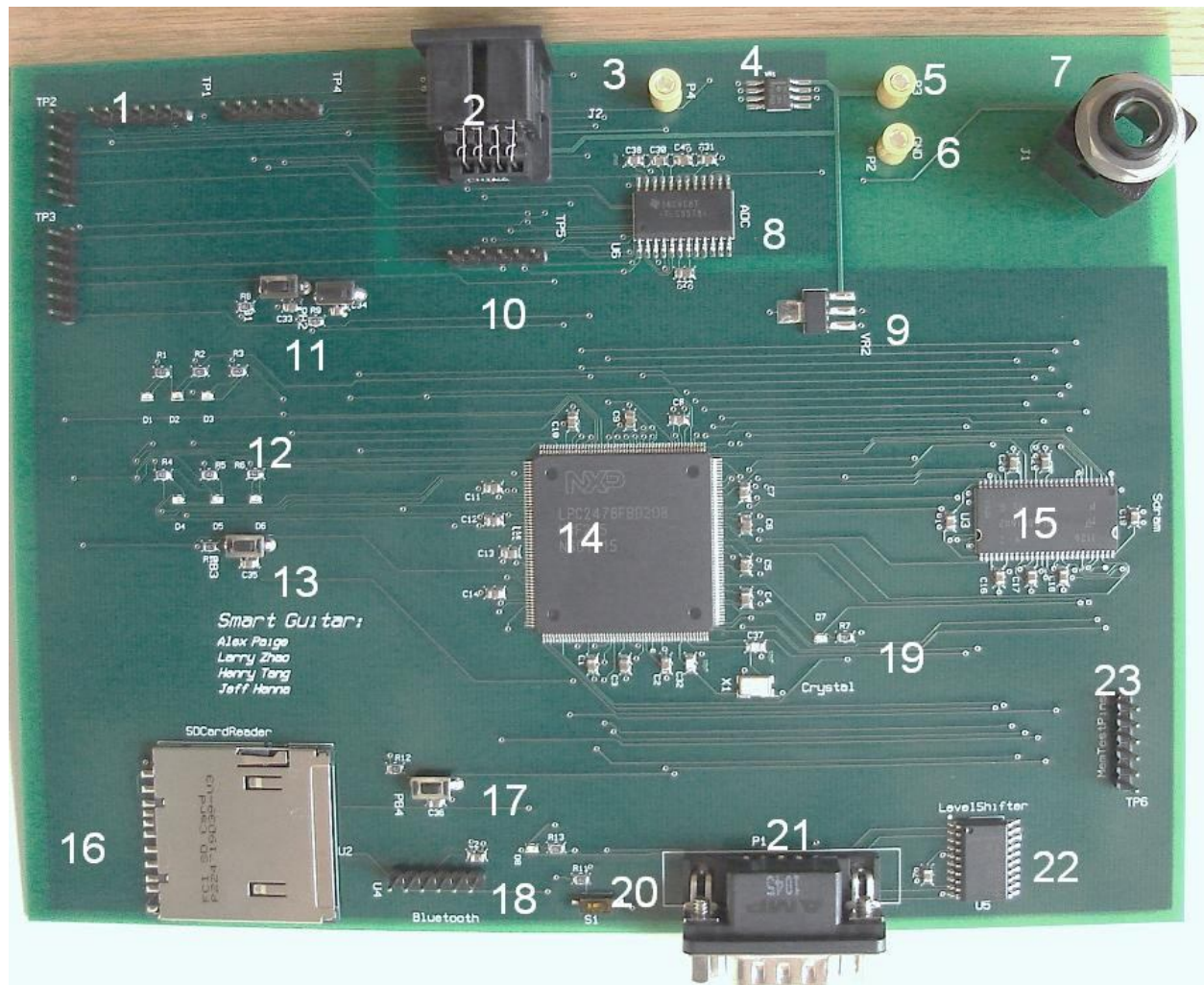


Figure 1.2: Completed PCB

- |                              |                                   |                           |
|------------------------------|-----------------------------------|---------------------------|
| 1. LCD connector pins        | 2. 13 pin Guitar connector        | 3. -7V power input        |
| 4. 5V voltage regulator      | 5. 7V power input                 | 6. Ground Pin             |
| 7. Audio jack to guitar amp. | 8. ADC                            | 9. 3.3V voltage regulator |
| 10. ADC test pins            | 11. Setting Push buttons(UP/DOWN) | 12. LED indicator         |
| 13. Mode select              | 14. NXP AMR7 Processor            | 15. SDRAM                 |
| 16. SD CARD Reader           | 17. Reset Button                  | 18. Bluetooth Connectors  |
| 19. Power On LED             | 20. Boot pin selector             | 21. RS232 connector       |
| 22. Level Shifter            | 23. SDRAM test pins               |                           |

**1. LCD connector pins**

Connector pins to LCD display module. Three digit display that indicates the note, time signature and BPM.

**2. 13 pin guitar connector**

Connect guitar output here.

**3. -7V power input**

Connect -7V from power supply here.

**4. 5V voltage regulator**

Regulate 7V input to 5V supply to ADC

**5. 7V power input**

Connect 7V from power supply here

**6. Ground Pin**

Connects to power supply's ground

**7. Audio jack to guitar amplifier**

Connects to guitar amp.

