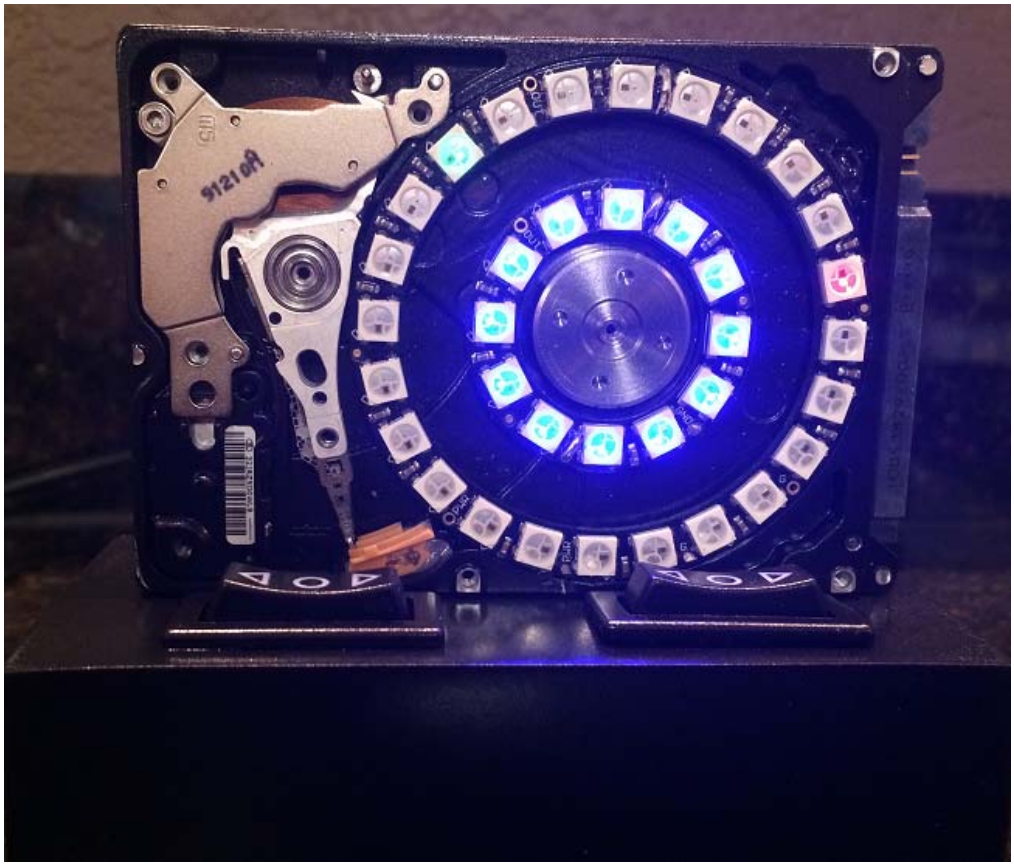
Hard Drive NeoPixel 3D Printed Clock

December 2015



Back to the Future Time Circuit 3D Printed Clock Construction

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1 Overview

The hard drive clock will display the time via the NeoPixels that are located on the hard drive platter area. This project is designed around utilizing a discarded notebook 2.5” hard drive.

The hard drive is mounted to a 3D printed enclosure. The hard drive clock utilizes (1) Adafruit Metro Mini 328 Arduino compatible controller, (1) ChronoDot - Ultra-precise Real Time Clock, (1) NeoPixel Ring - 12 x WS2812 5050 RGB LED with Integrated Drivers, (1) NeoPixel Ring - 24 x WS2812 5050 RGB LED with Integrated Drivers and (2) Momentary (on)-off-(on) SPDT Up-Down Rocker Switches. A complete parts list along is provided at the end of this “Instructable”.

The .stl files for printing the clock parts, Arduino code and wiring diagram are located here. The clock was printed on a Lulzbot mini with HIPS filament.

2 Components

The Clock is controlled by a small form factor Arduino based controller. The Arduino based controller handles the interface to (2) NeoPixel rings, (2) increment/decrement switches and a ChronoDot real time clock.

2.1 Arduino Based Adafruit Metro Mini 328 Controller

The clock utilizes a small form factor Arduino based controller (Adafruit Metro Mini 328). The Adafruit Metro Mini 328 is programmed to monitor and control the entire clock.

The Adafruit Metro Mini 328 can be purchased at Adafruit.com
http://www.adafruit.com/product/2590

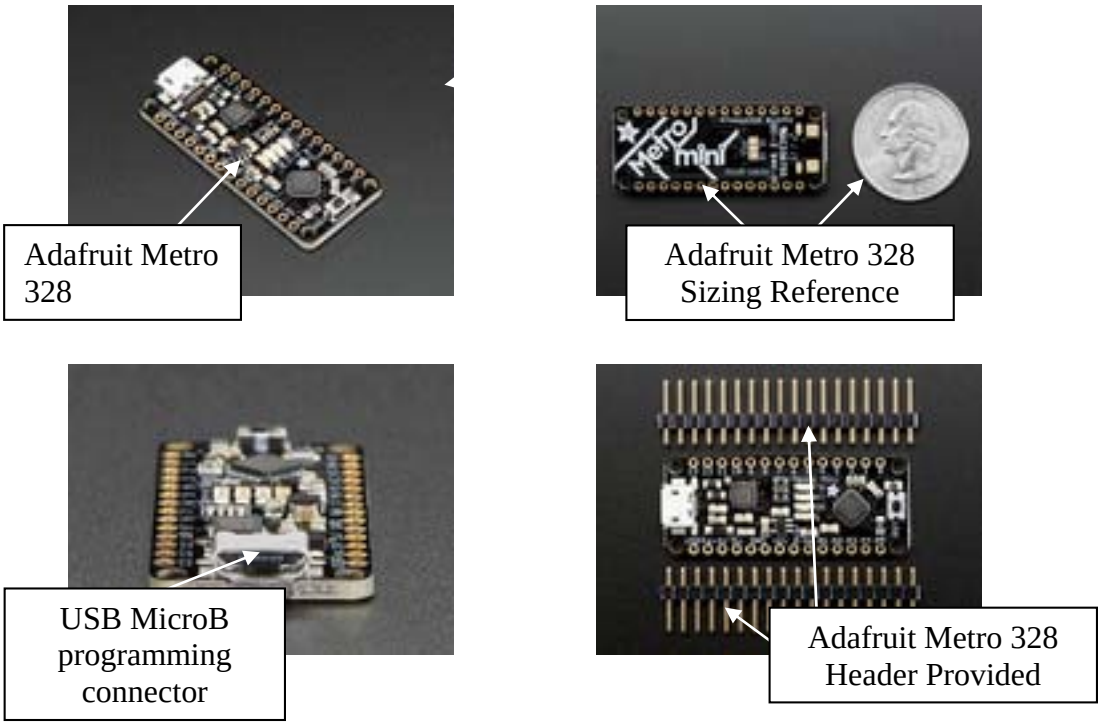

Figure 2.11 – Adafruit Metro Mini 328

2.2 ChronoDot Real Time Clock

The Hard Drive NeoPixel 3D Printed Clock ChronoDot module will keep track of the time even when power is removed. The ChronoDot real time clock module utilizes a coin cell battery that will keep the time for five years.

The ChronoDot Real Time Clock can be purchased at Adafruit.com http://www.adafruit.com/products/264 . The only connections to the ChronoDot module that are required are 5 VDC power and the SDA and SCL pins. The SDA and SCL connections are interfaced to the Arduino based Adafruit Metro Mini 328 via pins A04 and A05. This is a simple and inexpensive solution for creating a clock. The ChronoDot module is mounted to the bottom of the 3D printed clock enclosure via a screw.

Note: The same clock can be created with a DS1307 purchased from Adafruit.com. The DS1307 requires some assembly and is a less accurate clock module. There are no code changes required if you use the DS1307 module.

Figure 2.21 – ChronoDot Real Time Clock

2.3 NeoPixel 12 Ring

The clock utilizes one NeoPixel ring that contains 12 smart LED's. The ring uses only one pin from the Adafruit Metro Mini 328. The 12 LED NeoPixel ring is used to display the 'Seconds' value for the current time.

The NeoPixel ring can be purchased at Adafruit.com http://www.adafruit.com/products/1643 . The pictures below show the front and back side of ring.

Figure 2.31 – NeoPixel 12 Front

Figure 2.32 – NeoPixel 12 Rear

The NeoPixel ring section requires three solder connections (5 VDC, GND, and Data In)

2.4 NeoPixel 24 Ring

The clock utilizes one NeoPixel ring that contains 24 smart LED's. The ring uses only one pin from the Adafruit Metro Mini 328. The 12 LED NeoPixel ring is used to display the 'Seconds' value for the current time.

The NeoPixel ring can be purchased at Adafruit.com http://www.adafruit.com/products/1586 . The pictures below show the front and back side of the ring.

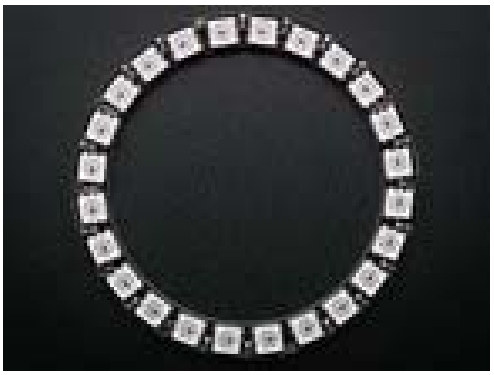

Figure 2.41 – NeoPixel 24 Front

Figure 2.42 – NeoPixel 24 Rear

The NeoPixel ring section requires three solder connections (5 VDC, GND, and Data In)

2.5 Socket and Servo Cables

I wired the clock using one 6 pin six inch socket cable as shown below for making attachments to the ChronoDot and the Adafruit Metro Mini 328. The socket to socket cable can be purchased at Adafruit.com https://www.adafruit.com/products/206 .

Figure 2.51– Socket Cable

I also used two 3 pin servo extension cables for the making connection to power and the SCL/SDA terminals. The servo extension cables can be purchased at Adafruit.com https://www.adafruit.com/products/972 .

Figure 2.52– Socket Cable

2.6 Power Supply

I used the following power supply for the Adafruit Metro Mini 328. The power supply was purchased at Adafruit.com.

http://www.adafruit.com/product/1995

The picture below shows the power supply that I used. This power supply provides 2 amps at 5 VDC. The higher amperage supply was chosen since it had a six foot cord. The clock does not need to ensure we would not exceed the current requirements of the clock.

Figure 2.61 – Power Supply

2.7 Filament

The clock utilizes HIPS black filament for the entire assembly.

The black hips filament was purchased at Lulzbot.com
https://www.lulzbot.com/products/hips-3mm-filament-1kg-reel-esun .

The pictures below show the filament colors.

Figure 2.71 – HIPS Black

2.8 Wire

I used the following wire for several connections.

The wire type that I used is stranded 22 awg hookup wire. The wire was purchased at Pololu.com https://www.pololu.com/category/139/stranded-wire.

The picture below shows the wire that I used.

Figure 2.81 – Hookup Wire

2.9 Liquid Electrical Tape

Liquid electrical tape is used to cover the platter area of the hard drive. The liquid electrical tape is used to ensure the NeoPixel rings and connections remain isolated from metal surfaces. The liquid electrical tape can be purchased at Lowes or Home Depot.

Figure 2.91 – Liquid Electrical Tape

2.10 Lacquer

The clock was coated with clear lacquer to provide a nice protective finish. I have used the satin and the semi-gloss finish for the clocks I have built. I found that the satin finish is more forgiving in regards to hiding imperfections. The lacquer can be purchased at Lowes or Home Depot in the wood stain section.

