**ELECTRONICS ONLINE CHALLENGE 2021**

VEX Transmitter and Receiver Part # 0-276-2153

Team 10C (Creation)

Exothermic Robotics

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## FINAL SUMMARY REPORT:

On a whim, I decided to check out the oldest picture we had in the gallery of the Exothermic Robotics website. Briefly described, it's a group photo of an all-girls team making V-signs over their—presumably victorious—robot. Sweet, I thought, but then I noticed that the girl farthest left in the picture was holding a—block? After inquiring my teammates as well as some of the more senior members of the club, I discovered that this so-called "block" was actually a VEX transmitter and receiver, and that we still had one of them lying around. Visually, it is easy to notice the huge improvements that have been made to the VEX controller over the years, yet what is less obvious are the advancements of the inner components—and that is what piqued my curiosity the most. And thus, the old VEX controller would soon meet its fateful demise, carried out by its greatest mortal enemies: the screwdriver and my own two hands.

The VEX controller beeped its final breaths as I pried open its case. Inside was a whole electronic ecosystem of its own, and included components such as coils, inductors, plugs, capacitors, switches, resistors, transistors, a crystal oscillator, and even items such as an Ethernet port and an LCD. Additionally, little microchips were scattered about on the PCB. With everything disassembled, I began the research process. To quickly summarize the roles of each of the components, coils produce a magnetic field, inductors store energy in a magnetic field, plugs join electrical conductors, capacitors store/release electrical energy, switches connect or disconnect electricity, resistors provide electrical resistance, transistors control the flow of current, and crystal oscillators create an electrical signal with constant frequency. The microchips, on the other hand, proved to be nightmarish to research: I only ended up successfully tracing two of the microchips back to the manufacturer, while the rest remained unidentified. The first chip was manufactured by Microchip Technology and supports bidirectional wire bus and data transmission protocol, while the second chip was manufactured by Rohm and mixes and selects digital/analog signals. Unfortunately, no TI components were found.

Through this process, I not only gained novel perspective about electronic components themselves—from their miniscule size to their vast numbers and indispensable functions—but I also gained a new realization regarding the significance of research. At the beginning of the project, I had little to no knowledge about electronic components, yet after hours of research online, I can confidently assert that I have learned quite a bit. Additionally, I discovered how essential patience, perseverance, and problem-solving are in the research as well as deconstruction process. During the deconstruction procedure, I ran across several issues including a stripped nail, forcing me to brainstorm various solutions—many of which failed. Likewise, while researching, I had to rearrange keywords numerous times to find an answer, and even then, I was often unsuccessful. However, these "failures" in research simply reminded me that investigation is a never-ending process: one can always dig deeper.