**8. ADC**

Analog to digital convertor

**9. 3.3V voltage regulator**

Regulates 7V to 3.3 voltage for digital components.

**10. ADC test pins**

Test pins for each of the 6 ADC inputs.

**11. Setting Push Buttons**

Left button to control numerator. Right button to control denominator of time signature.

**12. LED indicators**

Programmable LEDs. Default function for top 3 leds are for guitar tuning, flat, sharp, and in tune. Bottom 3 leds are for mode indication, streaming, write to SD Card, and converting.

**13. Mode select**

Toggles between all three modes mentioned above

**14. Processor (Processing Unit)****15. SDRAM**

128 MB SDRAM

**16. SDCard Reader**

SD Card for file storage.

**17. Reset Button**

Reset button for the board

**18. Bluetooth Connector**

Connect to Bluetooth module

**19. Power On LED**

Board power indicator

**20. Boot pin selector**

Switch to control boot from flash or flash programming.

**21. RS232 connectors**

Connects to RS232 compatible devices

**22. Level Shifter**

Level shifter for RS232 connectors

**23. SDRAM test pins**

Test pins for SDRAM control signals.

## Setup of Parts

For Smart Guitar to work properly there is a specific way one needs to setup the parts. Starting from the 6 string Epiphone guitar you need to plug the 13 pin cable to the build in Roland device inside the guitar. Next instead of plugging the cord into the connector on the board one must put each string through an op amp circuit as seen below to increase the voltage coming out of the Roland device.

