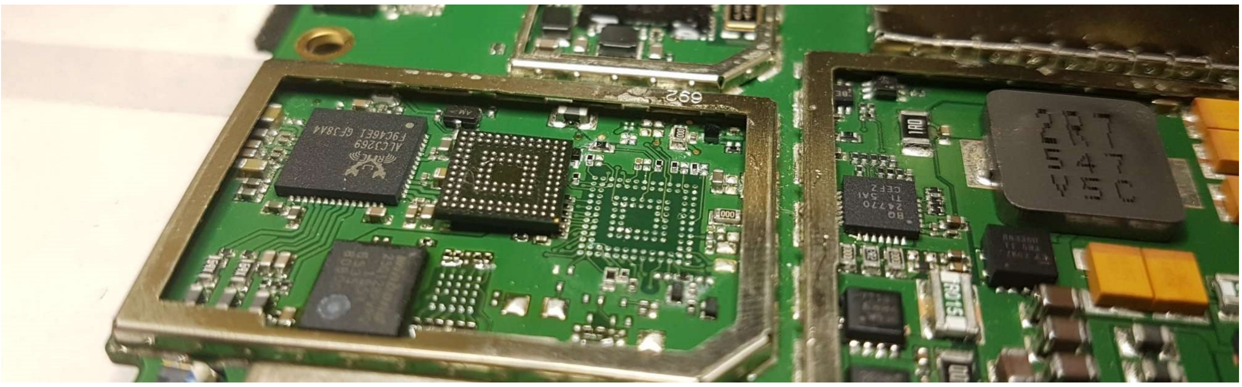


# MICROSOFT SURFACE PRO 4 – NO POWER, NO SCHEMATICS, NO PROBLEM!

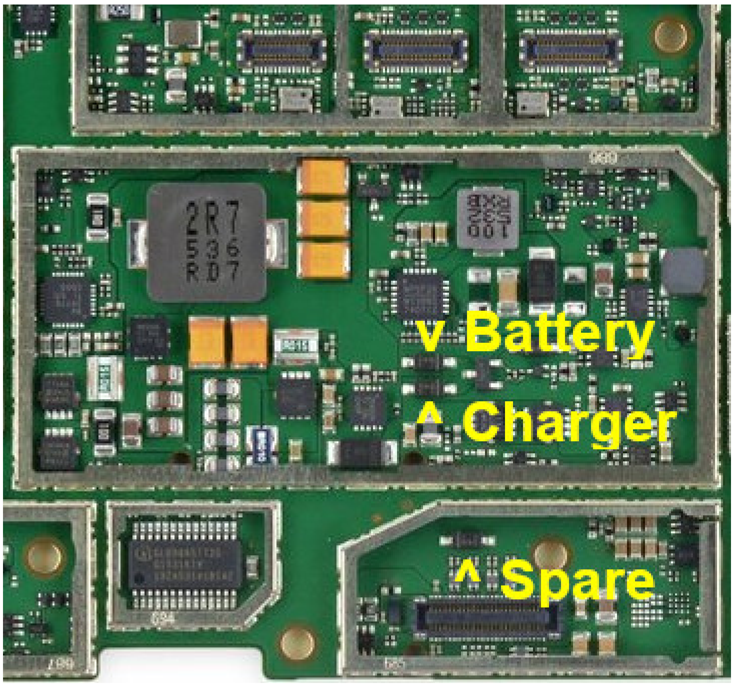
March 18, 2020 A One Mobiles (https://www.aonemobiles.com.au/author/aonemob/) 4 (https://www.aonemobiles.com.au/2020/03/microsoft-surface-pro-4-no-power-no-schematics-no-problem/#comments) Information, Advice, and Guides (https://www.aonemobiles.com.au/category/information/), Microsoldering, Motherboard Repairs (https://www.aonemobiles.com.au/category/board-repairs/), Repairs (https://www.aonemobiles.com.au/category/repairs/),

There's an issue that plagues technicians and consumers alike. When a Microsoft Surface Pro 4 suddenly no longer powers on. Sometimes this happens seemingly randomly, other times, immediately following a repair.

