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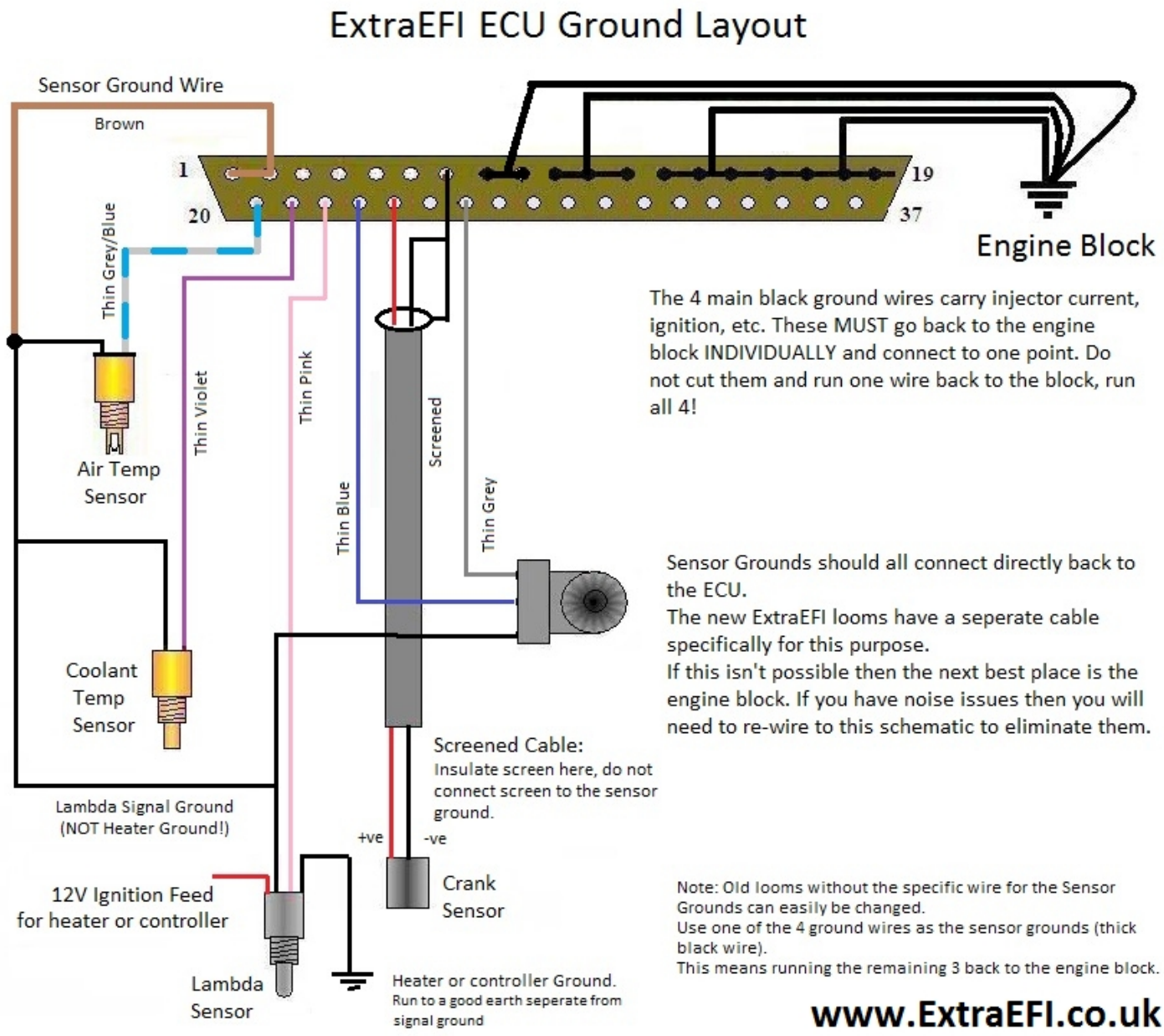
Wiring Basics

Grounds: The looms I supply have 4 or more grounding wires connected to them. This is to ensure that noisy signals (ignition driver grounds) can be grounded to the same point and that they travel down different cables to eliminate as much noise as possible. It is important to keep these as individual wires all the way back to the engine block and connect them to one point on the block. Soldering them all to one ring lug connector is idea, if not solder them to several ring connectors, do not crimp them as this type of connection is not always good, but ensure they are connected to the engine block.

However, if possible, one of the ground wires from the ExtraEFI loom, should be wired to the temp sensors, TPS and the lambda signal ground (not the heater ground!). This ensures the reference point for these are directly connected to the ECU. My new looms now have a dedicated wire for the sensor grounds, so that the delicate inputs are referenced directly back to the ECU. This will be labeled as the Sensor Ground cable.
If this isn't possible then ensure all the grounds that are related to inputs for the MS ECU (Air, coolant, lambda, TPS, etc) ALL connect to the engine block, do NOT connect some to the chassis and some to the battery! The Sensor Ground Cable in the loom can then be connected along side the other loom grounds, directly onto the engine block.

Spark Driver grounds, main loom grounds, etc, should also connect to the engine block. DO NOT connect some to the battery and some to the engine as this WILL give you some serious grounding loops and will be a nightmare to cure.
Lambda sensors often have a ground for the heater and another ground for the signal reference (Innovates widebands have this wiring too) it is important to keep these grounds separate. The heater ground can connect to the chassis or most any ground point, do not connect the 2 grounds together at the sensor and run one wire to the block, run them separately!



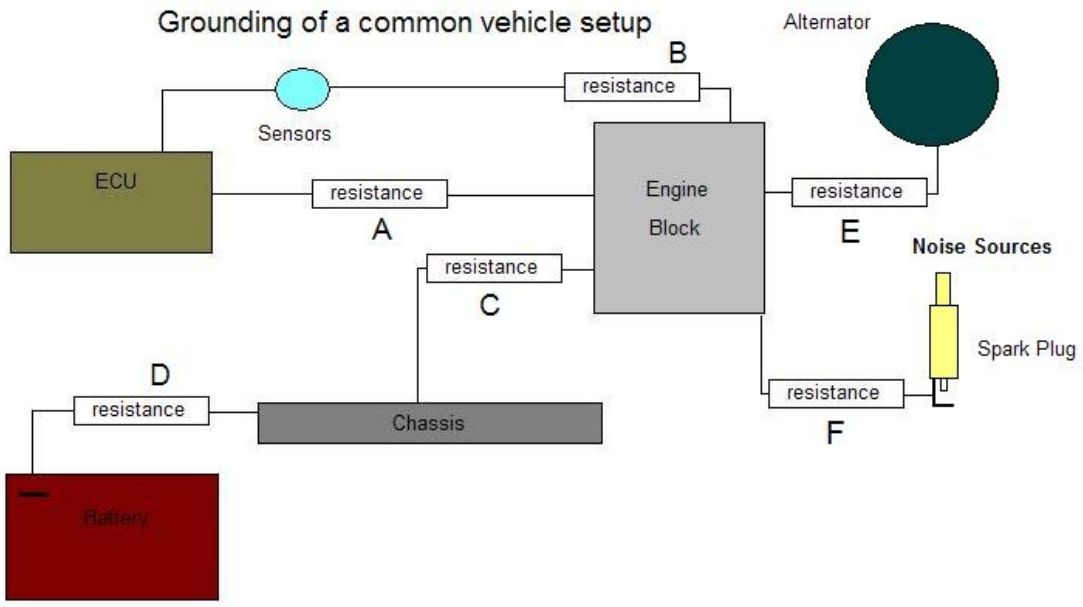
Why? Wiring these seperate may not seem important to you, indeed you may say that a wire connected to the engine block is the same point as the engine block so surely it doesn't matter? Well lets take the O2 sensor as an example:

There are usually at least 2 ground wires, one ground for the heater and one for the signal reference ground.
Basic VIR formular gives us that **V (volts) = I (current) x R (resistance)**
So the heater wire will have say **5 Amps** running down it back to the engine block.
There will be a small resistance in the cable, call this **Rc**.
So at the sensor end of the heater ground cable we will have a voltage at the sensor of **Vs = 5A x Rc**.
If we connected the sensor signal ground to this same cable the ground would sit at Vs, this will offset all the O2 readings by a significant amount!
As the current for the signal ground is very small, say 50mA (0.05A) then if it has it's own ground wire, then the equation is **Vsig = 0.05A x Rc**, which is very small indeed (100 times smaller).

Capacitors: The ignition coils need to have a capacitor (10-20uF) connected to the 12V feed in order to stop any spikes in the voltage creating unwanted noise. These are fitted to most OEM setup's and should be standard on any install you do. These are available from scrap yards (normally bolted to the coil pack bracket) or from Auto shops. They should be connected to each ignition coil 12V supply as close to the coil as possible and grounded to the engine block. Here is a Ford example:

Cable Size:

12V feed to the MS ECU - 0.5mm or bigger and protected by a 2-5A fuse.
Signal cables (Air, Coolant, TPS, O2) - 0.2mm or larger as they carry next to no current.
Injector output cables from ECU - 0.5mm or larger.
Injector supply cable - 0.5mm or larger, 5-10A fuse, depending on how many injectors you have fitted.
Relay Outputs (Fuel Pump) - 0.2mm or larger.
Fuel pump - 1.0mm or larger, protected with a 15A fuse.
Ignition coil supplies - 0.5 - 1.0mm, protected by a 10A fuse.
Ignition driver outputs, from the MS ECU - 0.5mm or larger. (Spark outputs)
Grounds - 0.5mm to 4mm depending on current usage. Main ECU has 4 x 0.5mm grounds, sensors, etc, can use 0.5mm.



Noise: There is a seperate page dealing with noise issues, it would be a good idea to read that before going too far, it can be found HERE or on the CD its in the README_Files directory called **Resets_Problems.pdf**. Basically if we have some resistance (a bad ground) and a current (noise) we get a voltage (Volts = Current x Resistance), decrease the resistance and you decrease the voltage, which is what effects the ECU.

The above drawing shows the layout of most common ground setups, indeed this is how my car is layed out. The Resistance is the resistance of the cable (where applicable) + the resistance of the connections.

Any noise will flow through the stray capacitance / inductance, resistance and back to stray capacitance/inductance. Take the noise of the alternator, it will have an ampiltude of Volts across E (V_E) + Volts across A (V_A).
V = Current x Resistance, so get resistance to zero and the voltage will be zero.

With the ECU grounded to the engine block, the True Ground (as far as the ECU is concerned) is the engine block. As all the noisey components are grounded to the engine block, the ECU see's that as ground.
The engine block is the path that has less resistance than using the Chassis or the Battery, as can be see above, because it only has Resistance A and B to cause issues. If you used the battery, then youd have C and D thrown in too, which would cause greater issues due to higher resistances, therefore a higher voltage.

This subject is massive and there is so much more to it than I can understand, I just hope this helps those with noise issues to see why it is important to sort grounds out.

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