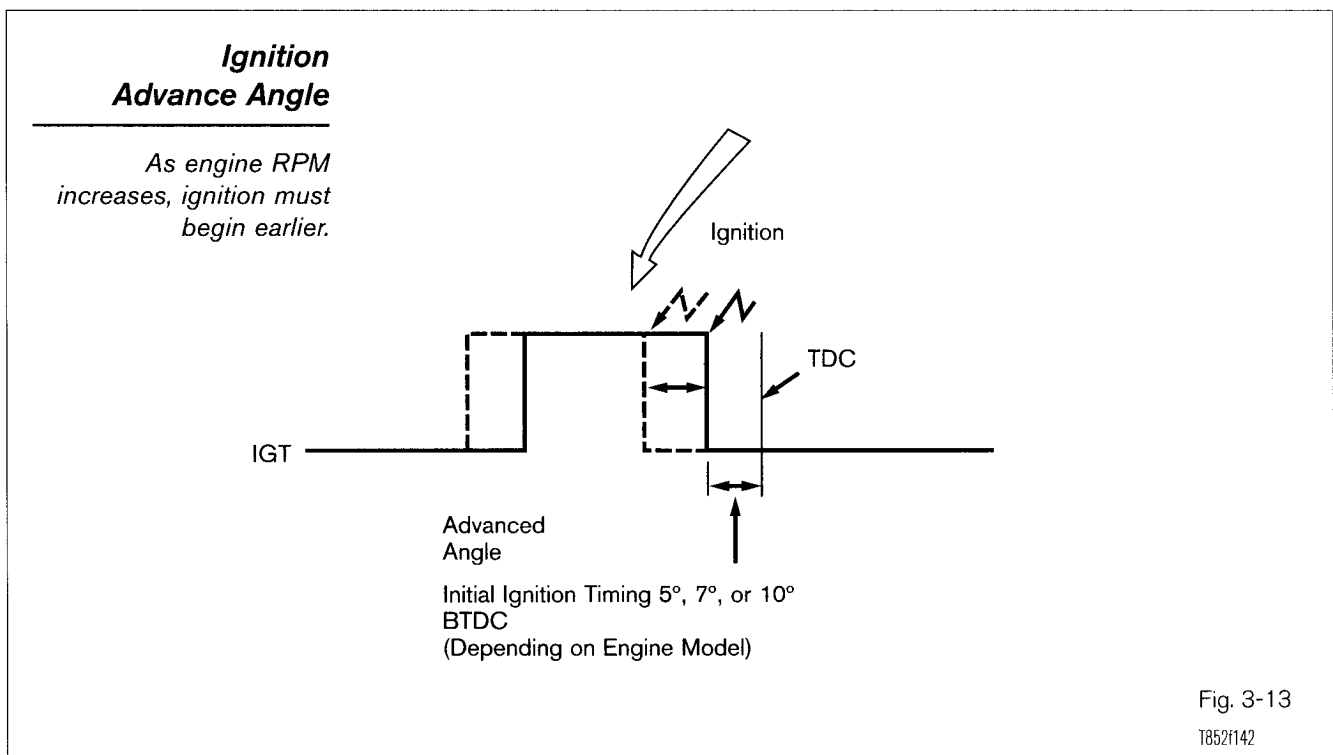


NE Signal and G Signal

Though there are different types of ignition systems, the use of the NE and G signals is consistent. The NE signal indicates crankshaft position and engine RPM.

The G signal (also called VVT signal) provides cylinder identification. By comparing the G signal to the NE signal, the ECM is able to identify the cylinder on compression. This is necessary to calculate crankshaft angle (initial ignition timing angle), identify which coil to trigger on Direct Ignition System (independent ignition), and which injector to energize on sequential fuel injection systems.

As ignition systems and engines evolved, there have been modifications to the NE and G signal. Timing rotors have different numbers of teeth. For some G signal sensors, a notch is used instead of a tooth to generate a signal. Regardless, you can determine what style is used by visually examining the timing rotor or consulting the Repair Manual. Many of the different styles are represented with their respective ignition system.



