1992 ENGINE PERFORMANCE
Infiniti Theory & Operation

G20, M30, Q45

INTRODUCTION

This article covers basic description and operation of engine performance-related systems and components. Read this article before diagnosing vehicles or systems with which you are not completely familiar.

COMPUTERIZED ENGINE CONTROLS

The Electronic Concentrated Engine Control System (ECCS) is a computerized emission, ignition and fuel control system. An Electronic Control Unit (ECU) accepts input voltage signals from a variety of input components. ECU compares each voltage input signal to a parameter which is preprogrammed into ECU. It instantly analyzes each of the input voltage values and adjusts output voltage signals accordingly. This allows optimum vehicle performance under a wide variety of operating conditions.

Voltage to ECU, and components requiring battery voltage, is supplied by ECCS relay. Relay is used to protect ECU in the event of reverse polarity at battery cables. To determine power distribution to ECCS components on specific models, see appropriate wiring diagram in L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

ELECTRONIC CONTROL UNIT (ECU)

ECU consists of a microcomputer, inspection light, diagnostic mode selector, connectors and wiring for voltage signal input, voltage signal output and power supply. See ECU LOCATION table. Unit is not serviceable and should not be opened. Inspection light is provided on side of unit so system operation can be checked. Control unit contains memory and logic circuits, which enable it to interpret sensor inputs and control various engine systems.

Continuous fused battery power is provided to ECU terminal No. 46 (G20) or terminal No. 58 (M30 and Q45). Battery power to drive ECU internal components is provided through ECCS relay, which is energized by ECU when ignition switch is turned to ON position.

ECU LOCATION TABLE

Application	Location
G20	Under Dash, In Center Console
M30 & Q45	Under Dash, Behind Right Kick Panel

NOTE: The ECCS components are grouped into 2 categories. The first is INPUT DEVICES, which are components that control or produce voltage signals monitored by ECU. The second category is OUTPUT SIGNALS, which are components controlled by ECU.

INPUT DEVICES

Vehicles are equipped with different combinations of input devices. Not all devices are used on all models. To determine input usage on a specific model, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section. Available input signals include the following:

Coolant Temperature Sensor

Coolant temperature sensor is located in upper radiator hose inlet housing. Sensor is a thermistor type, which provides ECU with engine temperature information. ECU uses this information to control air/fuel mixture, ignition timing, idle speed, exhaust gas recirculation system and canister purge system. On Q45, this input is also used in calculating ECU control of variable valve timing.

To determine engine temperature, ECU supplies and monitors a voltage signal to coolant sensor. As engine temperature increases, sensor internal resistance decreases, causing ECU monitored voltage to decrease as more signal voltage passes through sensor to ground.

Crankshaft Angle Sensor

Crankshaft angle sensor monitors engine speed and piston position. Crankshaft angle sensor is built into the distributor (G20 and M30) or into a separate sensor mounted on front of engine (Q45). Crankshaft angle sensor has a rotor plate and a wave-forming circuit. Rotor plate has 360 small (outer) slits to determine crankshaft angle (one slit for each degree of sensor rotation). Rotor plate also has 8, 6 or 4 larger (inner) slits at 45-degree (V8), 60-degree (V6) or 90-degree (4-cylinder) intervals to determine engine speed. Inner slit for No. 1 cylinder is wider than the other inner slits to allow ECU to determine TDC for No. 1 cylinder. See Fig. 1.

When the signal rotor plate passes the space between the Light Emitting Diode (LED) and photo diode, slits in signal rotor plate alternately cut light that is sent to photo diode from LED. This causes a pulsating voltage, which is converted into an on-off pulse by wave-forming circuit, and sent to ECU. For Q45, also see SUB-CRANK ANGLE SENSOR.

Detonation (Knock) Sensor

Detonation sensor is a piezoelectric crystal capable of converting vibration caused by engine knock (detonation) into voltage signals. Intensity of voltage signal is proportional to severity of knock. ECU modifies ignition timing to reduce detonation. Detonation is not a result of normal engine operation and should not be present on a properly functioning vehicle using quality fuel. Q45 uses 2 detonation sensors (one for each side of engine).

Exhaust Gas (Oxygen) Sensor

Sensor measures amount of unburned oxygen in exhaust gases. When heated in the presence of exhaust gases, sensor provides a voltage signal which is used to adjust air/fuel mixture (amount of injection time), so that optimum combustion can occur. Two types of oxygen sensor are used.

G20 and Q45 use a Zirconia oxygen sensor which, when heated in the presence of exhaust gases, produces a varying voltage signal relative to oxygen content of exhaust gases. Sensor also contains an additional heating circuit in order to bring sensor quickly to operating temperature. Ground for heating element is controlled by ECU. Two oxygen sensors are used on Q45.

M30 uses a Titania oxygen sensor, which is a type of resistor. ECU provides Titania oxygen sensor with a 1-volt reference signal. Resistance of ceramic Titania varies when subjected to lean and rich conditions. A rich exhaust gas mixture causes sensor resistance to drop and a lean exhaust gas mixture causes sensor resistance to increase.

ECU monitors signal from oxygen sensor and adjusts air/fuel mixture based upon this signal. Sensor also contains an additional heating circuit to quickly bring sensor to operating temperature.

Exhaust Gas Temperature Sensor (California)

Exhaust gas temperature sensor, located near EGR valve, detects temperature of exhaust gases passing through EGR valve. Sensor, which incorporates a thermistor, changes its resistance value in response to changes in exhaust gas temperature. As temperature of exhaust gases increases, resistance of sensor decreases. These changes in resistance are interpreted by ECU and used in calculations to control output voltage signals to EGR solenoid.

Fuel Temperature Sensor (M30)

Fuel temperature sensor is built into the fuel pressure regulator and senses fuel temperature. When fuel temperature is higher than prespecified level, ECU enriches fuel injection by increasing injection pulse width. This temperature input is also used to determine operation of fuel pressure regulator control solenoid. DO NOT remove fuel temperature sensor from pressure regulator. Replace regulator/temperature sensor as an assembly.

Gear Position (M30)

Automatic transmission control unit provides transmission gear position information to ECU. ECU uses this information to determine control of idle speed, ignition timing and injector pulse width.

Mass Airflow Meter (G20)

Mass airflow meter uses a hot wire type sensing element. Hot wire is heated to a precalibrated temperature by ECU. Incoming air passing through airflow meter causes hot wire to cool, resulting in the need for ECU to apply additional current to maintain precalibrated hot wire temperature. ECU measures airflow by monitoring change in required current supplied to hot wire.

If airflow meter output current is outside of normal operational range, ECU senses an airflow meter malfunction. ECU will then take driving condition information from throttle position sensor. During this period, ECU limits engine speed to less than 2000 RPM. This alerts driver vehicle is operating under fail-safe conditions and needs attention.

Since hot wire is exposed to atmospheric contamination, ECU is programmed to clean hot-wire each time ignition switch is cycled off. This is accomplished by heating hot wire to 1832°F (1000°C) for one second after ignition has been turned off for 5 seconds.

Mass Airflow Meter (M30 & Q45)

Airflow meter measures intake airflow rate by measuring a part of entire airflow. Measurements are made so ECU receives electrical output signals varied by amount of heat emitting from a hot film placed in the stream of intake air.

When intake air flows into intake manifold through a route around the hot film, heat generated from hot film is taken away by air. The amount of heat reduction depends on airflow. Temperature of hot film is automatically controlled at a predetermined heat.

Therefore, the hot film must be supplied with more electric current in order to maintain temperature of hot film. ECU detects airflow by means of this current change.

If airflow meter output current is outside of normal operational range, ECU senses an airflow meter malfunction. ECU will then take driving condition information from throttle position sensor. During this period, ECU limits engine speed to less than 2000 RPM. This alerts driver vehicle is operating under fail-safe conditions and needs attention.

Park/Neutral Relay (Q45)

ECU applies and monitors voltage to park/neutral relay on ECU terminal No. 44. When gear selector lever is in PARK or NEUTRAL position, relay is supplied voltage through selector switch. When relay is energized, contacts inside relay close, pulling voltage on ECU monitored circuit (terminal No. 44) low. This is interpreted by ECU as a park or neutral signal.

Power Steering Oil Pressure Switch (G20 & Q45)

This switch is attached to power steering high pressure line and detects power steering load, sending a load signal to ECU. When oil pressure exceeds a predetermined amount, ECU sends a voltage signal to idle speed control valve to increase idle speed, in order to assist with power steering load.

Sub-Crank Angle Sensor (Q45)

In the event optical crank angle sensor should fail, sub-crank angle sensor acts as its back-up. Sub-crank angle sensor consists of a magnetic pick-up and a signal rotor containing 8 machined grooves. Sensor produces a fluctuating AC voltage signal to ECU.

Sensor is capable of producing an RPM signal only, not a No. 1 cylinder TDC signal. While sensor is providing RPM input (during crank angle sensor failure), ECU will operate in a fail-safe mode, resulting in simultaneous rather than sequential fuel injection.

Throttle Position Sensor (TPS) & Idle Switch

TPS incorporates a potentiometer, which varies output voltage in response to changes in throttle position. This information is relayed to ECU as input voltage signals on 3-terminal TPS harness. TPS also has ability to inform ECU of rate of speed changes taking place in throttle plate movement. It is attached to throttle body housing and actuated with movement of accelerator pedal.

Idle switch, which is an integral part of TPS, is closed at idle and open during all other conditions. Switch signal is used in event of TPS failure to inform ECU when throttle is closed for fuel cut on deceleration.

Vehicle Speed Sensor (VSS)

VSS generates a pulsed vehicle speed signal to ECU. Speed sensor consists of a reed switch and rotating permanent magnet, which are installed in speedometer unit. Changes in polarity caused by the rotating magnet (located adjacent to reed switch) open and close reed switch, which has a constant polarity of its own.

On Q45, a second speed sensor consisting of a Permanent Magnet (PM) generator and pick-up coil assembly is located in transmission. Rotating PM generator produces an AC voltage signal in winding of pick-up coil. Signal generated by speed sensor is used by transmission control unit and monitored by ECU.

OUTPUT SIGNALS

Vehicles are equipped with different combinations of computer-controlled components. Not all components are used on every vehicles. To determine control (output) usage on specific models, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section. Available output signals from ECU include the following. For theory and operation of specific output components, refer to system indicated after component.

A/C Clutch Control

See MISCELLANEOUS CONTROLS.

Airflow Meter Self-Cleaning
See INPUT DEVICES.

Air Regulator (G20 & M30)
See IDLE SPEED under FUEL SYSTEM.

Auxiliary Air Control Solenoid
See IDLE SPEED under FUEL SYSTEM.

Canister Purge Solenoid (Q45)
See FUEL EVAPORATION SYSTEM under EMISSION SYSTEMS.

CHECK ENGINE Light
See SELF-DIAGNOSTIC SYSTEM.

ECCS Relay
See COMPUTERIZED ENGINE CONTROLS.

EGR Control Solenoid
See EXHAUST GAS RECIRCULATION (EGR) under EMISSION SYSTEMS.

Fuel Injectors
See FUEL CONTROL under FUEL SYSTEM.

Fuel Pressure Regulator
See FUEL DELIVERY under FUEL SYSTEM.

Fuel Pump Control Unit (Q45)
See FUEL DELIVERY under FUEL SYSTEM.

Fuel Pump Relay
See FUEL DELIVERY under FUEL SYSTEM.

Ignition Coil Relay (Q45)
See IGNITION SYSTEM.

Oxygen Sensor Heating Element (Exhaust Gas Sensor)
See INPUT DEVICES.

Power Transistor(s) & Ignition Coil(s)
See IGNITION SYSTEMS.

Self-Diagnostic System
See SELF-DIAGNOSTIC SYSTEM.

Valve Timing Control Solenoids (Q45)
See VALVE TIMING CONTROL SYSTEM under MISCELLANEOUS CONTROLS.

