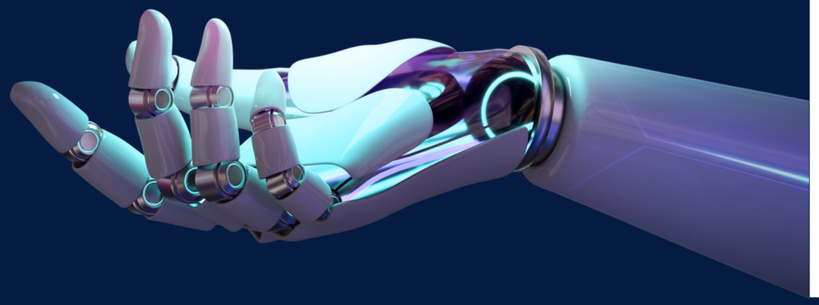
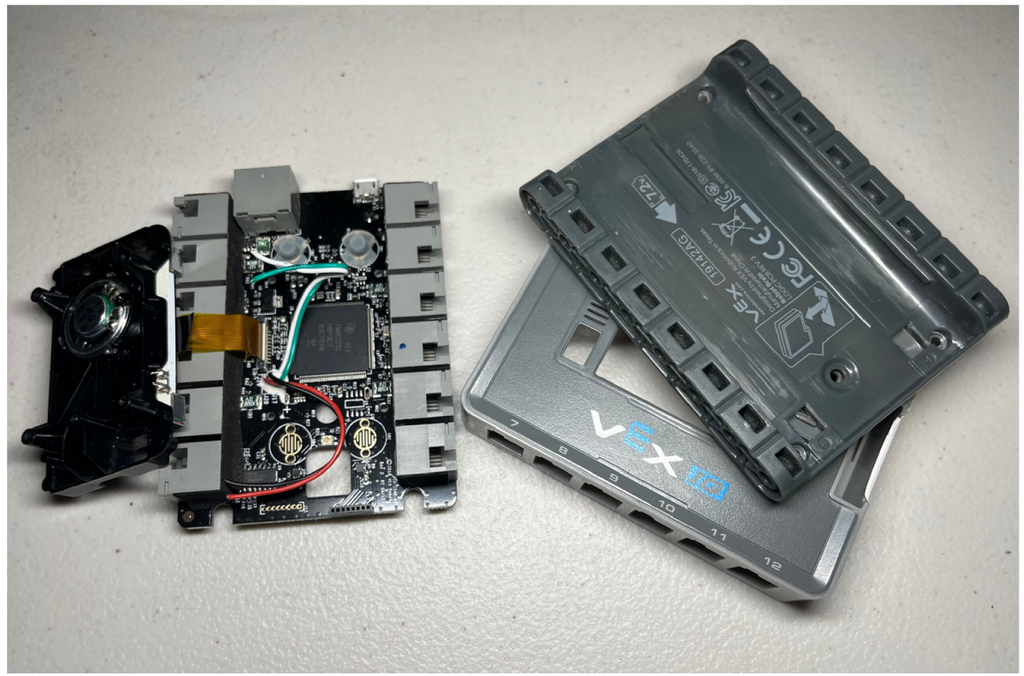
Reverse Engineering

65018B - Nameless
By: Cindy Zhang & Lexus



Disassembling the VEX Brain



Introduction - The VEX Brain

The VEX Brain is undeniably the most complex part of a basic robot design. It is the main component that allows robots to function properly, by using signals, wires, power source, sensors, and much more to benefit the robot into its proper use. Since the brain is the center control of the robot, there are many different parts contained in this device. The six main components are the power source, CPU, Input, Output (Display), Sensors, and ECU. Each of these parts play an important role in making the robot function properly. And there are much more pieces to the Brain than the ones listed. A key feature of robots is that they interact with the world, making changes to the world through their actions and responding to events. Robots perform useful tasks, extend the capabilities of humans and reduce our risks when operating in hazardous environments, which is why we decided on taking apart of VEX Brain to learn further more about its functions.

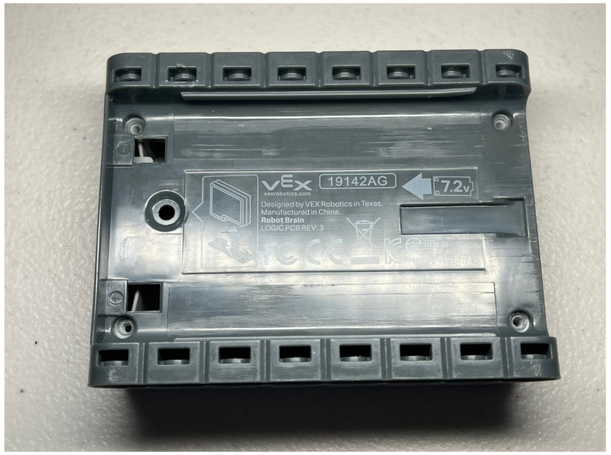
Outer Shell

Front Outer Layer

The outer shell of the VEX Robot Brain is as simple as can be, it is simply made up of plastic shells in the same material that most of our VEX IQ Parts are made up of. When the inside of the Brain, the internal functions have been dissected apart, we are able to see the blankness that the buttons, chips, detectors, and much more left after being taken away. Our team noticed that on the front of the outer side of the Shell, the side slot where a blue chip goes into for connection is left empty as well.

