Automotive Electrical & Engine Performance 8/E
Chapter 14 CAN & Network Communications
Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This Automotive Electrical & Engine Performance 8th edition provides complete coverage of automotive areas pertaining vehicle electrical systems and engine performance. It correlates material to task lists specified by ASE and ASEEducation (NATEF) and emphasizes a problem-solving approach. Chapter features include Tech Tips, Frequently Asked Questions, Case Studies, Videos, and Animations that are listed in this Lesson Plan. This Lesson Plan also references ASEEducation (NATEF) Task Sheets available from Jim's web site.
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge to figure why the engine does not work correctly and how this saves diagnosis time, which translates into more money.
State the learning objectives for the chapter or course you are about to cover and explain this is what they should be able to do as a result of attending this session or class.	Explain the chapter learning objectives to the students. 1. Describe the types of networks and serial communications used on vehicles. 2. Discuss how the networks connect to the data link connector and to other modules. 3. Explain how to diagnose module communication faults. **This chapter will help you prepare for the ASE Electrical/Electronic Systems (A6) certification test content area "A" (General Electrical/Electronic System Diagnosis)**
Establish the Mood or Climate	Provide a *WELCOME,* Avoid put downs and bad jokes.
Complete Essentials	Restrooms, breaks, registration, tests, etc.
Clarify and Establish Knowledge Base	Do a round robin of the class by going around the room and having each student give their backgrounds, years of experience, family, hobbies, career goals, or anything they want to share.

NOTE: This lesson plan is based on Automotive Electrical & Engine Performance 8th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

DOWNLOAD Chapter 14 Chapter Images: From

http://www.jameshalderman.com/books_a8.html#anchor2

ICONS	Ch14 CAN & Network Communications
	**1. SLIDE 1 CH14 CAN & NETWORK COMMUNICATIONS**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED** **No videos this chapter.** **Go to www.youtube.com**
	**At the beginning of this class, you can download the crossword puzzle & Word Search from Jim's web site to familiarize your class with terms in this chapter & then discuss them, see below:** **HTTP://WWW.JAMESHALDERMAN.COM/BOOKS_A8.HTML#ANCHOR2** **DOWNLOAD** **CROSSWORD PUZZLE (MICROSOFT WORD) (PDF)** **WORD SEARCH PUZZLE (MICROSOFT WORD) (PDF**
	**DISCUSSION: DISCUSS DIFFERENT TYPES OF COMMUNICATION BETWEEN MODULES OR NODES. WHY DO THERE NEED TO BE DIFFERENT TYPES OF COMMUNICATION?**
	**3. SLIDE 3 EXPLAIN Figure 14-2** network allows all modules to communicate with other modules.
	**DEMONSTRATION: Demonstrate or explain to the students how a power window system worked 10 years ago and how a modern power window system works. Use Project Board to demo CAN & Network Communication** **TRAINER TASK: Have student do the setup shown in previous DEMONSTRATION**
	**4. SLIDE 4 EXPLAIN Figure 14-3** Ring link network reduces # of wires it takes to interconnect all of modules.
	**5. SLIDE 5 EXPLAIN Figure 14-4** In star link network, all of the modules are connected using splice packs.

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	6. **SLIDE 6 EXPLAIN Figure 14-5 BUS** system showing module CAN communications and twisted pairs of wire. **DISCUSS FREQUENTLY ASKED QUESTION:** ***What Is a BUS?*** **A 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.**
	**DISCUSS FREQUENTLY ASKED QUESTION:** ***What Is a Protocol?*** **A protocol is a set of rules or a standard used between computers or electronic control modules. Protocols include type of electrical connectors, voltage levels, and frequency of transmitted messages. Protocols, therefore, include both the hardware and software needed to communicate between modules.**
 	**DISCUSSION: Ask students to discuss CAN network pictured in Figure 14–5. Do all of modules on this bus need to be able to talk to each other?** Meter Usage Check CAN Circuit (View) (Download) Controller Area Network, CAN (View) (Download) CAN Circuit Check (View) (Download) CAN Signal (View) (Download) • **NTERNET TASK: SEARCH INTERNET: Have students use the Internet to research Society of Automotive Engineers (SAE) standards for the 3 categories of in-vehicle network communications. Do these standards apply in every country? Ask students to report their findings to the class.**
	7. **SLIDE 7 EXPLAIN Figure 14-6 UART** serial data master control module connected to data link connector at pin 9 8. **SLIDE 8 EXPLAIN Figure 14-7** E & C serial data is connected to data link connector (DLC) at pin 14. 9. **SLIDE 9 EXPLAIN Figure 14-8** Class 2 serial data communication accessible at DLC at pin 2.

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	**10. SLIDE 10 EXPLAIN Figure 14-9** 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). **11. SLIDE 11 EXPLAIN Figure 14-10** GMLAN uses pins at terminals 6 and 14.
	**DISCUSS FREQUENTLY ASKED QUESTION:** ***Why Is a Twisted Pair Used?*** **A twisted pair is where two wires are twisted to prevent electromagnetic radiation from affecting the signals passing through the wires. By twisting the two wires about once every inch (9 to 16 times per foot), the interference is canceled by the adjacent wire. • SEE FIGURE 14–11.**
	**12. SLIDE 12 EXPLAIN FIGURE 14-11 twisted pair** is used by several different network communications protocols to reduce interference that can be induced in the wiring from nearby electromagnetic sources. **13. SLIDE 13 EXPLAIN Figure 14-12** CANdi module will flash green LED rapidly if communication is detected. **14. SLIDE 14 EXPLAIN Figure 14-13** A Ford OBD-I diagnostic link connector showing that SCP communication uses terminals in cavities 1 (upper left) and 3 (lower left). **15. SLIDE 15 EXPLAIN Figure 14-14** A scan tool can be used to check communications with the SCP BUS through terminals 2 and 10 and to the other modules connected to terminal 7 of the data link connector (DLC). **16. SLIDE 16 EXPLAIN Figure 14-15** Many Fords use UBP module communications along with CAN.
	**DISCUSS FREQUENTLY ASKED QUESTION:** ***What Are U Codes?*** **The U diagnostic trouble codes were at first "undefined" but are now network-related codes. Use the network codes to help pinpoint the circuit or module that is not working correctly.**

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	**17. SLIDE 17 EXPLAIN Figure 14-16** CCD signals are labeled plus and minus and use a twisted pair of wires. Notice that terminals 3 and 11 of the data link connector are used to access the CCD BUS from a scan tool. Pin 16 is used to supply 12 volts to the scan tool. **18. SLIDE 18 EXPLAIN Figure 14-17** differential voltage for CCD BUS is created by using resistors in a module. **19. SLIDE 19 EXPLAIN Figure 14-18** Many Chrysler vehicles use both SCI & CCD for module communication
	**20. SLIDE 20 EXPLAIN Figure 14-19** CAN uses a differential type of module communication where the voltage on one wire is 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 (high) goes up 1 volt to 3.5 volts and CAN L (low) goes down 1 volt to 1.5 volts. **21. SLIDE 21 EXPLAIN Figure 14-20** typical (generic) system showing how the CAN BUS is connected to various electrical accessories and systems in the vehicle.
	**22. SLIDE 22 EXPLAIN Figure 14-21** DLC from a pre-CAN Acura shows terminals in cavities 4, 5 (grounds), 7, 10, 14, and 16 (B+). **23. SLIDE 23 EXPLAIN Figure 14-22** Honda scan display showing a B & 2U codes, all indicating a BUS-related problem(s). **24. SLIDE 24 EXPLAIN Figure 14-23** typical 38-cavity diagnostic connector as found on many 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.
	**DISCUSS FREQUENTLY ASKED QUESTION:** ***How Do You Know What System Is Used*? Use service information to determine which network communication protocol is used. However, due to the various systems on some vehicles, it may be easier to look at the data link connection to determine the system. All OBD-II vehicles have terminals in the following cavities.** • **Terminal 4: chassis ground** • **Terminal 5: computer (signal) ground**

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	• **Terminal 16: 12-volts positive** • **Terminals in cavities 6 and 14 mean that this vehicle is equipped with CAN as the only module communication protocol available at the DLC. To perform a test of the BUS, use a breakout box (BOB) to gain access to terminals while connecting to the vehicle, using a scan tool. • SEE FIGURE 14–24 for a typical OBD-II connector breakout box.**
	**25. SLIDE 25 EXPLAIN Figure 14-24** Breakout Box (**BOB**) used to access BUS terminals while using a scan tool to activate modules. Breakout Box is equipped with LEDs that light when circuits are active.
	**ON-VEHICLE TASK: Use Vocabulary Scavenger Hunt Task Sheet to identify parts on vehicle related to CAN and describe purpose of each part.**
	**26. SLIDE 26 EXPLAIN Figure 14-25** This Honda scan tool allows the technician to turn on individual lights and operate individual power windows and other accessories that are connected to the BUS system. **27. SLIDE 27 EXPLAIN Figure 14-26** Modules used in a GM vehicles can be "pinged" using a Tech 2 scan tool. **28. SLIDE 28 EXPLAIN Figure 14-27** Checking terminating resistors using an ohmmeter at the DLC
	**EXPLAIN TECH TIP: *No Communication? Try Bypass Mode.* 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 are not shown.**

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	**29. SLIDE 29 EXPLAIN Figure 14-28** Use front-probe terminals to access the data link connector. Always follow the specified back-probe and front-probe procedures as found in service information. **30. SLIDE 30 EXPLAIN Figure 14-29 (a)** Data is sent in packets, so it is normal to see activity then a flat line between messages.
	**DISCUSS CASE STUDY: *Radio Caused No-Start*** **Story: 2012 GMC pickup truck 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 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 does not start. The radio was replaced to solve no-start condition.** **Summary:** • **Complaint—engine did not start.** • **Cause—hotline service helped the technician narrow the cause to a fault in the radio that took the Class 2 data line to ground.** • **Correction—radio was replaced, which restored proper operation of Class 2 data bus.**
	**31. SLIDE 31 EXPLAIN Figure 14-29 (b)** CAN BUS should show voltages that are opposite when there is normal communications. CAN H (high) circuit should go from 2.5 volts at rest to 3.5 volts active. CAN L (low) circuit goes from 2.5 volts at rest to 1.5 volts active.

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	**HANDS-ON TASK: Print out steps for diagnosing and testing network diagnostic code. Ask students to follow diagnostic steps to see repair path.**
	32. **SLIDE 32 EXPLAIN Figure 14-30** 16 pin OBD-II DLC with terminals identified. Scan tools use the power pin (16) and ground pin (4) for power so that a separate cigarette lighter plug is not necessary on OBD-II vehicles
	**DISCUSS FREQUENTLY ASKED QUESTION: *Which Module Is Gateway Module?* The gateway module is responsible for communicating with other modules and acts as main communications module for scan tool data. Most GM vehicles use BCM or IPC module as gateway. To verify which module is gateway, check schematic and look for one that has voltage applied during all of following conditions.** • **Key On, Engine Off (KOEO)** • **Engine Cranking** • **Engine Running**
	**EXPLAIN TECH TIP: *Check Computer Data Line* Circuit Schematic Many General Motors vehicles use more than one type of BUS communications protocol. Check service information (SI) and look at the schematic for computer data line circuits, which should show all of data BUSES and their connectors to DLC.• SEE FIGURE 14–31.**
	33. **SLIDE 33 EXPLAIN FIGURE 14-31** schematic of a Chevrolet Equinox shows that vehicle uses **GMLAN** BUS **(DLC pins 6 & 14),** plus Class 2 (pin 2) and UART.
	**Students complete ASEEDUCATION Task Sheet G5: Diagnose body electronic system using scan tool**
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	**HOMEWORK: SEARCH INTERNET: Research vehicle communication networks on Internet . Include a history of networks and improvements that have been made that are used in the present-day automobile.**