Oculus Rift CV1 Teardown

Teardown of the Oculus Rift CV1 (Consumer Version 1) performed on March 29, 2016.

Written By: Evan Noronha

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INTRODUCTION

We've had our eyes on Oculus since the beginning, having dismantled (and successfully re-mantled) both development versions of their VR headset. But today, we've got the real deal: the final, consumer-ready, OMG-it's-finally-here Oculus Rift. After four long years of development, what changed? What stayed the same? And can we put it down long enough to actually take it apart and find out?

Grab your tools and join us around the teardown table, because the future is now. We're tearing down the Oculus Rift.

Like what you see? Make us your virtual friend on Facebook, Instagram, or Twitter.

[video: https://youtu.be/zfZx_jthHM4]

TOOLS:

- Phillips #1 Screwdriver (1)
- T3 Torx Screwdriver (1)
- iFixit Opening Tools (1)
- Spudger (1)

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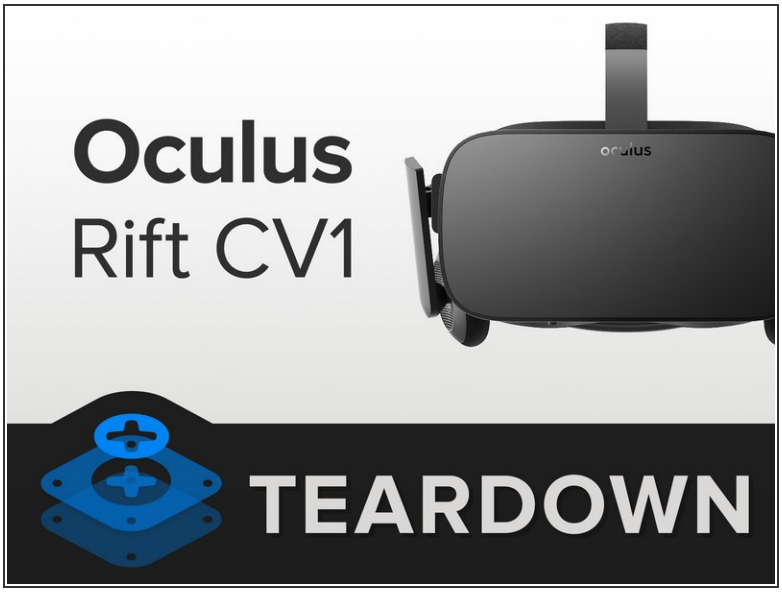
Step 1 — Oculus Rift CV1 Teardown



- We've had two prerelease versions on our teardown table, so we're excited to see what tweaks this Rift has in store. Here's the scoop so far:
  - Two OLED displays with a combined resolution of 2160 x 1200
  - 90 Hz refresh rate
  - Accelerometer, gyroscope, and magnetometer
  - 360-degree headset tracking via Constellation IR camera
  - Horizontal field of view greater than 100º

The Rift's custom VR motion controllers, known as Oculus Touch, will be ready later this year. Perhaps we'll tear them down at that time, if we're not hopelessly lost on the Grid.

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Step 2

- Improving the VR experience means improving the head tracking—and tracking means dots. Lots of dots.
- *Infrared* dots, to be precise; they're generated by tiny LEDs embedded in the headset. You'll never see them during normal use, but our infrared camera sees all—just like the Oculus' tracker, known as "Constellation."

  ⓘ It's called Constellation because it looks like you're wearing a star chart on your face.
- Turn your head around, and you're still being tracked. Unlike its predecessors, the latest Rift has IR LEDs in the front *and* the back. You can spin in circles and never break immersion—until you trip over the cord.

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Step 3



- This is definitely the sleekest Rift yet—lightweight, impressively comfortable, and now with earphones built right in for maximum immersion.
- A thick foam frame attempts to minimize the effects of Oculus Face. It's simply attached with clips.
  - Fewer screws means less weight!
- With the frame removed, we can unplug the ~~spinal cord~~ single cable from the head-mounted display.
  - The cable management has really seen some impressive evolution across the generations of Rift.

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Step 4

- Removing the adjustable earphones couldn't be easier.
- An embedded flathead barrel nut secures the speaker arm, and spring contacts connect it to the wires in the headband. Sweet!
- We've seen our share of expensive, un-repairable, nigh-impossible-to-disassemble earphones, so this is a welcome surprise.
  - Especially considering these lil guys are prime damage targets should your headset "fall" to the ground following a rough PvP match.

