

## Title: How I fixed my RAV4 EV On-Board Charger

The bottom line is this: If your RAV4 EV tries to charge a few times but it will not then it is probably a problem with the on-board charger. 90% of the time, just replacing the fuses fixes this problem like this ([dfergenson Repair](#)) and this ([Tech26 Repair](#)). Unfortunately, I was in that 10% where a “simple” fuse replacement did not fix my on-board charger. Not only did I need to buy a used Gen 1 Tesla Model S onboard replacement charger, but it took nearly six months to get my car back up and running because, 1) I knew almost nothing about electric cars, 2) I am fortunate enough to have two cars so repairing my RAV4 EV, while important to me, was not urgent, 3) several other issues surfaced along the way, 3) I needed help from some amazing people on this forum, especially **alflash** and **dfergenson**, 4) it took swapping some of the guts between my original charger and the replacement charger. For those interested, here is my story and the details of how it unfolded.

First, I must thank **alflash**, **dfergenson** and his wife. And my family for putting up with my out of service car for six months. If you have a problem with your RAV4 then I highly recommend asking **alflash** for help figuring out what the problem might be. He has a simple and quick way to connect to the Tesla side of your car and diagnose any Tesla system problem.

For me, the problem with my charger started in January 2022 when my car would charge sporadically. It was sporadic because sometimes it would stop charging after 10 miles of charge, other times 20 miles and other times it would fully charge. I took my car to my local Toyota dealership, and they charged me \$180 to diagnose the problem. The salesperson said the DC-DC Converter was bad and they could replace it for \$5,000. Based on sales at the time, my Car was worth about \$14,000 so I declined their offer and I elected to research the problem myself. Now you need to know that, at this point in time, I knew essentially nothing about the inner workings of electric cars. There were indications that Tesla provided some of the parts for the car, but I had no clue that it was really a Model S on a RAV4 body.

I drove the car for a few weeks with the sporadic charging. Finally, I took the car to work with a full charge. After several trips, I returned home with about 8 miles of charge remaining. Ready to head to work the next morning, this is when the car decided to completely fail to charge. It had the same symptoms as others; charging would start for a few seconds, stop then start about three times before stopping with below Check EV message on the dashboard.



At this time, I knew virtually nothing about the inner workings of my RAV4 EV, let alone how to take things apart. I had never worked on a car before except for simple things like changing a tire, headlights, oil and brake pads. I knew that Tesla had provided some of the guts of the vehicle, but I did not know yet that it really was a generation 1 Model S in a RAV4 body.

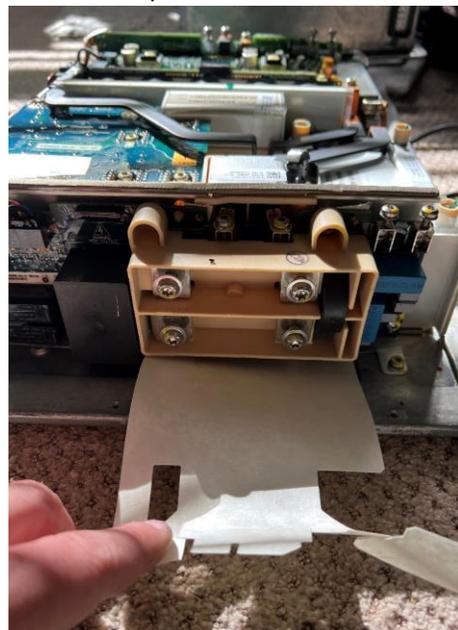
There were several YouTube videos that I found on this forum about the likely problem with the DC-DC Converter. I did not have an account on this forum at the time so I could not post my issue and ask for help. My enrollment request sat for over a month until I reached out to the moderator. There is no one to blame but myself since, in the end, the moderator had my account set up within a day of my reaching out to them.

## DC to DC Converter



In the meantime, I figured out how to remove the DC-DC Converter, open the case and check the fuses (related video: <https://www.youtube.com/watch?v=HWTcgFswHXE>). As it turned out, the fuses were fine, so I carefully read the dealership technicians write up of their diagnosis. While the salesperson talked to me about replacing the DC-DC Converter, there was also mention of the On-Board Charger. After further research about what the On-Board Charger does, I became convinced that this was the source of the problem and that the DC-DC Converter was working fine.