Figure 2.101 – Spray Lacquer

2.11 Mounting Screws

I used #2 x 3/8 inch Philips screws for mounting the ChronoDot and the Adafruit Metro Mini 328. I also used #4 x 3/4 inch Philips screws for mounting base of the clock to the upper clock assembly. The screws can be purchased at Lowes.

Figure 2.111 – Mounting Screws

2.12 Bumpers

I install bumpers on the base of the clock to avoid scratching furniture. The bumpers shown below were purchased at Walmart but can also be purchased at Home Depot or Lowes.

Figure 2.121 – Bumpers

3 3D Printing

The entire clock was printed using a Lulzbot Mini 3D printer. I used HIPS material for printing the clock base and clock cover.

The files are in .STL format and are as follows:

Clock Base.stl
This file is the where the ChronoDot and Adafruit Metro Mini 328 mount to. This is printed with black HIPS filament.

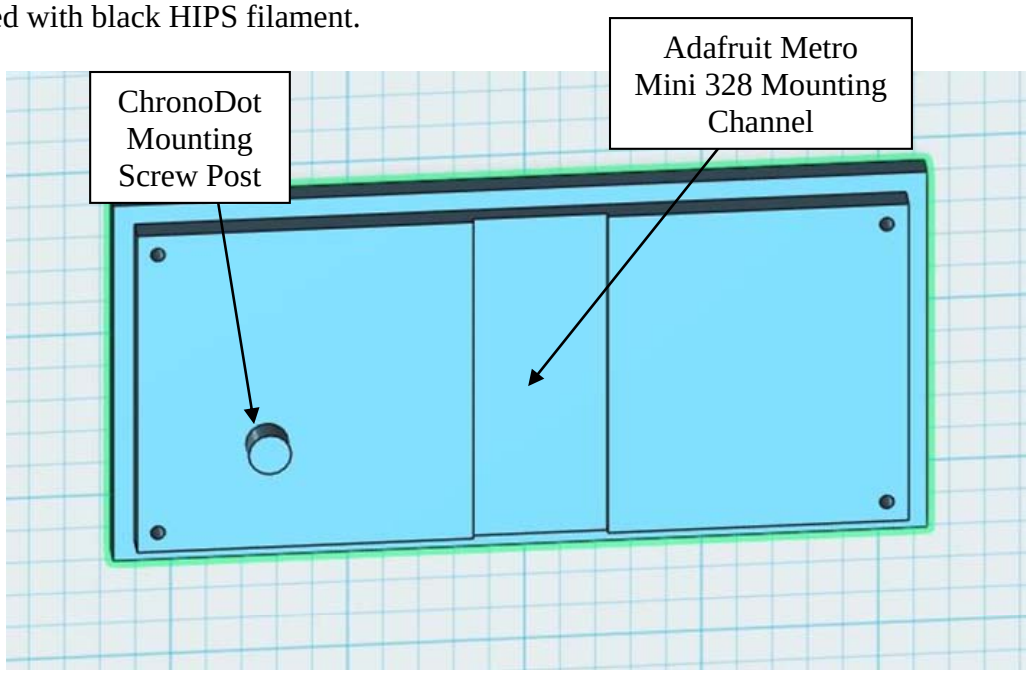

Figure 3.1 – Clock Base Top View

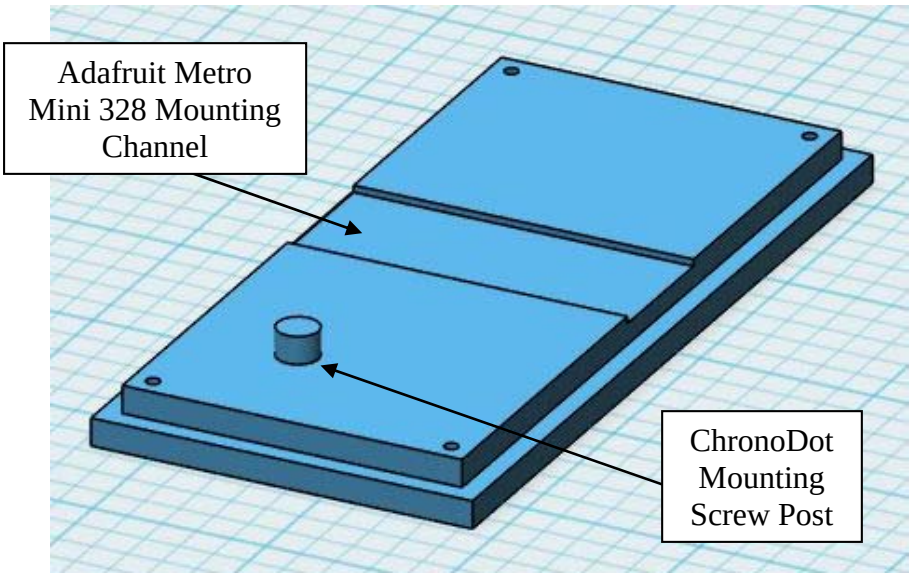

Figure 3.2 – Clock Base Top View

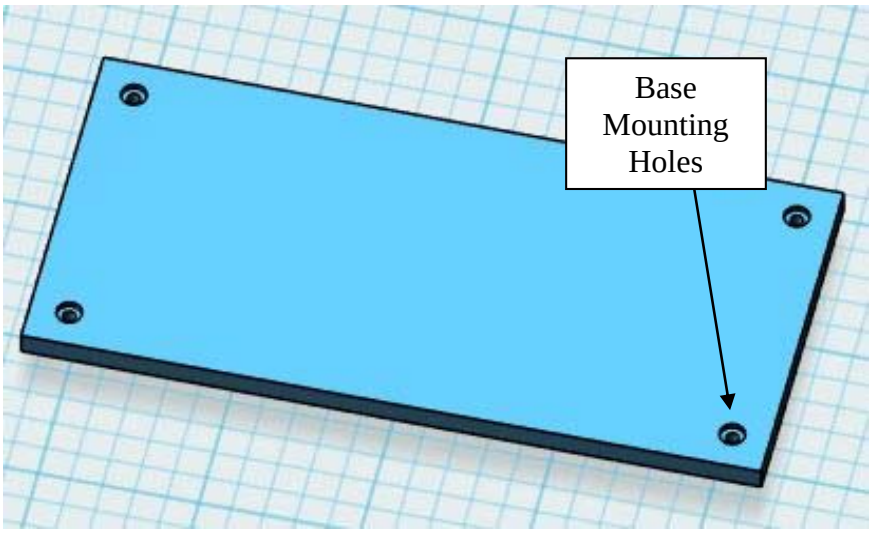

Figure 3.3 – Clock Base Bottom View

Clock Cover.stl

This file is the where the Hard Drive and Time Set switches are mounted to. This is printed with black HIPS filament.

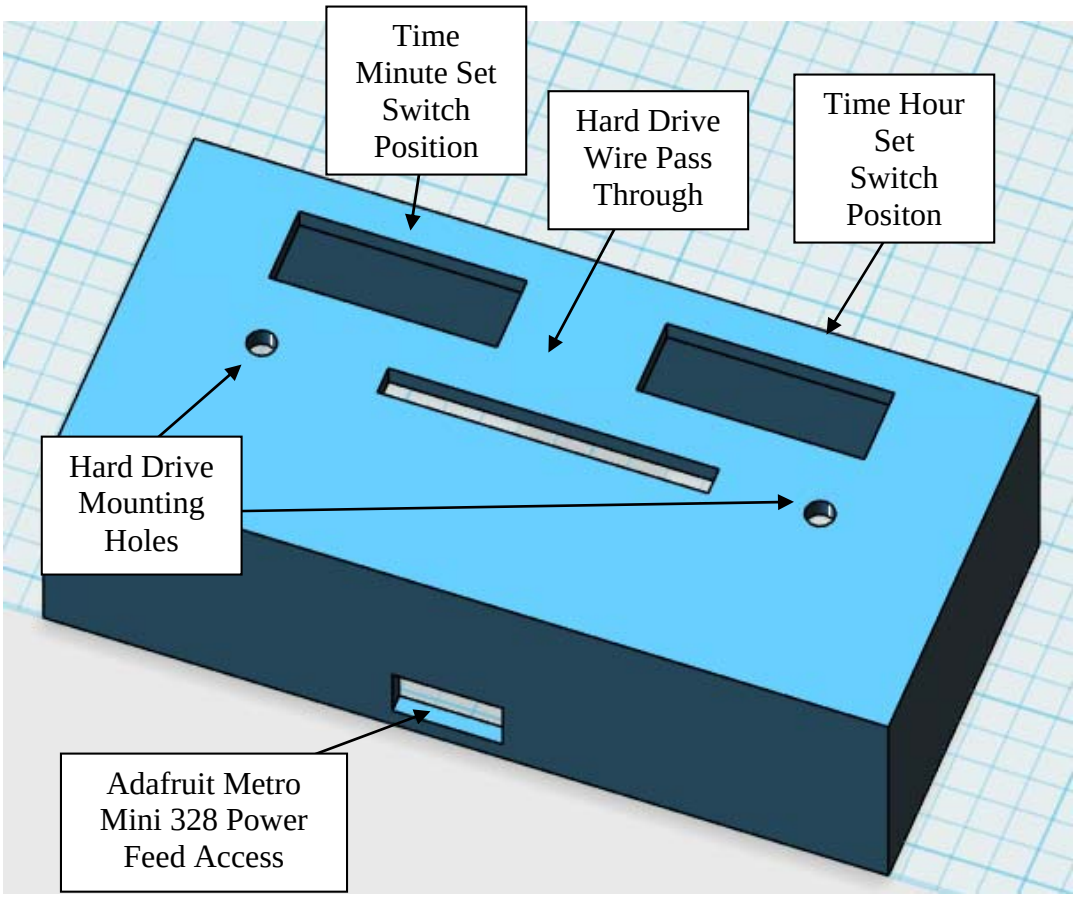

Figure 3.4 – Clock Cover Top View

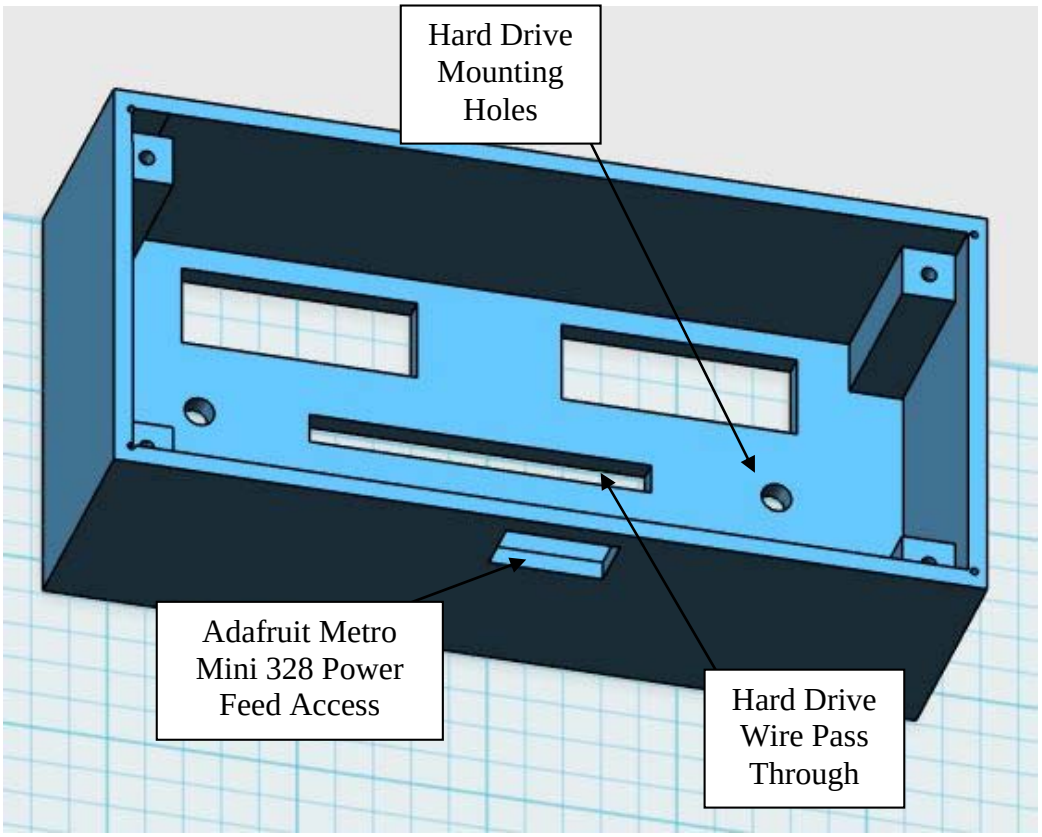

Figure 3.5 – Clock Cover Bottom View

Assembly View Back Side

The picture below shows assembly view from the back side of the clock.