Word Count: 500

## THE EXTERNAL ANATOMY


**FIGURE 1.0:** Top view

**FIGURE 1.1:** Bottom side view

**FIGURE 1.2:** Right side view

**FIGURE 1.3:** Top side view

**FIGURE 1.4:** Left side view

**FIGURE 1.5:** Back view


**FIGURE 1.6:** VEX Label


**FIGURE 1.7:** Missing Frequency Module

## DECONSTRUCTION PROCESS

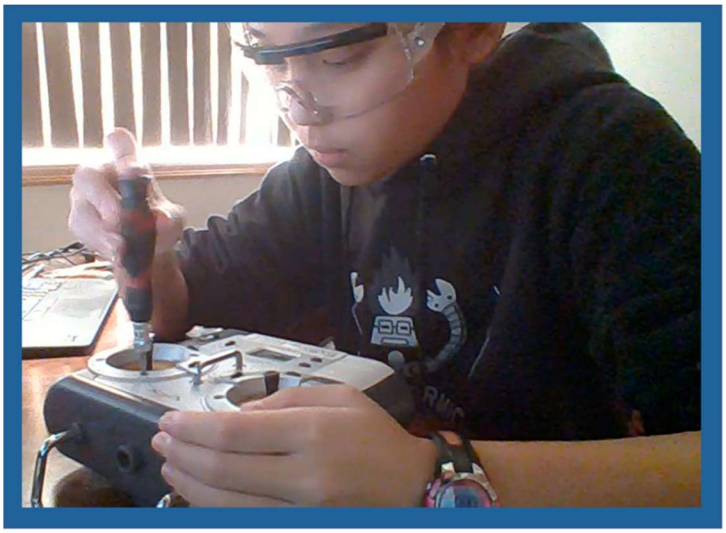


**FIGURE 2.0:** Removing screws on the front of the controller


**FIGURE 2.1:** Front screws removed

**FIGURE 2.2:** Removing screws on the back of the controller

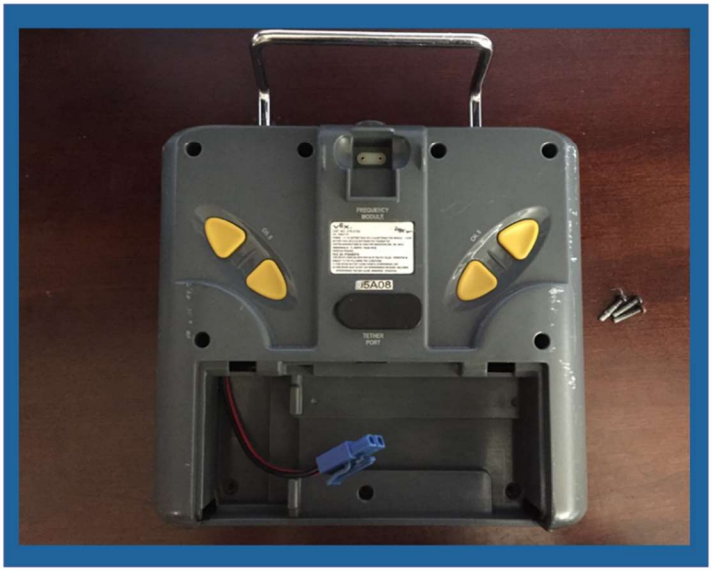


**FIGURE 2.3:** Three of the back screws removed

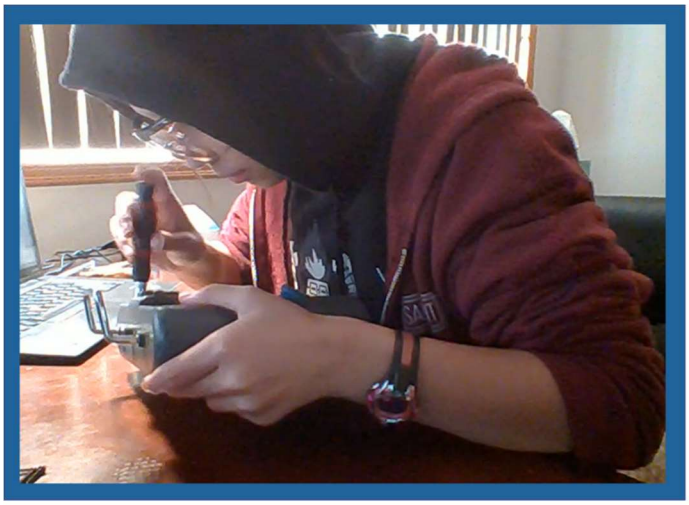


**FIGURE 2.4:** Several screws on the back were too deep for the screwdriver to reach

**FIGURE 2.5:** Switched to a new screwdriver, solved the problem!

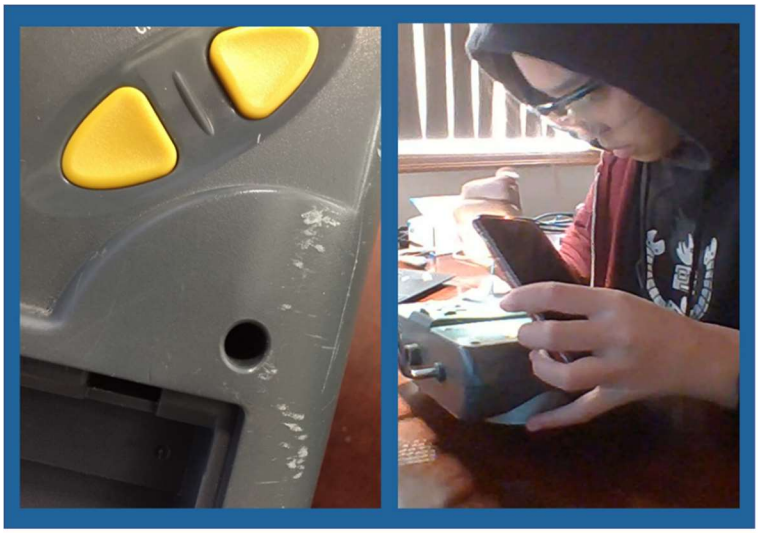


