Engine Control System Diagram

- **Ignition**
- **Fuel Pump**
- **Fuel Pump Resistor**
- **Ignition Fuel Pump**
- **Resistor**
- **Vapor Pressure Sensor**
- **VSV (for EVAP)**
- **VSV (for Pressure Switching Valve)**
- **VSV (for Canister Closed Valve)**
- **Accelerator pedal position sensor**
- **Intake Air Temp. Sensor**
- **Mass Air Flow Meter**
- **Throttle Position Sensor**
- **Accelerator pedal position sensor**
- **Throttle Control Motor**
- **VSV for Air Conditioning**
- **VSV for ACIS**
- **Camshaft Timing Oil Control Valve**
- **Camshaft Position Sensor**
- **Knock Sensor**
- **Crankshaft Position Sensor**
- **ECM**
- **Battery**
- **MIL**
- **DLC3**
- **Starter**
- **Vehicle Speed Sensor (for Transmission)**
- **Park/Neutral Position Switch**
- **Electronic Controlled Transmission Solenoid Valves**

*1: Engine Coolant Temp. Sensor
*2: Heated Oxygen Sensor
4. Layout of Main Components

- Ignition Coil with Igniter
- VSV (for EVAP)
- Throttle Control Motor
- VVT Sensor (Bank 2)
- Mass Air Flow Meter
- VSV (for Canister Closed Valve)
- Knock Sensor (Bank 2)
- Injector
- Heated Oxygen Sensor (Bank 1, Sensor 2)
- Fuel Pump
- VSV (for Pressure Switching Valve)
- Vaper Pressure Sensor
- DLC 3
- Neutral Start Switch
- Knock Sensor (Bank 1)
- Accelerator Pedal Position Sensor
- Heated Oxygen Sensor (Bank 1, Sensor 1)
- VSV for ACIS
- Knock Sensor (Bank 1)
- Heated Oxygen Sensor (Bank 2, Sensor 1)
- Camshaft Timing Oil Control Valve (Bank 2)
- Engine Coolant Temp. Sensor
- Throttle Position Sensor
- Camshaft Position Sensor
- Camshaft Position Sensor
- ECM
- Camshaft Timing Oil Control Valve (Bank 1)
75. Main Components of Engine Control System

General

The following table compares the main components of the 3UZ-FE engine in the ’01 LS430 and 1UZ-FE engine in the ’00 LS400.

<table>
<thead>
<tr>
<th>Engine Type</th>
<th>3UZ-FE</th>
<th>1UZ-FE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Components</td>
<td>Outline</td>
<td>Quantity</td>
</tr>
<tr>
<td>Mass Air Flow Meter</td>
<td>Hot-Wire Type</td>
<td>1</td>
</tr>
<tr>
<td>Crankshaft Position Sensor (Rotor Teeth)</td>
<td>Pick-Up Coil Type (36-2)</td>
<td>1</td>
</tr>
<tr>
<td>Camshaft Position Sensor (Rotor Teeth)</td>
<td>Pick-Up Coil Type (1)</td>
<td>1</td>
</tr>
<tr>
<td>VVT Sensor</td>
<td>Pick-Up Coil Type (3)</td>
<td>2</td>
</tr>
<tr>
<td>Throttle Position Sensor</td>
<td>Linear Type</td>
<td>2</td>
</tr>
<tr>
<td>Accelerator Pedal Position Sensor</td>
<td>Linear Type</td>
<td>2</td>
</tr>
<tr>
<td>Knock Sensor</td>
<td>Built-In Piezoelectric Type</td>
<td>2</td>
</tr>
<tr>
<td>Oxygen Sensor (Bank 1, Sensor 1)</td>
<td>With Heater Type</td>
<td>4</td>
</tr>
<tr>
<td>Oxygen Sensor (Bank 2, Sensor 1)</td>
<td>←</td>
<td></td>
</tr>
<tr>
<td>Oxygen Sensor (Bank 1, Sensor 2)</td>
<td>←</td>
<td></td>
</tr>
<tr>
<td>Oxygen Sensor (Bank 2, Sensor 2)</td>
<td>←</td>
<td></td>
</tr>
<tr>
<td>Injector</td>
<td>4-Hole Type with Air Assist</td>
<td>8</td>
</tr>
</tbody>
</table>

