Eunos Cosmo Starter Relay

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Version: 1.0

Context

The starting system (Wiring Diagram section „A") in the Cosmo is actuated by two coils. When the ignition key is in the ST position, both coils are energized through the ignition key. When the coils pull in the solenoid armature it connects the motor directly to battery, however one of the coils also grounds through the motor.

Overall, this system means the resistance of the whole line through the ST position is about 250 milli-Ohms. That means with ideal connection in the ignition key and inhibitor switch, it would pull 50 amps. **This is clinically insane and will never work properly.** This much power simply causes damage / soot buildup in both the ignition switch and the inhibitor switch. When these reach around 500 milli-Ohm (yes, that is half an Ohm) the coils will no longer engage the starter. This can happen very easily and quickly, hence the common no-start on these cars. Wiggling the gear selector and re-trying the ignition key can often work as it might engage the contacts better.

As an example, in my car with recently cleaned ignition and inhibitor switch, the resistance in the switches varied between 200 and 1500 milli-Ohms as I tried moving them around.

The Plan™

So how do we fix this? Simple. Add a relay that takes care of the big power requirement. The relay will be controlled by the ST signal and switch power directly from the battery.

The ST line goes to a 6.3mm sliding connector on top the starter. This is disconnected, and the cable coming from the inside is connected to the coil of the new relay. The other end of the coil is grounded at the location of your choice.

The battery power is taken from the starter's main connection. The screw is 8mm in diameter. Use at least 4mm^2 cable, preferably 6mm^6 (although this shouldn't be used for too long, so it doesn't matter *that* much). This goes onto the relay's switched side. Optionally add 60A fuse in this cable. The other end goes back to the connector on top of the starter.

The relay itself must at least be 50A, I used a generic automotive 4pin 70A relay, with 80 Ohms of coil resistance. This cuts down the power to around 200 milli-Amps, or 1/250 of the original power.

For the record, Banzai Racing has a pre-made solution (along with a guide: http://www.banzai-racing.com/starter_relay_instructions.htm) for this exact problem on the FD, which uses a similar style of starter. You can very well use that kit as well*, I wanted to do it my way for a more factory look.

*Except if you have an electronic brake booster. More on that later.

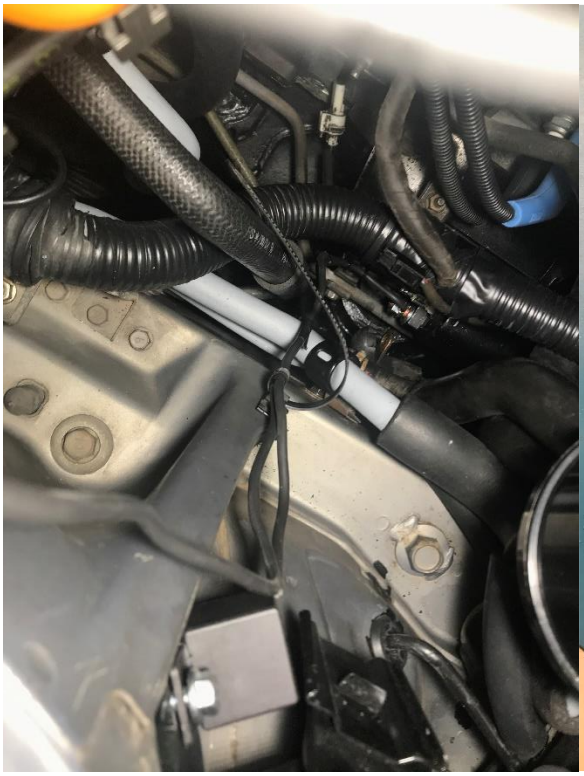
The Implementation

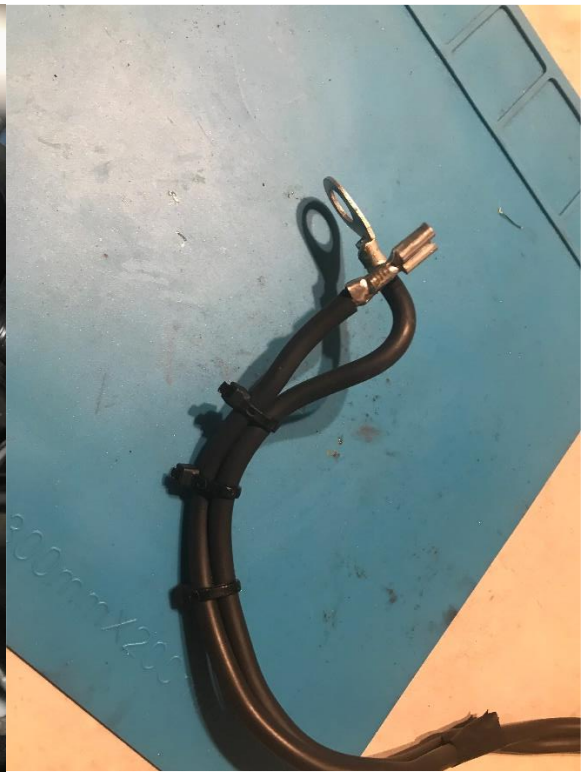
Here are the parts I used:

- 6mm^2 cable for the power, 1 meter is enough.
- 1.5mm^2 cable for the relay control, 1 meter is enough.
- 70A 4-pin automotive relay with 9.3mm power and 6.3mm control legs.
- 6.3/9.3mm connectors, 8mm screw terminal for the starter, 6mm screw terminal for relay ground.

I decided to put the relay where the 10A Aircon-clutch fuse is located (note that this is a recall item – your car might not have it). This is right next to the charcoal canister and is a very tight fit. I had to move the charcoal canister slightly rearwards by enlarging its mounting hole.

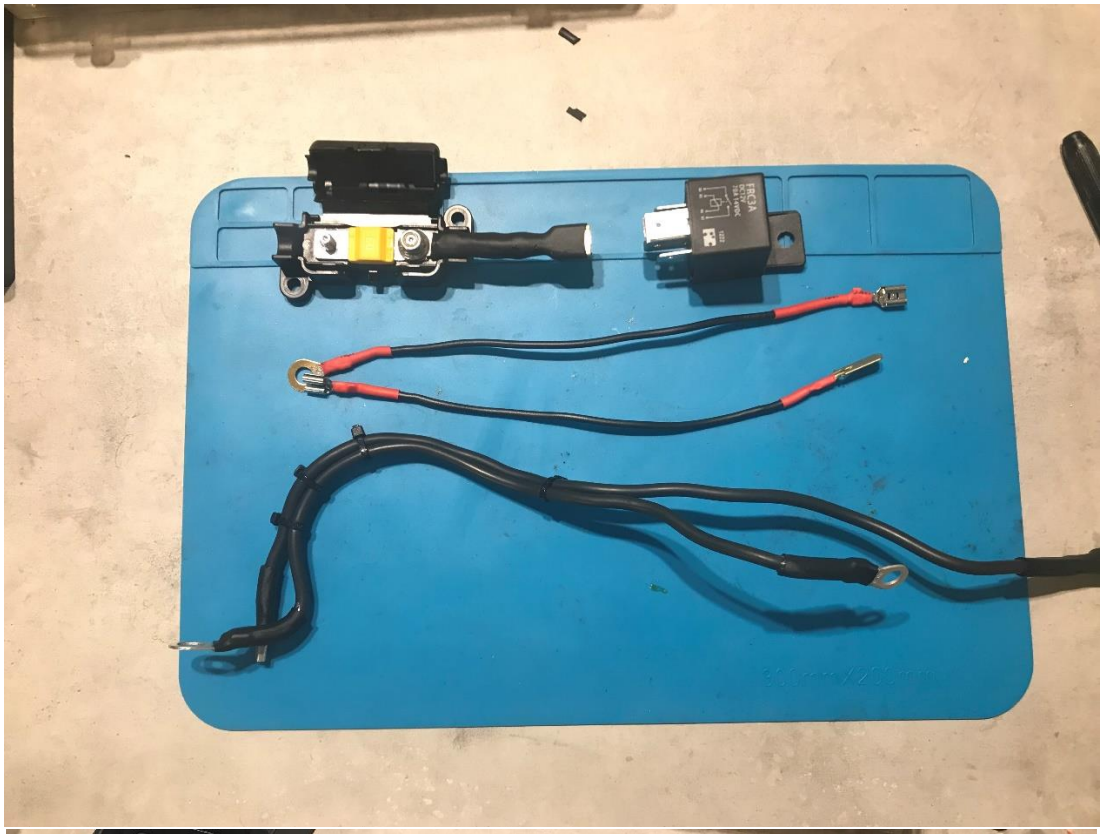
After the location was selected, I measured out the wire lengths roughly then crimped on the connectors on the starter side on both leads of the thick power wire. Then I shaped the cable so it routes nicely up to the relay's location.