Electronic Spark Advance Operation

For maximum engine output efficiency, the air/fuel mixture must be ignited so that maximum combustion pressure occurs approximately 10'-15' after TDC. As engine RPM increases, there is less time for the mixture to complete its combustion at the proper time because the piston is traveling faster. The ECM controls when the spark occurs through the IGT signal. By varying the time the IGT signal is turned off, the ECM changes ignition spark timing.

Ignition Advance Modes and Corrections

The ECM calculates the IGT signal on time based on engine operating modes and conditions. The IGT signal is based primarily on the crankshaft position sensor signal, engine load, temperature, knock sensor, etc.

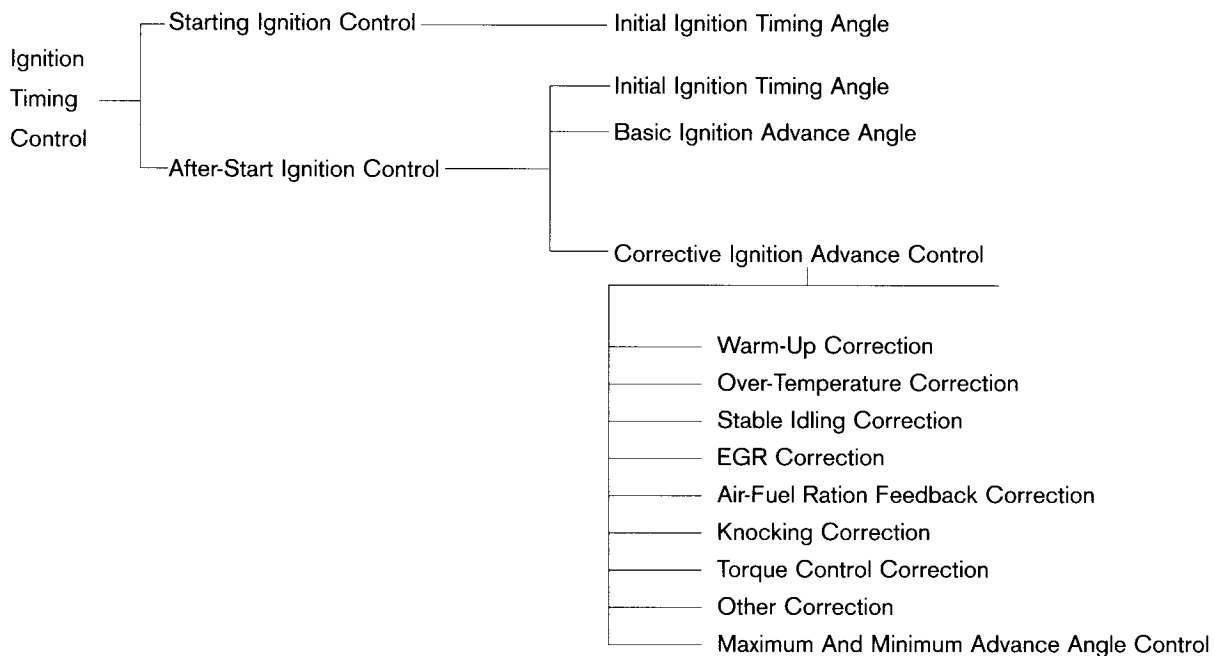


Fig. 3-14

Starting Ignition Control

Ignition timing control consists of two basic elements:

- ignition control during starting.
- after start ignition control.

Ignition Control During Starting

Ignition control during starting is defined as the period when the engine is cranking and immediately following cranking. The ignition occurs at a fixed crankshaft angle, approximately 5'- 10' BTDC, regardless of engine operating conditions and this is called the initial timing angle.

Since engine speed is still below a specified RPM and unstable during and immediately after starting, the ignition timing is fixed until engine operation is stabilized.