**FIGURE 2.6 – 2.7:** Using a phone's flashlight to examine a stripped screw

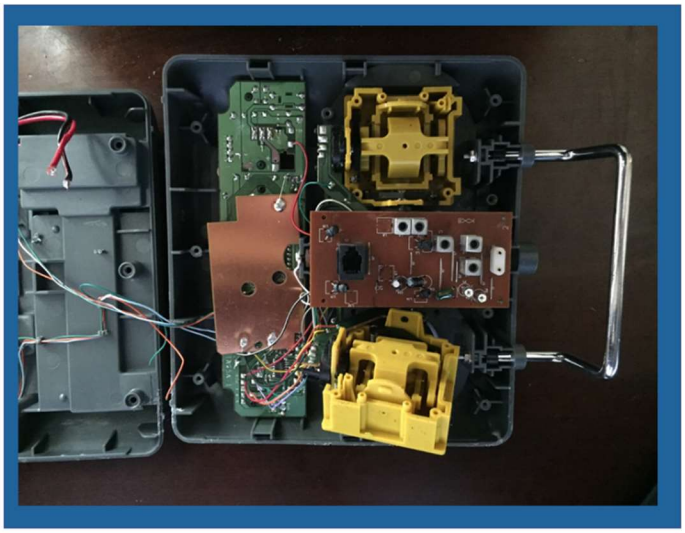


**FIGURE 2.16:** Inside of the controller. I had to pry it open because of the stripped screw.

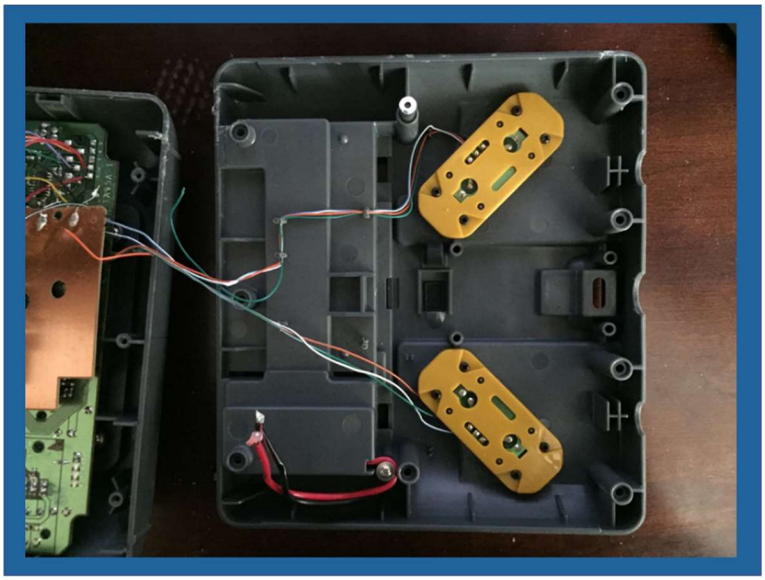


**FIGURE 2.9:** Other part of the inside of the controller

**FIGURE 2.10 – 2.12:** Taking off the yellow cover protecting a circuit board

**FIGURE 2.13:** Yellow buttons for the different channels on the controller

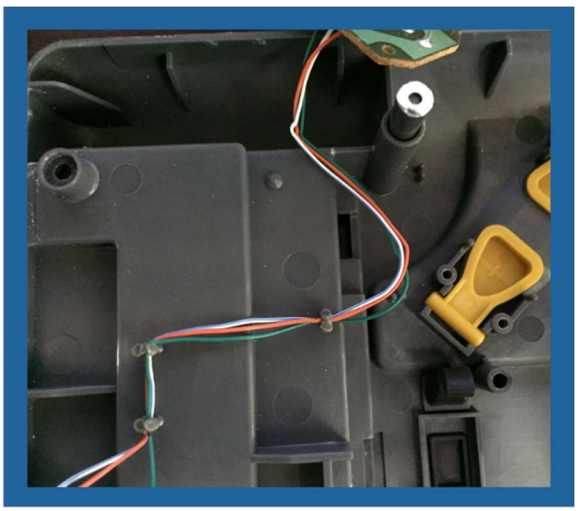


**FIGURE 2.14:** Wires attached to the case

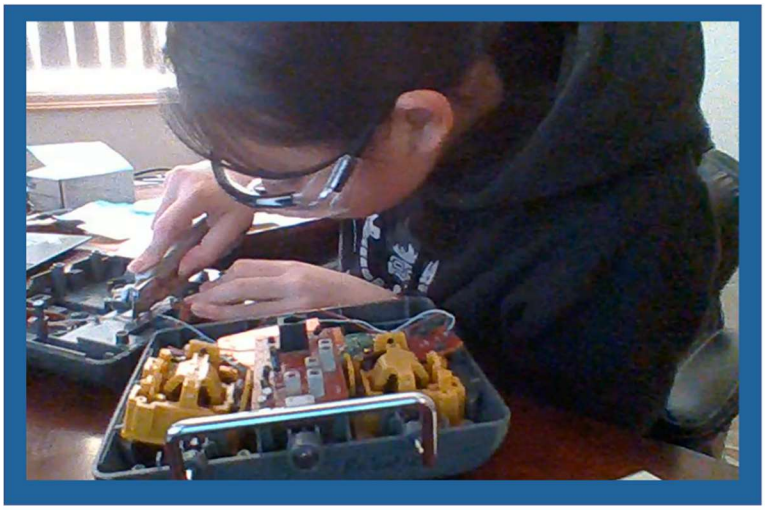