FUEL SYSTEM

FUEL DELIVERY

Fuel Pump

Electric in-tank fuel pump is activated by ECU through fuel pump relay. Fuel pump is energized by ECU for up to 5 seconds when ignition is first turned on, during cranking, and running. Fuel pump is de-energized within 1.5 seconds after engine stops.

Fuel Pump Control Unit (Q45)

Fuel pump control unit is located above fuel tank at rear of vehicle. Based on signals from ECU, control unit regulates voltage supplied to fuel pump. By increasing or decreasing current flow through fuel pump, fuel volume can be adjusted to one of 3 levels.

High voltage (11-14 volts) is applied to fuel pump during the following conditions: engine cranking, engine operation when coolant temperature is less than 32°F (0°C), and high-speed operation engine load. This produces maximum volume. During middle load and middle speed conditions, medium voltage (7.8 volts) is applied to fuel pump. This produces medium fuel volume. During all other modes of operation, low voltage (5.6 volts) is applied to fuel pump, providing minimum volume. Fuel pump control unit is operated by ECU.

Fuel Pump Relay (G20 & M30)

Fuel pump relay receives current from ignition switch when switch is in ON or START position. Same line supplies voltage to fuel pump. Fuel pump is energized when ground circuit for fuel pump is energized through fuel pump relay. Relay is energized by ECU when a ground is supplied. ECU energizes relay for about 5 seconds when ignition is first turned on. If RPM signals (One-degree signals from crank angle sensor) are not received by ECU, relay is de-energized. ECU will de-energize relay within 1.5 seconds after RPM signal has ceased. If ECU detects a fuel pump circuit failure, it will energize fuel pump through a back-up circuit.

Fuel Pump Relay (Q45)

Fuel pump relay receives current from ignition switch when switch is in ON or START position. Fuel pump relay supplies basic power (12-14 volts) for fuel pump and fuel pump control unit when relay is energized by ECU. Relay will be energized for approximately 5 seconds when ignition is first turned on. If RPM signals (one-degree signals from crank angle sensor) are not received by ECU, relay is de-energized. ECU will de-energize relay within 1.5 seconds after RPM signal has ceased.

Fuel Pressure Regulator

Fuel is delivered to injectors from in-tank electric fuel pump. Fuel pressure at injector is controlled by fuel pressure regulator located in fuel line between injectors and fuel tank. Pressure regulator is a sealed unit, divided by a diaphragm into 2 chambers: fuel and spring. Fuel chamber receives fuel through inlet side from injector fuel rail. Spring chamber is connected to intake manifold vacuum.

A vacuum-operated diaphragm inside regulator limits fuel pressure within a specific range, taking into consideration changes in engine load. Intake manifold vacuum is high at idle, causing diaphragm to be pulled down. This allows excessive fuel to return to fuel tank through an internal return passage in regulator. As throttle is depressed, intake manifold vacuum is decreased, allowing regulator spring to overcome manifold vacuum. This causes diaphragm to block fuel return passage to fuel tank, thus increasing fuel pressure for high-speed operation engine load.

Pressure Regulator Control Solenoid (M30)

When pressure regulator control solenoid is energized, vacuum to fuel pressure regulator is blocked, causing increased fuel pressure. ECU energizes pressure regulator control solenoid for 30 seconds each time engine is started. When coolant temperature is greater than 167°F (75°C), and engine speed is lower than 2500 RPM or with a light load, ECU will energize pressure regulator control solenoid for up to 3 minutes. This helps improve hot engine starting.

Feedback System

ECU calculates base injection pulse width by processing signals from crankshaft angle sensor and mass airflow meter, which detect various engine conditions. After receiving signals from each sensor, ECU adds fuel enrichments (preprogrammed into control unit) to base injection width. This provides optimum mixture for a wide variety of operating conditions. Fuel enrichment is always available under the following engine conditions: warm-up, starting, off idle, heavy load and high cylinder head temperature.

Fuel injection system incorporates mixture ratio feedback. It is designed to maintain a precise mixture ratio. Through use of a Zirconia (G20 and Q45) or Titania (M30) exhaust gas O2 sensor in exhaust manifold, ECU can decide whether to enrich or reduce air/fuel ratio to precisely control exhaust emissions and engine performance. This function takes place during closed loop operation. ECU continuously monitors itself to stay within an acceptable emission output range. However, this feedback system can be overridden and will operate in open loop when one or more of the following conditions exist: engine starting, engine and/or exhaust sensor cold, driving at high speeds or under heavy load, idling, exhaust gas sensor monitors a too rich condition for over 10 seconds, fuel shutoff solenoid activated, exhaust gas temperature sensor malfunctioning, or vehicle is decelerating.

Port Fuel Injection

Port fuel injected vehicle can operate in one of two modes: simultaneous or sequential injection. In simultaneous injection mode, fuel is injected into all cylinders at same time. This is done once for each crankshaft revolution, providing one-half of required fuel for each combustion cycle. In sequential injection mode, injectors are triggered in spark plug firing order.

If airflow meter should malfunction, ECU will enter a fail-safe mode. In fail-safe mode, injection will be determined from internal default tables based on throttle position, CHECK ENGINE light will glow and engine speed will be limited to 2400 RPM maximum. When engine speed cannot exceed 2400 RPM, fail-safe mode is in effect. This informs driver that vehicle needs attention.

IDLE SPEED

Engine idle speed is controlled by ECU based on engine operating conditions and component/model application. ECU senses engine operating conditions and determines best idle speed. Basic idle speed is adjusted by changing amount of air by-passing throttle plate via Auxiliary Air Control (AAC) Valve.

Fast idle required for cold starts is accomplished through use of an ECU-controlled Fast Idle Control Device (FICD) and air regulator (G20 and M30) or thermowax pellet fast idle cam (Q45).

Auxiliary Air Control (AAC) Solenoid

ECU processes signals from monitored sensors to determine optimum idle speed under varying engine conditions. ECU uses input from the following to detect engine operating condition and determine the best idle speed: mass airflow meter, crank angle sensor, coolant temperature sensor, ignition switch, throttle position sensor, park/neutral (inhibitor) switch, A/C switch, power steering pressure switch (G20 and Q45), battery voltage input, and vehicle speed sensor. ECU then sends an electrical on-off signal corresponding to difference between actual idle speed and desired idle speed. AAC solenoid regulates amount of by-passing air by varying length of time that electrical signal is present.

Air Regulator (G20 & M30)

Air regulator provides air by-pass when engine is cold to allow fast idle during warm-up. A bimetallic heater and rotary shutter valve control rate of by-passing air. When bimetallic heater and shutter are cold, air by-pass port is open. As engine starts, ECU permits electrical current to flow through bimetallic heater. As heater warms, air by-pass port closes. Current for bimetallic heater is supplied through fused ignition when ignition is in START or RUN position. ECU supplies ground for air regulator.

Fast Idle Cam (Q45)

Fast idle cam is installed on throttle chamber to maintain adequate engine speed while engine is cold. When internal wax pellet is cold, it is in a contracted solid state, allowing air to by-pass throttle plate. As wax pellet warms, it changes to an expanded liquid state, blocking flow of by-passed air.

Fast Idle Control Device (FICD) Solenoid (G20 & M30)

FICD increases idle speed for a few seconds under the following conditions: when vehicle is first started, when A/C compressor is engaged or when an electrical load placed on alternator causes idle speed to drop.

IGNITION SYSTEM

NOTE: All models use a crankshaft angle sensor with light emitting diodes. For additional information on operation, see INPUT DEVICES.

DISTRIBUTORLESS IGNITION SYSTEM (Q45)

Distributorless Ignition System (DIS) uses one ignition coil per cylinder. Individual coils are plugged directly onto spark plugs. No conventional distributor or high tension wires are used. An optical crankshaft angle sensor, used in place of distributor, monitors engine speed and piston location. See Fig. 1. See CRANKSHAFT ANGLE SENSOR under INPUT DEVICES.

Signals created by crankshaft angle sensor are sent to Electronic Control Unit (ECU). ECU then delivers timing control signals to left and right power transistors. Power transistors, mounted on left and right valve covers, trigger appropriate ignition coil. Power for ignition coils is supplied from ignition switch through ignition coil relay.

OPTICAL DISTRIBUTOR IGNITION SYSTEM (G20 & M30)

An optical crankshaft angle sensor, mounted inside of distributor, monitors engine speed and piston location. See Fig. 1. See CRANKSHAFT ANGLE SENSOR under INPUT DEVICES. Signals created by crankshaft angle sensor are sent to Electronic Control Unit (ECU). ECU then delivers ignition timing signals to power transistor. Power transistor triggers ignition coil. Power for ignition coil is supplied by ignition switch when switch is in START or RUN position.

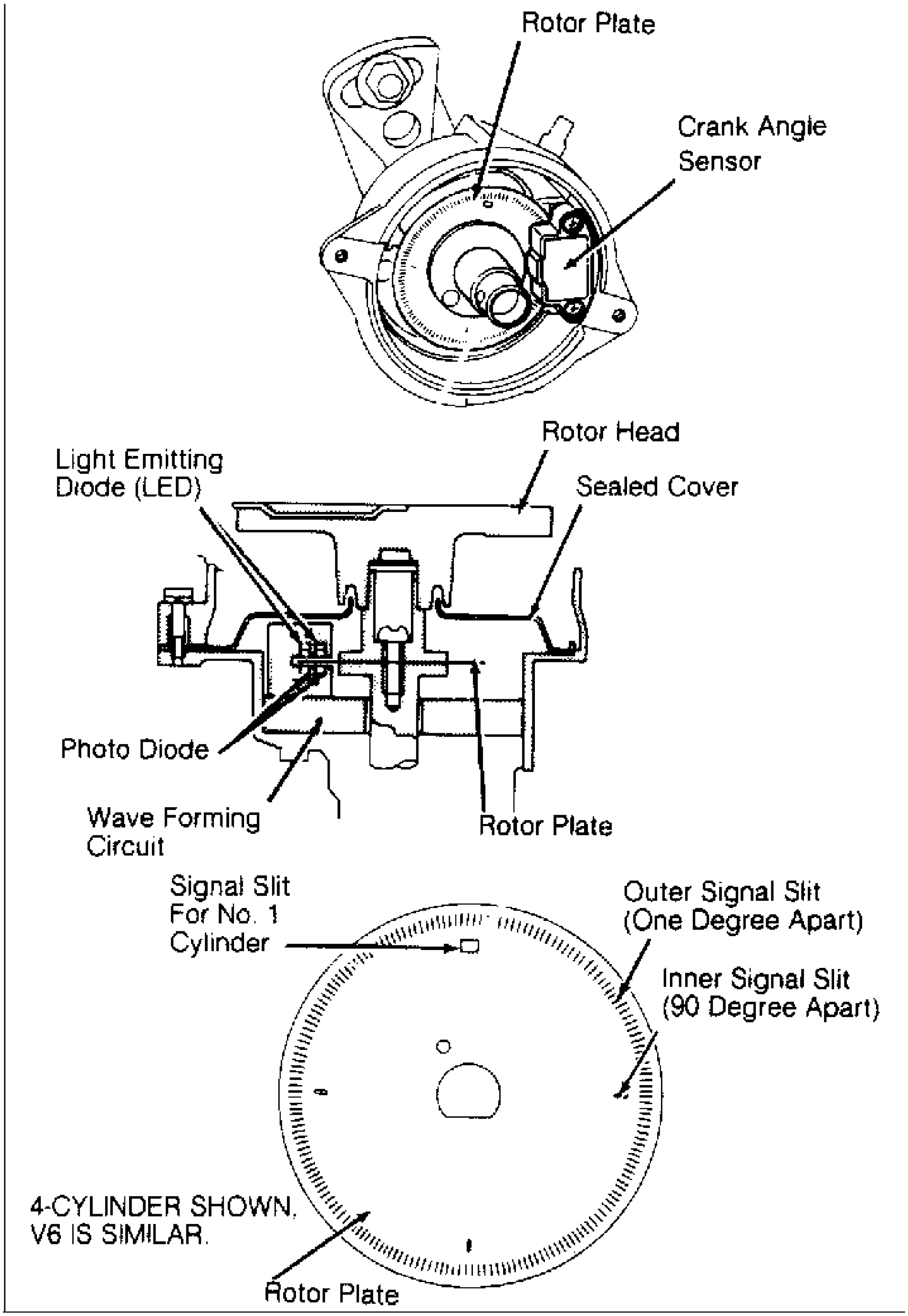

Fig. 1: Optical Crankshaft Angle Sensor ID (Typical)
Courtesy of Nissan Motor Co., U.S.A.

IGNITION TIMING CONTROL SYSTEM

Ignition Timing Control

ECU controls ignition timing based on engine operating conditions. Optimum ignition timing for various driving conditions is pre-programmed into ECU. Electrical signals sent to ECU from operating sensors are processed within logic circuit. After determining optimum timing signal for present driving conditions, ECU outputs a voltage signal to power transistor, which in turn controls timing advance.

Detonation Retard Operation

Since engine is engineered to prevent detonation (engine knocking), retard system does not work under normal operating conditions. However, if engine knock occurs, detonation sensor monitoring knocking condition sends a signal to ECU. After receiving signal, ECU retards ignition timing to eliminate knocking condition. Q45 is equipped with 2 detonation sensors, one for each bank of cylinders.

EMISSION SYSTEMS

NOTE: For component and system application, see B - EMISSION APPLICATIONS article in the ENGINE PERFORMANCE Section.

FUEL EVAPORATION SYSTEM

Fuel evaporation system is used to reduce level of hydrocarbon (HC) emissions released into atmosphere. System consists of a sealed fuel tank, vacuum relief filler cap, charcoal canister, purge control valve, fuel check valve, canister purge solenoid (Q45), canister purge and vacuum signal lines, and vapor vent lines.

Charcoal Canister

Fuel vapor from sealed fuel tank is stored in activated charcoal canister when engine is not running. Canister retains fuel vapor until purge control valve opens, allowing fresh air to be drawn through bottom of canister, carrying vapors into intake manifold to be burned when engine is running.

Purge Control Valve

Purge control valve is located on top of charcoal canister. With engine running at idle, purge control valve is closed. As engine speed increases, and throttle vacuum increases, vacuum is applied to purge control signal line. If canister purge control solenoid valve (Q45) is open, vacuum will be applied to purge control valve. Vapors are then drawn into intake manifold through purge vacuum line.

Canister Purge Solenoid (Q45)

Canister purge is controlled by ECU using canister control solenoid valve. Vacuum supplied through canister purge signal line to canister purge valve is regulated by canister purge solenoid. When solenoid is energized by ECU, vacuum signal to purge control valve is interrupted. When solenoid is de-energized, vacuum signal is allowed to pass through solenoid and act upon canister purge valve diaphragm.

EXHAUST GAS RECIRCULATION (EGR)

To lower emissions of oxides of nitrogen (NOx) exhaust gas, an ECU-controlled EGR system is used. Exhaust gas recirculation is accomplished when a portion of exhaust gases from exhaust manifold are routed to intake manifold and then to combustion chamber to be reburned. EGR system consists of an EGR valve, an ECU-regulated EGR control solenoid valve, an EGR temperature sensor (California vehicles) and a backpressure transducer (G20 and Q45).

Under some conditions, such as the following, EGR is not desirable: engine starting, idling (throttle valve switch on), heavy load, low engine temperature, and high engine speeds.

EGR Backpressure Transducer (G20 & Q45)

A backpressure transducer is installed in vacuum hose to EGR valve. During periods of low exhaust backpressure, EGR is not desirable and transducer allows EGR vacuum signal to bleed off to atmosphere. When backpressure increases, internal diaphragm of transducer lifts, blocking off vacuum bleed, allowing vacuum to pass through transducer and react upon EGR diaphragm.

EGR Control Solenoid

Under operating conditions when EGR action is not needed, ECU energizes coil windings within control solenoid. This pulls internal solenoid plunger downward, allowing control vacuum to bleed off to atmosphere.

EGR Temperature Sensor (California)

California vehicles are equipped with an exhaust gas temperature sensor located near EGR valve. This sensor is used to determine when EGR is actually taking place. If sensor indicates a low exhaust gas temperature when EGR action is commanded, ECU can determine if an EGR fault is present.

SELF-DIAGNOSTIC SYSTEM

NOTE: For additional information and operating procedures for self-diagnostic system, refer to G - TESTS W/ CODES article in the ENGINE PERFORMANCE Section.

Self-diagnostic system is capable of detecting ECCS malfunctions and storing related trouble code. Since intermittent codes are also stored, all codes are available for interpretation, unless codes have been cleared or ignition has been cycled 50 times since malfunction last occurred.

Self-diagnostic system will be operated in one of 2 modes. Modes are manually changed using screwdriver through access port on ECU.

Turn ignition off. Turn ignition on with engine off. With screwdriver turned fully clockwise, inspection lights will begin to flash (at least 2 seconds). When desired mode has been entered, turn screwdriver fully counterclockwise. In different modes, Red LED located on side of ECU will perform different functions. CHECK ENGINE light located on dash will flash simultaneously with Red LED.

Mode I

This is normal vehicle operating mode. If a malfunction occurs in Mode I, Red LED and CHECK ENGINE light will glow, indicating an ECCS malfunction has occurred. Under normal condition, with ignition on and engine off, Red LED and CHECK ENGINE light will glow steadily as a bulb check.

Mode II

If engine is started with ECU in Mode II, Red LED is used to monitor air/fuel mixture feedback control. In open loop, Red LED will remain on or off; therefore, vehicle must be in closed loop in order for Mode II results to be valid. Closed loop can be attained by operating vehicle at 2000 RPM for about 2 minutes under a no-load condition. In closed loop at 2000 RPM, Red LED will indicate system operating condition as follows: rich - light is off longer than it is on; lean - light is on longer than it is off. Light must change state at least 5 times every 10 seconds. Ideal air/fuel ratio would be 5 or more state changes, with equal on and off time indicated by LED or CHECK ENGINE light.

When Mode II is accessed and engine is not started, codes stored in ECU memory will be flashed simultaneously by Red LED on side of ECU and by CHECK ENGINE light on dash. Light flashes will consist of long and short duration flashes, with approximately a one-second pause between flashes. A 2-second pause will exist between multiple stored codes. For example: three .6-second flashes followed by three .3-second flashes would indicate a Code 33.

CHECK ENGINE LIGHT

All vehicles are equipped with a CHECK ENGINE light located on dash. As a bulb check, light will glow when ignition switch is turned to ON position. On all except California vehicles, light will also glow when ECU detects a central processor or crankshaft angle sensor fault. On California vehicles, light will glow when any of 11 ECCS faults have been detected during normal operation (Mode I) with engine running.

MISCELLANEOUS CONTROLS

NOTE: Although some of the controlled devices listed here are not technically engine performance components, they can affect driveability if they malfunction.

A/C CLUTCH

A/C Clutch Relay

ECU controls A/C clutch control relay based on signals from A/C amplifier. Also taken into consideration are idle speed, throttle position, and gear selector position. On G20 and Q45, power steering pressure switch input may also affect A/C clutch relay operation. ECU will disengage relay when idle quality may be affected, or when ECU determines A/C clutch should be disengaged due to engine power requirements.

VALVE TIMING CONTROL SYSTEM

To improve engine performance and reduce exhaust emissions, Q45 is equipped with variable valve timing. This is accomplished through use of intake valve timing control solenoids located on intake camshaft pulleys. Intake valve opening and closing is controlled according to engine operating conditions as monitored by ECU. Input signals from mass airflow meter, crank angle sensor, coolant temperature sensor, throttle position sensor and park/neutral (inhibitor) switch are used to determine intake timing.

Intake camshaft pulley position is regulated by oil pressure, which is controlled by valve timing control solenoids. Intake valve timing is controlled under the following conditions: engine is not idling, coolant temperature is 158-230°F (70-110°C), engine speed is less than 4600 RPM, engine load is high and transmission is not in Park or Neutral. During these conditions, solenoid is energized by ECU. This causes intake valve opening and closing time to advance and valve overlap to increase.