Parts of this puzzle have already been answered elsewhere on the internet. But what happens when its "neither of those"?

With no available schematics, it's difficult to determine the fault. We had a few of these in the queue, so we decided to reverse engineer one. We've put together a list of the 3 most common failures to check for, in order of likelihood.

## 1. A bad Schottky Diode




If you made it here from a search engine, you've probably already seen this failure 10 times over.

A diode (https://en.wikipedia.org/wiki/Diode) is effectively a one-way valve. It allows power to travel in one direction, and blocks it from traveling in the other. Unfortunately, a diode also causes a drop in voltage as power passes through it (known as the "forward voltage"). This is generally not ideal or efficient, and the voltage that is lost results in heat dissipation. This effect worsens the more current the diode passes.

Diodes also have a rated maximum current. Exceeding that current (say by overloading or short circuiting) can result in failure. Diodes fail in one of two ways. Either the forward voltage increases substantially (sometimes infinitely), or the diode effectively turns into a wire, allowing current to flow in both directions.

A Schottky Diode (https://en.wikipedia.org/wiki/Schottky_diode) is a slightly “better” diode. These are commonly found in all kinds of electronics. Schottky diodes have a lower forward voltage compared to their silicon counterparts, are available with higher current ratings, are more efficient, and as a result allow for higher switching speeds.

The Surface Pro 4 has an abundance of Schottky Diodes on the motherboard. In reality, any of them have the potential to fail. In most cases though, one of the diodes pictured here will fail. These diodes allow either the battery or the charger to power the device. The use of diodes means that whichever input is higher voltage will feed power to the unit, without feeding power backwards into the other input. For example, with the charger connected, the charger will power the unit, without feeding the battery and potentially over-charging it. Conversely if you leave the charger connected but not powered on, the charger won’t cause the battery to drain.

If you have a lower end Surface Pro 4, you may find that the “charger” diode is not populated. This is because the dedicated charging IC has enough capacity to charge the battery, while the battery simultaneously feeds power into the motherboard. In either case, a failure of the diodes will present with the following symptoms:

- **Battery:** A failure of this diode will result in the device immediately turning off when the charger is disconnected. This won’t effect charging the battery, or the battery reporting its state to the operating system, but will prevent the device running from the battery. In the case of a lower end unit (without the “charger” diode), the device will not function at all.
- **Charger:** A failure of this diode (on higher end devices that have it) will result in the unit running from the battery, but not the charger. This may mean the device says it is charging, but the percentage decreases as it gets used. Alternatively (depending on the mode of failure), the device may not charge at all.
- **Spare:** Funnily enough, on all of the devices we have seen so far, Microsoft was kind enough to provide us with a spare (https://www.reddit.com/r/mobilerepair/comments/f6hmmr/surface_pro_4_schottky_diode_replacement_see/) Schottky Diode. On the boards we checked, both sides of this diode connect to ground, and as such, it does nothing at all. We aren’t quite sure what happened here. Either there are variations of the SP4 that have this diode in use, or the part was accidentally left in the pick and place queue and nobody noticed. In either case, it’s handy to know in the event of a single diode failure, there’s probably a spare waiting for you in the device.

## Testing the Diodes

So if a diode is bad, how can we tell?

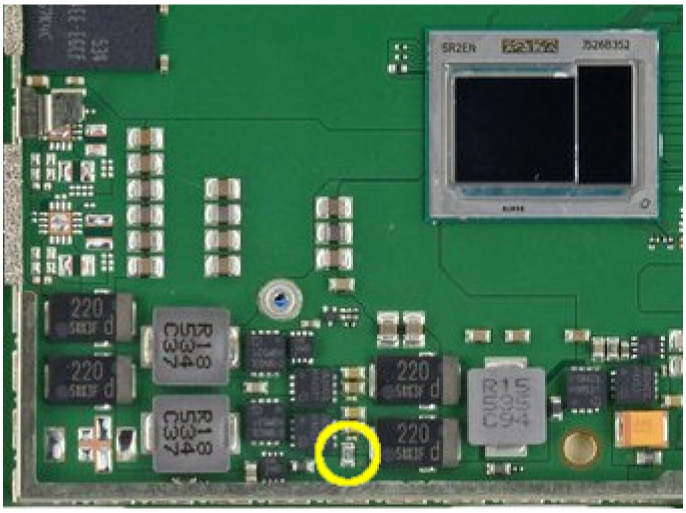
With the battery isolated (this is important) use a multimeter in forward voltage test mode (diode mode).
Measure across the diode leads. You should have no more than **0.250V** forward voltage, and no less than **0.100V**.
With the probes switched around, you should get a very high voltage (like **2.800V**), or “**OL**“.

