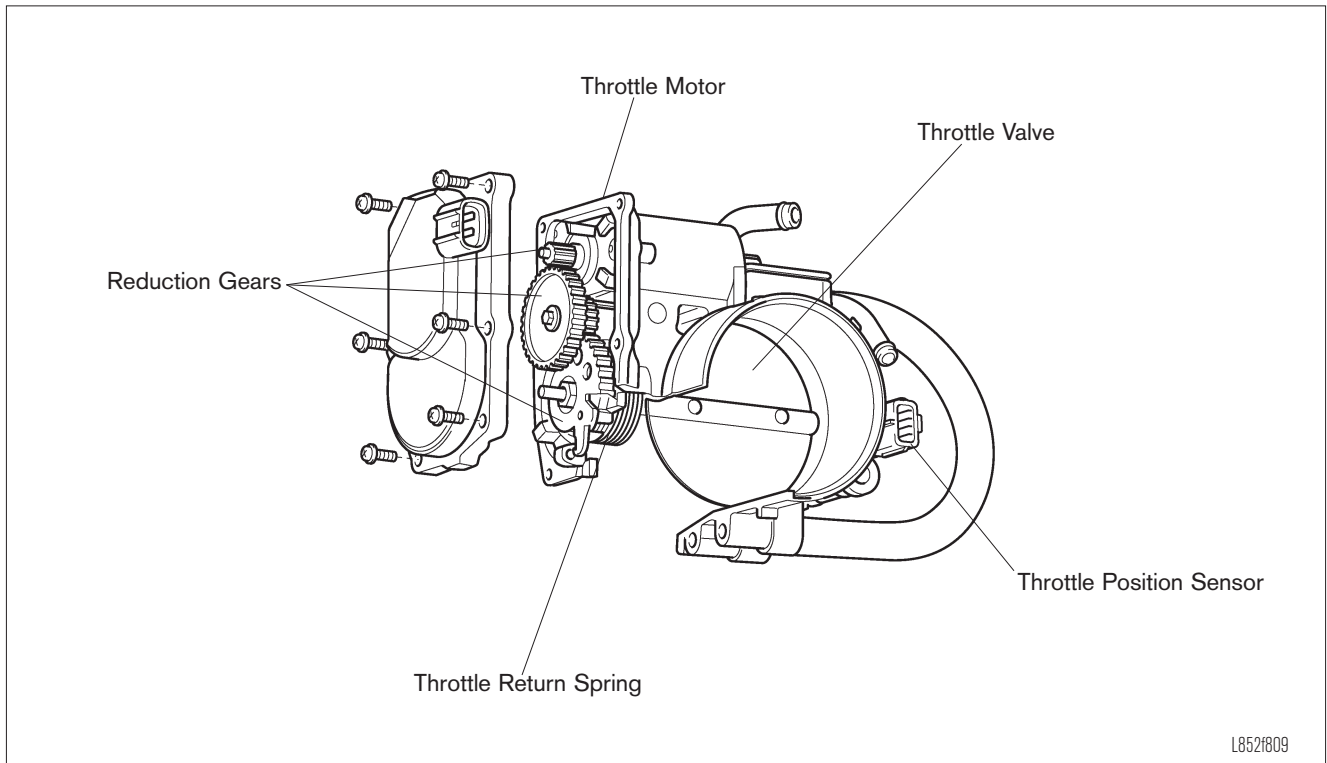


# Electronic Throttle Control Systems



- 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)*

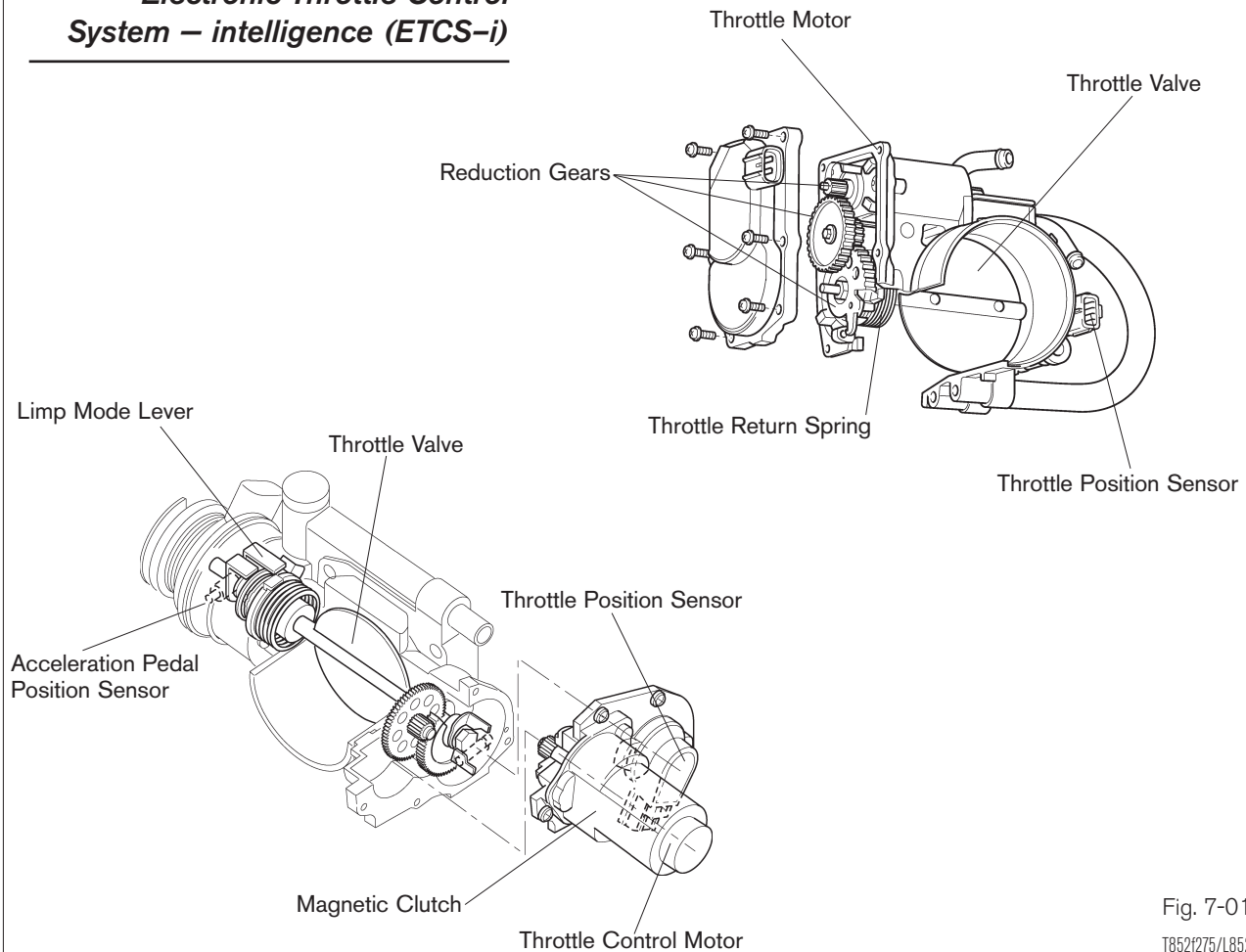


Fig. 7-01

T8521275/L8521809

### Electronic Throttle Control Systems Overview

Electronic throttle control system-intelligence(ETCS-i) has several advantages over a mechanical linked throttle valve system because the ECM can position the throttle valve for optimum performance under a variety of conditions.

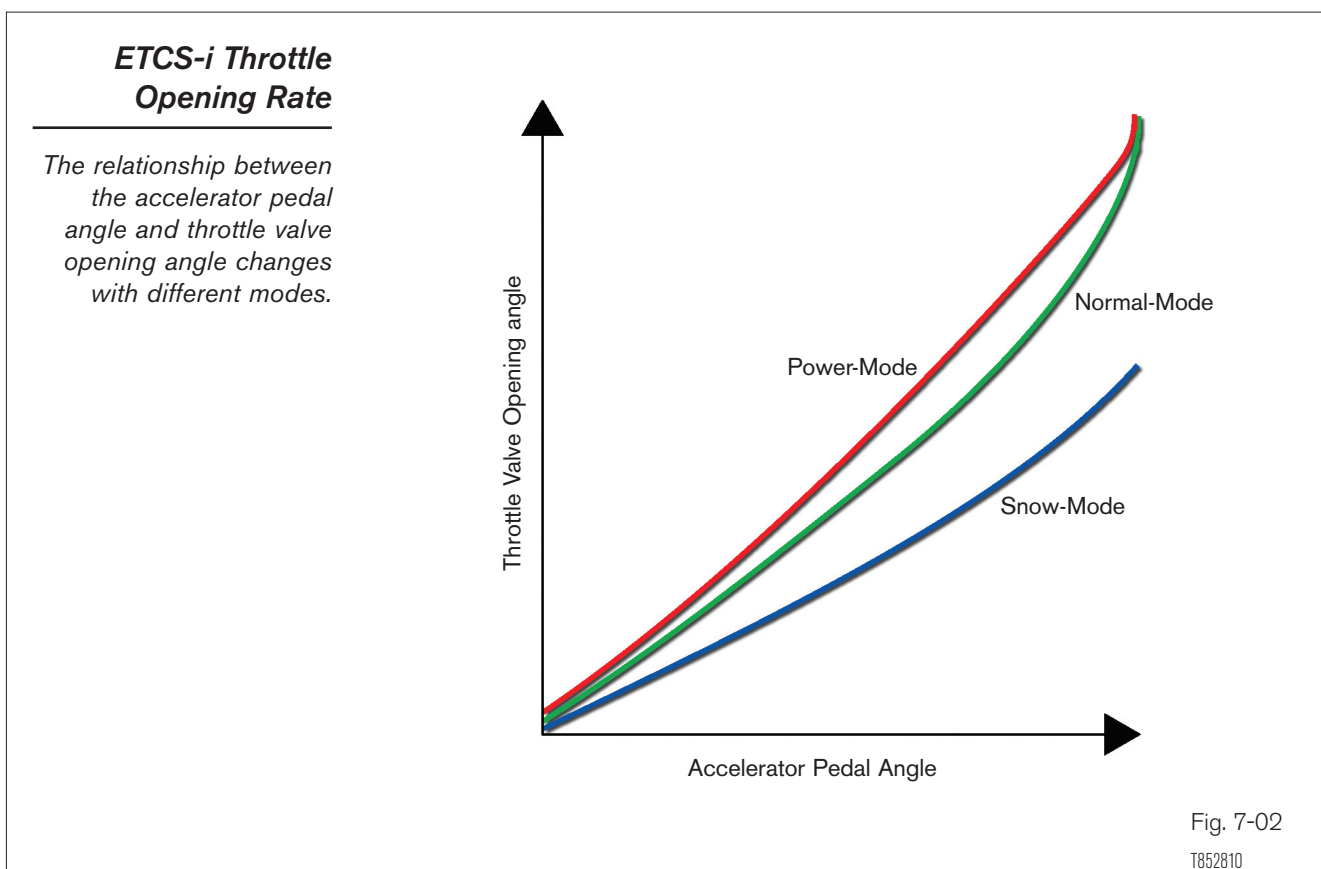
In a mechanical system, the ratio between the throttle valve angle and accelerator pedal position is fixed. This is not desirable under a variety of conditions. An ETCS-i equipped engine can change the relationship between the throttle valve angle and accelerator pedal position for optimum engine performance. For example, on vehicles equipped with Vehicle Skid Control (VSC), ETCS-i will adjust the throttle valve to maintain traction on acceleration.

With ETCS-i, the ISC system and cruise control functions are built into the system. There is no separate ISC or cruise control motor.