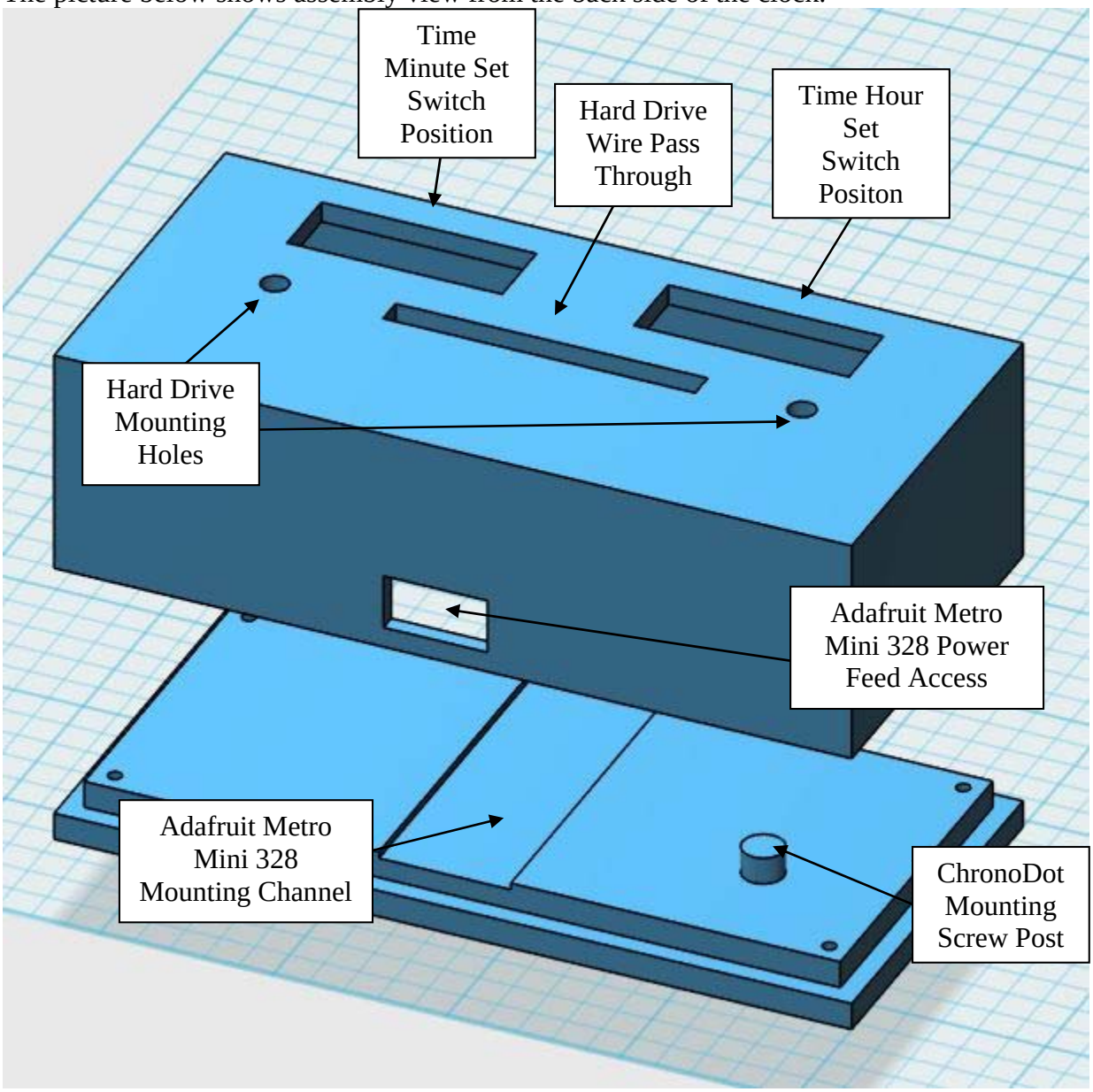

Figure 3.6 – Assembly View Clock Back Side

Assembly View Front Side

The picture below shows assembly view from the front side of the clock.

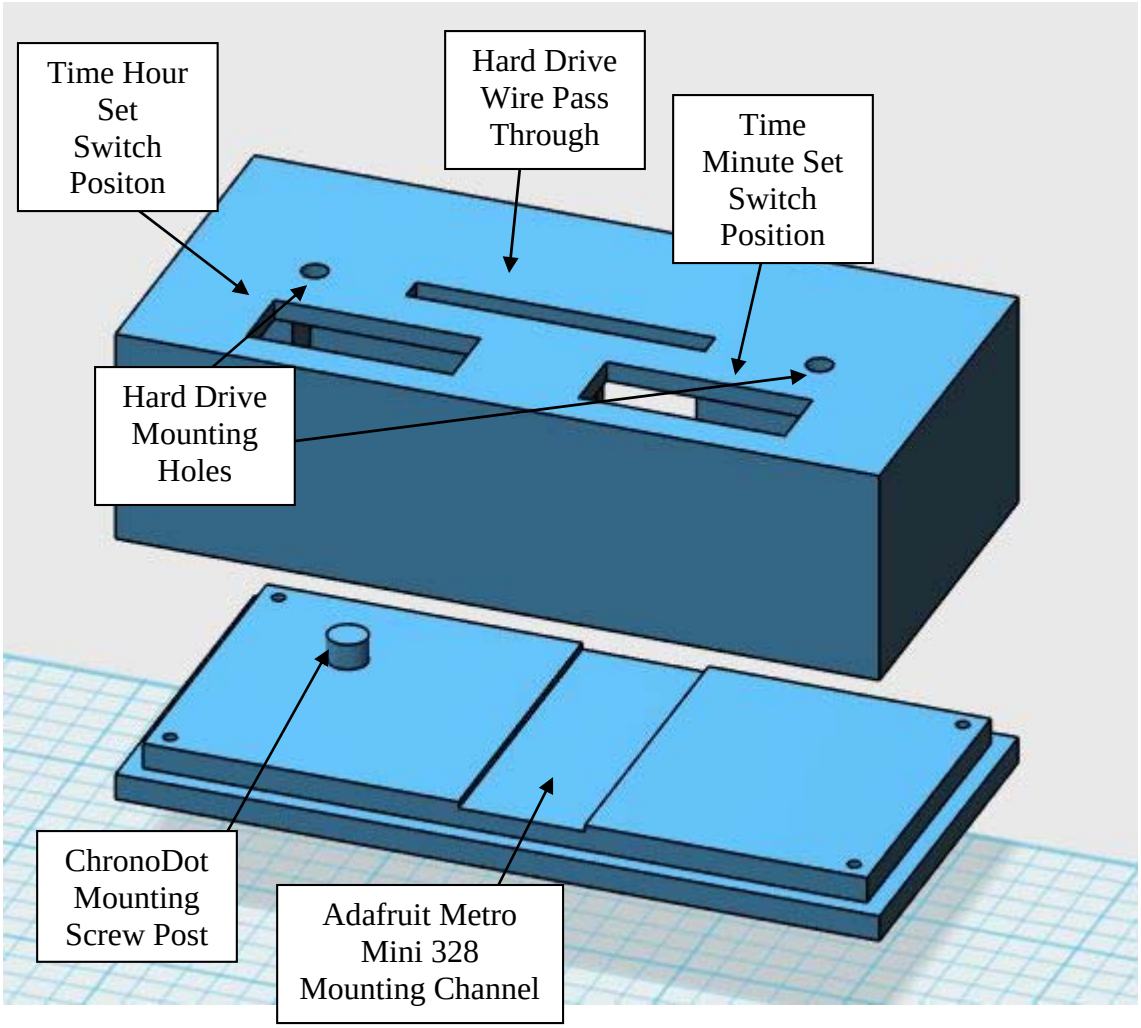

Figure 3.7 – Assembly View Clock Front Side

4 Construction

Once the 3D parts are printed and the components have been gathered, it is time to start the build process. The following steps outline the assembly process.

4.1 Hard Drive

This project requires an old notebook hard drive (2.5 “). I have built these clocks using Seagate and Wester Digital drives. I prefer these types of hard drives since the screws can be removed using a T6 Torx screw driver. Remove the Torx screws as shown below.

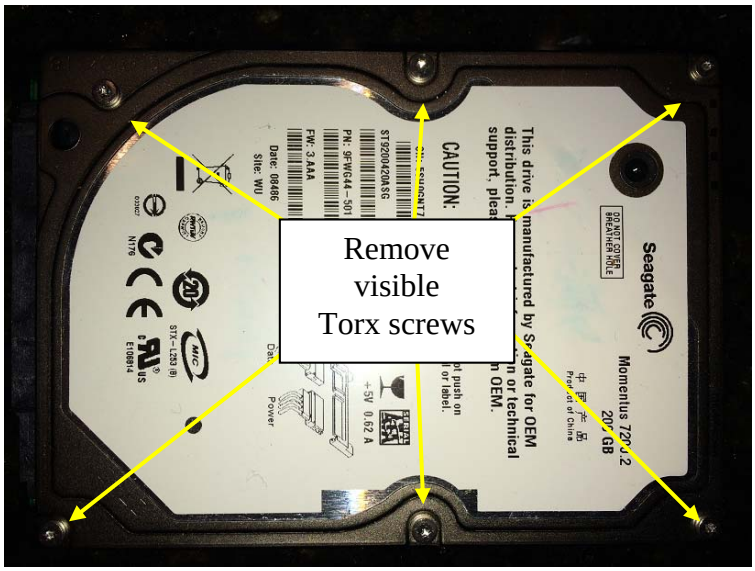

Figure 4.11 – Exposed Torx Screw Removal

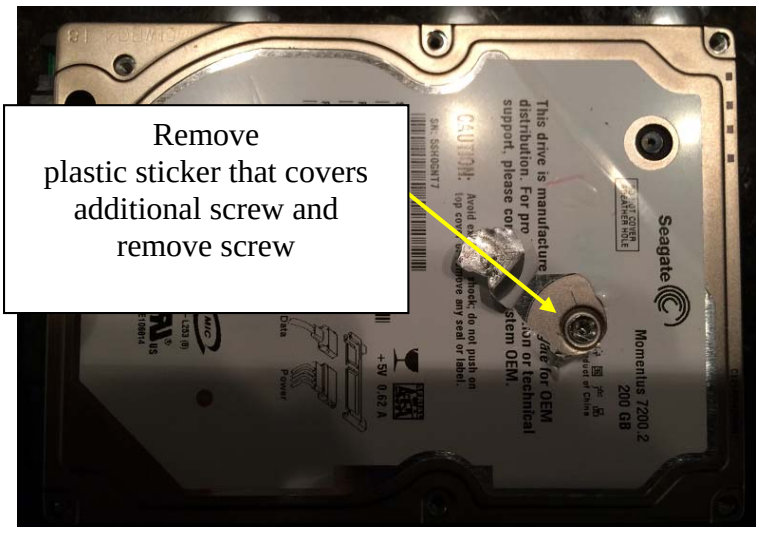

Figure 4.12 – Hidden Torx Screw Removal

Remove the cover and the hard disk pater will be exposed and remove the Torx screw as shown below so that the platters can be removed.

