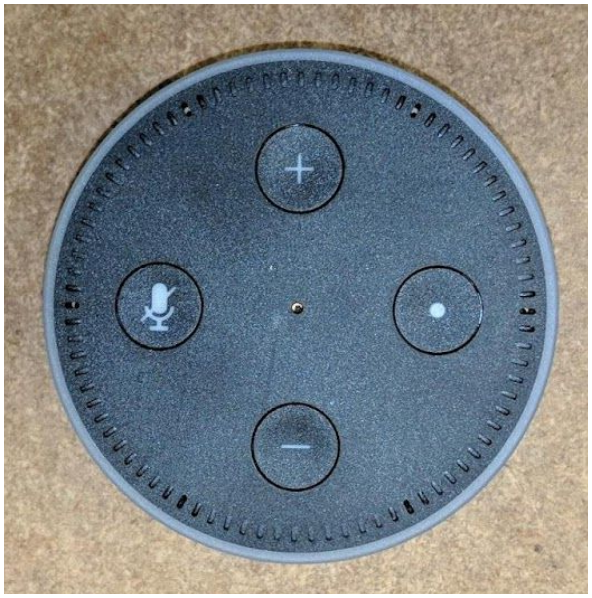
3946C

Electronics Online Challenge Sponsored by Texas Instruments

Amazon Echo Dot Gen 2



Report

Our team wanted to take apart something that was a relatively new product that we use in our daily life. We were originally wanted to take apart a google home mini, but due to its almost impossible opening process that involves boiling the glue, we chose the Echo Dot.

The hardest part was removing the anti slip pad. It required a very small tool to get to the adhesive which was recessed from the body (Figure 2a and 2b). Once that was off it was only a matter of finding the right screwdriver to take out the 4 screws (Figure 3). Originally, we thought there would only be one PCB that handled power, microphone input, and speaker output. However, once we opened the Echo we found two distinct PCB's connected by ribbon cable (Figure 4a). The lower one that had the USB and audio jack handled the power as well as the speaker (Figure 8a). The upper board handled both the buttons and the microphone (Figure 7). We were very surprised to see 7 microphones inside (See Chip Analysis 1). After further research the seven microphones allows the echo dot to filter out noise and hear a human even when it's playing music. They also allow the device to know where in the room the human is speaking from and light the LEDs correspondingly.

Unfortunately, as the device is cheap and profit margins are slim a lot of the chips that we found we were not able to identify. However, we did find the use for every major chip on the board. The ARM system-on-a-chip that the echo dot uses, is manufactured by Mediatek (See Chip Analysis 3). The power IC and the wireless module that includes Bluetooth and Wifi are also both manufactured by Mediatek (See Chip Analysis 3). The 4 analog-to-digital converters that handle the seven microphones are all made by Ti (See Chip Analysis 1). Ti also make the digital to analog converter that converts the digital signal into something the speaker output (See Chip Analysis 4). We were surprised to find a light sensor on the top of the device hidden

under one of the buttons (See Chip Analysis 2). We believe this is used for controlling the brightness of the LEDs.

This experience was a great way for our team to apply what we learn in robotics in a different way. The ease of disassembly was surprising compared to most smartphones and other small electronics. We all thought that the internals would be more compact. Through this process we learned how to identify chips and how to read data sheets. We also learned how big technology companies utilize sensors in their products. Over all our team learned a lot by taking the echo do apart and we were all surprised on how many of the chips could come from suppliers that were not amazon.

All of the figure images are hyperlinked to higher resolution copies.

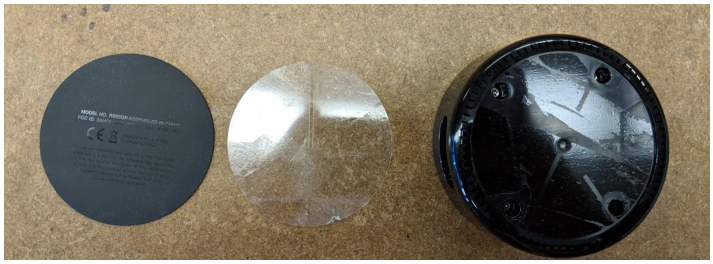
Figure 1:

The Echo Dot is a very compact device.