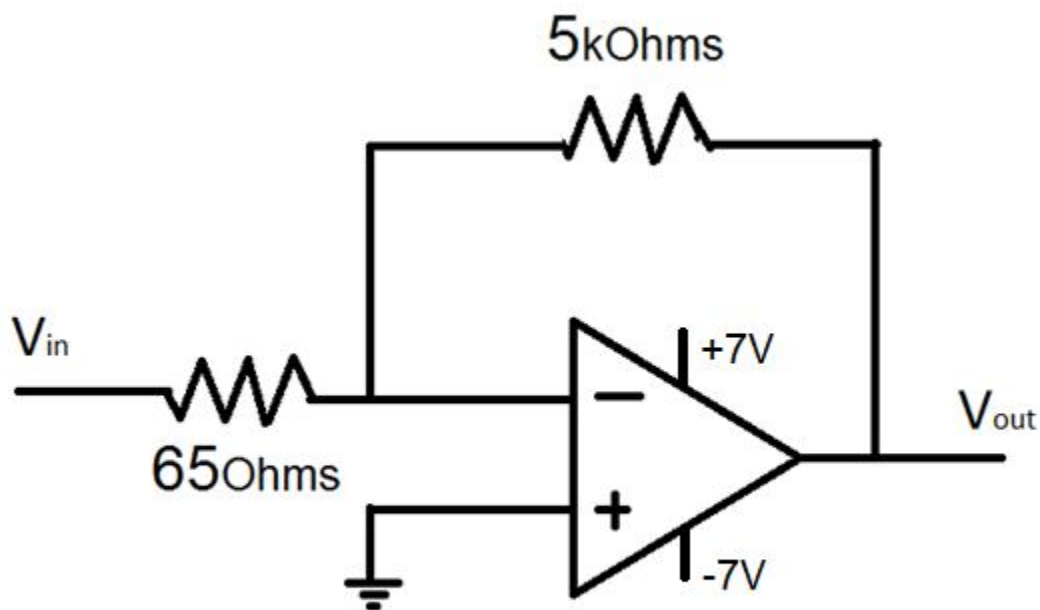


Figure 1.2: Inverting Op Amp Circuit

After this one must take the output signal and plug it into the corresponding string that you want. The easiest way to do this is to use the test pins labeled TP4 on the board. Each test pin correlates to one string on the guitar. One thing to double check after you have made these connections is the common ground. You will not

be able to get a clean signal unless your circuit board is going to the same ground as your guitar. Ground the guitar through the normal input jack that is face up on the guitar. To verify that you are getting the amount of voltage you want coming from the op amp circuit (3V-7V) it is recommended that the signal is verified through using an oscilloscope. You should see a peak wave with decreasing overtones see picture below. Finally plug in your RS232 cable at position 22 on the diagram that is connected to the computer.

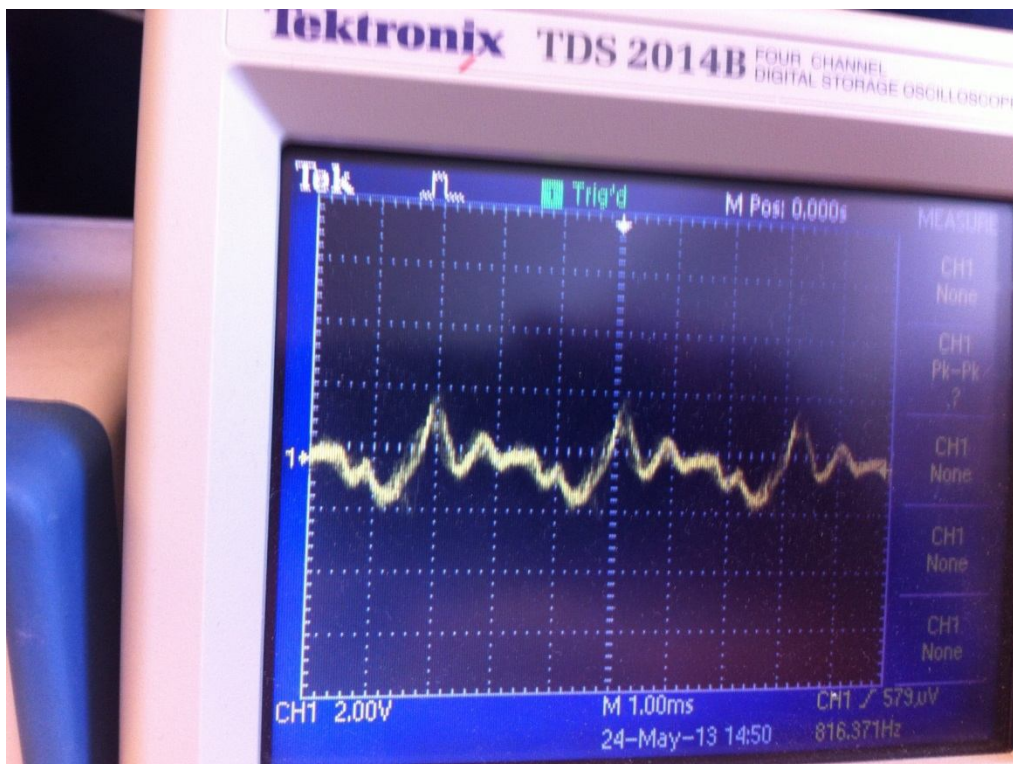


Figure 1.3: Example of the output from the Op- Amp circuit

## **Power-Up Board**

In order to power up the board one must supply two separate voltages. The first is +7V that is used by the Roland Device, Processor and all other peripherals. The second supply is -7V and is needed exclusively for the Roland device. Plug in your +7V into the slot labeled "5". Plug in your -7V into the slot labeled "3". Also plug in your common ground to the slot labeled "6". Since we are bypassing the Roland connector on the board (because of op amp circuit) you must also ensure that you are supplying the guitar with the +/- 7V that it needs in order for the Roland device to work (see picture below). You should see a red light turn on on the guitar indicating that you have powered and grounded the guitar correctly. Also remember that your rails on your op amp needs to be set to +/- 7V.