There are different versions of the ETCS-i. One version is called a link type system because there is a cable connected from the accelerator pedal to the throttle body.

Another version is called a linkless system because there is no mechanical connection from the accelerator pedal to the throttle body.

If the ECM detects an abnormal condition, the engine is put into Fail-Safe mode and the vehicle under limited power can get home. This is called the limp home feature. The following is an overview that is common to both systems.



### ETCS-i Control Modes

The ECM drives the throttle valve to a specified angle as determined by operating conditions. Different throttle valve angles in relation to the accelerator pedal position are used to achieve different engine output characteristics. The following describes the different modes that affect throttle valve angles. Not all of the following modes are found on all ETCS-i equipped vehicles.

- **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 output to achieve better performance and comfort.
- **Power-mode Control** - On vehicles equipped with a POWER switch, turning this switch on causes the ECM to increase the ratio of accelerator pedal position to throttle valve angle. The increase engine output in relation to accelerator pedal position.
- **Snow-mode Control** - When slippery conditions are anticipated, the driver can turn on the SNOW switch. This will decrease the throttle valve opening in proportion with the accelerator pedal position. With the SNOW switch on, engine output is reduced in relation to accelerator pedal position. This will in vehicle stability and tire traction.
- **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 Control** - 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 driving wheel.
- **VSC Coordination Control** - VSC performance is enhanced when the throttle valve opening angle is modified by the ABS, TRAC, and VSC ECU's.
- **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

This circuit consists of two transistors on the MO and MC wires. 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.

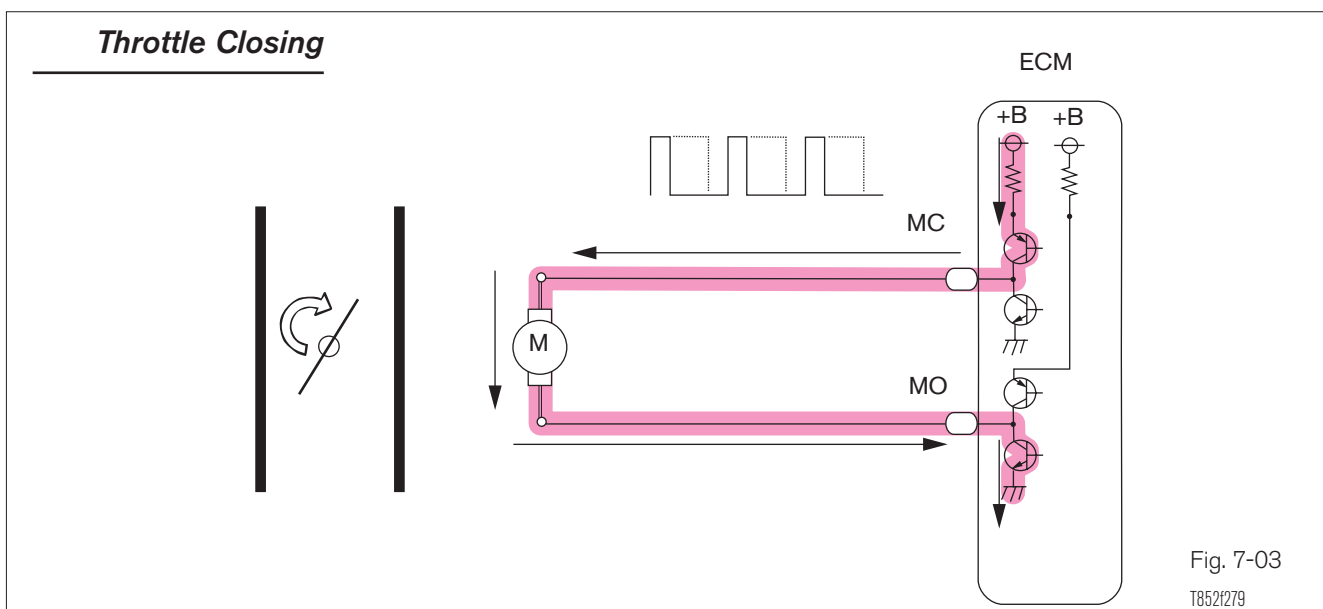
This circuit is also pulsewidth modulated to control the rate of throttle movement and to hold the throttle in a given position. For rapid throttle opening, the pulse width duty ratio will be high (current flow high) for rapid movement.

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

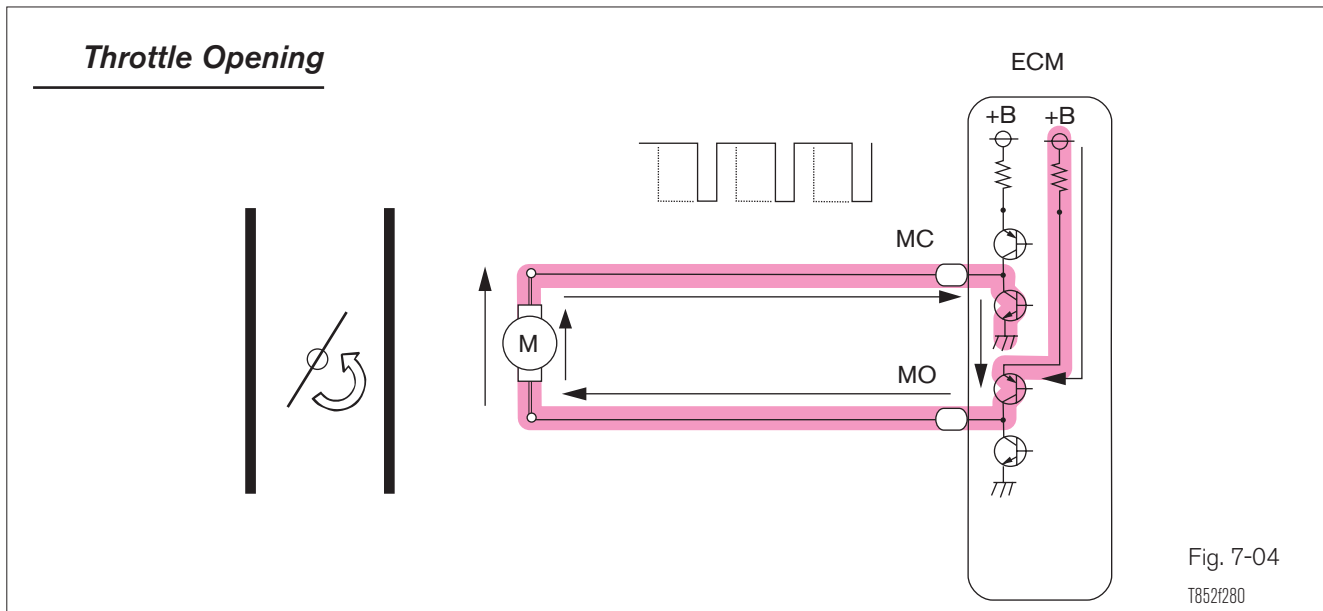
If the traction control mode is engaged, the pulsewidth will be less, limiting the rate of opening from idle. If the throttle valve is opened too far, the ECM will decrease the pulsewidth closing the throttle.

