Electronics Online Challenge 2020

3D Printer

Monoprice Select Mini V2

Team #: 2211 A

Team Name: KHU Inventors

School: Homeschool

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Summary Report

Our team wanted to take apart a unique device for this challenge and decided to disassemble a 3d Printer. A 3D Printer is an electronic device that can build a three-dimensional object by laying down successive layers of melted material. We love 3d printing and wanted to know more about the components inside.

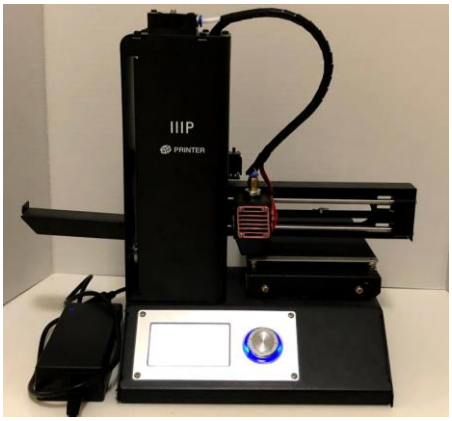


Fig. 1. Monoprice Select Mini V2 3D Printer

The process began by removing the bottom and side metal plates. This revealed the internal components of the printer. We separated and catalogued each component and started researching its functions.

For the small components on the motherboard and LCD screen board, we used the component code to search, finding datasheets, photos, and interesting information. Some components had logos and names of their companies, but others had just numbers. Because of this, we searched for the company that makes that type of component and found information for almost all. We did not find any TI components.

The internal parts have cable connectors used to attach components with cables to the board. Capacitors store electricity in a circuit and release it when necessary. The integrated circuits hold thousands of small components in a small volume. Resistors limits and reduces the amount of current in an electric circuit. Crystal Oscillators use quartz crystals to create a constant electric signal. A rotary encoder is used to navigate around the LCD screen. A Coil filters and stops high frequency electric currents. The transistors amplify or switch electrical power in an electric circuit. The Sd Card Holder connects an SD card to the motherboard and loads the file to be printed. The Micro USB Connector connects a micro USB cable to the board. Many diodes allow electricity to pass in one direction, while blocking it in the opposite direction.

For the external electrical components, we discovered that the motors were stepper motors: a type of motor that move in discrete steps. They have multiple coils that are organized in groups called "phases". By energizing each phase in sequence, the motor will rotate, one step at a time. They control all the 3d printer's movements. The motors were attached to different mechanisms like gear belts and screw shafts. The extruder is the component in charge of melting and extruding plastic. There also were fans, limit switches, potentiometer, LCD screen, and LED lights.

There were many learning experiences during this process. We learned how to catalogue and research about a specific electrical component. We discovered that there are many different manufacturers and that a standard alphanumeric code is used to identify parts in a motherboard. It surprised us that there were three different types of stepping motors working together. We learned about the different technologies included in the construction of the primer, like the surface mount technology which makes flat, small components, like resistors, to occupy less space. Finally, this experience helped us understand in depth how a 3d printer works and how it is built. This knowledge will help us improve our workflow while solving the challenges we encounter.