It was now late February. I had learned how to reset the error codes on the Toyota side, but I knew nothing about the Tesla side. After seeing videos of people replacing the 50A fuses in the On-Board Charger (related video: <https://www.youtube.com/watch?v=yPOtAotzvTY>), I decided to remove that as well. It took me about twelve hours and a friend to get it out, but I was so thrilled when I opened the On-Board Charger, tested the fuses, and found that both of them were bad. After ordering new fuses that took over two weeks to arrive, I replaced them and reinstalled charger.



Alas, when I tried to charge the car, I encountered the same charging problem. With my account now set up on this forum, I posted my first plea for help on March 16, 2022, and several of you responded with suggestions. Again, I was still ignorant about the workings of my RAV4 EV, but I was on mission to fix it myself and save \$5,000.

One particular response to my first post caught my eye.

*"Guessing" is not the best way to "treat"/repair..."*

*First, you need to make a diagnosis of Tesla systems \* (read codes, collect and analyze live data with IGN ON, Ready and Charge), state all the external signs of a malfunction.*

*And after analyzing the results, make a final diagnosis.*

This reply was from alflash. After some discussion, he wanted me to get a MikroTik router (<https://mikrotik.com/product/RB941-2nD>) so that he could link to the Tesla side of my car and try to determine what the problem was. After thinking it over for a couple of days, I ordered the \$24 router. While waiting for the router to arrive, I grabbed an old laptop and loaded Toyota diagnostic software, wired up an interface connector per alflash's specifications ([Communications Cable](#)) and figured out how to link the soon-to-arrive router to my home network through a firewall that would isolate the router network from my home network. At this point, I still did not know who would be entering my network, so I wanted to protect it, just in case.

When the router arrived, alflash's tech support configured it by remotely controlling my old laptop using TeamViewer. It took them minutes and I then connected the router to the RAV4 and immediately alflash began the diagnostic process. We communicated via Skype and all that I did was stand by the car to turn it on and off, open and close doors, and plug in to try to start charge at his direction.



We started the diagnostics at about noon Pacific time, 10 PM Ukrainian time. It took about two hours for alflash to look the car over and try to figure out what the problem with it was. Unfortunately, he could not identify the exact problem, but he was certain that the issue continued to be the on-board charger. Below is a screen capture of the diagnostics result provided by alflash on April 1, 2022. As I now know, this proved correct, and the dealership's DC-DC converter

suggestion was not. After putting everything away, alflash reached out and asked if he could connect to the car again. I could tell that he was determined to figure out the problem and what needed to be fixed.

The screenshot displays the Tesla Powertrain Diagnostics interface (Service 1.1.42) with several panels open:

- Alert List:** Shows "Currently Active Alerts" and "Alert History". The active alert is "CHG\_002 Charger internal problem detected" on 2022-04-01 at 02:27:22.
- Drive Inverter:** Shows State: DL\_STATE\_STANDBY, Cruise State: CRS\_STATE\_OFF, Cruise Set Point: 0.00 MPH, Inverter Temp: 16 DegC, and Stator Temp: 16 DegC.
- Battery Shipping:** Shows Max Cell Temp: 17.00 DegC, Isolation Resistance: 3620 kOhm, Internal Isolation Fault: (green indicator), and Ok To Ship By Land: (green indicator).
- Battery Status:** Shows User Display State of Charge: 0.00 %, HV Safety Interlock (HVIL) Status: (green indicator), Isolation Resistance: 3620 kOhm, Energy Remaining (Until Empty): 0.00 kWh, HV Battery State: BMS\_STANDBY, Contactor State: BMS\_CTRSET\_OPEN, HV Battery Voltage: 264.89 V, and HV Battery Current: 0.00 A.
- Battery Return:** Shows Min State of Charge: 0.00 %, Energy Remaining (Until Empty): 0.00 kWh, Lifetime Discharged Energy: 30334.12 kWh, Battery Serial Number: T14E0004738, Battery Date of Manufacture (YYYY-MM): 2014-05, and Battery Age: 7.9 Years.
- Charger:** Shows Charger State: CHG\_MAIN\_STATE\_FAULT, Sub-state: CHG\_STATE\_FAULTED, Proximity: CHG\_PROXIMITY\_LATCHED, Pilot Current: 40.00 A, 12 Volt: 12.600000 V, Input Voltage: 0 V, Line Current: 0.00 A, Available Line Current: 0.00 A, Setpoint Line Current: 0.00 A, and Available Power: 0.00 kW.
- DC-DC Converter:** Shows Input Power: 320 W, Output Voltage: 13.50 V, Output Current: 20 A, Coolant Request: (grey indicator), Over Temperature: (green indicator), Output Over Voltage: (green indicator), Output Under Voltage: (green indicator), Output V Regulation Error: (green indicator), and Current Thermally Limited: (green indicator).
- Thermal Controller:** Shows Powertrain Pump: 35 %, Battery Pump 1 (left): 30 %, Battery Pump 2 (right): 30 %, Radiator Fan: 0 %, Battery Heater Active: (grey indicator), Battery Chiller Active: (grey indicator), and Cabin Evaporate Mag. Valve: (green indicator).

