

Accelerator pedal renovation for NHW11 Prius
Doug Schaefer, May 2006

Note 1: These instructions are provided for informational purposes only, and if you choose to follow them, **the responsibility and risk rest entirely with you!**

Note 2: In the newer (NHW20) model Prius 2004 and later, the accelerator pedal assembly (APA) was changed to a Hall effect sensor. It is possible that the change happened sooner, during the 2003 model year. If yours does not look exactly like the pictures below, these instructions do not pertain to you and I urge you not to cut it open!

Note 3: If you have an APA problem, an error message appears on the screen, and you have less than 36,000 miles on the odometer and 36 months on the car, the problem may be fixed for free under Technical Service Bulletin EG-0xx. Contact your favorite Toyota shop for service.

Note 4: People who wish to renovate their own APAs may benefit from this information, but see Note 1 above. If you want me to do the work instead, email me at

dougschaefer@scientist.com

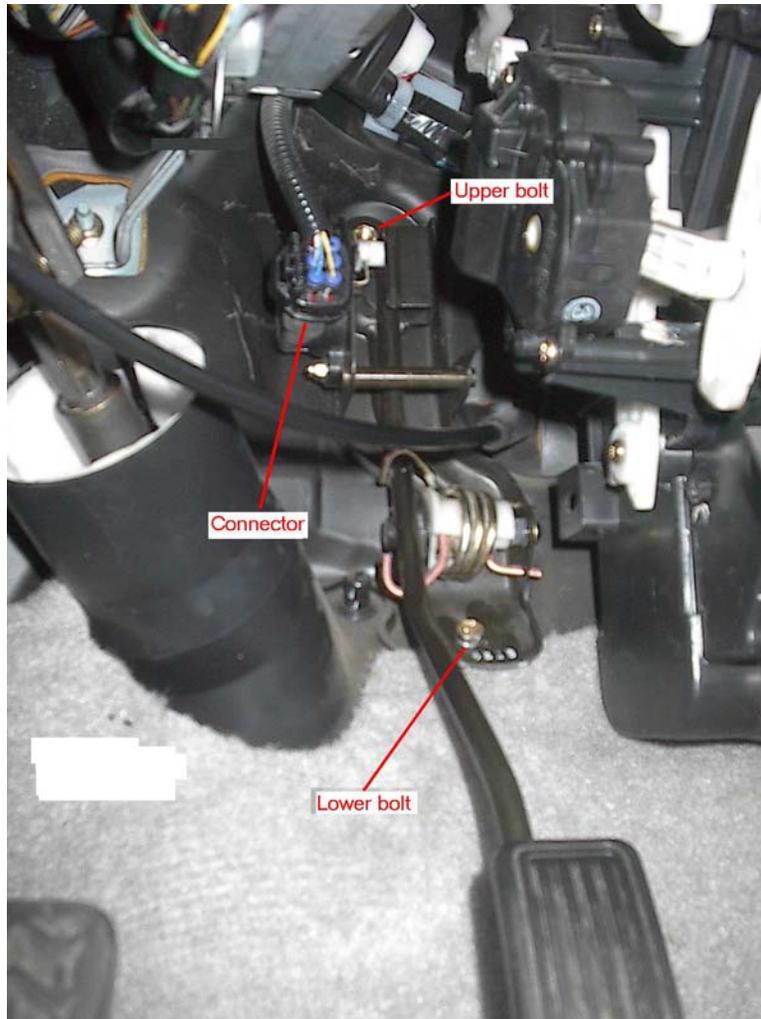
and we will make arrangements.