Figure 2a:

There were no visible screws so we took off the anti-skid pad. It was only attached with some adhesive (Figure 2b).

Figure 2b:

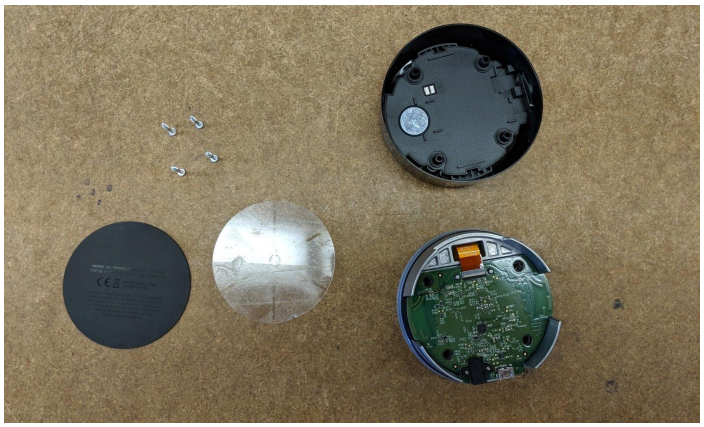


The pad was easy to get off. However, the adhesive was still stuck to the body of the device. It was a little harder to get off.

Figure 3:

This revealed 4 screws. After trying some different bits, the T8 torque bit worked.

Figure 4a:



Once the screws were out the boards slipped out easily leaving the base with a mainly plastic puck (Figure 4b).

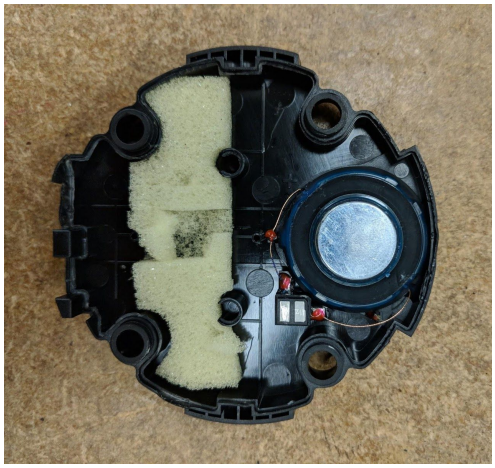
Figure 4b:

This puck is seeded on the screw mounts an has two contact pads (probably used for data/power transfer) and a metal circle.

Figure 4c:

The puck took a little bit of prying to get out and its other side reveals nothing to help us determine its use.

Figure 4d:

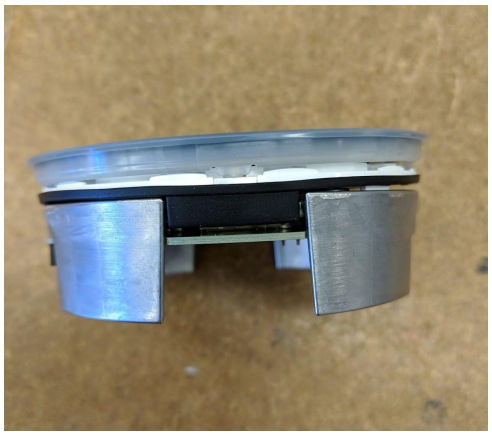


With a lot more prying the puck separated revealing a speaker.