Mass Air Flow Meter

A hot-wire type mass air flow meter has been adopted. This mass air flow meter, which is a plug-in type, allows a portion of the intake air to flow through the detection area. By directly measuring the mass and the flow rate of the intake air, the detection precision has been improved and the intake air resistance has been reduced.
**Crankshaft Position Sensor**

The timing rotor of the crankshaft consists of 34 teeth, with 2 teeth missing. The crankshaft position sensor outputs the crankshaft rotation signals every 10°, and the missing teeth are used to determine the top-dead-center.

**Camshaft Position Sensor**

The camshaft position sensor is mounted on the left bank cylinder head. To detect the camshaft position, a protrusion that is provided on the timing pulley is used to generate 1 pulse for every 2 revolutions of the crankshaft.

**VVT Sensor**

A VVT sensor is mounted on the intake side of each cylinder head. To detect the camshaft position, a timing rotor that is provided on the intake camshaft is used to generate 3 pulses for every 2 revolutions of the crankshaft.
7-6. VVT-i (Variable Valve Timing-intelligent) System

General

The VVT-i system is designed to control the intake camshaft within a wide range of 45° (of crankshaft angle) to provide a valve timing that is optimally suited to the engine condition, thus realizing improved torque in all the speed ranges and fuel economy, and reduce exhaust emissions.
Construction and Operation

1) VVT-i Controller

The VVT-i controller comprises the outer gear that is driven by the timing belt, the inner gear that is affixed to the camshaft and a movable piston that is placed between the outer gear and inner gear. Having helical splines (twisted, vertical grooves) on its inner and outer periphery, the piston moves in the axial direction to shift the phase of the outer gear and inner gear, thus causing the valve timing to change continuously.

The VVT tube drives the exhaust camshaft via the scissors gear that is installed on the back.

2) Camshaft Timing Oil Control Valve

The camshaft timing oil control valve controls the spool valve position in accordance with the duty control from the ECM thus allocating the hydraulic pressure that is applied to the VVT-i controller to the advance and the retard side. When the engine is stopped, the camshaft timing oil control valve is in the most retarded state.
Operation

- The camshaft timing oil control valve selects the path to the VVT-i controller according to the advance, retard or hold signal from the ECM. The VVT-i controller rotates the intake camshaft in the timing advance or retard position or holds it according to the position where the oil pressure is applied.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Camshaft Timing Oil Control Valve Drive Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advance</td>
<td>Advance Signal</td>
<td>When the camshaft timing oil control valve is positioned as illustrated in accordance with the advance signal from the ECM, the oil pressure is applied to the chamber at the advance side. Then, the twist of the helical spline causes the camshaft to rotate in the direction of timing advance.</td>
</tr>
<tr>
<td></td>
<td>Duty Ratio</td>
<td></td>
</tr>
<tr>
<td>Retard</td>
<td>Retard Signal</td>
<td>When the camshaft timing oil control valve is positioned as illustrated in accordance with the retard signal from the ECM, the oil pressure is applied to the chamber at the retard side. Then, the twist of the helical spline causes the camshaft to rotate in the direction of timing retard.</td>
</tr>
<tr>
<td></td>
<td>Duty Ratio</td>
<td></td>
</tr>
<tr>
<td>Hold</td>
<td>Hold Signal</td>
<td>The ECM calculates the target timing angle according to the traveling state to perform control as described above. After setting at the target timing, the valve timing is held by keeping the camshaft timing oil control valve in the neutral position unless the traveling state changes. This adjusts the valve timing at the desired target position and prevents the engine oil from running out when it is unnecessary.</td>
</tr>
<tr>
<td></td>
<td>Duty Ratio</td>
<td></td>
</tr>
</tbody>
</table>

188EG48 157EG35
188EG49 157EG36
188EG50 157EG37
In proportion to the engine speed, intake air volume, throttle position and water temperature, the ECM calculates an optimal valve timing under each driving condition and control the camshaft timing oil control valve. In addition, ECM uses signal from the VVT sensors and the crankshaft position sensor to detect the actual valve timing, thus performing feed back control to achieve the target valve timing.