BACKGROUND

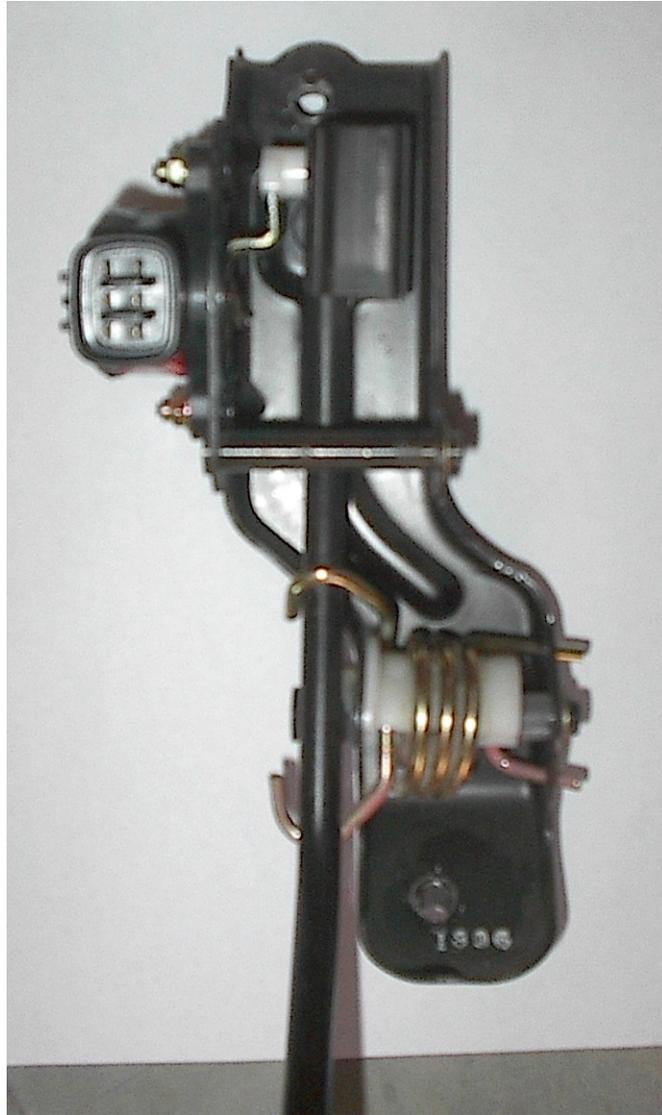
The Prius accelerator is a totally electrical system. The accelerator pedal assembly (APA) converts pedal angle to electrical resistance. The resistance values are interpreted by the hybrid vehicle ECU, which controls the operation of the gasoline engine. In some instances, the potentiometers become dirty, “noisy” or otherwise present bad data to the HV ECU. The car may then be slow/reluctant to respond to pedal input, and this is often referred to as the “BIG HAND Syndrome”. A replacement APA can be installed by Toyota for several hundred dollars. But in some cases at least, the original APA can be removed, renovated and reinstalled, and then the car works fine. The purpose of this document is to explain the steps I follow in renovating classic Prius APAs.

ORIENTATION

Your right foot controls the pedal angle of the APA, so you already know where it is. The APA consists of the accelerator pedal, a mechanical linkage that rotates two ganged potentiometers inside a “potentiometer box”, springs that provide mechanical resistance to pedal motion in both directions, a 6-position electrical connector to vehicle wiring harness and a metal frame that is held to the car by 2, 10-mm bolts. Here is what it looks like installed:



and removed:



BEFORE YOU REMOVE THE APA

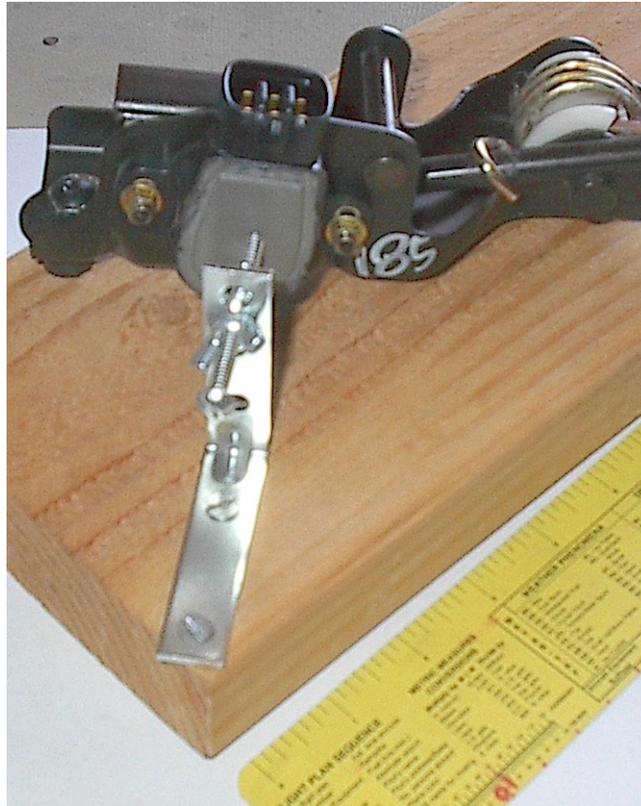
Remove its electrical connector and spray some electrical contact cleaner, WD-40, or similar on the six contact pins. Reconnect, disconnect, etc., several times. Then depress and release the pedal about 30 times, with the car off. Then drive the car and see if it works any better. It is possible that these steps will be sufficient.

APA REMOVAL

Unhook the electrical connector. Remove the top and bottom 10-mm bolts. Now the entire APA can be removed. Obviously the car is now completely non-functional until a working APA is reinstalled. Once you cut the thing open, you are committed, **so please read and understand the entire document before proceeding.**

BUILD A "JIG" TO HOLD THE APA

The purpose of this jig is to hold the APA and potentiometer box cover in good and stable alignment when they get epoxied back together later. But it is also handy during the cutting and cleaning steps, so now is a good time to prepare it. I use a 2 by 6 inch piece of wood, but anything similar should work as well. You will put 2 screws through the APA bolting holes, into the wood. You will also attach a small metal "L-bracket" to the jig, and run a bolt through it, to press lightly against the potentiometer box cover and hold it in place while the epoxy is setting up, later on. For now, just make sure you have left room to install the L-bracket and pushing-bolt later, and leave those pieces off. Here is my current jig, using a pair of wing nuts to press on the P-box lid. Note the APA in this image has already been cut open:



CUT OPEN THE POTENTIOMETER BOX

Decide if you want to have the APA mounted on your jig, or handheld for cutting. If the former, screw it into place on the jig. I use a Dremel mototool and an abrasive wheel for the cutting. Look at the potentiometer box. Its sides are black and its top is gray, and both are plastic (ABS perhaps?). Here we go! It is easy to cut, even though there will be some melting from heat generated by the abrasive wheel. It is also easy to cut too deep!

