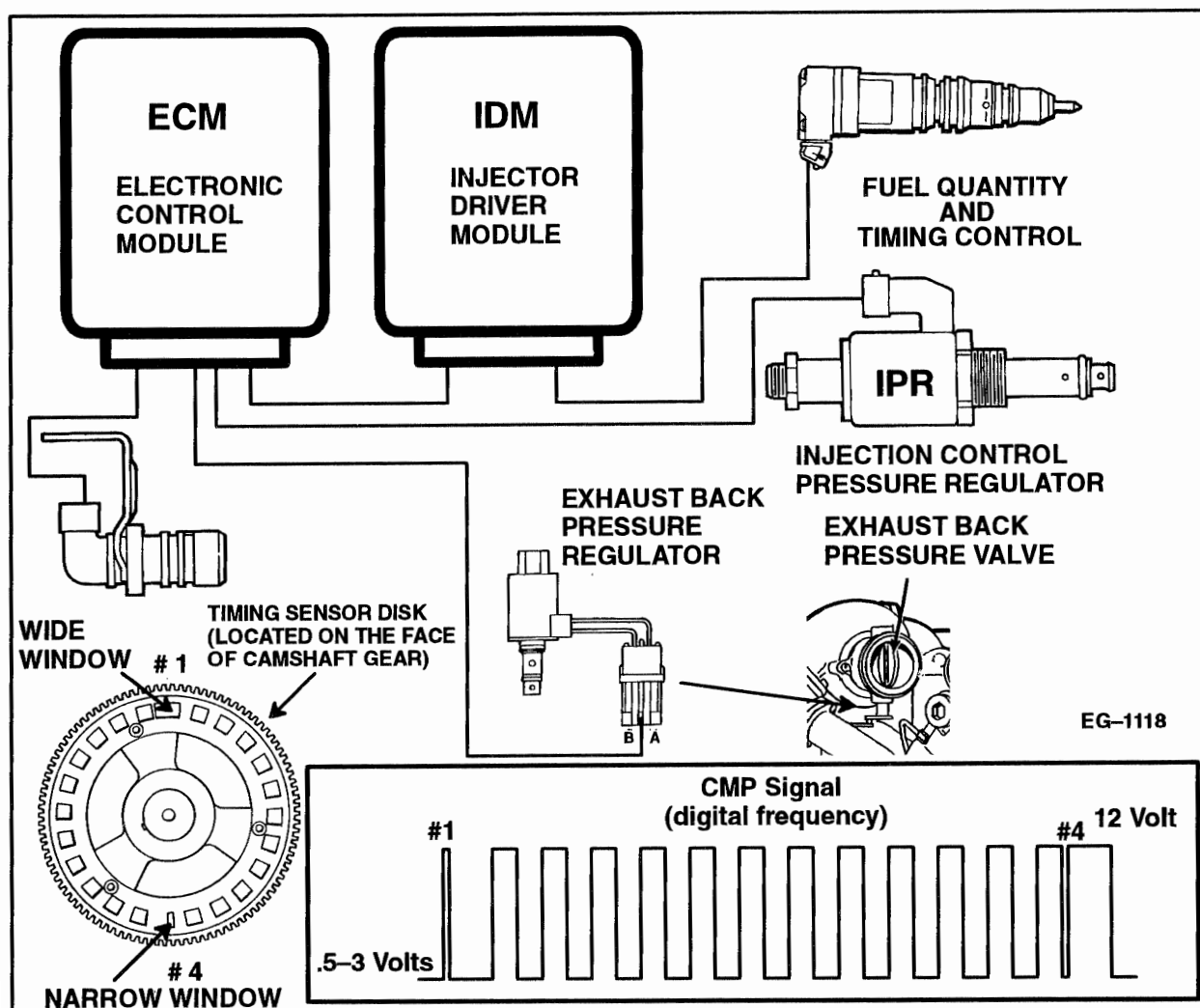


## CAMSHAFT POSITION (CMP) SENSOR



## SIGNAL FUNCTIONS

The CMP (Camshaft Position) sensor is a Hall Effect type sensor that generates a digital frequency as windows on the timing disk pass through its magnetic field. The frequency of the windows passing by the sensor as well as the width of selected windows allows the ECM to detect engine speed and position.

**Engine Speed** – Is determined by counting 24 windows on the timing sensor disk each camshaft revolution.

**Fuel Timing Control** – The position of cylinder #1 and #4 is determined by distinguishing a narrow or wide window on the camshaft timing sensor disk.

**Engine Mode Selection** – Allows the ECM to discern when the engine is in the off, crank or run mode.

**Injection Control Pressure** – Engine speed is one of the controlling variables in the calculation of desired injection control pressure.