The bottom status bar shows "Monitoring" for VIN 2T3YL4DV6EW003141, with system icons and a taskbar at the bottom.

I mentioned above that the charge of the battery was extremely low. Several weeks prior, while I was testing the car myself, I had left the car ignition on. I suspect it remained on until the accessory 12-Volt battery completely discharged. It appears that, over those days, the high voltage (HV) battery had discharged to the point that the remaining drive miles were no long showing. According to alflash, the battery voltage was down to 280V which, I was told, is a critically low level.

In retrospect, the low battery level was not an issue, but it did prevent me from being able to run diagnostics because when alflash reconnected to the car later in the afternoon, the ignition would no longer go into READY, while it had earlier in the day. He explained that the car can never charge through traditional means if it will not go into READY mode. We ran the car through many tests to try get it to go to READY with no luck.

At this point, alflash was concerned that the battery charge had dropped below a safe level and had reached a "deep discharge" state. As I mentioned, this was not the problem, but we had no evidence that anything else had changed with the car except the charge level and I still believed that I was in the 90% of all people whose car could be repaired by changing the fuses, so we focused our efforts on solving this problem first.

This was the very last day of March, and I was giving up all hope of recovering the car. Over the week, alflash would not give up on finding a way to get my HV battery charged and find out what was wrong with the charger. He and I reached out to several of you to see if we could find other answers but there did not seem to be many good options. Option 1 was to ship the car to QC Charge in Southern California; however, I did not think the cost of shipping and repair was worth the cost. Option 2, find a way to bypass the battery and trickle charge the HV battery with a high voltage, low amperage power supply; Option 3, was to somehow get the car into READY mode and spin the tires to charge the battery through regenerative braking; or Option 4 was to sell the car for parts. I even considered buying a totaled

RAV4EV from auction for around \$2,000 to swap parts back and forth but they do not auction the cars to regular people, just dealers and auto mechanics.

I was about to give up all hope after alflash described the above options to me. He also asked me to contact someone else that was having the same charging problem as I was. He wanted me to explain what I was trying to do to fix my car. As it turned out, this contact was a turning point in the whole experience.

By this time, I had worked so closely with alflash that I trusted him completely. I was happy to help alflash and this new person. On my first contact with dfergenson, who lived 60 miles from me, we discussed the similarities of our car troubles. Within a day, he and his wife came by in a rental car to pick up my MikroTik router and cables. Their RAV4 EV is their only car so fixing it was more of a priority for them than for me. In the next day or two, alflash had diagnosed their problem but I already suspected the problem to be the same fuses that I had replaced in my on-board charger. To help dfergenson out, my wife and I drove to their house and helped them pull the charger out of their car. After a lot of grunting and laughs we got it out and sure enough one of the two fuses was blown.

I was now mid-April. dfergenson ordered new fuses and reinstalled the charger into his car as soon as they arrived. At my encouragement, he also bought a used Gen 1 Model S on-board charger for around \$250 on eBay. The thought was that if his charger still did not work then he would have a replacement on hand; and if it did work then I would buy the charger from him since mine was still not working. In a fantastic twist of fate, dfergenson's car started charging immediately after he reinstalled the charger after replacing the fuses. Now the mystery was why mine would still not charge. Suspecting it was due to faulty reinstallation, I removed the charger again; thoroughly checked all the connections; and reinstalled it. Again, the car would not go into READY mode and alflash could not determine the exact problem.

But that was okay because dfergenson had bought the used Model S charger and it would arrive soon. It was now dfergenson and his wife's turn to come to our house. On April 24<sup>th</sup>, they brought the charger and we spent most of the day uninstalling my original charger and installing the new one. By the end of the day, alflash was ready to connect to the router and to the car to run the diagnostics from Ukraine.

And... nothing. Because of the Russian invasion of Ukraine, his internet access had changed so he could not connect to the router. We tried charging the car but still nothing worked. It was a couple days before alflash's team were able to reconfigure the router for his new internet service. When he was finally able to connect, he could read the status of every Tesla device except the charger. This was, of course, very disappointing and confusing.

