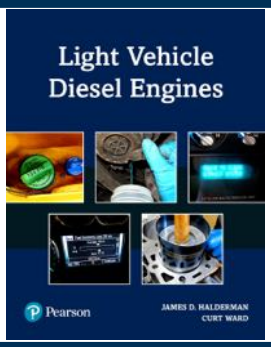
Light Vehicle Diesel Engines

First Edition



Chapter 18
CAN and Network Communication

LEARNING OBJECTIVES (1 of 2)

18.1 Prepare for ASE Electrical/Electronic Systems (A6) certification test content area "A" (General Electrical/Electronic Systems Diagnosis).

18.2 Describe the types of networks and serial communications used on vehicles.

18.3 Discuss how the networks connect to the data link connector and to other modules.

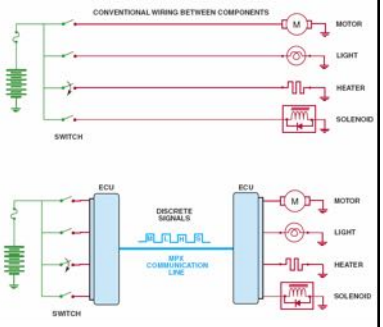
18.4 Explain how to diagnose module communication faults.

MODULE COMMUNICATIONS AND NETWORKS

- **NEED FOR NETWORK** Page 205
  - Since the 1990s USED
  - Modules to control operation of most components.
    - Vehicle will have 10 or more modules
  - Communicate with each other over data lines
    - or hard wiring, depending on application.
- **ADVANTAGES**
  - **Fewer Wires**
  - **Common sensor data shared W/other modules**

NETWORK FUNDAMENTALS (1 of 2)

FIGURE 18–1 Module communications makes controlling multiple electrical devices and accessories easier by utilizing simple low-current switches to signal another module, which does actual switching of current to device.



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NETWORK FUNDAMENTALS (2 of 2)

- **MODULES & NODES** **Page 205**
- **TYPES OF COMMUNICATION**
  - **Differential**
  - **Parallel**
  - **Serial data**
  - **Multiplexing**

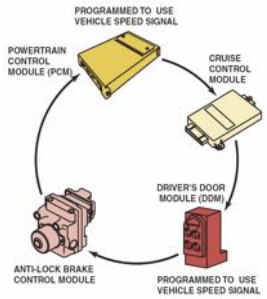

FIGURE 18–2 A network allows all modules to communicate with other modules.

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What Is a BUS?

FREQUENTLY ASKED QUESTION

- **BUS** is a term used to describe a communications network. Therefore, there are *connections to the BUS* and *BUS communications* , both of which refer to digital messages being transmitted among electronic modules or computers.

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What Is a Protocol?

FREQUENTLY ASKED QUESTION

- **PROTOCOL**: set of rules or a standard used between computers or electronic control modules. Protocols include type of electrical connectors, voltage levels, and frequency of the transmitted messages. Protocols, therefore, include both the hardware and software needed to communicate between modules.

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MODULE COMMUNICATIONS CONFIGURATION

- 3 most common types of networks used:
  - Page 207
    - –Ring Link Networks
    - –Star Link Networks: J42236
    - –Ring/Star Hybrid

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FIGURE 18–3 ring link network reduces the number of wires it takes to interconnect all of the modules

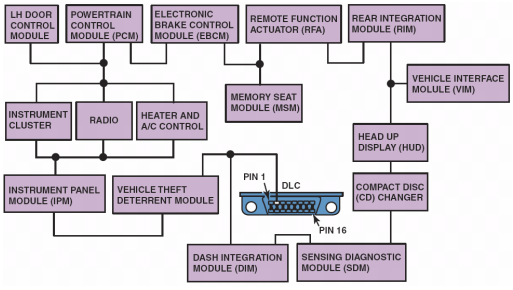

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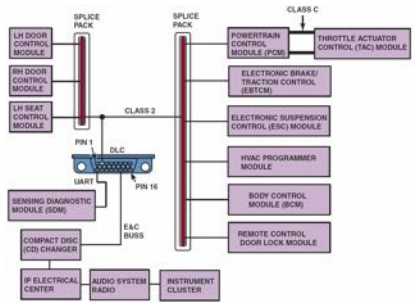
FIGURE 18–4 In a star link network, all of the modules are connected using splice packs



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NETWORK COMMUNICATIONS CLASSIFICATIONS

- **SAE** standards include the following three categories of in-vehicle network communications.
  - **CLASS A** P23
  - **CLASS B**
  - **CLASS C**

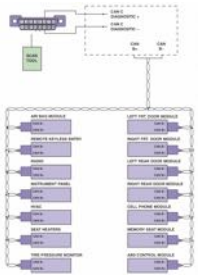

FIGURE 18–5 BUS system showing module CAN communications and twisted pairs of wire.

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GM COMMUNICATIONS PROTOCOL (1 of 5)

- **UART:**
- **Entertainment & Comfort Communication**
- **Class 2 Communications**
- **Keyword Communication**
- **GMLAN**
  - **Low-speed GMLAN:**
    - **Power windows & door locks**
  - **High-speed GMLAN**
    - **two-twisted-wire circuit**
    - **DLC on pins 6 and 14**

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FIGURE 18–6 UART serial data master control module connected to data link connector at pin 9

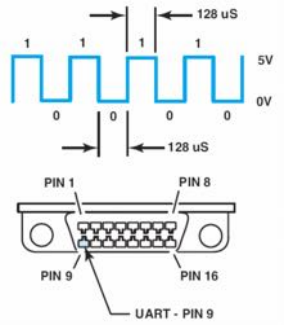

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FIGURE 18–7 E & C serial data is connected to data link connector (DLC) at pin 14.

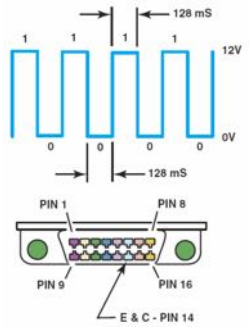

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FIGURE 18–8 Class 2 serial data communication is accessible at data link connector (DLC) at pin 2

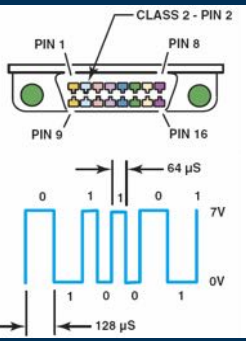

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FIGURE 18–9 Keyword 82 operates at a rate of 8,192 bps, similar to UART, and keyword 2000 operates at a baud rate of 10,400 bps (the same as a Class 2 communicator).

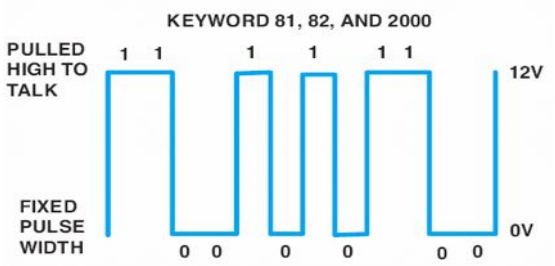

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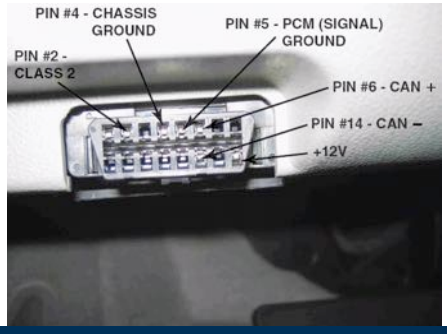
FIGURE 18–10 GMLAN uses pins at terminals 6 and 14



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Why Is a Twisted Pair Used? See Figure 18-11

? FREQUENTLY ASKED QUESTION

- Twisted pair is where 2 wires are twisted to prevent electromagnetic radiation from affecting signals passing through wires. By twisting two wires about once every inch (9 to 16 times per foot), **interference is canceled by adjacent wire**.

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FIGURE 2–11 twisted pair is used by several different network communications protocols to reduce interference that can be induced in wiring from nearby electromagnetic sources.

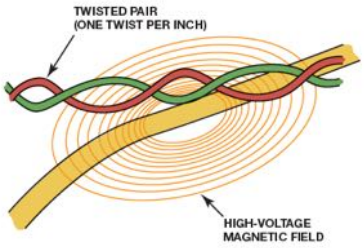

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FIGURE 18–12 A CANDi module will flash green LED rapidly if communication is detected.

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FORD NETWORK COMMUNICATIONS PROTOCOLS

- **STANDARD CORPORATE PROTOCOL**
- **UART-BASED PROTOCOL**

FIGURE 18–13 A Ford OBD-I diagnostic link connector showing that SCP communication uses terminals in cavities 1 (upper left) and 3 (lower left).

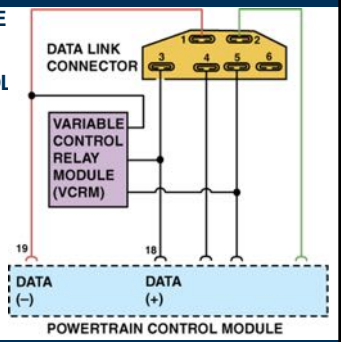

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FIGURE 18–14 scan tool can be used to check communications with the SCP BUS through terminals 2 &10 & to other modules connected to terminal 7 of DLC

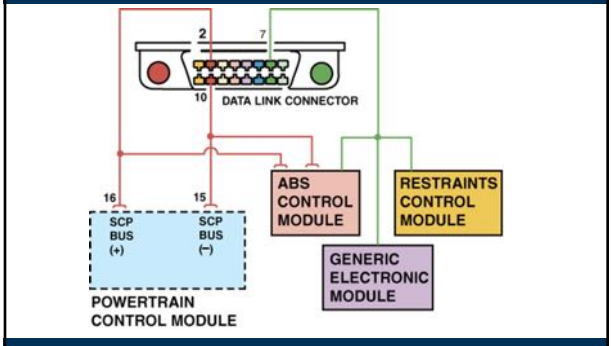

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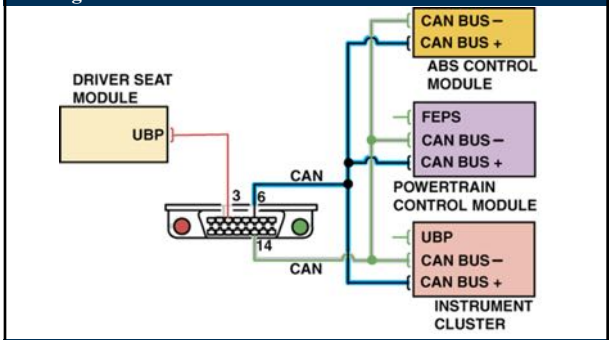
FIGURE 18–15 Many Fords use UBP module communications along with CAN.



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What Are U Codes?

FREQUENTLY ASKED QUESTION

- **"U" diagnostic trouble codes** were at first "undefined" but are now **network-related codes**. Use network codes to help pinpoint the circuit or module that is not working correctly.
- **U instead of "P" in DTC**

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CHRYSLER COMMUNICATIONS PROTOCOLS (1 of 4)

- CCD
- PROGRAMMABLE CONTROLLER INTERFACE
- SERIAL COMMUNICATIONS INTERFACE

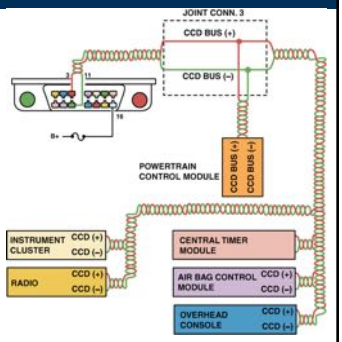

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FIGURE 18–17 Differential voltage for CCD BUS is created by using resistors in module.

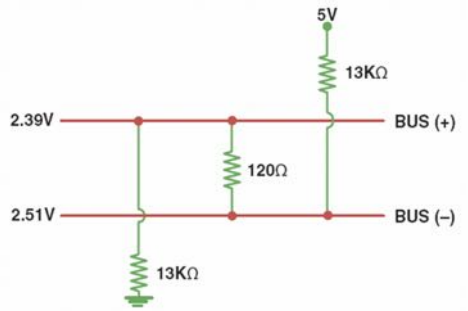

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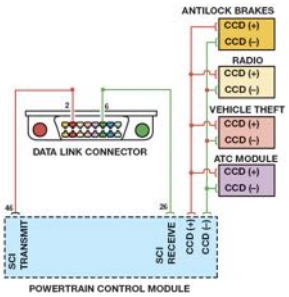
FIGURE 18–18 Many Chrysler vehicles use both SCI and CCD for module communication



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CONTROLLER AREA NETWORK (1 of 5)

- CAN FEATURES (Bosch Developed)
  - Faster than other BUS communication protocols
  - Less affected by electromagnetic interference (Data is
  - transferred on two wires that are twisted together, called
  - twisted pair, to help reduce EMI interference.)
  - Message based rather than address based,
  - No wakeup needed because it is a two-wire system

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CONTROLLER AREA NETWORK (2 of 5), Figure 18-19