Final Summary Word Count: 495

Deconstruction Photos

Fig. 1. Inside of the 3d Printer

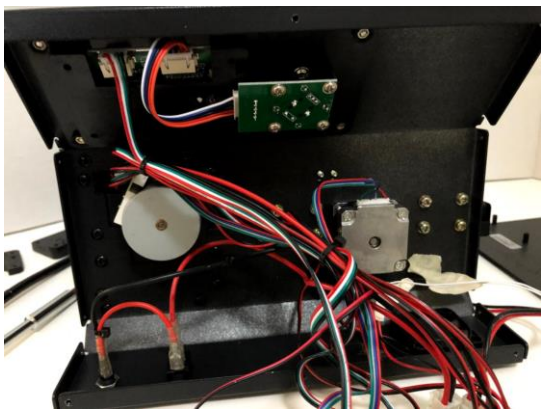


Fig. 2. Motherboard connected to every component

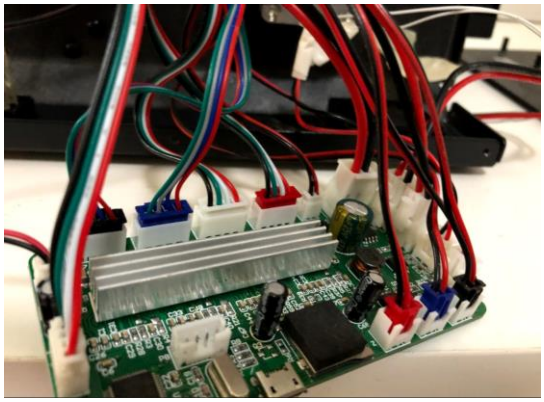


Fig. 3. X and Y axis Stepper motors

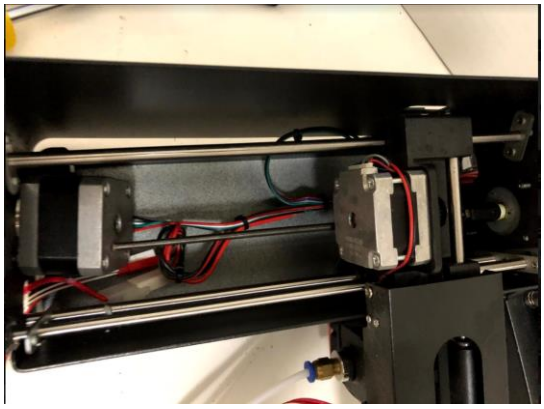


Fig. 4. Y-axis movement Mechanism

Fig. 5. The x-axis moves the extruder with a gear,belt attached to a stepper motor.

