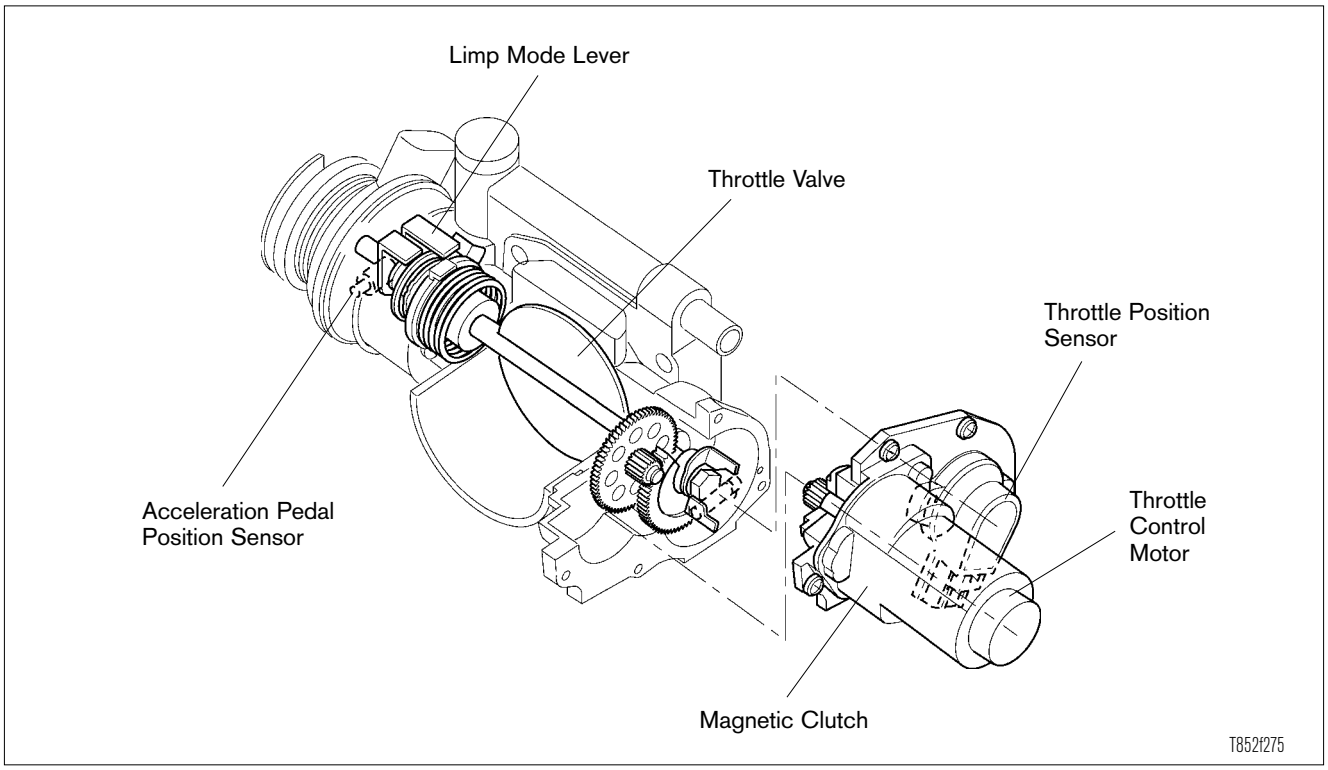
Electronic Throttle Control Systems



Lesson Objectives

1. Determine the condition of the ETCS-i system based on engine data
2. Determine the root cause of a failure(s) in the ETCS-i system using the appropriate diagnostic procedures

Notes

Electronic Throttle Control Systems

Electronic Throttle Control System — intelligence (ETCS–i)