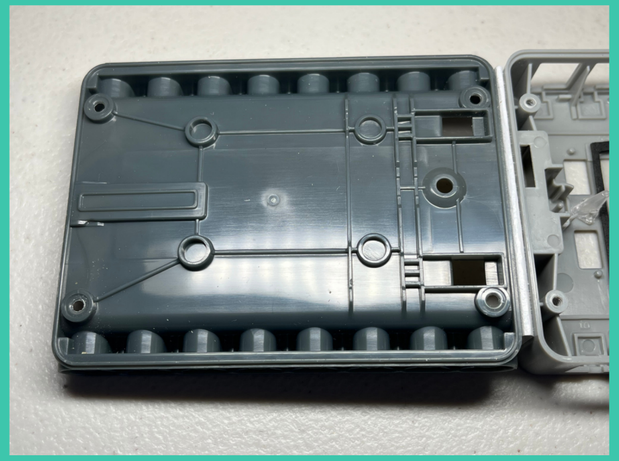
Back Outer Layer

There are simple slots that the metal detecters/sensors on the internal segment of the Brain lead out from.



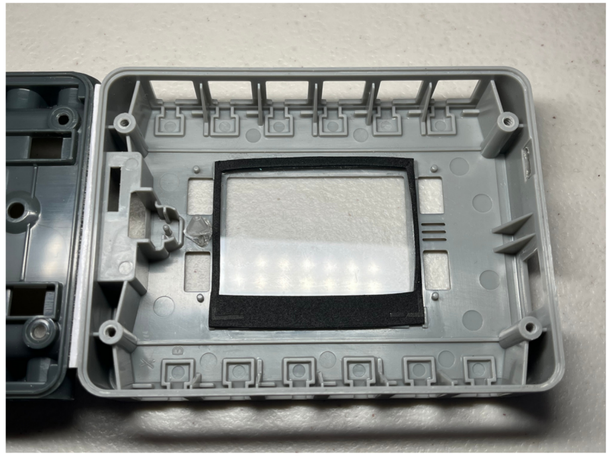
Front Inner Layer

The inside has a basic design nearly identical to the outer layer. In this piece, our team noticed that the slots of the device control segment on either top and bottom of the shell is rounds instead of squared.



Back Inner Layer

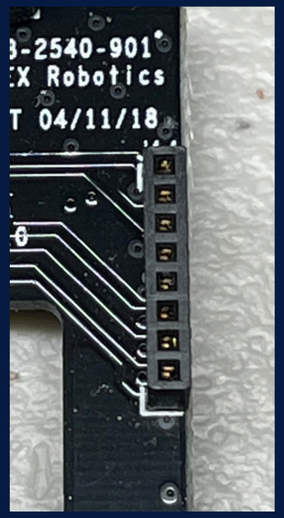
The Back Inner Layer is just as similar to all other layers of the shell, but instead, it contains the clear layer of plastic for users to see through and be shown to the display screen.



Smart Radio

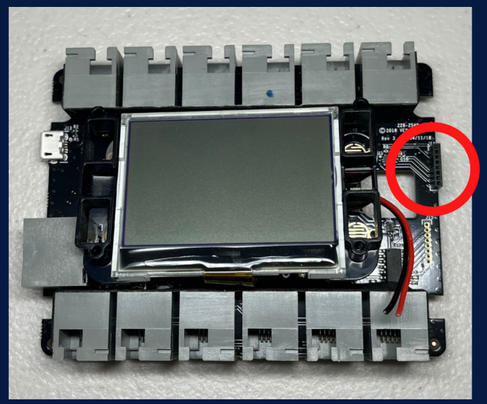
The Smart Radio (1st generation) expands the potential of the VEX IQ Robot Brain and Controller by enabling wireless communication with smartphones, tablets and computers using Bluetooth ® 4.0+ connections. When combined with apps designed to utilize the Smart Radio, this allows for wireless programming of robots, interaction with robots using smartphones or tablets running Bluetooth ® 4.0 or higher, and other advanced features.

The Smart Radio Piece connects through the shell of the Outer Shell and onto the Receiver piece on the internal of the Robot Brain. The Receiver is a black plastic piece with metal on the inside. The two pieces connect so that the Brain is able to connect onto the controller wirelessly. It will be able to send information from the controller telling the brain to control each part of the devices, achieving its desired movement or programming.



