Exorcising an old Toyota Echo

How do you fix an old car's ECU when the replacement is worth more than the car? This is a common scenario these days, particularly with cars more than 20 years old. B. Y., of Mackay in Queensland faced the problem a Toyota Echo and managed to fix the faulty ECU with an interesting workaround. . .

A few weeks before last Christmas, my wife complained that the engine on her 2002 Toyota Echo sounded "funny". Sure enough, it was only running on three cylinders and I knew what the problem was immediately – a rat. This is the third time this has happened. There is a convenient nesting spot under the exhaust manifold and within chewing distance of No.3 fuel injector.

After removing the engine top cover I could see that the cables had been chewed through yet again. On the pre-

vious occasions (some two and three years ago) I did the repair job, I solved the problem by liberally spreading chilli oil over the cables to deter the blighters.

Unfortunately, after fixing the cables this time, the car still only ran on three cylinders and I concluded that the ECU was damaged. A phone call to Toyota confirmed that the cost of a new ECU was greater than the value of the car and in any case there were none in the country. However, they did tell me that if I obtained a second-hand ECU they would be able to reprogram it to suit my car.

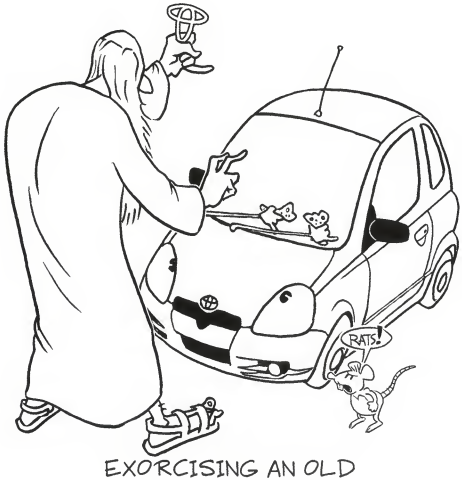
Unfortunately, after I had acquired a second-hand ECU via eBay, this story changed and I was told that the immobiliser prevented the unit being reprogrammed though there may be aftermarket specialists who could help. I spoke to several auto electricians in Mackay where I live but although they were helpful none had the expertise required – apparently the one who did had relocated to Cairns some time earlier.

So, what to do? I took the lid off the "new" ECU and, having previously traced the cables back from the fuel injectors, quickly determined that the four fuel injectors were driven by two SPF0001 dual driver chips. The equivalent circuit of each driver is a transistor with protection diodes and a typical H_{FE} of 800 but it is neither a Darlington pair nor a Sziklai pair, as V_{BE} and V_{CE} (saturated) are similar to those of an NPN transistor.

The chips are surface-mount, of course but worse, the "collector" connections are on the underside of the chips as part of their thermal management. I didn't fancy my chances of replacing one of these without damaging something else – there are components on both sides of the PCB.

Sending the ECU away for a specialist to replace the chip would be both expensive and time-consuming and it was just before Christmas, as noted above. I did a bit of research into fuel injectors and they are basically solenoid valves and the measured resistance of 14Ω indicates that the Echo uses saturation types as fitted to most cars.

In other words the drive is a simple switch but, unlike most solenoid circuits, the flyback voltage is not clamped to 0.7V or so with a diode but used to control the closing rate of the



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injector. The driving transistor therefore requires a high working voltage.

I decided to replace the broken half of the SPF0001 with an NPN/PNP Sziklai pair. This way I could leave the circuit driving it unchanged and I figured that the higher V_{CE} saturation of 1V or so would not make too much difference.

I did consider using a Mosfet but BJTs are more rugged and I understand Mosfets have been used in the past but are less reliable in this application. The local electronics store had a BF469 (250V) and a TIP42C (100V) and I added a 75V zener to limit the flyback excursion.

Now I took the old ECU out of the car, removed the cover and noted a bulge on what I believed was the offending SPF0001; so far so good. I was as concerned about vibration as much as anything else as there wasn't much to fix to.

I isolated the bad chip half by cutting the PCB wire to the connector and the "base" pin on the chip. I could now string the components between those points and a convenient PCB earth in a way that gave reasonable mechanical support.

I put it all back in the car and it worked. Whoopee! Five months later, it is still good so it looks as though I've had a win. I've also fitted some wire mesh into the space under the manifold. Hopefully this will deter rodents in the future! SC