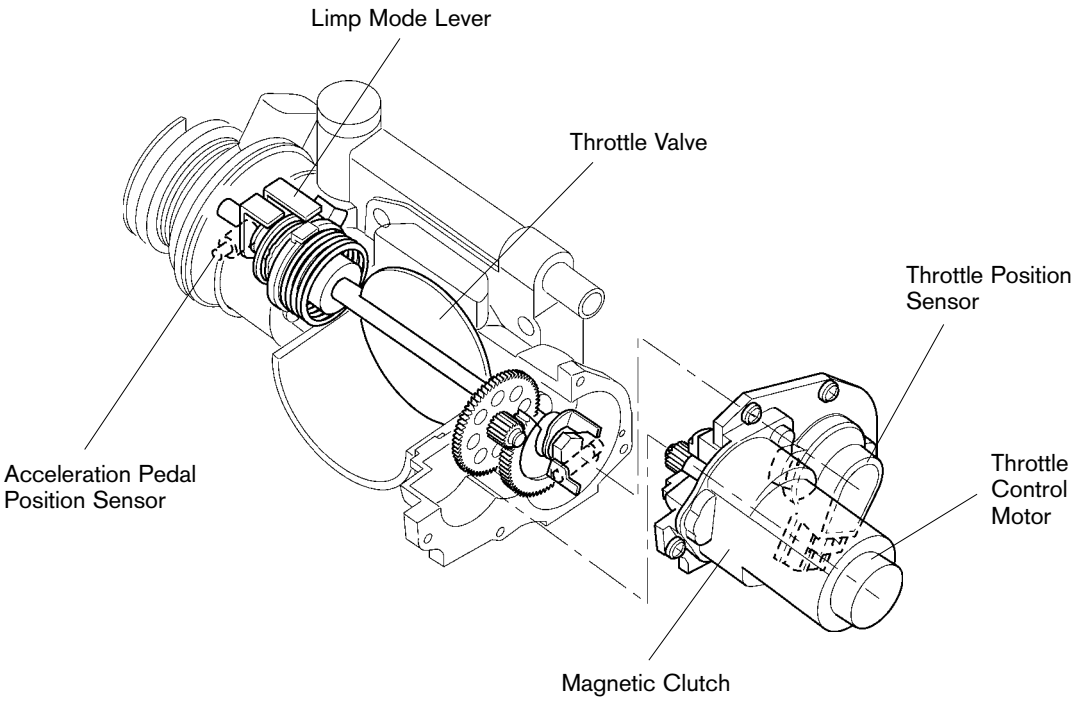


Fig. 7-01
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Electronic Throttle Control System

Electronic Throttle Control System - intelligence (ETCS-i) has several advantages because the ECM will position the throttle valve for optimum performance. In a mechanical system, the opening rate of the throttle valve is controlled directly by the driver. ETCS-i can control the rate for better engine performance. On vehicles equipped with Vehicle Skid Control (VSC), ETCS-i will adjust the throttle valve to maintain traction on acceleration. The ISC system and cruise control functions are part of the ECTS-i system. There is also a limp home feature if the system is shut off.

The throttle motor operates the throttle valve. An electromagnetic clutch connects the throttle motor to the throttle valve. The throttle position sensor detects throttle valve angle. The accelerator pedal position sensor detects accelerator pedal position. The ECM adjusts the throttle valve angle in response to engine and vehicle conditions. Some versions used a thermostat to keep the throttle body at the proper temperature.

