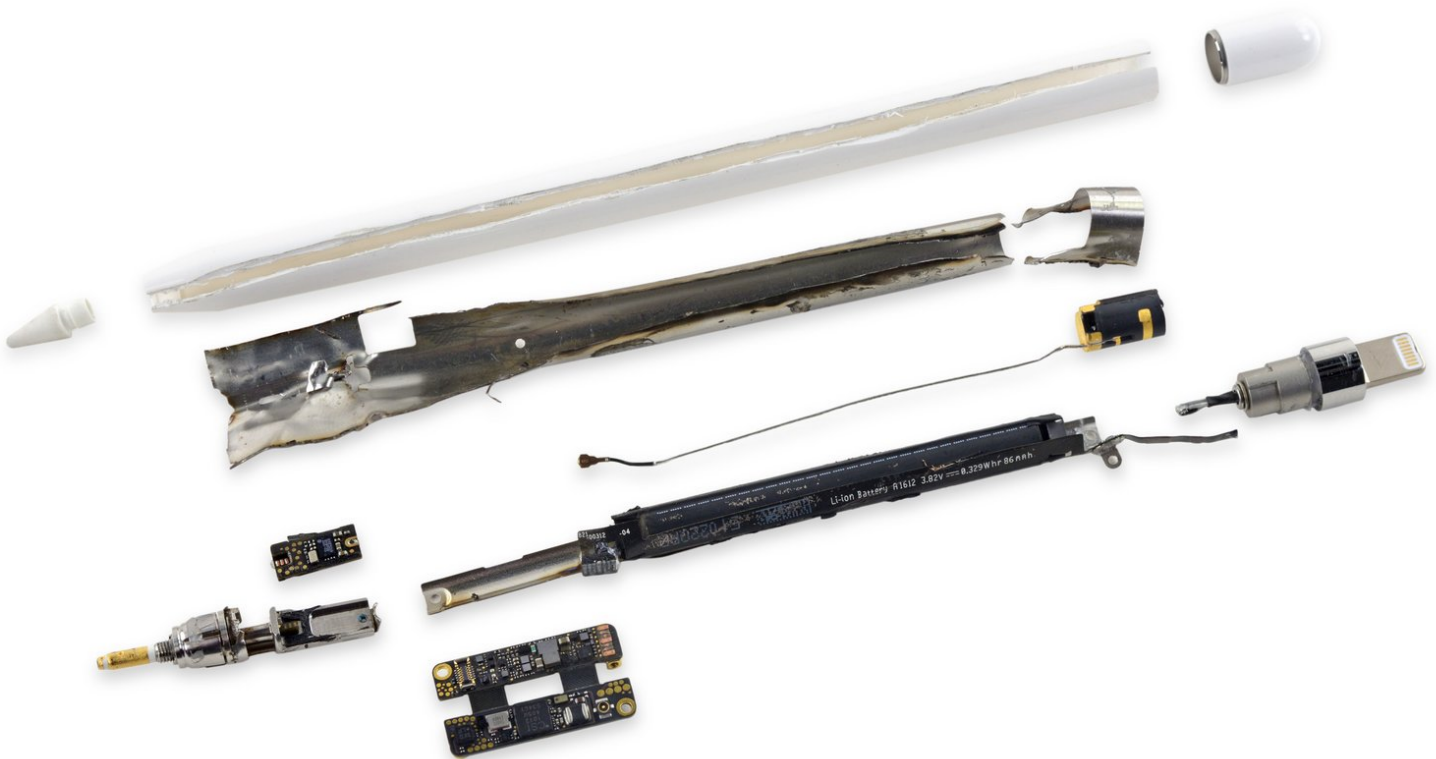




Apple Pencil Teardown

Apple Pencil Teardown on November 18, 2015.

Written By: Walter Galan



INTRODUCTION

Since the dawn of the iPad, Apple has remained resolute that the iPad is meant to be enjoyed sans-stylus. So when the iPad Pro debuted with a \$99 must-have accessory in the form of a stylus, we were obviously intrigued. What makes the Apple Pencil so special? From what we've heard, it's got some nifty features, but we're more interested in what's going on inside that shiny white cylinder. Join us as we find out!