**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. In this state, the idle is higher than normal when the engine is at operating temperature.

**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.



**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.

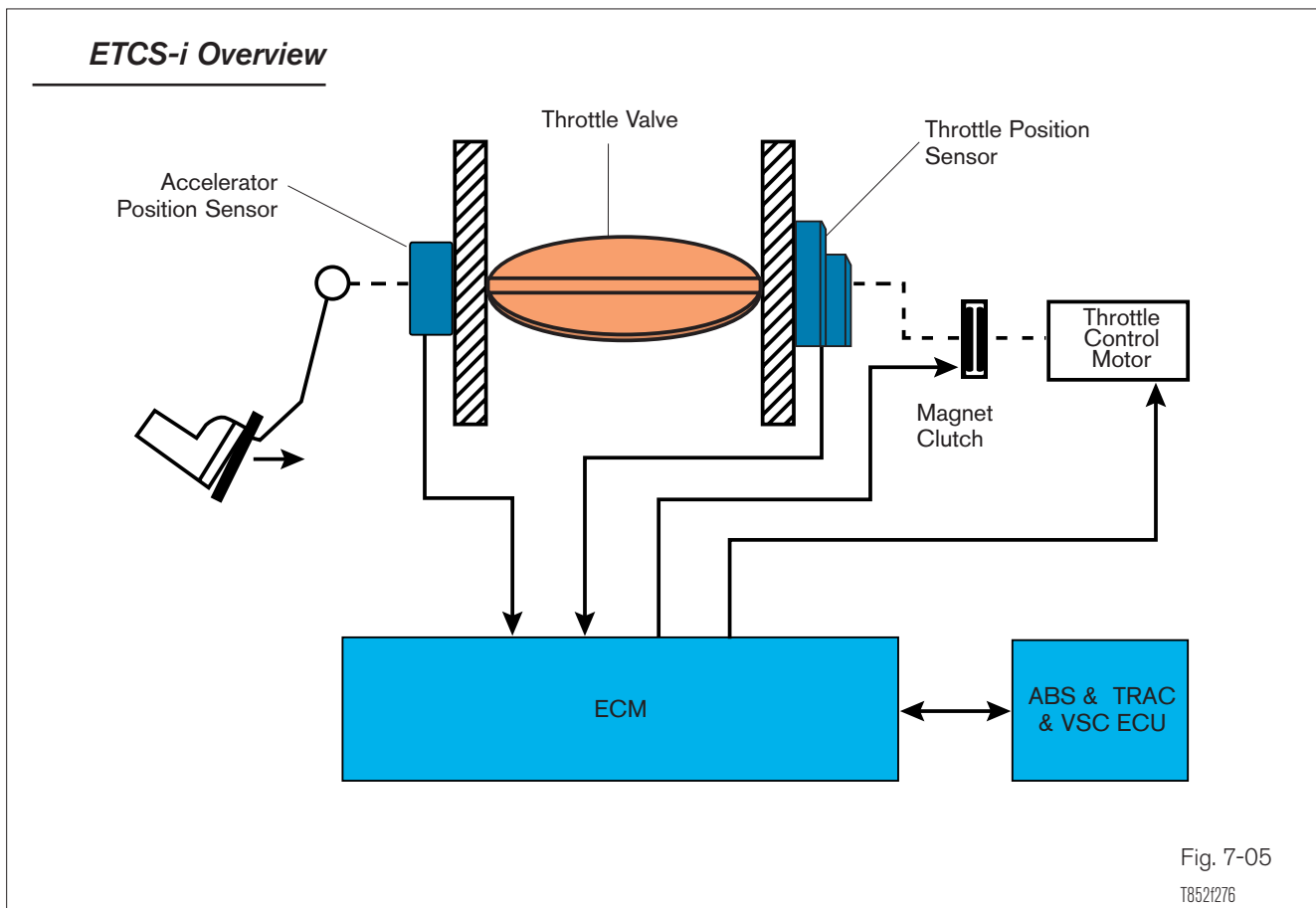


**Throttle Hold** To maintain the desired throttle valve angle, the applied duty ratio creates enough force in motor to oppose spring pressure.

**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.

### ETCS-i Link Type System Operation

The throttle motor operates the throttle valve as described previously. 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 throttle lever is connected by cable to the accelerator pedal. As the driver moves the accelerator pedal the APPS signal voltage changes indicating a new pedal position. The ECM then adjusts the throttle angle based on the APPS signals, engine conditions, and vehicle conditions. Later versions used a thermostat to keep the throttle body at the proper temperature.