If you get close to **0.000 in both directions**, your diode is **shorted** and needs to be replaced. If you get a high reading or **“OL” in both directions**, your diode is **blown** and needs to be replaced. A burn or hole is also a pretty good indication.

To replace the defective diode(s), you may be able to use the “spare” that we have noted above.

**If you don’t wish to do so, or if you have more than one defective diode, we also sell replacements in our store (https://www.aonemobiles.com.au/product/surface-pro-4-charging-battery-schottky-diode-sod123-60v-2a/).**

# 2. A bad Fuse



If the Schottky Diodes are good, or you replaced them both and the device does not work as expected, the next thing to check is the “fuses”. There are actually a number of these on the board. So many that we can’t list them all. We’ve circled the most common “fuse” to cause no power.

There are 3 variations of these fuses we have seen. In most cases they are a 0 ohm resistor, either marked “0”, or “000”. We still call them fuses, but in reality, they are 0 ohm resistors, aka “links”, aka “jumpers”. Less commonly, Microsoft chose to populate these with **actual fuses**, typically marked P or L.

If you locate the fuse we have circled, whatever it looks like is likely going to be the same for all the others.

## Testing the Fuses

If you’ve ever used continuity mode on your multimeter, you will be quick to grab it out and check for the “beep”, indicating a connection.
**Before you do though, be warned that this method is NOT fool proof, and may lead to misdiagnosis.**

While a lack of continuity would certainly indicate a “blown” fuse, a 0 ohm measurement or “beep” certainly does not indicate a working one. This actually applies for all kinds of devices, and we learned this the hard way on iPhone Backlight fuses many years ago.

To correctly test the fuse, you need to pass some current through it. Your multimeter uses a very small amount of current to test for continuity, and it isn't enough. There is a common failure mode where the fuse will appear to have continuity, until you try to pass current through it.

**To confirm operation of the fuse, we set our DCPS to 1V, and 0.05A (50mA) to 0.10A (100mA).**
The voltage here really doesn't matter, but its a good habit to use less than the circuit is designed for. This prevents damage to components should you accidentally slip and power the circuit.

- With probes connected to the DCPS, we verify the current limit by touching the probes together. **The "CC" (Constant Current) LED on your DCPS should illuminate.**
- Now, place your probes either side of the fuse. **The DCPS "CC" LED should illuminate, and the voltage should drop down to 0V.** If it does, you have confirmed your fuse can pass current.
- If the "CC" LED does not illuminate, if it doesn't stay illuminated, or if your voltage does not drop to 0, your fuse is not working properly.

To replace the fuse, you can use a 0 ohm resistor, an iPhone/iPad backlight filter/fuse (https://www.aonemobiles.com.au/product/ipad-backlight-filter/), or even a piece of wire (although we would advise against it).

# Where to from here?

**If it's not the Schottky Diodes, and it's not the fuses, what's next?**

Unfortunately, this is where the availability of information on the internet ends. It would seem that without schematics, nobody has worked out (or documented) what causes no power if its neither of the aforementioned.

We had a few devices that fit this criteria, so we set to work reverse engineering them to find out why.

To begin with, we connected the device to a DCPS directly and prompted the SP4 to boot with the power button. We figured if there is a short somewhere, injecting power and looking for heat dissipation is a good way of finding it.
**We got no response at all.**

This is unusual. Without schematics, we don’t really know what is responsible for the power on sequence, what IC is responsible for what rails, if any of our rails are powering up upon prompt to boot etc.

