

Single-Point (Throttle Body) Fuel Injection for the Subaru EA81

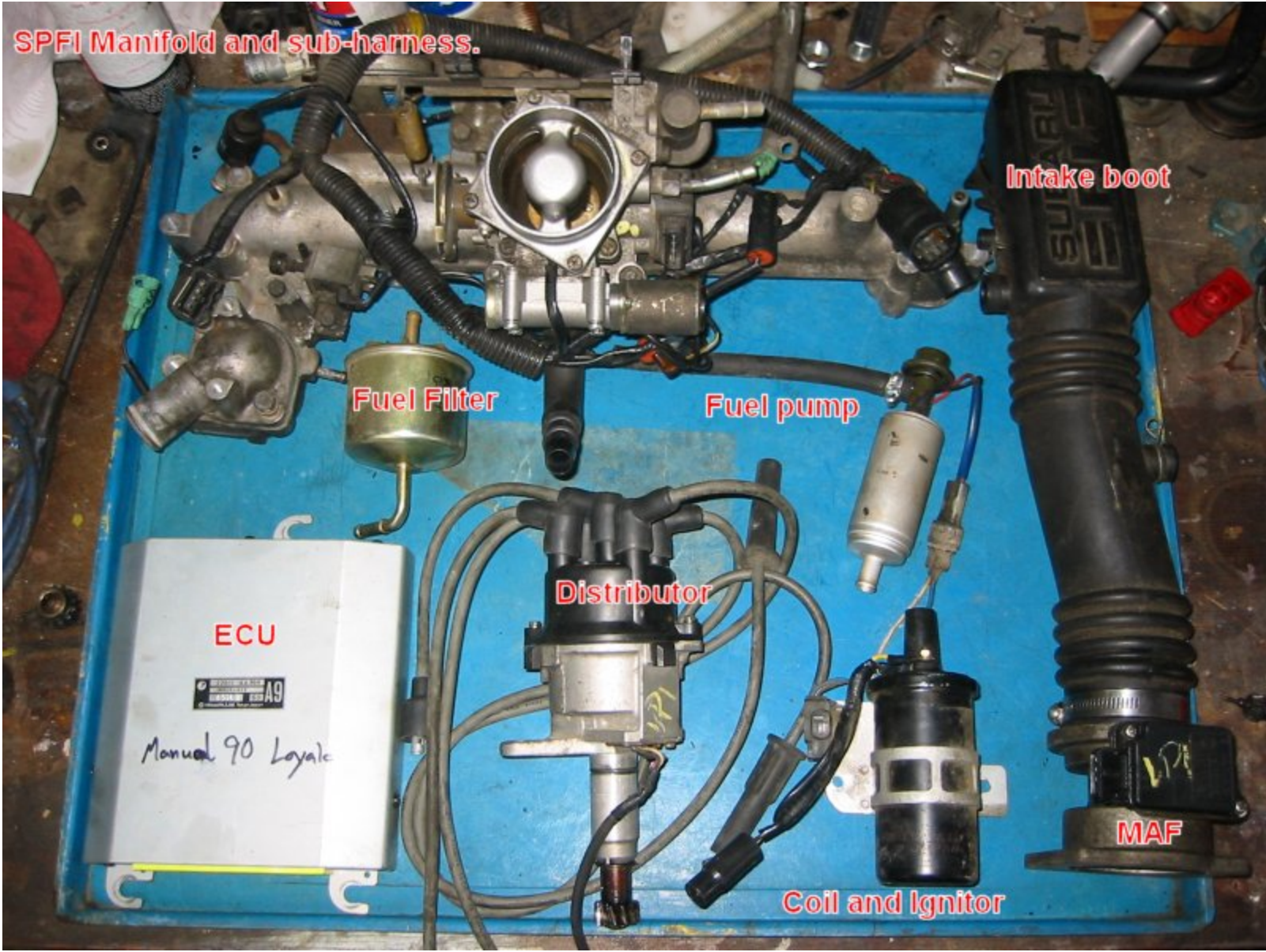
All EA81's (talking non-turbo here) were equipped with carburetors from the factory. Either the Hitachi 2 barrel, or the Carter-Weber single barrel. Both have their array of problems, are rather anemic in the performance department, and have a vast array of complicated vacuum lines. As well as extra systems to make them economical, and environmentally friendly - even to the point of using computers to control the carburetor mixture adjustments.

Fortunately, Subaru gave us an excellent upgrade path. In 1986, Subaru introduced the Single Point Fuel Injection (SPFI) to the US market on its EA82 engine. This engine happens to share the exact same intake ports on the heads, and the same overall length for the intake manifold as the EA81. Sadly the EA82 engine, while sporting an almost indestructible, very simple fuel injection system, has troublesome timing belts, is prone to ticking lifters, and (because of the timing belt arrangement) can be difficult and time-consuming to work on. It also does not fit in the EA81 vehicle engine bay without modifications to the frame rails, and moving the hill-holder valve. Because of the similarities between the manifolds, the almost self-contained fuel injection manifold from the EA82 bolts straight onto the EA81 engine with minimal modifications.

But just because the manifold mounts similar doesn't mean there aren't challenges. There's wiring to do, the fuel injection distributor must be modified, the fuel pump and lines need to be swapped, and the coil and bracket swapped. There are seven main components to this swap:

- SPFI fuel pump and lines**
- SPFI Intake Manifold**
- SPFI distributor**
- SPFI coil and bracket**
- SPFI ECU**
- SPFI wiring harness**
- Oxygen Sensor** (not pictured)

SPFI Manifold and sub-harness.



Intake boot

Fuel Filter

Fuel pump

Distributor

ECU

Manual 90 Loyale

MAF

Coil and Ignitor



(click for larger images)

Aquireing Parts

First lets discuss where to get all of these items. We are in luck as the SPFI was widely used from 1986 till 1994. You will find the SPFI system on these models:

1986 and 1987 2WD GL wagons, sedans, and 3-door coupes (excluding XT and turbo)
1988 and 1989 GL or DL wagons, sedans, and 3 door coupes (excluding XT and turbo)
1990 through 1994 Loyale models (excluding 1990 turbo)

It is best to get all your parts from one vehicle, as over the years some of the wiring connectors changed. The parts themselves are largely the same - the big differences are with the wiring and ECU's. There are two primary models of ECU's - each of which have about 4 or 5 different configurations based on if the car was sold in California or not, and the type of transmission the car was equipped with (auto or manual). It is best to get all your parts from a single source to avoid conflicts between the the ECU and the harness. Mixing and matching ECU's can work if you are aware of the differences between the years and can actually be helpful in some sitations which I'll discuss later. There are 4 different main catagories of harness years: 1986, 1987 to 1988, 1989, and 1990 to 1994. And each of these can further be divided into automatic, manual, California and "49 states" harnesses. One ECU is black (and there are several versions of this unit), and one is silver. I'm not 100% sure when the change was made, but all Loyale's (1990 and newer) use the silver boxed ECU. 1989 may be either depending on when it was made durring that year, and 86 - 88 use a black painted ECU. The programming and wiring is slightly different between the two, with the older black ECU being the easier to setup for manual tranmissions as it does not require a clutch switch..... more on that later.

EA81 Vehicle Differences

It's also relevant to speak here about which EA81 vehicles this swap applies to, and what the challenges are with each:

--1980/1981--

The 80/81 models have a couple challenges. The gauge cluster does not contain a speed sensor (pulse generator) device.

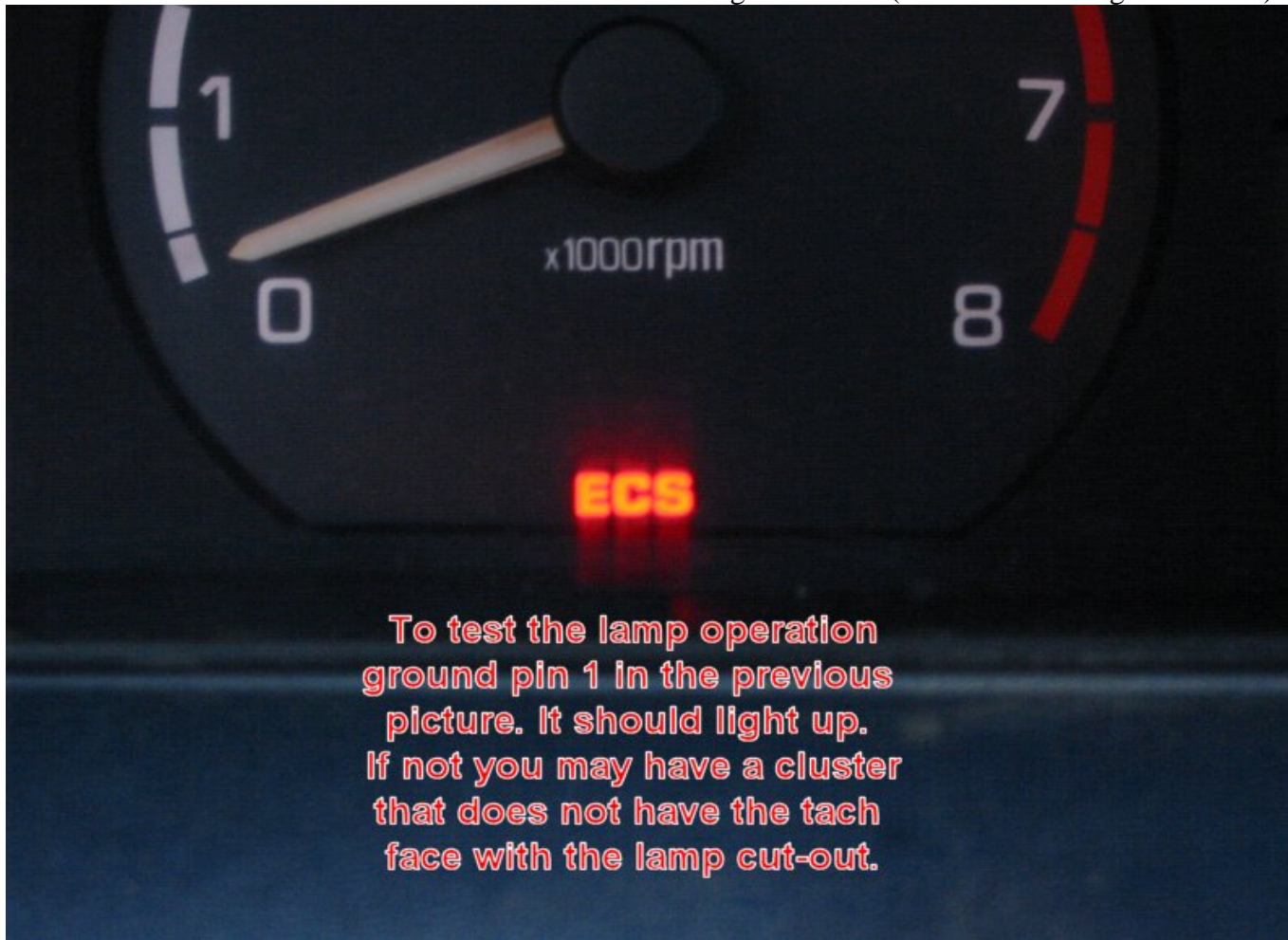
This does not seem to cause a problem with the ECU, but it will throw a code every time the car is driven which is annoying - at least to me as the Check Engine Light will come on. The 80/81 also has no fuel return line as the fuel pump is located in the engine bay. This is not acceptable for the SPFI, as the pressure regulator needs to return a large volume of fuel back to the tank. A return line can be run with steel tubing - yet another excercise for the reader.

Note that this swap will not work with the EA71 engine. The manifold is too long, and will not bolt up.

--1982 to 1984--

The only problem I have encountered with the later EA81's is that some gauge clusters were not equipped with a fully

functional "ECS" light to use for the CEL (check engine lamp). The ECU will ground pin 22 to indicate a system fault and the "ECS" (emissions control system) lamp is the obvious choice for this function. It was functional on any EA81 equipped with the computer controlled "feedback" carburetor. But on models that didn't have this computer, the lamp is there, and will light up fine, but will not shine through the face of the tachometer as the "ECS" letters were not cut-out when it was manufactured. You can either replace the tach face, replace the entire cluster, or hook up another light somewhere else on the dash to indicate faults. Later model Brat's and Hatchback's (85 to 89) seem to be ok in this respect. My 85 Brat had a fully functional lamp despite having no feedback system. Another 83 dash I have from a 2WD sedan does not have it. Here's a shot of the "ECS" light in action (bulb check with ignition "ON"):



(picture text is for a later section)

--All--

No EA81's, unless they had a feedback carb, were equipped with O2 sensors. The best way to deal with this is to find

a y-pipe from an EA81 that had the feedback carb. Alternatively, you can take your existing pipe to a muffler shop, and have an O2 sensor bung welded into the pipe. Or I'm sure some of you can do that yourself. I have had the good fortune of always finding O2 equipped pipes from feedback carbs, but here in Oregon we have a lot of soobs to choose from so this may be more of a challenge for some.