### Thermostat

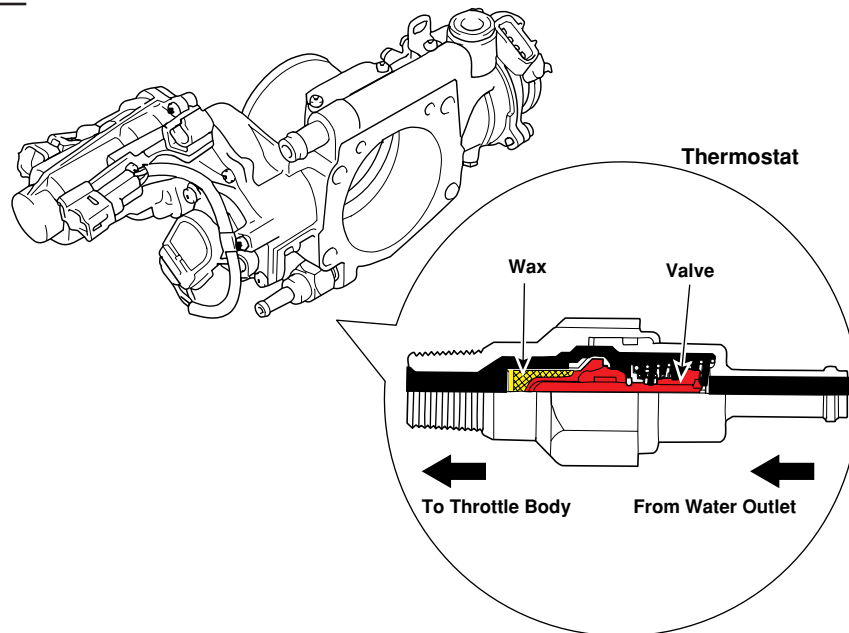


Fig. 7-06

T8521277

#### ETCS-i Link Type System Component Operation

The following is description on the function of the major components.

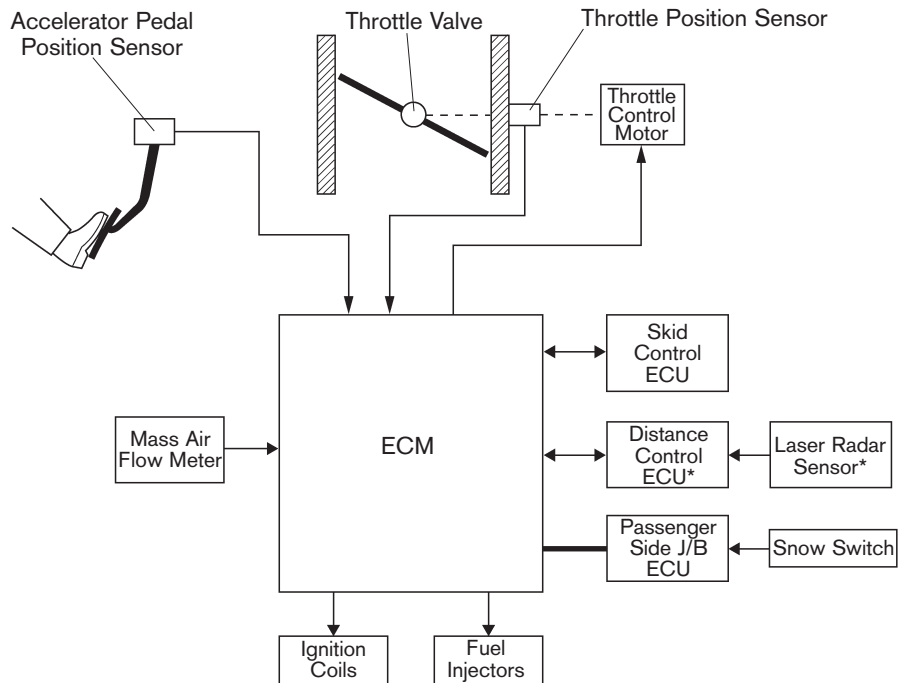
- Acceleration Pedal Position Sensor (APPS)** - The APPS, which is mounted on the throttle body, is integrated with the throttle lever. The throttle lever is connected by cable to the accelerator pedal. As the driver moves the accelerator pedal the APPS signal voltage changes indicating pedal position. 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 cycle regulated). If there is a malfunction in the system, the ECM shuts the circuit (and clutch circuit) off and the return springs return the throttle to the default position. 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 that will put the ETCS-I into Fail-Safe, the ECM will turn off the clutch circuit disengaging the motor from the throttle valve. If the ECM detects too much or not enough amperage in the circuit, the ECM will turn off the clutch.
- **Thermostat** - A thermostat is installed on some throttle bodies 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 Mode Link Type** 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 returns 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. The driver will notice the pedal travel is longer in relation to engine response and that the MIL is on. Furthermore, ISC and cruise control functions will not operate.

### ETCS-i Linkless Type System

*There is no mechanical link or electromagnetic clutch with this system.*



\*with Laser Cruise Control

Fig. 7-07

L852/1811

### ETCS-i Linkless Type System Operation

The linkless ETCS-i uses a compact throttle body with no mechanical connection between the accelerator pedal and throttle body. The accelerator pedal position sensor is mounted at the accelerator pedal. As the driver moves the accelerator pedal the APPS signal voltage changes indicating a new pedal position. The ECM then adjusts the throttle angle based on the APPS signals, engine conditions, and vehicle conditions. The throttle position sensor detects throttle valve angle.

This system does not use a magnetic clutch. Operation of this system is nearly identical to the link type.

### ETCS-i Linkless Type System Component Operation

The following is description on the function of the major components.

- Acceleration Pedal Position Sensor (APPS)** - The APPS is mounted at 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. By using two signals the ECM is able to compare and detect if there is anything wrong with the APPS's performance. See Fail-Safe Mode Linkless Type for more information.

- **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. See Fail-Safe Mode Linkless Type for more information.
- **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 cycle regulated). If there is a malfunction in the system, the ECM shuts the circuit off and the return springs return the throttle to the default position. The ECM will turn the motor off if there is excessive amperage or not enough amperage in the motor circuit.

Fail Safe Mode 3UZ-FE Linkless Type There are three different Fail-Safe modes with this system.

- **Fail-Safe Mode APPS Single Circuit Failure** - If either the main or sub Accelerator Pedal Position circuits should fail, the ECM provides an active throttle range from idle to approximately twenty-five percent of maximum throttle opening. The driver will notice distinct loss in power, but has limited control of engine RPM.

### Fail-Safe Mode APPS Single Circuit Failure

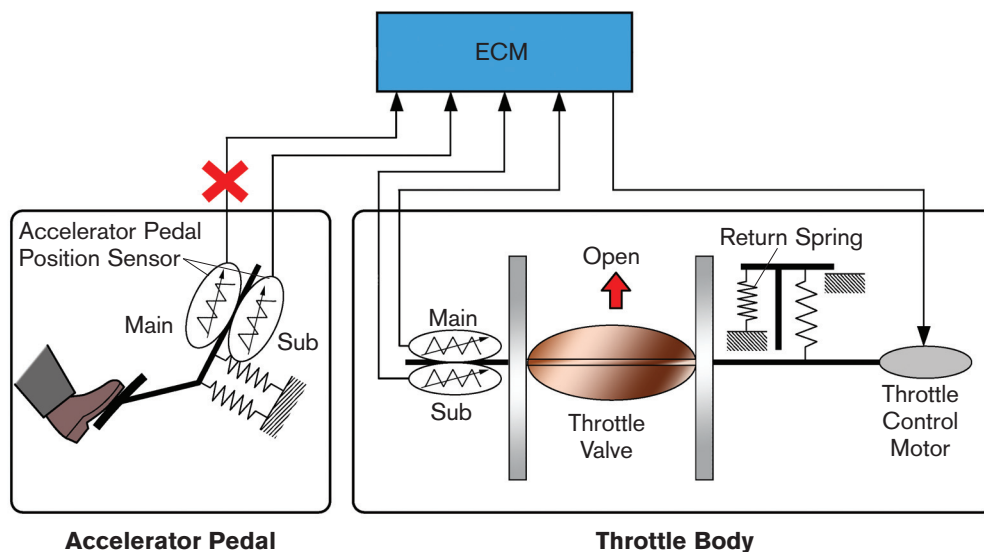


Fig. 7-08

L8521812

- Fail-Safe Mode APPS Dual Circuit Failure** - If the ECM detects a failure in both circuits of the Accelerator Pedal Position Sensor current to the throttle motor is turned off, and the force of the return spring causes the throttle valve to return and stay at a fixed (default) position. In this state, engine RPM is fixed. The driver has no control over engine RPM, but the vehicle will run allowing the vehicle to limp home.

### *Fail-Safe Mode APPS Dual Circuit Failure*

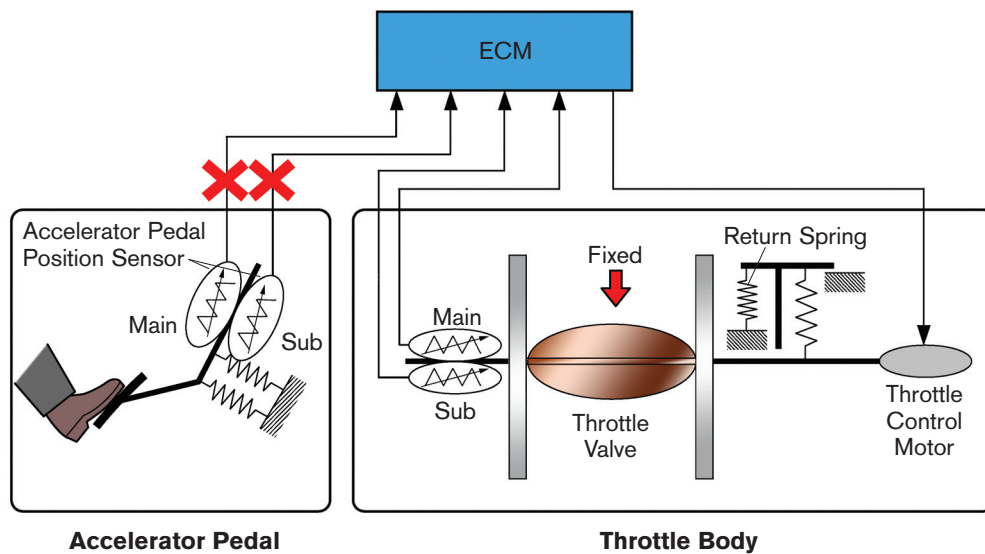


Fig. 7-09

L852f812

- Fail-Safe Mode TPS Circuit Failure** - Any failure of either of the TPS main and sub circuits causes the ECM to turn off the throttle control motor and the throttle valve is then held in a fixed (default) position by the return spring. But in this mode, engine RPM is regulated by controlling fuel injection and ignition timing according to the APPS signals. The driver will notice a distinct loss in power, but has limited control of engine RPM.