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[video: https://www.youtube.com/watch?v=yVTw3Y7_ATo]



TOOLS:

- [iOpener](#) (1)
- [Rotary Tool](#) (1)
- [Tri-point Y000 Screwdriver](#) (1)
- [Metal Spudger](#) (1)
- [Tweezers](#) (1)

Step 1 — Apple Pencil Teardown



- Apple's been tight-lipped on this pointer's finer points, but here's what we know for sure:
 - Bluetooth 4.1
 - Scans at twice the rate of finger inputs
 - Up to 12 hours of battery life
 - 175 mm (L) x 8.9 mm (D)
 - Lightning connector for charging

Step 2



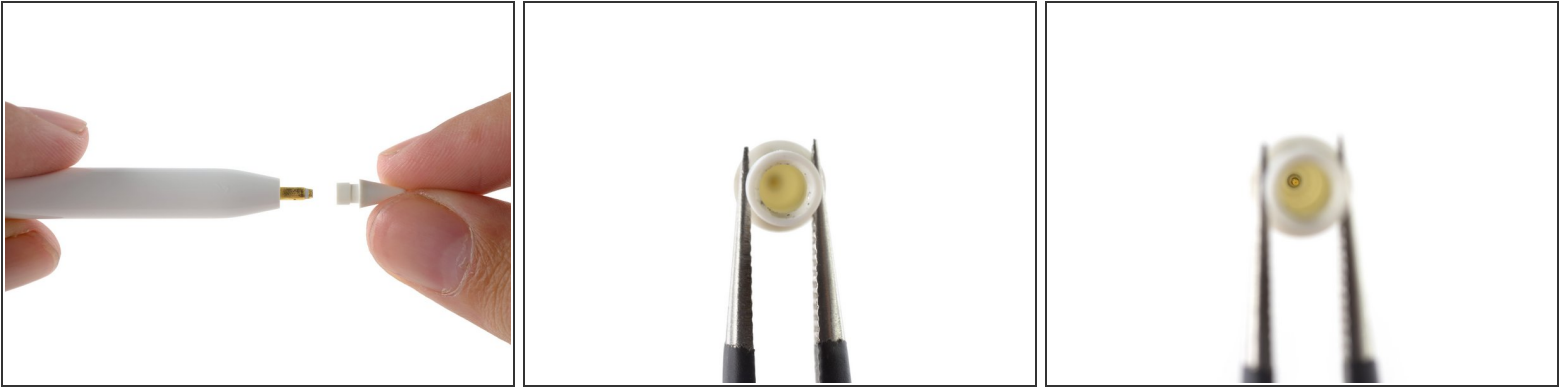
- There's been a lot of talk about Pencil. Let's sketch out a couple quick comparisons to some other styling styluses.
- First: the Microsoft Surface Pen (from a [Surface Pro 4](#)).
- Second: The original "[iPad Pencil](#)" by 53. It works specifically with their Paper app, and has a lot of the same features as the new Apple Pencil.
- ⓘ Also, it's really easy to open up and get the battery out.
- ⓘ Double-also, it has an eraser.