We set our sights on the power button. The first step to powering on the device, is obviously here. We were expecting to find a regulated 1.8V, 3.3V, or Battery Voltage at the power button. This is because the power button either needs to start “HIGH” and get pulled “LOW” (power button GPIO has a pull-up resistor), or start “LOW” and get pulled “HIGH” (power button GPIO has a pull-down resistor).

Upon probing around, we find that we have none of the above. Instead, we have a curious 0.157V. **That’s bizarre.** We appear to have located an issue.

**Now to find out whats causing it..**

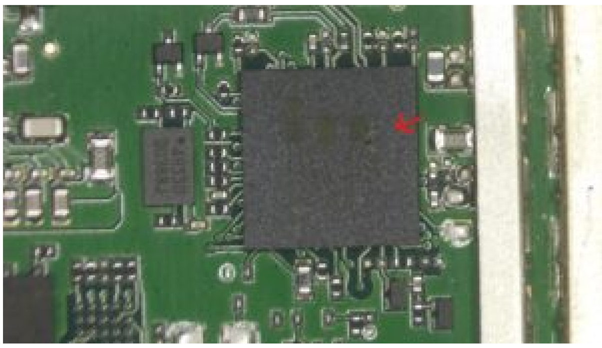
Luckily, we have multiple devices in our queue, some of which are now working. We quickly probe the power button on a working device and find that we have 3.3V. Now we need to find out where this 3.3V rail goes, where it comes from, and why we don’t have it on some devices.

We found a 3.3V regulator on the board, but unfortunately, its generating 3.3V no problem. There must be more than one. We started probing around and **found our mysterious 0.157V in multiple locations**, next to multiple IC’s.

(https://www.aonemobiles.com.au/wp-content/uploads/2020/02/sp4-3v3.jpg)


## 3. The secret answer. A missing 3.3V rail.

(https://www.aonemobiles.com.au/wp-content/uploads/2020/02/WIN_20200220_06_05_04_Pro_LI.jpg)



While investigating our missing 3.3V rail, and mapping out all of the locations we have a mysterious 0.157V, we noticed a suspicious mark on the **IT8528VG**.

Just next to this is a capacitor where we expect to find 3.3V, but instead have only 0.157V

We cleaned the **IT8528VG** to see if it was an impurity sitting on the surface. Nope. That's a very, very small hole. Huh…

At this point, we were thinking this IC might be responsible for our 3.3V output. A hole, and subsequently internal damage, would certainly explain why the output is low. We removed the IT8528VG and tested again, expecting to have 0V. **Our 3.3V is back!**

It turns out, the 3.3V rail is actually incredibly low current. So much so that a short on the rail, or excessive current draw, doesn't appear obvious when powering the device from a DCPS. We assume this rail is a reference for digital I/O. We still don't know where it comes from, but we now know why it was low. Our **IT8528VG** has failed, and developed an internal short.

We just happened to have a donor device, so we promptly pulled the **IT8528VG** from it. Without a stencil, we had to manually reball the IC.

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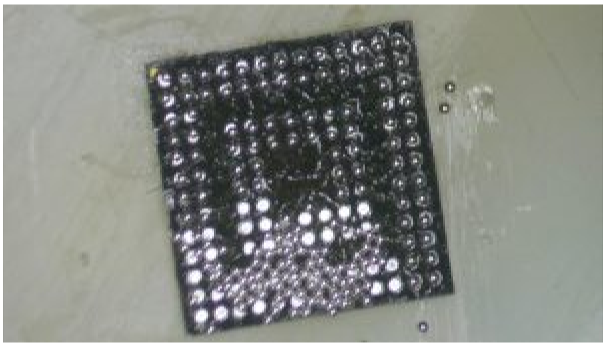

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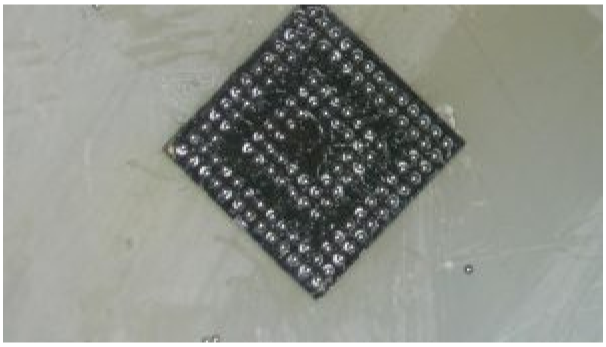