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Step 5

- Stretchy black lycra surrounds the lenses, covering a thin plastic frame. This dustproof fabric cleverly protects the Oculus' innards, while still allowing the adjustable lenses some freedom to move.
  - The frame also contains a small anchor point for the over-the-head strap.
- But how to remove it? We're momentarily stumped—until our teardown engineer finds the hidden interior clips that secure the frame. After a few well-placed flicks of the spudger, it's free.
- With that, we pop our Kato mask off the Oculus for our first real peep inside!

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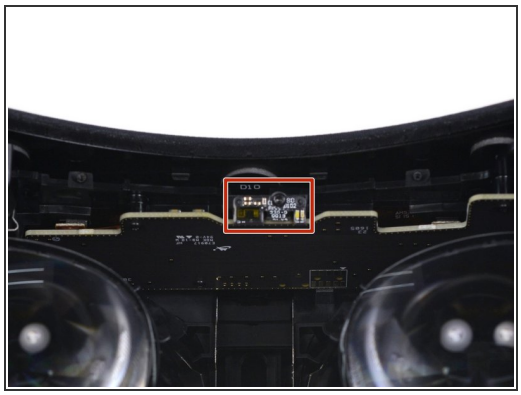
Step 6





- The DK2 prototype used a single 1080p display panel yanked from Samsung's Galaxy Note 3. But this time, something's different...
- Instead of a smartphone display, Oculus has doubled your order! Two displays, mounted right to the lenses, adjustable with this knobby thing!
  - Until the day the eyePhone drops, this will do.
- What's this? Looks like ~~a face detector~~ an ambient light sensor, present to check if you're wearing the Rift, or perhaps to adjust display brightness to account for extra light leaking into the headset.

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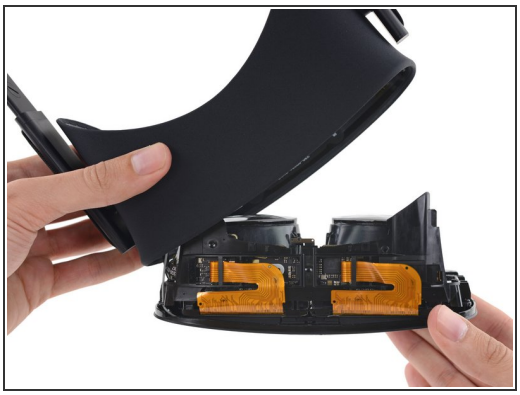
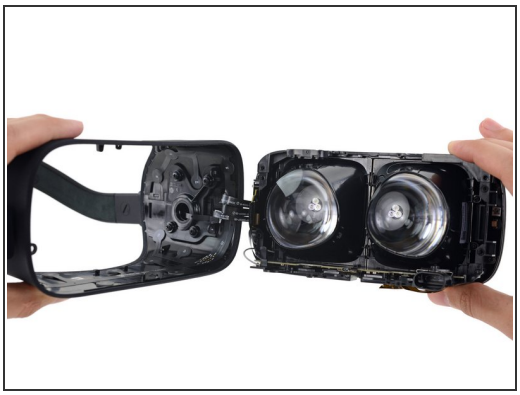
Step 7


- Lifting off the cowling reveals a couple standard-issue ribbon cables. The extra slack lets the eyepiece assemblies wiggle around and move back and forth to adjust the interpupillary distance, or IPD (that is, the distance between your eyes).
- Three more ribbon cables attach the LED control board to the IR LED array, webbed around the inside of the headpiece housing.
  - We don't particularly love fiddly cables connecting two halves of our hardware, but at least they're nicely labeled for reassembly... More on that later.
- Here's the meat of the Oculus!
  - Vegetarians please note: we found no actual meat in the Oculus.

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Step 8

- Leaving the meat for the main course, let's take a peek at the ~~salad~~ LED array.
- Those fiddly cables connect to a set of three IR LED arrays: Top, Bottom, and Strap heading up the rear.
- Each LED is labeled, and D8 through D10 are hanging out near a lone " hidden" microphone. What's that for, we wonder.
  - Future features like in-game chat, voice commands, or ambient noise volume adjustment are good bets.