The ECM recognizes the engine is being cranked when it receives the NE and G signal. On some models, the starter (STA) signal is also used to inform the engine is being cranked.

Initial Ignition Timing Angle

This angle is calculated from the first NE signal that follows a G signal. The ignition occurs at a fixed crankshaft angle, approximately 5°-10° BTDC, regardless of engine operating conditions, and this is called the initial timing angle.

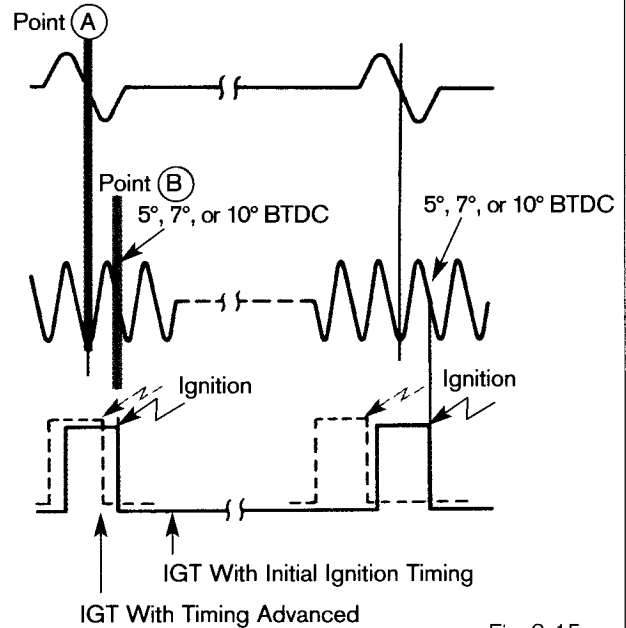
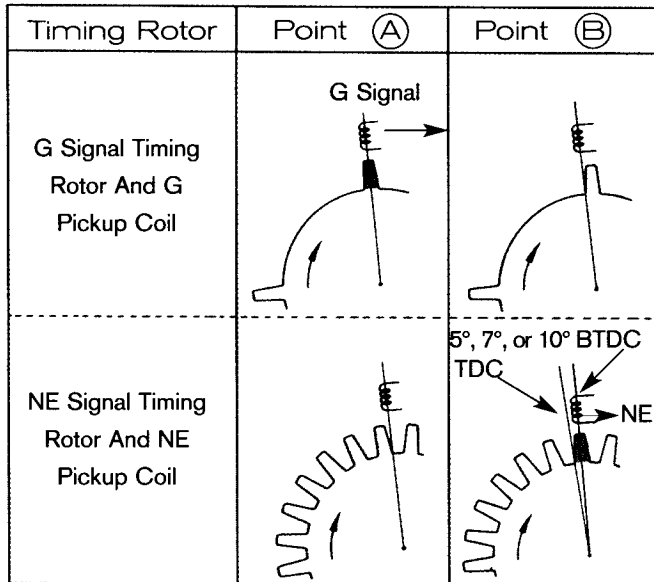


Fig. 3-15
T8521143/T8521144

Initial Ignition Timing Angle Symbol

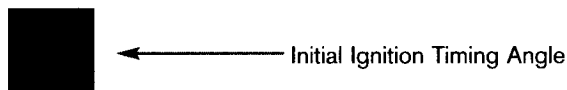


Fig. 3-16
T8521145

After-Start Ignition Control

After-start ignition control will calculate and adjust ignition timing based on engine operating conditions. The calculation and adjustment of ignition timing is performed in a series of steps, beginning with basic ignition advance control.

Various corrections are added to the initial ignition timing angle and the basic ignition advance angle during normal operation.

After-start ignition control is carried out during normal operation.