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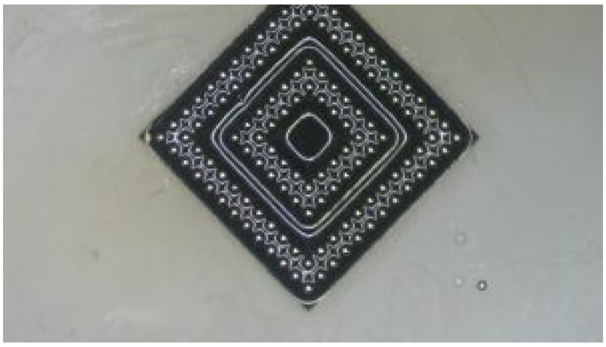

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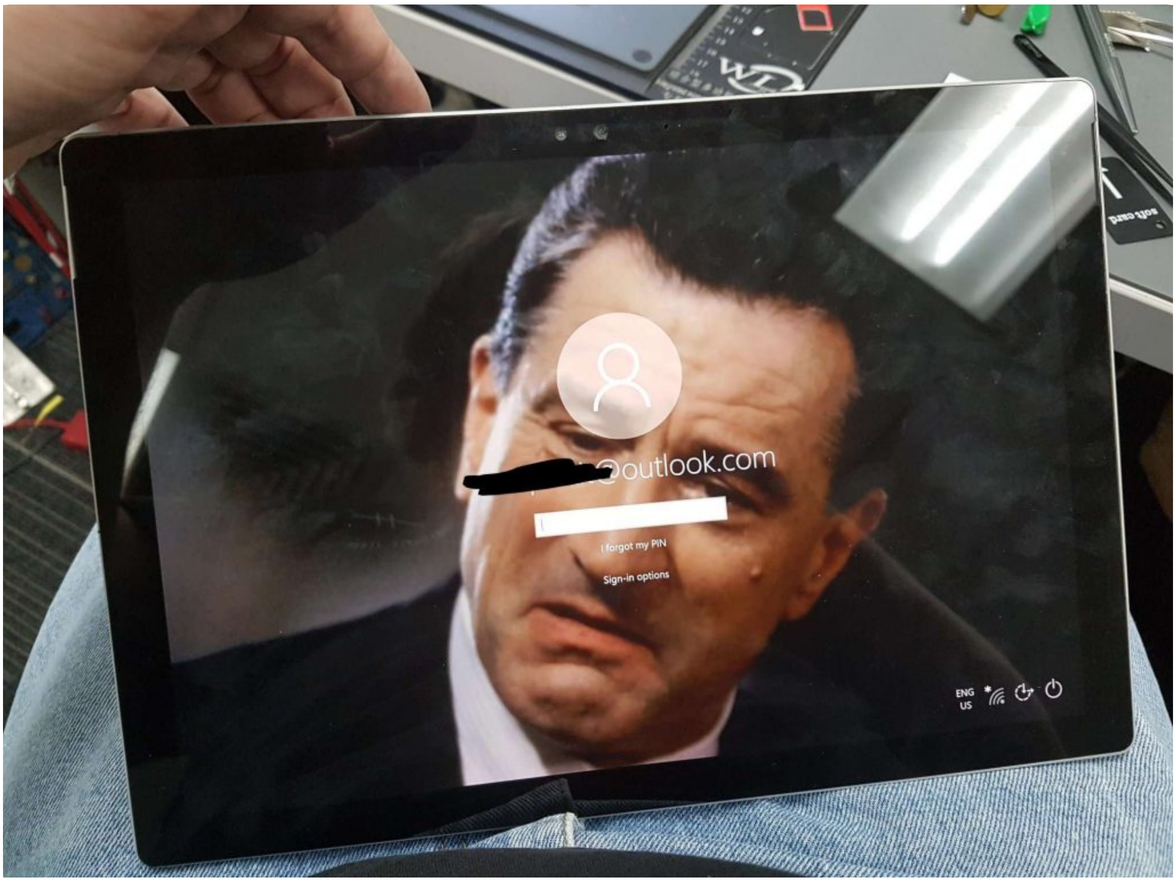
(https://www.aonemobiles.com.au/wp-content/uploads/2020/02/WIN_20200220_07_24_51_Pro.jpg)

With a replacement **IT8528VG** ready to go, we installed it and checked our 3.3V rail again.