### ***Fail-Safe Mode TPS Circuit Failure***

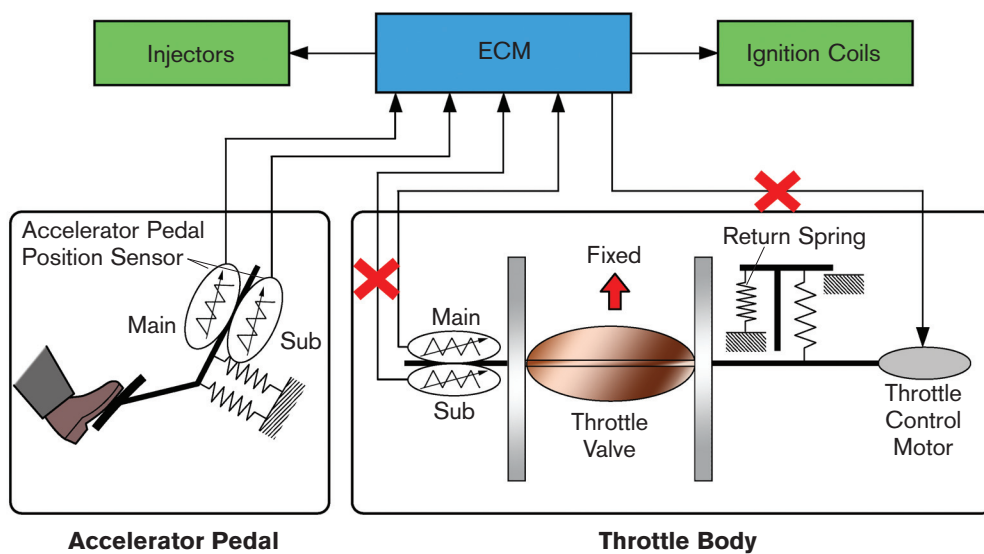


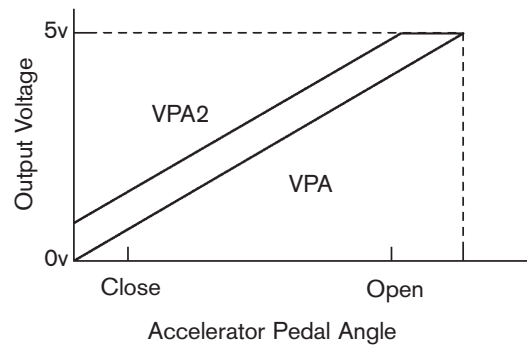
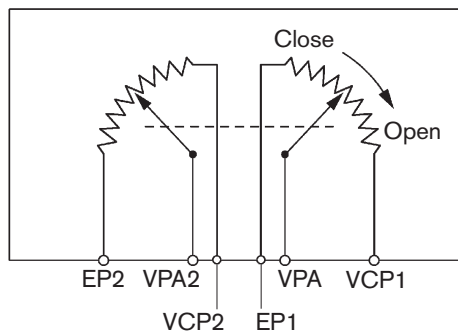
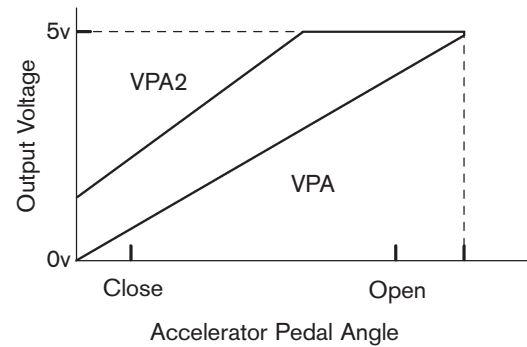
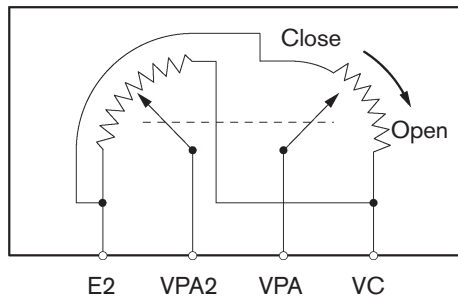
Fig. 7-10

L8521812

**Diagnosis** The diagnostic procedures for both systems are nearly identical. All ETCS-i DTCs are one trip DTCs. Retrieve the DTCs and follow repair manual procedures. The following is a general overview.

## APPS

*There are minor circuit variations with different APPSs. The circuits are checked by comparing voltage output to pedal position.*



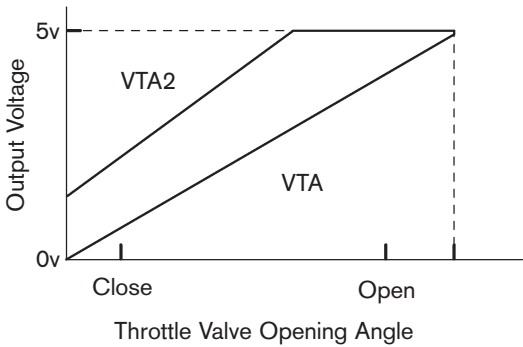
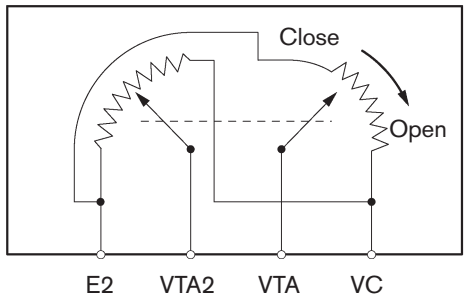
Accelerator pedal postion expressed as voltage				Trouble area
Accelerator pedal released		Accelerator pedal depressed		
ACCEL POS#1	ACCEL POS#2	ACCEL POS#1	ACCEL POS#2	
0V	0V	0V	0V	VC circuit open
0V	0.9V - 0.3V	0V	3.4 - 5.0V	VPA circuit open or ground short
0.5 - 0.1 V	0V	3.0 - 4.6V	0V	VPA2 circuit open or ground short
0V	0V	0V	0V	E2 circuit open

Fig. 7-11

T852f81/L852f815  
L852f816/L852f813

**TPS**

*The main and sub TPS circuits are checked by comparing voltage output to pedal position. If the TPS needs to be replaced, it must set according to the repair manual.*



Accelerator pedal postion expressed as percentage and voltage				Trouble area
Accelerator pedal released		Accelerator pedal depressed		
THROTTLE POS#1	THROTTLE POS#2	THROTTLE POS#1	THROTTLE POS#2	
0%	0V	0%	0V	VC circuit open
0%	2.0 - 2.9V	0%	4.6 - 5.1V	VTA circuit open or ground short
8 - 20%	0V	64 - 96%	0V	VTA2 circuit open or ground short
100%	5V	100%	0V	E2 circuit open