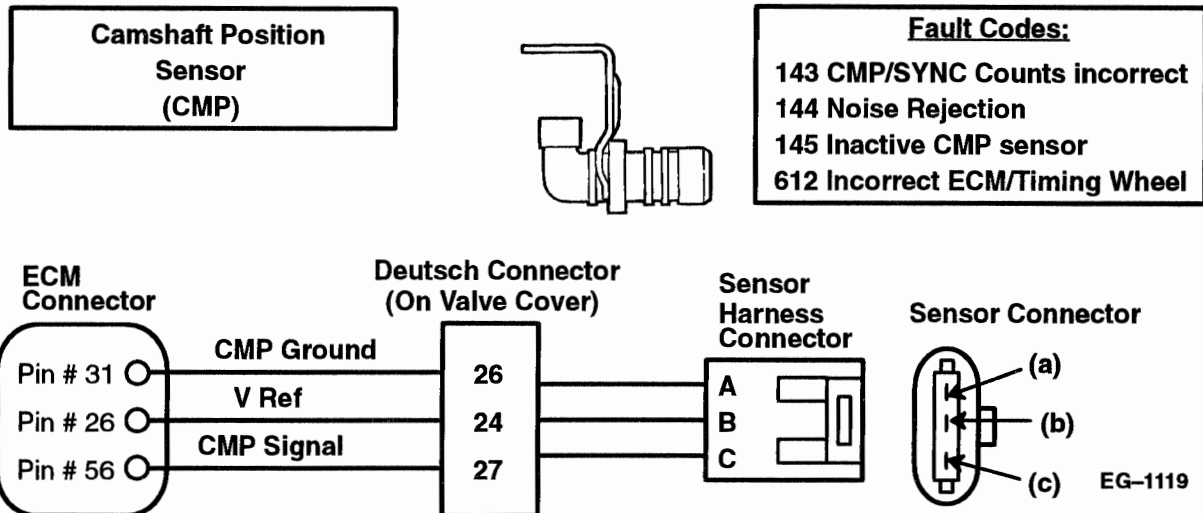
**Exhaust Back Pressure** – Exhaust back pressure control is a function of engine speed and load.

**Fuel Quantity Control/Torque Limiting** – Engine torque and fuel is controlled and is dependent on engine speed. Fuel quantity is determined by engine speed.

## FAULT DETECTION/MANAGEMENT

An inactive CMP signal during cranking is detectable by the ECM. An inactive CMP signal will cause a no start condition. Electrical noise can also be detected by the ECM, if the level is sufficient to effect engine operation a corresponding fault code will be set. **The engine will not operate without a functioning CMP signal.**

## CAMSHAFT POSITION SENSOR (CMP)



**After removing connector always check for damaged pins, corrosion, loose terminals etc.**

#### Connector Checks to Chassis Ground

(Check with Sensor Connector Disconnected and Ignition key off, all accessories off)

Test Points	Spec.	Comments
A to Grd.	< 5 ohms	Resistance to chassis ground check with key off, if > than 5 ohms harness is open.
B to Grd.	> 1000 ohms	Resistance less than 1000 ohms indicates a short to ground.
C to Grd.	> 1000 ohms	Resistance less than 1000 ohms indicates a short to ground.

#### Connector Voltage Checks

(Check with Sensor Connector Disconnected and Ignition Key On)

Test Points	Spec.	Comments
B to Grd.	$5 \pm .5$ volts	VRef check key on, VRef not present check open/short to grd #26 to B, see VRef circuit.
C to Grd.	$12 \pm 1.5$ volts	If < than 10.5 v check for poor connection, if 0 v check for open/short to grd circuit.

#### Harness Resistance Checks

(Check with breakout box installed on engine harness only with ignition key Off)

Test Points	Spec.	Comments
#31 to A	< 5 ohms	Resistance from harness connector to 60 pin connector – Signal grd (CMP has dedicated grd circuit)
#26 to B	< 5 ohms	Resistance from harness connector to 60 pin connector – V Ref.
#56 to C	< 5 ohms	Resistance from harness connector to 60 pin connector – CMP signal

Operational Voltage Checks		
(Check with breakout box installed in line with the ECM and ignition key ON)		
Test Points	Position	Comments
(+) #56 to (–) #31		
Voltage		
$12 \pm 1.5$ v	Vane	With the breakout box installed, the CMP sensor & ECM connected, bar engine by hand.
.5v to 3v	Window	The CMP signal voltage should change voltage state as timing wheel on cam is rotated.

#### Fault Code Descriptions

- 143 = Incorrect number of sync to transition counts detected, possible intermittent CMP sensor / circuit fault
- 144 = Electrical noise detected, check wire routing and grounds
- 145 = Inactive CMP signal detected during engine cranking when ICP pressure was sufficient for starting
- 612 = ECM/target disk mismatch detected (wrong ECM installed)

## ELECTRONIC CONTROL SYSTEM DIAGNOSTICS

### CAMSHAFT POSITION SENSOR (CMP)

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#### CAMSHAFT POSITION SENSOR (CMP) EXTENDED SYSTEM DESCRIPTION

##### FUNCTION

The Navistar engine control system includes a Camshaft Position Sensor (CMP). This sensor provides the Electronic Control Module (ECM) with a signal that indicates camshaft position and engine speed.

The CMP sensor signal is used by the ECM to synchronize piston position to injector firing sequence. The injector firing order sequence begins when the ECM detects the narrow vane on the timing disk indicating #1 cylinder. Engine position for each cylinder is then continuously calculated as each vane on the timing disk passes by the CMP sensor. This information is processed by the ECM and used for injection timing and fuel delivery control. The ECM can then initiate the beginning of firing.

##### OPERATION

The Camshaft Position Sensor is a Hall Effect type sensor that generates a digital frequency as windows on the timing disk pass through the magnetic field. The frequency of the windows passing by the sensor as well as the width of selected windows allows the ECM to detect engine speed and position. When the narrow vane passes the CMP sensor the signal on time is less than when the other vanes pass the sensor. This produces a signal that the ECM uses to indicate engine position.

Engine speed is detected by the ECM by counting the frequency of the 24 signal pulses for each camshaft revolution.

##### ECM DIAGNOSTICS

Once the ECM has recognized the narrow vane (wide window) it will synchronize the engine firing order to the timing of the CMP signal. Every 2 crankshaft revolutions it will verify that synchronization. If the ECM receives too many or too few pulses for the number of engine revolutions, it will set a fault code.

The engine will not operate without a functioning CMP signal. However, the ECM will attempt to de-

termine the cause of an invalid signal and identify it with a fault code.

CMP codes that are set will become inactive codes if the key is turned off. These codes can be retrieved using the Self Test Input (STI) switch/(Engine Diagnostics switch) located on the vehicle dashboard or the Electronic Service Tool.

##### FLASH CODE 143

###### ATA CODE SID 21 FMI 2

###### *WRONG # OF CMP SIGNAL TRANSITIONS PER CAM REVOLUTION*

Code 143 indicates the ECM has received CMP signals with the wrong number of transitions. This indicates that the ECM has counted the voltage transitions and found less than the specified number of pulses from the sensor. When this problem is continuous, the engine will stop running and the ECM will log an active code. If the key is shut off, the code will become an inactive code. This code will not turn the warning light on.

Possible causes for code 143: Intermittent CMP signal caused by an intermittent circuit, defective Camshaft Position Sensor, or incorrect CMP sensor to timing disk clearance.

##### FLASH CODE 144

###### ATA CODE SID 21 FMI 2

###### *CMP SIGNAL NOISE DETECTED*

Code 144 indicates that the ECM has detected voltage spikes or transitions other than the CMP signal. If this problem is continuous the engine could stop running and the ECM will log an active code. If the key is shut off, the code will become an inactive code. This code will not cause the warning light to illuminate.

Code 144 may be due to: Poor ground connections for CMP or other electronic components. Wire harness shielding missing or incorrectly installed on the engine harness. Outside components that could induce voltage signals.

**CAMSHAFT POSITION SENSOR (CMP)**

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**CAMSHAFT POSITION SENSOR (CMP)  
EXTENDED SYSTEM DESCRIPTION (Continued)****FLASH CODE 145****ATA CODE SID 21 FMI 12*****CMP SIGNAL INACTIVE WHILE ICP HAS INCREASED***

Flash code 145 indicates that the ECM does not detect a CMP signal. This code would be set if the engine was rotating and the ECM detected a rise in ICP pressure, but did not detect a CMP signal. To set this code the engine must be rotated long enough for the ICP to increase. When this code is set the engine will not operate. This code will not cause the warning light to illuminate.

Possible causes for flash code 145: Defective CMP sensor, faulty sensor circuitry, or improper air gap between sensor and camshaft timing disk.

**FLASH CODE 612****ATA CODE SID 21 FMI 7*****INCORRECT ECM INSTALLED FOR CMP TIMING DISK***

Flash code 612 indicates that the ECM has moni-

tored the CMP signal and the signal is incorrect for the programming in the ECM. This means that the ECM does not recognize the signal generated from the timing disk and CMP sensor.

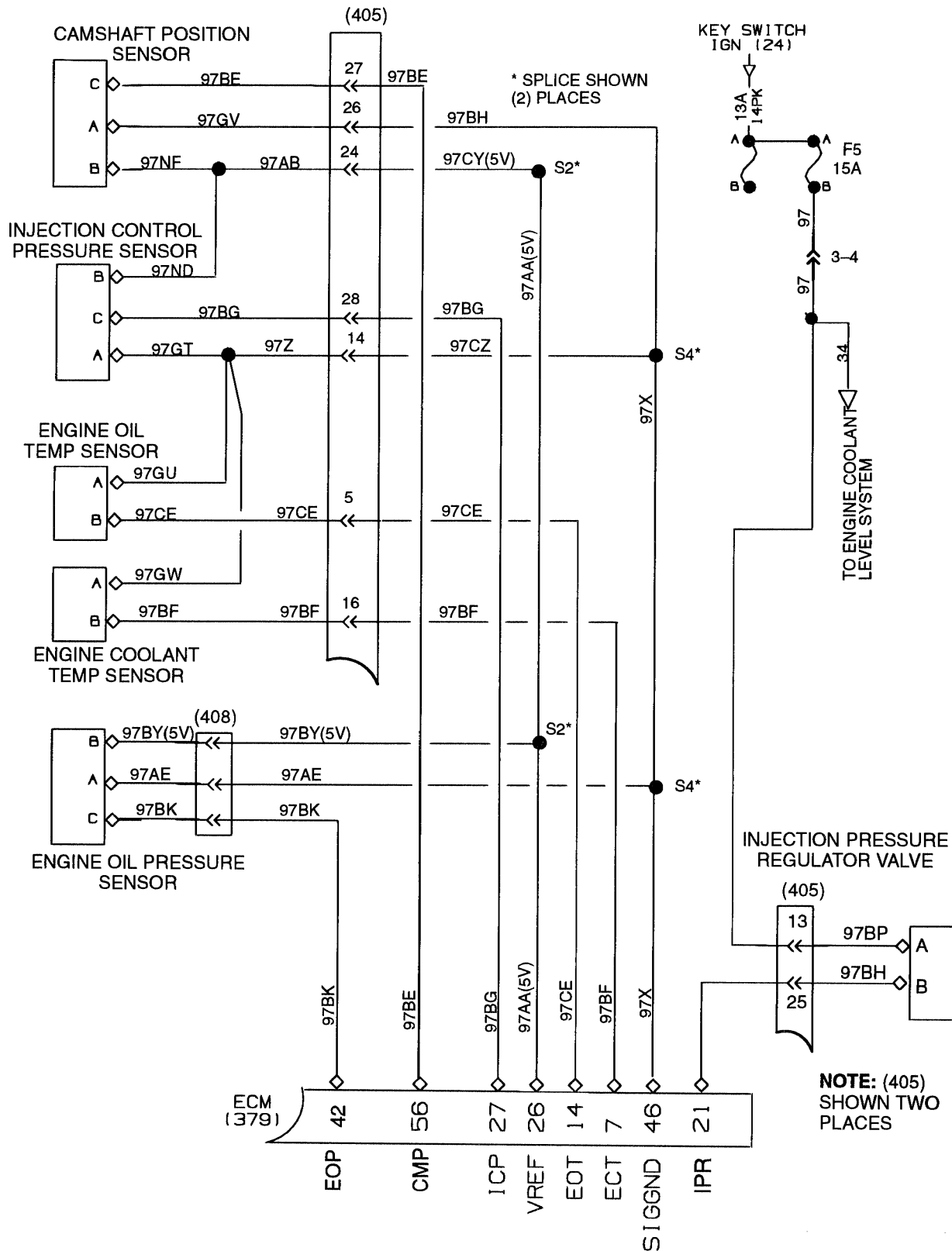
When this condition exists, the ECM does not send a Fuel Demand Command Signal (FDCS) to the Injector Drive Module (IDM). The engine cannot operate without a FDCS signal from the ECM.

Possible causes: ECM has been accidentally replaced with an incorrect ECM for the particular engine application. (For example, the timing disk for the V-8 (T444E) and the I-6 are different and generate a different signal. An ECM from an I-6 engine will not run a V-8 (T444E) engine.) Incorrect signal due to a defective CMP sensor or incorrect air gap between the CMP sensor and the timing disk.

# ELECTRONIC CONTROL SYSTEM DIAGNOSTICS

## CAMSHAFT POSITION SENSOR (CMP)

### SENSOR CIRCUITS (DIAGRAM)



## CAMSHAFT POSITION SENSOR (CMP)

## CAMSHAFT POSITION SENSOR (CMP) CIRCUIT DIAGNOSTICS

Refer to circuit diagram  
on page 34.