**FIGURE 2.15:** Using X-ACTO knife to free the wires from the case

**FIGURE 3.4:** Freeing the battery wire from the case

**FIGURE 2.17:** Battery wire is freed!

**FIGURE 2.18:** Pulled out battery wire from case

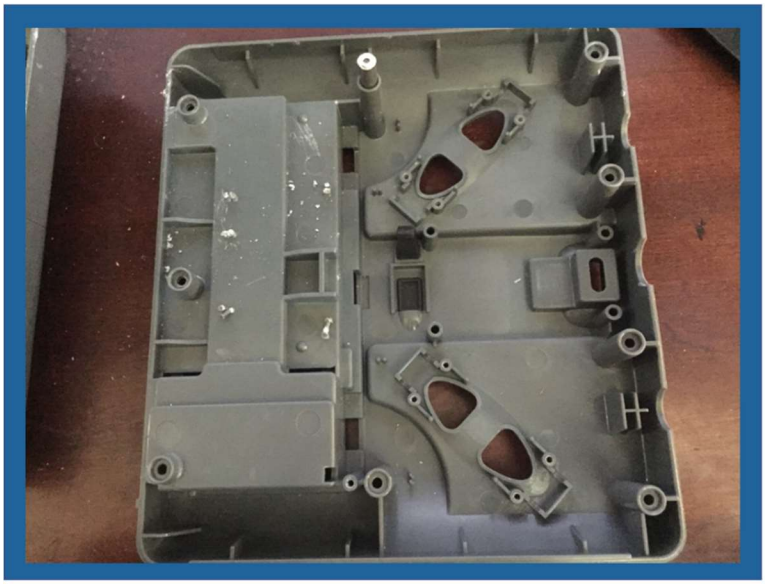


**FIGURE 2.19:** Inner part of back of the case


**FIGURE 2.20:** Outer part of back of the case

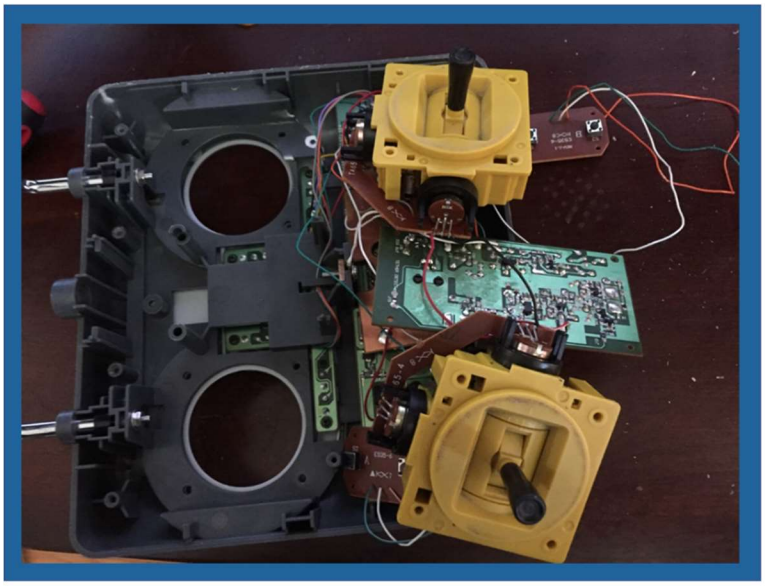


**FIGURE 2.21:** Inside of the other part of the case

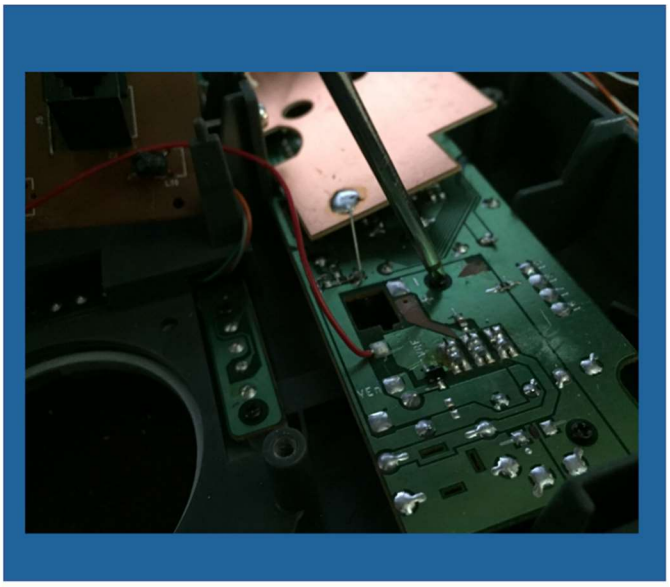


**FIGURE 2.22:** Unscrewing another circuit board from the case

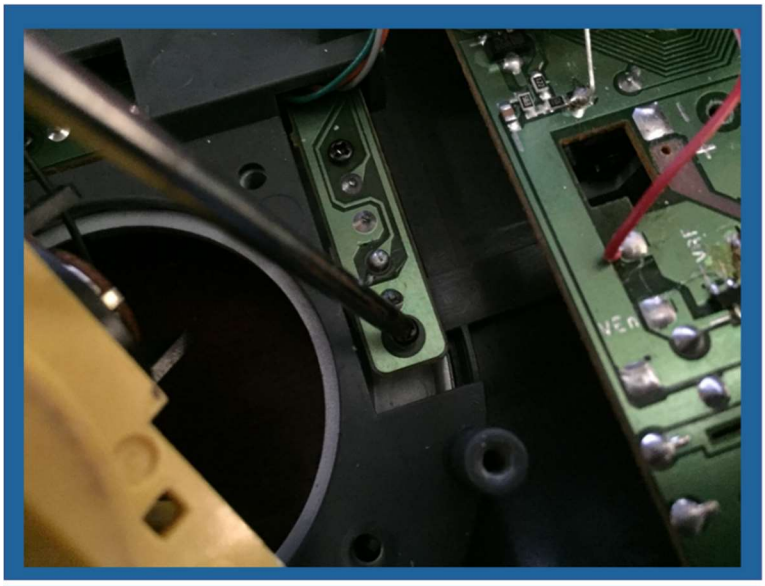


**FIGURE 2.23:** Unscrewing *another* circuit board from the case

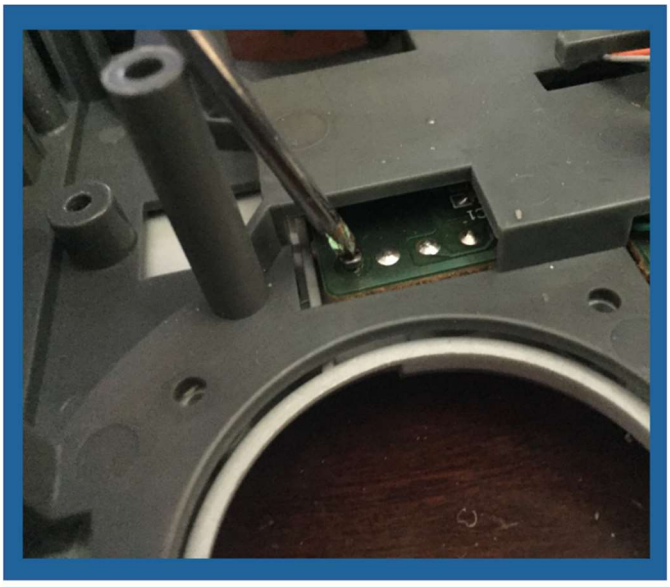


**FIGURE 2.24:** Still unscrewing the circuit board

**FIGURE 2.25:** Loosening the nut attaching the metal handle to the case w/ pliers

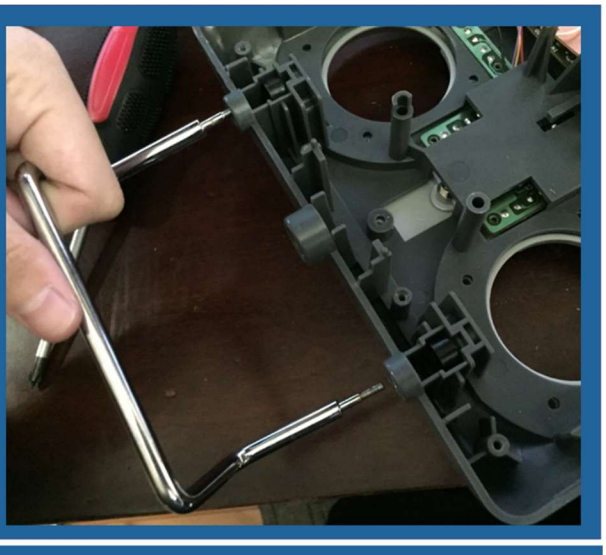