A MEMS microphone is found beneath the Kapton tape at the bottom of the case.

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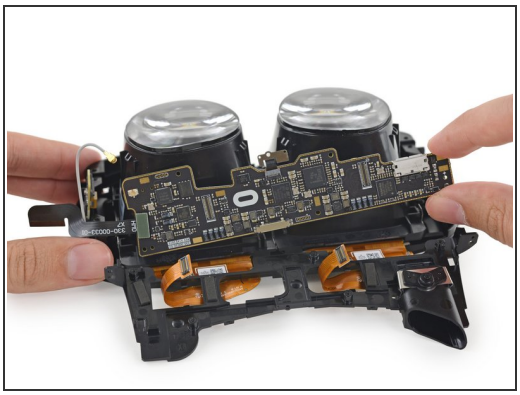
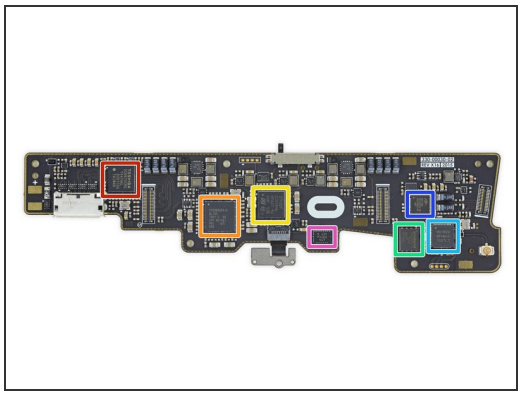
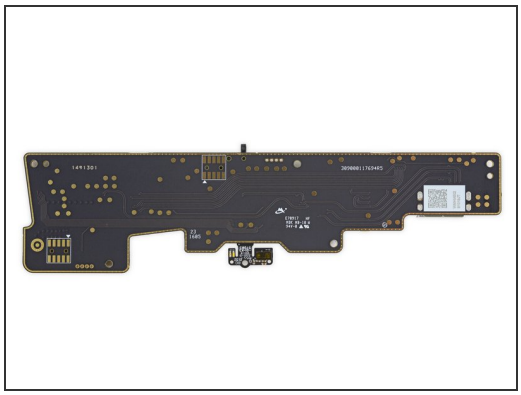
Step 9

- The top of the lens assembly hosts the motherboard. And chips!
  - Toshiba TC358870XBG 4K HDMI to MIPI Dual-DSI Converter
  - Cypress Semiconductor CYUSB3304 USB 3.0 Hub Controller
  - STMicroelectronics STM32F072VB ARM Cortex-M0 32-bit RISC Core Microcontroller
  - Winbond W25Q64FVZPIG 64 Mb Serial Flash Memory
  - Nordic Semiconductor nRF51822 Bluetooth Smart and 2.4GHz proprietary SoC
  - CMedia CM119BN USB Audio Controller
  - Bosch Sensortec BMI055 6-axis Inertial Sensor