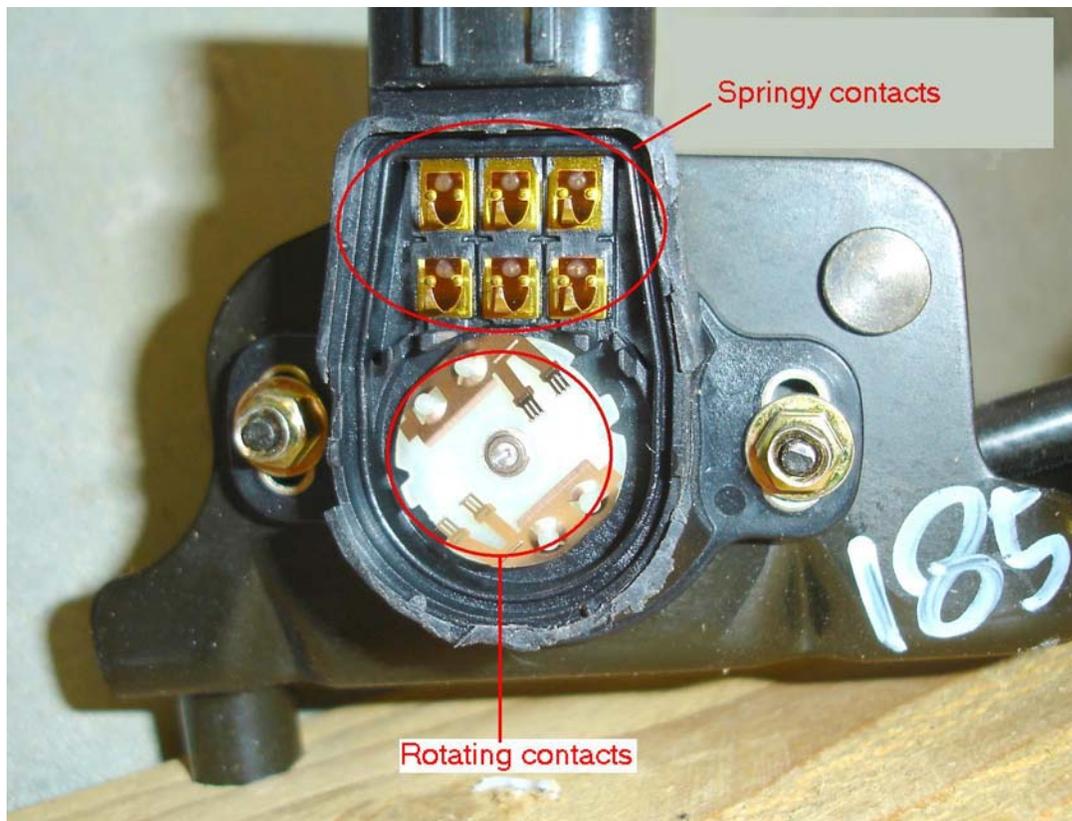
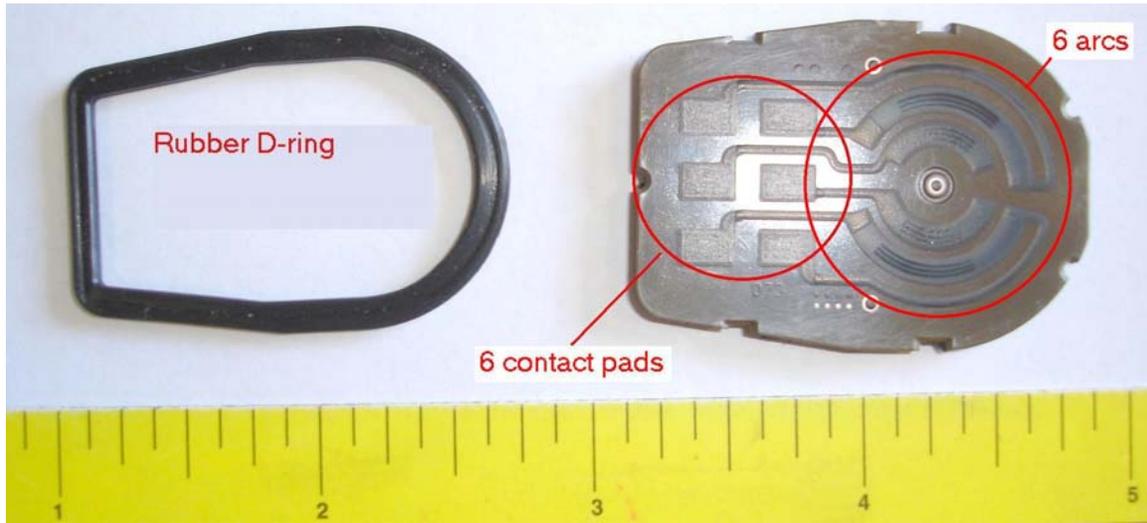
The P-box lid is not just a piece of plastic; the resistive and conductive “traces” are on it (inside, not visible yet). The goal here is to cut away “just enough” of the black plastic box edges so you can lift off the gray plastic lid. The gray lid will get nicked, but (ideally) not enough to impair the later epoxying shut. Cut away as little as possible from both black and gray, and try to remove the lid. If no open, go back and cut a little bit more. Finally you will be able to lift off the lid, and there will be enough “edges” remaining so that it can get epoxied back together. Hint, work slowly, and say to yourself “if I mangle this thing the replacement will cost me \$700”. That will help you maintain a light touch while grinding/cutting/melting. My first effort could have been cut a bit less aggressively:



EXAMINE THE GUTS OF THE POTENTIOMETER BOX

When “enough” plastic is removed, the lid will simply lift off. Inside the lid, you see 6 arcs of conductive or resistive material, and 6 “contact pads”. Inside the box you will see the rotating contacts, each with 3 little fingers. Also 6 springy metal contacts. Each of these items will be cleaned by you. There is also a rubber “O-ring” (shaped more like a

“D”) which you will not fail to reinstall when the time comes. Please make a note of its correct orientation and set it safely aside for now. If any of the “fingers” or “springy contacts” are broken, or if the arcs appear discontinuous, probably your APA is dead. Don’t clean it; contact Toyota for a new one or contact me to ask if I may have a spare. If there are any little foreign objects inside the P box, remove them. It is time to start cleaning.



CLEANING THE GUTS

Items needed: Isopropyl (rubbing) alcohol (70% or higher), or naphtha (Coleman white gas camping fuel), or a similar solvent. These are the only two I have used, but others may also be suitable. I have not used spray contact cleaner inside, because it may leave a residue, and that may not be wise. We want this potentiometer box to be squeaky punctilious clean inside, when it's epoxied shut. There will then be no further access to the inside, unlike the 6-position APA connector that I advised you to spray contact cleaner on, above.

Items needed: A diamond- or sapphire-encrusted fingernail file. Perhaps a plain old metal file would work instead, but whatever you use, clean it beforehand (see solvents above). Remember, no foreign objects must remain inside the potentiometer box, however small. You are not going to do much with this tool, but it seems important.

Items needed: about 30 Q-tips/generic cotton swabs. There are also small, disposable cleaners with a bit of foam on the tip (polyethylene I suppose) that would probably work even better, because they won't shed cotton lint bits (such bits must be carefully removed before closing).

Begin (lid): Dip the Q-tip into solvent and wipe down one of the 4 inner arcs. Notice that the Q-tip is "dirty". That's why we're here! Wipe that same arc again w/clean Q-tip. Repeat. After about 4 wipes, notice that the amount of "dirt" removed is less. Now might be a good time to stop cleaning that arc. **IF THERE IS ANY INDICATION THAT THE ARC ITSELF IS BEGINNING TO BREAK DOWN, STOP CLEANING IT!** (this has never happened to me, but remember we have a lot at stake at this point) Use a dry Q-tip to remove any excess solvent. Clean the other 3 inner arcs in the same way. There is no need to touch the two outer arcs.

Continue (lid): Gently scrape the 6 contact pads with the fingernail file. See how much shinier they become. The goal is only to remove the darker surface coating, so be gentle. Now clean the pads with Q-tip and solvent.

Continue (box): Clean the 4 sets of "wipers", each with 3 little fingers, Q-tip and solvent. If they appear to have any corrosion (mine haven't), remove it gently with the fingernail file first. This is a close-vision task; maybe use a magnifying glass. And this is where cotton Q-tip lint wants to stick, and it must be removed from the little fingers. If anything you have done has bent any fingers out of alignment, carefully reset them now.

Continue (box): Gently abrade the tips of the 6 springy contacts with the file. This is where I have seen corrosion, but only by looking very closely. Clean each with solvent Q-tips. Bend each one up **SLIGHTLY**, because the previous actions may have bent them down. Try and get them all to the same height. Realize that these touch against the contact pads you just cleaned, and that your Prius goes only if all 6 are making good electrical contact.

Last: the P-box is clean. Make sure there is no lint, etc., anywhere inside.