Treatise on Neutrality

I'm going to talk largely about the SPFI as it applies to manual transmission applications. The automatic's have an "inhibitor switch" responsible for telling the ECU what state the transmission is in, and a kickdown system with a relay that is controlled by the ECU and operates a solenoid on the side of the transmission. I have no experience with hooking these up, but it seems fairly straightforward - the inhibitor switch looks to be inside the shifter of the EA82, and the kickdown solenoid is on the side of the tranny. Being the EA81 used the same automatic transmission, I'm guessing it wouldn't be a huge deal to hook it up. However I have no experience with them. The manual transmission setup is what I want to discuss, and specifically the differences between the older black ECU, and the later silver ECU.

The black ECU used in 1986 was only used on automatic transmissions according to my research. Only 2WD automatics got the SPFI in 86, and the 2WD 5 speed version was probably either carbureted, MPFI, and possibly some turbo models. 4WD's did not begin receiving the SPFI system till the 88 model year (late 87). This makes the 86 ECU unsuitable for anything but automatic installations, and the wiring harness has some unusual connectors for things like the distributor, coolant temp sensor, O2 sensor, and possibly some others. Personally I avoid this early 86 system's wiring harness, and ECU because of these differences. They are, fortunately, pretty rare as well but it's important to know the differences in case you do run across one or acquire one for parts. Most of the components other than the wiring and ECU are the same and can be used with later systems either directly, or sometimes by just changing the wiring plug.

The black ECU used from 87 to 89 uses only a single neutral switch located on the side of the transmission. This is obviously a problem for the EA81 4WD, 4 speed manual and the 2WD, 5 speed manual because they were never equipped with this switch and sadly have no provision for adding one. Additionally, the 86 and 87 4WD, 5 speed transmissions (a common upgrade for the EA81) do not have the neutral switch either. The 88 and up transmissions should all have the switch as carburetors were discontinued after 87 and all the forms of fuel injection require it. The neutral switch provides information to the ECU on the gear state of the transmission. It's a simple switch that is closed when in gear, and open when not. Some claim that not hooking this switch up at all is "ok", but I prefer to hook as much up as I can as it's not possible for us to look into the ECU's software and foresee all possible consequences of the alternative, and even though it might run fine, the ECU will complain with a "check engine" lamp after driving for only a few miles. Also if another component fails it could setup a scenario where the ECU is forced into "limp mode" due to too many system failures when it would not otherwise have done so had the neutral switch code not been present. Thus I suggest you make every effort to install the system the way it was intended to be installed. One solution I've found with a transmission that does not have the switch is to use a clutch pedal switch used with EA81's and EA82's (and possibly others) to control the cruise control. This switch is shaped like a bolt with two nuts on it and it threads into the stop-bolt location

on the clutch pedal. Just like the transmission neutral switch, the cruise control switch is designed to be closed when the clutch is released (in gear), and open when the clutch is engaged (neutral). So as a surrogate neutral switch it works well, and is acceptable enough to the ECU to prevent the code 51 error indicating the ECU can't find the switch. You can see the cruise control switch I used in my Brat in this picture:



The later silver ECU's have not only the neutral switch discussed above, but also have a "clutch switch" that operates

exactly opposite of the cruise control clutch switch. It is mounted on the pedal assembly such that it is closed only when the clutch is engaged (pushed in), and is open when the clutch is released. This switch is located only on Loyale (90 to 94) manual transmission pedal assembly's, and if this ECU is to be used I suggest you also swap over to the Loyale pedal assembly so you have this switch. The clutch cable is also different and would need to be swapped along with the pedal assembly to be used in an EA81 body vehicle. The alternative is to source a black ECU from 87 to 89 so you don't have worry about this switch.

Stripping the parts car:

The SPFI fuel pump is located at the rear of the vehicle on a shelf near the fuel tank. Remove it, and as much of the high pressure fuel line as you can get (the smaller fitting on the pump is the high pressure side). Take care when disconnecting the high pressure lines, as often they can remain pressurized even after sitting in the junk yard for long periods. I like to use a sharp knife or utility blade to puncture a line near it's end, while holding a rag over it to keep it from spraying. If you can, disconnect the pump electrical supply, and crank the engine to remove fuel pressure - of course that's not possible at the junk yard. Take the entire shelf as you will need part of the mounting hardware to mount the pump to the existing EA81 shelf. Cut the electrical supply to the pump before the body side connector so you have both sides of the plug too - you will need it as the EA81 pump has a different plug style. The SPFI pump runs at a pressure of about 50 psi, and the pressure regulator on the throttle body steps this down to 21 psi. The stock EA81 carb pump puts out around 2 to 3 psi so will not suffice for SPFI use. The stock EA81 rubber fuel lines are also not rated for this high pressure, and new high pressure line from the parts store runs about \$5 per foot - so grab as much as you can get, try not to cut it if you can, and grab all of the stainless steel hose clamps you can as well.

The SPFI intake manifold is fairly straightforward to remove. There's three large 12mm bolts on each head. Be careful removing these as they tend to rust in place. I like to hit them with a *very* low setting on my 1/2" impact. The shock loads from the impact are not strong enough to break the bolt, but help to break the grip of the rust and scale. PB Blaster or your favorite penetrant helps a lot as well. If you do break one, file the top flat, center punch it and drill out the old bolt. DO NOT use an "easy out" - these more often than not will break off and cause a lot more problems than they solve. It may be necessary to drill it oversized and use a heli-coil or timesert to bring back the threads. The EGR tube from the passenger head also lines up perfectly with the EA81 port, so just unscrew it from the head and leave it attached to the manifold. There are two large wiring plugs for the manifold sub-harness. Just detach them and take the wiring off with the manifold. Disconnect the throttle cable, heater core hose, brake booster hose, and cabin environment vacuum supply from the manifold. Disconnect the fuel lines, and be prepared with a rag to cover any squirts of fuel as the system can maintain pressure for quite some time even in the junk yard. Grab the fuel filter, and as much high pressure fuel line as you can get. Unbolt the flange to the air filter box, pop the connector off of the MAF sensor, and take the whole intake plenum (the rubber part) off with the manifold.

The SPFI distributor is pretty obvious - two 10mm bolts, and one 4 pin harness, and it slides out of the EA82 cam case. The drive gear will have to be changed, but I'll save that discussion for later.

The SPFI coil and bracket are located on the drivers side of the engine bay. Take the entire bracket and coil as a single unit. It's held on by two 10mm bolts.

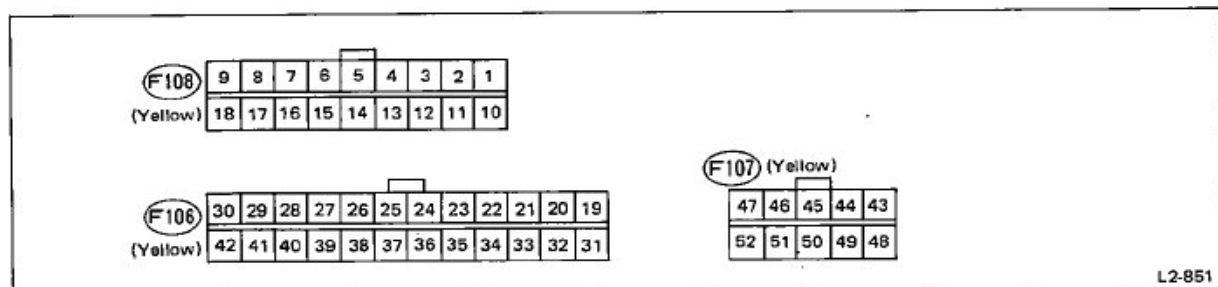
The SPFI ECU is located under the drivers kick panel. It's attached to the steering column with three 12mm nuts. Disconnect the three yellow plugs, and take the ECU out.

The SPFI wiring harness is the difficult one. You can't separate the SPFI harness from the rest of the vehicle's harness without first removing the front sub-harness from the car. Just pull the entire harness out. To do this, there will be many connectors, and lots of ties. You will have to remove the drivers side fender to feed the harness through into the cabin. Take everything - as much as you can get your hands on. The dash harness is not needed, but take the engine bay harness back to the ECU including the fuel pump and ignition relays, and fuse panel.

Preparing your parts collection

--Wiring--

I'm going to start with the wiring harness since it's the most involved, and should you feel nauseated you can leave without having invested too much of your valuable time. The harness will need to be stripped so you can work with it. So the first step is to remove all the electrical tape, and conduit that wraps all the wires. Just this job can take an hour or so. Do it in an open space and rather than moving the harness around, move your chair along the length of the harness. Once it's free from the tape it can turn into a tangled mess, so try to keep each branch separate while you remove all the material from it. Once you have the harness free of it's tape prison, you can start to remove parts that aren't needed for the SPFI. The rules are simple - if it's not connected to an SPFI component or the ECU itself, it can go. More than half of the full harness can be eliminated. Battery cables, headlight and turn signals (and their ground wires), marker lights, air conditioning wiring, etc can all be removed. Do not remove anything you are unsure about till you trace each wire to it's source. Some wires will pass through the fuse panel on their way to the ECU (the start signal is fused, and one of the power off-shoots of the green fuseable link is fused as well), and some others go from the fuse panel to the ECU to supply ignition switched power. Make note of the fuse sizes used for your harness, and label each wire you cut from the fuse panel so you know what it powers, and what amp fuse to use for it. To get started, you will need this reference to the ECU pinouts. I suggest printing it for reference in the garage (it's also in the '89 FSM PDF file):

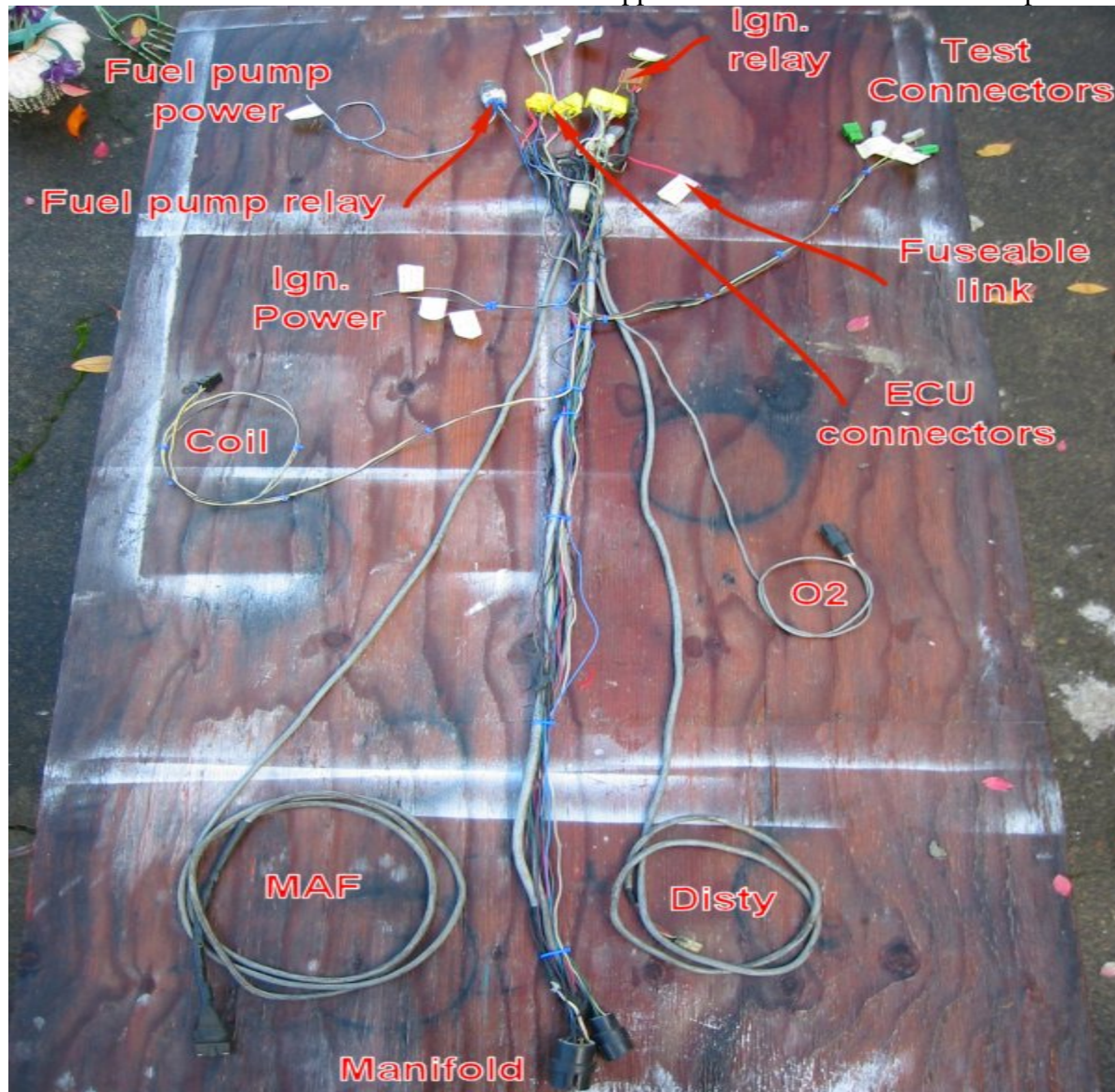


L2-851

Fig. 36

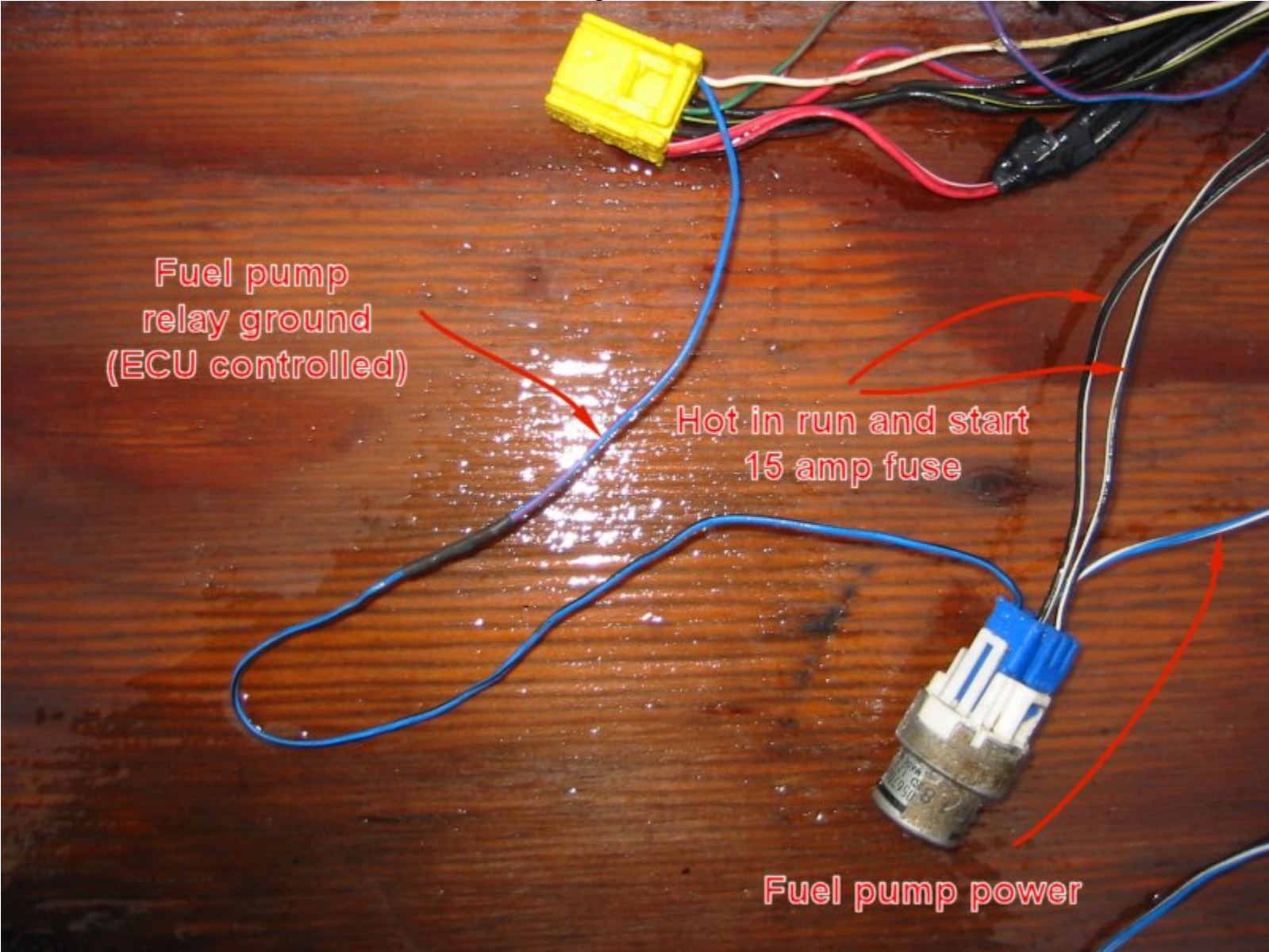
1	LG	Kick-down control	27	BW	Power (input)
2	RL	CHECK ENGINE light	28	GW	Self-shutoff signal
3	R	Test 4	29	W	Power (input)
4	LR	EGR solenoid (control)	30	BR	GND
5	GL	Purge control solenoid	31	Br	Test mode connector (used at line end only)
6	LY	Air conditioner signal	32	BR	Test mode connector (used at line end only)
7	—	—	33	Lg	49-state/Cal identification
8	W	Air flow meter (signal)	34	SA	O ₂ sensor
9	B	Air flow meter (GND)	35	B	GND
10	Y	Line end cord output	36	WR	EGR monitor
11	L	Line end cord output	37	LgR	Test mode connector (used at line end only)
12	RL	Line end cord output	38	RL	Ignition switch
13	YR	Inhibitor switch (AT models only)	39	LgW	Clear memory
14	YG	Neutral switch	40	—	—
15	YL	Parking switch (AT models only)	41	W	Power (input)
16	LgR	Kick-down monitor	42	BR	GND
17	R	Air flow meter power (output)	43	RW	Injector ⊕
18	LgY	Starter switch	44	BR	GND
19	GB	Crank angle sensor power (output)	45	GR	Air control valve
20	GY	Crank angle sensor signal (reference)	46	GY	A/C control
21	BW	Crank angle sensor signal (position)	47	LB	Fuel pump
22	YG	Car-speed sensor	48	RB	Injector ⊖
23	WB	Water temperature sensor	49	RL	Power (input)
24	LG	Idle switch	50	BY	GND
25	W	Throttle sensor (signal)	51	B	GND
26	R	Throttle sensor power (output)	52	WY	Ignition control

And here is an overview of the harness once it's stripped of the non-ECU related components:



The fuel pump relay (blue connector - see picture below) gets power from the fuse panel (ignition switched) to both its black w/white stripe wires. Do not cut them away from the relay. You will find a 4-way connection in the black/white wires where two go to the relay, one goes to the coil ignitor plug, and the other goes to the fuse panel - notice in the schematics below how they both share fuse #11. Cut the one that goes to the fuse panel, and label it "Hot in run and start, 15 amp fuse". You can extend this wire as needed to reach your relay/fuse locations. The blue w/white stripe wire is the fuel pump power

supply - cut this away from the big connector it goes to and label it "Fuel Pump Power". The remaining wire (blue w/black stripe) goes to the ECU, which controls the relay ground to turn on the pump. Connect this wire to the wire from pin 47 on the ECU now. Here's a picture of the ECU connection:



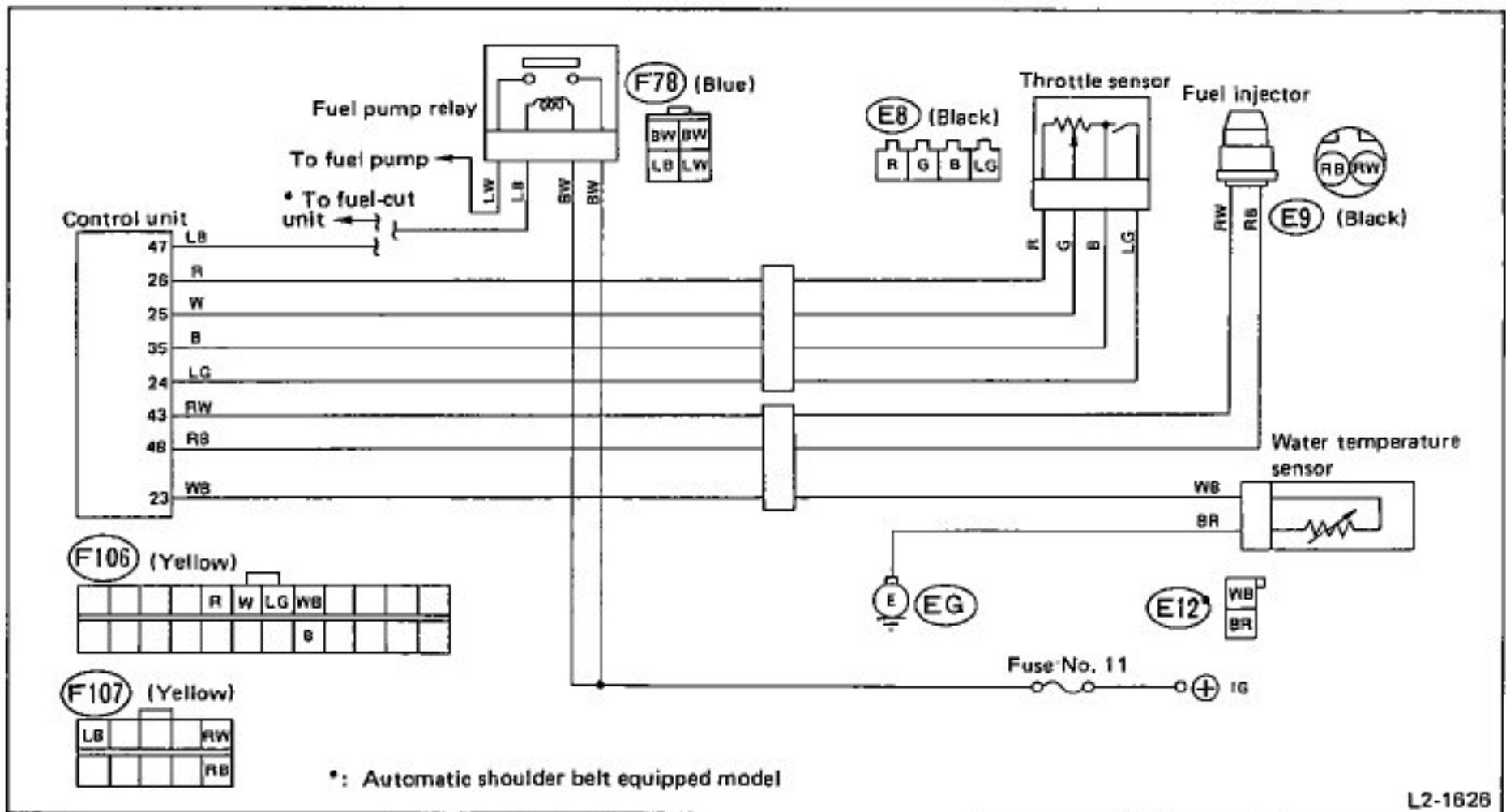
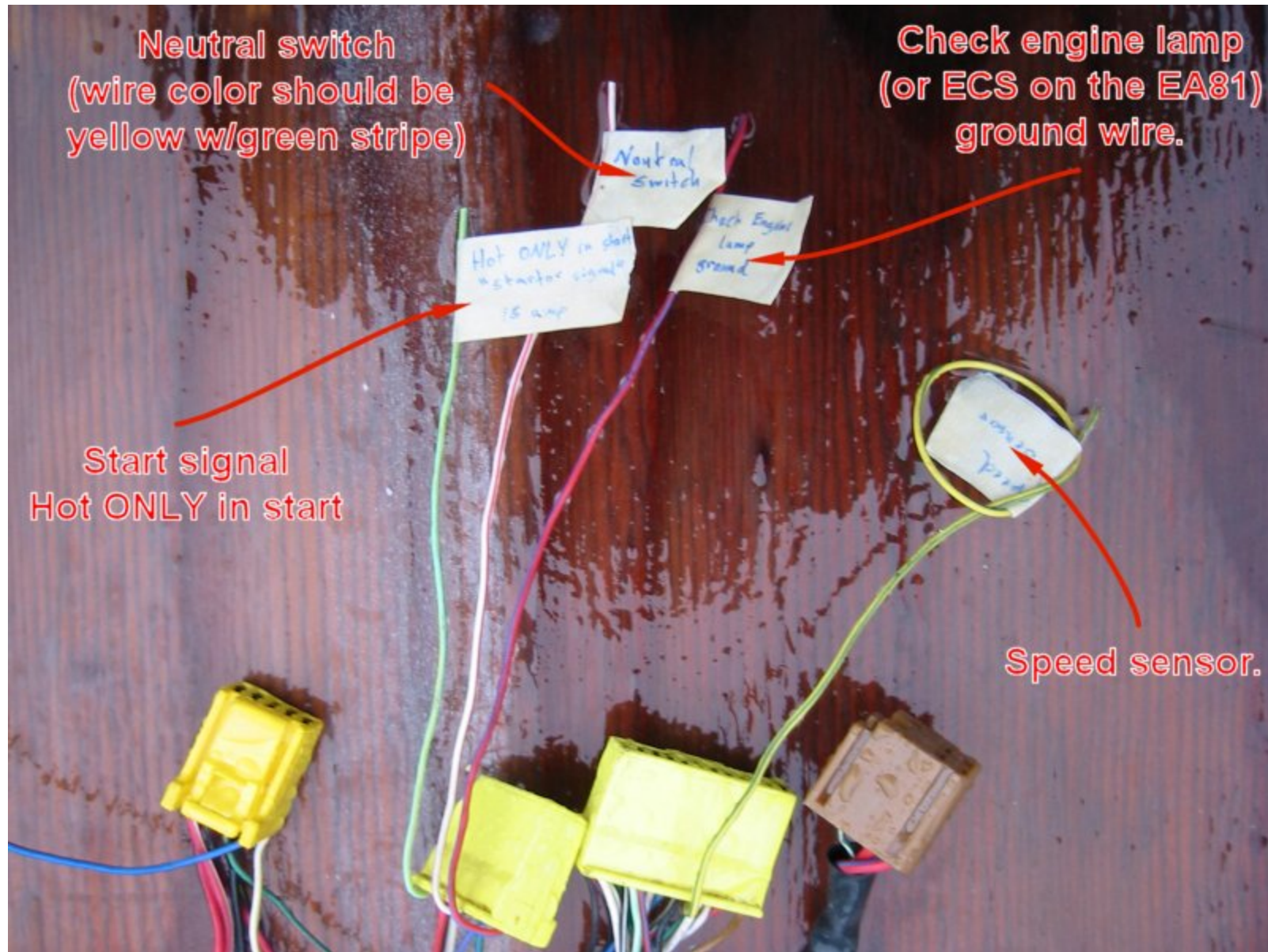


Fig. 55

The CEL lamp (or ECS) ground wire is the red w/blue stripe wire from pin 2 of the ECU. Cut the wire (it runs to a dealer only diagnostic plug which you can eliminate) and label it "Check engine lamp ground". This will be connected to the CEL ground wire we previously prepared under the dash. See the image below.

The speed sensor wire is the yellow w/green stripe wire from pin 22 of the ECU. Cut the wire and label it "Speed sensor". We'll connect this to the wire previously prepared under the dash. See the image below.

The neutral switch wire is another yellow w/green stripe from pin 14 of the ECU. In the image below the wire is the wrong color - I changed the color when I was working on this document - pay no attention to the color in the image. It **SHOULD** be yellow w/green stripe. Cut and label this wire "Neutral switch" if you are using the cruise control clutch switch method, or leave the wire connected to it's transmission connector if you are using a transmission that has the switch in it (black oval shaped 2-pin connector). See image below.



There are two more power supply wires for the ECU, sensors, and the ignition relay (the brown one). One is another black w/white stripe wire that goes to both the ignition relay and to the ECU directly. This wire is always hot - in the original harness configuration, the 12 gauge wire from the green fuseable link goes to the ignition relay, and to the fuse panel. At the fuse panel it supplies a 15 amp fuse that supplies the black w/white stripe wire I'm referring to. So cut the wire away from the fuse panel and label it "hot at all times from green fuseable link, 15 amp fuse". Extend this wire as needed to the location of your fuses. It will not require a relay, but a fuse from

the fuseable link supply wire (the big red one). The other power supply wire is a 16 gauge red w/blue stripe that needs ignition switched power through a relay. This wire can be found by locating the small grey diode near the ECU connectors. Trace the red w/blue stripe wire back to the junction where it splits off to the fuse panel, and cut the fuse supply line. Again - extend this as needed to where your fuses and relays will be located and label it "Hot in run and start, 15 amp fuse". You should now have four wires from the harness and three from the car meeting where your fuses and relays are going to connect. Two supply wires from the battery, one ignition switched hot lead from the ignition switch harness under the dash, two ignition switched power wires for the ECU, and two "hot at all times" leads for the green fuseable link.

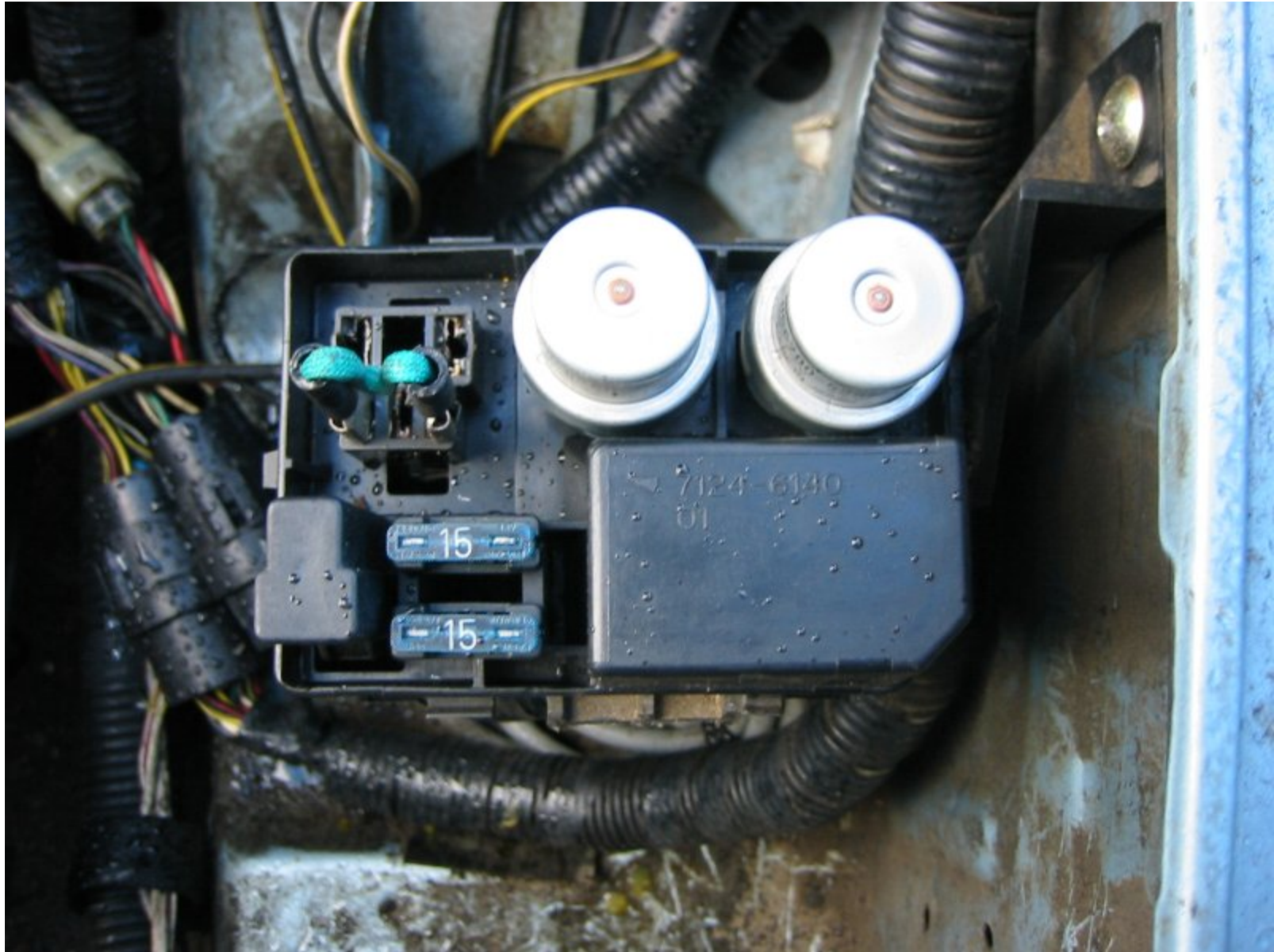


RELAY
RELAIS

A/C FAN (0.47A)	A/C COND. FAN VENT. A/C	A/C CLUTCH EMB. A/C
A/C FAN (0.47A)	10A A/C CLUTCH A/C EMB.	FUSE FUSIBLE
VENT. A/C (0.47A)	20A A/C FAN A/C VENT.	

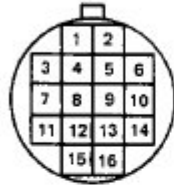
USE THE DESIGNATED FUSES ONLY.
UTILISER SEULEMENT LES FUSIBLES PRESCRITS.





The picture below shows the pin-outs for the body side of the large, round manifold connectors. There are several wires that can be removed as they do not pertain to the fuel injection system. On the larger of the two, pins 2 and 4 are the wires that normally supply the temperature guage and the oil pressure guage on the dash of the EA82. We will not be using either one - instead we will use the old connectors from the EA81 harness for these two functions. Cut these two wires at the back of the plug and remove them from your harness.

Intermediate connector I (body side) . . . (F41)



L2-912

Fig. 37

1	BR	Ground
2	YB	Oil pressure (to combination meter)
3	--	-----
4	YG	Thermometer (to combination meter)
5	B	Injector ⊖
6	B	Shield
7	LG	Idle switch
8	--	-----
9	R	Throttle sensor (power)
10	W	Injector ⊕
11	BY	Ground
12	W	Throttle sensor (signal)
13	B	Ground
14	B	Ground
15	RL	Power supply
16	BR	Ground

Intermediate connector II (body side) . . . (F42) (Black)



L2-853

Fig. 38

1	GR	Air control valve (control)
2	Lg	Identification of specifications
3	GL	Purge solenoid (control)
4	WR	EGR gas temperature sensor
5	LR	EGR solenoid (control)
6	WB	Water temperature signal

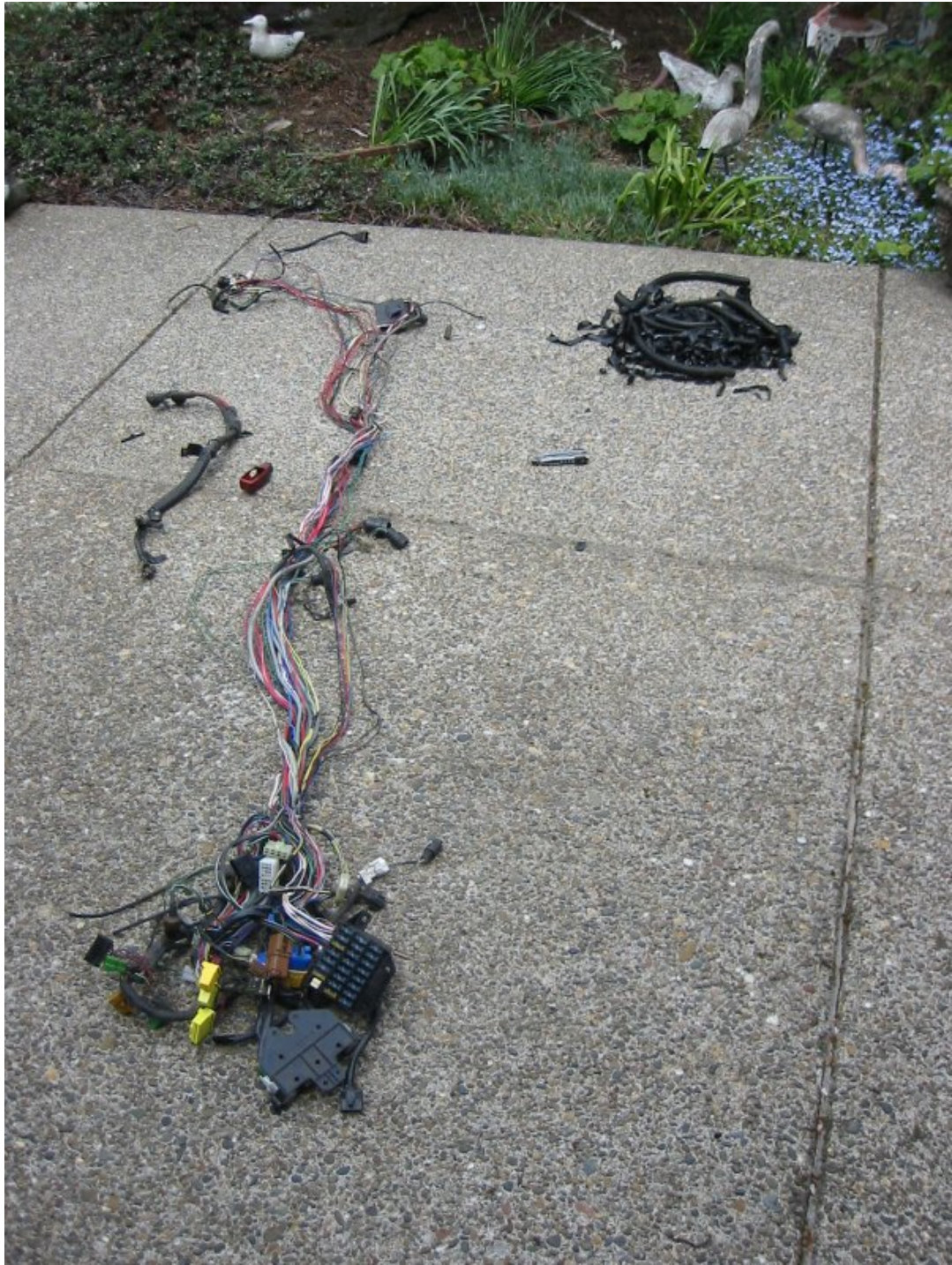
The rest of the connectors are pretty obvious - the shielded wires all go to various sensors like the distributor, MAF, O2 sensor, and manifold sub-harness. These will simply need to be routed safely when you install the harness.





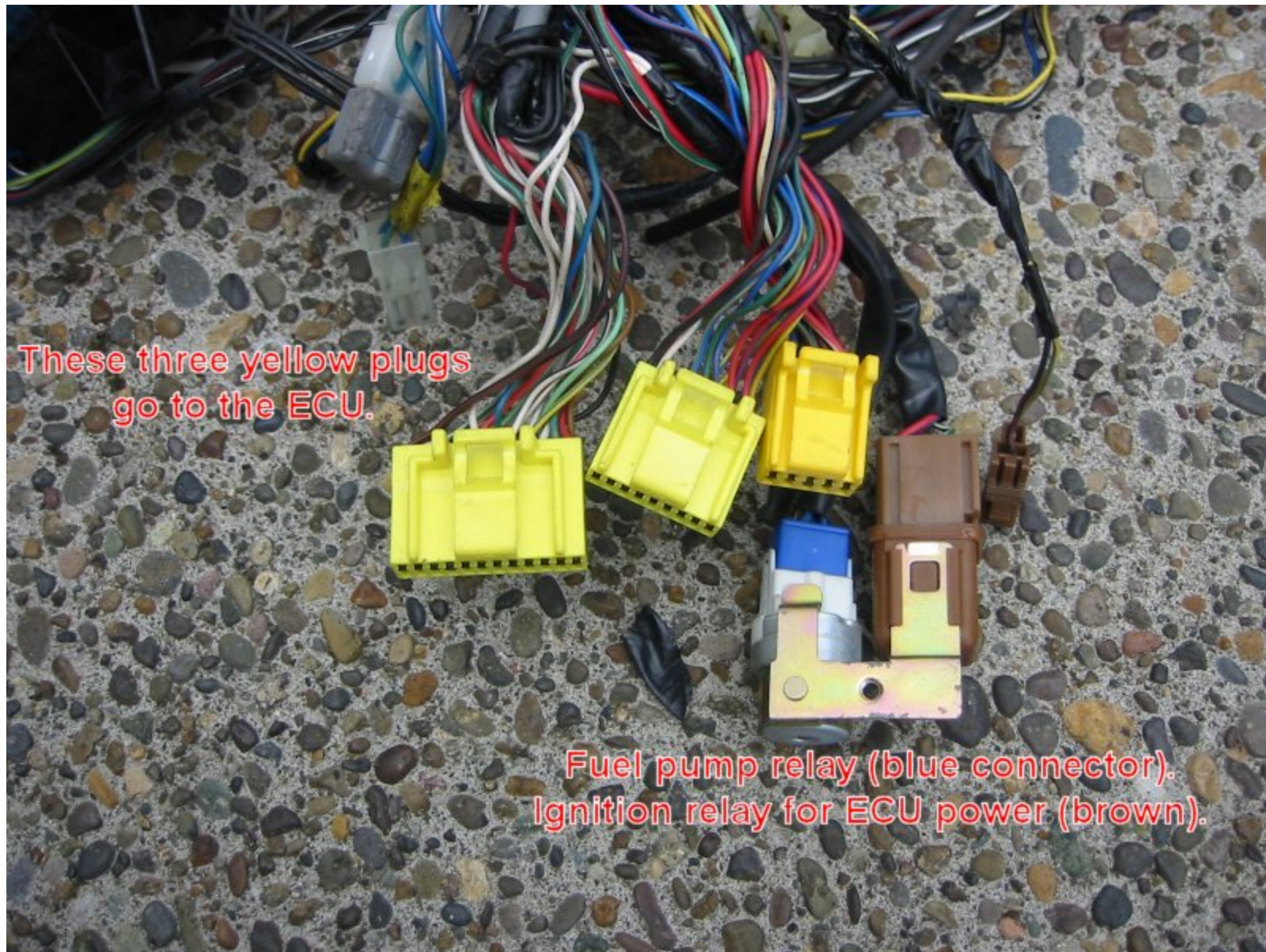








Keep all the tubing - it will come in handy for wrapping the harness back up after all the stuff you don't need is cut out.



--Manifold--

Now it's on to the manifold. The manifold is pretty well self contained, but some changes need to be made to accommodate the location of the EA81 distributor. Fortunately the component that's in our way is easily flipped over so it does not interfere

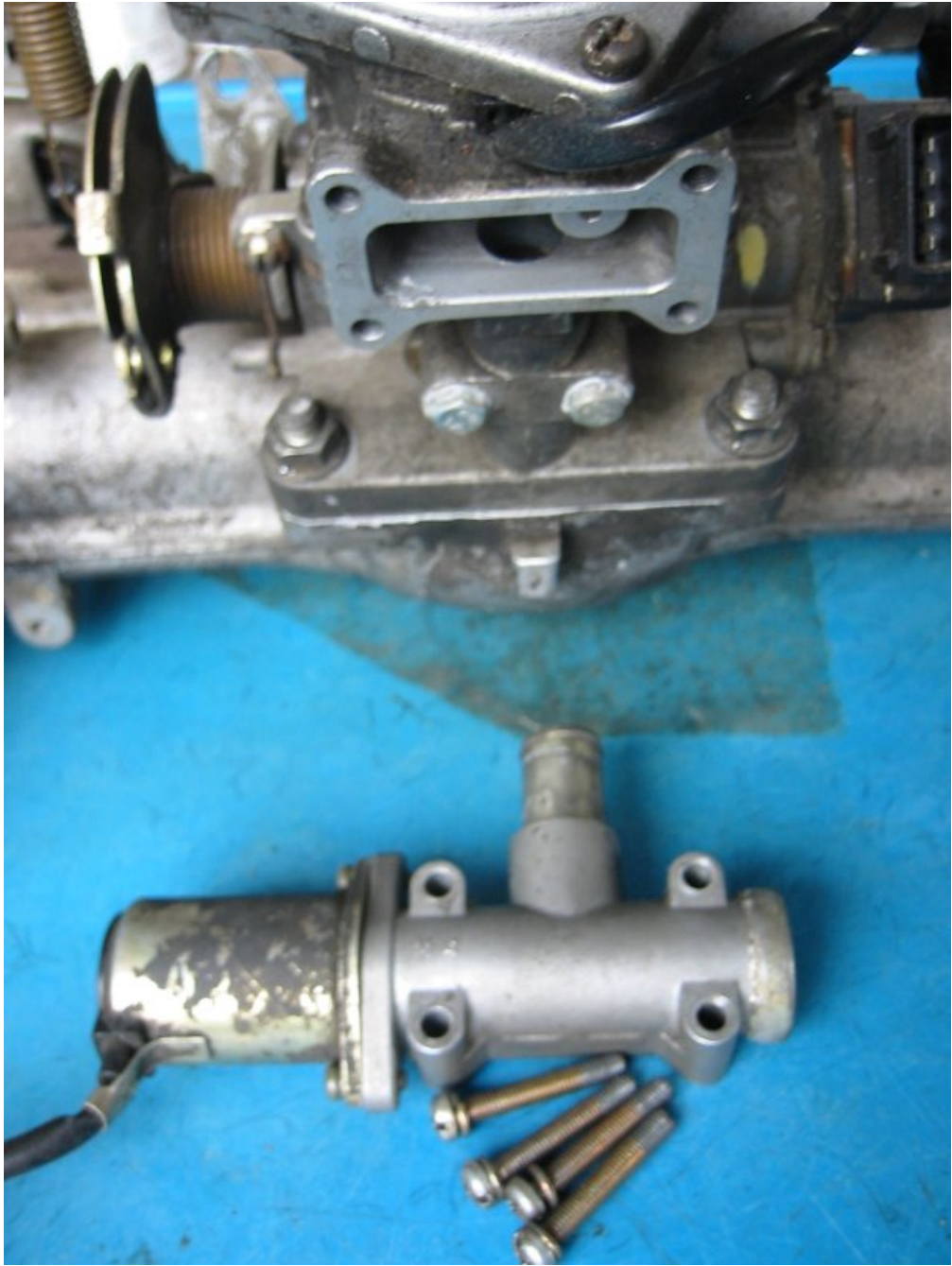
with the distributor. The IAC valve (Idle Air Control valve) attached to the front of the throttle body needs to be flipped over. Pictures are best to describe this one, so here's a series that will show the needed changes. All you need is a screwdriver.

It would be wise to soak the IAC in some carb cleaner for a bit to clean it up. Remove the solenoid before you soak it. The inlet hose will be pointing down after the flip, so it's necessary to use a U-shaped bend of 5/8" heater core hose to bring the inlet back up to where it can connect to the stock SPFI idle valve hose. To clear this U-bend hose, the two vacuum supply lines that supply the EGR solenoid, and the Purge solenoid need to either be removed, or if you prefer to keep these two functions the ports need to be bent to the side to clear the hose. I have provided pictures of both styles depending on how you want yours installed. It's also important to note that the TPS connector will be very close to the IAC solenoid, and the solenoid needs to be loosened for the TPS connector to be removed. Fortunately this isn't really every required, and it's really no big deal to remove the four screws for the IAC if you do need to get at it.

The distributor will not clear the IAC solenoid in its stock orientation. We are going to rotate the IAC assembly 180 degrees to clear the distributor.



IAC Valve
(Idle Air Control Valve)
Stock (EA82) Orientation











New IAC valve solenoid orientation provides space for the EA81 distributor.



If you want to keep the purge and EGR solenoids, these two vacuum supply line's must be bent outward as I have done here. This is to clear the IAC hose.



This shows how the bent vacuum lines are still accessible with the u-bend IAC hose.



Alternatively, you can pull the supply tubes out, and thread some small bolts into the holes to effectively block them off. Use some RTV to prevent vacuum leaks.



A u-bend peice of 5/8" heater core hose makes an effective connection for the IAC hose.



--Distributor--

The distributor is possibly the most involved modification required for this swap. Specifically, the drive gear portion of the modification requires some very careful drilling of the distributor shaft with at **least** a small drill press, and a jig to hold the shaft stationary and centered (or a **very, very** good eye - I actually did my first one that way). The procedure is to remove

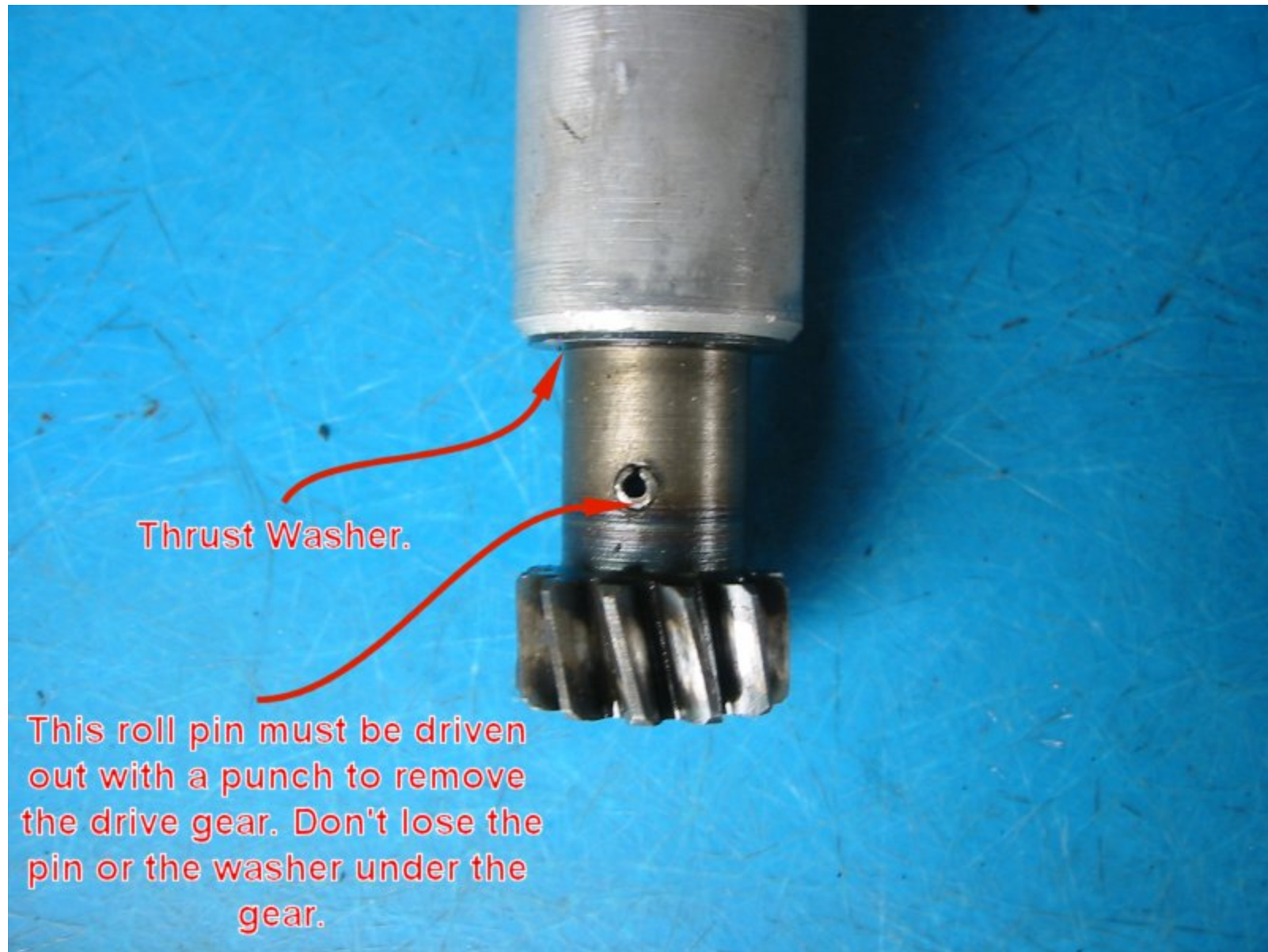
the drive gear from a **Hitachi** (used on 4WD EA81's) EA81 carburetor distributor, and pin it to the EA82 SPFI distributor shaft. Both distributors are made by Hitachi, and so share the same exposed shaft length, and the same shaft diameter. The only difference between the Hitachi carburetor distributor, and the Hitachi optical crank angle distributor is the drive gear pin location and the mounting tabs. Here's a few pictures to orient you to the different distributors you may encounter, the drive gears found on them, and the removal of the Hitachi gears:





Hitachi:
Only this drive gear will
fit the SPFI distributor.

Nippon-Denso:
Drive gear is too short
and pin must be drilled
for removal.



If you have a Nippon-Denso distributor for your EA81 (the 2WD distributor) you will either need to source a used Hitachi unit for its drive gear, or source a new drive gear that will match. After you remove the gear from both the EA81 and EA82 distys, slide the EA81 drive gear onto the EA82 disty and familiarize yourself with how the drilling is going to work. The shaft isn't hardened, and can be drilled with a plain high-speed steel drill bit. I do my drilling with the gear on the shaft (don't forget the thrust washer that goes on before the gear), and I drill right through the hole in the gear. If you line it up properly and use

a clamp to hold it to the drill press, it should punch right out the other side and line up almost perfectly with the hole in the other side of the gear. Wear eye protection - if the bit binds when it comes out the other side of the shaft it can snap off. I have had success with using a bit very slightly larger than the hole in the drive gear. I then spread the roll pin apart a tiny bit by lightly pounding a sharp chisel into the slot in the pin. With a little adjustment the pin will fit nice and tight. Once you have the pin installed the drive gear portion is done. Make sure to clean all the drill bit shavings from the distributor.

The EA81 distributor has only a single mounting ear on the side, while the EA82 distributor has two mounting ears (I have no idea why this was done - I have seen plenty of EA82's where one bolt was missing anyway - seemingly to no effect). This means one ear will need to be eliminated from the EA82 distributor body. I have prepared a special series of pictures that illustrate where the cuts need to be made. They don't have to be pretty, they just have to clear some of the casting of the EA81 block. The metal "band" that holds the wiring harness will need to be cut away - again to clear part of the block casting. The adjustment bolt slot will also have to be enlarged as it does not quite line up with the adjustment bolt on the distributor plate of the EA81. All of these are relatively easy tasks that can be completed with a file and a hacksaw. As before remember to clean up all the shavings well:



The adjustment slot needs to be made wider to fit the EA81 distributor bracket. Remove the area outlined in red.

Cut along these two planes to remove the extra mounting ear on the EA82 distributor.



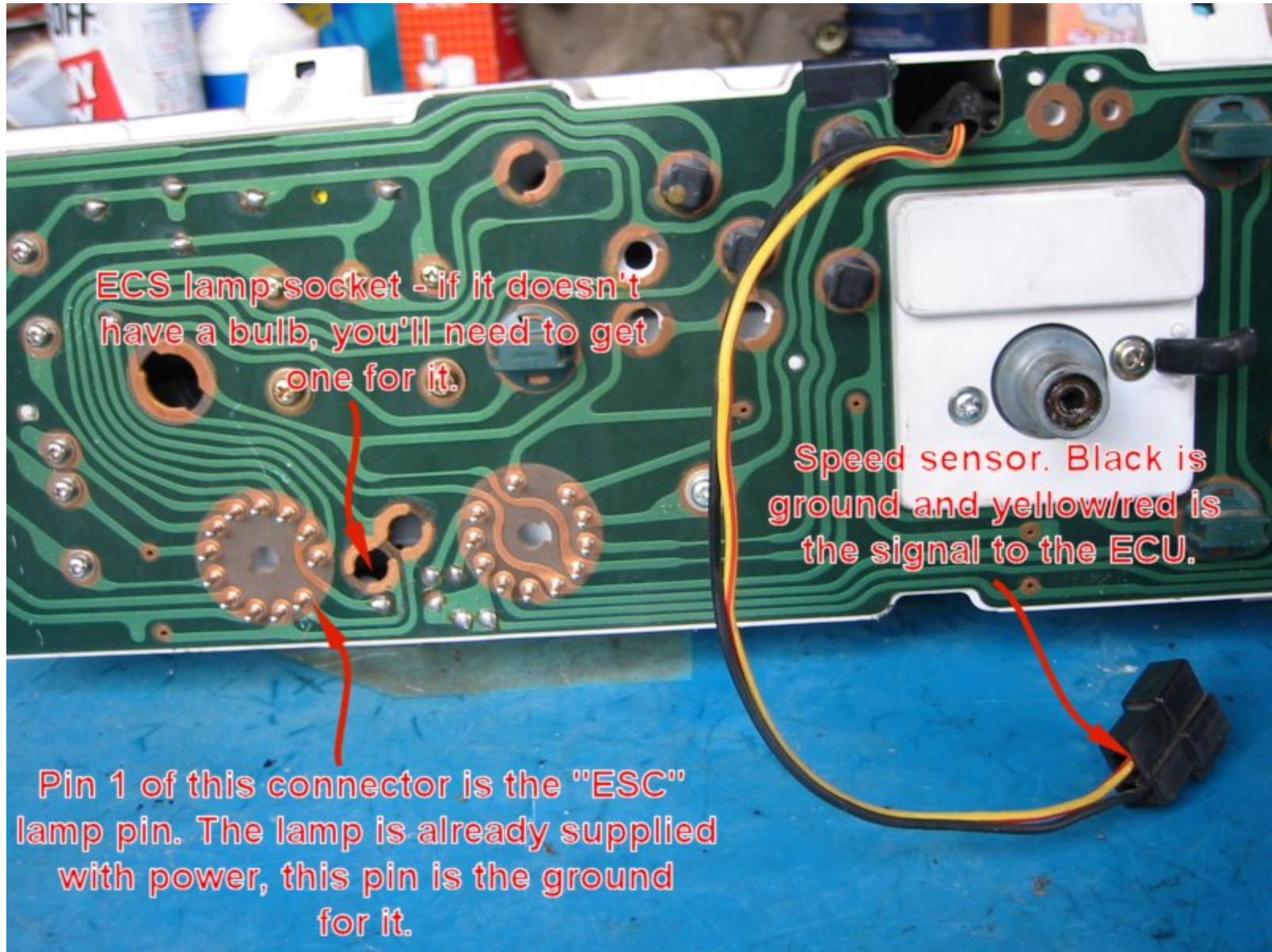
Pre-Install Vehicle Preparation

To minimize down time for your vehicle, it's desirable to complete as many steps as possible while it's still on the road. I'm going to split the pre-install into bite sized sub-tasks that can be completed in a relatively short time to avoid confusion, to keep things orderly, and to keep the vehicle's down time to a minimum. I'll start with tasks that can be completed while

the vehicle is still being driven, and leave the final assembly for the end hopefully resulting a quick and easy start-up. I've had plenty of vehicles immovable for days or weeks because of poorly planned swaps like this. Not having all the right parts and assuming something will take less time than it actually does is usually the culprit. Learn from my mistakes, and do the task in the order I have layed out and it should go smoothly. I've designed these steps to be self-contained as much as possible, and to familiarize the installer with the vehicle to assure all the needed parts will be available for the final stage durring which the vehicle will be undrivable for a few hours or days.

--Gauge Cluster Wires--

Some wires you will need have to be located and routed to where they can be connected to the ECU. The first two of these is the speed sensor and the ECS lamp wires that are located behind the gauge cluster. It is best to just remove the cluster to gain access to both of these. Theoretically if you have cruise control, AND a feedback carb equipped vehicle, you should be able to find these wires at the cruise control unit, and the feedback ECU without pulling the cluster but for most vehicles this will not be the case, and the cluster will have to be pulled out to splice into one or the other, or both of the wires. The speed sensor is a two wire plug running directly out the top of the guage cluster right over the speedometer. One wire is yellow and one is black. The black wire must be run to a ground (or if you have cruise control, it will already be grounded through the CC unit, so no change is required), and the yellow wire is the signal wire that you need to splice an 18 guage wire to and run down under the dash so it may be connected to pin 22 on the SPFI ECU. The ECS lamp is a bulb at the base of the tachometer that lites to indicate a fuault in the "emmissions control system", and is the most obvious choice for the CEL (Check Engine Light) function of the SPFI. The light is very important for notifying the driver of a fuault in the SPFI system and is used in conjuction with the ECU oxygen sensor monitor lamp, and the green test connectors under the hood to run diagnostics (known as D-Check mode - short for "Dealer Check") on the SPFI system. As I mentioned previously, the ECS light socket is always present on the 82 through 89 EA81 guage clusters, but in the 82 through 84 clusters it may not shine through the tach face. If this is the case for your application, it may be better to just run a new lamp and mount it where it can easily be seen. The light should be provided with 12 volt ignition switched power, and the ground wired to pin 2 on the SPFI ECU. In the case that you have a working ECS bulb and socket in your guage cluster, you may still need to add the pin to the socket of the vehicle's wiring harness. The socket is the large round one to the passenger side of the cluster. Pin 1 (the first pin clockwise from the large gap looking at the back of the cluster) is the ECS lamp pin. A pin from one of the round plugs for the gauge cluster of another EA series subaru will slip right in and provide a conveinent wire to splice onto and drop down to the ECU. The socket is already powered, and pin 1 is the ground wire for the ECS lamp. Leave the wire from this pin hanging under the dash for later connection to pin 2 on the SPFI ECU. These two wires are all that is needed from behind the cluster, so it can be put back together once these two wires are accesible from behind the drivers kick panel. Label the two wires as "speed sensor" and "CEL ground" with some masking tape so you know what they are for later when the time comes to install the SPFI harness. This step is a nice easy one that can be accomplished in a few hours after work and will make the install easier when the time comes for the full wiring harness to be installed.



ECS lamp socket - if it doesn't have a bulb, you'll need to get one for it.

Speed sensor. Black is ground and yellow/red is the signal to the ECU.

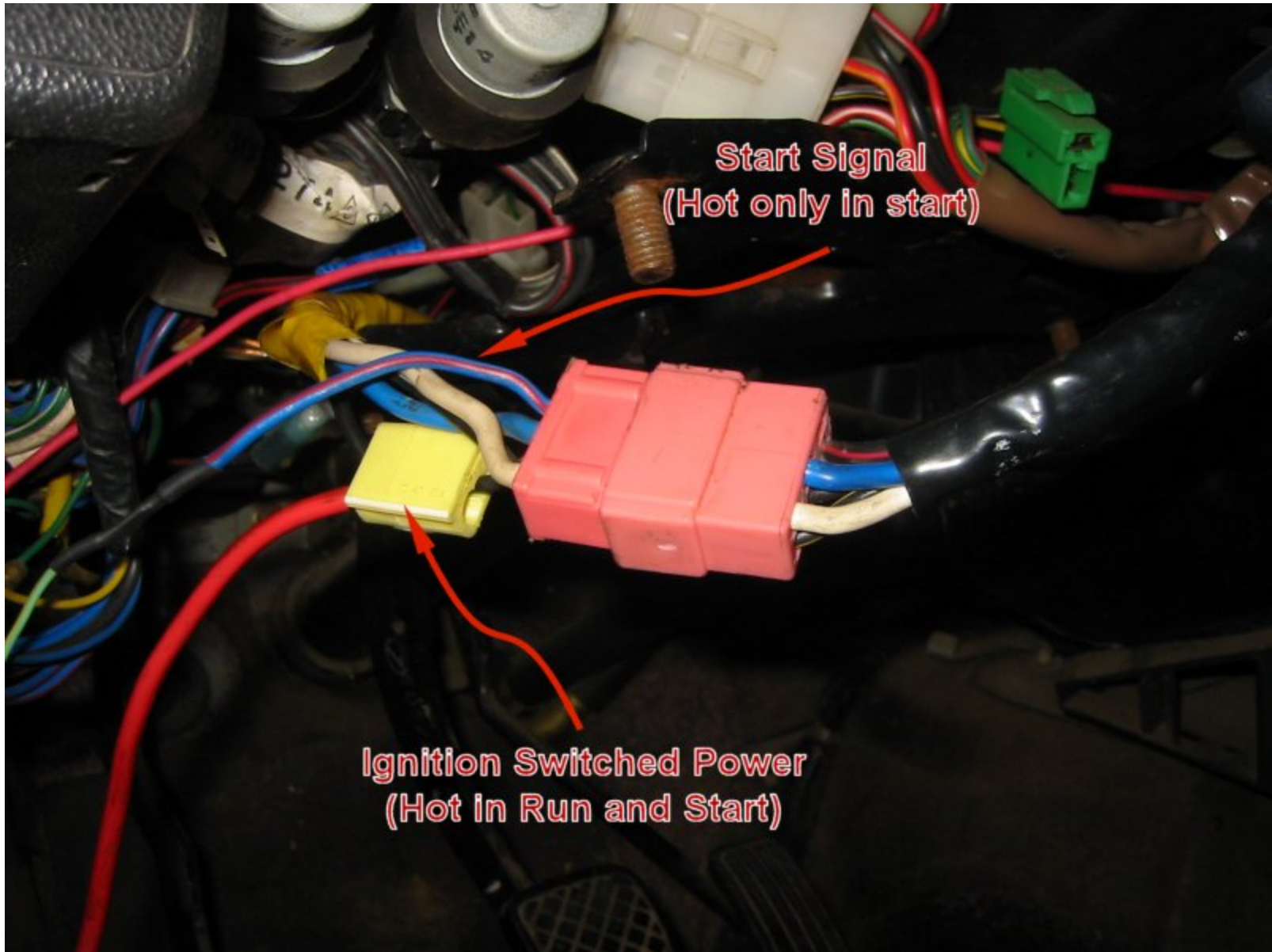
Pin 1 of this connector is the "ESC" lamp pin. The lamp is already supplied with power, this pin is the ground for it.



--Ignition Switch Wires--

The next sub-task is to access two wires you will need from the ignition switch harness. The connector we are going to work with is a pink 6 pin connector running to the ignition switch. It will have several large wires running into it. Disconnect the plug and with a multi-meter (on the 20 volt DC setting) find out which wire on the body side of the connector has a constant 12

volts by testing each wire with the red (positive) lead on the connector pin and the black (negative) lead on a good chassis ground. Make note of which pin that was, and then with the ignition key in the "ON" position, and your multi-meter set to the 100 Ohm setting, find out which pin shows continuity with the pin that has the constant 12 volt supply. We will tap into this line for the ignition relay control. It will turn on the relays we will use to power the fuel injection ECU and sensors. The 3M wire taps are ideal for this purpose as no cutting or soldering of the body side ignition switch harness is required. The yellow size is perfect for this. Tap this line either with the 3M tap, or by stripping a small section of insulation, and soldering a length of wire to it. Make sure to wrap the solder joint in electrical tape to insulate it. Run a 12 gauge wire from this source to where you plan on locating the two relays and fuses for the SPFI power supplies. I located mine in the engine bay using a small relay/fuse box I got from a junkyard car. The one I used has two relays and two fuses in a weather resistant box intended for mounting in the engine bay. It came from an early 90's Mitsubishi Eclipse, and looks to have been for the Mitsubishi's AC system. But whatever you can find that's got at least two relays and two fuses will work, or you can also locate the relays and fuses under the dash but this results in a mess of wires, and makes it difficult to check fuses and relays if something should burn out later on down the road. At any rate, make the 12 gauge relay control wire long enough to reach where you intend to locate them. A good 8 feet will cover just about any place in the engine bay. Just coil it up and make sure to wrap the end in some electrical tape or heat shrink to keep it from grounding out on something. The next wire we need from this plug is the "start signal" wire. This wire is only hot in the start position of the switch (while cranking). Use your multi-meter again to verify continuity with the hot pin while the key is held in the "Start" position. The switch supports this function, but the EA81 vehicles did not use it, so it will be one of the pins that is unused on the body side of the pink plug. You will need to remove the start signal wire from the body side of the EA82 donor car's ignition switch harness and insert it into the body side of the EA81 harness plug. It's usually a 14 or 16 gauge wire. This will be wired to pin 18 on the ECU. It tells the ECU that the engine is being cranked, and without this wire it will be extremely difficult to start. Run this wire under the dash and coil it up so you can connect it to the ECU through a 15 amp fuse later when we install the harness. This completes the wires you need from under the dash of the EA81. Label these two leads as "starter signal" and "ignition switched power" with some masking tape so you know what they are for when you are ready to hook them up to the SPFI harness. You can see in the picture the 3M tap on the ignition switched hot lead, and the blue with red accent wire for the start signal:



Start Signal
(Hot only in start)

Ignition Switched Power
(Hot in Run and Start)

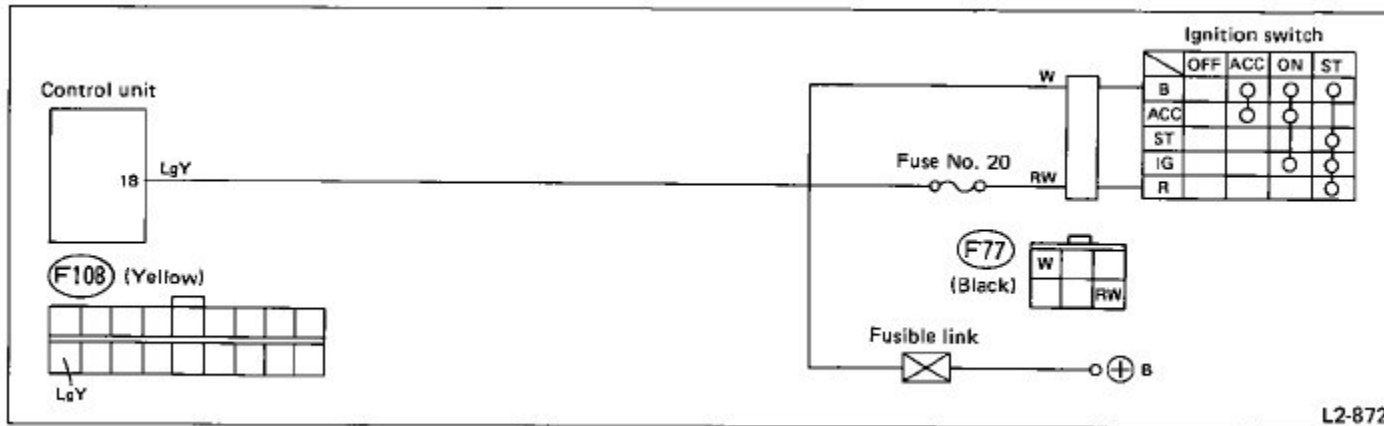


Fig. 58

L2-872

--Fuel Pump Power--

Moving on, the next task is to run a 14 gauge wire to supply the fuel pump power to the SPFI fuel pump. The stock wiring for the carb fuel pump is not up to the task of running the fuel injection pump. The injection pump is a rotary-vane style pump and has a higher amperage draw than the old carb pump (which is a vibrating diaphragm pump). While the stock wiring *might* work, it also might not, and it's best in my opinion to not mess around with wiring that may or may not catch fire around a pump responsible for delivering highly flammable liquids at pressures exceeding 50 psi. The exact routing of this wire is dependant on the body style of the vehicle it's being installed on, but in general terms it's best to keep the wire inside the cabin for as much of the distance as possible. On my Brat I ran the wire under the door jam plastic trim, behind the rear wall plastic, and through the same grommet that the stock fuel pump wires run through. I ran the ground wire from the pump to the chassis on one of the bolts that holds the fuel pump bracket to the frame rail - making sure to clean the bolt, and the mounting bracket to make a good ground connection with the frame. This ground wire, and the wire from the cabin should be soldered and insulated (heat shrink or electrical tape) to the body side connector for the fuel pump. Wrap the newly completed injection pump harness in ribbed conduit and electrical tape and tie the wire and harness up out of the way. Replace all the interior trim peices and coil the power lead under the dash. This lead will be connected to the ECU controlled fuel pump relay when we install the SPFI harness. Label this lead with a peice of masking tape as "fuel pump power" so as not to be confused later.

--Battery Power--

Two final wires need to be prepared to supply power to the fuses, relays and the green fuseable link for the ECU. These can both be run from the battery positive terminal to where you plan on keeping the fuses and relays. I located my fuse/relay box right above the stock jack holder under the hood. And I ran these two wires from the battery positive terminal around the back of the spare tire area, and down to the jack area. One wire should be 10 guage, and the other 12 guage. The 10 will supply two 15 amp circuits through the two relays, and the 12 will supply the green fuseable link for constant voltage to the ECU. Use some waterproof ring terminals to mount the wires to the battery terminal, and run the wires to the location where the fuses

and relays will be located. Leave an extra foot or two on the ends and coil them up making sure they don't come in contact with any ground sources. Don't wrap the wires in conduit or electrical tape yet, as more wiring will be run near them later when the harness is installed and all the wires can be bundled together at that time. That about covers what can be done to the vehicle before taking it off the road.

Installation

--Fuel Pump--

The SPFI fuel pump will bolt down to the EA81 pump shelf with minimal modifications. The carb pump mounts with three rubber bushings bolted to three threaded studs on the mounting shelf, and the SPFI pump mounts similar, but with only two bushings and studs. Cut one of the three off - which one depends on which way you want the pump to mount, and the type of EA81 it's being used on - wagon/sedan, Brat, and hatchback are all slightly different and in different locations. Don't be surprised if your shelf doesn't look like the one in the pictures below. They all use a similar mounting system, and it shouldn't be a big deal to bolt the SPFI pump up. Here's a few pictures to get you oreinted, and then we'll discuss the plumbing and wiring. These are pictures of the pump mounted and hooked up under my 85 Brat:

Adaptor for fuel pump supply.

Fuel pump power wire from cabin.

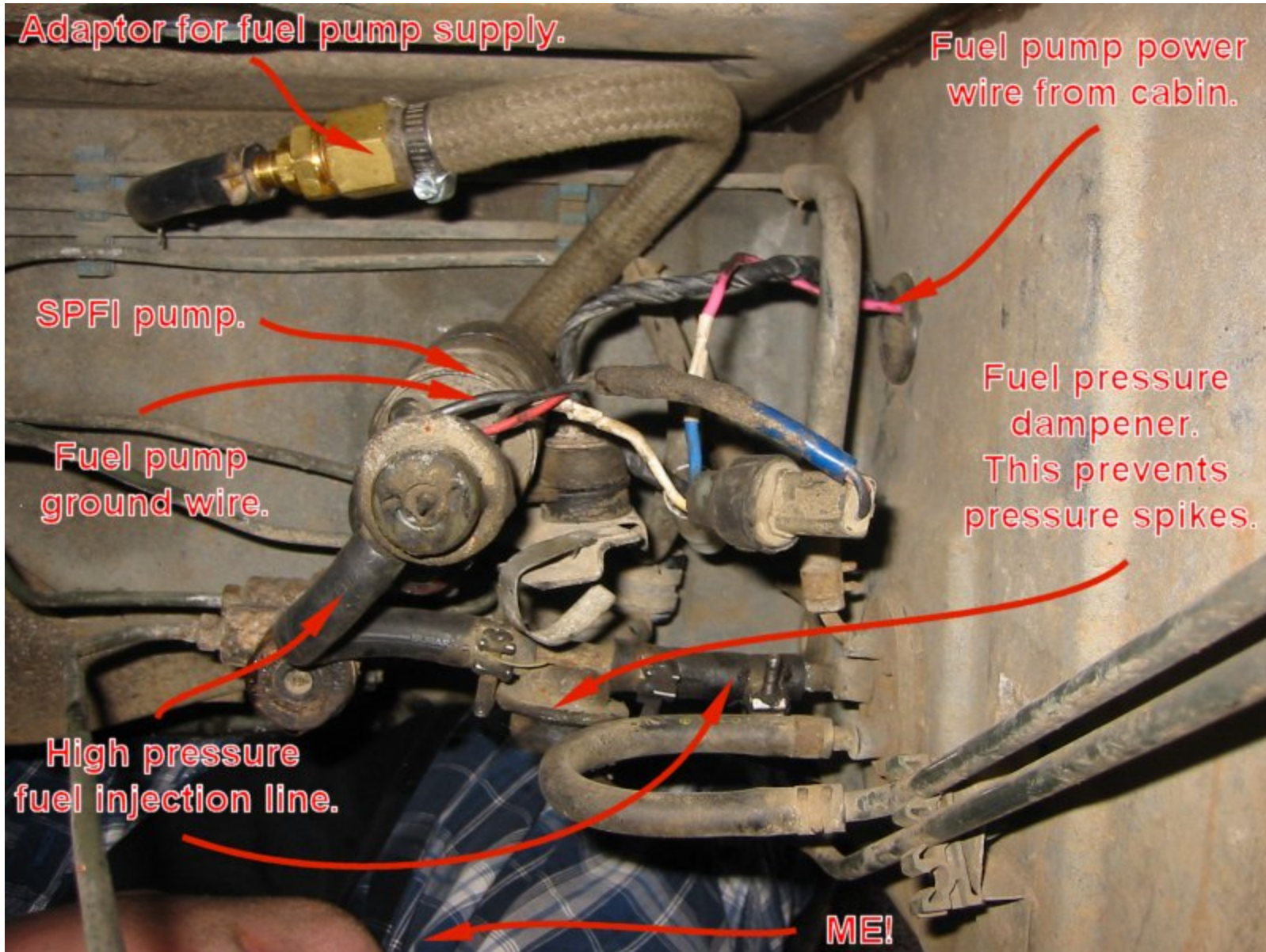
SPFI pump.

Fuel pump ground wire.

Fuel pressure dampener.
This prevents pressure spikes.

High pressure fuel injection line.

ME!





On the body side of the EA82 pump electrical harness, connect the blue wire (red on the pump side of the plug) to the power supply wire we ran earlier from under the dash to the pump area. Connect the white wire (black on the pump side) to a ground wire and use a ring terminal to ground this to one of the bolts that holds the pump shelf to the body. Make sure to clean the metal well for a good connection, and in areas that may experience rust or corrosion, properly coat the area with a good underbody rust preventative. Replace all the fuel line from the hard line entering the cabin all the way back to the

pump with high pressure line. Use the pressure dampener in the high pressure line as it was used in the EA82. Use a brass adaptor to go from the small supply line of the tank to the larger inlet of the fuel injection pump. I used 3/8" on the tank side, and 5/8" on the pump inlet side of the adaptor - Home Depot or a good auto parts store should have what you need for this application. Make sure to use some teflon tape on the threads between the two adaptors to prevent any leakage.

--Manifold--

The manifold installation is really fairly simple. Clean the gasket surfaces (I like to scrape them with a razor blade gasket scraper, and then use a wire wheel in an electric drill). Chase the block threads with a tap, and wire wheel the bolts then coat them with anti-seize. Use new gaskets from the DEALER ONLY. Then torque the bolts to 12 ft/lbs. Everything on the manifold hooks up as it should, but you will have to replace the heater core hoses with some new lengths of 5/8" heater core hose. If you are using the purge and EGR solenoids, you will have to re-route some of the vacuum lines that are near where the distributor slips into the block.

Remove the carburetor rubber fuel supply and return lines from the car - remember which line is which. The two are right next to each other, and the larger of the two is the supply line. Attach fuel injection hose and the fuel filter from the supply to the front most supply port on the throttle body. Then run another length of FI hose from the throttle body return port (to the rear, and slightly higher - it's the pressure regulator) to the return line on the body - using an adaptor to go from the 3/8" return port to the 1/4" return hard line on the body. You will need a small section of 1/4" fuel injection rated hose for this, and another set of adaptors from Home Depot. Remember to use teflon tape between the adaptors.

Disconnect the spade connector for the temperature gauge sender, and hook up the old one from the EA81 harness. You will not be using the one for the SPFI harness, and we already removed the corresponding wires from the body side of the harness, so just snip off this wire to get it out of the way. The same goes for the oil pressure sender wire. Snip it off, and use the old one from the EA81 harness.

You will also want to figure out some sort of air filter for the intake boot. The stock EA82 airbox really doesn't have anywhere to bolt to, and the battery is in the way. I used a commonly available MAF adaptor for an early 90's Nissan Sentra. They use a similar bolt pattern and will fit the EA82 MAF housing. You can pick up an adaptor and a cheap cone filter on ebay for about \$20 shipped. Here's a search link that will take you to many, many auctions for them:
<http://search.ebay.com/search/search.dll?from=R40&satitle=Sentra+MAF+adapter>

--Coil--

The coil should be bolted to the engine bay. The bracket MUST be grounded in order for the system to fire the plugs. I chose to mount it right above the jack holder similar to where it was located in the EA82's. This has the advantage that the wiring harness is already the right length. There is a single yellow wire from the coil portion of the harness - this wire is the tach signal and needs to be spliced to the yellow wire from the oil carburetor coil. I just removed a nice long yellow wire from the leftover harness, and ran it from the new coil around behind the spare tire area and spliced it to the old tach signal wire. While we are on the subject of the old coil, you should remove it, and make sure to tape up the positive coil power wire for it or the wire could ground out on the frame

and blow a fuse. The other connection from the coil is a black ground wire - it should be grounded to the engine block. This is the spark ground and it's best to ground it directly to the block for the shortest spark path.

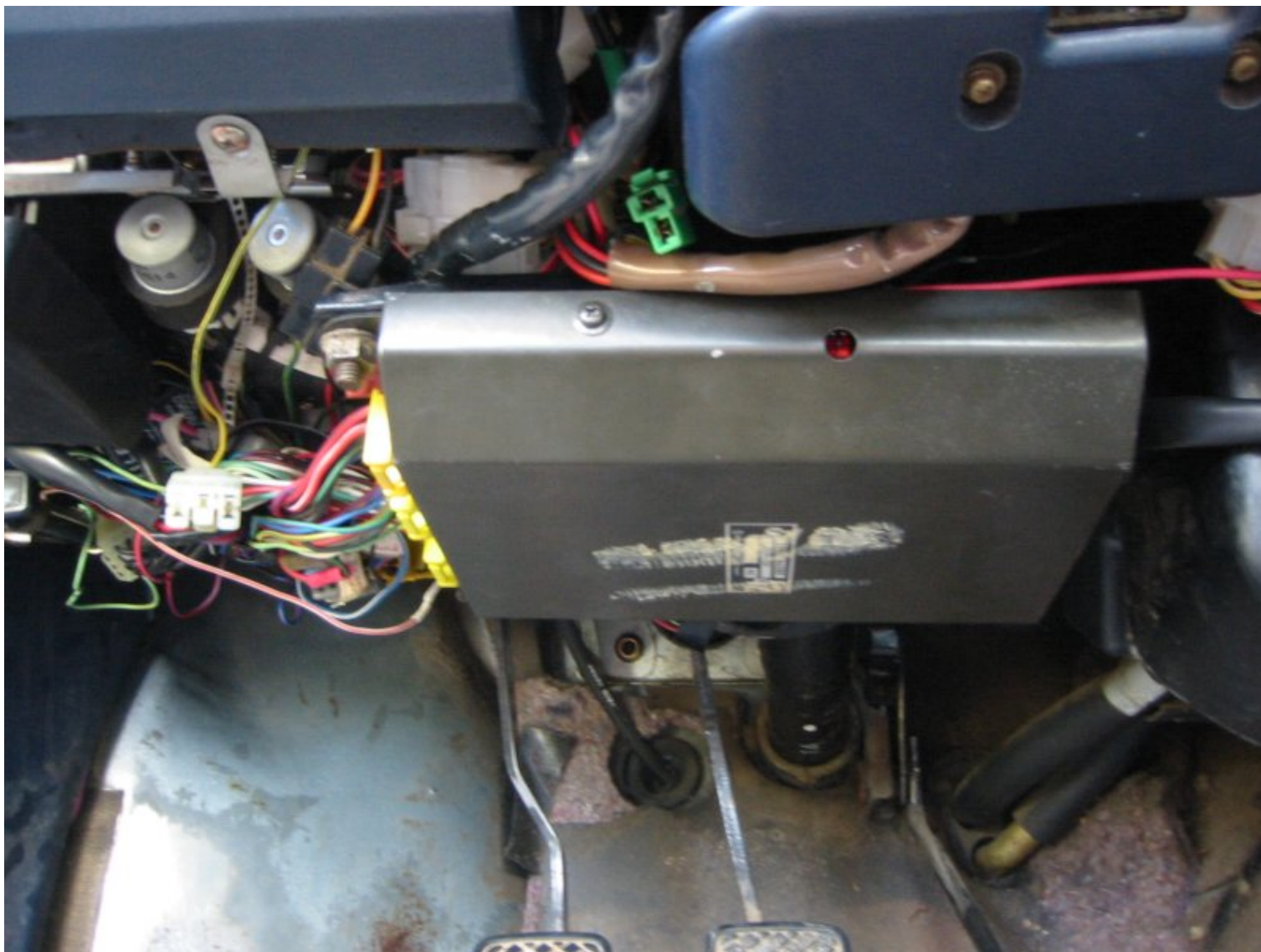


--Distributor--

The distributor just slides into the block after the modifications have been made to it. Time it by lining up the engine at 20 degrees BTDC on the compression stroke, and line the rotor on the distributor up with whichever plug wire tower on the cap you want to be #1. The rotor rotates counter-clockwise, so hook up the rest of the wires from #1. The firing order is 1-3-2-4, number 1 is passenger side front, 3 is behind it, 2 is passenger side front, and 4 is behind that. That will get it close enough to start and do the final timing with a light. Bolt the distributor down with the 10mm bolt from the EA81 bracket.

--ECU--

For the ECU, the studs on the column will not line up. I just cut off the single passenger side stud, and the one furthest from the drivers seat. I bolted the ECU to the single remaining stud, and then used a couple zip ties to hold the other side. It's not terribly critical how you mount it, just so long as it suits you.



--Wiring Harness--

Start by taking loose the big rubber grommet that surrounds where the wiring harness enters the cabin behind the drivers side strut tower. Pull it out enough to make an incision along the rear-most flat edge. Remove a section of rubber between the size of a nickle and a quarter from inside of the rubber to make room for the new harness section to enter through the grommet. Try to make as clean of a cut as possible to allow you to seal it back up around the edges with a bit of silicone to glue the cut you made in

the outside edge back together. Insert the ECU connectors, fuel pump relay, ignition relay, and all your labeled wires that need to connect under the dash, and the power supply wires if you plan to keep the fuses and relays under the dash (I don't recommend doing this as it's cluttered, and will make it difficult to check fuses and relays later if you have a problem). Don't seal up the grommet till you are done and it's running as you may find you need to run a wire or change something.



Connect your various wires under the dash. If you have labeled things appropriately, it should be a simple matter of matching them

up. Solder and heat shrink each connection. Keep the wires as neat as possible, and wrap them up as you go to prevent confusion.

Under the hood the situation should be similar. Connect the main manifold plugs (the two big round ones), and the ignition coil bracket plug. Connect the distributor harness, MAF, O2, and the fuses and relays if you are locating them under the hood. Find spots to secure things, and wrap the branches of the harness in tubing and electrical tape similar to how it was originally.

Final thoughts, links, and acknowledgments

First I would like to thank Snowman from the [Ultimate Subaru Message Board](#) for his excellent SPFI conversion manual. My first conversion was done using his manual as a guide. It's an excellent read, but does not cover the EA81 aspects of conversion. I have made it available here for download. It's a PDF file, but I have zipped it to save space:

[EA82 SPFI conversion manual by Snowman](#)

Also, here is a partial engine section from the 1989 factory service manual that details the entire SPFI system, and how to troubleshoot it. All the schematics and pin-outs in this document came from this source. Again it's a zip file, and you will need to download it and uncompress it for viewing.

[1989 Factory Service Manual engine section](#)