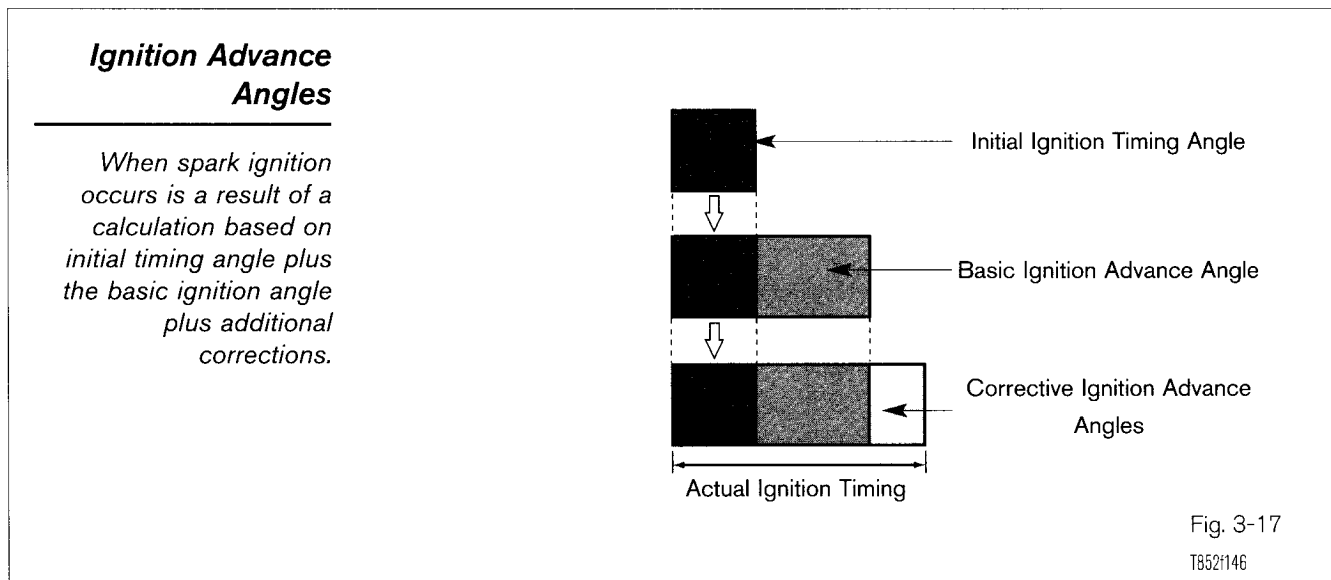
IGNITION #2 - ELECTRONIC SPARK ADVANCE

The various corrections (that are based on signals from the relevant sensors) are added to the initial ignition timing angle and to the basic ignition advance angle (determined by the intake air volume signal or intake manifold pressure signal) and by the engine speed signal:

Ignition timing = initial ignition timing angle

- basic ignition advance angle
- corrective ignition advance angle

During normal operation of after-start ignition control, the Ignition Timing (IGT) signal calculated by the microprocessor in the ECM and is output through the back-up IC.



Basic Ignition Advance Control

The ECM selects the basic ignition advance angle from memory based on engine speed, load, throttle valve position, and engine coolant temperature.

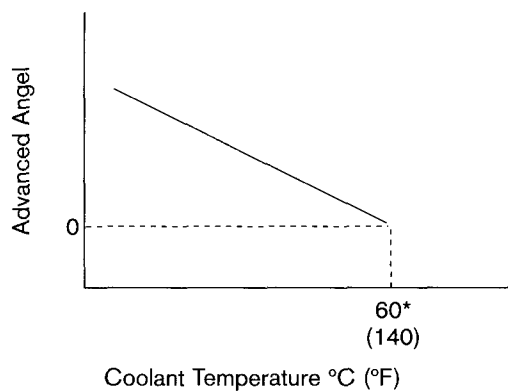
Relevant Signals:

- Intake air volume (VS, KS, or VG) (Intake manifold pressure (PIM)).
- Engine speed (NE).
- Throttle position (IDL).
- Engine Coolant Temperature (THW).

Corrective Ignition Advance Control

The Corrective Ignition Advance Control makes the final adjustment to the actual ignition timing. The following corrective factors are not found on all vehicles.

Warm Up Correction



*Depending on the Engine Model.