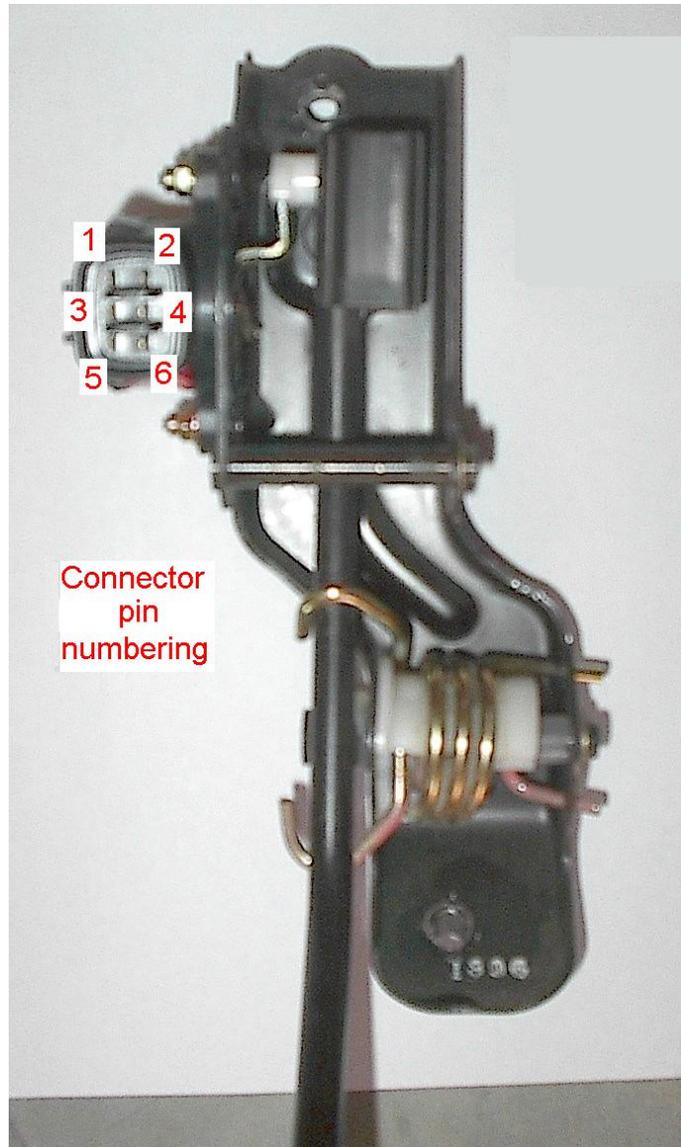
PREPARE TO CLOSE THE APA

Mount the APA on the jig, if not already done. Install the O-ring and the P-box lid. If there are any bits of plastic "flashing" (from your grinding) preventing the lid from sitting down nicely, remove them now. If any little plastic bits get inside, remove them prior to closing. Install to the jig the L-bracket so that it is square to the P-box lid, and its pushing screw will contact the P-box lid very near its center. Its only function is to secure the lid while the epoxy is drying, and it does this via a screw or bolt. Most recently I have used wing nuts on a small-diameter screw to provide the push. If you have a grinding wheel or similar, make rounded the end of this pushing screw. We want it to push nicely, but with no risk of damaging the P-box lid.

To make sure that the epoxy adheres nicely, it would be good to "scuff up" a few millimeters on the gray and black plastic surfaces outside the box, on either side of their junction, which is where you will glop on epoxy. Use mototool with some abrasive bit. Clean the inside of the P box again, if needed, after this step.

AN ASIDE TO THOSE WITH DIGITAL MULTIMETERS

Before you finally close the patient, you can confirm that the main and subsidiary resistances are as they should be, and I recommend it. With the P-box lid firmly and correctly in place on your jig, look at the 6 pins on its connector. I number them 1 through six:



Main resistance is read between pins 4 and 5, and subsidiary between 1 and 3. The correct (or at least, functional) resistance values are:

Measure	pedal released	pedal fully depressed
Main ohms	500	2000
Subsidiary ohms	1000	2500