Receiver

The Receiver fits from under the slot and the blue smart radio connect from the top.



Power Source

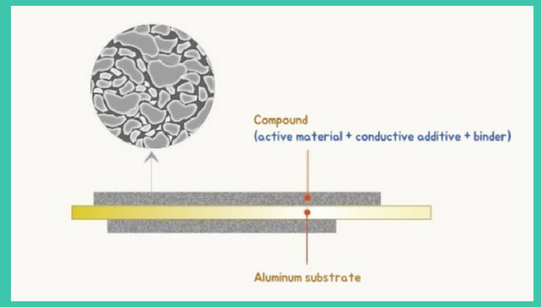
The Power Source is a large component of the Brain. It serves as the much-needed oxygen that is required to breathe life into any electronic device. In this case, the power source for the VEX Brain is a rechargeable battery block. The four main parts of the Power Source are the Anode, Cathode, Electrolyte, and the Separator, all of which has to work together in order to produce power for the six main components of the VEX Brain

Anode

Just like the cathode, the anode substrate is also coated with active material. The anode's active material performs the role of enabling electric current to flow through the external circuit while allowing reversible absorption/emission of lithium ions released from the cathode. When the battery is being charged, lithium ions are stored in the anode and not the cathode. At this point, when the conducting wire connects the cathode to the anode (discharge state), lithium ions naturally flow back to the cathode through the electrolyte, and the electrons (e-) separated from lithium ions move along the wire generating electricity. For anode graphite which has a stable structure is used, and the anode substrate is coated with active material, conductive additive and a binder. Thanks to graphite's optimal qualities such as structural stability, low electrochemical reactivity, conditions for storing much lithium ions and price, the material is considered suitable to be used for anode.

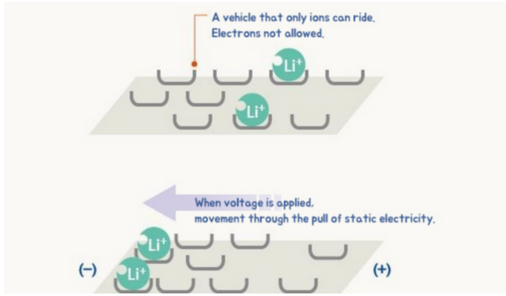
Cathode

A Lithium-ion battery generates electricity through chemical reactions of lithium. This is why, of course, lithium is inserted into the battery and that space for lithium is called "cathode". However, since lithium is unstable in the element form, the combination of lithium and oxygen, lithium oxide is used for cathode. The material that intervenes the electrode reaction of the actual battery just like lithium oxide is called "active material". In other words, in the cathode of a Li-ion battery, lithium oxide is used as an active material.



Electrolyte

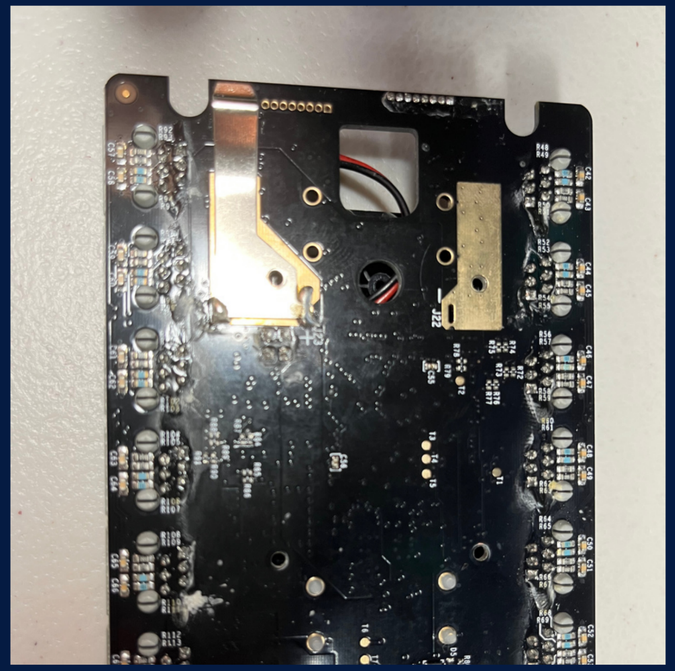
When explaining about cathode and anode, it was mentioned that lithium ions move through the electrolyte and electrons move through the wire. This is the key in enabling the use of electricity in a battery. If ions flow through the electrolyte, not only can't we use electricity but safety will be jeopardized. Electrolyte is the component which plays this important role. It serves as the medium that enables the movement of only lithium ions between the cathode and anode.



