



Engine Management Systems, Part 2

In addition to determining the injector opening time and the ignition timing, the ECU also controls idle speed and other factors.

By Julian Edgar



The most important components that the ECU controls are the injectors. The amount of fuel that flows through the injectors is determined by the length of time that the ECU switches them on for. The time that they are open for is called their pulse width. When they are on, fuel squirts out of them in a fine spray. While it varies from car to car, the injectors in many cars pulse on for a single very short squirt each two rotations of the crankshaft. If more fuel is required, the injectors are switched on for a longer time period. The pulsing on and off of the injectors is the clicking noise that you can hear if you listen really closely to an injected engine.

The percentage of time that the injectors are open for is called the duty cycle. An injector open for half the time has a 50 per cent duty cycle, while if it's open for three-quarters of the available time it has a 75 per cent duty cycle. At max power in a standard engine, the injectors might have an 85 per cent duty cycle. That means the injectors are flowing at 85 per cent of their full capacity. A good quality multimeter can be used to read off the injector duty cycle by back-probing the injector plug when it is connected to the injector.



It's when modifying an engine that the duty cycle and flow capability of the injectors becomes very important. For example, adding an aftermarket blower means that the engine will breathe a lot more air. Because of this, extra fuel will need to be injected if the right air/fuel ratio is to be maintained. But are the injectors big enough to do this? The maximum injector flow occurs when the injectors are held open all of the time. This is the same as saying that when the injector duty cycle is 100 per cent, that's as much fuel as you're going to get (at that fuel pressure). If more fuel is needed than the injectors can flow even with a 100 per cent duty cycle, larger injectors should be fitted.



We'll be covering the modification of factory engine management systems a bit later, but here's an easy example of how to overcome the problem of injectors that are a little too small. If the budget doesn't stretch to larger injectors, an increase in fuel pressure will squeeze slightly more fuel through the standard sized injectors (and standard opening times!). A pressure regulator that performs this function is called a rising rate fuel pressure regulator. It increases fuel pressure by an increasing amount as boost is sensed in the inlet manifold. For example, fuel pressure might go up three times as quickly as manifold pressure. However, increasing fuel pressure isn't as good as fitting larger injectors and then making the required ECU modifications - but it's a lot cheaper!



In most cars, the ECU doesn't directly control the ignition coil. Instead, an ignition module is used to switch the power to the coil on and off. The ECU tells the ignition module exactly when it needs to do this switching so that the spark occurs at just the right time. Some engine management systems are equipped with a single coil and a distributor. The distributor sends the high voltage electricity to the spark plug at the right moment using a rotor spinning around inside the cap. In this type of system, the crankshaft position sensor is usually located inside the dizzy body.



However, most modern cars use a multi-coil arrangement. This can involve a single coil for each spark plug as shown here, or double-ended coils. Direct fire ignition systems like these do not use a distributor because the right coil is fired at the time that the spark is needed. With double ended coils, two of the engine's spark plugs are fired at the same time - one on a cylinder that's on the compression stroke (that does something), and one on the cylinder on an exhaust stroke (which doesn't do much)! The crankshaft position sensor on these engines is usually mounted on the crank itself.



Idle speed control is carried out by changing the amount of air that can bypass the nearly closed throttle butterfly. Some cars used a pulsed valve (a bit like an injector in the way it switches on and off) to regulate the amount of air that can get past the throttle body. If the idle speed needs to be lifted, the duty cycle of the valve is increased and more air squeezes through. Other cars also use an extra valve to control idle speed when the engine is not yet up to operating temperature. The valve gradually closes up as it gets hot. This means that more air can be breathed by the engine when it is cold, keeping the idle speed high. This latter type of valve is heated by coolant and also an electric heater. When the engine is warm, less air passes through the valve and so the idle speed drops. Engines such as the pictured BMW V12 with electronically controlled throttles ("fly by wire") use the throttle stepper motors to regulate throttle blade opening to control idle speed.



There are a host of other things that can be operated by the ECU. The radiator fan is a common item switched on and off by the ECU and in turbo cars, the boost level is often ECU-controlled. The auto transmission control is often integrated into the engine management system also. All engine managed cars control the fuel pump through the ECU and a separate relay. Finally, the Check Engine Light is an important ECU output. Not only does it indicate when there is an engine management problem, but it can also be used to communicate what the problem actually is.

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[Engine Management, Part 3 - The ECU](#)

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