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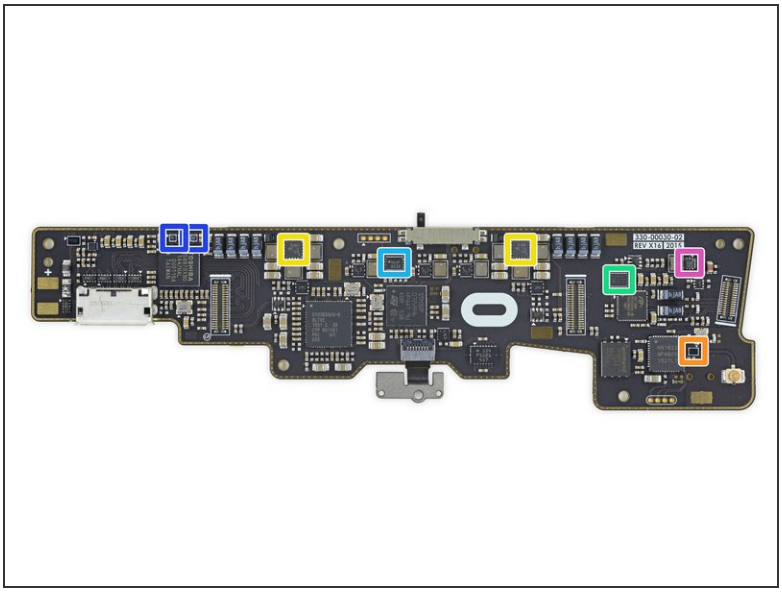
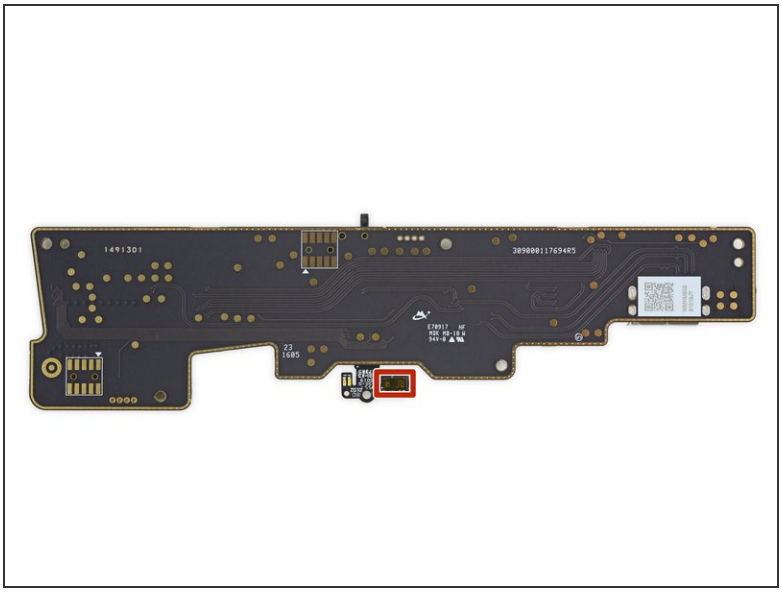
Step 10





- Motherboard IC identification, continued:
  - STMicroelectronics VL53L1X time-of-flight sensor (likely)
  - STMicroelectronics BALF-NRF01D3 Bluetooth balun
  - Texas Instruments display power management
  - ON Semiconductor CAT93C46B 1 Kb serial EEPROM
  - STMicroelectronics M24C64-F 8 Kb serial EEPROM
  - Texas Instruments TPS22908 load switch
  - Ricoh R1202L721A step-up DC-DC converter

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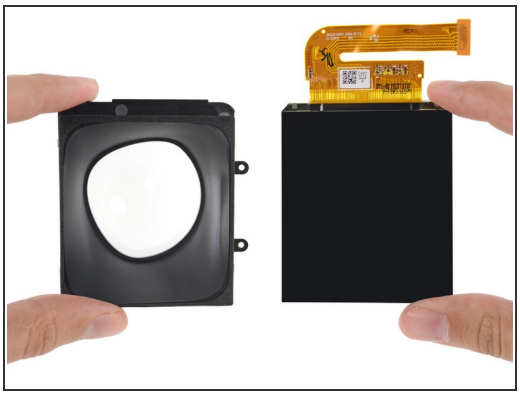
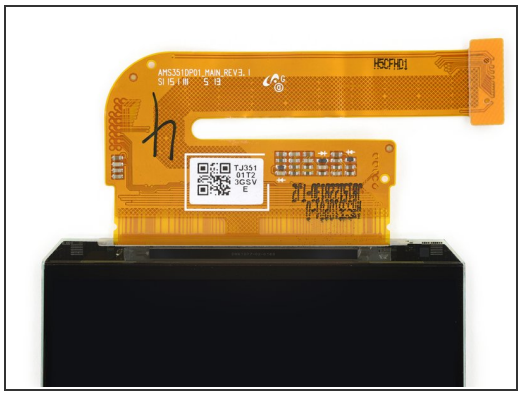
Step 11





- Separating the lens assembly reveals the custom, non-Note, larger-than-lens-aperture display!
- These OLEDs measure in at 90 mm apiece, for a resulting pixel density of ~456 ppi. In contrast, the display on an iPhone 6s Plus comes in at 401 ppi, while the Galaxy S7 is a cut above at 576 ppi.

  Given that pixel density, an average user would need to be 8 inches from the display for the pixels to become indistinguishable. The Rift's fancy optics make the display *look* much farther away to the user—but also much bigger, surrounding you with pixels.