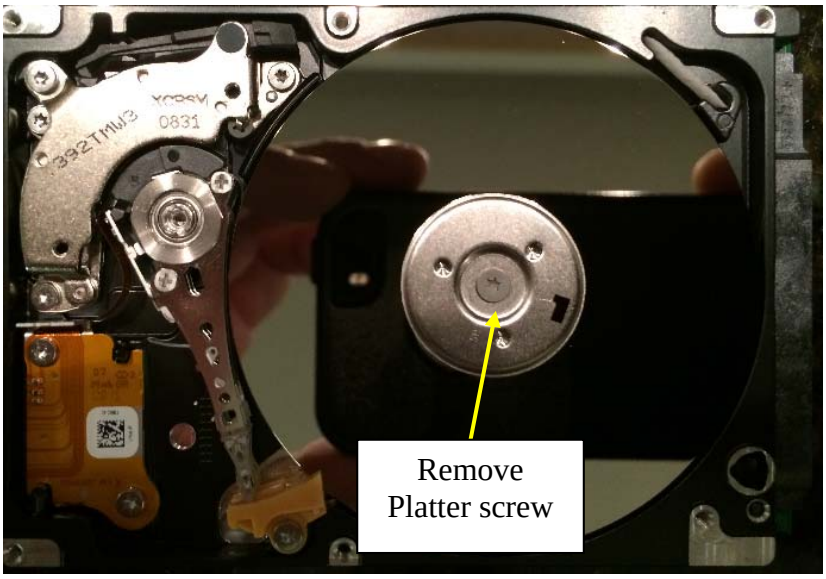

Figure 4.13 – Platter Torx Screw Removal

With the platter screw removed, lift off the platter retainer and platters.

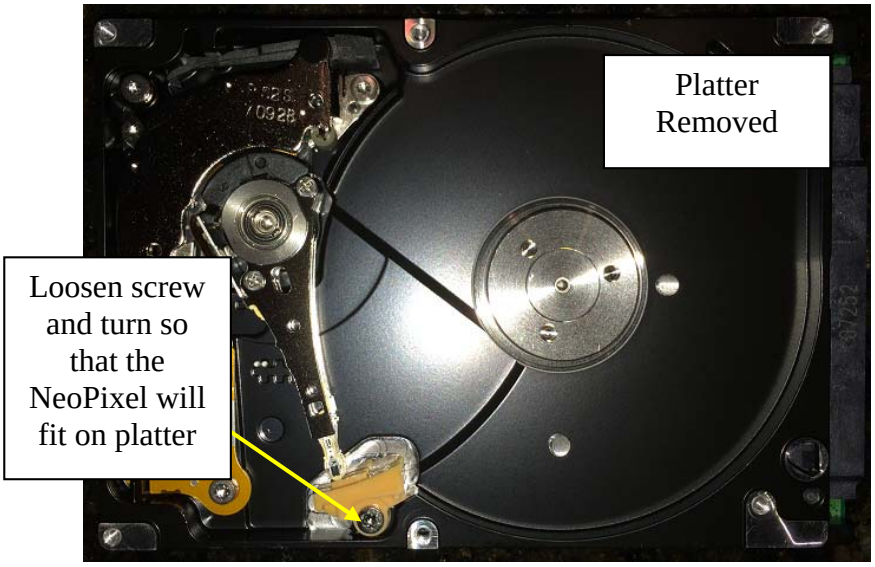

Figure 4.14 – Platters Removed

Flip the hard drive over and removed the Torx or Phillips head screw from the circuit board and lift off the circuit board.

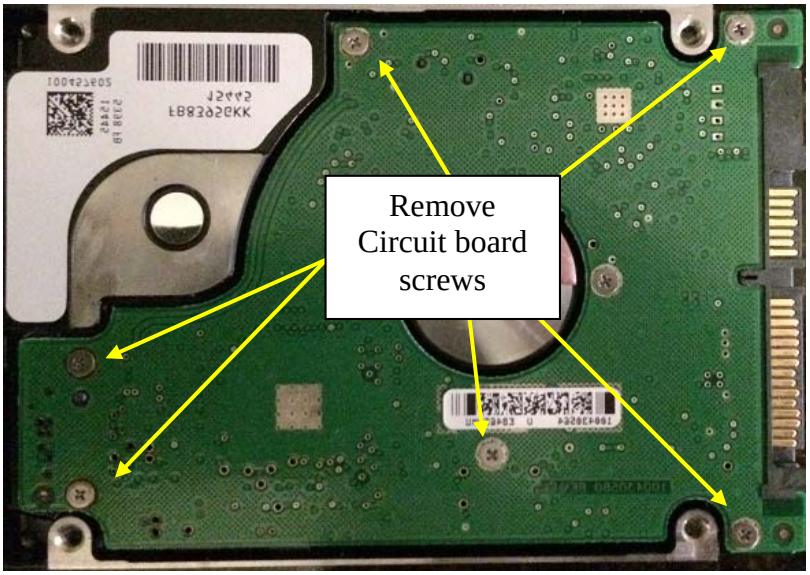

Figure 4.15 – Circuit Board Screws

Congratulations! You just finished the hard drive disassembly.

4.2 Mark NeoPixel Ring Drilling Points

Dry fit the NeoPixel rings on the hard drive where the platters once were. In this step we are going to mark the drilling locations for the Data In, Power and Ground wires.

The LED to the left of the Data In terminal (Neo Pixel LED facing you) should be at the twelve O'clock position for both NeoPixels. This is important since the Arduino code relies upon this LED being at the twelve O'clock position.

Once the NeoPixels are in the proper orientation, use a marker to indicate the outer edge of the holes that will be drilled.

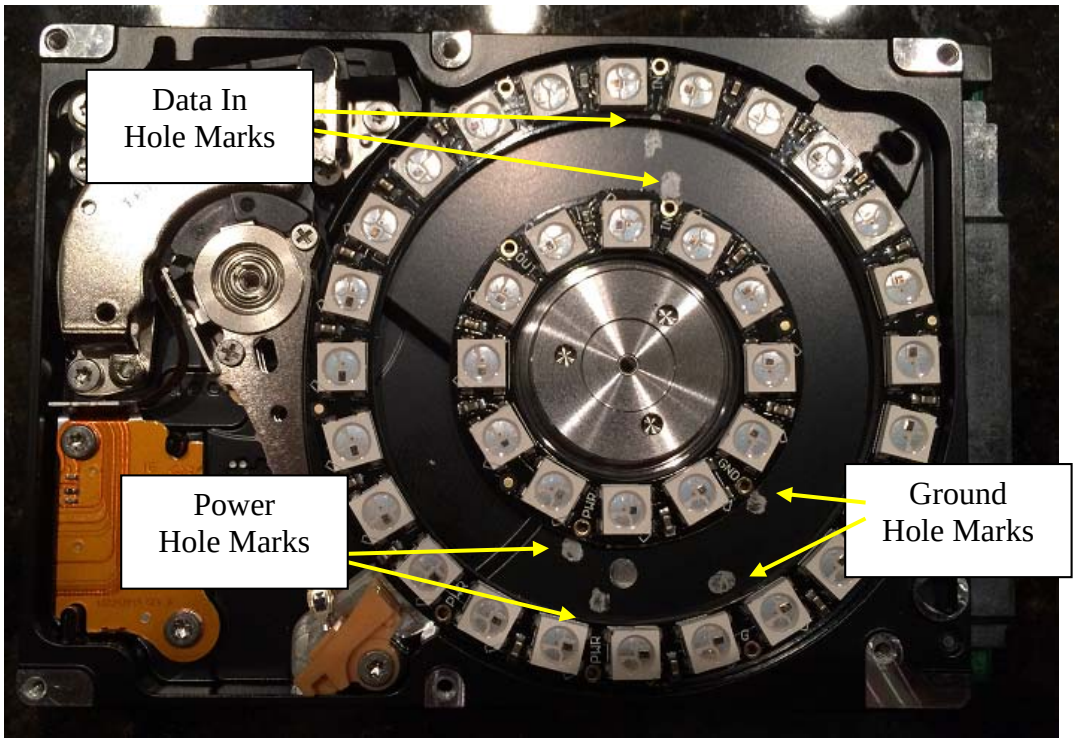

Figure 4.21 – NeoPixel Alignment Marks

4.3 Drill NeoPixel Wire Holes

One you drill the holes, you will find that you need a wider hole depending how you soldered the wire to the NeoPixels. The example shown below, illustrates one of my worst hole drilling alignments and represents how I drill some additional holes to allow the wires to easily pass through to the circuit board side of the hard drive. Do not worry if you make the hole a little too large. Prior to installing the NeoPixels, I use the liquid electrical tape to cover the entire area and it fills in gaps nicely.

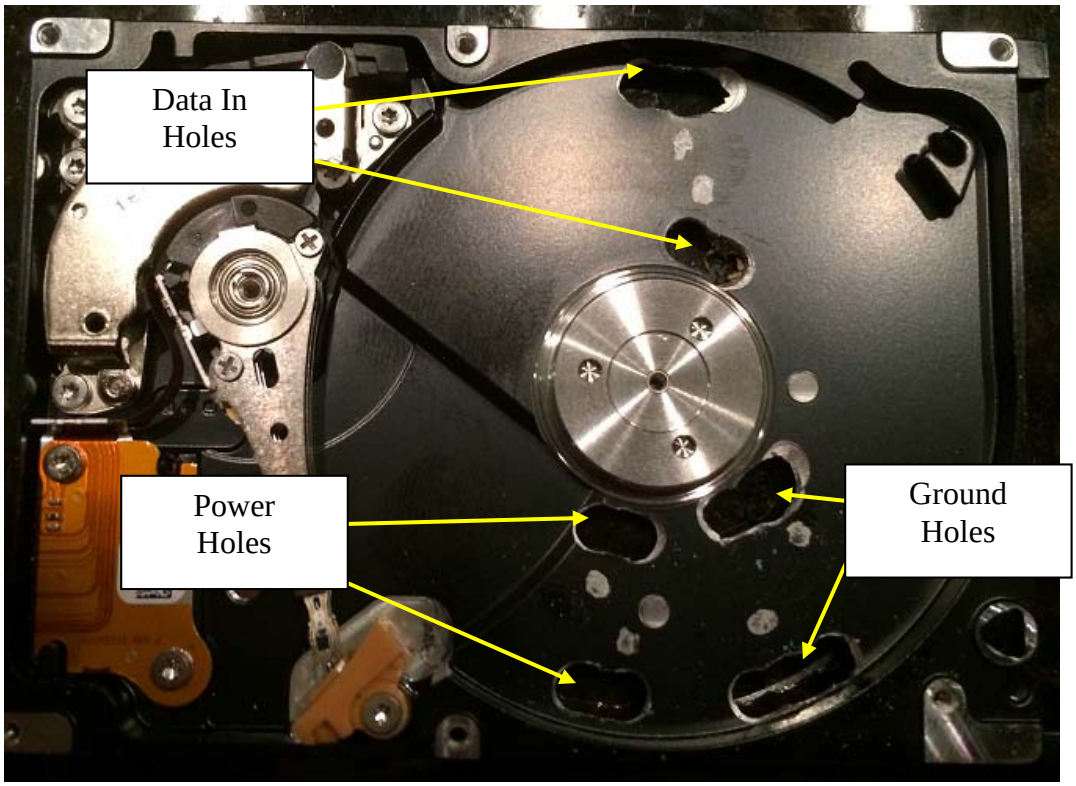

Figure 4.31 – NeoPixel Wire Pass-through Holes

4.4 File Slot for the NeoPixel Wires

File a slot as shown below for the NeoPixel wires to pass between the hard drive and the clock 3D printed cover. I drilled a few small holes first then used a file.