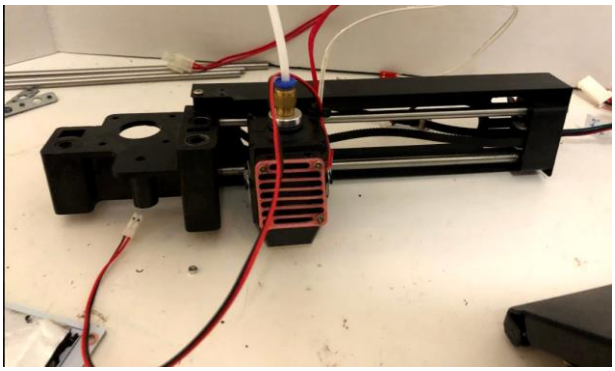


Fig. 6. Electric Components connected to the motherboard

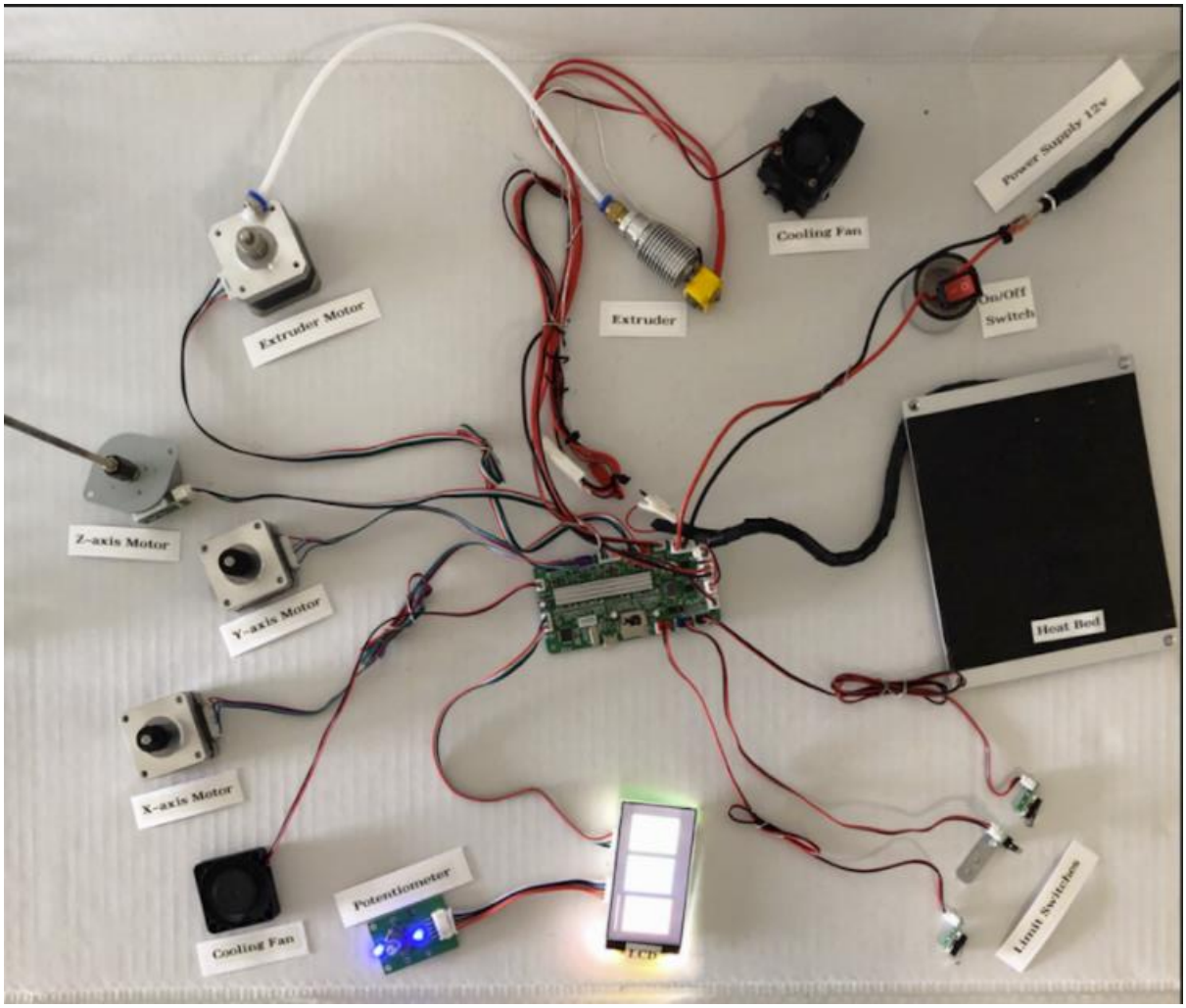


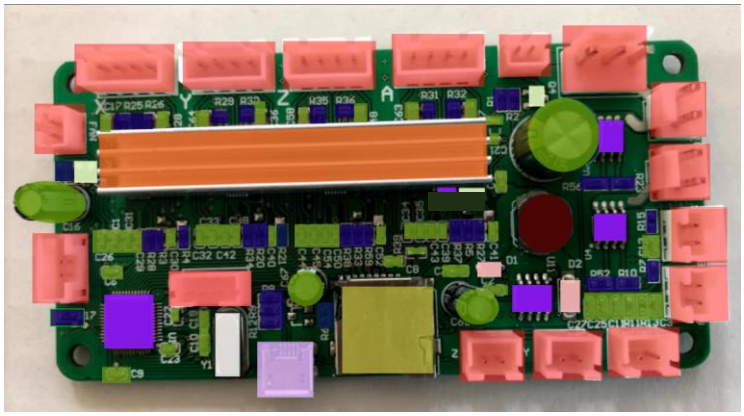
Fig. 7. Miscellaneous Parts

Fig. 8. Metal Frame Parts

Circuit Boards Photos

1) Motherboard

Fig. 9. 3d Printer Motherboard



Cable Connectors Capacitors Coil ICs

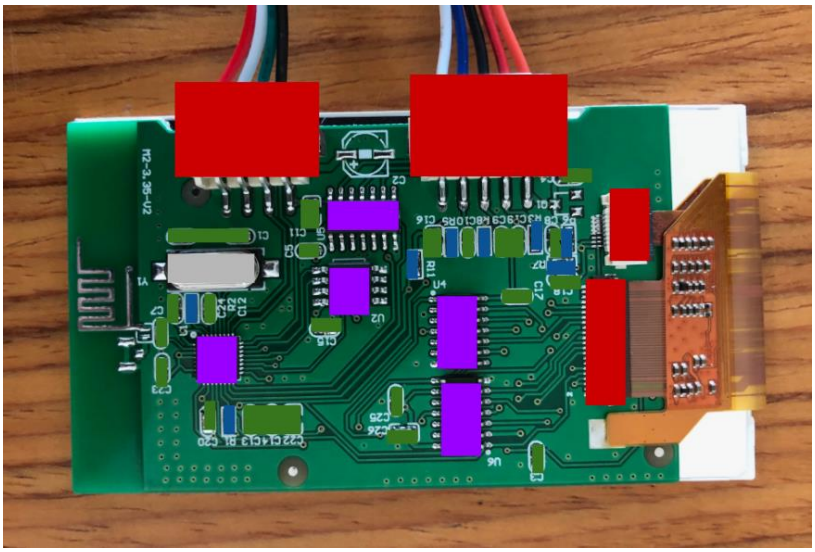
Resistors Transistors SD Card Holder

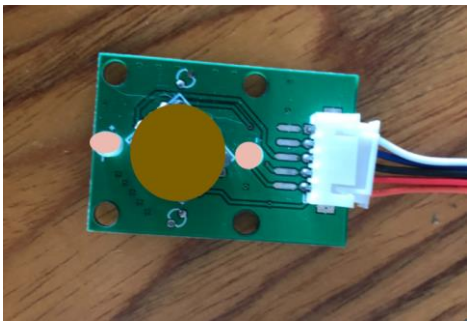
Cristal Oscillator Micro USB Connector

Diodes Heat Dissipator (mounted in 4 ICs)

Fig. 10. Color Coded Motherboard

2) User Interface





Cable Connectors Capacitors ICs

Resistors Cristal Oscillator

Potentiometer Led Lights

Fig. 11, 12. Color Coded User Interface Components

Research Process

Table 1 – User Interface Components

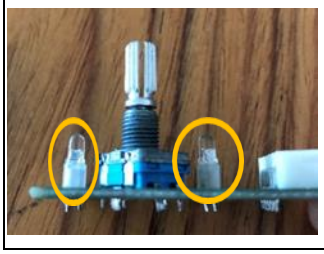
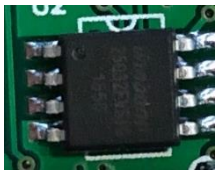
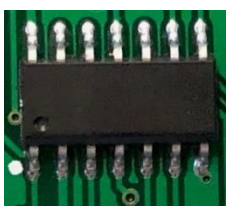
Component	Quantity	Function/Comments
LCD Screen 	1	Displays images using liquid crystal properties. This LCD displays the user interface.
Rotary Encoder 	1	Measures the rotation of the control knob. Used to navigate through the screen.
LED lights 	2	Light Emitting Diodes (LED) illuminate the border of the control knob in a blue color.

Table 2 – Integrated Circuits

Component	Quantity	Description	Manufacturer	Information
STM32F070CBT6 	1	ARM®-based 32-bit MCU processor	ST Microelectronics	Datasheet
HR4988 	4	Stepper Motor driver	Shenzhenshi YONGFUKANG Technology	Datasheet
ESP8266EX 	1	Wifi microchip - 32-bit MCU & 2.4 GHz Wi-Fi SoCs	Espressif Systems	Datasheet
25Q32FVSIG 	1	32m-bit serial flash memory	Winbond	Datasheet
74HC164D 	3	8-bit serial-in, parallel-out shift register	NXP Semiconductors	Datasheet

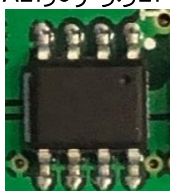
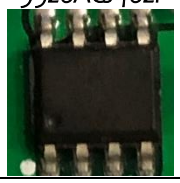
XL1509 -3.3E1 	1	2A 150KHz 40V Buck DC to DC Converter	unclassified manufacturer	Datasheet
9926ACJ462F 	2	Electric Power control	KIA Semiconductor	Datasheet

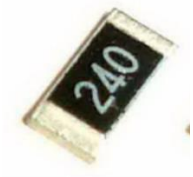
Table 3 – Other Small Components

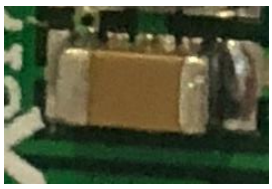
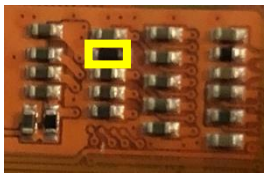
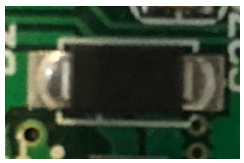
Component	Quantity	Function/Comments	Manufacturer
YXC8.OSDX Crystal Oscillator 	2	Sends a constant electric signal. Used for calculating time.	Yangxing Technology
70uf25v Capacitor 	1	Stores electricity and releases it if necessary.	Chengx
2uf16v Capacitor 	3	Stores electricity and releases it if necessary.	Chengx

470 Inductor Coil 	1	Filters and stops high frequency electrical currents.	Shenzhen Coilank Technology Co., Ltd.

Table 4 – Surface Mounted Devices (SMD)

SMDs are circuit components made flat to occupy less space in the board.

Component	Quantity	Function/Comments	Manufacturer
R500 Resistor 	8	Reduces the amount of current in a circuit.	There are many possible manufacturers
240 Resistor 	6	Reduces the amount of current in a circuit.	There are many possible manufacturers
822 Resistor 	3	Reduces the amount of current in a circuit.	There are many possible manufacturers
472 Resistor 	3	Reduces the amount of current in a circuit.	There are many possible manufacturers

01C Resistor 	9	Reduces the amount of current in a circuit.	There are many possible manufacturers
332 Resistor 	3	Reduces the amount of current in a circuit.	There are many possible manufacturers
01B Resistor 	1	Reduces the amount of current in a circuit.	There are many possible manufacturers
SMD Capacitors 	92	Perform various functions that require small capacitance values	There are many possible manufacturers
Small SMD Diodes 	3	Allows electric current to pass in one direction, while blocking it in the opposite direction.	Diodes Inc.
SK34 Diode 	1	Allows electric current to pass in one direction, while blocking it in the opposite direction.	Diodes Inc.