**FIGURE 2.26:** Removing the handle!

**FIGURE 2.27:** Outer part of front of the case

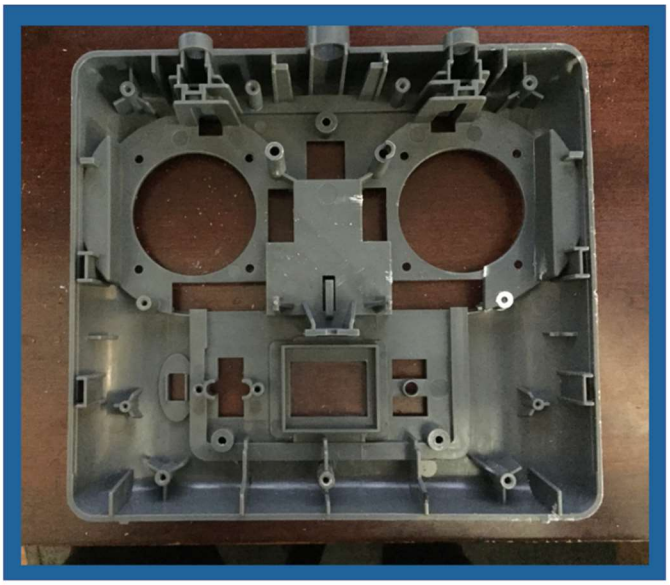


**FIGURE 2.28:** Inner part of front of the case

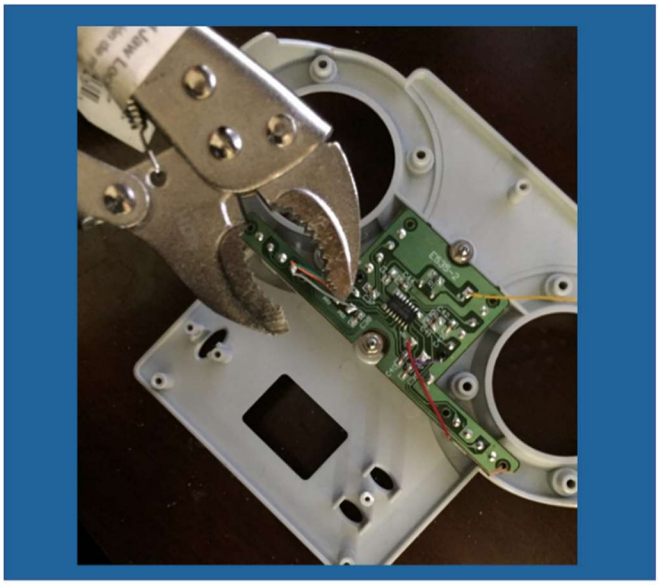


**FIGURE 2.29:** Preparing to detach the circuit board from the case


**FIGURE 2.30:** Silver part of the case

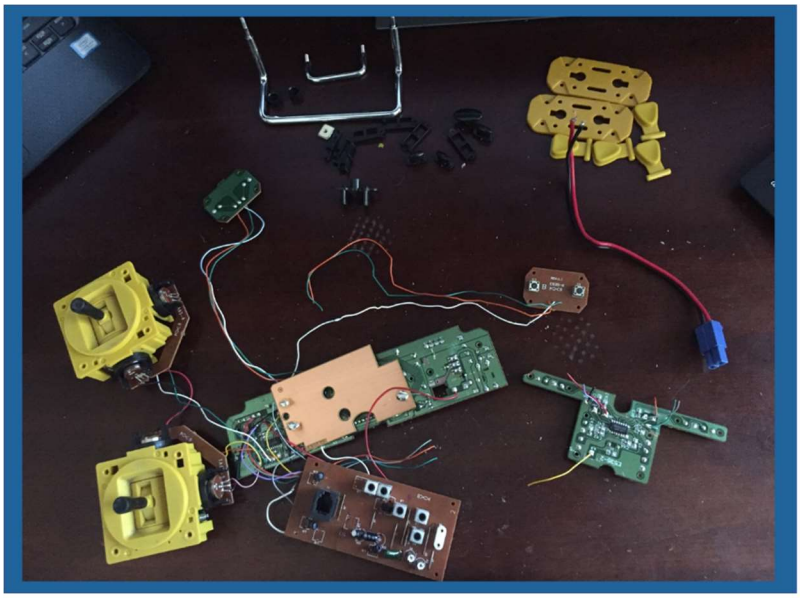


**FIGURE 2.31:** All the internal components!

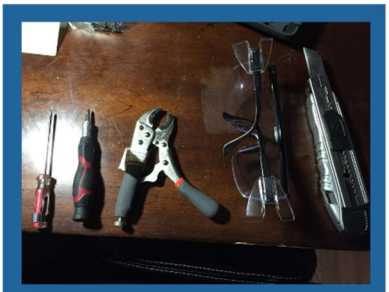


**FIGURE 2.32:** Tools for the deconstruction process

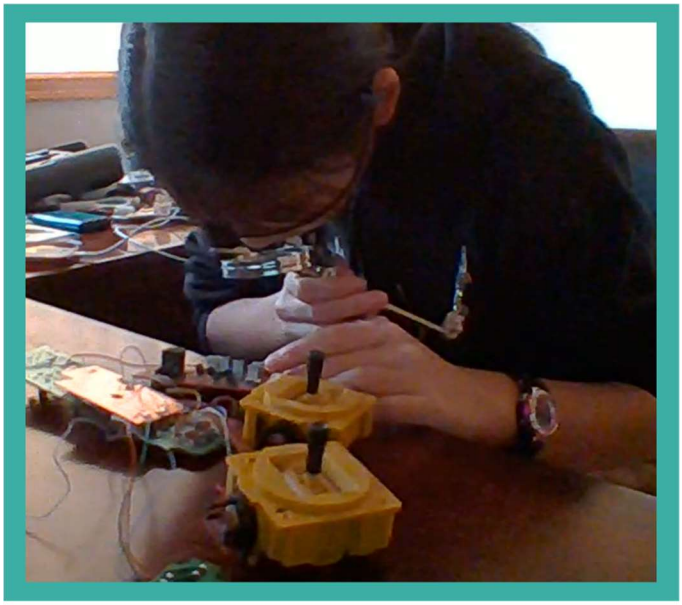


FIGURE 3.0: Using a magnifying glass to examine the circuit board components

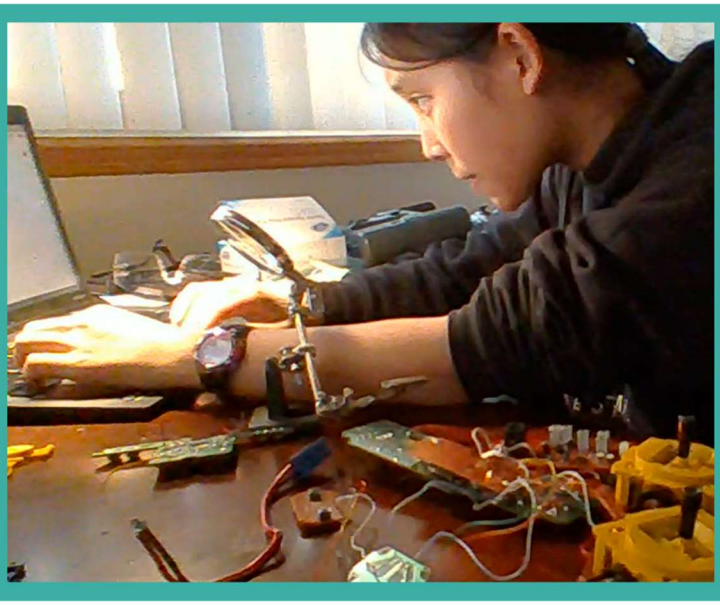


FIGURE 3.1: Researching components online by looking at datasheets, overviews, forums, and wikis.