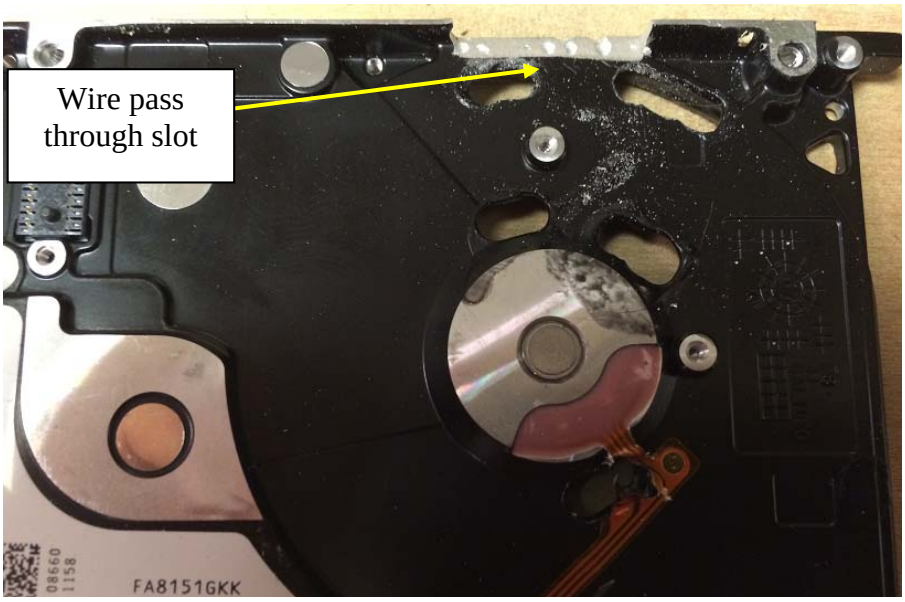

Figure 4.41 – NeoPixel Wire Slot

4.5 Solder Wires to NeoPixels

Solder a wire to the Data In, Power and Ground for each NeoPixel ring. The wire goes through the back side of the NeoPixel and is soldered on the LED side of the NeoPixel.

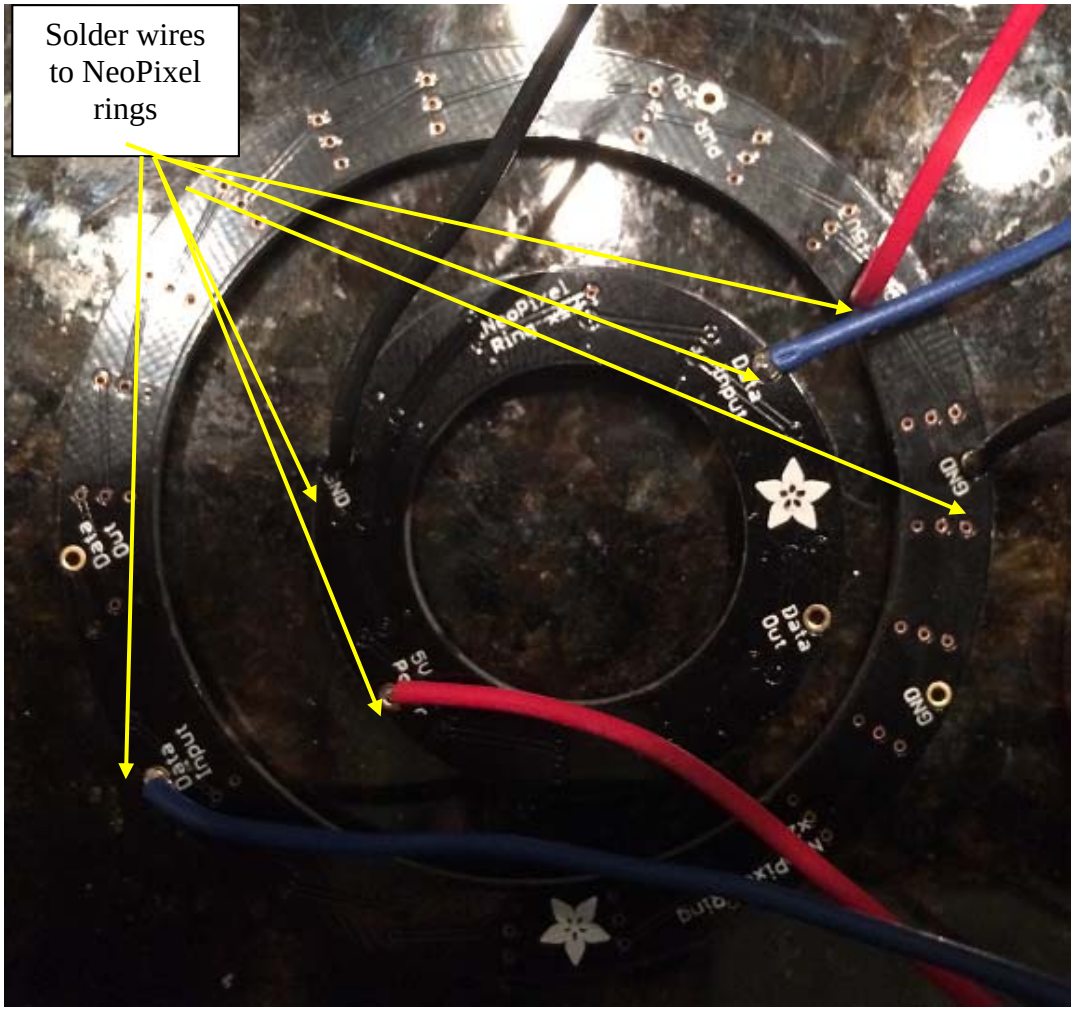

Figure 4.51 – NeoPixel Wire

4.6 Test Fit NeoPixel Rings

Perform a test fit of the NeoPixel rings to the hard drive to verify the holes that you previously drilled are large enough and in the proper location. Run each wire through the corresponding hole to make sure everything lines up.

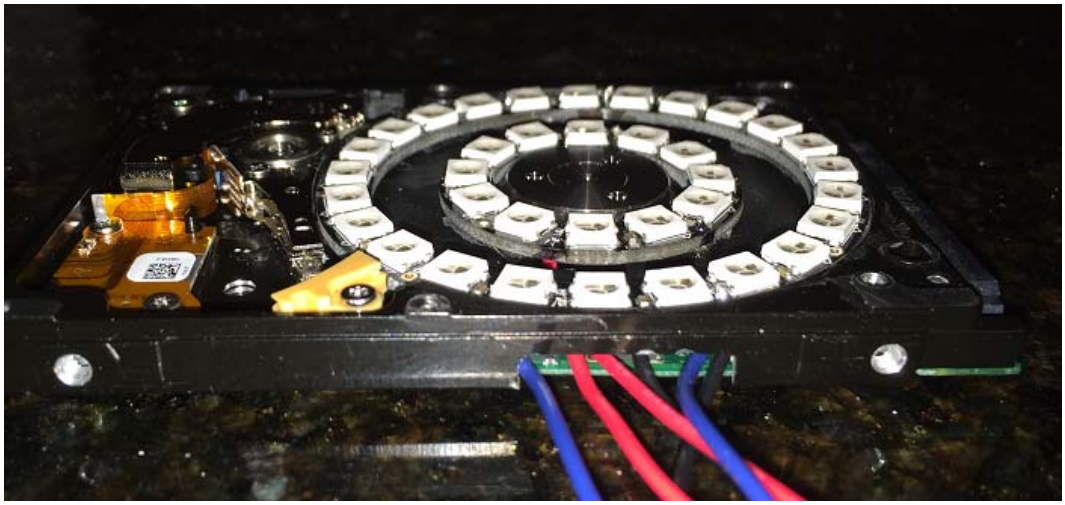

Figure 4.61 – NeoPixel Test Fit

4.7 Place Tape on NeoPixel Ring

Clear mounting tape is used to hold the NeoPixel rings on the hard drive. The tape shown below was used since it is clear and double sided. I used scissors to cut small end pieces of tape and placed them around the back of the NeoPixel rings. I purchased the tape at Home Depot. The NeoPixel rings fit on the hard drive snuggly without the tape but the tape adds isolation from the hard drive as well as preventing the NeoPixel rings from coming loose.

Figure 4.71 – Clear Mounting Tape

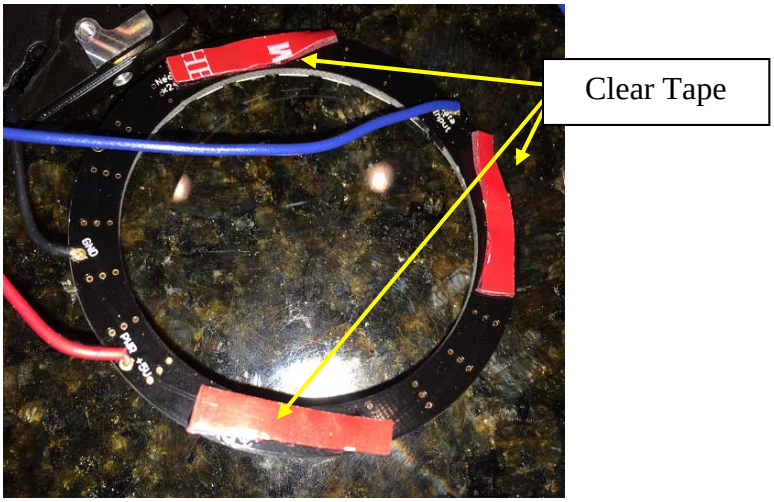

Figure 4.72 – Tape Applied

4.8 Apply Liquid Electrical Tape

I use liquid electrical tape to ensure the NeoPixel rings and connections remain isolated from metal surfaces. The liquid electrical tape provides an easy means to accomplish this. The tape can be also purchased in colors. I used black to keep with the look of my project. Do not worry if you see brush marks as most of the platter area is covered with the NeoPixels.

Figure 4.81 – Liquid Electrical Tape

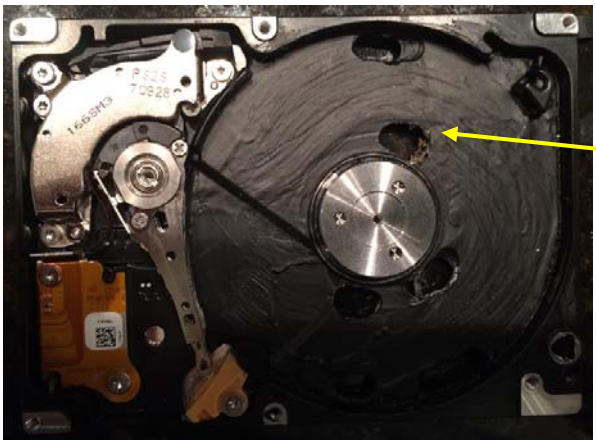

Figure 4.82 – Liquid Electrical Tape Applied

4.9 Install NeoPixel Rings

Install the NeoPixel rings on the hard drive. Run the NeoPixel ring wires through the holes drilled in the hard drive platter area. Remove the plastic tape covering and adhere each NeoPixel to the platter.

Figure 4.91 – NeoPixels Adhered

4.10 Install Circuit Board

Install the circuit board on the back of the hard drive. Carefully route the wires so they exit the slot created as shown below. Once the circuit board is in the proper position, attach the retaining screws.