Step 3



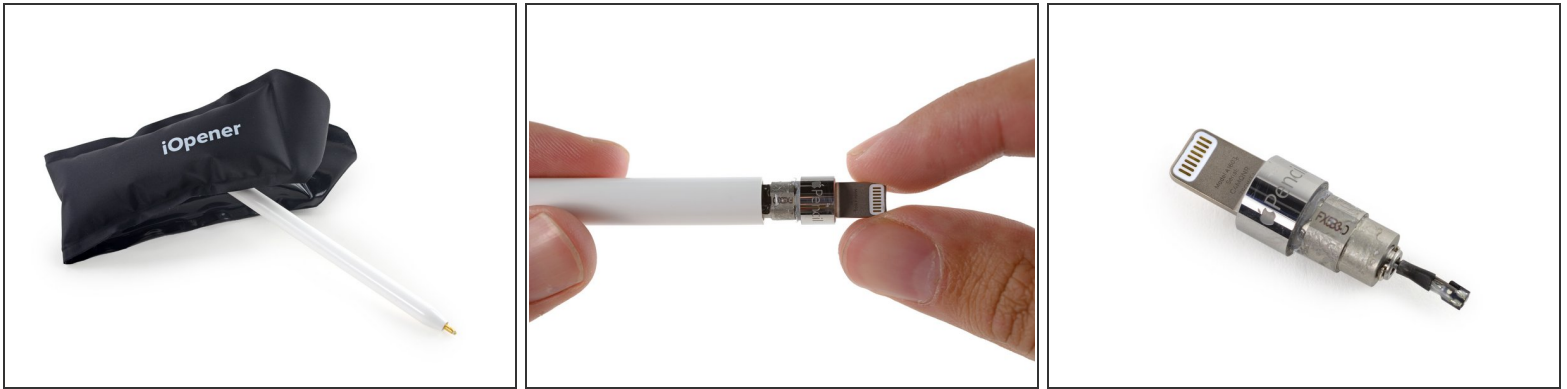
- Apple was nice enough to include a spare tip, as well as a Lightning-to-Lightning adapter (a last minute [addition](#)) to save users from having to precariously charge their Pencils directly from their iPads.
- The Lightning Connector cap snaps into place with magnets, but we're expecting most of these will be [lost](#) by next month.
- Popping the cap off reveals a brand new, never-before-seen model number: A1603. Welcome to the world, Pencil!

Step 4



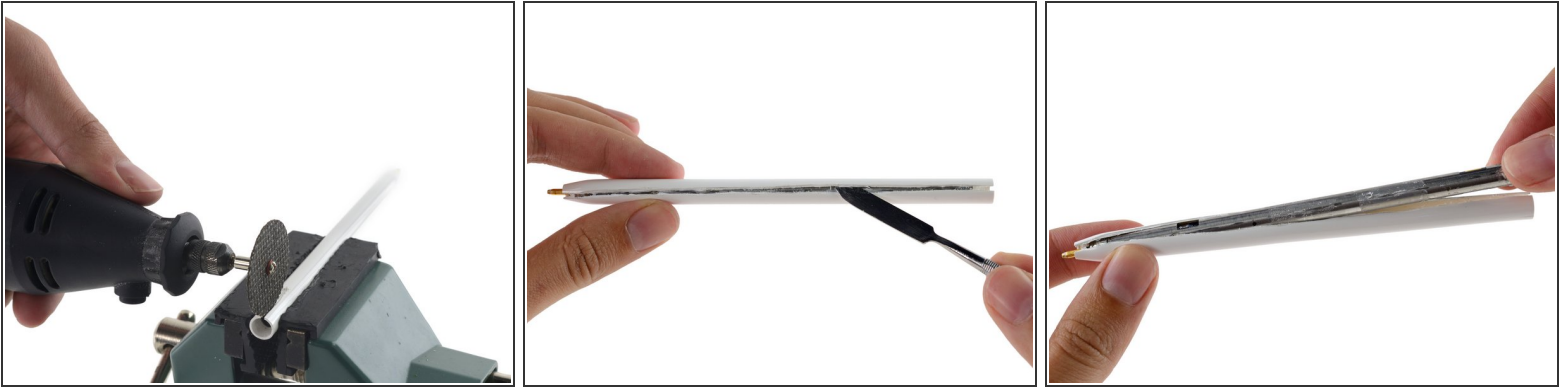
- Taking a nosedive into the Pencil, we start at the nib, which comes off quietly with a few quick twists.
- A peek inside reveals a tiny metal bit sunk deeply into the tip, presumably to get as close to the screen as possible.
- ① This likely connects to one of the two emitters in the tip that allow the iPad Pro to determine the Pencil's angle and orientation relative to the display, and adjust the pen stroke accordingly.
- The digitizer on an iPad Pro should be able to determine the distance from each emitter to the screen—and from that calculate the angle of the Pencil relative to the iPad.