  - So for now at least, individual pixels are still very much visible, or "indivisual," a technical term that we just made up.

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Step 12



- Where prior Oculus Rift kits shipped with interchangeable circular lenses (left), the CV1 uses a single set of non-removable, asymmetric lenses (right).
- A closeup of the CV1 lens reveals these concentric rings, a telltale sign of Fresnel lenses. These cleverly manufactured lenses do the same job as the thick, bulging, curved plastic lenses seen in prior Rifts—using thin arrays of concentric prisms that *weigh* far less.
  - The Fresnel lens yields the same large viewing angle and short focal length, but with a fraction of the material—which is exactly what VR needs. It all has to go into a brick-sized device you can strap to your face for hours, without putting a strain on your poor neck muscles.
- Bonus round: by varying the size and shape of the concentric prisms, Oculus was able to fine-tune the lens for this specific application, minimizing spherical aberrations (or distortions) that may result from a traditional curved lens. This probably explains the asymmetric shape.

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Step 13

- But wait—if Fresnel lenses do away with the bulging curves of traditional lenses, why are these lenses curved?
- Turns out, Oculus went a step further down the optical tunnel, and manufactured *hybrid* Fresnel lenses.
- These lenses are made up of concentric prisms of uniform thickness (like any other Fresnel lens). But an extra, sloping layer is added to the back of the lens, creating a shape that mimics a traditional curved lens—and allowing the *focus* to vary along the vertical axis of the lens.

  That's why the Rift instructs you to focus the headset by simply pushing it higher or lower on your face. Look through a different part of the lens until you find the focus suited to your eyes. Bingo, no more three-sets-of-lenses Rifts.

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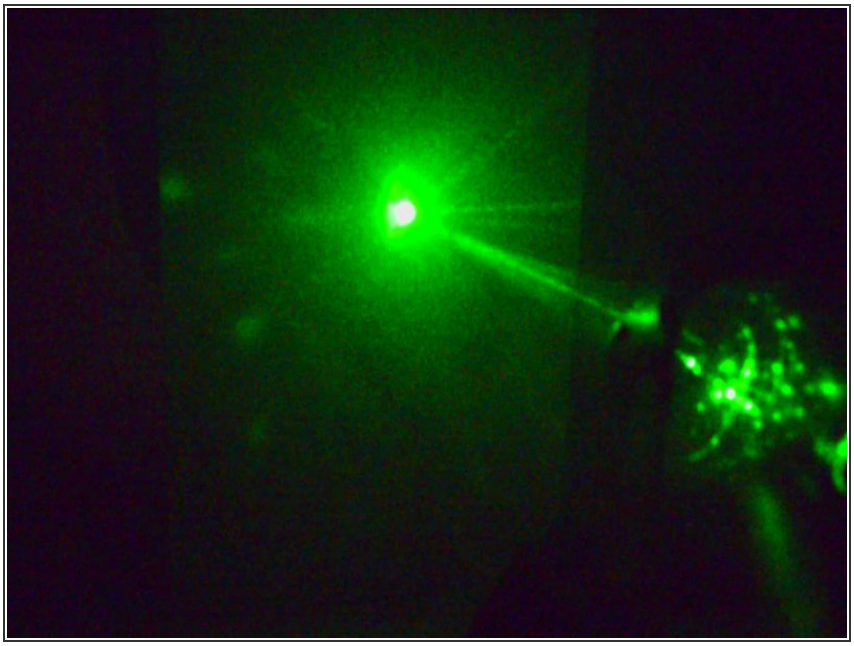
Step 14



- We interrupt this teardown for a Science Party. Dim the lights, fire up the smoke machine, and bring the laser beams!
- So when you put it all together, what does a lens in a VR headset actually *do*?
- For the VR experience to be realistic and not cause great discomfort, you need the optics to do two things: magnify the display so that you can't see the edges (which would kill the immersion), and focus the display at *optical infinity*.

  That last one is a fancy optics term that means objects on the display have to appear far away. The lens realigns the incoming light into parallel rays, so you don't have to do any work to focus, preventing eye strain.

- TL;DR: The Rift's lenses make up for your eyes' and the displays' shortcomings, making you think you're looking at an endless, distant display (instead of a TV screen glued to your face).