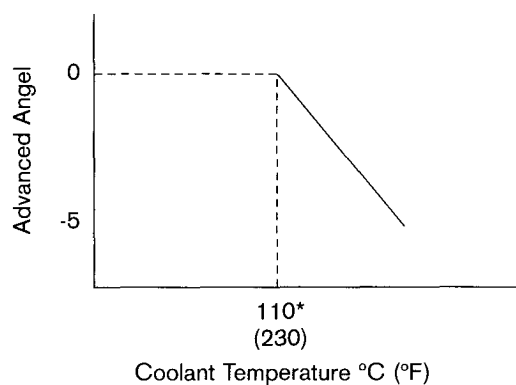
Fig. 3-18

T852f147

Warm-Up Correction

The ignition timing is advanced to improve driveability when the coolant temperature is low. In some engine models, this correction changes the advance angle in accordance with the intake air volume (intake manifold pressure) and can advance approximately 15° (varies with engine model) by this correction during extremely cold weather.

Over Temperature



*Depending on the Engine Model.

Fig. 3-19

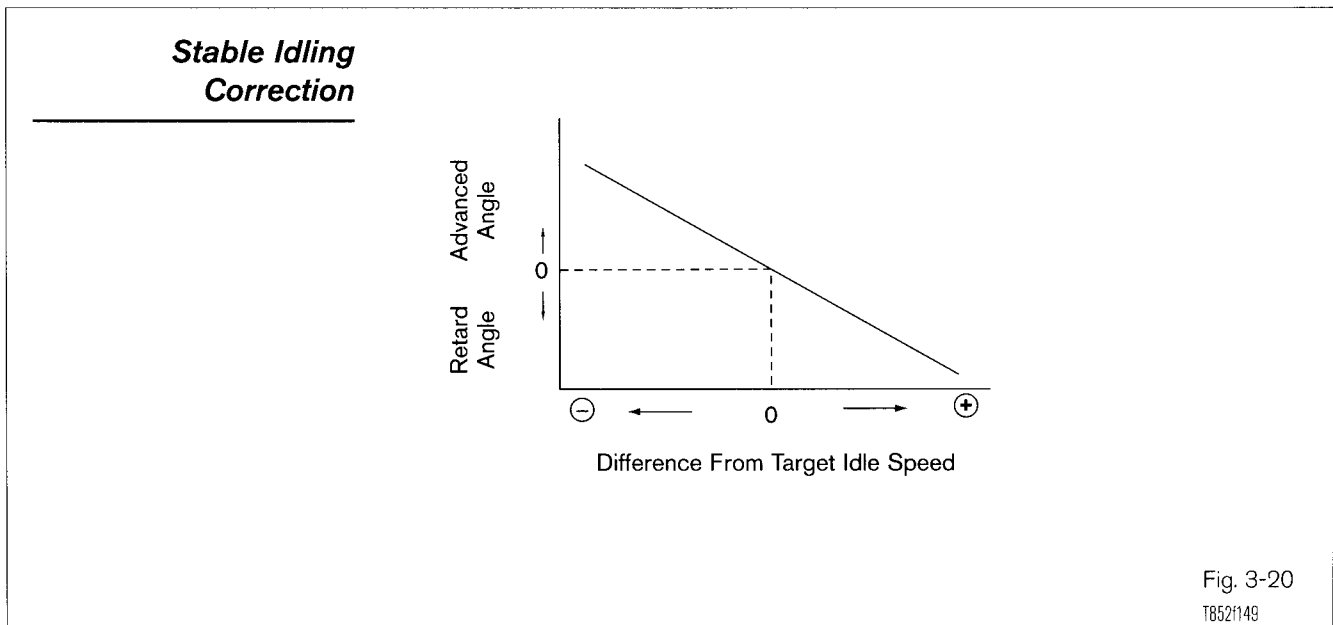
T852f148

Over Temperature Correction

To prevent knocking and overheating, the ignition timing is retarded when the coolant temperature is extremely high. The timing may be retarded approximately 5° by this correction.