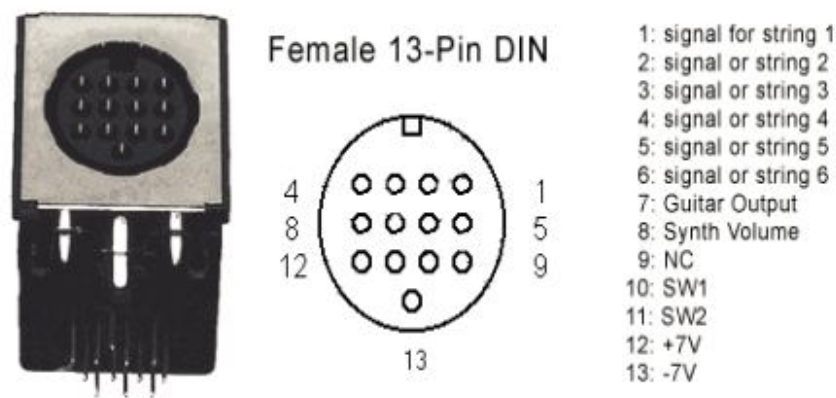


Figure 1.4: Connections of the 13 pin connector

## **Booting Up Code**

In order to boot up the code that contains all of modules controlling the Processor and the FFT modules you must boot up the code through the RS232 connector. This is "21" on the PCB. To load the code on the processor you must have the switch in boot mode in the left position. The boot switch is labeled "20" on the PCB board. After you put the switch in boot mode then you hit reset and the code is loaded on the processor. Make sure to flip the switch back after you are

complete with the upload. After this you need to open up putty and go to the right port to be able to see the output from your processor.