Fig. 7-12  
T852f281/L852f814



### 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.

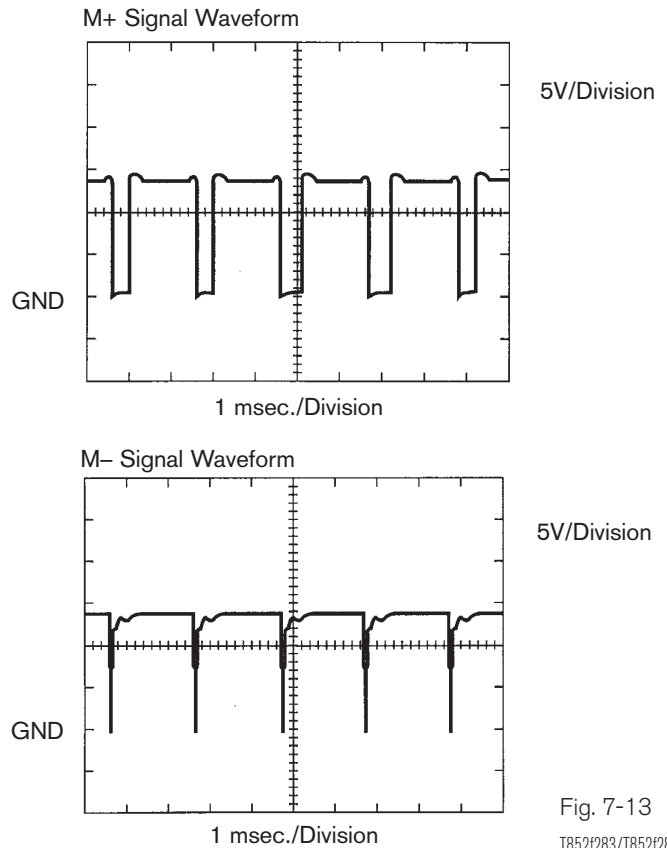


Fig. 7-13

T852f283/T852f282

### 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.

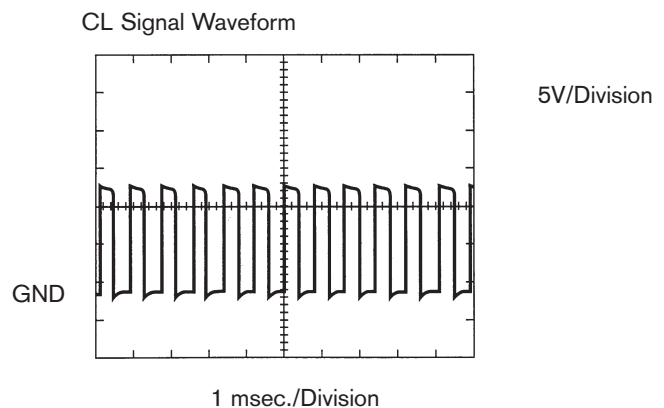


Fig. 7-14

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.

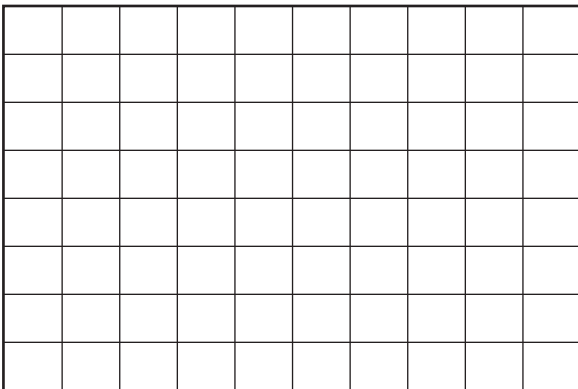
### Tools and Equipment

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

### Section 1

#### Throttle Control Motor

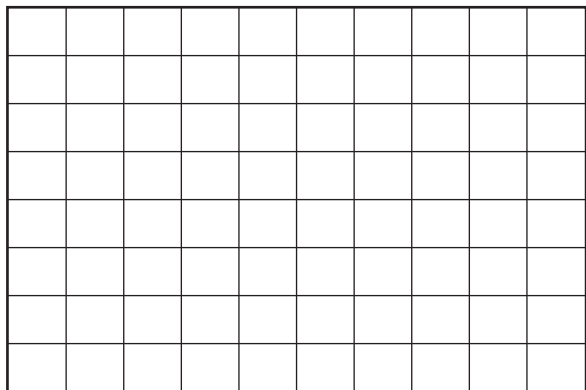
1. Connect the Diagnostic Tester Auto probe to the throttle motor circuit according to the Repair Manual. Start the engine and raise engine to approximately 1000 RPM. Draw or print the waveform.



2. Does the waveform match the Repair Manual waveform?

---

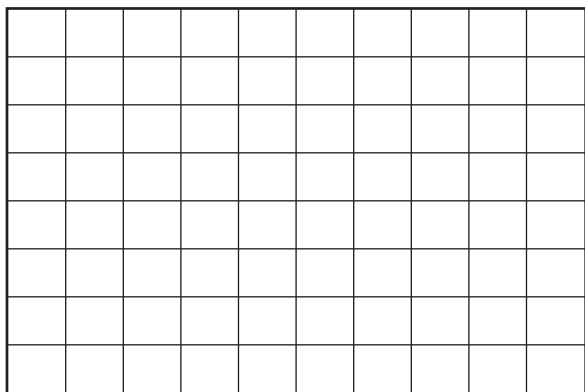
3. Raise engine RPM to 2000. What happened to the waveform and frequency? Draw the pattern.



### Throttle Clutch (Link Type Only)

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*			

\*If equipped



**Notes**

## ETCS-i System

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	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <i>I have questions</i> </div>	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <i>I know I can</i> </div>	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 with oscilloscope			
Test clutch with oscilloscope			
Check and retrieve relevant DTCs			
Check and retrieve relevant DTCs			
Locate in the RM two sections related to ETCS-i system concerns			



**Notes**