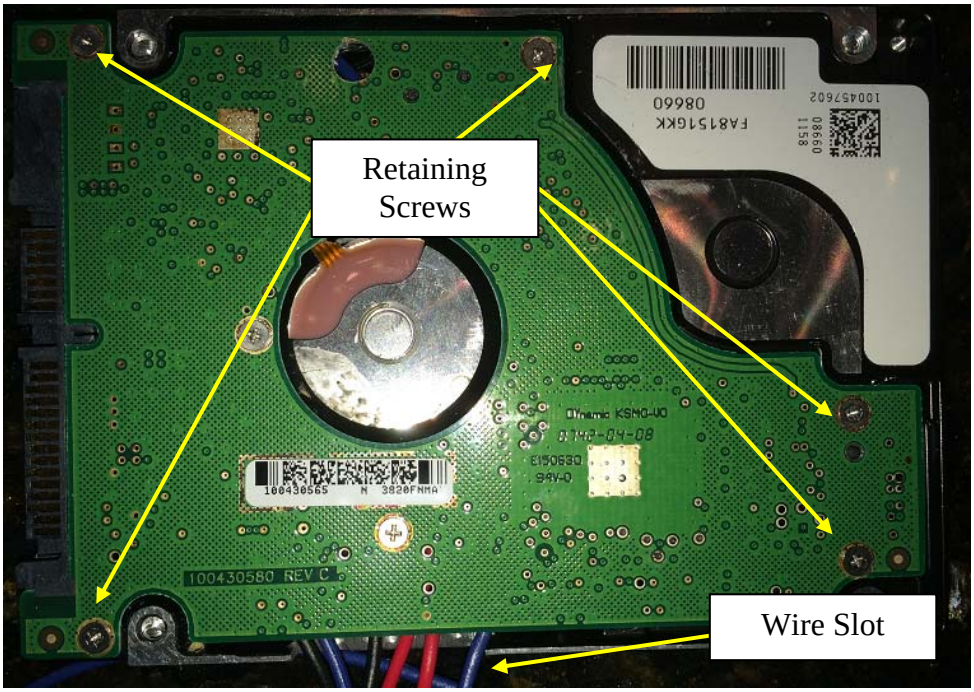

Figure 4.101 – NeoPixels Adhered

With the hard drive assembly completed, we work on the clock cover and base.

4.11 Countersink Base Attachment Holes

Countersink each of the base attachment holes so the head of the attachment screws will become recessed in the base when the base is attached to the cover. I use a 5/16" drill bit and turned it by hand in the existing hole.

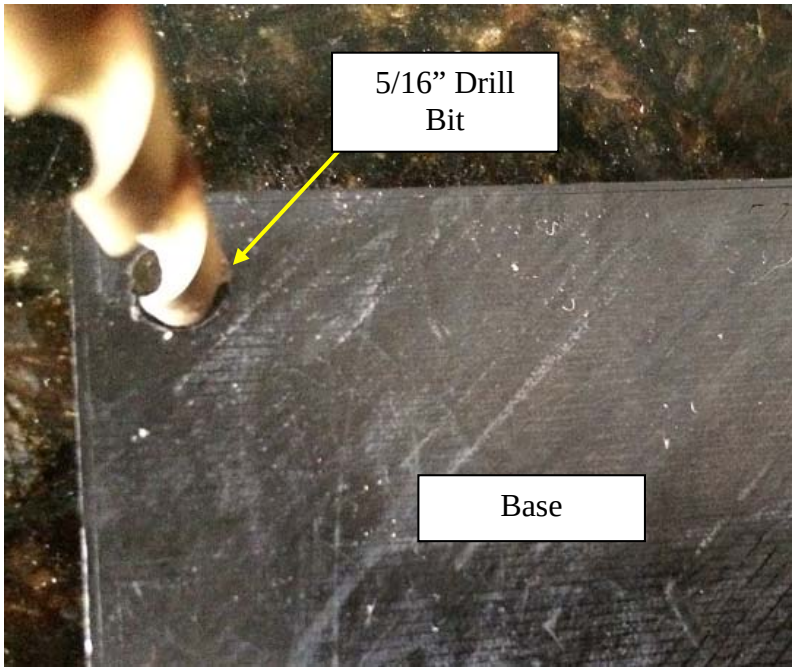

Figure 4.111 – Countersink Drill Bit

When all holes are completed, the base should look like the picture below:

Figure 4.112 – Countersink Holes Complete

4.12 Sand Clock Base and Cover

The pictures shown illustrate the clock cover and base once they have been sanded. Only the outside of the cover and base require sanding. Sand using 220 grit sandpaper.

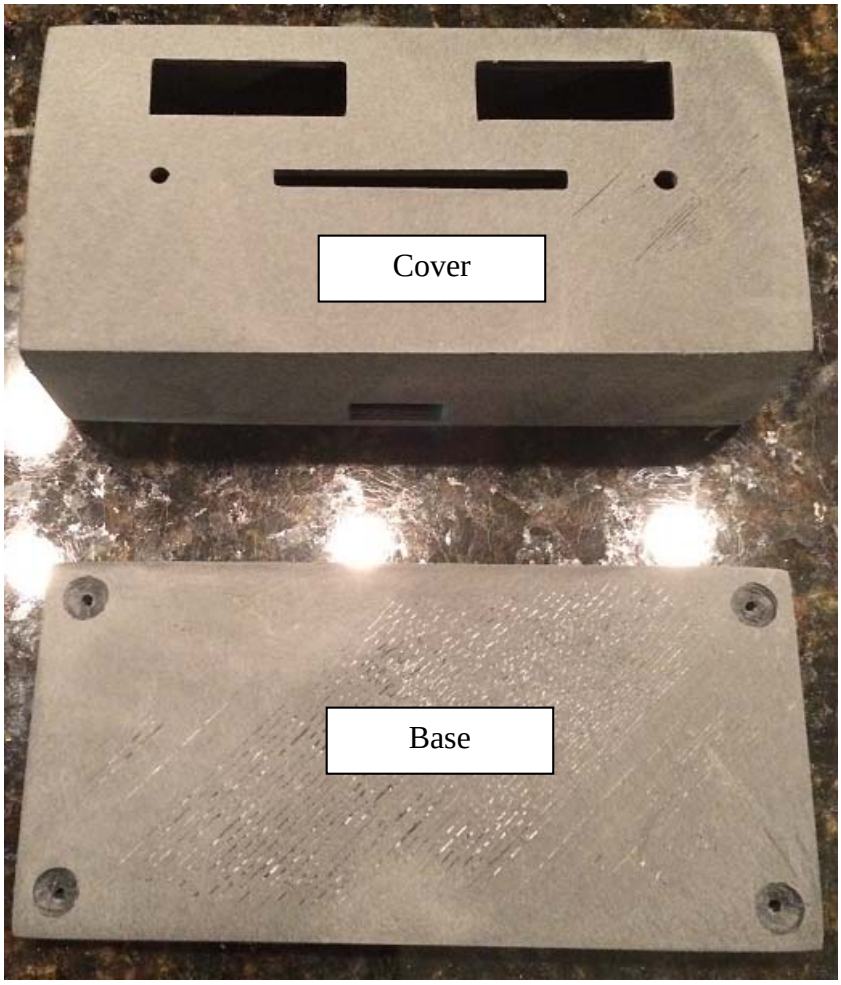

Figure 4.121 – Cover and Base Sanded

4.13 Solder and Attach Time Set Switches

The Hour and Minute time set switches are soldered next. As shown below, the switches are inserted into the cover. Solder a wire to each terminal of the switch. The center terminal is connected to the ground terminal on the Adafruit Metro Mini 328.

Once the wires were soldered to the switches, I use heat shrink around each terminal.

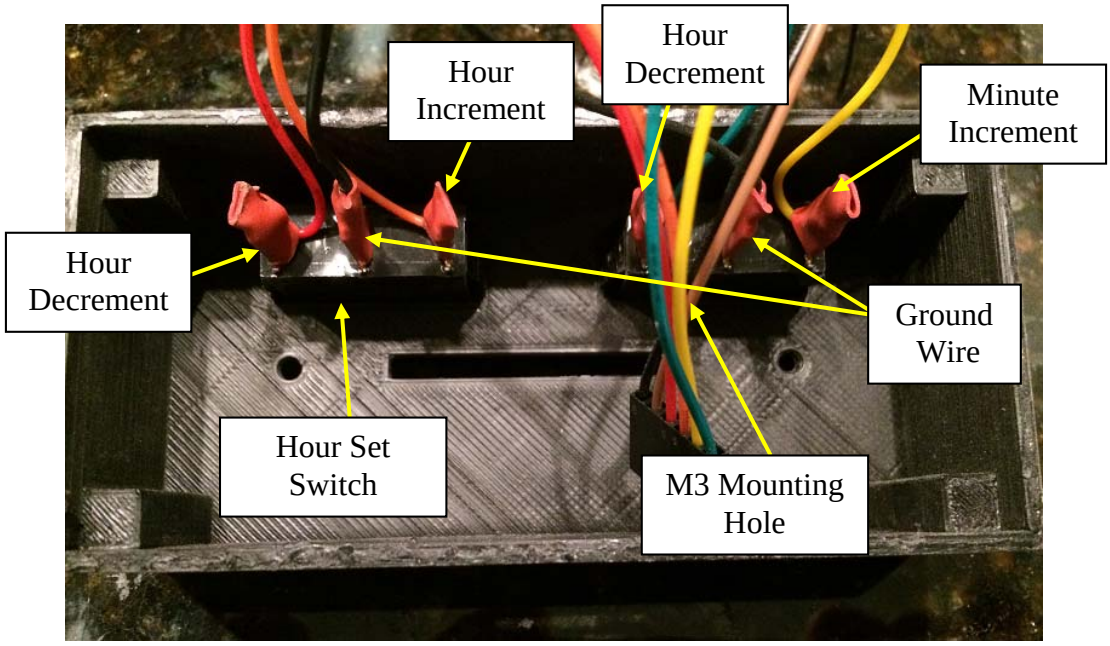

Figure 4.131– Hard Drive Time Set Switches

I used the 6 pin six inch socket cable as shown below for making attachments to the ChronoDot and the Adafruit Metro Mini 328. The socket to socket cable can be purchased at Adafruit.com https://www.adafruit.com/products/206 .

I cut one of the connectors off and used the connector end to slide over the .1" pins on the ChronoDot and Adafruit Metro Mini 328. The wire end was soldered to the switches.

Figure 4.132– Socket Cable

I also use two 3 pin servo extension cables for the making connection to power and the SCL/SDA terminals. The servo extension cables can be purchased at Adafruit.com https://www.adafruit.com/products/972 .

I cut the male end off and used the female end to slide over the .1" pins on the Adafruit Metro Mini 328.

Figure 4.133– Socket Cable

4.14 Attach Hard Drive to Cover

The hard drive will attach to the cover via the two threaded mounting holes on the hard drive. An M3 screw will be used to attach the hard drive to the cover. Since the screws I used were a little long, I used washers to prevent the M3 screw from bottoming out in the hole.