Everything looks good. We have 3.3V in all the places we previously had 0.157V. This includes our power button.

We checked the device on the DPCS. Upon prompt to boot, we immediately see current draw that is consistent with CPU activity.

**Time for a final test..**

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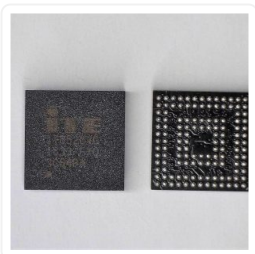
## It works!

**We looked at the other devices in our queue.**

All of them had the same missing/low rail, but none of them had a hole in the **IT8528VG**. Regardless, we removed the **IT8528VG** and sure enough, **our 3.3V rail came back.**

Since our discovery we ordered a bunch of replacement **IT8528VG**'s.
**You can now buy a replacement IT8528VG (https://www.aonemobiles.com.au/product/ite-it8528vg-fxo-power-management-ic-surface-pro-4/) from our store.**



**ITE IT8528VG FXO POWER MANAGEMENT IC (SURFACE PRO 4)**

**SURFACE PRO 4 CHARGING/BATTERY SCHOTTKY DIODE (SOD123 60V 2A)**

**IPAD BACKLIGHT FILTER**

$0.60 AUD inc. GST

**(https://www.aonemobiles.com.au/product/ipad-backlight-filter/)**

**Add to cart (?add-to-cart=1645)**

$14.00 AUD inc. GST

**(https://www.aonemobiles.com.au/product/ite-it8528vg-fxo-power-management-ic-surface-pro-4/)**

**Add to cart (?add-to-cart=4847)**

$2.00 AUD inc. GST

**(https://www.aonemobiles.com.au/product/surface-pro-4-charging-battery-schottky-diode-sod123-60v-2a/)**

**Add to cart (?add-to-cart=4861)**

Disclaimer: We can't say for sure that your device will absolutely have one of the 3 failures mentioned. There are many events that can cause many parts to fail. This is just a list of the most common failures we have encountered.

We have however fixed all of the Microsoft Surface Pro 4 Tablets in our queue. We have also assisted in the diagnosis of other devices around the world suffering from the same issue. In almost all cases we have encountered so far, the failure has been one of these 3 things.

Tags: Advice (https://www.aonemobiles.com.au/tag/advice/), Australia (https://www.aonemobiles.com.au/tag/australia/), Battery (https://www.aonemobiles.com.au/tag/battery/), Charging (https://www.aonemobiles.com.au/tag/charging/), Information (https://www.aonemobiles.com.au/tag/information/), Micro Soldering (https://www.aonemobiles.com.au/tag/micro-soldering/), Motherboard (https://www.aonemobiles.com.au/tag/motherboard/), No Boot (https://www.aonemobiles.com.au/tag/no-boot/), No Power (https://www.aonemobiles.com.au/tag/no-power/), Repair (https://www.aonemobiles.com.au/tag/repair/), Tablet (https://www.aonemobiles.com.au/tag/tablet/)