Relevant Signals:

- ECT - THW.
- The following may also be used on some engine models.
- MAF (VS, KS, or VG).
- Engine Speed - NE signal.
- Throttle position TA or (IDL).



Stable Idling Correction

When the engine speed during idling has fluctuated from the target idle speed, the ECM adjusts the ignition timing to stabilize the engine speed. The ECM is constantly calculating the average engine speed. If the engine speed falls below the target speed, the ECM advances the ignition timing by a predetermined angle. If the engine speed rises above the target speed, the ECM retards the ignition timing by a predetermined angle.

This correction is not executed when the engine exceeds a predetermined speed.

In some engine models, the advance angle changes depending on whether the air conditioner is on or off. In other engine models, this correction only operates when the engine speed is below the target engine speed.

Relevant Signals:

- Engine Speed (NE)
- TPS (VTA or IDL)
- Vehicle Speed (SPD)

EGR Correction

When EGR is operating, the ignition timing is advanced according to intake air volume and engine RPM to improve driveability. EGR has the effect of reducing engine knocking, therefore the timing can be advanced.

Relevant Signals:

- Engine Speed (NE)
- TPS (VTA or IDL or PSW)
- Intake air volume (VS, KS, or VG) (Intake manifold pressure (PIM))

Torque Control Correction

This correction reduces shift shock and the result is that the driver feels smoother shifts. With an electronically-controlled transaxle, each clutch and brake in the planetary gear unit of the transmission or transaxle generates shock to some extent during shifting. In some models, this shock is minimized by delaying the ignition timing when gears are upshifted. When gear shifting starts, the ECM retards the engine ignition timing to reduce the engine torque. As a result, the shock of engagement and strain on the clutches and brakes of the planetary gear unit is reduced and the gear shift change is performed smoothly. The ignition timing angle is retarded a maximum of approximately 200 by this correction. This correction is not performed when the coolant temperature or battery voltage is below a predetermined level.

Relevant Signals:

- Engine Speed (NE)
- TPS (VTA or IDL or PSW)
- ECT (THW)
- Battery voltage (+B)

Knock

When the spark plug ignites the air/fuel mixture, cylinder pressure increases. If the increase in heat and pressure is high enough, the air/fuel mixture will ignite at a location other than the spark plug. This is referred to as spontaneous combustion and produces engine knock.

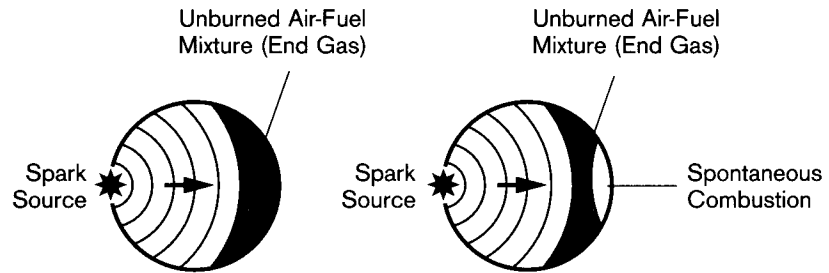


Fig. 3-21
T8521150

Knock Correction

Engine knock, if severe enough, can cause engine damage. Combustion chamber design, gasoline octane, air/fuel ratio, and ignition timing all affect when knock will occur. Under most engine conditions, ignition timing needs to be near the point when knock occurs to achieve the best fuel economy, engine power output, and lowest exhaust emissions. However, the point when knock occurs will vary from a variety of factors. For example, if the gasoline octane is too low, and ignition takes place at the optimum point, knock will occur. To prevent this, a knock correction function is used.