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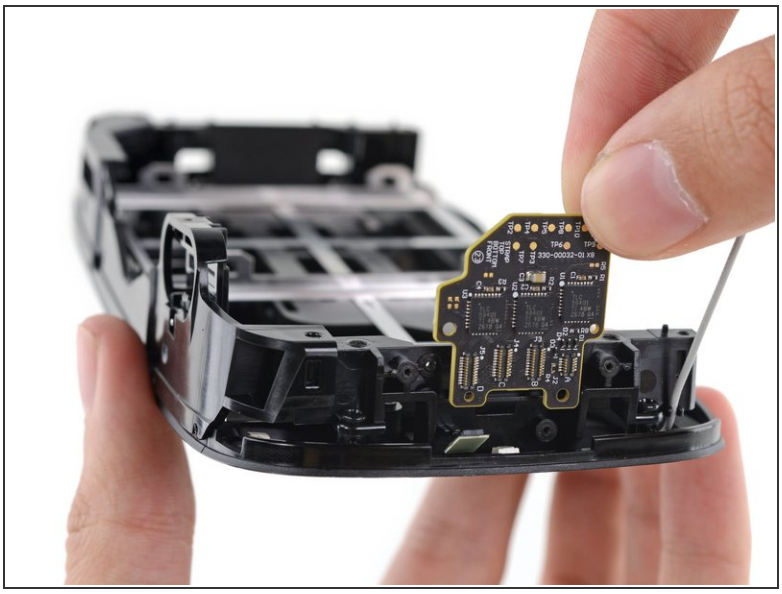
Step 15



- What was behind those lenses and dual displays? A super-sleek, spring-loaded, dual rack-and-pinion mechanism for adjusting the spacing between the display + lens assemblies.
  - The use of dual displays was a major advance between Rift DK2 and the Crescent Bay prototype. By allowing each lens + display assembly to move as a unit, the Rift provides enough adjustment to accommodate the 5th-95th percentile of IPD—while keeping other key optical properties intact.
  - TL;DR: If you have eyes, you can probably use this. Nice.
- Next to come out is the LED driver board, featuring all the labels a teardowner/reassemblist could want...

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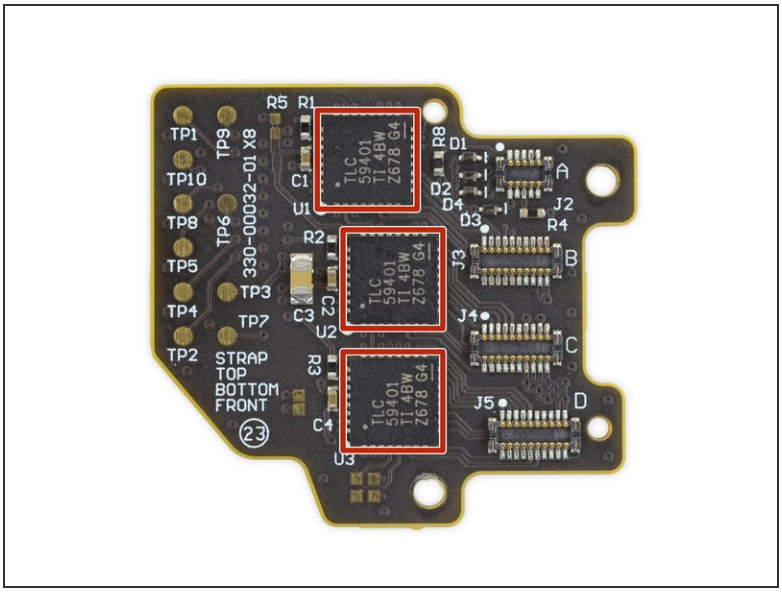
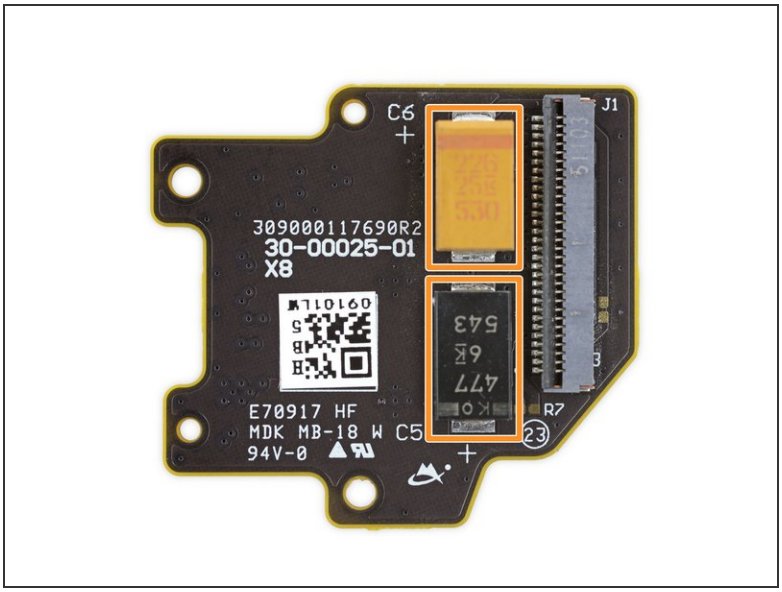
Step 16





- The aforementioned well-labeled board, complete with over a dozen test points and the essential control hardware.

Unlike the STMicroelectronics LED drivers we found in the Development Kit 2, this IC array hails from Texas Instruments:

- 3x Texas Instruments TLC59401 16-Channel LED Driver with Dot Correction and Grayscale PWM Control
- On the reverse, we see a pair of (relatively) large capacitors—probably necessary to smooth the intermittent load of pulsing such a huge array of IR LEDs.

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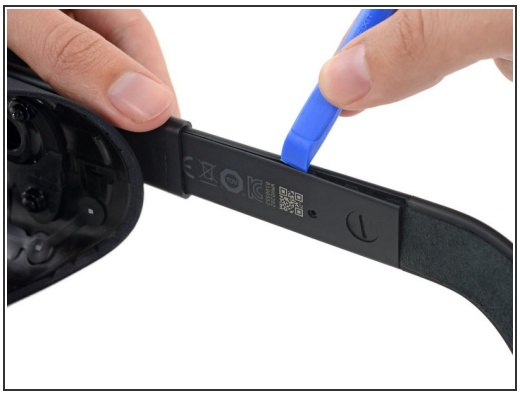
Step 17



- Optics: *check*. Silicon: *check*.
- Time to go hunting for headband hardware. Plastic opening tool in hand, we pry the FCC labels off in search of LEDs and headphone wiring.
- Peeling back a layer of fabric, we find a slick black ribbon cable that wraps around your head to feed the LEDs in the back. Neat!
- But wait—what are these mechanical things?

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Step 18

- Headband springs! These spring-loaded tracks in the sides of the headband each give an extra inch or so of play—without the fuss of a buckle or strap.
- That means you can get the Oculus on and off your head about as easily as a baseball cap. No further adjustment required.

While we were able to fit a dozen employee noggins with no fiddling, this springy mechanism *is* a possible point of failure. Considering the headband is darn near impossible to disassemble, your virtual reality may eventually have to rely on its straps rather than its springs.

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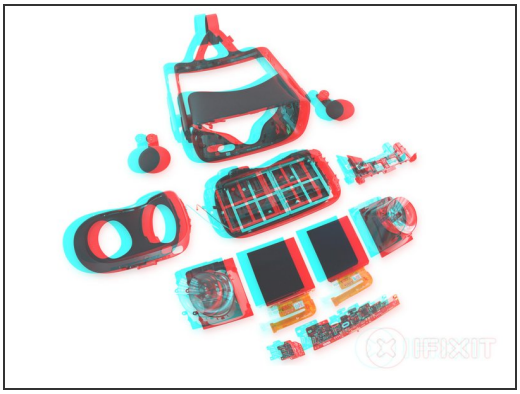
Step 19



- The Oculus Rift CV1 Repairability Score: **7 out of 10** (10 is best):
  - Cable management is much improved from the development kits, with a sturdy connector for easy removal.
  - The earpiece speakers are super easily removed thanks to spring connectors.
  - The face pad is held in with plastic clips and pulls out easily.
  - Getting inside is difficult, with hidden internal clips securing the dust shield.
  - Replacing the head strap is impossible without cutting through the fabric on the headset.
  - Intricate design and delicate ribbon cables makes it very difficult to remove the lenses, displays, and motherboard.

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