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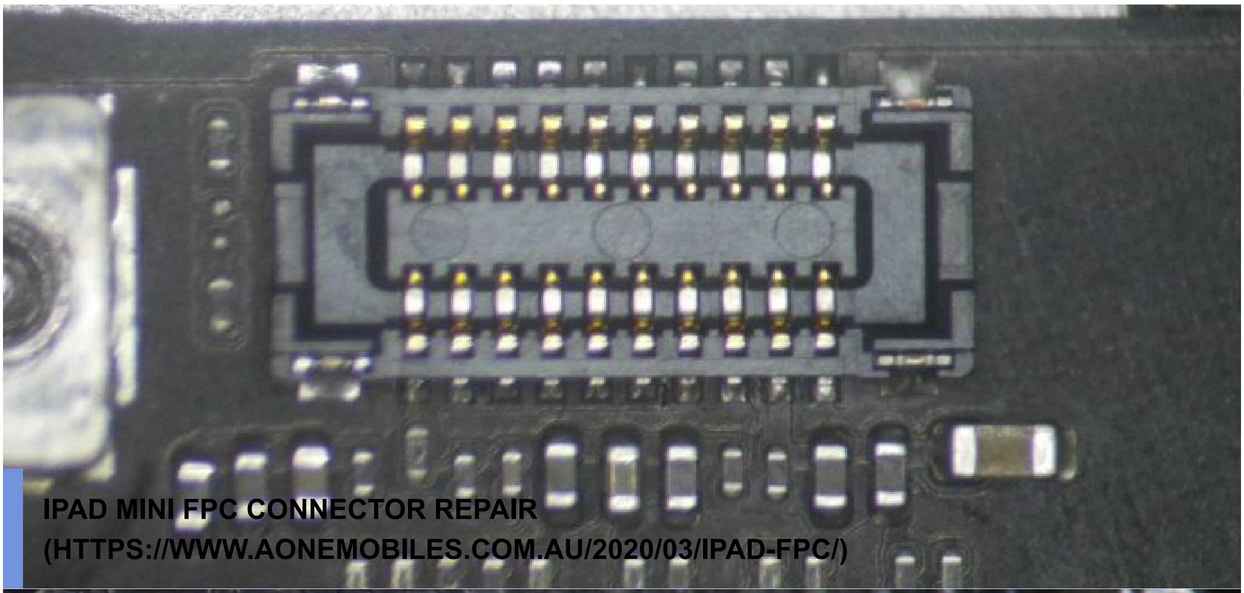
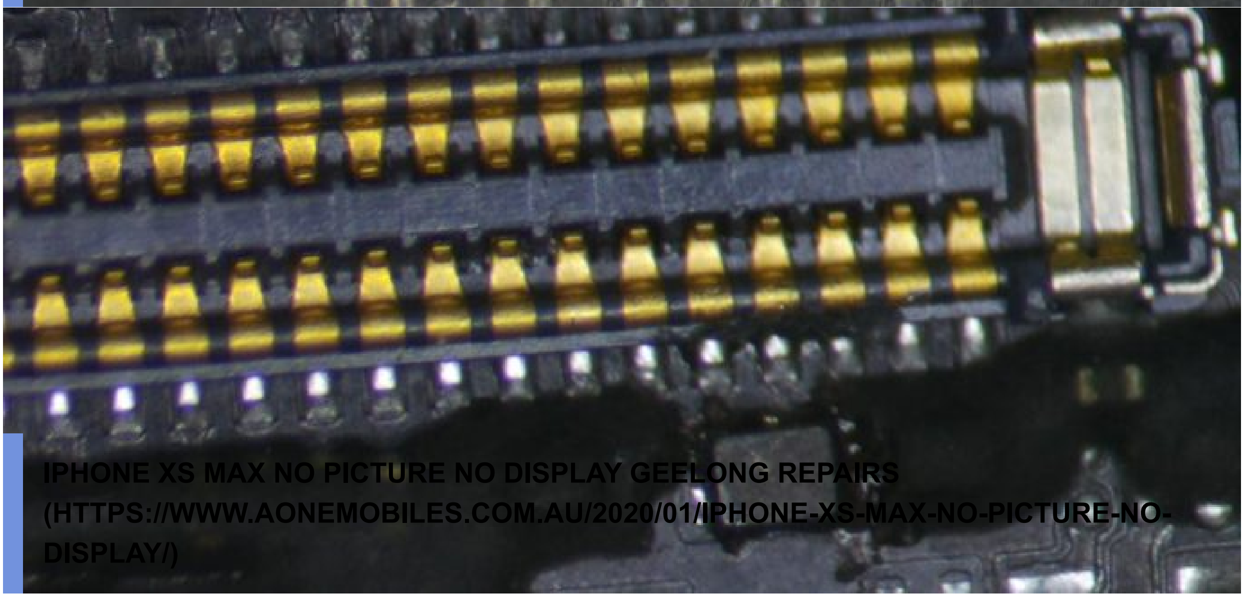