Engine Knock Control Loop

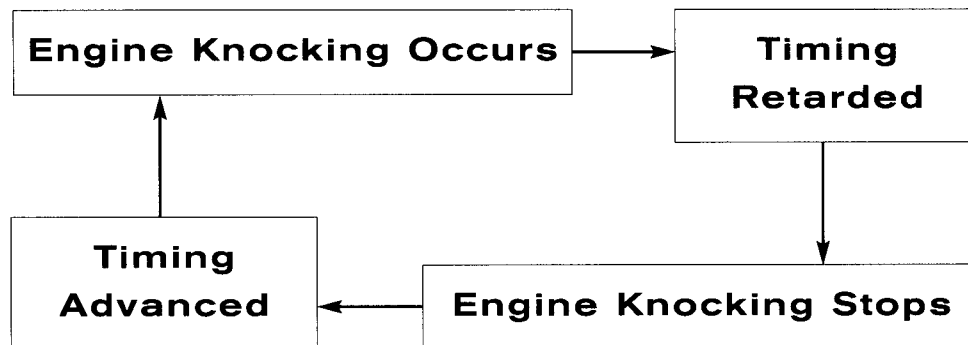


Fig. 3-22

Engine Knock Control

The ECM retards the timing in fixed steps until the knock disappears. When the knocking stops, the ECM stops retarding the ignition timing and begins to advance the timing in fixed steps.

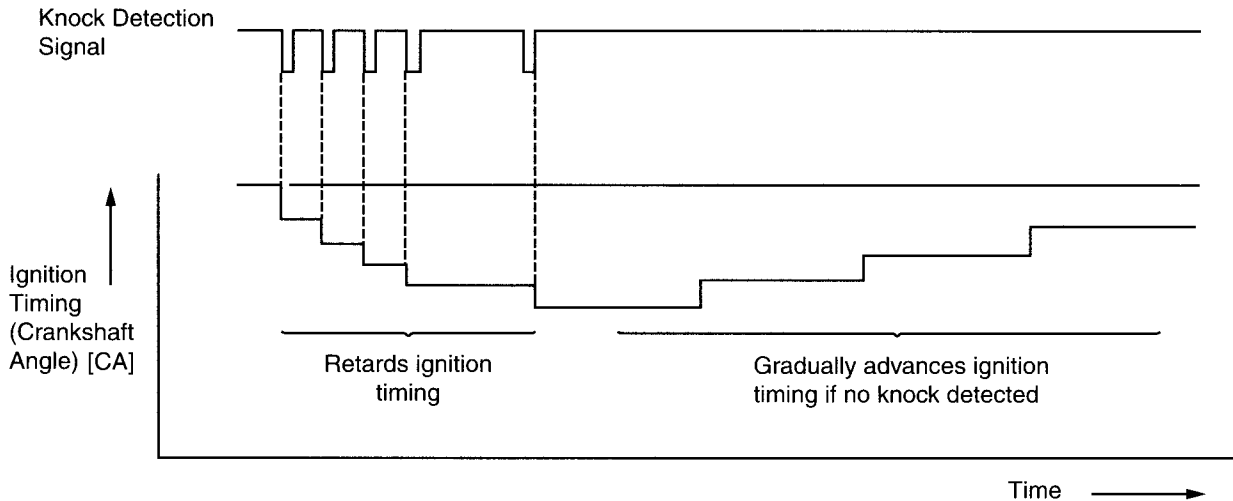


Fig. 3-23
T852f151

When engine knocking occurs, the knock sensor converts the vibration from the knocking into a voltage signal that is detected by the ECM. According to its programming, the ECM retards the timing in fixed steps until the knock disappears. When the knocking stops, the ECM stops retarding the ignition timing and begins to advance the timing in fixed steps. If the ignition timing continues to advance and knocking occurs, ignition timing is again retarded.