**Operation During Various Driving Condition (Conceptual Diagram)**

<table>
<thead>
<tr>
<th>Operation State</th>
<th>Range</th>
<th>Valve Timing</th>
<th>Objective</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>During Idling</td>
<td>1</td>
<td>EX</td>
<td>Eliminating overlap to reduce blow back to the intake side</td>
<td>Stabilized idling rpm Better fuel economy</td>
</tr>
<tr>
<td>At Light Load</td>
<td>2</td>
<td>EX</td>
<td>Decreasing overlap to eliminate blow back to the intake side</td>
<td>Ensured engine stability</td>
</tr>
<tr>
<td>At Medium load</td>
<td>3</td>
<td>EX</td>
<td>Increasing overlap to increase internal EGR for pumping loss elimination</td>
<td>Better fuel economy Improved emission control</td>
</tr>
<tr>
<td>Operation State</td>
<td>Range</td>
<td>Valve Timing</td>
<td>Objective</td>
<td>Effect</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-------</td>
<td>--------------</td>
<td>-----------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>In Low to Medium Speed</td>
<td>4</td>
<td>EX IN</td>
<td>Advancing the intake valve close timing for volumetric efficiency improvement</td>
<td>Improved torque in low to medium speed range</td>
</tr>
<tr>
<td>Range with Heavy Load</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In High Speed Range with</td>
<td>5</td>
<td>EX IN</td>
<td>Retarding the intake valve close timing for volumetric efficiency improvement</td>
<td>Improved output</td>
</tr>
<tr>
<td>Heavy Load</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At Low Temperatures</td>
<td>—</td>
<td>EX IN</td>
<td>Eliminating overlap to prevent blow back to the intake side leads to the lean burning condition, and stabilizes the idling speed at fast idling.</td>
<td>Stabilized fast idle rpm Better fuel economy</td>
</tr>
<tr>
<td>Upon Starting/Stopping the</td>
<td>—</td>
<td>EX IN</td>
<td>Eliminating overlap to minimize blow back to the intake side</td>
<td>Improved startability</td>
</tr>
<tr>
<td>Engine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
7. ETCS-i (Electronic Throttle Control System-intelligent)

General

- The ETCS-i system, which realizes excellent throttle control in all the operating ranges, has been adopted. However, in the new 3UZ-FE engine, the accelerator cable has been discontinued, and an accelerator position sensor has been provided on the accelerator pedal. Accordingly, the limp-mode control during the fail-safe mode has been changed.

- In the conventional throttle body, the throttle valve opening is determined invariably by the amount of the accelerator pedal effort. In contrast, the ETCS-i uses the ECM to calculate the optimal throttle valve opening that is appropriate for the respective driving condition and uses a throttle control motor to control the opening.

- The ETCS-i controls the ISC (Idle Speed Control) system, the snow mode control system, the cruise control system, the TRAC (Traction Control) system, and the VSC (Vehicle Skid Control) system. In addition to these controls, a function to control the adaptive laser cruise control has been added to the model with the adaptive laser cruise control.

- The torque-activated power train control has been newly adopted. This control enables the engine to generate the necessary torque as desired by the driver, as well as to realize a smooth engine output characteristic.