ETCS-i Overview

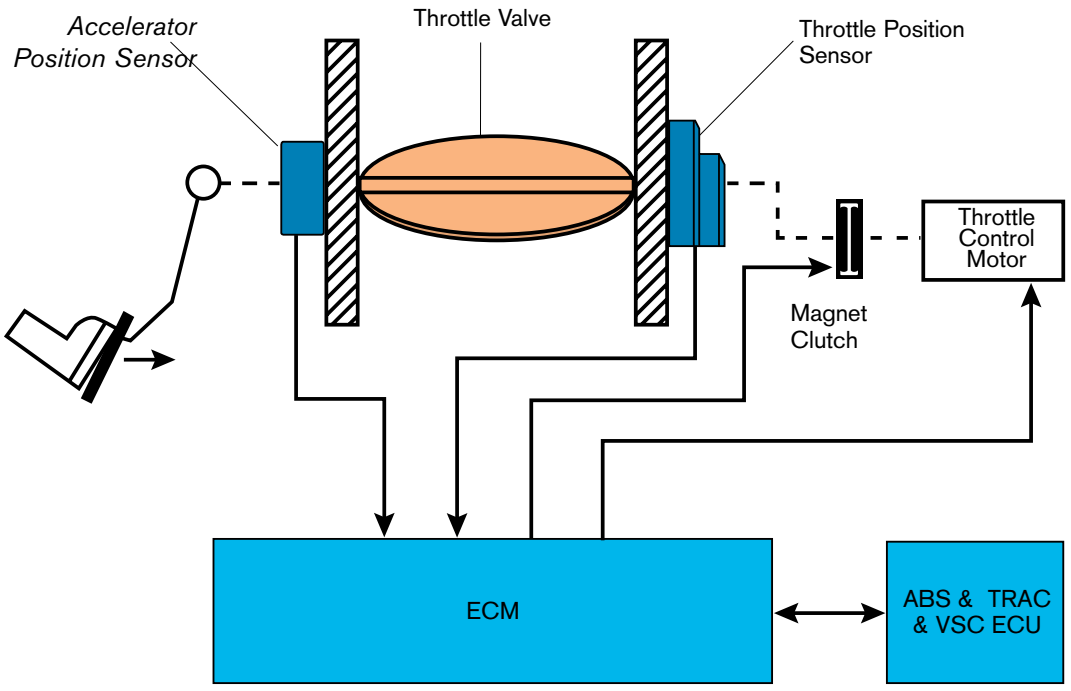

Fig. 7-02

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Thermostat

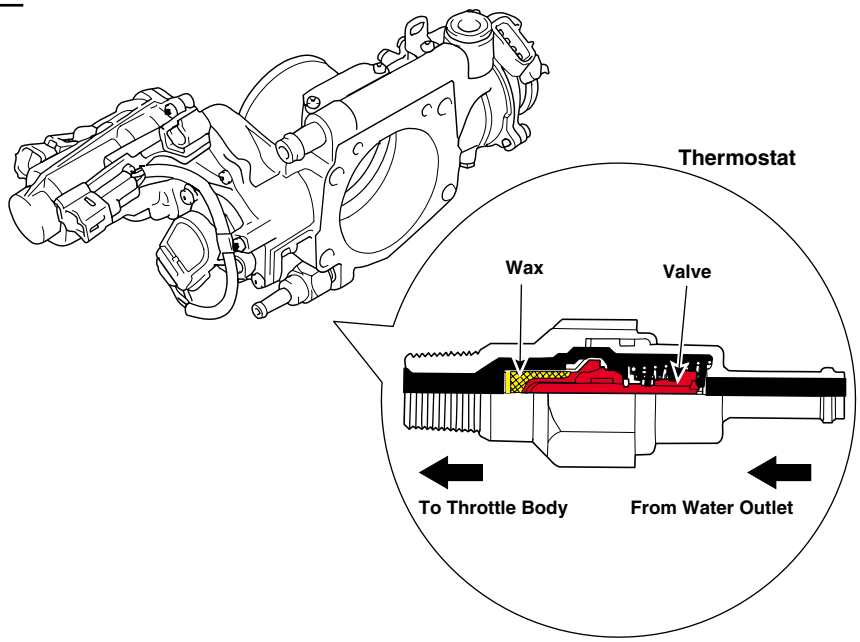

Fig. 7-03

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Operation

The following describe the functions of the major components of ETCS-i.

- **Acceleration Pedal Position Sensor (APPS)** - The APPS, which is mounted on the throttle body, is integrated with the throttle lever. The throttle lever is connected by cable to the accelerator pedal. As the driver moves the accelerator pedal the APPS signal voltage changes indicating pedal position. There are two voltage output signals from the APPS. The ECM uses these two signals to calculate the desired throttle valve angle. Also, by using two signals the ECM is able to compare and detect if there is anything wrong with the APPS's performance.

- **Throttle Position Sensor** - The TPS is used to detect the actual angle of the throttle valve. This signal indicates to the ECM throttle valve position and that the throttle valve moved to the desired angle. Throttle valve position detection is necessary for the ECM to make adjustments to the throttle valve position and to detect if there is a failure in the system.

- **Throttle Control Motor** - The throttle control motor is a DC motor controlled by the ECM. The ECM controls the direction and the amperage of the current through the motor. The circuit is pulsewidth modulated (duty ratio cycle regulated). If there is a malfunction in the system, the ECM shuts the circuit (and clutch circuit) off and the return springs close the throttle valve. The ECM will turn the motor off if there is excessive amperage or not enough amperage in the motor circuit.

- **Magnetic Clutch** - Under normal operation, the magnetic clutch connects the throttle control motor to the throttle valve. The circuit is pulsewidth modulated reducing power consumption. If there is a malfunction in ETCS-i, the ECM turns off the clutch circuit (and motor) if there is too much or not enough amperage in the circuit.

- **Thermostat** - A thermostat is installed in the throttle body to shut off the flow of coolant when coolant temperature is high. This prevents the throttle body from heating up the intake air reducing performance. The thermostat uses a wax expansion valve to open and close the coolant passage.

- **Fail-Safe** - If an abnormal condition occurs with the ETCS-i, the MIL will illuminate to alert the driver. At the same time, current to the throttle control motor and magnetic clutch are cut off. With no power to the motor or magnetic clutch, the return spring closes the throttle valve to the default position. In this situation, called limp mode, the accelerator pedal operates the limp mode lever. When in limp mode, the throttle can only be partially opened reducing engine power. Furthermore, ISC and cruise control systems will not operate.

ETCS-i Throttle Opening Rate

With the SNOW switch on, or in slippery conditions engine output is reduced in relation to accelerator pedal effort. In other words, the driver will have to push further on the accelerator than normal to achieve a similar power output.

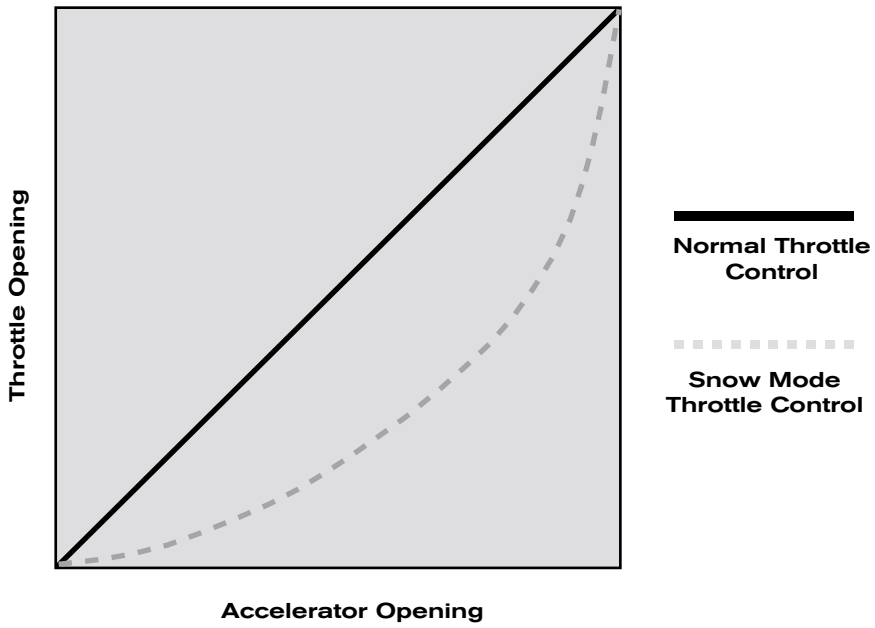

Fig. 7-04
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ETCS-i Control Modes

The ECM drives the throttle control motor to a target throttle angle as determined by operating conditions. The following describes the different modes:

- **Non-linear Control** - Non-linear control means the ECM can control the throttle valve opening rate and position based on such factors as accelerator pedal effort and engine rpm to achieve better performance and comfort. In slippery conditions, the throttle valve can be controlled to aid in vehicle stability.

- **Shift Shock Reduction Control** - The throttle control is synchronized to the Electronically Controlled Transmission control during the shifting of the transmission to reduce the shift shock.

- **Idle Speed Control** - The ECM adjusts the throttle opening to maintain the target idle speed.

- **TRAC Throttle Contro**l - As part of the TRAC system, the throttle valve is closed by a demand signal from the ABS, TRAC, and VSC ECU if an excessive amount of slippage is occurring at the driven wheel.

- **VSC Coordination Control** - VSC performance is enhanced when the throttle valve opening angle is modified by the ABS, TRAC, and VSC ECUs.

- **Cruise Control** - ETCS-i eliminates the need for a separate cruise control system. Cruise control strategies and functions are incorporated into the ECM.

ETCS-i Throttle Motor Circuit Operation

The ECM controls the direction and amount of current needed to activate the throttle control motor to adjust throttle valve position. The throttle motor can be in any one of the following five modes:

- Default position.
- Throttle closing.
- Throttle opening.
- Throttle hold.
- Idle speed control.

The motor circuit consists of four control transistors on the MO and MC circuits. One transistor supplies power and the other transistor completes the path to ground. This configuration allows the ECM to control the direction of current through the motor.

This circuit is also pulsewidth modulated to control the rate of throttle movement and to hold the throttle in a given position. For rapid throttle opening, the pulse width duty ratio will be high (current flow high) for rapid movement.

To hold the throttle in the desired position, the ECM applies enough current to oppose spring pressure.

If the traction control mode is engaged, the pulsewidth will be less, limiting the rate of opening from idle. If the throttle valve is opened too far, the ECM will decrease the pulsewidth closing the throttle.

Default Position

When there is no current applied to the motor, the springs hold the throttle valve in the default position. This condition occurs when the engine ignition key is off or when the ECM has detected a failure in the ETCS-i system. When a failure is detected, current to the motor and clutch is turned off. These actions disengage the motor from the throttle shaft and prevent the motor moving the throttle valve. In this state, the idle is higher than normal when the engine is at operating temperature. The throttle valve will move if the driver presses down further on the accelerator pedal.

Throttle Closing

Current flows from the MC to the MO terminal. The MC supply transistor and the MO ground transistor are turned on. The rate the throttle valve closes is a combination of spring tension, pulsewidth duration, and direction of current flow. To further close the throttle valve after the default position, current must flow as shown in the drawing.

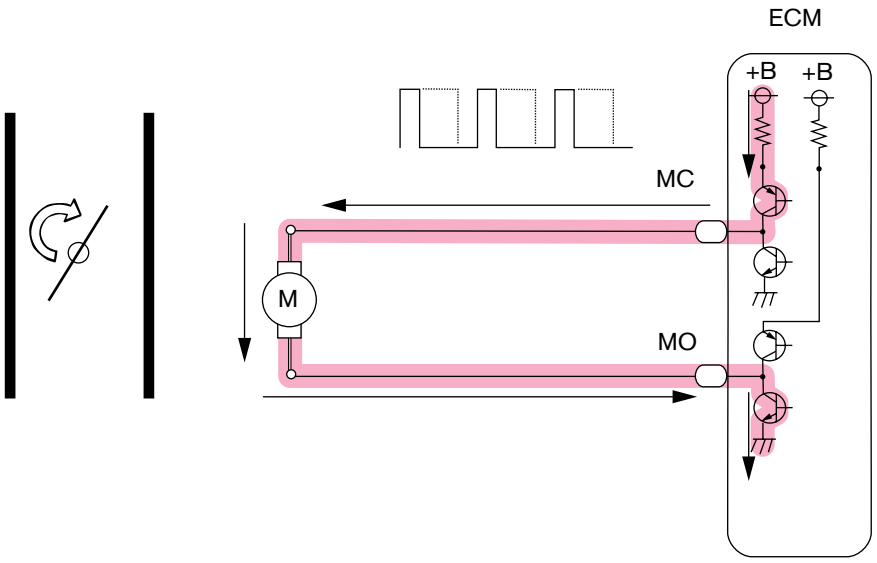

Fig. 7-05
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Throttle Opening

Above the default position, the MO supply transistor and MC ground transistor are turned on allowing current to flow from MO to MC terminals.

Below the default position, the current flow direction is the same as in the throttle close operation, but the pulsewidth is decreased and in combination with spring tension, the throttle valve opens.

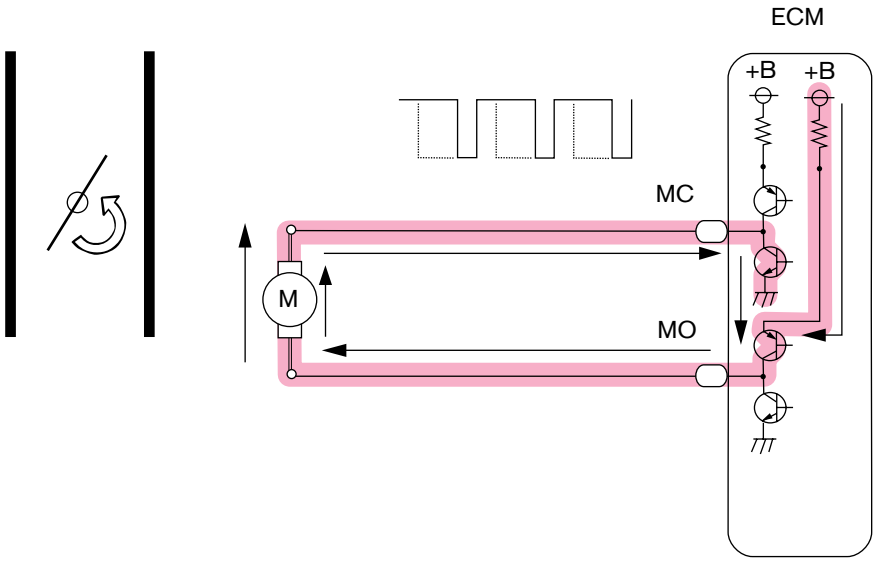

Fig. 7-06
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Throttle Hold To maintain the desired throttle valve angle, the applied duty ratio creates enough force in the motor to oppose spring pressure.

Idle Speed Control The throttle valve is adjusted to maintain the desired idle speed. If the desired idle speed needs the throttle valve below the default position, the throttle close circuit is activated. Any decrease in duty ratio will open the throttle valve and raise engine RPM. If the desired idle speed needs the throttle valve above the default position, the throttle open circuit is activated.

Diagnostics When ETCS-i is in Fail Safe mode, the driver will notice the pedal travel is longer in relation to engine response and that the MIL is on. Retrieve the DTCs and follow repair manual procedures.

APPS & TPS

The APPS and TPS are checked like a conventional TPS. The difference is that there is an extra voltage signal to check.

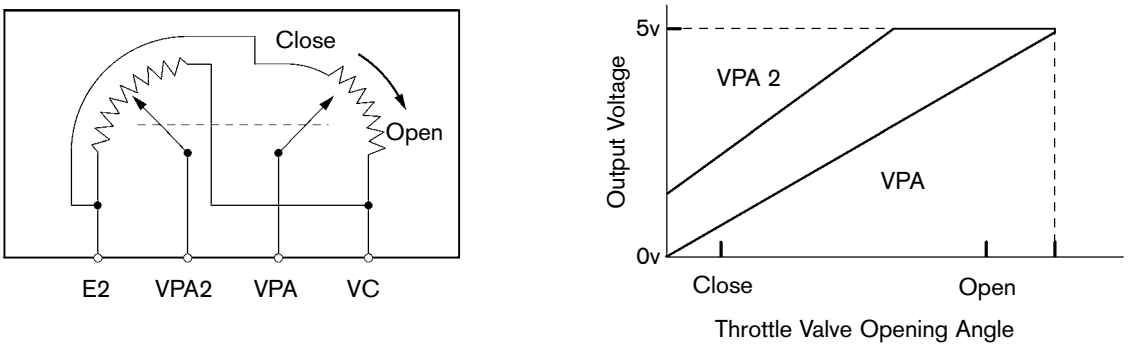

Fig. 7-07
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Throttle Motor

The throttle motor control circuit operational check is performed with an oscilloscope. The RM provides the waveform when connected to the M+ or M- terminal. The waveform will vary with a change in throttle angle. An ohmmeter is used to check the resistance of the motor coils.

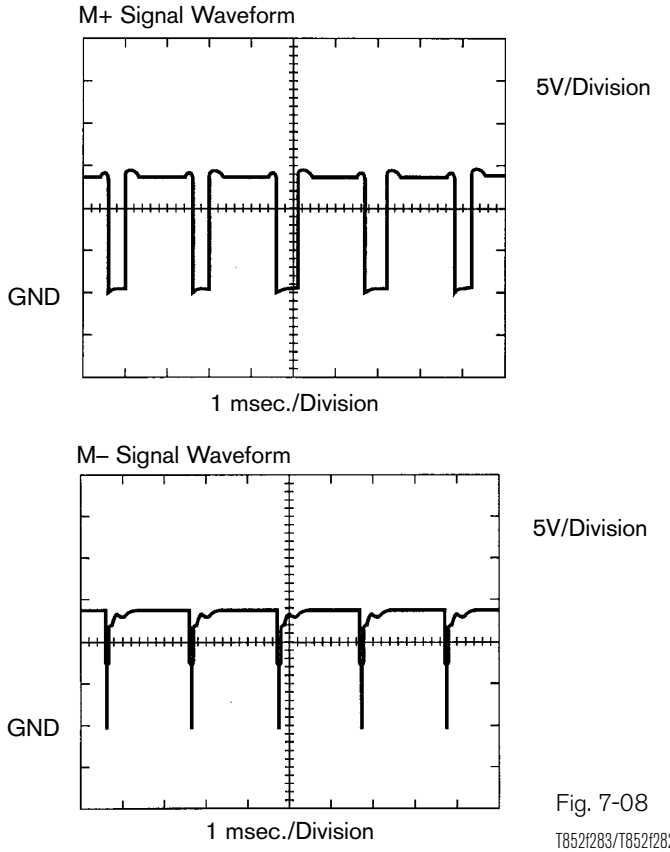

Fig. 7-08
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Electromagnetic Clutch Circuit

Like the throttle control circuit, the clutch circuit is checked with an oscilloscope. A normally operating circuit will be a square wave. An ohmmeter is used to check the resistance of the clutch coil.

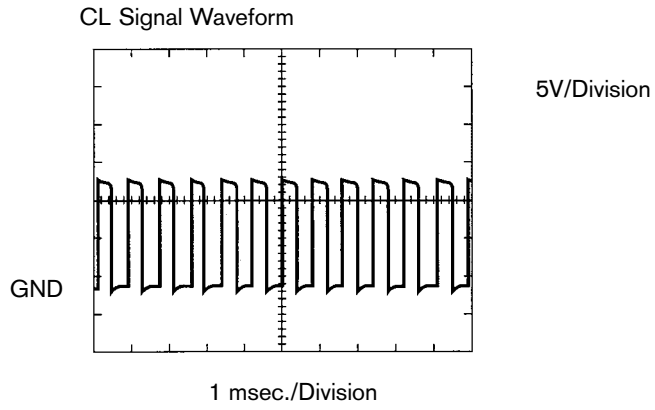


Fig. 7-09
T852f284

Notes

WORKSHEET 7–1
ETCS-i System

Vehicle	Year/Prod. Date	Engine	Transmission

Technician Objectives

With this worksheet, you will learn to test ETCS-i systems using the required tools and equipment, retrieve and apply the needed service information, retrieve and interpret service data information.