Step 5



- We're eager to get a closer look at the ~~eraser~~ Lightning Connector, so we turn up the heat with our trusty iOpener.
 - ⓘ Author's note: the fact that they bothered to call this the Pencil—and not the Pen/Stylus—and then *failed to include an eraser* is just absurd.
- Even after a warm conversation with our iOpener, the Lightning Connector assembly still doesn't want to come *completely* out of its shell, but a quick tug frees it from the Pencil.
- But at what cost... We definitely tore a flex cable...
 - ★ Something tells us this isn't going to be one of those teardowns where everything goes back together at the end.

Step 6



- Having thoroughly dissected the top and bottom portions and finding no obvious point of entry, we throw caution to the wind and break out the big guns.
- Cutting through the ~~Bie~~ Apple Pencil's plastic casing reveals ~~an ink cartridge~~ a metal casing.
- ❗ And we haven't punctured the battery...yet! Looks like our [Operation](#) skills are finally paying off.

Step 7



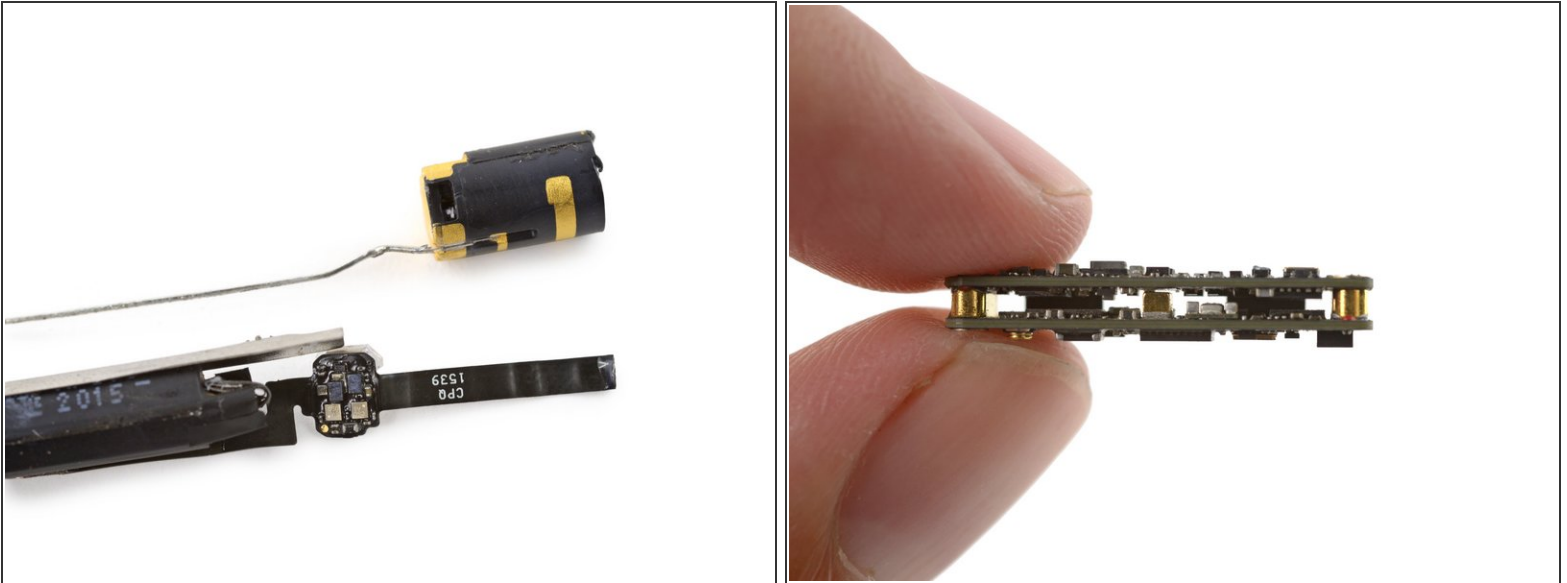
- Whew—that was some work! Wiping up the plastic dust and pausing for a quick burrito break, we take a moment to appreciate the [fruit](#) of our efforts: Pencil sans case.
- A quick glance along the inner metal cylinder reveals a tiny tri-point screw à la [Apple Watch](#).
- ❗ Luckily we've got the tools for this in our arsenal now. No files needed!
- Below the tiny fastener, we spy some tiny contacts, which we assume are for Apple's internal testing.