Knock Signal Identification

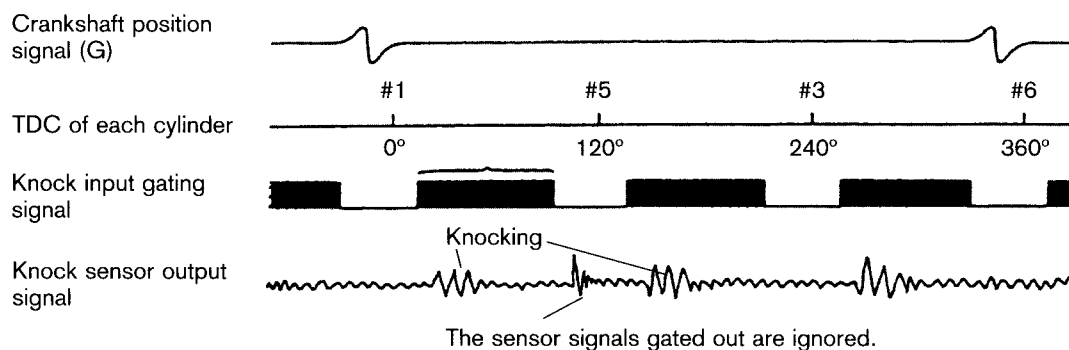


Fig. 3-24
T852f152

IGNITION #2 - ELECTRONIC SPARK ADVANCE

The ECM is able to determine which cylinder is knocking by when the knock signal is received. The ECM knows the cylinder that is in the power stroke mode based on the NE and G signals. This allows the ECM to filter any false signals.

Some mechanical problems can duplicate engine knocking. An excessively worn connecting rod bearing or a large cylinder ridge will produce a vibration at the same frequency as engine knocking. The ECM in turn will retard the timing.

Air/Fuel Ratio Correction

The engine is especially sensitive to changes in the air - fuel ratio when it is idling, so stable idling is ensured by advancing the ignition timing at this time in order to match the fuel injection volume of air - fuel ratio feedback correction.

This correction is not executed while the vehicle is being driven.

Relevant Signals:

- Oxygen or A/F sensor.
- TPS (VTA or IDL).
- Vehicle Speed (SPD).

Other Corrections

Engines have been developed with the following corrections added to the ESA system (in addition to the various corrections explained so far), in order to adjust the ignition timing with extremely fine precision.

Transition Correction - During the transition (change) from deceleration to acceleration, the ignition timing is either advanced or retarded temporarily in accordance with the acceleration.

Cruise Control Correction - When driving downhill under cruise control, in order to provide smooth cruise control operation and minimize changes in engine torque caused by fuel cut-off because of engine braking, a signal is sent from the Cruise Control ECU to the ECM to retard the ignition timing.

Traction Control Correction - This retards the ignition timing, thus lowering the torque output by the engine, when the coolant temperature is above a predetermined temperature and the traction control system is operating.

IGNITION #2 - ELECTRONIC SPARK ADVANCE

Acoustic Control Induction System (ACIS) Correction - When the engine speed rises above a predetermined level, the ACIS operates. At that time, the ECM advances the ignition timing simultaneously, thus improving output.

Maximum and Minimum Ignition Advance Control

If the actual ignition timing (basic ignition advance angle + corrective ignition advance or retard angle) becomes abnormal, the engine will be adversely affected. To prevent this, the ECM controls the actual advance so that the sum of the basic ignition and corrective angle cannot be greater or less than preprogrammed minimum or maximum values.

Approximately, these values are:

- MAX. ADVANCE ANGLE: 35'-45'
- MIN. ADVANCE ANGLE: 100-00.

Advance angle = Basic ignition advance angle + Corrective ignition advance angle

IGNITION #2 - ELECTRONIC SPARK ADVANCE

ASSIGNMENT

NAME: _____

1. Explain in detail the Electronic Spark Advance Operation:
2. Describe the three Ignition Advance Angles:
3. List the four Relevant Signals of the Basic Ignition Advance Control:
4. Explain "Warm-Up" correction:
5. Explain "Over Temperature" correction and list the relevant input signals used:
6. Explain "EGR" correction and list the relevant input signals used:
7. Explain "Stable Idling" correction and list the relevant input signals used:
8. Explain "Knock" correction and list the relevant input signals used:
9. Explain in detail how the PCM (Engine Computer) uses the Knock Sensor to control timing.
10. Explain "Cruise Control" correction: