TABLE OF CONTENTS

TABLE OF CONTENTS - Continued

TABLE OF CONTENTS - Continued

TABLE OF CONTENTS - Continued

TABLE OF CONTENTS - Continued

NOTES

1.0   INTRODUCTION

The procedures contained in this manual include all the specifications, instructions, and graphics needed to diagnose <u>engine control module (ECM) and sentry key immobilizer system (SKIS) problems; they are no start, diagnostic trouble code, and no trouble code problems for the ECM.</u> The diagnostics in this manual are based on the trouble condition or symptom being present at the time of diagnosis.

When repairs are required, refer to the appropriate volume of the service manual for proper removal and repair procedure.

Diagnostic procedures change every year. New diagnostic systems may be added; carryover systems may be enhanced. IT IS RECOMMENDED THAT YOU REVIEW THE ENTIRE MANUAL TO BECOME FAMILIAR WITH ALL NEW AND CHANGED DIAGNOSTIC PROCEDURES.

This manual is designed to begin all diagnosis at the DTC TEST, which is located at the beginning of Section 7.1. This will cover all the necessary requirements to begin a logical diagnostic path for each problem. If there is a diagnostic trouble code (DTC) detected, it will direct you to the trouble code test. If there are no trouble codes present, it will direct you by symptom to a no-trouble code test.

This book reflects many suggested changes from readers of past issues. After using this book, if you have any comments or recommendations, please fill out the form at the back of the book and mail it back to us.

1.1   System Coverage

This diagnostic procedures manual covers all 1999 GS body equipped with the 2.5L VM diesel engine.

1.2   Six-Step Troubleshooting Procedure

Diagnosis of the engine control module (ECM) and SKIS is done in six basic steps:

- verification of complaint
- verification of any related symptoms
- symptom analysis
- problem isolation
- repair of isolated problem
- verification of proper operation

2.0   IDENTIFICATION OF SYSTEM

The engine control module (ECM) is located in the center of the passenger compartment behind the lower console. The sentry key immobilizer module is located below the steering column behind the steering wheel.

3.0   SYSTEM DESCRIPTION AND FUNCTIONAL OPERATION

3.1   General Description

The 2.5L VM diesel engine system is equipped with the latest in technical advances. The on-board diagnostics incorporated with the engine control module and SKIM are intended to assist the field technician in repairing vehicle problems by the quickest means.

3.2   Functional Operation

3.2.1   ECM On-Board Diagnostics

The ECM has been programmed to monitor many different circuits of the diesel fuel injection system. This monitoring is called "on-board diagnosis".

Certain criteria must be met for a diagnostic trouble code to be entered into the ECM memory. The criteria may be a range of: engine rpm, engine temperature, and/or input voltage to the ECM. If all of the criteria for monitoring a system or circuit are met and a problem is sensed, then a trouble code will be stored in the ECM.

It is possible that a trouble code for a monitored circuit may not be entered into the ECM memory even though a malfunction has occurred. This may happen when the monitoring criteria have not been met.

The ECM compares input signal voltages from each input device with specifications (the established high and low limits of the range) that are programmed into it for that device. If the input voltage is not within specifications and other trouble code criteria are met, a trouble code will be stored in the ECM memory.

3.2.2   ECM Operating Modes

As input signals to the engine control module (ECM) change, the ECM adjusts its response to output devices. For example, the ECM must calculate a different fuel quantity and fuel timing for idle than it does for wide open throttle. There are several different modes of operation that determine how the ECM responds to the various input signals.

Ignition Switch On (Engine Off Mode)
When the ignition switch activates the fuel injection system, the following actions occur:

1. The ECM determines atmospheric air pressure from the atmospheric pressure sensor located in the ECM.

2. The ECM energizes the fuel quantity actuator and the fuel shudown solenoid if no faults are present.

If the engine is not started within 5 seconds of ignition on, the ECM deactivates the fuel quantity actuator and the fuel shutdown solenoid to prevent overheating.

Engine Start-Up Mode -The ECM uses the engine temperature sensor, fuel temperature sensor, atmospheric pressure sensor, boost pressure sensor and the engine speed sensor to determine fuel delivery during this mode.

Normal Driving Modes - Engine idle, warm-up, acceleration, deceleration and wide open throttle modes are all controlled based on the sensor inputs to the ECM and are modified based on engine temperature, boost pressure and engine speed.

Overheat Protection Mode - If engine temperature becomes too hot, the ECM activates high speed radiator fan operation and limits fuel quantity for engine protection.

Limp-In Modes - The ECM operates in limp-in mode when certain system faults are detected. The ECM operates in one of the following modes based on the severity of the fault:

1. 10% torque reduction.

2. 50% torque reduction.

3. Engine speed limited to 1100 rpm.

After-Run - When fused ignition switch output is removed from the ECM cavity 47, the ECM performs a self-diagnostic check in the following order:

1. Electrical shut-off test

2. Fuel quantity actuator test

3. Monitoring module test

4. Voltage regulator test

5. Main relay test (if tests 1-4 pass)

If any of tests 1-4 fail, the fault is stored in memory, and can be retrieved during the next ignition cycle using the DRB.

3.2.3 Monitored Circuits

The ECM is able to monitor and identify most driveability related trouble conditions. Some circuits are directly monitored through ECM feedback circuitry. In addition, the ECM monitors the voltage state of some circuits and compares those states with expected values. Other systems are monitored indirectly when the ECM conducts a rationality test to identify problems.

Although most subsystems of the powertrain control module are either directly or indirectly monitored, there may be occasions when diagnostic trouble codes are not immediately identified. For a trouble code to set, specific conditions must be met and unless these conditions are encountered, a code will not set.

3.2.4 SKIS On-Board Diagnostics

The SKIS module has been programmed to transmit and monitor many different coded messages as well as CCD Bus messages. This monitoring is called "On-Board Diagnosis".

Certain criteria must be met for a diagnostic trouble code to be entered into the Sentry Key Immobilizer Module (SKIM) memory. The criteria may be a range of: input voltage, CCD Bus messages, or coded messages to the SKIM. If all of the criteria for monitoring a circuit or function are met and a fault is sensed, a diagnostic trouble code will be stored in the SKIM memory.

3.2.5 SKIS Overview

The Sentry Key Immobilizer System (SKIS) is an immobilizer system designed to prevent unauthorized vehicle operation. The system consists of a Sentry Key Immobilizer Module (SKIM), ignition key(s) equipped with a transponder chip, engine controller and body controller. When the ignition switch is turned on, the SKIM interrogates the ignition key. If the ignition key is "Valid" the SKIM sends a CCD Bus message to the body controller indicating the presence of a valid ignition key. The BCM then supplies the ECM with a valid immobilizer signal allowing the engine to continue to operate.

3.2.6 SKIS Operation

When ignition power is supplied to the SKIM, the SKIM performs an internal self-test. After the self-test is completed, the SKIM energizes the antenna (this activates the transponder chip) and sends a challenge to the transponder chip. The transponder chip responds to the challenge by generating an encrypted response message using the following:

Secret Key – This is an electronically stored value (identification number) that is unique to each SKIS. The secret key is stored in the SKIM, BCM and all ignition key transponders.

Challenge – This is a random number that is generated by the SKIM at each ignition key cycle.

The secret key and challenge are plugged into an algorithm that produces the encrypted response message. The transponder uses the crypto algorithm to receive, decode and respond to the message sent by SKIM. After responding to the coded message, the transponder sends a transponder I.D. message to the SKIM. The SKIM compares the transponder I.D. to the available valid key codes in SKIM memory (8 key maximum). After validating the key the SKIM sends a CCD Bus message called a "Seed Request" to the body controller then waits for a body controller response. If the body controller does not respond, the SKIM will send the seed request again. After three failed attempts the SKIM will stop sending the seed request and store a trouble code. If the body controller sends a seed response, the SKIM sends a valid/invalid key message to the body controller. This is an encrypted message that is generated using the following:

VIN – Vehicle Identification Number

Seed – This is a random number that is generated by the BCM at each ignition key cycle.

The VIN and seed are plugged into a rolling code algorithm that encrypts the "valid/invalid key" message. The body controller uses the rolling code algorithm to receive, decode and respond to the valid/invalid key message sent by SKIM. After sending the valid/invalid key message the SKIM waits 3.5 seconds for an PCM status message from the body controller. If the BCM does not respond with a valid key message to the SKIM, a fault is detected and a trouble code stored.

The SKIS incorporates a warning ("ALARM SET") lamp located in the message center. The lamp receives switched ignition voltage and is hardwired to the body controller. The lamp is actuated when the SKIM sends a CCD Bus message to the body controller requesting the lamp on. The body controller then provides the ground for the lamp. The SKIM will request lamp operation for the following:

   – bulb check at ignition on
   – to alert the vehicle operator to a SKIS malfunction

For all faults except transponder faults and VIN mismatch, the lamp remains on steady. In the event of a transponder fault the light flashes at the rate of 1Hz (once per second). If a fault is present the lamp will remain on or flashing for the complete ignition cycle. If a fault is stored in SKIM memory which prevents the system from operating properly, the ECM will allow the engine to start and run (for 2 seconds) up to six times. After the sixth attempt, the ECM disables the starter relay until the fault is corrected..

3.3   Diagnostic Trouble Codes

Each diagnostic trouble code is diagnosed by following a specific testing procedure. The diagnostic test procedures contain step-by-step instructions for determining the cause of trouble codes as well as no trouble code problems. It is not necessary to perform all of the tests in this book to diagnose an individual code.

Always begin by reading the diagnostic trouble codes using the DRB. This procedure begins in the DTC TEST - Checking the System for Diagnostic Trouble Codes. This will direct you to the specific test(s) that must be performed.

3.3.1   Hard Code

A diagnostic trouble code that comes back within one cycle of the ignition key is a "hard" code. This means that the defect is there every time the engine control module/SKIM checks that circuit or function. Procedures in this manual verify if the trouble code is a hard code at the beginning of each test. When it is not a hard code, an "intermittent" test must be performed.

3.3.2   Intermittent Code

A diagnostic trouble code that is not there every time the engine control module/SKIM checks the circuit is an "intermittent" code. Most intermittent codes are caused by wiring or connector problems. Defects that come and go like this are the most difficult to diagnose; they must be looked for under specific conditions that cause them. The following checks may assist you in identifying a possible intermittent problem:

- Visually inspect related wire harness connectors. Look for broken, bent, pushed out, or corroded terminals.

- Visually inspect the related harnesses. Look for chafed, pierced, or partially broken wire.

- Refer to any hotlines or technical service bulletins that may apply.

NOTE: Electromagnetic (radio) interference can cause an intermittent system malfunction. This interference can interrupt communication between the ignition key transponder and the SKIM.

3.3.3   Reset Counter

The reset counter counts the number of times the vehicle has been started since codes were last set, erased, or the battery was disconnected. The reset counter will count up to 255 start counts. The number of starts helps determine when the trouble code actually happened. This is recorded by the ECM and can be viewed on the DRB as the RESET COUNTER.

When there are no trouble codes stored in memory, the DRB will display "NO TROUBLE CODES FOUND" and the reset counter will show "RESET COUNT = XXX."

3.3.4   ECM Diagnostic Trouble Codes

A/C CONTROL SHORT CIRCUIT
A/C CONTROL OPEN CIRCUIT
A/C SYSTEM PRESSURE SIGNAL HIGH EXCEEDED
A/C SYSTEM PRESSURE SIGNAL LOW EXCEEDED
A/C SYSTEM PRESSURE SUPPLY HIGH EXCEEDED
A/C SYSTEM PRESSURE SUPPLY LOW EXCEEDED
ACCELERATOR PEDAL SENSOR SIGNAL HIGH EXCEEDED
ACCELERATOR PEDAL SENSOR PLAUSIBILITY
ACCELERATOR PEDAL SENSOR PWG PLAUS WITH LOW IDLE SWITCH
ACCELERATOR PEDAL SENSOR PWG PLAUS WITH POTENTIOMETER
ATMOSPHERIC PRESSURE SENSOR SRC HIGH EXCEEDED
ATMOSPHERIC PRESSURE SENSOR SRC LOW EXCEEDED
BATTERY VOLTAGE SRC HIGH EXCEEDED
BRAKE SIGNAL PLAUS WITH REDUNDANT CONTACT
CLUTCH SIGNAL PLAUSIBILITY
CONTROL SLEEVE SENSOR SIGNAL HIGH EXCEEDED
CONTROL SLEEVE SENSOR START END POS. NOT ATTAINED
CONTROL SLEEVE SENSOR STOP END POS. NOT ATTAINED
CRUISE STATUS INDICATOR LAMP SHORT CIRCUIT
DIAGNOSTIC LAMP OPEN CIRCUIT
DIAGNOSTIC LAMP SHORT CIRCUIT
DIESEL POWER RELAY SHUTS OFF TOO EARLY
DIESEL POWER RELAY SHUTS OFF TOO LATE
EEPROM PLAUSIBILITY CHECKSUM ERROR FOR ADJ. (EGR)
EEPROM PLAUSIBILITY CHECKSUM ERROR IN CC212
EEPROM PLAUSIBILITY COMMUNICATION WITH EEPROM
EEPROM PLAUSIBILITY FUNC. SWITCH WRONG OR MISSING
EEPROM PLAUSIBILITY VER. NUMBER NOT CORRESPONDING

EGR OPEN CIRCUIT
EGR SHORT CIRCUIT
ENGINE SPEED SENSOR DYNAMIC PLAUSIBILITY
ENGINE SPEED SENSOR OVER SPEED RECOGNITION
ENGINE SPEED SENSOR STATIC PLAUSIBILITY
FAN CONTROL OPEN CIRCUIT FAN#1
FAN CONTROL OPEN CIRCUIT FAN #2
FAN CONTROL SHORT CIRCUIT FAN #1
FAN CONTROL SHORT CIRCUIT FAN #2
FUEL QUANTITY ACTUATOR NEG. GOV. DEVIATION COLD
FUEL QUANTITY ACTUATOR NEG. GOV. DEVIATION WARM
FUEL QUANTITY ACTUATOR POS. GOV. DEVIATION COLD
FUEL QUANTITY ACTUATOR POS. GOV. DEVIATION WARM
FUEL TEMPERATURE SENSOR SRC HIGH EXCEEDED
FUEL TEMPERATURE SENSOR SRC LOW EXCEEDED
GLOW RELAY #1 CONTROLLER OPEN CIRCUIT
GLOW RELAY #2 CONTROLLER OPEN CIRCUIT
GLOW RELAY #1 CONTROLLER SHORT CIRCUIT
GLOW RELAY #2 CONTROLLER SHORT CIRCUIT
IMMOBILIZER SIGNAL LOST
INVALID SKIM MESSAGE
INDUCTIVE AUX. SPEED SENSOR DYNAMIC PLAUSIBILITY
INDUCTIVE AUX. SPEED SENSOR OVERSPEED RECOGNITION
INDUCTIVE AUX. SPEED SENSOR PLAUSIBILITY
INDUCTIVE AUX. SPEED SENSOR STATIC PLAUSIBILITY
MICROCONTROLLER GATE-ARRAY MONITORING
MICROCONTROLLER GATE-ARRAY WATCHDOG
MICROCONTROLLER PREPARE FUEL QUANTITY STOP
MICROCONTROLLER RECOVERY HAS OCCURRED
MICROCONTROLLER REDUNDANT OVERRUN MONITORING
NEEDLE MOVEMENT SENSOR SRC HIGH EXCEEDED
NEEDLE MOVEMENT SENSOR SRC LOW EXCEEDED
REDUNDANT EMER. STOP PLAUSIBILITY IN AFTER-RUN
REDUNDANT EMER. STOP POWERSTAGE DEFECTIVE
REGULATOR LOWER REGULATOR LIMIT
REGULATOR UPPER LIMIT
SOLENOID VALVE CONTROLLER OPEN CIRCUIT
SOLENOID VALVE CONTROLLER SHORT CIRCUIT
TEMPERATURE OF ENGINE COOLANT SRC HIGH EXCEEDED
TEMPERATURE OF ENGINE COOLANT SRC LOW EXCEEDED
TERMINAL #15 PLAUSIBILITY AFTER START-UP
TIMING GOVERNING NEGATIVE GOVERNOR DEVIATION
TIMING GOVERNING POSITIVE GOVERNOR DEVIATION
TURBOCHARGER BOOST SENSOR SIGNAL HIGH EXCEEDED
TURBOCHARGER BOOST SENSOR SIGNAL LOW EXCEEDED
TURBOCHARGER BOOST SENSOR SUPPLY HIGH EXCEEDED
TURBOCHARGER BOOST SENSOR SUPPLY LOW EXCEEDED
TURBOCHARGER BOOST SENSOR PLAUSIBILITY
VEHICLE SPEED SENSOR PEC FREQUENCY TOO HIGH
VEHICLE SPEED SENSOR SIGNAL SRC HIGH EXCEEDED
VEHICLE SPEED SENSOR PLAUSIBILITY

3.3.5 SKIM Diagnostic Trouble Codes

ANTENNA FAILURE
COP FAILURE
EEPROM FAILURE
PCM STATUS FAILURE
INTERNAL FAULT
RAM FAILURE
ROLLING CODE FAILURE
SERIAL LINK EXTERNAL FAULT
STACK OVERFLOW FAILURE
TRANSPONDER COMMUNICATION FAILURE
TRANSPONDER CRC (CYCLIC REDUNDANCY CHECK) FAILURE
TRANSPONDER ID MISMATCH
TRANSPONDER RESPONSE MISMATCH
VIN MISMATCH

3.3.6 Handling No Trouble Code Problems

After reading Section 3.0 (System Description and Functional Operation), you should have a better understanding of the theory and operation of the on-board diagnostics, and how this relates to the diagnosis of a vehicle that may have a driveability-related symptom or complaint.

The "no code" system is broken down into three test methods:

– No Code Complete Test

– No Code Quick Individual Test

– No Code Quick Symptom Test

3.4 Using the DRB

Refer to the DRB user's guide for instructions and assistance with reading trouble codes, erasing trouble codes, and other DRB functions.

3.5 DRB Error Messages and Blank Screen

Under normal operation, the DRB will display one of only two error messages:

– User-Requested WARM Boot or User-Requested COLD Boot

This is a sample of such an error message display:

```
ver: 2.14
date: 26 Jul93
file: key_itf.cc
date: Jul 26 1993
line 548
err: 0x1
User-Requested COLD Boot

Press MORE to switch between this display
    and the application screen.
Press F4 when done noting information.
```

3.5.1   DRB Does Not Power Up

If the LED's do not light or no sound is emitted at start up, check for loose cable connections or a bad cable. Check the vehicle battery voltage (data link connector cavity 16). A minimum of 11 volts at DLC cavity 16 is required to adequately power the DRB. Check for proper ground connection at DLC cavities 4 and 5.

If all connections are proper between the DRB and the vehicle or other devices, and the vehicle battery is fully charged, an inoperative DRB may be the result of faulty cable or vehicle wiring. For a blank screen, refer to the appropriate diagnostics manual.

3.5.2   Display is Not Visible

Low temperatures will affect the visibility of the display. Adjust the contrast to compensate for this condition.
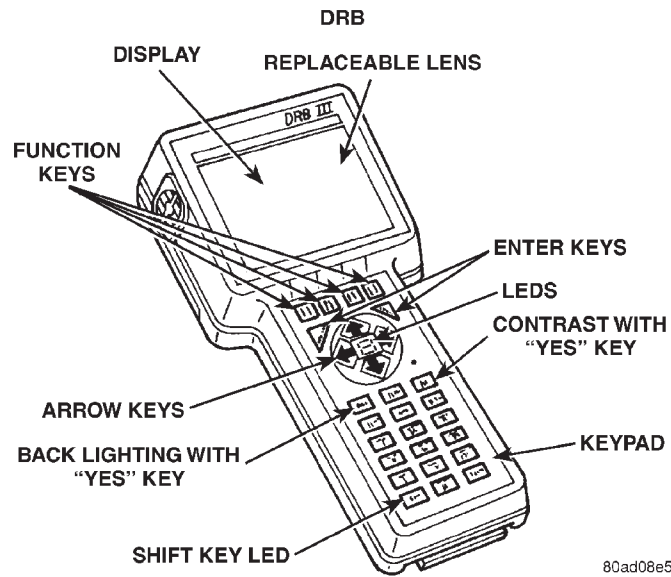
4.0   SYSTEM COMPONENT LOCATIONS

4.1   Engine Control Module

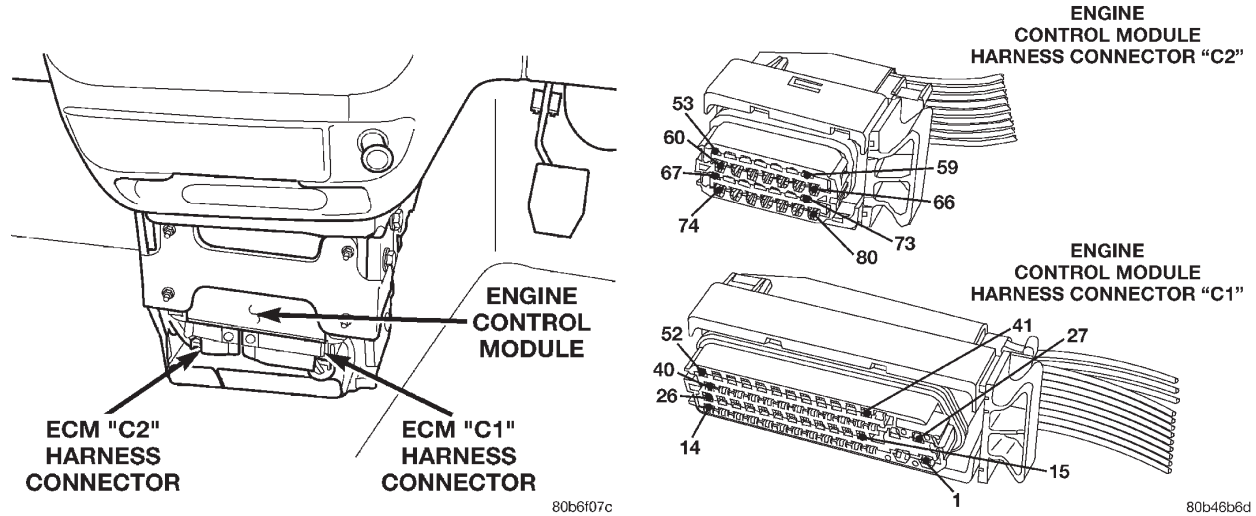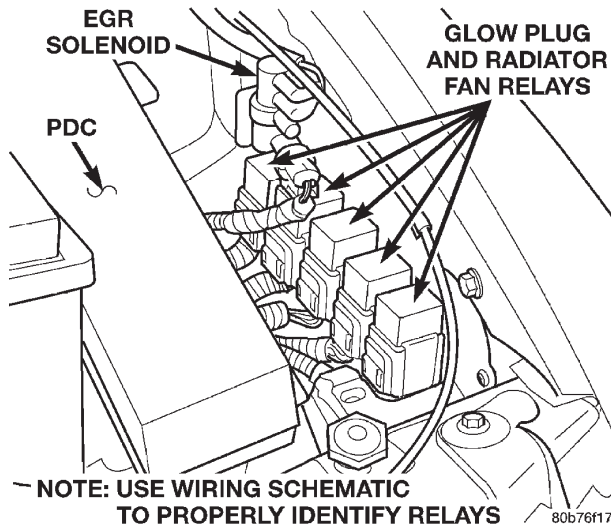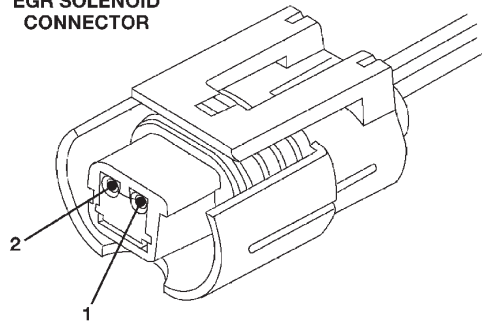### 2.5L

ENGINE
CONTROL
MODULE

ECM "C2"
HARNESS
CONNECTOR

ECM "C1"
HARNESS
CONNECTOR

ENGINE
CONTROL MODULE
HARNESS CONNECTOR "C2"

ENGINE
CONTROL MODULE
HARNESS CONNECTOR "C1"

80b6f07c

80b46b6d

CAV	CKT/COLOR	FUNCTION
1	Z12 BK/TN	Ground
2	A142 DG/OR	Diesel Power Relay Output
3	K90 TN	Starter Relay Control
5	C13 DB/OR	A/C Compressor Clutch Control
6	K159 VT/RD	Engine Speed Sensor Signal Output
8	C103 DG/LB	A/C Switch Signal
9	K29 WT/PK	Secondary Brake Switch Signal
11	K6 VT/WT	5-Volt Supply
12	K151 WT	Low Idle Position Switch Sense
13	K21 BK/RD	Intake Air Temperature Sensor Signal
17	C24 DB/PK	Low Speed Fan Control
20	L50 WT/TN	Primary Brake Switch Signal
23	K167 BR/YL	Accelerator Pedal Position Sensor Ground
24	K22 OR/DB	Accelerator Pedal Position Sensor Signal
27	Z12 BK/TN	Ground
28	A142 DG/OR	Diesel Power Relay Output
29	K35 GY/YL	EGR Solenoid Control
30	V38 LB/RD	Speed Control Lamp Control
33	K51 DB/YL	Diesel Power Relay Control
34	G385 OR/PK	Diagnostic/Glow Plug Lamp Control
38	G56 OR/BK	Immobilizer Signal
39	K9 LB	5-Volt Supply
40	K1 DG/RD	Boost Pressure Sensor Signal
41	C137 YL	High Speed Fan Control

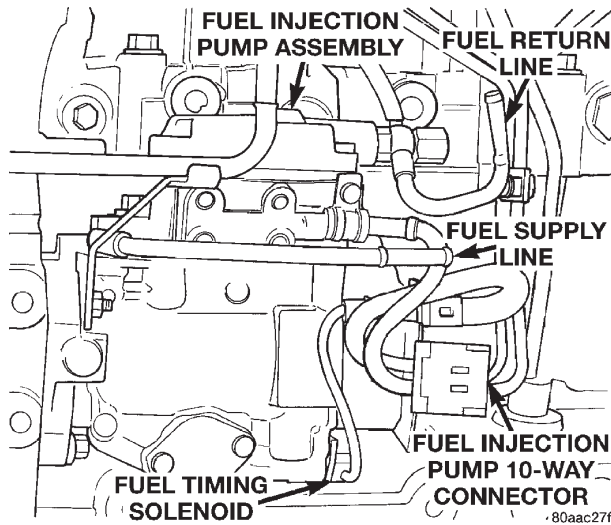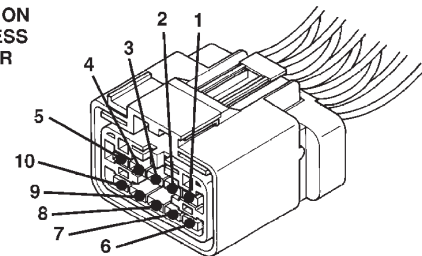| CAV	CKT/COLOR	FUNCTION
42	K152 WT/DG	Glow Plug Relay #1 Control
43	K252 LG/OR	Glow Plug Relay #2 Control
45	D21 PK	ISO K-line
46	K119 LG/BK	Clutch Pedal Switch Signal
47	F87 WT/BK	Ignition Switch Supply
50	K7 OR	5-Volt Supply
51	G7 WT/OR	Vehicle Speed Sensor Signal
52	C18 DB	A/C Pressure Sensor Signal
53	K156 GY	Fuel Temperature Sensor Signal
54	K2 TN/BK	Engine Coolant Temperature Sensor Signal
55	K68 LG/YL	Needle Movement Sensor Ground
56	K134 LB/BK	Control Sleeve Position Sensor Signal
57	K57 LG/OR	Middle Tap
58	K135 WT/BK	Measure Coil
59	K140TN/WT	Fuel Quantity Actuator Control
60	V37 RD/LG	Speed Control Switch Signal
61	K4 BK/LB	Sensor Ground
62	K67 BR/BL	Neddle Movement Sensor Signal
66	K140 TN/WT	Fuel Quantity Actuator Control
67	K24 GY/BK	Engine Speed Sensor Signal
69	K3 BK/VT	Engine Speed Sensor Ground
77	K153 OR/DG	Fuel Shutdown Solenoid Control
79	K126 LG	Fuel Timing Solenoid Control
80	K140 TN/WT	Fuel Quantity Actuator Control

9

4.2 Controls and Solenoids

EGR SOLENOID

PDC

GLOW PLUG AND RADIATOR FAN RELAYS

NOTE: USE WIRING SCHEMATIC TO PROPERLY IDENTIFY RELAYS

80b76f17

EGR SOLENOID CONNECTOR

2

1

80ae5fa4

CAV	COLOR	FUNCTION
1	DG/OR	DIESEL POWER RELAY OUTPUT
2	GY/YL	EGR SOLENOID CONTROL

FUEL INJECTION PUMP ASSEMBLY

FUEL RETURN LINE

FUEL SUPPLY LINE

FUEL TIMING SOLENOID

FUEL INJECTION PUMP 10-WAY CONNECTOR

80aac27f

FUEL INJECTION PUMP HARNESS CONNECTOR

2 1
3
4
5
10
9
8
7
6

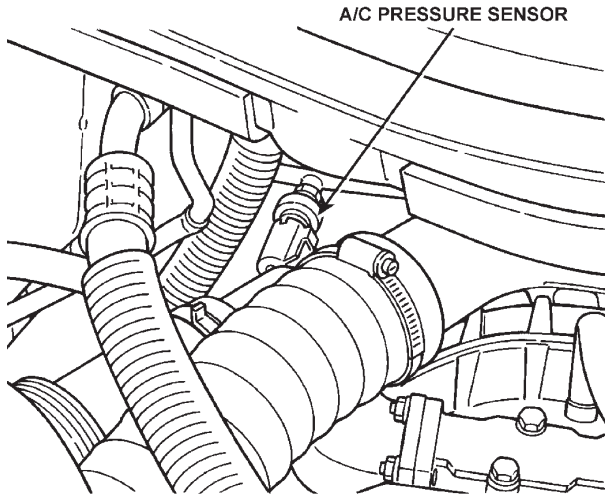| CAV	COLOR	FUNCTION
1	LB/BK	Control Sleeve Position Sensor Signal
2	LG/OR	Middle Tap
3	WT/BK	Measure Coil
4	BK/LB	Fuel Temperature Sensor Ground
5	LG	Fuel Timing Solenoid Control
6	OR	Fuel Shutdown Solenoid Control
7	GY	Fuel Temperature Sensor Signal
8	TN/WT	Fuel Quantity Actuator Control
9	DG/OR	Diesel Power Relay Output
10	DG/OR	Diesel Power Relay Output

80aaf0b1

4.3 Data Link Connector

16-WAY DATA LINK CONNECTOR

80a4835f

DATA LINK CONNECTOR

3
4
11
5
7
16

CAV	COLOR	FUNCTION
3	VT/BK	CCD BUS +
4	BK/LG	GROUND
5	BK/WT	GROUND
7	PK	ISO K-LINE
11	WT/BK	CCD BUS -
16	PK	FUSED (B+)

80ababf7

4.4   Sensors

A/C PRESSURE SENSOR

80aac2a7

A/C PRESSURE
SENSOR HARNESS
CONNECTOR

2
1
3
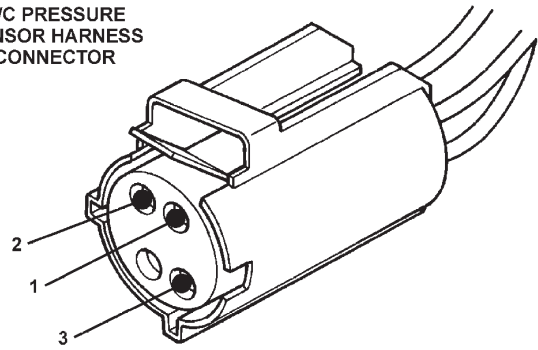
CAV	COLOR	FUNCTION
1	BK/LB	SENSOR GROUND
2	OR	5-VOLT SUPPLY
3	DB	A/C PRESSURE SENSOR SIGNAL

80aa4b64

ACCELERATOR
PEDAL
POSITION
SENSOR
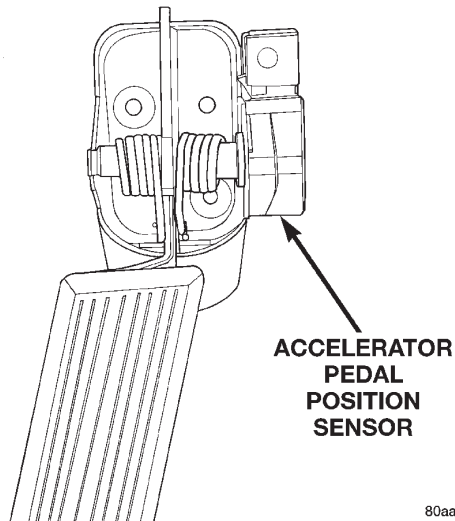
80aafb00

ACCELERATOR PEDAL
POSITION SENSOR
HARNESS CONNECTOR

10
8
7
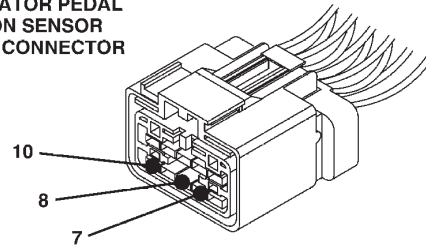
CAV	COLOR	FUNCTION
7	OR/DB	ACCEL PEDAL POSITION SENSOR SIGNAL
8	BR/YL	SENSOR GROUND
10	VT/WT	5-VOLT SUPPLY

80aa4b8b

FUEL INJECTION
PUMP ASSEMBLY

FUEL RETURN
LINE

FUEL SUPPLY
LINE

FUEL INJECTION
PUMP 10-WAY
CONNECTOR

FUEL TIMING
SOLENOID

80aac27f

FUEL INJECTION
PUMP HARNESS
CONNECTOR

2 1
4 3
5
10
9
8
7
6

CAV	COLOR	FUNCTION
1	LB/BK	Control Sleeve Position Sensor Signal
2	LG/OR	Middle Tap
3	WT/BK	Measure Coil
4	BK/LB	Fuel Temperature Sensor Ground
5	LG	Fuel Timing Solenoid Control
6	OR	Fuel Shutdown Solenoid Control
7	GY	Fuel Temperature Sensor Signal
8	TN/WT	Fuel Quantity Actuator Control
9	DG/OR	Diesel Power Relay Output
10	DG/OR	Diesel Power Relay Output

80aaf0b1

SENSOR
ELECTRICAL
CONNECTOR

ENGINE SPEED
SENSOR

80ab36c8

ENGINE SPEED
SENSOR HARNESS
CONNECTOR

3

1
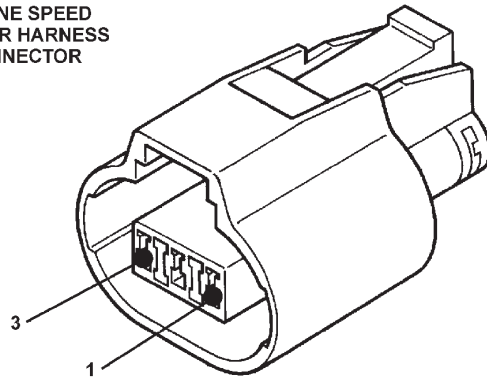
CAV	COLOR	FUNCTION
1	BK/LB	SENSOR GROUND
3	GY/BK	ENGINE SPEED SENSOR SIGNAL

80aa4b86

BOOST
PRESSURE
SENSOR
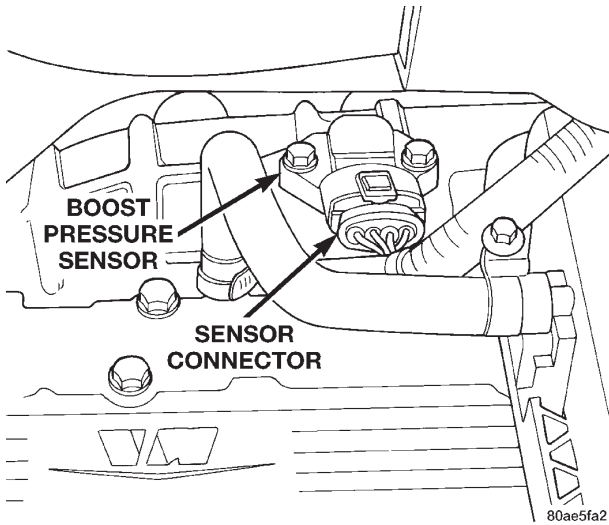
SENSOR
CONNECTOR

80ae5fa2

BOOST PRESSURE SENSOR
HARNESS CONNECTOR

1

4
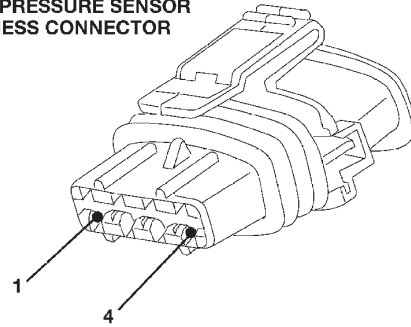
CAV	COLOR	FUNCTION
1	BK/LB	SENSOR GROUND
2	BK/RD	IAT SENSOR SIGNAL
3	LB	5-VOLT SUPPLY
4	DG/RD	BOOST PRESSURE SENSOR SIGNAL

80b7707c

NEEDLE MOVEMENT
SENSOR

FUEL INJECTOR
(NUMBER 1
CYLINDER ONLY)

COPPER
WASHER
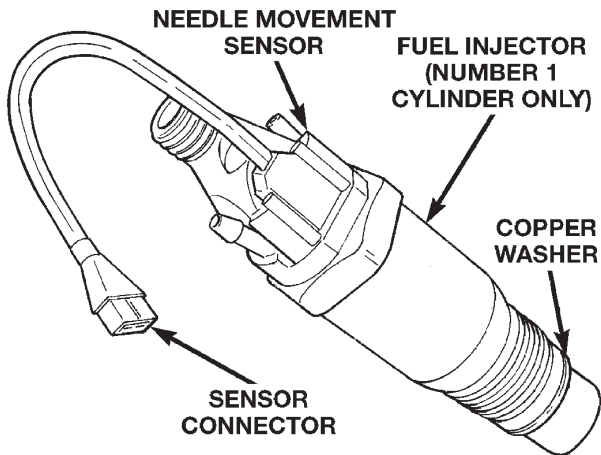
SENSOR
CONNECTOR

80ab36c9

NEEDLE MOVEMENT SENSOR
HARNESS CONNECTOR

1

2
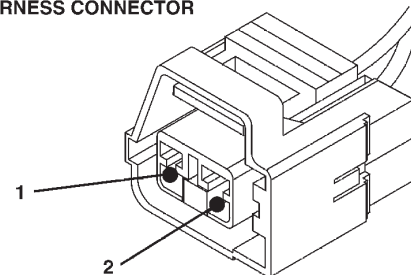
CAV	COLOR	FUNCTION
1	BR/BK	NEEDLE MOVEMENT SENSOR SIGNAL
2	LG/YL	NEEDLE MOVEMENT SENSOR GROUND

80aa4b89

FUEL INJECTION PUMP

ENGINE COOLANT TEMPERATURE SENSOR
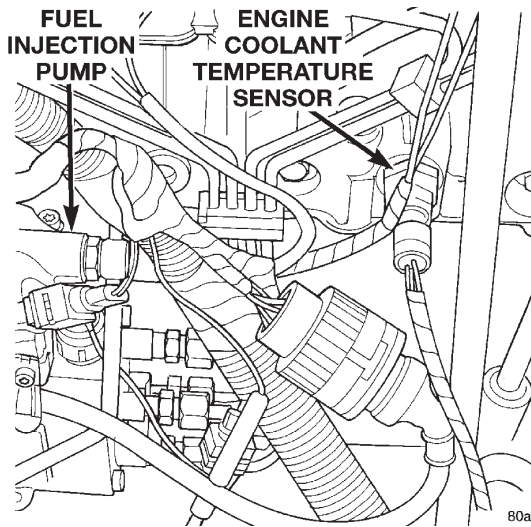
80ab36ca

ENGINE COOLANT TEMPERATURE SENSOR HARNESS CONNECTOR
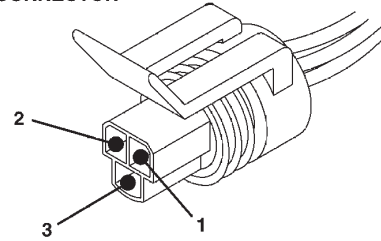
CAV	COLOR	FUNCTION
1	TN/BK	ECT SENSOR SIGNAL
2	BK/LB	SENSOR GROUND
3	BK/YL	ECT SENSOR SIGNAL

80aa4b88

SENSOR ELECTRICAL CONNECTOR

VEHICLE SPEED SENSOR
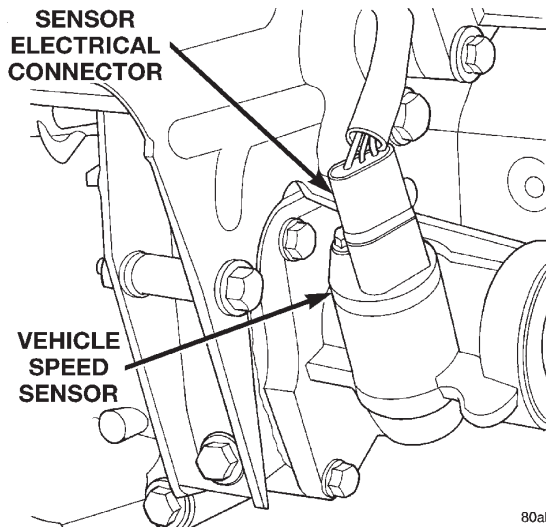
80ab36cb

VEHICLE SPEED SENSOR HARNESS CONNECTOR
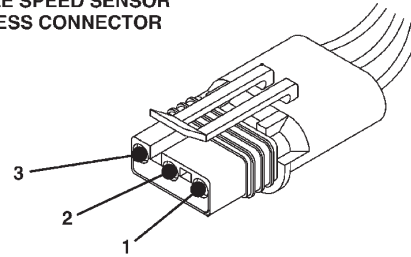
CAV	COLOR	FUNCTION
1	WT/BK	FUSED BATTERY SUPPLY
2	BK/LB	VSS GROUND
3	WT/OR	VSS SIGNAL

80aa4b87

4.6   Relays

(REAR OF) POWER DISTRIBUTION CENTER

DIESEL POWER RELAY

3 (30)   5 (87)   4(87A)   2(85)   1(86)
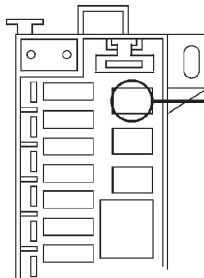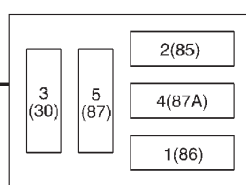
CAV	COLOR	FUNCTION
3(30)	*	FUSED BATTERY SUPPLY
2(85)	DB/YL	DIESEL POWER RELAY CONTROL
1(86)	*	BATTERY SUPPLY
5(87)	DG/OR	DIESEL POWER RELAY OUTPUT

* BUS BAR

80b6f077

(FRONT OF) POWER DISTRIBUTION CENTER

A/C CLUTCH RELAY

87   87A   85   86   30
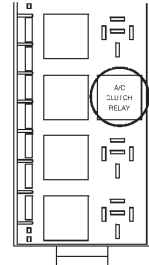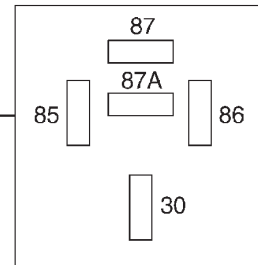
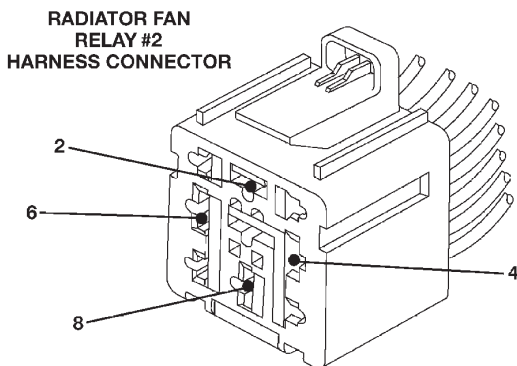| CAV	COLOR	FUNCTION
30	*	FUSED BATTERY SUPPLY
85	DB/OR	A/C COMP CLUTCH RELAY CONTROL
86	DG/OR	DIESEL POWER RELAY OUTPUT
87	DB/BK	A/C COMP CLUTCH RELAY OUTPUT

* BUS BAR

80ae0eab

G E N E R A L   I N F O R M A T I O N

4.6   Relays (Continued)

EGR SOLENOID

PDC

GLOW PLUG AND RADIATOR FAN RELAYS

NOTE: USE WIRING SCHEMATIC TO PROPERLY IDENTIFY RELAYS

80b76f17

RADIATOR FAN RELAY #1 HARNESS CONNECTOR
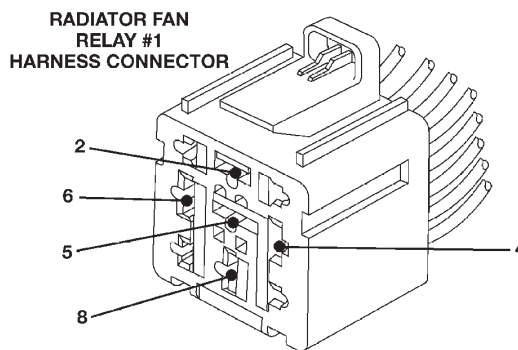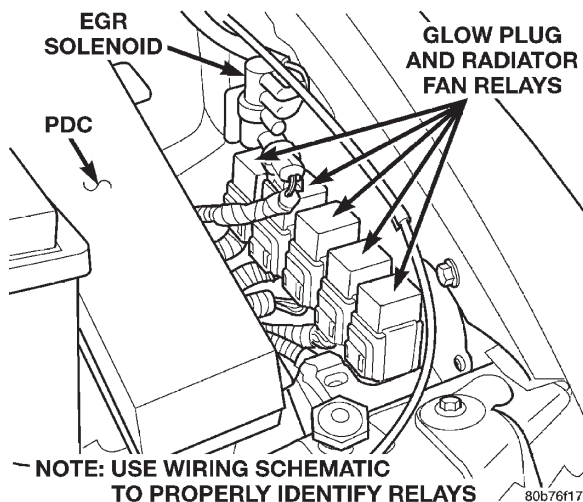
CAV	COLOR	FUNCTION
2 (87)	BK	GROUND
4 (86)	DG/OR	DIESEL POWER RELAY OUTPUT
5 (87A)	DB/PK	FAN SUPPLY
6 (85)	YL	HIGH SPEED FAN CONTROL
8 (30)	LG/WT	GROUND

80b76e6e

RADIATOR FAN RELAY #2 HARNESS CONNECTOR

CAV	COLOR	FUNCTION
2 (87)	YL	FAN RELAY #2 OUTPUT
4 (86)	DG/OR	DIESEL POWER RELAY OUTPUT
6 (85)	DB/PK	LOW SPEED FAN CONTROL
8 (30)	GY	BATTERY SUPPLY

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RADIATOR FAN RELAY #3 HARNESS CONNECTOR
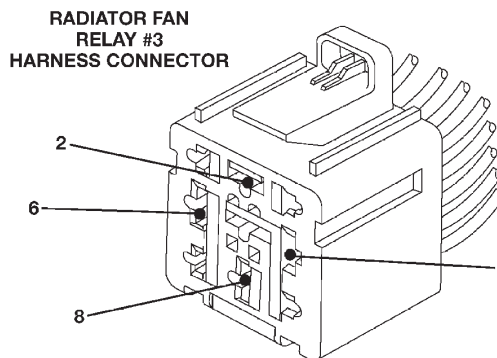
CAV	COLOR	FUNCTION
2 (87)	DB/PK	FAN RELAY #3 OUTPUT
4 (86)	DG/OR	DIESEL POWER RELAY OUTPUT
6 (85)	YL	HIGH SPEED FAN CONTROL
8 (30)	RD/BK	BATTERY SUPPLY

80b76e70

GLOW PLUG RELAY #1 HARNESS CONNECTOR
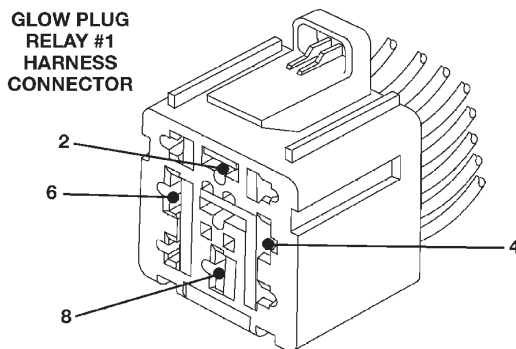
CAV	COLOR	FUNCTION
2 (87)	GY	GLOW PLUG RELAY #1 OUTPUT
4 (86)	WT	GLOW PLUG RELAY #1 CONTROL
6 (85)	DG/OR	DIESEL POWER RELAY OUTPUT
8 (30)	RD	FUSED B (+)

80b6f07f

GLOW PLUG RELAY #2 HARNESS CONNECTOR
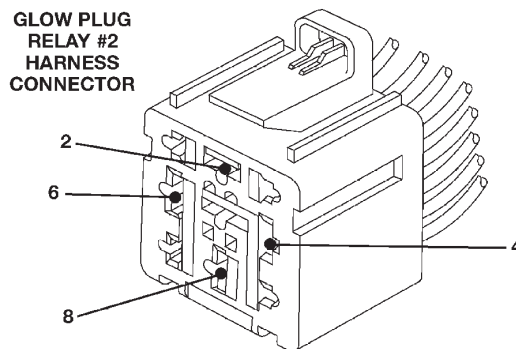
CAV	COLOR	FUNCTION
2 (87)	GY	GLOW PLUG RELAY #2 OUTPUT
4 (86)	WT	GLOW PLUG RELAY #2 CONTROL
6 (85)	DG/OR	DIESEL POWER RELAY OUTPUT
8 (30)	RD	FUSED B (+)

80b76e73