## **Tuning Mode**

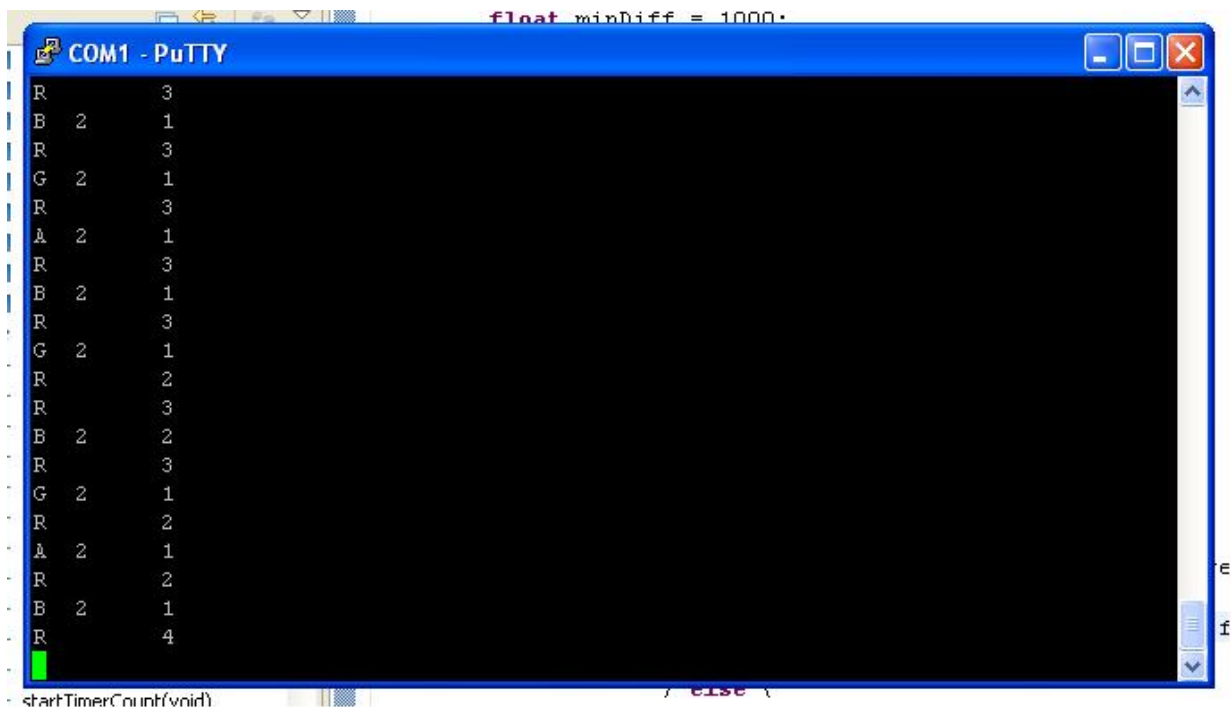
This is one of two modes of Smart Guitar. In this mode you can tune any string to the correct frequency. To get to tuning mode you must first hit the pushbutton labeled "17" on the board in which you will be reset the board and will see "Configure" pop up on the screen. Next you push the pushbutton "13" once and you will be put in tuning mode. Every time you strum the string that you are trying to tune you will get the name of the note that you are playing as well as a carrot symbol (" $<$  D"). The carrot symbol when pointed left means that the string that you are trying to tune is flat. While you increase the pitch of your string you will get to the double carrots (" $<>$  D"). This means that the string you are playing is correctly in tune. If the carrot symbol is pointing to the right (" $>$  D") then you know the string that you are trying to tune is sharp. To the right of the note name is the octave as well. Below is a screenshot of what you should see while in this mode.

```
float minDiff = 1000;
COM1 - PuTTY
>C# 2
< D 2
< D 2
< D 2
< D 2
< D 2
< D 2
< D 2
< D 2
< D 2
< D 2
< D 2
< D 2
< D 2
< D 2
< D 2
< D 2
< D 2
< D 2
< D 2
< D 1
< D 1
< D 1
<>D 2
<>D 2
```



## Live Streaming Mode

After tuning all the strings in the tuning mode you can go directly to the live streaming mode. By pushing the mode selection button "13" you go straight into live streaming mode. In this mode it allows you to play a string(s) and be able to see on Putty what you played and how long and in what sequence. On the left you will see the name of the note that you are playing. Next you will be able to see the octave of the note. To the right of the octave you will see a number representing the duration of time. The time increments we are using are based on how long it takes for the signal to be sampled and run through the FFT algorithm. This is a consistent time interval that does not change. An added functionality to this would be to take this duration and convert it to seconds. Also as you can see below there is an "R" that shows up on the screen between the notes. This represents rest and is the amount of time between two notes. When no notes are being played for a while the R will show up with a big duration like 450. A side note while playing in this mode make sure that you cleanly pluck the one string at a time.



The screenshot shows a PuTTY terminal window titled "COM1 - PuTTY" with a blue title bar. The terminal output consists of a sequence of notes and rests, each represented by a letter, an octave number, and a duration number. The notes are: R (3), B (2, 1), R (3), G (2, 1), R (3), A (2, 1), R (3), B (2, 1), R (3), G (2, 1), R (2, 2), R (3), B (2, 2), R (3), G (2, 1), R (2), A (2, 1), R (2), B (2, 1), and R (4). A green cursor is visible at the end of the last line. Above the terminal window, a line of code is visible: `float minDiff = 1000;`. Below the terminal window, a line of code is visible: `startTimerCount(void)`.

```
float minDiff = 1000;

COM1 - PuTTY
R      3
B  2   1
R      3
G  2   1
R      3
A  2   1
R      3
B  2   1
R      3
G  2   1
R  2   2
R      3
B  2   2
R      3
G  2   1
R      2
A  2   1
R      2
B  2   1
R      4

startTimerCount(void)
```

## **Guitar Out**

If you want to hear the guitar while using the board you need to connect the guitar out to an external speaker. The guitar out is labeled "7" on the board. You must ensure that there is +/- 7V getting to the Roland Device or you will get nothing out of the guitar.