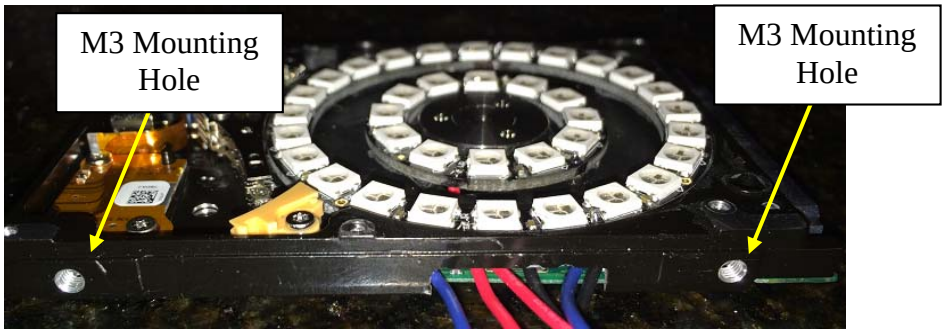

Figure 4.141– Hard Drive Mounting Holes

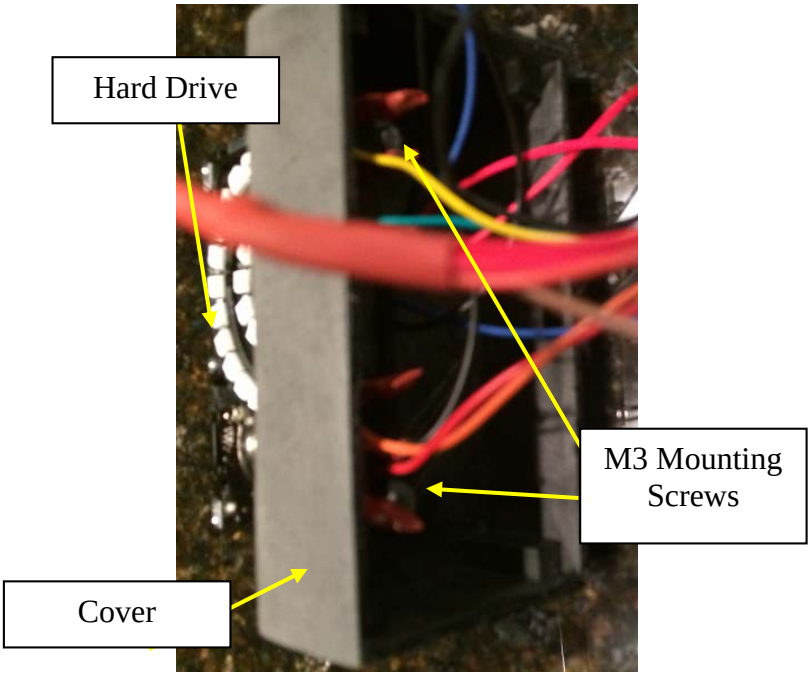

Figure 4.142 – Mounting Screw Location

4.15 Mount Components to Base

Mount the components to the base as shown below. Use the #2 screws recommended in previously. Do not tighten the ChronoDot too tight since you will need to turn it slightly when installing the cover and all of the wiring to aid in the assembly process.

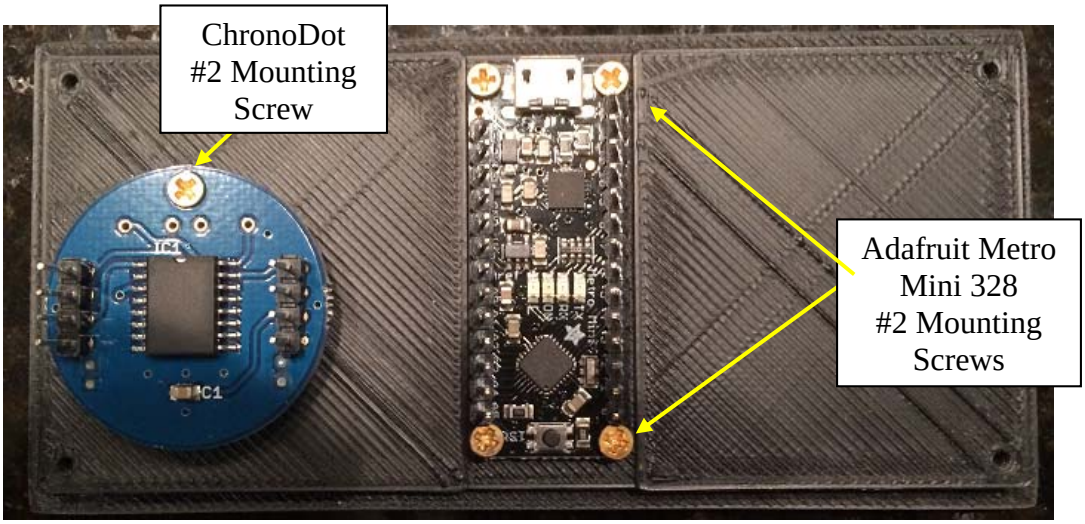

Figure 4.151– Base Components Mounted

Be sure to orient the Adafruit Metro Mini 328 as shown so the USB connector aligns with the cover when assembled.

4.16 Attach Wires to ChronoDot and Metro Mini 328

Attach all of the wires as detailed in the electrical schematic.

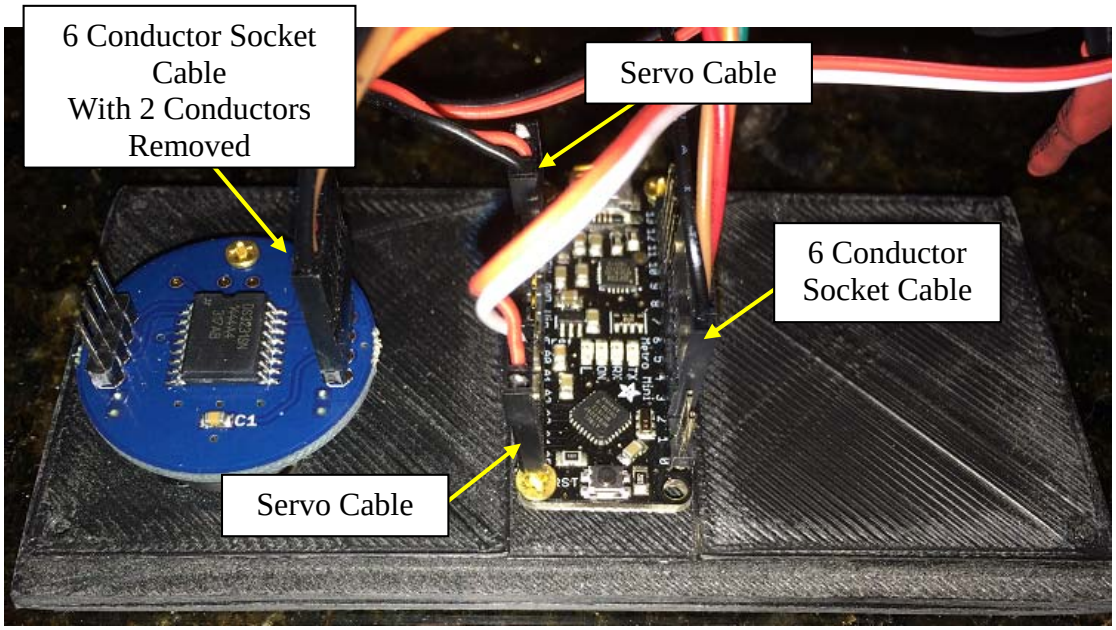

Figure 4.161– Wiring Attachments

4.17 Attach Base to Cover

Attach the base to the cover using the #4 Philips head screw as shown below.

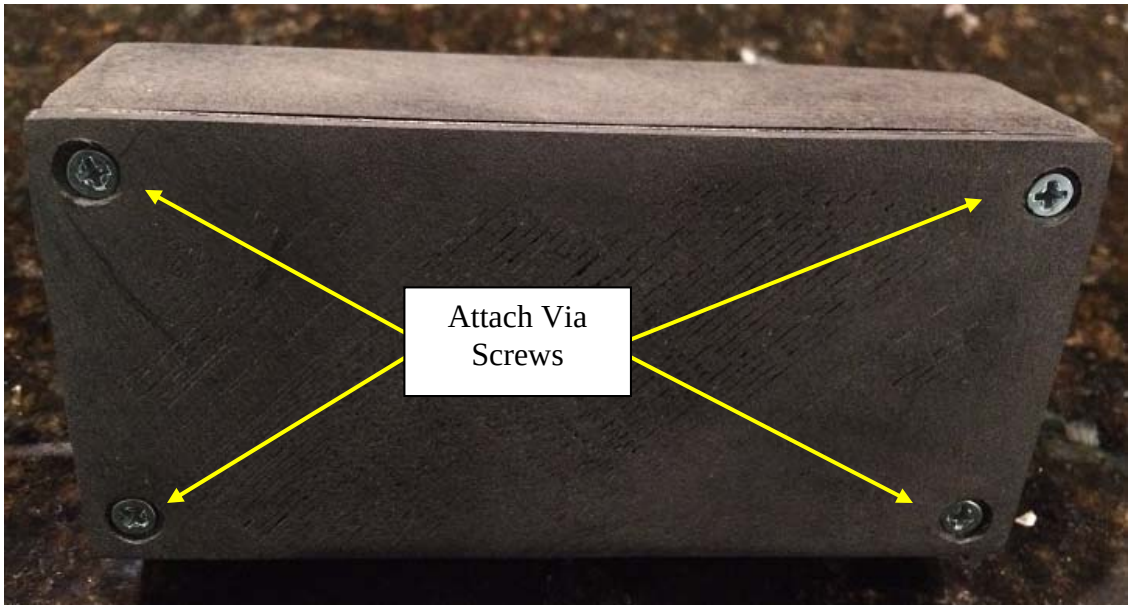

Figure 4.171– Wiring Attachments

When attaching the base, be sure you have all of the wires tucked so they are not pinched between the cover and the base. You may need to rotate the ChronoDot about the ChronoDot screw attachment point o get everything to fit nicely. I have built three of these clocks so I am positive this can be done with a little patience.

4.18 Apply Spray Lacquer to the Clock

With the assembly complete, I sprayed three coats of lacquer on the entire clock (Not just the 3D printed area). Wait about 30 minutes between coats and do not spray the clock in a humid environment. You may get some clouding if you apply the lacquer too heavy. This often disappears once everything is dry but it is best to avoid this in the first place by apply light coats to the clock. Once everything is dry, the time set rock switches will need to be exercised a few times to break free any lacquer that has dried around the switches. I have used satin and semi-gloss. The semi-gloss is less forgiving as far as showing defects.

Figure 4.181 – Lacquer

The pictures shown below illustrate what the first clock will look like after semi-gloss lacquer is applied.