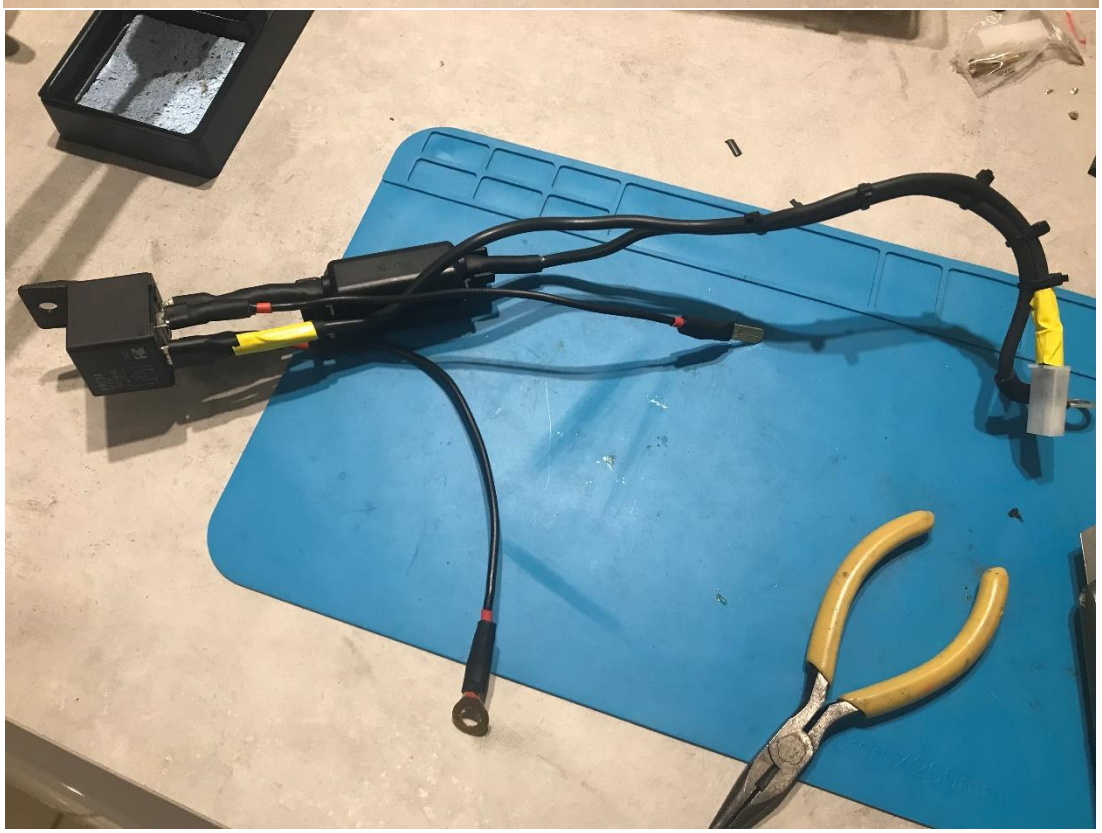




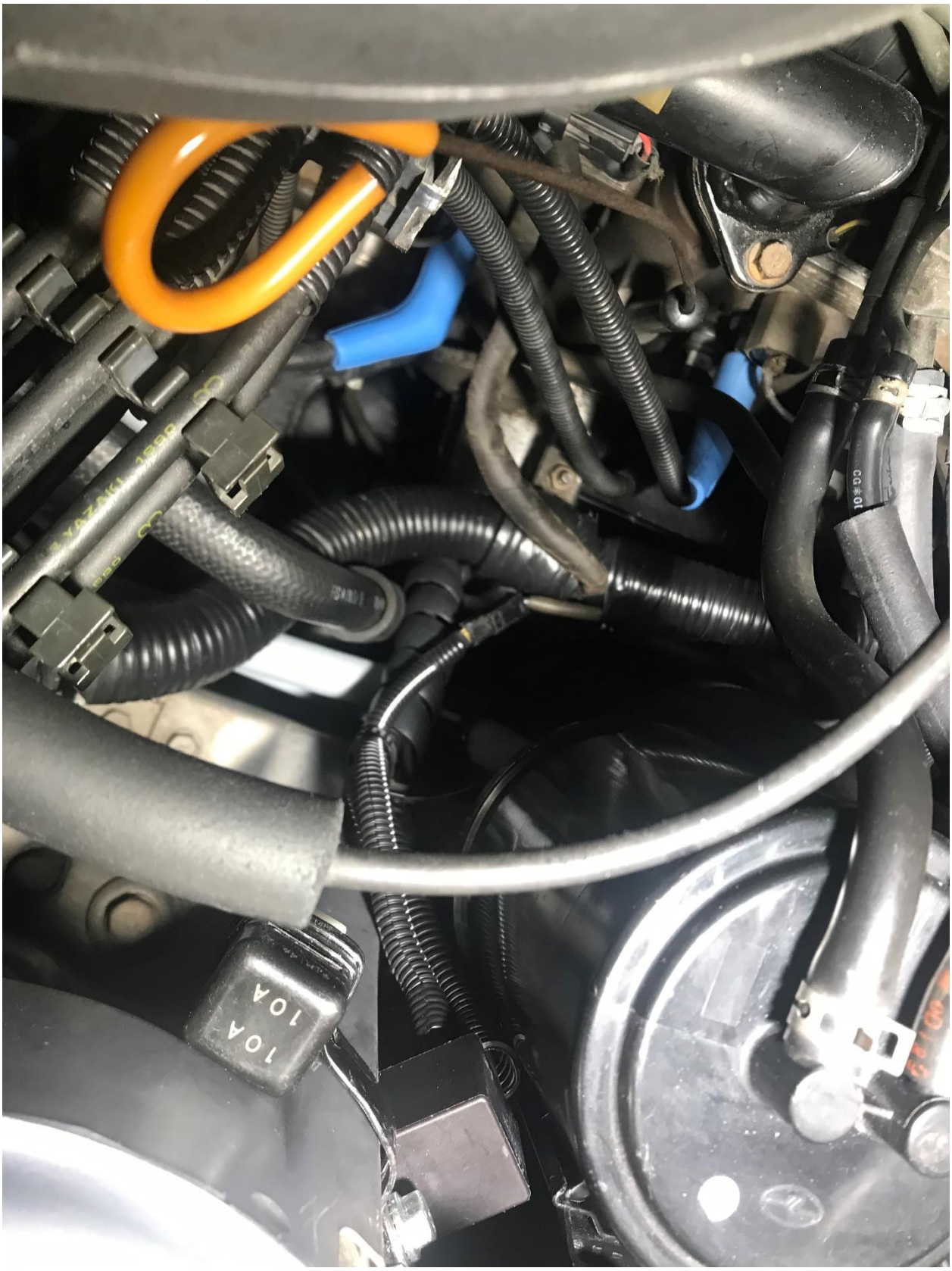
The cables are tied together to keep their relative position that allows good contact with the starter connector. Then I added the fuse to the relay, then finally measured and cut the exact lengths along with the thin control cables.

The complete wires separately, and assembled onto the relay:





Assembled with wire protectors on for that factory look:



The Electronic Booster

The parts until now work perfectly fine (and it's the same setup as Banzai's relay). Except, it makes the starter "stick": After starting, the motor stays engaged as long it has ignition. This is caused by the fact that Mazda choose a very *interesting* way of turning off the electronic booster pump when the starter is engaged.

Normally, the booster has a relay called "ABS Motor Relay #1" (Relay #2 is the main relay for it). This is connected to IG1 and allows power through if IG1 is on. It is grounded through the ST line and the starter. So normally, it grounds through the starter motor, which is fine, the relay is very high resistance compared to the starter, so the relay an operate while the starter won't do anything. If you start cranking the ground is now 12 volts as well, which causes the relay to turn off, disabling the booster pump. Don't ask why they didn't connect relay #2 to IG2, when IG2's entire point is that it is ignition but not when starting. Precisely what is needed here.

Anyways, with the relay setup now relay #1 wants to ground through my new starter relay. Two high resistance relays in series means neither has enough power to turn on. However, applying start can still turn on the starter relay as then it has full voltage. The fun part is you need a lot less power to keep a relay closed compared to closing it. That "lot less" is less than what flows through the two series relays, so after it turned the starter on, it will never open with the ignition on. Not a good situation, but hey, I had the world's first petrol-oil-electric hybrid Cosmo.

The Solution to This

I went the easy route and removed relay #1, connecting the two large (6.3mm) pins. This means power always flows through it, so it won't turn off for starting. The battery really ought to have enough power to start the car anyways, and you can always wait until the booster charges up.

If you want something better, find an IG2 source and connect it to that. The relay is behind the steering column so there should be an IG2 around.

Wiring diagram

Finally, here is the factory wiring diagram (and some handy explanations) of the changes I made: