

# Automotive Electrical & Engine Performance 8/E

## Chapter 27 Audio System Operation and Diagnosis

### Opening Your Class

KEY ELEMENT	EXAMPLES
<b>Introduce Content</b>	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.
<b>Motivate Learners</b>	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.
<b>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.</b>	<p>Explain the chapter learning objectives to the students.</p> <ol style="list-style-type: none"> <li>1. Describe how AM (amplitude modulation), FM (frequency modulation), and satellite radio work.</li> <li>2. Describe antennas and their diagnosis.</li> <li>3. Discuss the purpose, function, and types of speakers.</li> <li>4. Discuss crossovers and voice recognition systems.</li> <li>5. Explain how Bluetooth systems work.</li> <li>6. List causes and corrections of radio noise and interference.</li> </ol> <p style="color: blue;"><b>This chapter will help you prepare for the ASE Electrical/Electronic Systems (A6) certification test content area “H” (Accessories Diagnosis and Repair).</b></p>
<b>Establish the Mood or Climate</b>	Provide a <i>WELCOME</i> , Avoid put downs and bad jokes.
<b>Complete Essentials</b>	Restrooms, breaks, registration, tests, etc.
<b>Clarify and Establish Knowledge Base</b>	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 8<sup>th</sup> Edition Chapter Images** found on Jim’s web site @ [www.jameshalderman.com](http://www.jameshalderman.com)

**DOWNLOAD Chapter 27 Chapter Images: From**  
[http://www.jameshalderman.com/books\\_a8.html#anchor2](http://www.jameshalderman.com/books_a8.html#anchor2)

## ICONS

## Ch27 Audio System Operation and Diagnosis



### 1. SLIDE 1 CH27 AUDIO SYSTEM OPERATION AND DIAGNOSIS

Check for **ADDITIONAL VIDEOS & ANIMATIONS**  
@ <http://www.jameshalderman.com/>  
**WEB SITE IS CONSTANTLY UPDATED**

### Videos

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](HTTP://WWW.JAMESHALDERMAN.COM/BOOKS_A8.HTML#ANCHOR2)

#### **DOWNLOAD**

**CROSSWORD PUZZLE (MICROSOFT WORD) (PDF)**





**WORD SEARCH PUZZLE (MICROSOFT WORD) (PDF)**

2. **SLIDE 2 EXPLAIN Figure 27-1** Audio systems use both electromagnetic radio waves and sound waves to reproduce sound inside the vehicle.
3. **SLIDE 3 EXPLAIN Figure 27-2** relationship among wavelength, frequency, and amplitude.
4. **SLIDE 4 EXPLAIN Figure 27-3** amplitude changes in AM broadcasting.
5. **SLIDE 5 EXPLAIN Figure 27-4** frequency changes in FM broadcasting and the amplitude remains constant.
6. **SLIDE 6 EXPLAIN Figure 27-5** Using upper and lower sidebands allows stereo to be broadcast. Receiver separates signals to provide left and right channels.

**DISCUSSION: HAVE STUDENTS DISCUSS TERMS RFI & EMI. HOW DO RFI & EMI RELATE TO AUDIO SYSTEMS? ASK THE STUDENTS TO DESCRIBE THE DIFFERENCE BETWEEN AM (AMPLITUDE MODULATION) AND FM (FREQUENCY MODULATION)**

**DISCUSSION: HAVE STUDENTS DISCUSS CORRELATION BETWEEN FREQUENCY &**



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    	<p>wavelength in the ground plane is literally underground. For ideal reception, the receiving antenna should also be the same as the wavelength of the signal. Because this length is not practical, a design compromise uses the length of the antenna as one-fourth of the wavelength; in addition, the body of the vehicle itself is one-fourth of wavelength. The body of the vehicle, therefore, becomes the ground plane. • <b>SEE FIGURE 27-7.</b></p> <p>Any faulty condition in the ground plane circuit Causes the ground plane to lose effectiveness, such as:</p> <ul style="list-style-type: none"> <li>• Loose or corroded battery cable terminals</li> <li>• Acid buildup on battery cables</li> <li>• Engine grounds with high resistance</li> <li>• Loss of antenna or audio system grounds</li> <li>• Defective alternator, causing an ac ripple exceeding 50 millivolts (0.050 volt)</li> </ul> <p>8. SLIDE 8 <b>EXPLAIN FIGURE 27-7</b> ground plane is actually one-half of the antenna.</p> <p>9. SLIDE 9 <b>EXPLAIN FIGURE 27-8</b> If all ohmmeter readings are satisfactory, the antenna is good.</p> <p><b>EXPLAIN TECH TIP: Hole in the Fender Cover</b>  <b>Trick:</b> A common repair is to replace the mast of a power antenna. To help prevent the possibility of causing damage to body or paint of the vehicle, cut a hole in a fender cover and place it over the antenna. • <b>SEE FIGURE 27-9.</b> If a wrench or tool slips during the removal or installation process, the body of the vehicle is protected.</p> <p>10. SLIDE 10 <b>EXPLAIN FIGURE 27-9</b> Cutting a small hole in a fender cover helps to protect the vehicle when replacing or servicing an antenna</p> <p><a href="#">Check Antenna (View) (Download)</a>  <a href="#">Check Speaker (View) (Download)</a></p>

## ICONS

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11. **SLIDE 11 EXPLAIN Figure 27-10** A typical power antenna assembly. Note the braided ground wire used to ensure that the antenna has a good ground plane

12. **SLIDE 12 EXPLAIN Figure 27-11** Between 6 and 7 volts is applied to each speaker terminal, and the audio amplifier then increases the voltage on one terminal and at the same time decreases the voltage on the other terminal causing the speaker cone to move. The moving cone then moves the air, causing sound.

13. **SLIDE 13 EXPLAIN Figure 27-12** A typical automotive speaker with two terminals. The polarity of the speakers can be identified by looking at the wiring diagram in the service manual or by using a 1.5 volt battery to check. When the battery positive is applied to the positive terminal of the speaker, the cone will move outward. When the battery leads are reversed, the speaker cone will move inward.

14. **SLIDE 14 EXPLAIN Figure 27-13** (a) Two 4 ohm speakers connected in series result in total impedance of 8 ohms. (b) Two 4 ohm speakers connected in parallel result in total impedance of 2 ohms.







**EXPLAIN TECH TIP: *Skin Effect:* When a high-frequency signal (AC voltage) is transmitted through a wire, the majority of it travels on the outside surface of the wire. This characteristic is called skin effect. The higher the frequency is, the closer to the outer surface the signal moves. To increase audio system output, most experts recommend the use of wire that has many strands of very fine wire to increase the surface area or the skin area of the conductor. Therefore, most aftermarket speaker wires are stranded with many small-diameter copper strands.**










**DISCUSSION: DISCUSS BASIC SPEAKER OPERATION. HOW DO SPEAKERS CONVERT ELECTRICAL ENERGY INTO ACOUSTICAL ENERGY?**







**DEMONSTRATION: SHOW STUDENTS EXAMPLES OF DIFFERENT TYPES OF**

























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   	<p><b>SPEAKERS &amp; EXPLAIN HOW TO DETERMINE THEIR USE</b></p> <p><b>HANDS-ON TASK:</b> USE 1.5-VOLT BATTERY TO TEST SPEAKER POLARITY. POLARITY OF SPEAKERS CAN BE IDENTIFIED BY LOOKING AT WIRING DIAGRAM OR BY USING A 1.5 VOLT BATTERY TO CHECK. WHEN BATTERY POSITIVE IS APPLIED TO POSITIVE TERMINAL OF SPEAKER, CONE WILL MOVE OUTWARD. WHEN BATTERY LEADS ARE REVERSED, SPEAKER CONE WILL MOVE INWARD.</p> <p><b>DISCUSS FREQUENTLY ASKED QUESTION:</b>  <b>WHAT IS A BASS BLOCKER?</b> A bass blocker is a capacitor and coil assembly that effectively blocks low frequencies. A bass blocker is normally used to block low frequencies being sent to the smaller front speakers. Using a bass blocker allows smaller front speakers to more efficiently reproduce the midrange and high-range frequency sounds.</p> <p>15. SLIDE 15 <b>EXPLAIN</b> Figure 27-14 Crossovers are used in audio systems to send high-frequency sounds to small (tweeter) speakers and low frequency sounds to larger (woofer) speakers.</p> <p><b>WARNING: HEARING LOSS IS POSSIBLE IF EXPOSED TO LOUD SOUNDS. ACCORDING TO NOISE EXPERTS (AUDIOLOGISTS), HEARING PROTECTION SHOULD BE USED WHENEVER THE FOLLOWING OCCURS.</b></p> <ol style="list-style-type: none"> <li><b>1. YOU MUST RAISE YOUR VOICE TO BE HEARD BY OTHERS NEXT TO YOU.</b></li> <li><b>2. YOU CANNOT HEAR SOMEONE ELSE SPEAKING WHO IS LESS THAN 3 FT (1 M) AWAY.</b></li> <li><b>3. YOU ARE OPERATING POWER EQUIPMENT, SUCH AS A LAWNMOWER.</b></li> </ol>








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	<p><b>DISCUSSION:</b> REVIEW OHM'S LAW &amp; WAY WIRING LOADS IN SERIES OR PARALLEL AFFECT CIRCUIT RESISTANCE &amp; CURRENT. ASK STUDENTS HOW SPEAKER RESISTANCE AFFECTS SPEAKER'S PERFORMANCE</p>
	<p><b>DEMO ON ELECTRICAL TRAINER:</b> BUILD SERIES &amp; PARALLEL CIRCUITS SIMILAR TO SPEAKER ARRAYS &amp; USE BULBS TO SIMULATE SPEAKER LOADS.</p>
	<p><b>HANDS-ON TASK:</b> PROVIDE STUDENTS WITH SAMPLE SERIES &amp; PARALLEL CIRCUITS ON <b>ELECTRICAL TRAINER</b>. ASSIGN VALUES TO LOADS AND SOURCE VOLTAGE. HAVE STUDENTS USE OHM'S LAW TO CALCULATE TOTAL RESISTANCE AND CURRENT IN EACH CIRCUIT.</p>
	<p>16. SLIDE 16 <b>EXPLAIN</b> Figure 27-15 Two capacitors connected in parallel provide the necessary current flow to power large subwoofer speakers.</p>
	<p><b>DISCUSS CHART 27-1 RATING OF CAPACITOR NEEDED TO UPGRADE AN AUDIO SYSTEM IS DIRECTLY RELATED TO WATTAGE OF SYSTEM.</b></p>
	<p><b>DISCUSSION:</b> DISCUSS IMPORTANCE OF FUSE SIZE AND PLACEMENT IN AFTERMARKET AUDIO SYSTEMS. WHAT IS REASON FOR USING A FUSE?</p>
	<p><b>DISCUSS FREQUENTLY ASKED QUESTION: WHAT DO THE AMPLIFIER SPECIFICATIONS MEAN? RMS POWER</b> RMS MEANS ROOT-MEAN-SQUARE AND IS THE RATING THAT INDICATES HOW MUCH POWER THE AMPLIFIER IS CAPABLE OF PRODUCING CONTINUOUSLY.</p> <p><b>RMS POWER AT 2 OHMS</b> THIS SPECIFICATION IN WATTS INDICATES HOW MUCH POWER THE AMPLIFIER DELIVERS INTO A 2-OHM SPEAKER LOAD. THIS 2-OHM LOAD IS ACHIEVED BY</p>




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      	<p><b>WIRING TWO 4-OHM SPEAKERS IN PARALLEL OR BY USING 2-OHM SPEAKERS.</b></p> <p><b>PEAK POWER</b> PEAK POWER IS THE MAXIMUM WATTAGE AN AMPLIFIER CAN DELIVER IN A SHORT BURST DURING A MUSICAL PEAK.</p> <p><b>THD</b> TOTAL HARMONIC DISTORTION (THD) REPRESENTS AMOUNT OF CHANGE OF SIGNAL AS IT IS BEING AMPLIFIED. THE LOWER NUMBER, BETTER AMPLIFIER (E.G., A 0.01% RATING IS BETTER THAN A 0.07% RATING).</p> <p><b>SIGNAL-TO NOISE RATIO:</b> THIS SPECIFICATION IS MEASURED IN DECIBELS (DB) AND COMPARES STRENGTH OF THE SIGNAL WITH THE LEVEL OF BACKGROUND NOISE (HISS). A HIGHER VOLUME INDICATES LESS BACKGROUND NOISE (E.G., A 105-DB RATING IS BETTER THAN A 100-DB RATING).</p> <p>17. SLIDE 17 <b>EXPLAIN</b> Figure 27-16 powerline capacitor should be connected through power wire to amplifier as shown. When amplifier requires more electrical power (watts) than battery can supply, capacitor will discharge into amplifier and supply necessary current for fraction of a second it is needed by amplifier. At other times when the capacitor is not needed, it draws current from the battery to keep it charged.</p> <p><b>DEMONSTRATION:</b> SHOW STUDENTS EXAMPLES OF DIFFERENT TYPES OF CAPACITORS, &amp; DEMONSTRATE HOW TO PROPERLY MATCH A CAPACITOR WITH AMPLIFIER OUTPUT.</p> <p><b>DISCUSSION:</b> ASK STUDENTS TO DESCRIBE HOW LOUD NOISES AFFECT HEARING, &amp; DISCUSS WHEN HEARING PROTECTION SHOULD BE WORN.</p> <p>18. SLIDE 18 <b>EXPLAIN</b> Figure 27-17 Voice commands can be used to control many functions, including navigation systems, climate control, telephone, and radio.</p> <p>19. SLIDE 19 <b>EXPLAIN</b> Figure 27-18 The voice command icon on the steering wheel of a Cadillac.</p>



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 	<p><b>DISCUSS FREQUENTLY ASKED QUESTION:</b>  <b>WHERE DID BLUETOOTH GET ITS NAME?</b> The early adopters of the standard used the term “Bluetooth,” and they named it for Harold Bluetooth, king of Denmark in late 900s. The king was able to unite Denmark and part of Norway into a single kingdom.</p>
 	<p><b>DISCUSS FREQUENTLY ASKED QUESTION:</b>  <b>CAN TWO BLUETOOTH TELEPHONES BE USED IN A VEHICLE? USUALLY.</b> In order to use 2 telephones, the second phone needs to be given a name. When both telephones enter vehicle, check which one is recognized. Say “phone status” and the system tells you to which telephone system is responding. If it is not the one you want, simply say, “next phone” and it moves to the other one.</p>
 	<p>20. <b>SLIDE 20 EXPLAIN Figure 27-19</b> Bluetooth earpiece that contains a microphone and speaker unit that is paired to a cellular phone. The telephone has to be within 33 ft (10 m) of the earpiece.</p>
 	<p>21. <b>SLIDE 21 EXPLAIN Figure 27-20</b> SDARS uses satellites and repeater stations to broadcast radio.</p>
 	<p>22. <b>SLIDE 22 EXPLAIN Figure 27-21</b> An aftermarket XM radio antenna mounted on the rear deck lid. The deck lid acts as the ground plane for the antenna.</p>
 	<p>23. <b>SLIDE 23 EXPLAIN Figure 27-22</b> A shark-fin-type factory antenna used for both XM and OnStar.</p>
 	<p><b>DISCUSS FREQUENTLY ASKED QUESTION:</b>  <b>WHAT DOES ESN MEAN? ESN MEANS ELECTRONIC SERIAL NUMBER. THIS IS NECESSARY INFORMATION TO KNOW WHEN REVIEWING SATELLITE RADIO SUBSCRIPTIONS. EACH RADIO HAS ITS OWN UNIQUE ESN, OFTEN FOUND ON A LABEL AT THE BACK OR BOTTOM OF THE UNIT. IT IS ALSO OFTEN SHOWN ON SCAN TOOLS OR</b></p>
 	
 	
 	
 	
 	

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      	<p><b>TEST EQUIPMENT DESIGNED TO HELP DIAGNOSE FAULTS IN THE UNITS.</b></p> <p>24. SLIDE 24 <b>EXPLAIN</b> Figure 27-23 radio choke and/or a capacitor can be installed in the power feed lead to any radio, amplifier, or equalizer.</p> <p>25. SLIDE 25 <b>EXPLAIN</b> Figure 27-24 Many automobile manufacturers install a coaxial capacitor, like this one, in the power feed wire to the blower motor to eliminate interference caused by the blower motor.</p> <p><b>EXPLAIN TECH TIP: <i>The Separate Battery Trick</i></b>  <b>Whenever diagnosing sound system interference, try running separate 14-gauge wire(s) from the sound system power lead and ground to a separate battery outside of vehicle. If the noise is still heard, the interference is not due to an alternator diode or other source in the wiring of the vehicle.</b></p> <p>26. SLIDE 26 <b>EXPLAIN</b> Figure 27-25 “sniffer” can be made from an old antenna lead-in cable by removing about 3 in. of the outer shielding from the end. Plug the lead-in cable into the antenna input of the radio and tune the radio to a weak station. Move the end of the antenna wire around the vehicle dash area. The sniffer is used to locate components that may not be properly shielded or grounded and can cause radio interference through the case (housing) of the radio itself.</p> <p><b><u>ON-VEHICLE ASE EDUCATION TASK</u></b>  <b>DIAGNOSE OPERATION OF ENTERTAINMENT AND RELATED CIRCUITS (SUCH AS: RADIO, DVD, REMOTE CD CHANGER, NAVIGATION, AMPLIFIERS, SPEAKERS, ANTENNAS, AND VOICE-ACTIVATED ACCESSORIES); DETERMINE NEEDED REPAIRS. <u>DISCUSS CHART 27-2 RADIO NOISE CAN HAVE VARIOUS CAUSES, AND KNOWING WHERE OR WHEN THE NOISE OCCURS HELPS PIN DOWN LOCATION.</u></b>  <b>DISCUSS CASE STUDY <i>LIGHTNING DAMAGE:</i></b>  <b>A radio failed to work in a vehicle that was outside during thunderstorm. The technician checked the fuses and verified that power was reaching the radio. Then the technician noticed</b></p>

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	<p>antenna. It had been struck by lightning. Obviously, high voltage from the lightning strike traveled to the radio receiver and damaged the circuits. Both the radio and antenna were replaced to correct problem.</p> <ul style="list-style-type: none"><li>• <b>SEE FIGURE 27-26.</b></li></ul> <p><b>SUMMARY:</b></p> <ul style="list-style-type: none"><li>• <b>Complaint</b>—customer stated that the radio did not work.</li><li>• <b>Cause</b>—visual inspection showed an antenna that had been struck by lightning.</li><li>• <b>Correction</b>—replacing the radio and the antenna restored proper operation</li></ul> <p>27. SLIDE 27 <b>EXPLAIN FIGURE 27-26</b> The tip of this antenna was struck by lightning.</p>