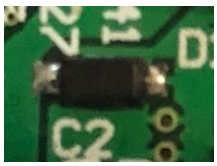
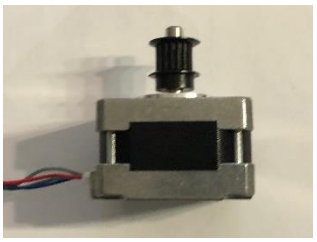
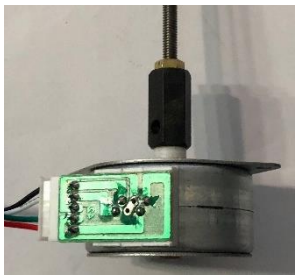
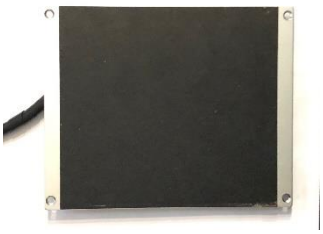
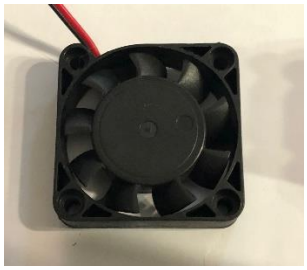
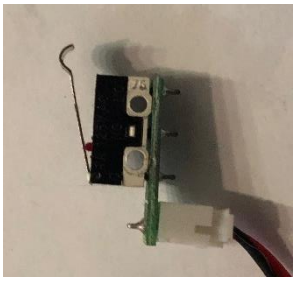
4F Diode 	1	Allows electric current to pass in one direction, while blocking it in the opposite direction.	Diodes Inc.
A2L SMD Transistor 	2	Amplifies or switches an electric current.	Advanced Semiconductor Inc.

Table 5 – External Electric Components

Component	Quantity	Function/Comments	Manufacturer
X-axis Stepper Motor (CF3925-100-SL) 	1	Controls sideways motion along the x-axis of the 3d printer. This motor is connected to a linear movement mechanism.	Casun
Y-Axis Stepper Motor (CF3925-100-SL) 	1	Controls sideways motion along the y-axis of the 3d printer. This motor is connected to a gear belt.	Casun

Z-axis Stepper Motor 	1	Controls vertical motion along the z-axis of the 3d printer. This motor is connected to a screw shaft that move the extruder up and down.	Casun
Extruder Stepper Motor (CD4234-100-SL) 	1	Controls the flow of filament in the extruder.	Casun
Extruder 	1	Melts and ejects material in liquid or semi-liquid form and deposits it in successive layers within the 3D printing volume.	Kingroon
Heat Bed 	1	Makes the cooling process of 3D-printed materials more controlled, for better results. Keeps the 3d printed part at a certain temperature.	Monoprice

Fans 	2	Cools the extruder, heat bed, and internal components when needed.	Dongguan Shuangteng Fang Industrial CO.
Mechanical Limit Switches 	3	Limit switches are sensors that allow the 3D printer to stop moving at a certain point.	Wenzhou Gangyuan Electronics Co.

Disassembly Video Link: [Disassembling a 3d Printer - KHU Inventors 2211-A - YouTube]

Research Sites

- ALLDATASHEET.COM - Datasheet search site for Electronic Components and Semiconductors and other semiconductors.
- Electronic Circuit Symbols: Component Schematic Symbols » Electronics Notes (electronics-notes.com)
- Circuit Board Parts - The Most Comprehensive Introduction Is Here (wellpcb.com)
- Replacement Parts [MP Select Mini / Malyan M200 3D Printer]
- Building a 3D Printer: Limit Switches (drdflo.com)
- Stepper Motor (lamtechnologies.com)
- Home - STMicroelectronics
- A2L - Miscellaneous - Semiconductor | Galco Industrial Electronics
- Rotary Encoder - MP Select Mini V1 and V2 - GigDigit
- List of IC Manufacturer Codes - The PCB Design, Assembly, and Trends Blog (ultralibrarian.com)
- Top Integrated Circuits Manufacturers and Suppliers in the USA and Internationally (thomasnet.com)
- How to identify computer chips or integrated circuits on circuit boards - a great resource for How To's from Wikia (fandom.com)
- BCM4712 (broadcom.com)