- CAN FEATURES (Bosch Developed)
  - Supports up to 15 modules plus a scan tool
  - 120 ohm resistor at the ends of each pair
    - Reduce electrical noise
  - Applies 2.5 volts on both wires:
  - H (high) goes to 3.5 volts when active
  - L (low) goes to 1.5 volts when active

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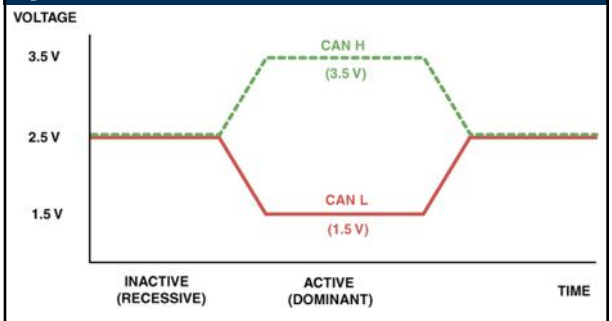
FIGURE 2–19 CAN uses a differential type of module communication where the voltage on one wire i the equal but opposite voltage on the other wire. When no communication is occurring, both wires have 2.5 volts applied. When communication is occurring, CAN H goes up 1 volt to 3.5 volts and CAN L goes down 1 volt to 1.5 volts.



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CONTROLLER AREA NETWORK (3 of 5)

- CAN CLASS A, B, & C: CAN A:
  - Only one wire at slow
  - less expensive to build
  - Data transfer rate 33.33 Kbs in normal mode
  - Up to 83.33 Kbs during reprogramming mode
  - uses vehicle ground as signal return circuit

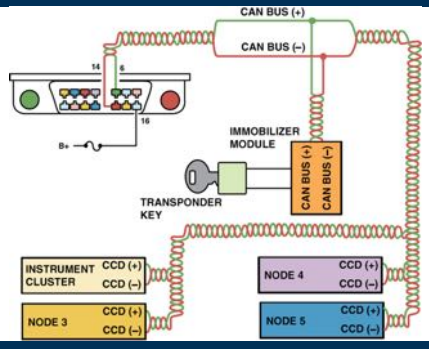
CONTROLLER AREA NETWORK (4 of 5)

- CAN CLASS A, B, & C: CAN B
  - 2-wire network, does not use vehicle ground as signal return
  - Data transfer rate of 95.2 Kbs
  - CANB (& CAN C) uses 2 network wires for differential signaling
  - 2 data signal voltages are opposite & one used for error
  - When signal voltage at one of CAN data wires goes high (CAN H)
    - Other one goes low (CAN L)
  - Differential signaling
    - Also used for redundancy, in case one of signal wires shorts out

CONTROLLER AREA NETWORK (5 of 5)

- CAN CLASS A, B, & C: CAN C
  - Highest speed CAN protocol: Speeds up to 500 Kbs
  - 2008: all vehicles sold in US must use CAN C BUS
  - For scan tool communications
  - Most OEMS started using CAN in older models
  - CAN BUS communicates to scan tool through
  - Terminals 6 and 14 of DLC

FIGURE 18–20 typical (generic) system showing how CAN BUS connected to various electrical accessories & systems in vehicle



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HONDA/TOYOTA COMMUNICATIONS

- Primary BUS communications on pre-CAN-equipped vehicles is ISO 9141-2 using terminals 7 &15 at OBD-II DLC

FIGURE 18–21 DLC from pre-CAN Acura. It shows terminals in cavities 4, 5 (grounds), 7, 10, 14, &16 (B+).

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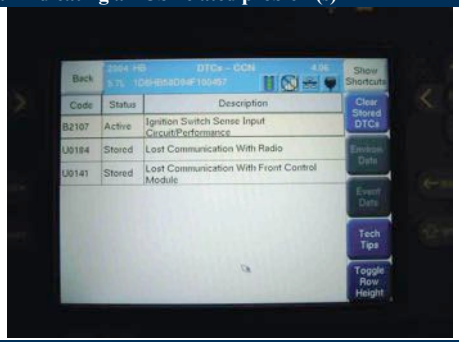
FIGURE 18–22 Honda scan display showing B and two U codes, all indicating a BUS-related problem(s)



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EUROPEAN BUS COMMUNICATIONS (1 of 2)

- UNIQUE DIAGNOSTIC CONNECTOR: Pages 215-216
- MEDIA ORIENTED SYSTEM TRANSPORT BUS
- MOTOROLA INTERCONNECT BUS
- DISTRIBUTED SYSTEM INTERFACE BUS
- BOSCH-SIEMANS-TEMIC BUS
- BYTEFLIGHT BUS
- FLEXRAY BUS
- DOMESTIC DIGITAL BUS
- LOCAL INTERCONNECT NETWORK BUS

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EUROPEAN BUS COMMUNICATIONS (2 of 2)

FIGURE 18–23 A typical 38-cavity diagnostic connector as found on BMW and Mercedes vehicles under the hood. The use of a breakout box (BOB) connected to this connector can often be used to gain access to module BUS information.