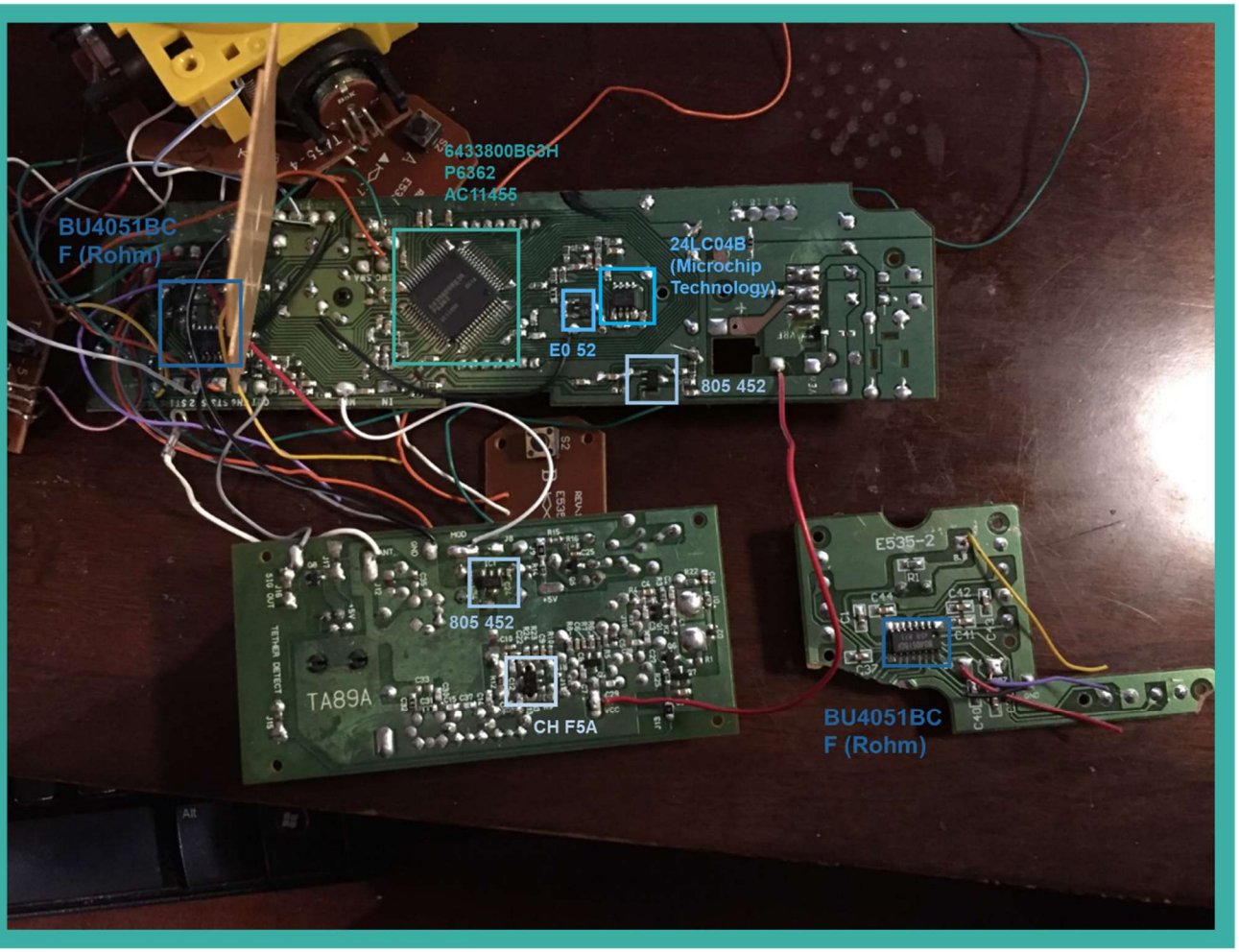
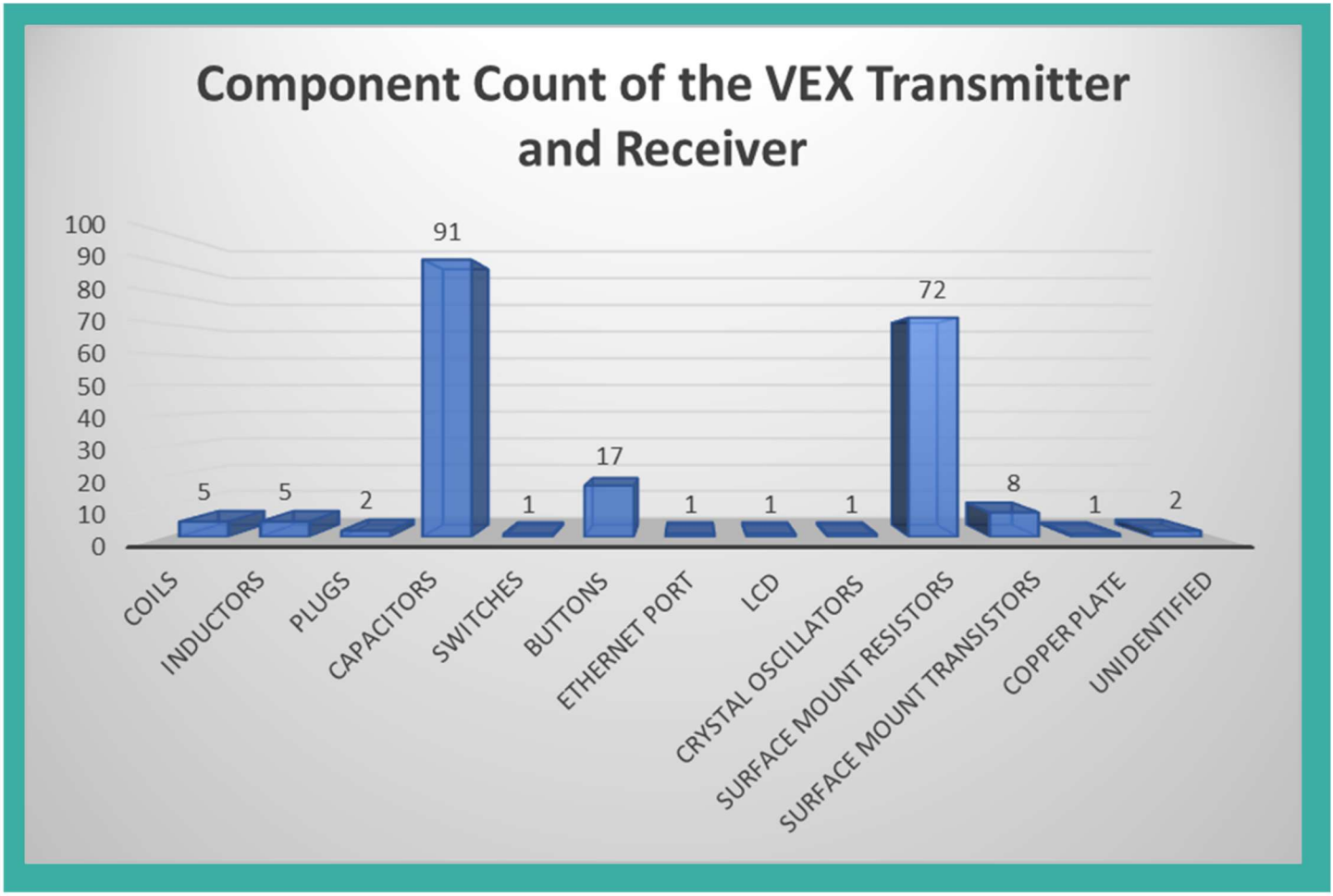
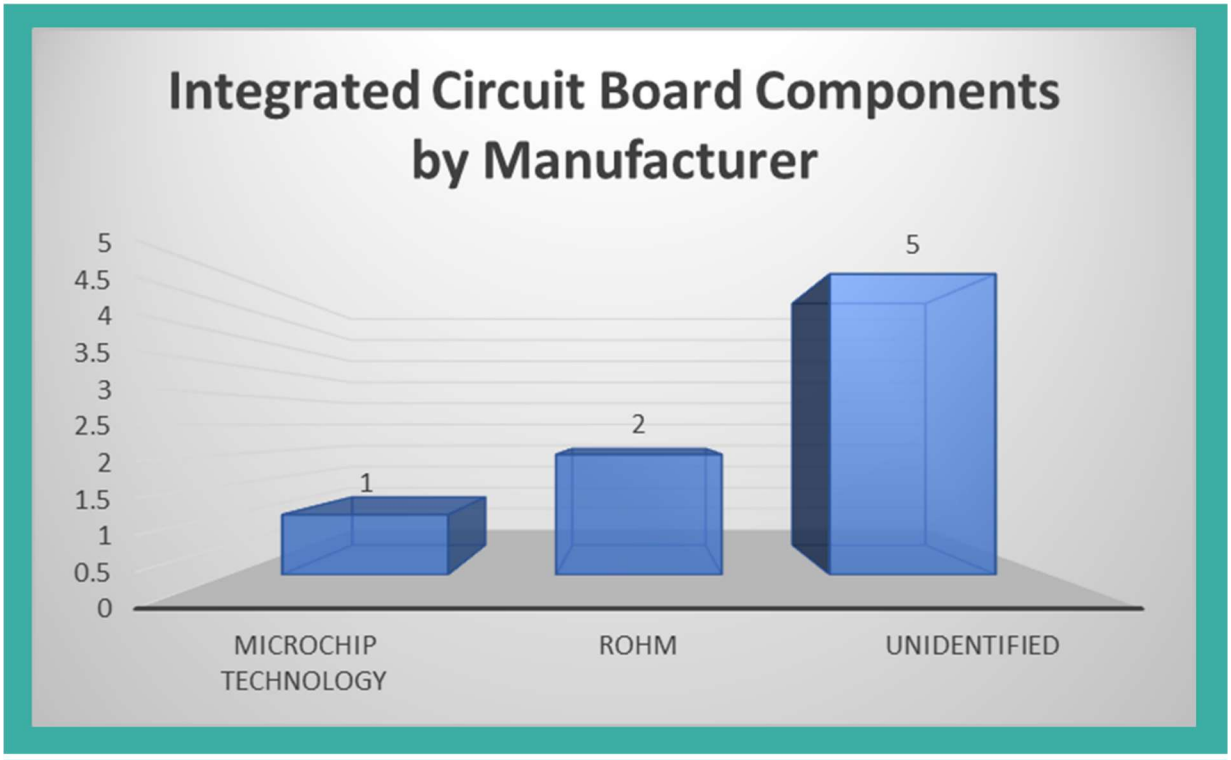



FIGURE 3.2: Layout of all identified chips

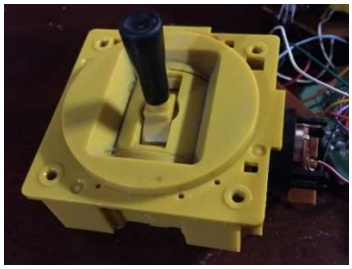



**GRAPH 1.0:** Internal Component Count



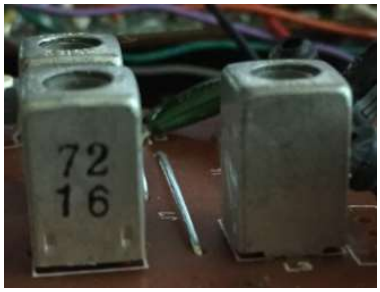
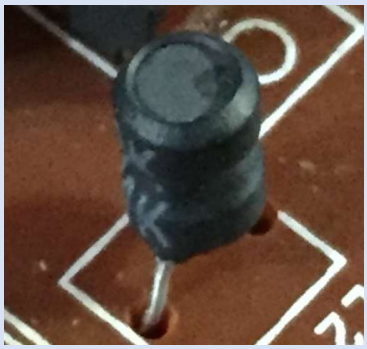
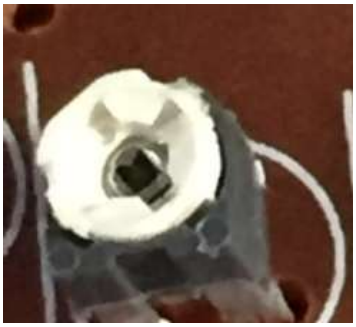

**GRAPH 2.0:** Integrated Circuit Board Components by Manufacturer

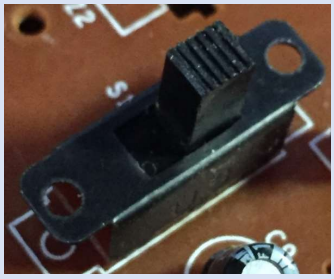
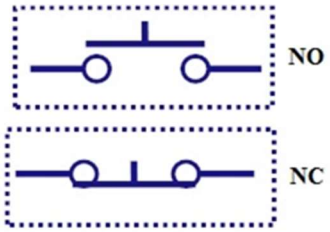
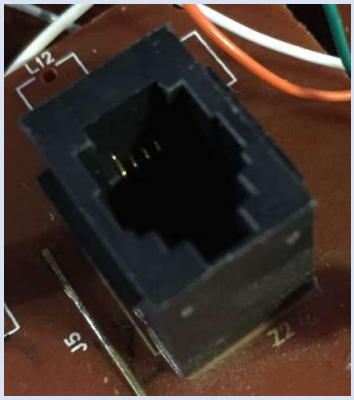
**TABLE 1.0: EXTERNAL COMPONENTS**

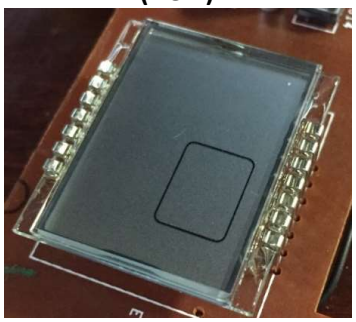
| External Components | Description | Function/Comments |
|---|---|---|
| **Power Pack**<br>  | 9.6V<br>1000 mAh<br>Nickel-cadmium | Supplies power to the controller when plugged in |
| **Grey and Silver Case**<br>  | Durable plastic case<br>Dimension: 10.1 x 9.9 x 5.1 in. | Makes the controller easy to hold and protects the inside components |
| **Joystick (x2)**<br>  | Black stick surrounded by a yellow case; moves in all directions | Allows person to manually control the robot's movement |
| **Channel 5 and 6 Buttons**<br>  | Yellow buttons | Enables various actions (depends on the program code for the buttons) |

| | | |
|---|---|---|
| **Channel 1, 2, 3, 4 Buttons & Other Buttons**<br>  | Black oval-shaped buttons | Enables various actions (depends on the button and the program code) |
| **Metallic Handles**<br>  | Sturdy metallic handles | Allows person to easily hold the controller |
| **Battery Cable**<br>  | Red and black wires attached to a blue head | Connects controller to the power pack |
| **VEX Label**<br>  | Includes CAT. No., manufacturer, and FCC ID | Identifies product as approved by Federal Communications Commission and gives details about manufacturer |
| **Screws and Washers**<br>  | Wide variety, from silver flathead screws to black panhead screws | Holds case and circuit boards together |

**TABLE 2.0: PRINTED CIRCUIT BOARD COMPONENTS**

| Component/Image | Quantity | Function | Other Notes |
|---|---|---|---|
| **Coils**<br>  | 5 | - Produces magnetic field or creates electrical resistance | - Can be found as raw wired coil or in other forms |
| **Inductor**<br>  | 5 | - Stores energy in a magnetic field when current flows through it | - 2R7K labelled on it |
| **Plug/Plug Connector**<br>  | 2 | - Used to join electrical conductors to create an electrical circuit | - A plug is the male component of an electrical connector |
| **Electrolytic Capacitor**<br>  | 4 | - Stores and releases electrical energy in a circuit | - Almost always used in a circuit<br>- Manufacturer: Chang Yang Electronics |

| | | | |
|---|---|---|---|
| **Ceramic Capacitor**<br>  | 1 | - Stores and releases electricity | - Has a large capacitance and small size<br>- Fixed-value capacitor where the ceramic acts as the dielectric |
| **Single Pole Double Throw Switch (SPDT)**<br>  | 1 | - Connects/disconnects a path in an electrical circuit | - Three terminals: 1 input, 2 output contacts<br>  |
| **Push Button Switch**<br>  | 16 | - Connects/disconnects a path in an electrical circuit | - Stays on as long as pressure is applied<br>  |
| **Ethernet Port**<br>  | 1 | - Opening to plug Ethernet cables into | - Connects wired network hardware |

| | | | |
|---|---|---|---|
| **Liquid Crystal Display (LCD)**<br>  | 1 | - Displays information and images | - Black box displayed on screen |
| **Crystal Oscillator**<br>  | 1 | - Creates an electrical signal with a constant frequency | - Placed close to the IC |
| **Surface Mount Capacitors**<br>  | 86 | - Charges and discharges electrical supply | - Small, in large quantities<br>- Accomplishes tasks requiring low capacitance values |
| **Surface Mount Resistors**<br>  | 72 | - Passively provide electrical resistance | - Small, in large quantities<br>- Lower power dissipation capability |
| **Surface Mount Transistors**<br>  | 8 | - Amplifies or switches electronic signals and electrical power | - F: Low Power Radio Frequency Amplifier |

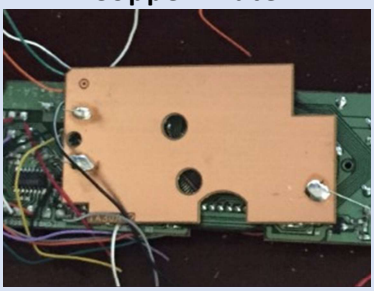
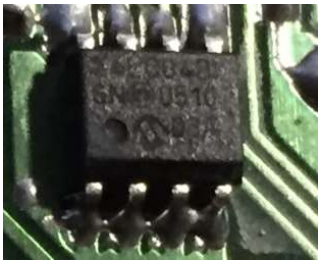
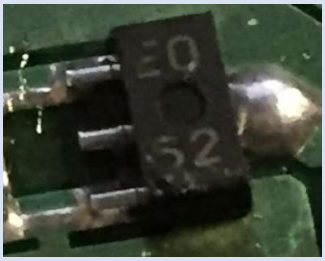
| | | | |
|---|---|---|---|
| **Copper Plate**<br>  | 1 | - Dissipates heat | - Placed directly on top of the main IC chip |

**TABLE 3.0: MISCELLANEOUS/UNKNOWN PRINTED CIRCUIT BOARD COMPONENTS**

| Component/Image (Best Guess) | Quantity | Function | Other Notes |
|---|---|---|---|
| **Resistor**<br>  | 1 | - Reduces current flow, divides voltages, adjusts signal levels, etc. | - Small hole in the center |
| **Unknown White Plastic Object**<br>  | 1 | Could not find any information | N/A |

**TABLE 4.0: INTEGRATED CIRCUIT BOARD COMPONENTS**

| Manufacturer Part Number Image | Quantity | Function | Further Information | Integrated Circuit Package Types |
|---|---|---|---|---|
| **Microchip Technology (USA)** | 1 | Provides bidirectional, 2-wire bus and data transmission protocol | Overview | - PDIP, MSOP<br>- SOIC, TSSOP<br>- SOT-23-5<br>- DFN |

| | | | | |
|---|---|---|---|---|
| **24LC04B**<br>  | | | | |
| **Rohm**<br>**(Japan)**<br>**BU4051BCF**<br>  | 2 | Multiplexers/demultiplexers that select and mix analog signal and digital signal | Datasheet | - DIP16<br>- SOP16<br>- SSOP-B16 |
| **Unidentified**<br>**805 452**<br>  | 2 | Researched device on forums, wikis, and blogs, but cannot come to a firm conclusion. | No Data Found | Unknown |
| **Unidentified**<br>**E0 52**<br>  | 1 | Researched device online and asked knowledgeable family members but still unsure. | No Data Found | Unknown |
| **Unidentified**<br>**CH F5A**<br>  | 1 | Researched device online but found no results. | No Data Found | Unknown |

| | | | | |
|---|---|---|---|---|
| **Unidentified**<br>**6433800B63H**<br>**P6362**<br>**AC11455**<br>  | 1 | Tried all 3 markings and different variations when researching but nonetheless found no results. | No Data Found | Unknown |

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