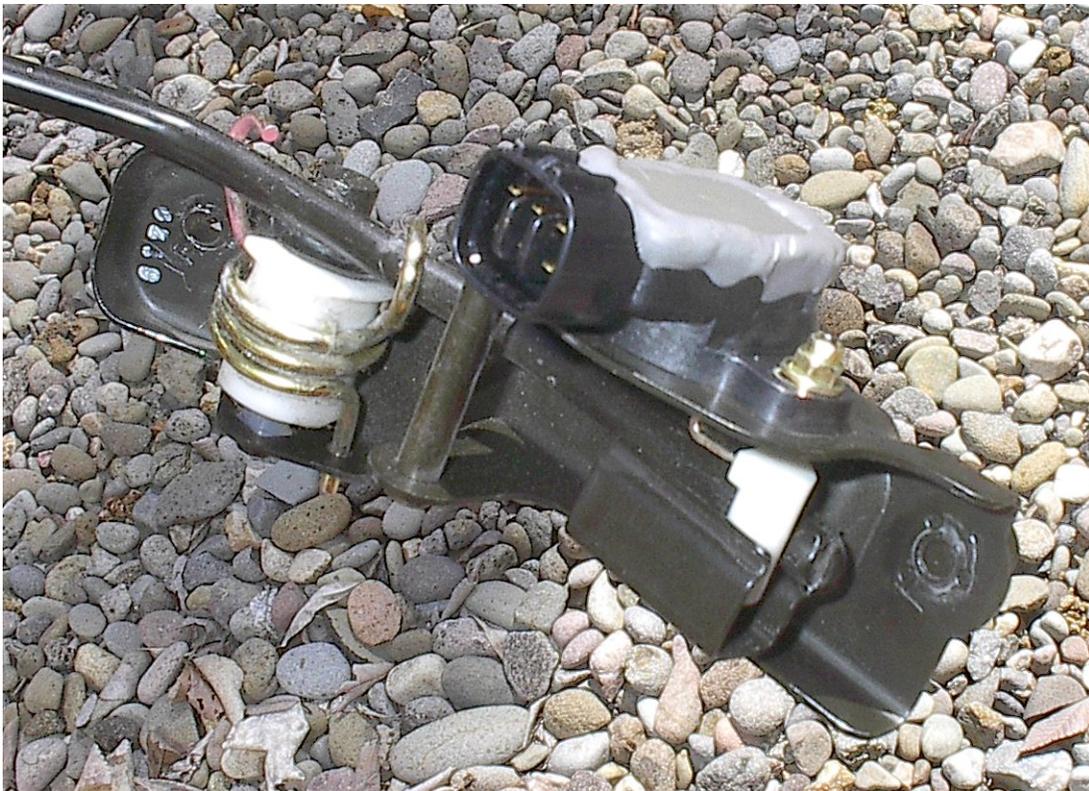
Are you within 10% of all these values? Good. If not, observe the two small bolts that hold the P-box in place. Loosen those bolts and rotate the P-box with respect to the APA frame, by small increments, and get the ohms as close as possible. Retighten the two small bolts. If you get some wacky resistance values, the P-box lid is not correctly in place. Correct this before proceeding.

A FURTHER ASIDE TO THOSE WHO WISH TO MAKE AUDIO RECORDINGS OF THEIR POTENTIOMETERS BEFORE AND AFTER CLEANING

I intend to write this section later.

CLOSING THE APA

Everything is on the jig and the lid is in place. The L-bracket's screw is firmly pressing on the lid. Time to finish. I use "J-B Weld" epoxy for this, but fell free to use something comparable if it's your favorite. The "J-B Weld" quick 5-minute epoxy does not give me enough time. But nothing short of epoxy is suitable for the task, IMHO. Put some sort of tape over the 6-pin connector socket and the two adjusting bolts to keep them free of epoxy. Mix your epoxy and glop it around the entire perimeter of the P-box lid, covering at least 3 mm of the gray and black plastic surfaces with glop. Here is a view of an APA that has been glopped:



REINSTALL THE APA

You are almost done, except for reinstalling the APA. Leave it alone until the epoxy sets up hard. Remove the L-bracket pushing screw, remove the two screws that hold the APA on the jig, and remove the APA from the jig. Place the APA into position in the car and install the 2, 10-mm bolts. Reconnect the connector from the car's wiring harness. Start your car and begin road-testing. It will work fine. If otherwise, first recheck that connector, then email me.



Tochatihu says hi