Figure 4.182 – Front View after Lacquer Spray

Figure 4.183 – Side View after Lacquer Spray

Figure 4.183 – Rear View after Lacquer Spray

4.19 Wiring Diagram

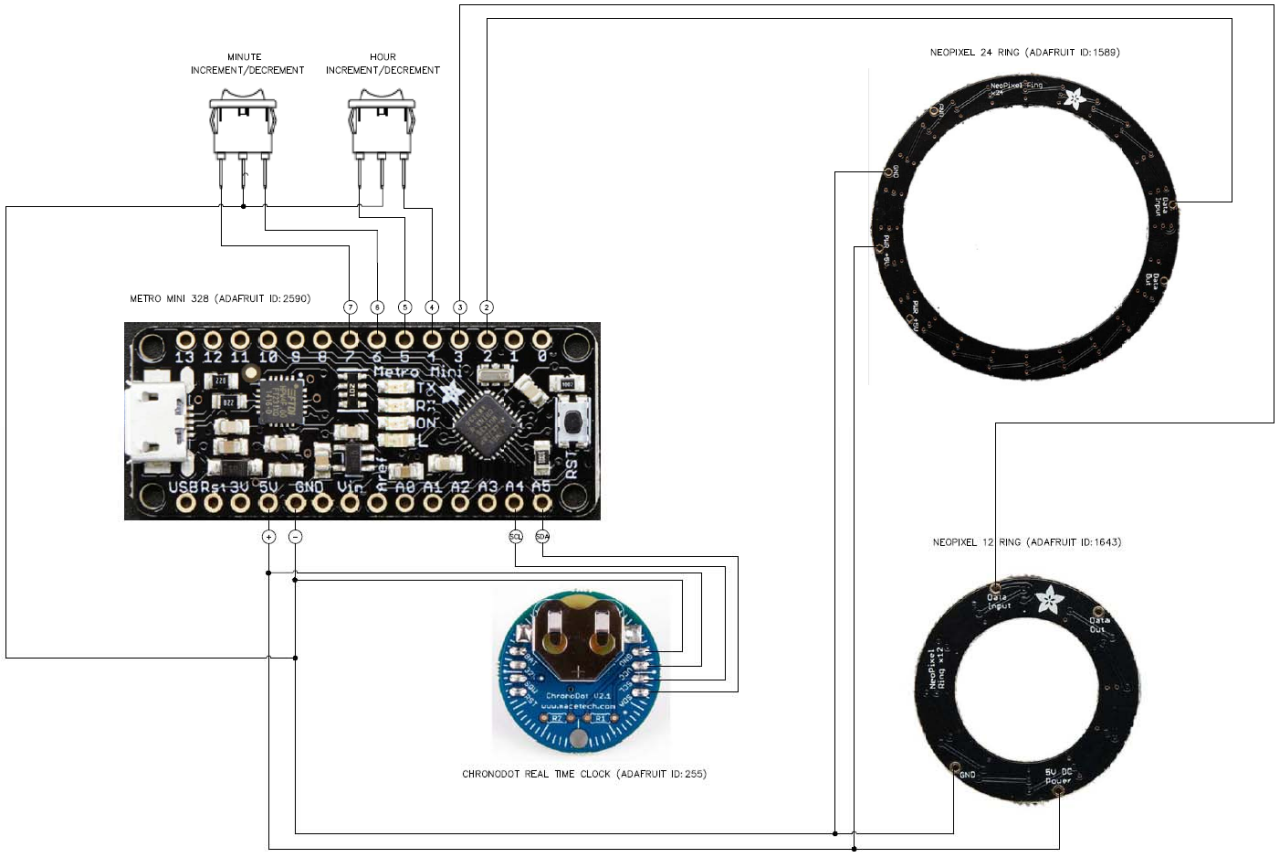

Figure 4.191 – Wiring Diagram

4.20 Attach Base / Bumpers

Bumpers should be installed to prevent the clock from scratching furniture. The pictures below shows the bumper installation.

Figure 4.201 – Mounting Screws Exposed

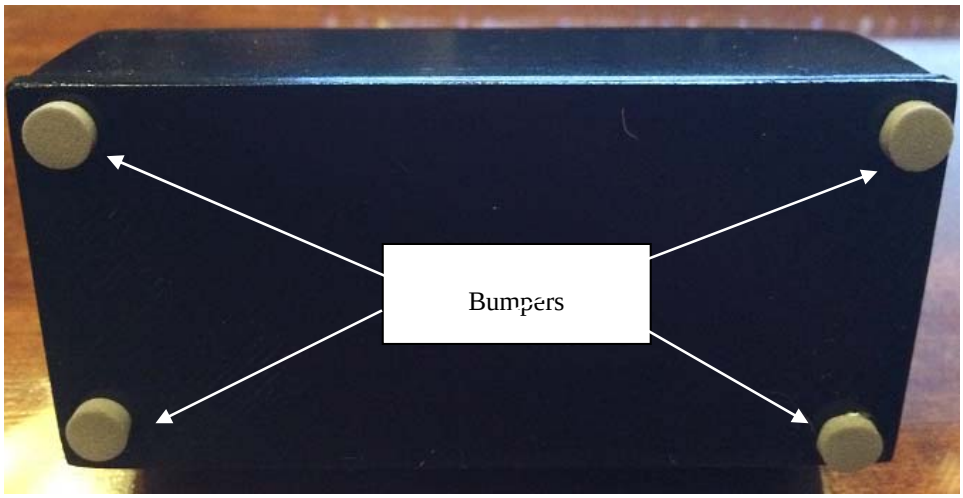

Figure 4.202 – Bumpers Attached

4.21 Program Adafruit Metro Mini 328

Plug a micro USB cable into the power/programming port on the back of the clock enclosure. Open the Arduino programming software and be sure to select the board type as “Arduino Uno” and set the appropriate port.

Once this is done, open the Hard_Drive_Clock sketch. Scroll down in the sketch until you see:

```
//******************RTC Initial adjustment ******************
// Run this to set the time to the PC Time on Arduino power up - comment out and download once you set the time
//   RTC.adjust(DateTime(__DATE__, __TIME__));
```

Remove the // from the following line and download the sketch.

```
//   RTC.adjust(DateTime(__DATE__, __TIME__));
```

Doing so will set the clock based on your computers date and time. Once this is done, add the // to the line and download once again. You must do this or every time you power on the clock, it will revert to the time you compiled the sketch and this defeats the purpose of a battery backed ChronoDot.

4.22 Make Power Connection

Plug the 5 VDC adapter into the micro USB port on the back of the enclosure.

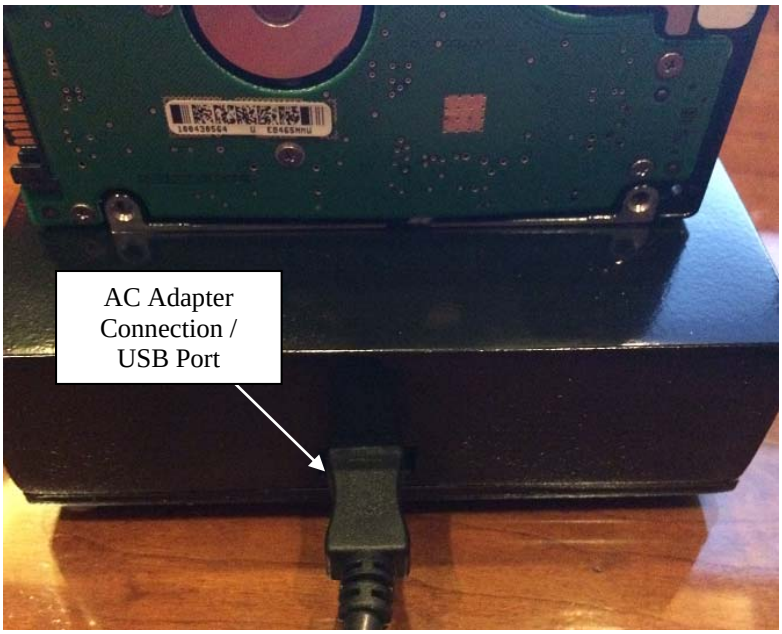

Figure 4.211 – Power / USB Connection

5 Time Set Switches

The two switches shown below are used to manually change the hours and the minutes without the need for connecting to a PC. This is useful for daylight savings time adjustment. A switch must be pressed for a few seconds before the clock will start performing the desired function.

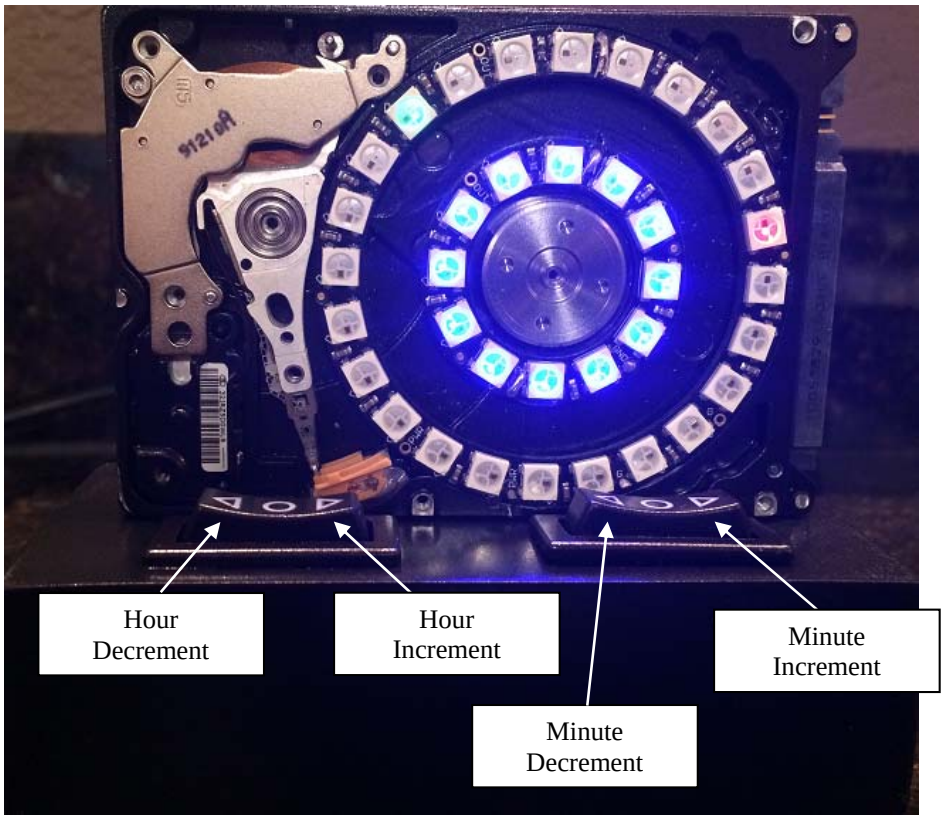

Figure 5.11 – Clock Time Set Switches

6 Time Displays

Hours – Outer Ring (Red LED)
The outer ring provide the hour hand indication via a red LED. The outer ring is comprised of a 24 pixel ring. When the minutes are greater than 30, the hour LED will advance by one. For example, if the time is 12:15, the top LED on the ring will be Red. If the time is 12:31, the LED to the right of the top LED will be illuminated. This simulates how an actual analog clock operates.

Minutes – Outer Ring (Green LED)
The time in minutes is shown as a green LED.

Hours = Minutes – Outer Ring (Blue LED)
When the Hour and Minutes occupy the same LED space, the LED will be blue. For example 3:15 will have one blue LED.

Figure 6.11 – Time is 2:50

Seconds – Inner Ring (White LED indicates seconds in 5 second increments)
The seconds are shown on the inner ring. The entire ring will change color and a white LED will appear every 5 seconds to indicate the actual number of seconds.

Figure 6.12 – Time is 2:50

Figure 6.13 – Time is 6:18

Figure 6.14 – Time is 6:45

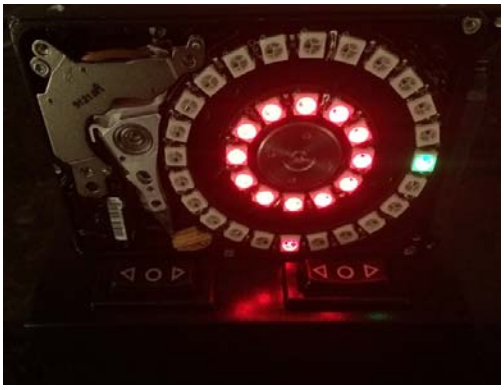

Figure 6.15 – Time is 6:18

7 Parts Listing

The parts listed below were used to make the clock.

Description	Purchased	Part #	Qty
Adafruit Metro Mini 328 - 5V 16MHz	Adafruit.com	Product ID: 2590	1
ChronoDot - Ultra-precise Real Time Clock - v2.1	Adafruit.com	Product ID: 255	1
NeoPixel Ring - 12 x WS2812 5050 RGB LED with Integrated Drivers	Adafruit.com	Product ID: 1643	1
NeoPixel Ring - 24 x WS2812 5050 RGB LED with Integrated Drivers	Adafruit.com	Product ID: 1586	1
5V 2A Switching Power Supply w/ 20AWG 6' MicroUSB Cable	Adafruit.com	Product ID: 1995	1
Servo Extension Cable - 30cm / 12" long	Adafruit.com	Product ID: 972	2
6-conductor 0.1" socket-socket cable - 6" long	Adafruit.com	Product ID: 206	1
Momentary (on)-off-(on) SPDT Up-Down Rocker Switches	EBay These are purchased in a pack of 5	http://www.ebay.com/item/380871128528	1
Lacquer	Lowes	Satin or semi-gloss	1
Screws	Lowes	#2 x 3/8” and #4 x ½ “	1
Bumpers	Walmart	-	1
Black Hips Filament	Lulzbot.com	Black HIPS 3mm, 1kg, filament (ESUN)	1