A Ford Focus with unusual fuel trims

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We recently had a call to the Autobiz Technical Helpline, from a workshop that had spent considerable time in their attempts to solve the fault. A customer brought them a Ford Focus 2014 1.6 16V petrol that had a misfire. The straightforward initial diagnosis showed low compression on 2 cylinders. The customer decided to opt for a used replacement, low mileage engine, rather than have his engine rebuilt.

Once the engine was fitted and test-driven, the misfire was present when the engine warmed up. The workshop set about diagnosing the misfire condition. All the usual suspects were checked, including a compression test on the replacement engine. Spark plugs, coil pack, and leads replaced, then moving on to a set of fuel injectors. The misfire persisted, but only after the engine was at operating temperature.

A specialist diagnostic technician was called in to investigate the issue. After some considerable testing time, it was decided that the Powertrain Control Module (PCM) could be the root cause. So, the PCM was removed and sent for testing. The PCM came back with no faults found, and it was refitted.

Interestingly, the vehicle presented no fault codes other than random misfire P0300. But would only occur after a considerable test drive. They continued for several months checking fuel flow and pressure, fuel contamination, still no closer to a fix.

About to give up, they contacted the Helpline and asked if we would take on the diagnosis. So, the vehicle was shipped to us for a deeper look into the issue.

We started the diagnosis from the beginning, with an engine health check. We noticed the original engine was an IQDB, and the replacement was an IQDA. Compression tested good, all cylinders around 150 psi. Valve clearances were checked, as this engine has shims not hydraulic tappets. They were all good, 0.22mm on the inlet 0.32 mm on the exhaust.

A Pico scope trace of the in-Cylinder pressures was then performed. This proved the valve timing, valve overlap, and pressures are all within specification.

The intake system was smoke tested for leaks and passed the test. No leaks were detected.

We moved onto scope testing the coil output and injector signals to determine the cause of the misfire. In the initial warmup phase, all signals were as expected: coil current even across all cylinder firing, and injector pulse settled to 4.4 milliseconds, with no apparent misfire counters. When the misfire counters in serial data began to increase on both cylinders 2 and 3, the injector pulse on these cylinders began to decrease, and stopped at 2.9 milliseconds.

A scope trace showed the injector firing times were shorter for cyinders 2 and 3 when the engine was at operationg temperature

The long term fuel trim (LTFT) indicated a decrease of 14%, even though the upstream lambda sensor was switching perfectly, the rear sensor output was 700mV.

This almost indicated the system was working as if it had a 2-bank fuel strategy, even though it only had one upstream lambda sensor, one catalyst, and one downstream sensor. Very odd.

When we looked up the engine wiring diagram for this vehicle it showed a dual Catalyst four lambda sensor system. With a single bank, one catalyst system, any fuel strategy should be applied to all four injectors not just cylinders 2 and 3.

Suspecting a software issue, we updated the PCM software, but this only made the misfire more prominent.

All the serial data was within acceptable limits, so we now suspected the PCM regardless of previous ECM testing results.

An ECU kit from a salvage vehicle was fitted to confirm the issue. The replacement was from a vehicle with an IQDB engine code. The issue was resolved, the LTFT fuel trim settled to 1.3% and the misfire counters settled to zero on all cylinders.

The original engine fault was that cylinders 2 and 3 had low compression, burnt valves and scored cylinders. We suspect the PCM had failed internally, and reverted to a two-bank fuelling strategy. This ran the engine lean on the number 2 and 3 cylinders for some considerable time, and unnoticed, until eventually the compression issue flagged a misfire code and set the engine warning light. Then, after the engine substitution, the misfire was noticeable.