Figure 5:

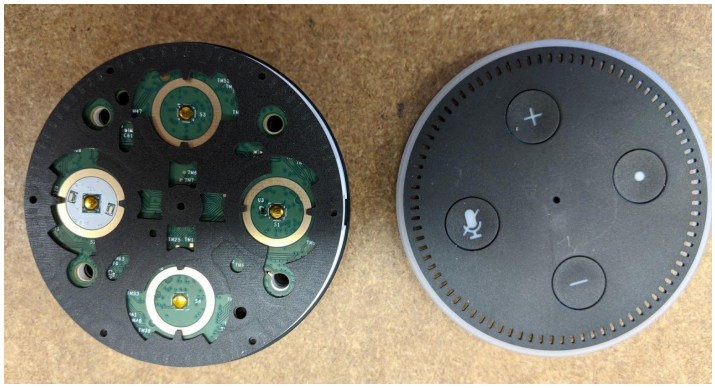
The only thing left in the plastic body is an antenna.

Figure 6a:



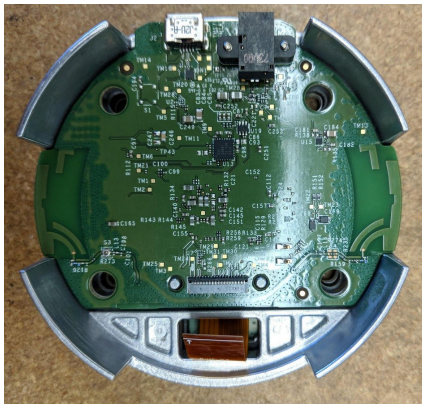
The other piece that came out of the body was actually a couple of pieces that were connected with one ribbon cable.

Figure 6b:



The top has 4 button pads and some foam. The white paints goes under the action button.

Figure 6c:

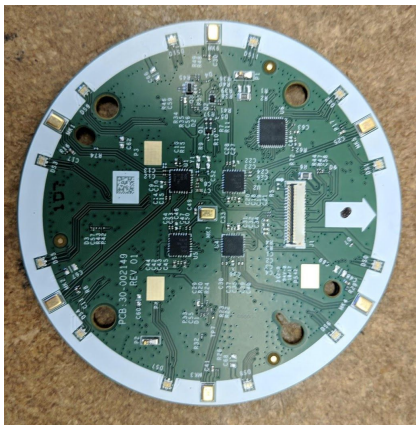


To separate the pieces we disconnect the ribbon cable.

Figure 6d:

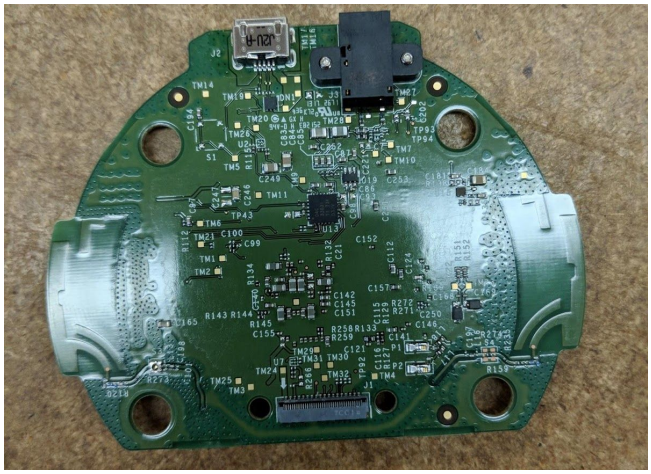
This allowed us to remove the rubber and plastic replacement pieces and separate the 2 PCB's.

Figure 7:



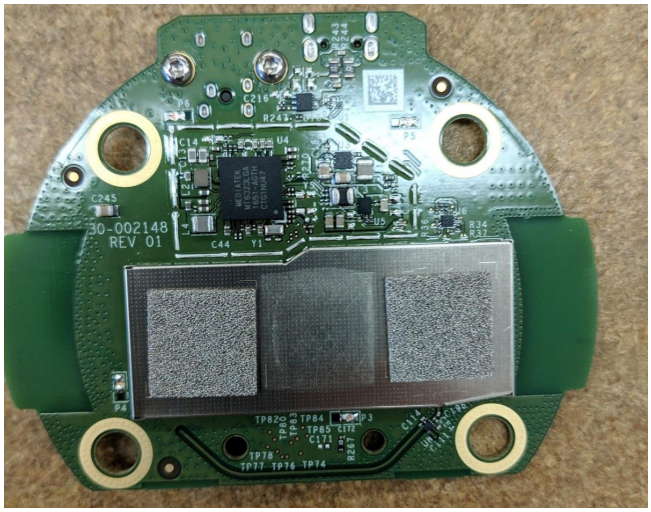
The bottom of the top PCB has a lot of chips and traces. Our guess is it handles the microphones.

Figure 8a:



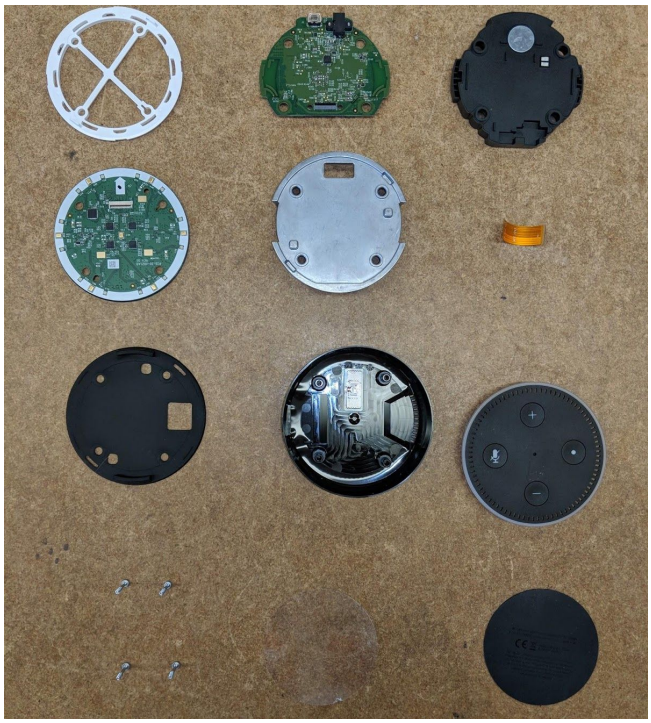
The bottom PCB definitely handles power. It also has a fair amount of small chips on it.

Figure 8b:



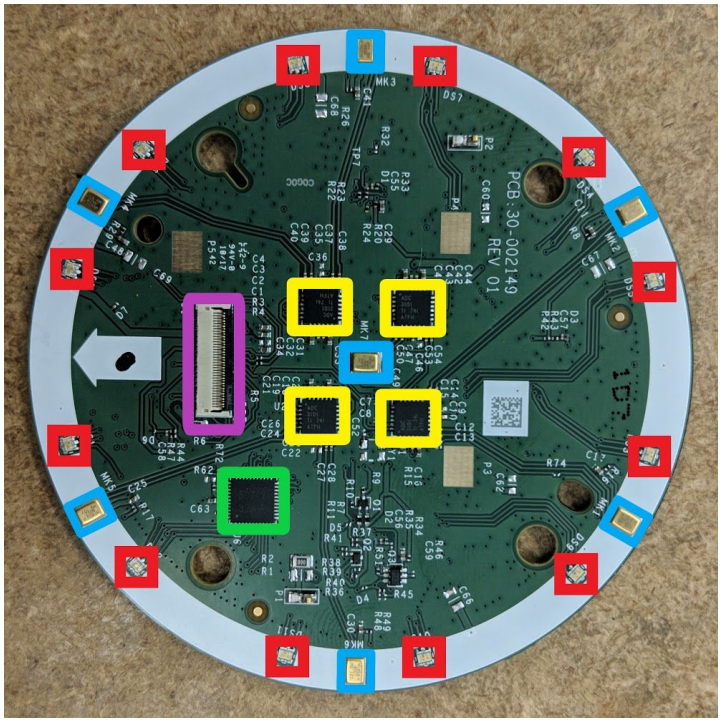
The bottom PCB also has the WiFi chips.

Figure 9:



This is all of the parts that make up the Echo Dot.