Step 8



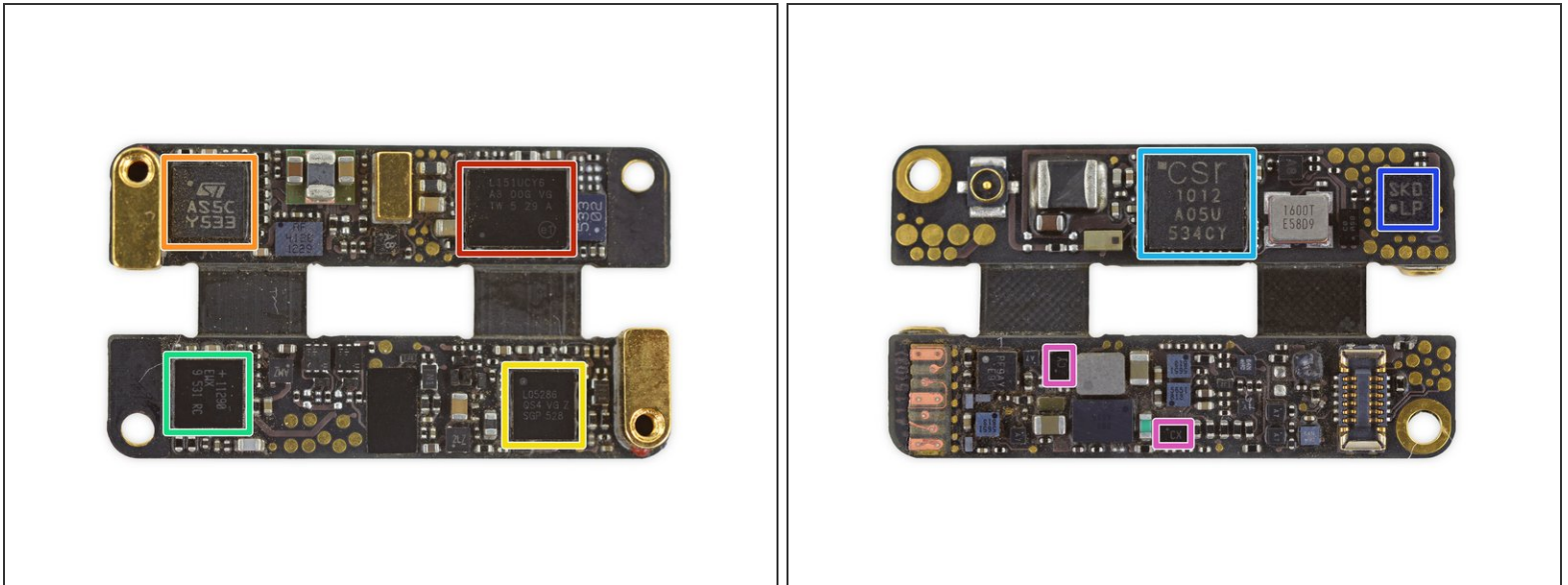
- After some more cutting and prying—and a brief conversation about laser cutters—we bust through a second (this time metal) layer.
- We're rewarded with the antenna and battery assembly. No graphite at the core of *this* Pencil.
- This tiny 3.82 V, 0.329 Wh lithium-ion battery holds just 5% of the charge of an [iPhone 6s](#) battery.
- ❗ For the sake of scorekeeping: Microsoft's Surface Pen has a user-replaceable [AAAA battery](#). These are usually rated anywhere from 0.4 to 0.9 Wh.

Step 9



- With the metal casing off, we pop off the antenna, decked in the familiar Apple black and gold.
- We also get a better look at that ribbon cable we sheared earlier... It runs between the Lightning connector and battery, with some battery charging ICs along the way (we assume).
- We've caught sight of more chips at the other end, so we ditch the battery and move to the fun stuff—like the [teeny logic board!](#)
- ❗ This little board is folded in half to make the most of the minimal space. Clever!

Step 10



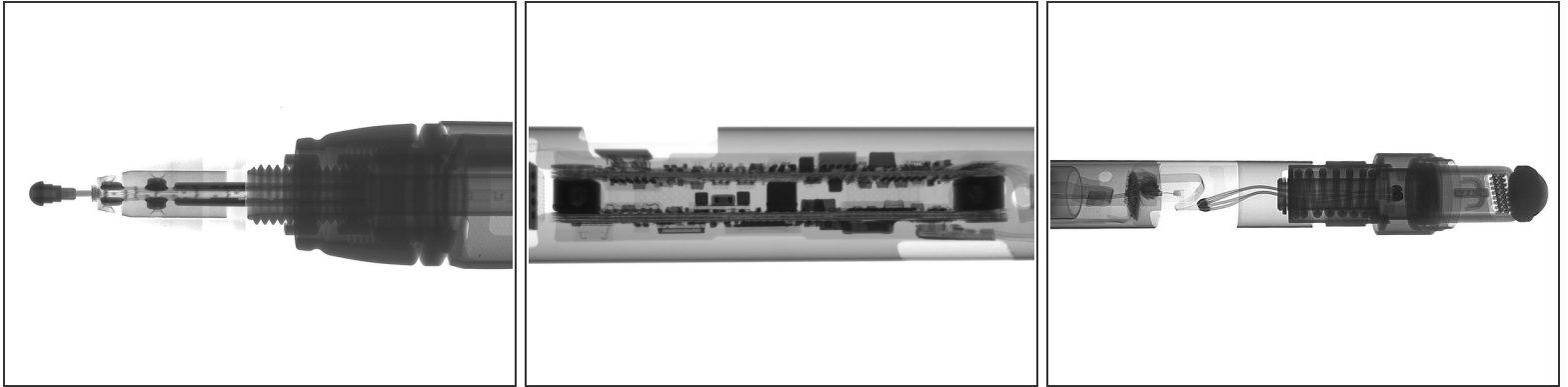
- What is this—a logic board for ants? Not quite, but weighing in at a whopping 1.0 gram it's definitely the smallest we've ever seen. With the hard work out of the way, we pause to see what makes the Pencil so smart:
 - STMicroelectronics [STML151UCY6](#) Ultra-low-power 32-bit RISC ARM-based [Cortex-M3](#) MCU
 - STMicroelectronics [STMLS05](#) 5-channel PMOS load switches
 - STMicroelectronics [STM32L052T8](#) 32-Bit ARM Cortex-M0+ Microcontroller w/ 64 Kb flash
 - Maxim Integrated [MAX11290](#) 24-bit delta-sigma A/D converter (likely)
 - Cambridge Silicon Radio (Qualcomm) [CSR1012A05](#) Bluetooth smart IC
 - Bosch Sensortec [BMA282](#) accelerometer
 - Maxim Integrated [MAX44284](#) high precision current-sense amplifier

Step 11



- We turn back to the metal casing to extract the pen nib and look for its sensor magic.
- Peeling up one of the tiniest boards we've ever seen we find a set of three matching ticks. Three on the end of the pen assembly, and three on the tiny board.
 - If we had to hazard a guess, we'd say these helped sense pressure by measuring [movement](#) between these two parts.
- Chances are this chip could tell us more about how this works...
 - It reads 8529043 343S00008-A1—likely a custom STMicroelectronics controller for the nib.

Step 12



- Further teardown of the tip seems impractical, but that's okay: *we have eyes everywhere*, thanks to some slick X-ray imaging from our pals at [Creative Electron](#).
 - Get a load of that tiny spring-loaded tip, and the two emitters buried within the shaft.
- Just for kicks, we also imaged the itty bitty folded logic board, and the Lightning Connector and cap.
- ① Fortunately this was captured when the Pencil was still intact, so you can still see the connector neatly soldered to its little ribbon cable. It's a thing of beauty (at least until the day you need to repair something).

Step 13



- Apple Pencil Repairability **1 out of 10** (10 is easiest to repair):
 - The pen nib and cap can be replaced if worn out (or lost).
 - The pencil is clearly not meant to be opened or repaired; you can't get inside without destroying the device.
 - The layers of plastic and metal holding interior components are impossible to remove without shredding.
 - The battery, enough for a 12 hour run, is impossible to replace, giving the device a limited lifespan.