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How Do You Know What System Is Used?

FREQUENTLY ASKED QUESTION

- Use **service information** to determine which network communication protocol is used. However, due to various systems on some vehicles, it may be easier to look at **DLC** to determine the system. All OBD-II vehicles have terminals in following cavities.
  - **Terminal 4: chassis ground**
  - **Terminal 5: computer (signal) ground**
  - **Terminal 16: 12 V positive**
- **Terminals in cavities 6 & 14 mean vehicle equipped with CAN** as only module communication protocol available at DLC. To perform a test of the BUS, use **BREAKOUT BOX (BOB)** to gain access to terminals while connecting to vehicle, using a scan tool.

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FIGURE 18–24 breakout box (BOB) used to access BUS terminals while using scan tool to activate modules. This breakout box is equipped with LEDs that light when circuits are active.

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No Communication? Try Bypass Mode:

TECH TIP

- If a Tech 2 scan tool shows "no communication," try using bypass mode to see what should be on the data display. To enter bypass mode, perform the following steps.
  - **STEP 1** Select tool option (F3).
  - **STEP 2** Set communications to bypass (F5).
  - **STEP 3** Select enable.
  - **STEP 4** Input make/model and year of vehicle.
  - **STEP 5** Note all parameters that should be included, as shown. The values will not be shown.

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NETWORK COMMUNICATIONS DIAGNOSIS (1 of 2)

- **STEPS TO FINDING A FAULT: Pages 216-217**
  - **Network Communications Fault Suspected:**
    - **STEP 1 Check everything does & does not work**
    - **STEP 2 Perform module status test**
    - **STEP 3 Check resistance of terminating resistors**
    - **STEP 4 Check data BUS for voltages**
    - **STEP 5 Use DSO to monitor waveforms of BUS circuit**
    - **STEP 6 Follow factory service information instructions to isolate cause of fault**

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NETWORK COMMUNICATIONS DIAGNOSIS (2 of 2)

FIGURE 18–25
Honda scan tool allows YOU to turn on individual lights & operate individual power windows & other accessories connected to BUS

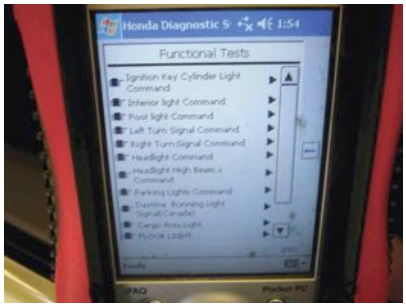

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FIGURE 18–26 Modules used in a GM vehicle can be "pinged" using Tech 2

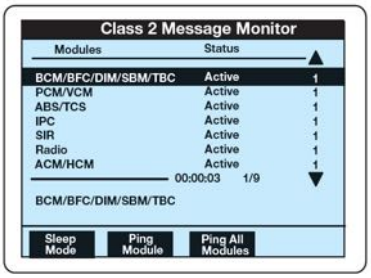

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FIGURE 18-27 Checking the terminating resistors using an ohmmeter at the DLC.

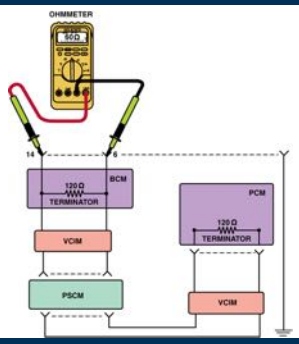

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FIGURE 18–28 Use front-probe terminals to access DLC. Always follow specified back-probe & front-probe procedures as found in service information

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FIGURE 18.29 (a) Data is sent in packets, so it is normal to see activity then a flat line between messages

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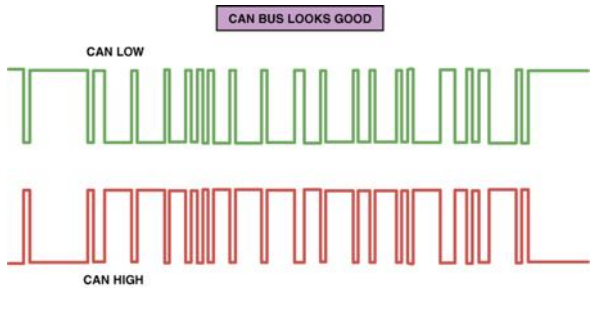
FIGURE 18.29 (b) A CAN BUS should show voltages that are opposite when there is normal communications.



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The Radio Caused No-Start Story

REAL WORLD FIX

- 2005 Chevrolet Cobalt did not start. A technician checked with a subscription-based helpline service and discovered that a fault with the Class 2 data circuit could prevent the engine from starting. The advisor suggested that a module should be disconnected one at a time to see if one of them was taking the data line to ground. The two most common components on the Class 2 serial data line that have been known to cause a lack of communication and become shorted-to-ground are the radio and electronic brake control module (EBCM). **The first one the technician disconnected was the radio**. The engine started and ran. Apparently the Class 2 serial data line was shorted-to-ground inside the radio, which took the entire BUS down. When BUS communication is lost, the PCM is not able to energize the fuel pump, ignition, or fuel injectors so the engine would not start. The radio was replaced to solve the no-start condition.

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Which Module Is the Gateway Module?

FREQUENTLY ASKED QUESTION

- The gateway module is responsible for communicating with other modules and acts as the main communications module for scan tool data. Most General Motors vehicles use the body control module (BCM) or the instrument panel control (IPC) module as the gateway. To verify which module is the gateway, check the schematic and look for one that has voltage applied during all of the following conditions.
  - Key on, engine off
  - Engine cranking
  - Engine running

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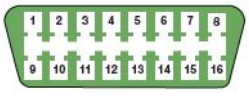
FIGURE 18.30 A 16 pin OBD-II DLC with terminals identified.



PIN	DESCRIPTION	PIN	DESCRIPTION
1	Vendor Option	9	Vendor Option
2	J1850 Bus +	10	J1850 Bus–
3	Vendor Option	11	Vendor Option
4	Chassis Ground	12	Vendor Option
5	Signal Ground	13	Vendor Option
6	CAN (J-2234) High	14	CAN (J-2234) Low
7	ISO 9141-2 K-Line	15	ISO 9141-2 L-Line
8	Vendor Option	16	Battery Power

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OBD-II DATA LINK CONNECTOR (1 of 2)

- GM VEHICLES Page 219
- ASIAN, CHRYSLER, AND EUROPEAN VEHICLES
- FORD VEHICLES

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Check Computer Data Line Circuit Schematic

TECH TIP

- Many GM vehicles use more than one type of BUS communications protocol. Check service information (SI) and look at schematic for computer data line circuits which should show all of data BUSs and their connectors to DLC

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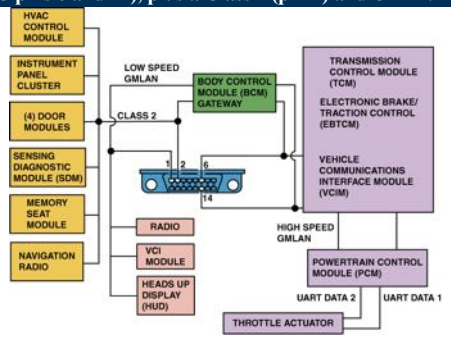
FIGURE 18-31 This schematic of a Chevrolet Equinox shows that the vehicle uses a GMLAN BUS (DLC pins 6 and 14), plus a Class 2 (pin 2) and UART.



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SUMMARY (1 of 2)

- The use of a network for module communications reduces the number of wires and connections needed.
- Module communication configurations include ring link, star link, and ring/star hybrid systems.
- The SAE communication classifications for vehicle communications systems include Class A (low speed), Class B (medium speed), and Class C (high speed).
- Various module communications used on General Motors vehicles include UART, E & C, Class 2, keyword communications, and GMLAN (CAN).

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SUMMARY (2 of 2)

- Types of module communications used on Ford vehicles include SCP, UBP, and CAN.
- Chrysler brand vehicles use SCI, CCD, PCI, and CAN communications protocols.
- Many European vehicles use an underhood electrical connector that can be used to access electrical components and modules using a breakout box (BOB) or special tester.
- Diagnosis of network communications includes checking the terminating resistor value and checking for charging voltage signals at the DLC.

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