Given the amount of time it took to remove the charger and reinstall it and how many times (3) we had done it with no progress, I decided to mount the charger on a test bed on top of all of the other components so I could test and verify that it worked before completely reinstalling it again. It took me almost two months to gather the parts and assemble them (see test bed images below). Finally, toward the end of June, I had everything ready. After the 4<sup>th</sup> of July, dfergenson and his wife came over to help. The week prior, I had reassembled the entire power train, except for the charger.



First, we mounted the replacement charger on the test bed and made all of the connections to the rest of the power train. As with the prior time, the car would not go into “READY” mode and the charger did not work. We disconnected and reconnected it a few times after checking a few things.

Then we removed the communication/control board from my original charger and swapped it with the replacement charger board (see below photo of the comm/control board that was swapped). After setting it back on the test bed and making the connections for the final time, we turned the car on, and it immediately went into “READY” mode. We then connected the charging cable, and the car began charging. Obviously, after six months of trying to get the charger

working, we were ecstatic. Not only did the car start to charge but, after reinstalling the charger into the engine, it has been working flawlessly ever since. After I completely reinstalled the charger and added coolant a few days later, Alflash connected to the car, and everything checked out. Alflash connected to the car, ran diagnostics and confirmed that the previous error codes were no long active. The below screen capture shows that diagnostic data on July 16, 2022. He also ran the coolant pumps to flush out any air bubbles while I topped up the coolant periodically as the air bubbles were purged from the powertrain cooling system.

Tesla Powertrain Diagnostics - Service 1.1.42

File Views Perspectives Configuration Help

**Firmware Version**

Vehicle Major Version: 1

Vehicle Mid Version: 3

Vehicle Minor Version: 101

**Alert List**

**Currently Active Alerts**

Alerts | First Seen

**Alert History**

Alerts | Start | End

Coolant Air Purge | Alert List

**Thermal Controller**

Powertrain Pump: 52 %

Battery Pump 1 (left): 52 %

Battery Pump 2 (right): 52 %

Radiator Fan: 0 %

Battery Heater Active:

Battery Chiller Active:

**Drive Inverter**

State: DI\_STATE\_STANDBY

Cruise State: CRS\_STATE\_OFF

Cruise Set Point: 0.00 MPH

Inverter Temp: 42 DegC

Stator Temp: 44 DegC

**Battery Status**

User Display State of Charge: 6.20 %

HV Safety Interlock (HVIL) Status:

Isolation Resistance: 2340 kOhm

Energy Remaining (Until Empty): 1.20 kWh

HV Battery State: BMS\_DRIVE

Contact State: BMS\_CTRSET\_CLOSED

HV Battery Voltage: 308.96 V

HV Battery Current: -1.00 A

**Battery Return**

Min State of Charge: 6.00 %

Energy Remaining (Until Empty): 1.20 kWh

Lifetime Discharged Energy: 30337.22 kWh

Battery Serial Number: T14E0004738

Battery Date of Manufacture (YYYY-MM): 2014-05

Battery Age: 8.2 Years

**Battery Shipping**

Max Cell Temp: 33.00 DegC

Isolation Resistance: 2340 kOhm

Internal Isolation Fault:

Ok To Ship By Land:

**Hardware Configuration**

Gateway Hardware Id: 7

Battery Management System Hardware Id: 20

Charger Hardware Id: 9

DC/DC Hardware Id: 255

Drive Inverter Hardware Id: 9

Pedal Monitor Hardware Id: 9

Thermal Controller Hardware Id: 8

**Modern Connection Status**

Green light indicates a fully functional connection.

Yellow light indicates connection failure, not necessarily a vehicle fault.

Modern Connection Status:

**Charger**

Charger State: CHG\_MAIN\_STATE\_STANDBY

Sub-state: CHG\_STATE\_IDLE

Proximity: CHG\_PROXIMITY\_DISCONNECTED

Pilot Current: 0.00 A

12 Volt: 14.300000 V

Input Voltage: 0 V

Line Current: 0.00 A

Available Line Current: 0.00 A

Setpoint Line Current: 0.00 A

Available Power: 0.00 kW

**DC-DC Converter**

Input Power: 240 W

Output Voltage: 14.30 V

Output Current: 14 A

Coolant Request:

Over Temperature:

Output Over Voltage:

Output Under Voltage:

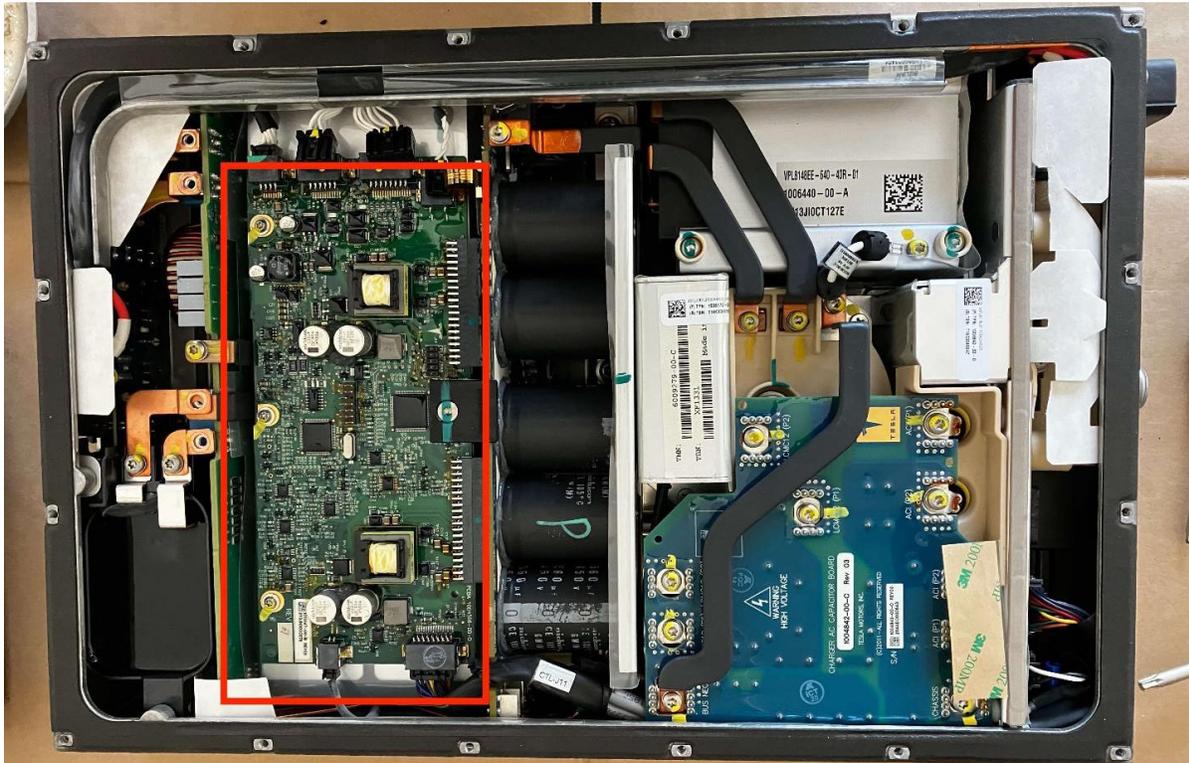
Monitoring | VIN: N/A

Введите здесь текст для поиска

Набр... winb... Tesla ... RU 0:39 17.07.2022

## Side Note

*This photo shows the communication/control board that we swapped from my original charger to the replacement charger. We believe Tesla locks the serial/registration number of the charge control board to the vehicle. By installing an unregistered charger into my car, Tesla would not allow the charger to function. By swapping my original charger control board into the replacement charger, the serial/registration number is now recognized so the replacement charge started working. Alternatively, the replacement charge communication/control board was faulty; thus preventing it's operation. If anyone has an idea about which is more likely, then I would appreciate your input.*



We are now 100% certain that the problem with my car was a faulty charger and that I'm among the unlucky few who experience this problem and can't simply fix it by replacing the fuses. We still do not know exactly what is wrong with the charger but that is a problem for another day.

I can say that I now know much more about my RAV4 EV and the Tesla Model S generation 1 EV drive train system that I ever thought I would. I am now confident that I can quickly fix my car if anything goes wrong again. I love this car and hope to be driving it in the years to come.

Again, I must thank Alflash and dfergenson for their help and support. Alflash is amazing. Even with the Russian invasion he was willing to help me every step of the way. The charge for his help was more than worth what it cost, and I pray that he, his family, friends, and his country defeat the Russians soon and they are never threatened by them again.

I don't know how many RAV4 EV are still on the road. Since only about 2,500 were built between 2012 and 2014, I cannot imagine that there are many. I still see a few in my neighborhood. If anyone needs some advice, then do not hesitate to contact me.

I know this story was long winded but, if you read this far, I hope it was worth your time.

Thank you