Tools and Equipment

- Vehicle Repair Manual
- Vehicle EWD
- Diagnostic Tester & DVOM
- Hand Tool Set

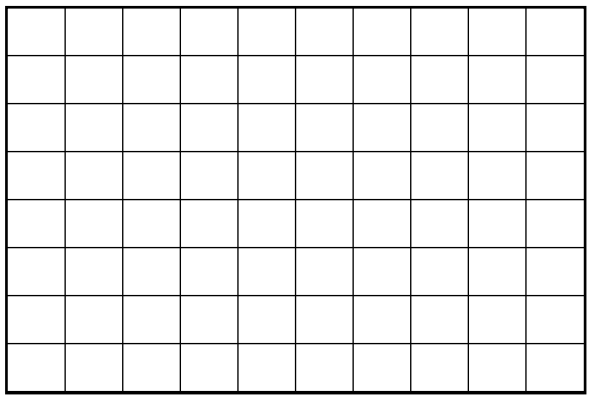
Section 1

Throttle Control Motor

1. Connect the Diagnostic Tester Auto probe to the throttle motor circuit according to the Repair Manual. Start the engine and raise engine to approximately 1000 RPM. Draw or print the waveform.

2. Does the waveform match the Repair Manual waveform?

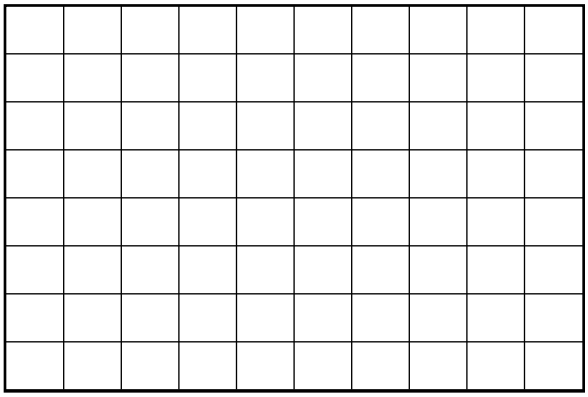
3. Raise engine RPM to 2000. What happened to the waveform and frequency? Draw the pattern.



Throttle Clutch

1. Connect the Diagnostic Tester Autoprobe to the ETCS-i clutch circuit. Set the Diagnostic Tester to the Oscilloscope function, according to the RM. Connect DVOM to DC volts, Hz.
2. Start the engine and at idle RPM note the waveform.
3. Does the waveform match the Repair Manual waveform?

4. Draw or print the waveform.



5. What is the frequency?

6. Raise engine RPM to 2000. What happened to the waveform and frequency?

Go to ETCS-i DATA LIST. Record the following at:

	Idle	1700 RPM	What parameters changed and why?
Parameter Name	DATA	DATA	
ACCEL POS #1			
ACCEL POS #2			
THROTTLE POS #2			
THROTTLE TARGET			
THROTL OPN DUTY			
THROTL CLS DUTY			
THROTTLE MOT			
ETCS MAG CLUTCH			
+BM			
ACCEL IDL POS			
THROTTLE IDL POS			
FAIL #1			
FAIL #2			
THROTTL INITIAL			
ACCEL LEARN VAL			
THROTTLE MOT			
ETCS MAG CLUTCH			

Name _____ Date _____

Review this sheet as you are doing the worksheet. Check each category after completing the worksheet and instructor presentation. Ask the instructor if you have questions. The comments section is for you to write where to find the information, questions, etc.

Topic	*I have questions*	*I know I can*	Comment
Locate components in the ETCS-i system using the EWD and RM			
Find wire colors, pin numbers in the fuel delivery electrical circuits using the EWD and RM			
Locate the ETCS-i Data List and compare to specs. to determine condition			
Test throttle control motor and clutch with oscilloscope			
Interpret ETCS-i Data List signals			
Check and retrieve relevant DTCs			
Locate in the RM two sections related to ETCS-i system concerns			