*: with Adaptive Laser Cruise Control
1) Accelerator Pedal Position Sensor

The accelerator pedal position sensor is attached to the accelerator pedal. This sensor converts the accelerator pedal depressed angles into electric signals with two differing characteristics and outputs them to the ECM. One is the VPA signal that linearly outputs the voltage along the entire range of the accelerator pedal depressed angle. The other is the VPA2 signal that outputs an offset voltage.
2) Throttle Position Sensor

The throttle position sensor is attached to the throttle body. This sensor converts the throttle valve opening angles into electric signals with two differing characteristics and outputs them to the ECM. One is the VTA signal that linearly outputs the voltage along the entire range of the throttle valve opening angle. The other is the VTA2 signal that outputs an offset voltage.

3) Throttle Control Motor

A DC motor with excellent response and minimal power consumption is used for the throttle control motor. The ECM performs the duty ratio control of the direction and the amperage of the current that flows to the throttle control motor in order to regulate the opening angle of the throttle valve.
The ECM drives the throttle control motor by determining the target throttle valve opening in accordance with the respective operating condition.

In addition to the controls listed below, functions to effect torque-activated power train control and radar cruise control (on models with adaptive laser cruise control) have been added.

1) Torque Activated Power Train Control ← New Control
2) Nomal-mode Control, Power–mode control and Snow-mode Control
3) Idle Speed Control
4) Shift Shock Reduction Control
5) TRAC Throttle Control
6) VSC Coordination Control
7) Cruise Control
8) Adaptive Laser Cruise Control ← New Control

1) **Torque Activated Power Train Control**

Controls the throttle to an optimal throttle valve opening that is appropriate for the driving condition such as the amount of the accelerator pedal effort and the engine operating condition. As a result, excellent throttle control and comfort in all operating ranges, as well as smooth startoff acceleration and elastic acceleration have been achieved.
2) Normal-mode Control, Power-mode control and Snow-mode Control

- Controls the throttle to an optimal throttle valve opening that is appropriate for the driving condition such as the amount of the accelerator pedal effort and the engine operating condition in order to realize excellent throttle control and comfort in all operating ranges.

- If turning ON the POWER switch of the pattern select switch and selecting the power-mode, the throttle valve opening angle is controlled to react more directly to operation of the accelerator pedal than the normal mode. With this, sporty driving is realized.

- In situations in which low-μ surface conditions can be anticipated, such as when driving in the snow, the throttle valve can be controlled to help vehicle stability while driving over the slippery surface. This is accomplished by turning on the SNOW switch of the pattern select switch, which, in response to the amount of the accelerator pedal effort that is applied, reduces the engine output from that of the normal driving level.

![Conceptual Diagram](image)

3) Idle Speed Control

Controls the ECM and the throttle valve in order to constantly effect ideal idle speed control.

4) Shift Shock Reduction Control

The throttle control is synchronized to the ECT (Electronically Controlled Transmission) control during the shifting of the transmission in order to reduce the shift shock.

5) TRAC Throttle Control

As part of the TRAC system, the throttle valve is closed by a demand signal from the skid control ECU if an excessive amount of slippage is created at a driving wheel, thus facilitating the vehicle in ensuring stability and driving force.

6) VSC Coordination Control

In order to bring the effectiveness of the VSC system control into full play, the throttle valve opening angle is controlled by effecting a coordination control with the skid control ECU.

7) Cruise Control

An ECM with an integrated cruise control ECU directly actuates the throttle valve to effect the operation of the cruise control.
84  8) Adaptive Laser Cruise Control

In addition to the functions provided by the conventional cruise control, the adaptive laser cruise control uses a laser radar sensor and a distance control ECU to determine the distance of the vehicle driven ahead, its direction, and relative speed. Thus, the system can effect deceleration cruising control, follow-up cruising control, cruising at a fixed speed control, and acceleration cruising control. To make these controls possible, the ECM controls the throttle valve.