**IPAD MINI FPC CONNECTOR REPAIR (HTTPS://WWW.AONEMOBILES.COM.AU/2020/03/IPAD-FPC/)**



**IPHONE XS MAX NO PICTURE NO DISPLAY GEELONG REPAIRS (HTTPS://WWW.AONEMOBILES.COM.AU/2020/01/IPHONE-XS-MAX-NO-PICTURE-NO-DISPLAY/)**

## About The Author

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## 4 Comments

***alpen.dev@gmail.com* says:**

April 6, 2020 at 12:05 am (https://www.aonemobiles.com.au/2020/03/microsoft-surface-pro-4-no-power-no-schematics-no-problem/#comment-2654)
Hello, I have a Surface 4 Pro i7 16gb (lower end unit with 1 schottky diode)

It only runs on Battery and is not charging. I have already replaced the battery diode with the spare one and didn’t make any changes.

Could you please assist/give any direction on where to look at?

Many thanks in advance and greetings from Switzerland

Log in to Reply (https://www.aonemobiles.com.au/wp-login.php?redirect_to=https%3A%2F%2Fwww.aonemobiles.com.au%2F2020%2F03%2Fmicrosoft-surface-pro-4-no-power-no-schematics-no-problem%2F)

***A One Mobiles (https://www.aonemobiles.com.au/)* says:**

August 10, 2020 at 1:41 pm (https://www.aonemobiles.com.au/2020/03/microsoft-surface-pro-4-no-power-no-schematics-no-problem/#comment-2789)
I would be investigating the charging IC itself. Primarily, you want to know if you actually get charger voltage at the IC. If not, start at the beginning of the chain. Do you get charger voltage at the charger connector itself? A bad port can cause this if not. If so, see if you can follow that voltage, and see where it disappears. You may find that you have charging voltage at a P-MOSFET, a low voltage on the gate (which is the condition a P-MOSFET requires to turn on), and low voltage on the drain side, which would indicate a bad MOSFET.

Or, you might find that the gate is high, which means the MOSFET is not being turned on. You would then investigate why, and what is responsible for turning that MOSFET on. This could also be the charging IC. They usually have some form of open-drain “Power OK” output used for this purpose.

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***September11* says:**

August 13, 2020 at 8:51 pm (https://www.aonemobiles.com.au/2020/03/microsoft-surface-pro-4-no-power-no-schematics-no-problem/#comment-2817)
L26h diode to be installed instead of Schottky diode 4b 4n?

Log in to Reply (https://www.aonemobiles.com.au/wp-login.php?redirect_to=https%3A%2F%2Fwww.aonemobiles.com.au%2F2020%2F03%2Fmicrosoft-surface-pro-4-no-power-no-schematics-no-problem%2F)

***A One Mobiles (https://www.aonemobiles.com.au/)*** **says:**

August 14, 2020 at 9:48 am (https://www.aonemobiles.com.au/2020/03/microsoft-surface-pro-4-no-power-no-schematics-no-problem/#comment-2818)
Sorry, I don't really understand the question. The specifics of what are written on the diode (both the one installed, and the one we provide) are not so important. In fact, if you order one of ours, there's every chance it will have something entirely different written on it.

What really matters is the Reverse Breakdown Voltage, the Current, and the forward voltage. The diodes we have chosen have a higher Reverse Voltage, and a higher Current Capability, while maintaining the same (or lower) forward voltage as the original. All of these values are arbitrary though. In an ideal world, the reverse breakdown voltage and current would be infinite, and the forward voltage would be 0.00. The diodes we provide are marginally closer to this criteria than the original, so they can be considered "more robust", but in reality, you could use just about any schottky diode, provided it was rated to handle "at least" the expected current and voltage.

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