Autopsie ECU IAW 5AM

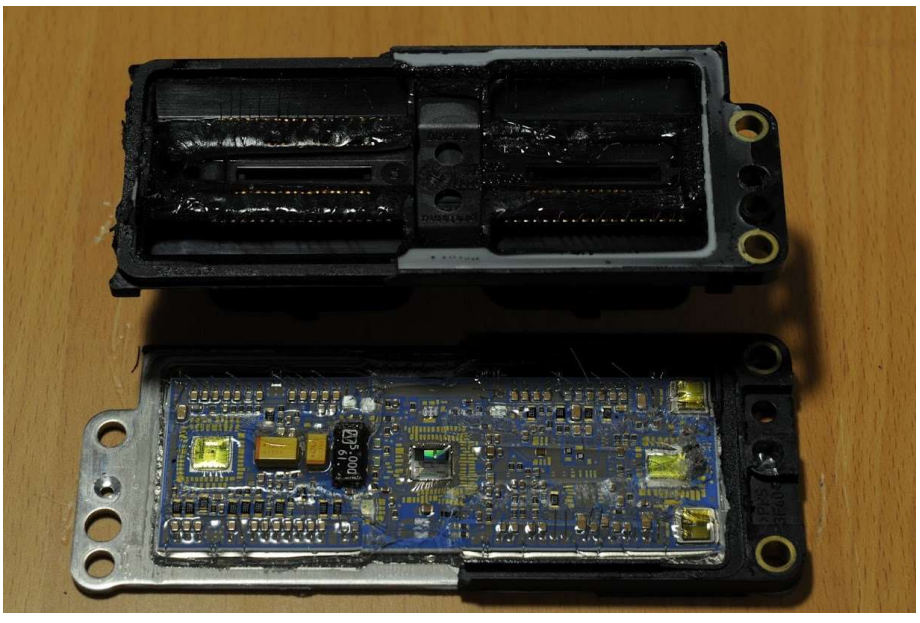
Description IAW 5AM :
L'unité de contrôle «autonome», conçue pour prendre en charge l'architecture «traditionnelle», utilise une technologie «hybride». Les composants reposent sur une sous-couche en céramique à haute densité qui réduit à la fois la taille et le poids. (Environ 200 grammes)
Et qui peut résister à des températures de fonctionnement de –40 ° C à + 110 ° C et à des vibrations élevées (jusqu'à 30 g).
Les connexions à l'entrée / sortie externe sont réalisées à l'aide de deux connecteurs de 38 voies chacun.
La centrale pilote jusqu'à 4 canaux d'injection et 2 canaux d'allumage indépendants, un moteur pas à pas pour un contrôle minimal et, pour les versions le nécessitant, le contrôle de la position de la soupape d'échappement et la gestion du contrôle de traction intégrés dans le système au niveau logique.
Le mélange est contrôlé au moyen de 2 sondes lambda du type ON / OFF chauffées.
Les dimensions réduites facilitent l'installation sur le véhicule.

Brad Black kindly donated a broken ECU from an ST4. This is a 5AM unit, the same as what's in many injected monsters.

I spent a little time this evening disassembling it. The long and the short of it is that they really aren't serviceable. Not even a little bit. I started by drilling out the plastic molten "rivets" holding the thing together, then clamping it in a vise to break the glue seal. What came out is rather interesting.

First, our victim:

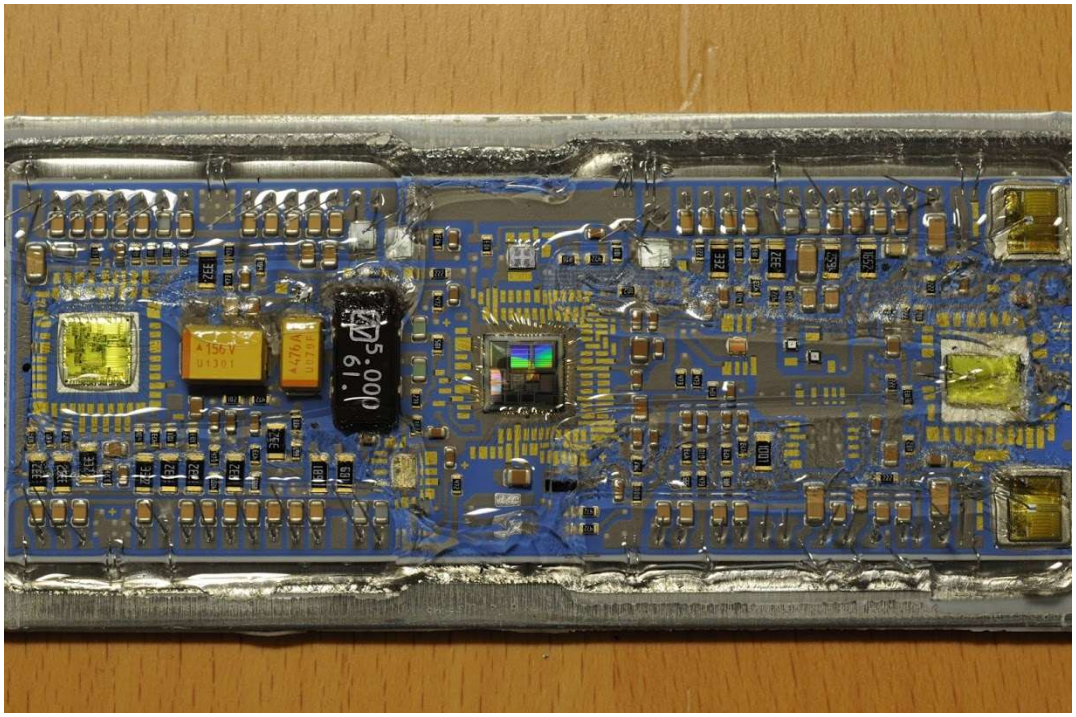
Now the two halves separated:



This construction is called "chip on board", and is popular in really high frequency radio stuff. It's pretty high tech, and explains why the ECU is so compact. The bare integrated circuit die are mounted directly on the board, and then wire bonded (a fancy welding process used in chip fabrication) to pads on the board. Power transistors and diodes are similarly mounted. Resistors and capacitors are soldered on like in a conventional circuit board. Finally more wire bonds are done from the circuit board to the connectors.

Magneti Marelli must churn these things out by the million - the engineering costs to come up with a design like this are huge. The only way that it's economically feasible are if they're making heaps of them, so they can amortise over many individually cheap units.

Here's a more detailed photo of the circuit board:



There are two large chips: I'm thinking the one on the left is most probably an analogue to digital converter or analogue ASIC - a circuit that allows a computer to sample analogue voltages (like TPS readings and temperatures etc). The big black rectangle is the timing crystal - a 5MHz one, which is pretty slow when you compare with your typical PC. The large orange components are filter capacitors.

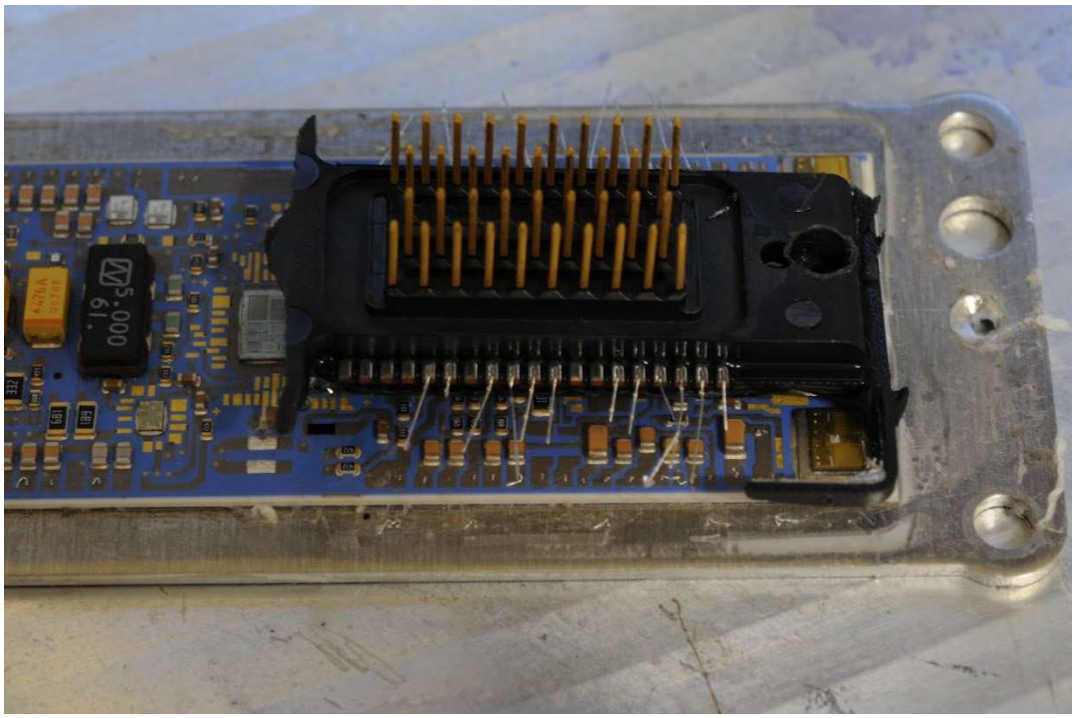
The chip in the middle is a microprocessor - you can tell by the large blocks of uniform features on it - these are memory. The two chips on the far right at the top and bottom appear to be power mosfets. My guess is they're the coil driver. The bit in between them is a power driver as well, but one with multiple outputs. It's no doubt responsible for driving injectors, starter solenoid, etc.

I'll take some more detailed photos once I figure out how to remove the conformal coating.

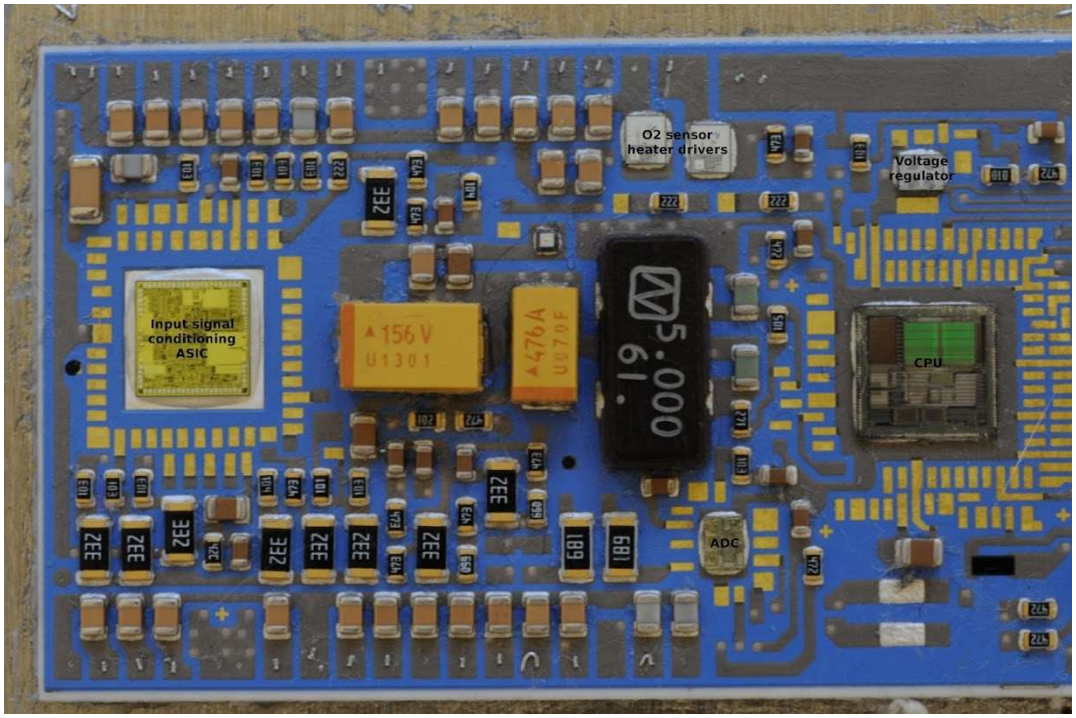
The inside of the connector sits on a separate frame, which suspends it above the circuit board. The pins are brought out to tabs in a leadframe, which are then bonded down to corresponding pads on the circuit board. It's a really neat construction method, but the bonds are pretty long (of order 10mm) and only 0.2mm dia. I'd be worried about the

ability of such long skinny bonds to drive big currents (like injectors and coils).

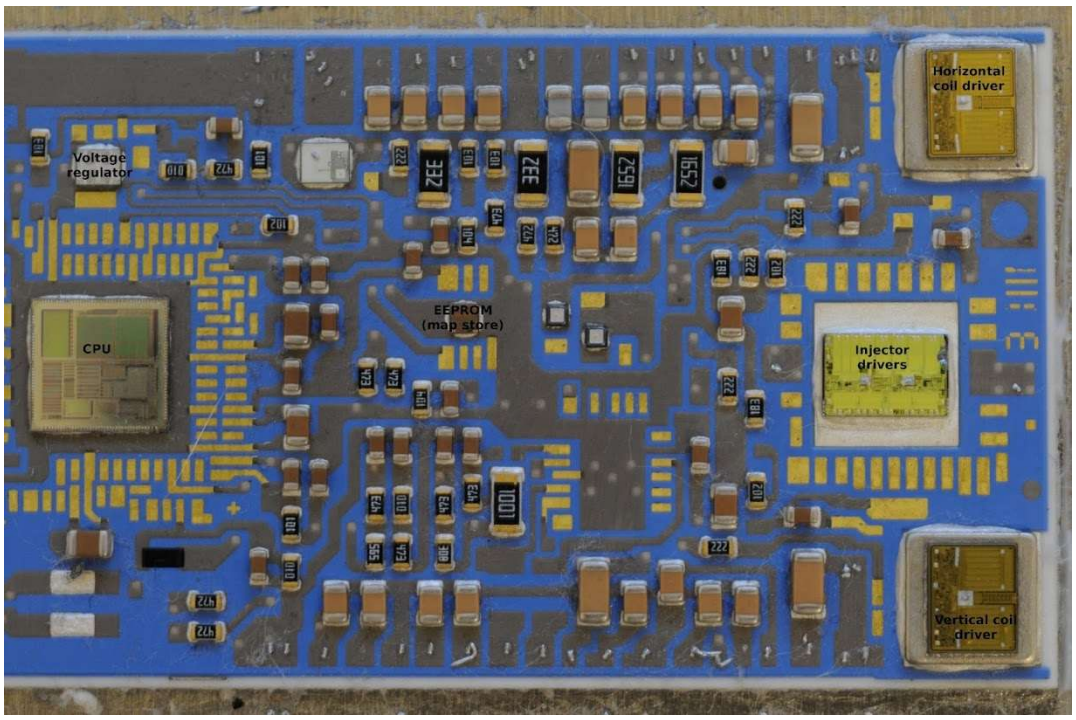
Here's a photo of the partially demolished connector frame, sitting approximately where it would be. I've removed the wirebonds from the circuit board while removing the silicone conformal coating, but you can still see where the bonds go.



Another couple of photos of the board, with much of the (amazingly gooey) encapsulating conformal coating removed. First the body connector side. I've added annotations to chips where it's clear what they do:



And the engine connector side:



The big chip on the body connector side isn't an ADC after all - my guess is it's an ASIC (application specific integrated circuit) to do sensor signal conditioning. It's got a designator "CU712B" in the middle, next to an SGS Thomson Logo (big chip manufacturer). I've googled CU712B and drawn a blank. The ADC is probably the little chip at the bottom under the large black crystal.
Above the crystal is the O2 sensor heater drivers. The one on the left is connected to an actual O2 sensor heater on our bikes. The one on the right powers the starter solenoid. If you connect your battery backwards, this chip emits it's smoke.

The CPU is obvious, right in the middle. The chip above it is the voltage regulator, both for the internal circuitry and for the sensors.
On the right (engine connector) side we have all the high power stuff. The coil drivers are the big chips on the far right top and bottom. These each drive just one coil. In between them is a chip (most likely another ASIC, made by SGS Thomson and labelled CU408A (I think - my drill bit damaged the end of the identifier)) for driving injectors. It has five high power outputs and three medium power outputs. Only the two right-most high power appear to be used - these drive the horizontal and vertical injectors. The ECU has a further three injector outputs, on engine pins 26, 36 and 27. These outputs would be used when this ECU drives four cylinder motors (in wasted spark mode).

There's an EEPROM (programable memory device, like a flash stick) just to the right of the CPU. This is where they store all the timing maps.

any thoughts on what bridges the starter button to the starter solenoid?
The starter button is an input to the CPU. It has an output that goes to the O2 heater drivers (they're labelled ST VN79C, fwiw, but google can't find matches). In any case, these are mosfet transistors. They turn on the starter solenoid by shorting it's negative side to ground.
You've almost definitely smoked the one on the right side. There is no practical fix for this beyond what you've already done, as opening the ECU kil ls it.