FUEL SYSTEMS – FUEL INJECTION – PART 2

FUEL INJECTION SENSORS - MEASURING ENGINE LOAD

In order for the electronic control module (ECM) to be able to compute the precise amount of fuel to mix with the air in the combustion chamber, the electronic control module must first find out how much air - the volume of air - is entering into the combustion chamber.

The volume of air entering into the combustion chamber must be computed by analyzing the data produced by various electronic sensors.

Any volume of air is affected by atmospheric air pressure, air temperature and air humidity. To begin with, a fuel injection system will typically have a barometric pressure sensor to measure air pressure, and another sensor to measure intake air temperature.

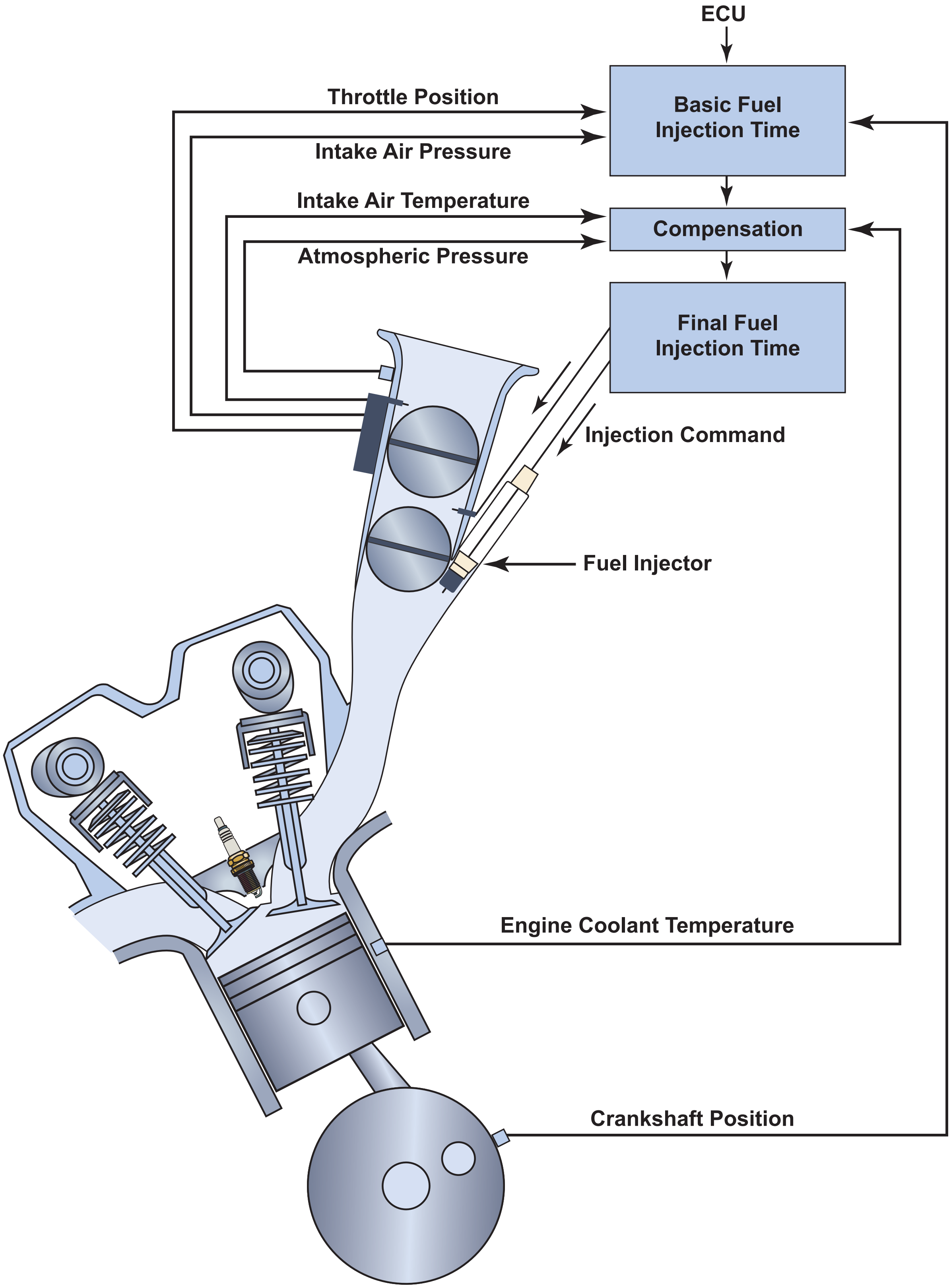
However, fuel injection ECMs use more data than just air pressure and air temperature to compute air volume. For example, is the rider riding fast down an interstate or on a racetrack? If so, the ECM will take that into consideration by analyzing how far the throttle is opened. This is done through the throttle position sensor.

Is the engine running at high rpm? If so, the engine needs a lot of air for the number of combustions needed each minute. Therefore, the ECM will analyze data from a crankshaft sensor that counts how many revolutions of the crankshaft are occurring – the rpm.

The ECM uses input from sensors to select the correct fuel map, and to compute the injector pulse width, which is the amount of time the injector is turned on to allow pressurized fuel to be injected into the intake port. Fuel maps will be discussed later.

The following are a list of common sensors that provide the ECM with information needed to compute the volume of air entering the combustion chamber, and to compute how much fuel will be needed to mix with that volume of air.

Fuel Injection Sensors and ECU Timing Calculation



Throttle Position Sensor (TPS)
Secondary Throttle Position Sensor (STPS)

The throttle position sensor measures engine load by measuring air volume. One method of measuring air volume is by using a potentiometer sensor which measures how fast and how far the throttle butterfly valve is opened in the throttle body. The potentiometer is attached to end of the throttle shaft, (inside the throttle bore), and translates the throttle valve angles into electrical signals measured as voltage that will be sent to the ECM to evaluate.

For example, the throttle angle at engine idle speed might translate to 0.5 volts. The throttle angle at wide open throttle might translate to approximately 5 volts. The more the throttle opens, the more the voltage signal will increase. The more the throttle closes, the more the voltage will decrease. In essence, the throttle position sensor measures engine load.

Throttle angle is also referred to as “alpha” in fuel injection vocabulary. The throttle controls air density, and the air density changes constantly depending on the throttle angle. For example, if the throttle is wide open (WOT), the sensor will tell the ECM that a large quantity of air is moving through the intake port by measuring the wide open throttle angle as a higher voltage value. The ECM will turn the injectors on longer to deliver more fuel to match the large amount of air going into the combustion chamber.

Crankshaft Position Sensor (CKPS) (CKP)
Crankshaft Sensor (CS)

Another factor in measuring engine load, is to find out how hard the engine is working by actually measuring how fast the crankshaft is rotating – the rpm. This is accomplished with a crankshaft position sensor, also called the crankshaft sensor. The crank rotational speed - the rpm of the crankshaft - is sent to the ECM.

In addition to communicating rpm to the ECM, the crank position sensor also communicates where the crankshaft is located in its rotation. It communicates top dead center (TDC) to the ECM. The ECM will use TDC as the reference point for computing when to fire the fuel injectors, just before the intake valve opens on the engine intake stroke.

The crankshaft position sensor utilizes an electromagnetic pickup coil in the crankcase. As the crankshaft rotates, it passes by the pickup coil and generates voltage in the coil. The crankshaft position sensor is typically a Hall effect sensor that senses gaps, or teeth, on the crankshaft or flywheel.

Voltage change is sensed by the ECM. Crankshaft speed is communicated to the ECM by a digital signal. The ECM is then able to calculate rpm, the rate at which the engine is accelerating, and engine position for the purpose of sequential fuel injection.

The faster and harder the crankshaft is turning, the more fuel will be needed. If the bike is accelerating, the increasing rpm information will be relayed by the crankshaft sensor to the ECM, which will increase fuel injector on-time. On the contrary, if the engine is idling slowly at a stoplight at low rpm, a shorter injector pulse width will be selected by the ECM.

The rpm sensor is typically called a crankshaft position sensor (CKPS), or simply a crankshaft sensor (CS). Note that the name and abbreviation for any sensor may vary among manufacturers. Specific terms are listed and defined in the service manual for a particular make and model of motorcycle.

Manifold Absolute Pressure Sensor (MAP)

The MAP sensor measures engine load by measuring engine vacuum. Air pressure begins to build up in the intake manifold, or intake runner, when the throttle is opened. The engine speed accelerates, and the pistons pull more and more air through the manifold on the intake stroke.

The intake manifold, or short intake runner section where MAP is measured, is located between the throttle valve and the intake port. The