**Fail-Safe**

If an abnormal condition occurs with the ETCS-i system, the malfunction indicator lamp in the combination meter illuminates to inform the driver. The accelerator pedal position sensor comprises two sensor circuits. Therefore, if an abnormal condition occurs in the accelerator pedal position sensor, and the ECM detects the abnormal voltage difference of the signals between these two sensor circuits, the ECM transfers to the limp mode by limiting the accelerator opening signal.

If an abnormal condition occurs in the throttle body system which comprises two sensor circuits, the ECM detects the abnormal voltage difference of the signals between these two circuits and cuts off the current to the throttle motor, causing the throttle valve to close. However, when the throttle motor is OFF, because a return spring is provided in the throttle valve, the force of the spring keeps the throttle valve slightly open from the fully closed state. In this state, fuel injection control and ignition timing retard control are effected in accordance with the accelerator opening, thus enabling the vehicle to be operated within the range of idling and limp mode.

**Diagnosis**

The diagnostic trouble codes can be output to a LEXUS hand-held tester via the DLC 3. For details, refer to the 2001 LEXUS LS430 Repair Manual (Pub. No. RM812U).
8. ACIS (Acoustic Control Induction System)

General

The ACIS (Acoustic Control Induction System) is realized by using a bulkhead to divide the intake manifold into 2 stages, with an intake air control valve in the bulkhead being opened and closed to vary the effective length of the intake manifold in accordance with the engine speed and throttle valve opening angle. This increases the power output in all ranges from low to high speed.

▶ System Diagram ◀
86 Construction

1) Intake Air Control Valve

The intake air control valve, which is provided in the middle of the intake manifold in the intake air chamber, opens and closes to change the effective length of the intake manifold in two stages.

2) VSV (Vacuum Switching Valve)

Controls the vacuum that is applied to the actuator by way of the signal (ACIS) that is output by the ECM.

3) Vacuum Tank

Equipped with an internal check valve, the vacuum tank stores the vacuum that is applied to the actuator in order to maintain the intake air control valve fully closed even during low-vacuum conditions.
1) When the Intake Control Valve Closes (VSV ON)

The ECM activates the VSV to match the longer pulsation cycle so that the negative pressure acts on the diaphragm chamber of the actuator. This closes the control valve. As a result, the effective length of the intake manifold is lengthened and the intake efficiency in the low-to-medium speed range is improved due to the dynamic effect of the intake air, thereby increasing the power output.

![Diagram showing effective intake manifold length and throttle valve opening angle.]

2) When the Intake Control Valve Open (VSV OFF)

The ECM deactivates the VSV to match the shorter pulsation cycle so that atmospheric air is led into the diaphragm chamber of the actuator and opens the control valve. When the control valve is open, the effective length of the intake air chamber is shortened and peak intake efficiency is shifted to the high engine speed range, thus providing greater output at high engine speeds.
9. Cooling Fan System

General

A cooling fan system has been adopted by the 3UZ-FE engine on the '01 LS430. To achieve an optimal fan speed in accordance with the engine coolant temperature, vehicle speed, engine speed, and air conditioning operating conditions, the ECM calculates the proper fan speed and sends the signals to the cooling fan ECU. Upon receiving the signals from the ECM, the cooling fan ECU actuates the fan motors. Also, the fan speed is controlled by ECM using the stepless control.

► Wiring Diagram ◄
90. Operation

As illustrated below, the ECM determines the required fan speed by selecting the fastest fan speed from among the following:
(A) The fan speed required by the engine coolant temperature, (B) the fan speed required by the air conditioning refrigerant pressure, (C) the fan speed required by the engine speed, and (D) the fan speed required by the vehicle speed.

10. Fuel Pump Control

A fuel cut control is adopted to stop the fuel pump when the airbag is deployed at the front or side collision. In this system, the airbag deployment signal from the airbag sensor assembly is detected by the ECM, which turns OFF the circuit opening relay. After the fuel cut control has been activated, turning the ignition switch from OFF to ON cancels the fuel cut control, thus engine can be restarted.