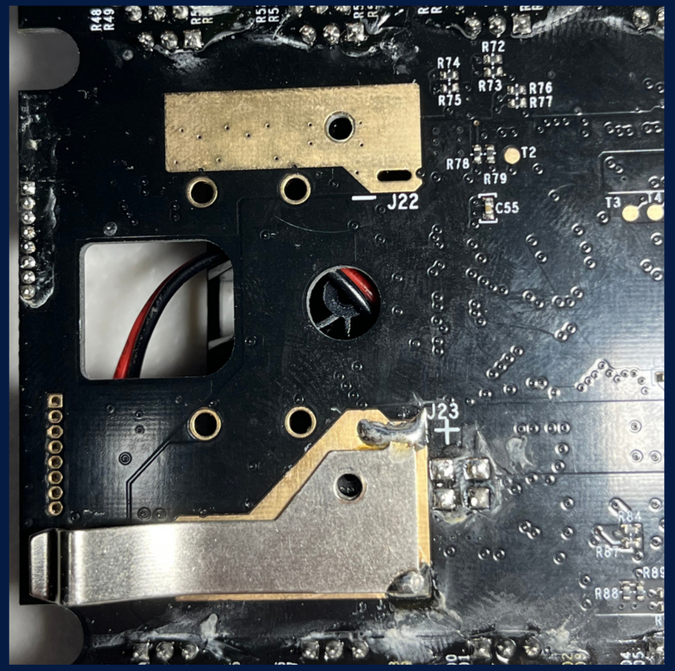
Separator

While the cathode and anode determine the basic performance of a battery, electrolyte and separator determine the safety of a battery. The separator functions as a physical barrier keeping cathode and anode apart. It prevents the direct flow of electrons and carefully lets only the ions pass through the internal microscopic hole. Therefore, it must satisfy all the physical and electrochemical conditions. Commercialized separators we have today are synthetic resin such as polyethylene (PE) and polypropylene (PP).

Outer View



Inner View



Closer View

Power (Battery) Input

One of them appears at the surface of the positive plate, while the other is at the surface of the negative. The “terminals” of each half-cell are a metal wire on one side, and an electrolyte-filled volume on the other (perhaps use a hose as a terminal connecting to the liquid, instead of a wire.) For example we can have a half-cell with lead and acid, or a zinc half-cell with zinc chloride solution, lithium half-cell, carbon, etc. Each creates its own special voltage, and it’s possible to mix and match the half-cells. Normally the two half-cells are connected together in series, with their water-conductors touching.

CPU

A central processing unit (CPU), also called a central processor, main processor or just processor, is the electronic circuitry that executes instructions comprising a computer program.

The CPU performs basic arithmetic, logic, controlling, and input/output operations specified by the instructions in the program. This contrasts with external components such as main memory and I/O circuitry, and specialized processors such as graphics processing units.

Most modern CPUs are implemented on integrated circuit microprocessors, with one or more CPUs on a single IC chip. Microprocessor chips with multiple CPUs are multi-core processors.

The individual physical CPUs, processor cores, can also be multithreaded to create additional virtual or logical CPUs. An IC that contains a CPU may also contain memory, peripheral interfaces, and other components of a computer; such integrated devices are variously called microcontrollers or systems on a chip (SoC).

Array processors or vector processors have multiple processors that operate in parallel, with no unit considered central. Virtual CPUs are an abstraction of dynamical aggregated computational resources.

CPU in the VEX Brain

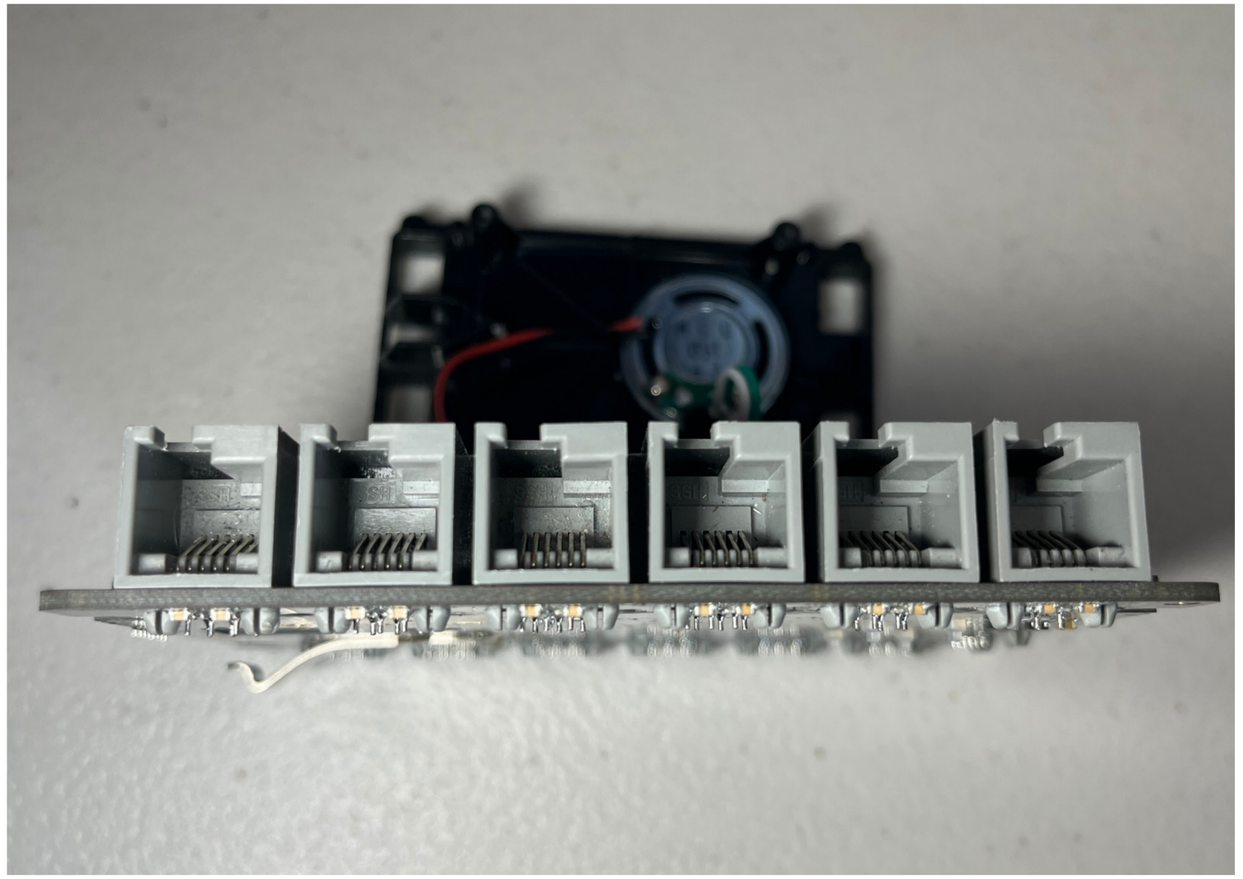
The CPU in the VEX Brain is a flat piece of technology that looks to have all sorts of tiny "spikes" sticking out from each side of the chip. These marks that sticks out from the design is used to Pins are the wires poking out of the surface of the CPU chip. They fit into a socket on the motherboard or backplane that the CPU is attached to. They form the electrical connection between the CPU and the outside world. The *number* of pins does not mean anything in particular. However you should keep in mind that those pins are the *only* way for signals (control and data) to get into or out of the CPU. In general, one "bit" of information can flow in or out across one pin on each clock cycle. So for a particular pin, the maximum possible data rate (in or out) expressed in bits per second is the same as the number of cycles per second that the CPU clock runs at. (*) obviously using a single pin would be inefficient as the only path in or out.

Microprocessors

Microprocessors, on the other hand, are CPUs manufactured on a very small number of ICs; usually just one.[51] The overall smaller CPU size, as a result of being implemented on a single die, means faster switching time because of physical factors like decreased gate parasitic capacitance.[52][53] This has allowed synchronous microprocessors to have clock rates ranging from tens of megahertz to several gigahertz. Additionally, the ability to construct exceedingly small transistors on an IC has increased the complexity and number of transistors in a single CPU many fold. In other words, a microprocessor, sometimes called a logic chip, is a computer processor on a microchip. The microprocessor contains all, or most of, the central processing unit (CPU) functions and is the "engine" that goes into motion when you turn your computer on. A microprocessor accepts binary data as input, processes that data, and then provides output based on the instructions stored in the memory. The data is processed using the microprocessor's ALU (arithmetical and logical unit), control unit, and a register array.

Control System

Every piece of energy-consuming equipment has some form of control system associated with it. The controls can be as simple as a snap switch or as complicated as a dedicated microcomputer chip system. Larger pieces of equipment, along with buildings and industrial processes, typically use complex computer-based control systems to optimally control and operate them. This article provides information about electronic control systems primarily used to control HVAC equipment. The sensors used in electronic control systems are simple, low-mass devices that provide stable, wide-range, linear and fast response. An electronic control system includes sensors, controllers, output devices such as actuators and relays; final control elements such as valves and dampers; and indicating, interfacing, and accessory devices. In the Brain, the CPU sends out the number listed on each of the connected devices. when a certain number is "called, the devices goes in order to individually process and check if the CPU is calling for their device. If not, the device moves on with no change, this process is repeated until the device being called comes to spot.



After removing the shell of the VEX Brain, it easily reveals the 12 total segments of the Brain that are used for connected connection wires onto the different devices, whether its motors, sensors, touch LEDS, and much more. On the bottom side of each slot, our team noticed little pointy ends sticking out from under, these points are used to connect the wires inserted into the CPU and transmit information about the connect device and its wanting.

1

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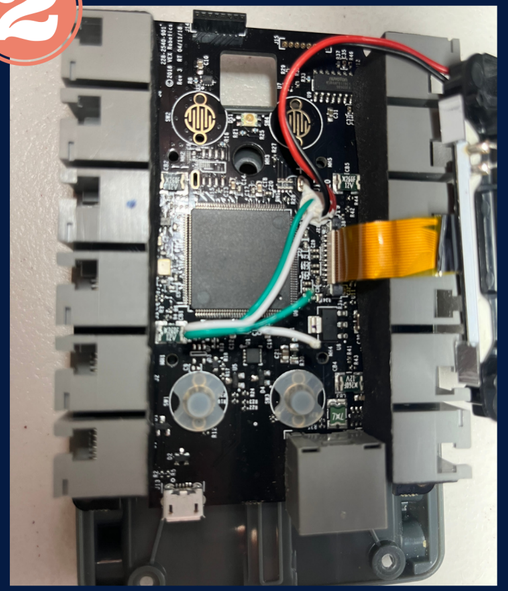

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Input

The Inputs of the Brain Internal are mainly the buttons next to the screens. The four buttons when pressed sends signals to the control center and it then tells the screen to display what has been commanded.

In figure 1, the picture shows a general look on the button slots after the outer shell and the individual buttons have been taken out.

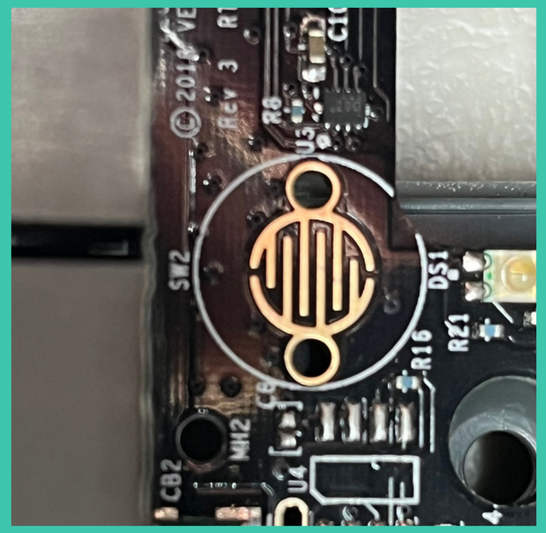
In figure 2, the screen has been taken apart and the under layer of the buttons (Where the bottom of each buttons touch), shows.

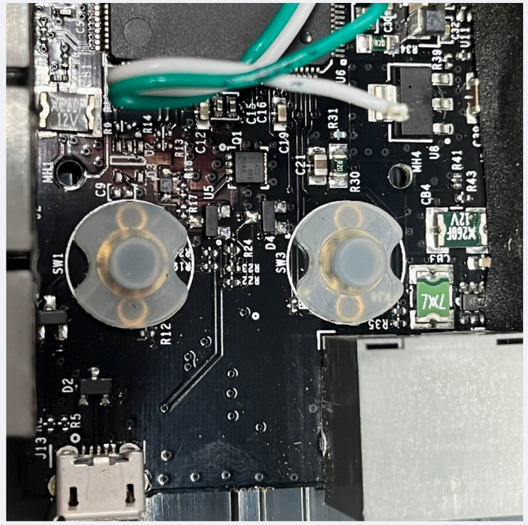
In figure 3, The picture has zoomed in once more and a clearer version of the elastic textured protection is under plain sight. That Layer of material is one of the most important part of the input component. (Will be later discussed)

In the Last Figure, the elastic outside has been removed, revealing two separate lines of contacts.

Buttons

The two round E shapes that faces each other to create a round circle format is the most important part of the function of the buttons. The reason behind this is because when the button is pressed down, it causes the elastic piece in Figure 2 to press down as well. The black thin piece is the Elastic dent piece also plays a big part in the function of the buttons. The black piece conducts electricity and connects the two lines of contact to line together. This way, the two parts contact into one and therefore the information is able to pass through in between the circle of space where the two sides connected. After this process is completed, the information/signal sent will then be transmitted into the CPU and commanding the output/display to function the way it should.





Output/Display

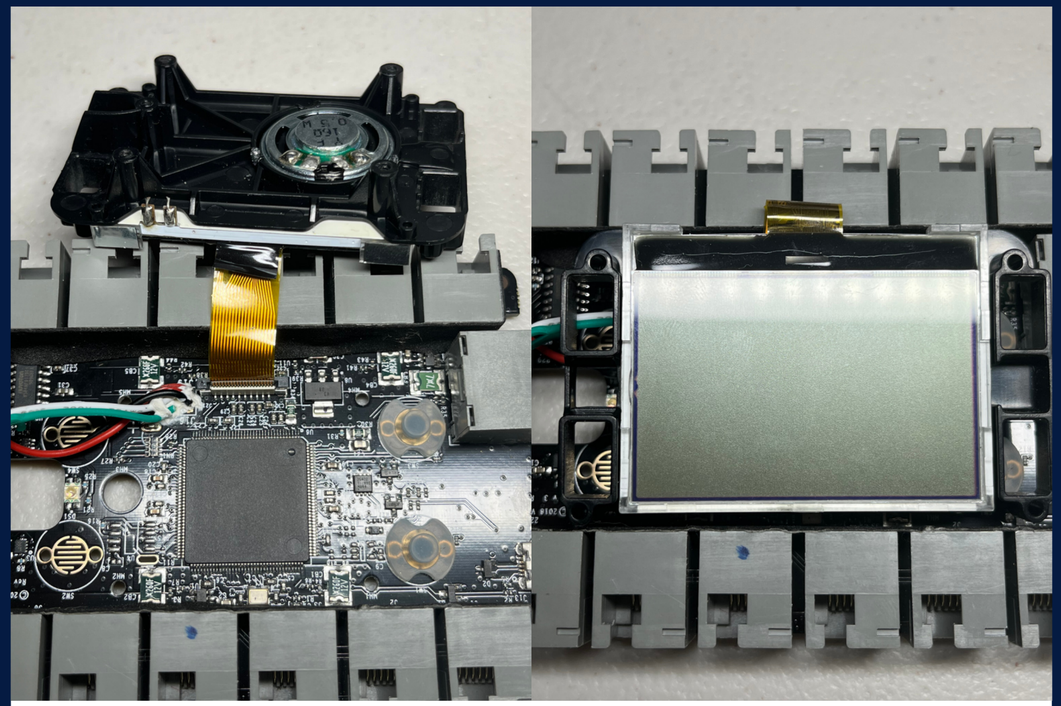
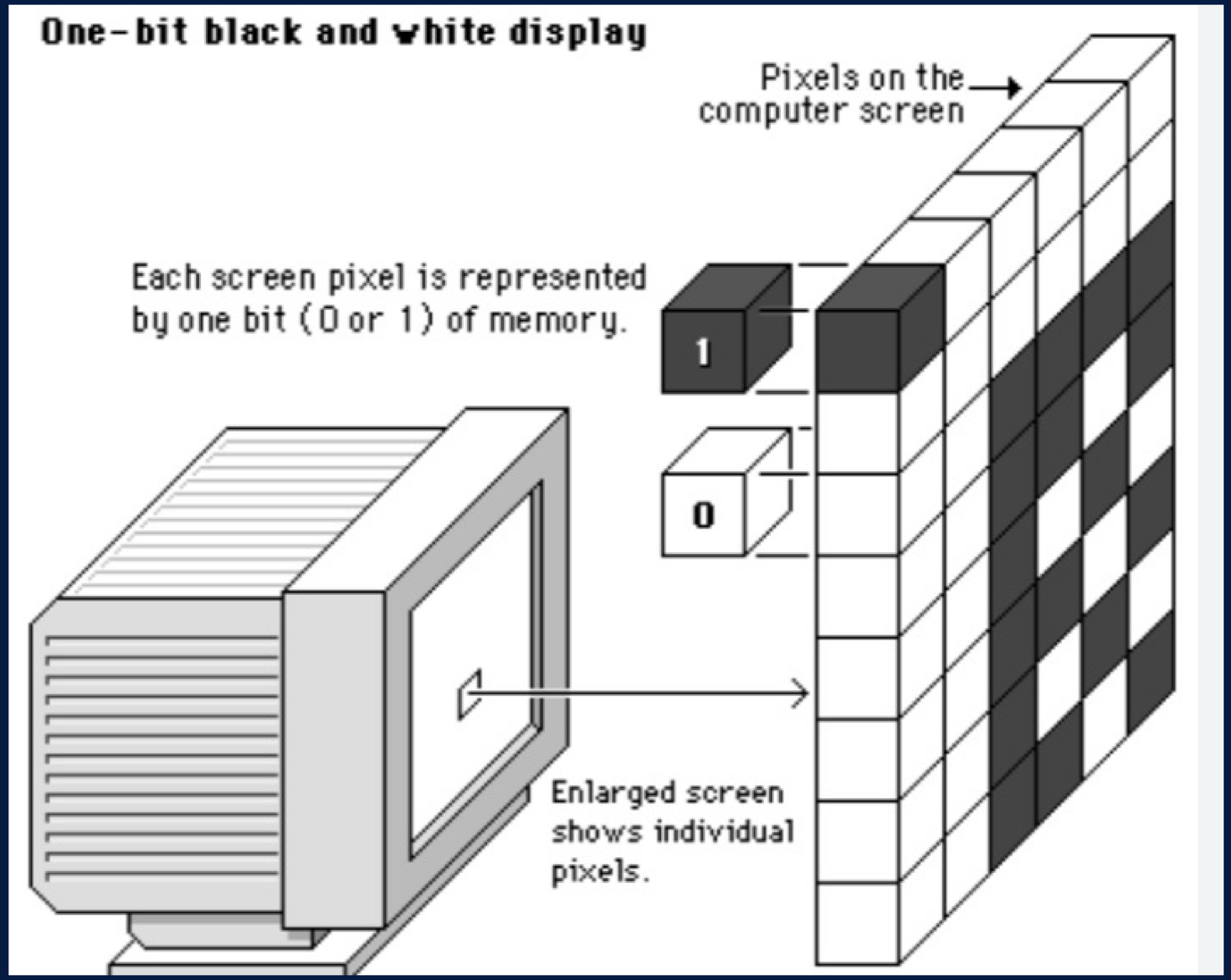


Figure 1 - Shows how the information is transmitted into the display screen

Figure 2 - Shows a image of the Display Screen

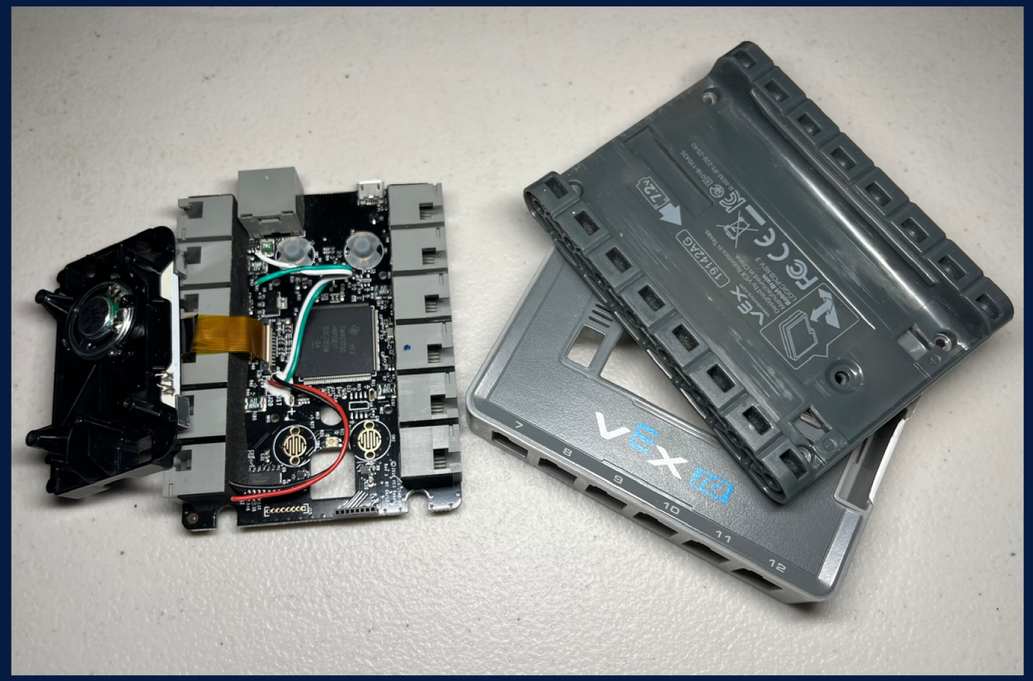
The Display

The display Component is also one of the major parts of the robot brain. It is the one singular output that this system provides. The way this system works to show images on the screen is that it is made up of many different small pixels. When the cpu alerts the output to display a certain design, the information is inserted and turned in different combinations of 1 and 0 to form the correct code for each spot to light up, creating the desired design.



This picture shows the pixels that make up parts of screens, each individual pixel, based on its row and column, has a different label (In numbers 1 & 0) to it. When an image is commanded to be formed, there will be a certain list of different numbers being called to represent each pixel lighting up. Therefore, creating a certain desired image.

Conclusion



The picture abovegives a general undertanding and image of the robot brains outer shell and internal design.

WHAT I LEANRED

Through this experience, my team learned the basics of many electronic components and systems. We learned about how to identify parts based on product number and how to decode information on the components. This knowledge will help us in future opportunities to learn about electronics. Not only that, a majority of the pieces and. devices that make up the inside of the Brain is similar to most electronic devices and can be used as important information in the future. The many parts we spent time researching about in the Brain really gave us a better understanding of how the robot we drive everyday works and how it is able to achieve the functions it does.