Chip Analysis



1:

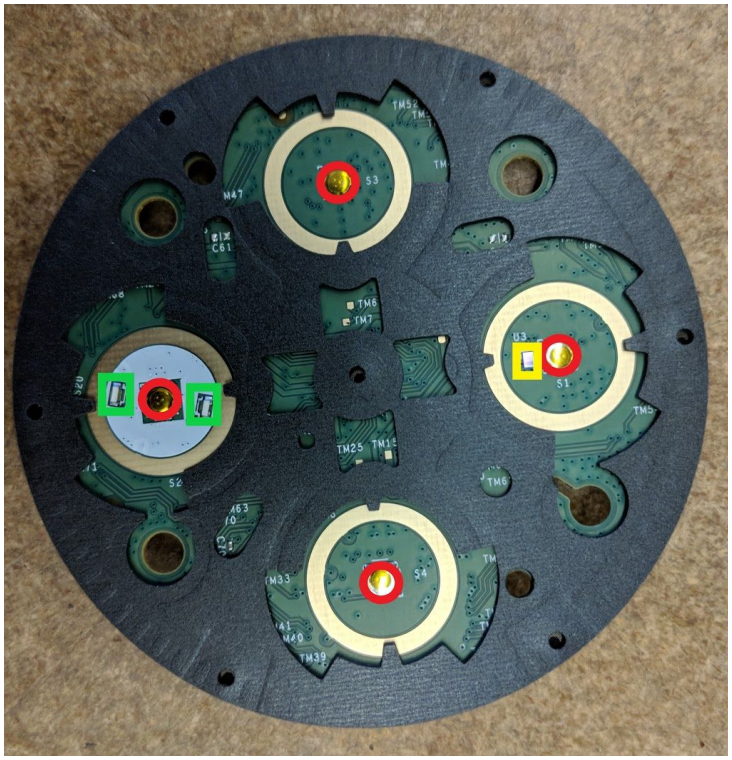
RGB LED (12)

Analog to Digital Converters For (4) - Ti Data Sheet

Microcontroller (1)

Microphone (7)

Ribbon Cable Connector (1)



2:

Button Switch (4)

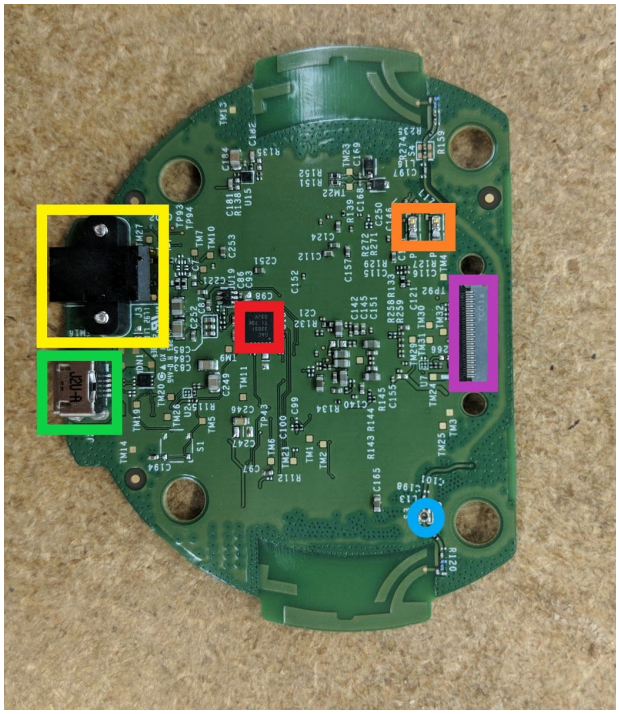
Light sensor (1)

Red LED (2)

3:

Power IC (1) - Mediatek Data Sheet

Wireless Chip (1) - Mediatek MT5525LN1632 could not find data sheet
ARM System on a Chip (1) - Mediatek Product Page



4:

Digital To analog converter (1) - Ti supplier
Pogo Pins to Speaker (2)
AUX Port (11)
Micro-USB Port (1)
Antenna (1)
Ribbon Cable Connector (1)