Noise Troubleshooting

OBJECTIVES

- Describe the five steps to eliminating noise problems in a vehicle.
- Describe the 4 types of noise problems in a vehicle.
- Discuss the different methods for solving noise problems based on the type of noise present.

INTRODUCTION

Unwanted noise, commonly referred to as 'engine noise', is an unwelcome reality in the Mobile Electronics industry. These noises can be quite irritating and can diminish the enjoyment of a customer's audio experience within their vehicle. These noises can be identified as whistling sounds, clicking or popping sounds, and ever-present humming sounds.

Noise problems in a vehicle occur in a very logical fashion and, when understood and analyzed correctly, can be eliminated and prevented. The presence of noise in an audio system after completion of the installation can be both frustrating and time consuming.

During the course of this section we will visit the most common types of audio system noise. The noise itself will be explained along with the most common causes of each particular noise problem. The emphasis of this section will be to discuss the steps that should be taken to eliminate all possibilities of the noise being introduced into the finished installation.

Types of Noise Problems

The Five Steps below will guide you in eliminating any noise problems you may encounter, in the least amount of time. The following pages will explain these five principles in detail.

- Noise Identification
- Noise Causes
- Noise Avoidance Techniques
- Isolation Process
- Noise Elimination Accessories

Note:
It is very important to check a customer's vehicle for existing noise problems before any work is carried out on the vehicle. The noise check needs to be done prior to any further audio equipment being installed into the vehicle, as the new product being installed may enhance the existing noise condition. If noise is present, the customer needs to be made aware of the condition prior to any disassembly of the vehicle. You may choose to offer the customer the option of allowing you to diagnose, and possibly, eliminate the problem at the prescribed hourly shop rate.

Noise Identification

Noise can manifest itself in several forms that can be easily identified. The proper identification of the noise is an integral part of solving the problem of audio system noise in a vehicle. Proper identification allows you to eliminate the need to troubleshoot parts of the vehicle, or vehicle components, which you know do not cause that particular type of noise. This greatly reduces the time it takes to

eliminate noise in a vehicle. Below are examples of the common types of audio system noises and their corresponding causes.

Types of Noise:

1) Power Line Noise

- Ground loop
- Defective Alternator
- Defective Battery
- Faulty Connections

2) Radiated Noise

- Improper Wiring Technique
- Equipment Location
- Defective Grounding Point
- Ignition Noise

3) Pulse Noise

- Switch Induced Noise
- Relay Induced Noise
- Ground Path Noise

4) System Noise

- Low Signal to Noise Ratio
- Component Mismatch

Noise Causes

The causes of the four types of audio system noise will be discussed. This will assist in planning for noise avoidance and, if noise is already present, will assist in the best solution to the noise problem.

Noise Avoidance Techniques

The first step taken in any install should be to anticipate, plan for, and predict possible audio system noise problems in advance. Once this is mastered and becomes common practice in each installation, the possibility of noise in an audio system greatly decreases. This is always preferable to eliminating noise after the installation is complete and the vehicle has been reassembled.

Isolation Process

The process of elimination works well when troubleshooting noise problems in a vehicle. Isolating the component(s), or area of the vehicle which is introducing the noise into the audio system, saves time when trying to determine the best solution to the problem.

Noise Elimination Accessories

Take steps to eliminate the noise utilizing installation techniques and electronic components. There are several manufactured items that help installers with solutions to many common noise problems. Generally these items should only be used as temporary solutions until the root problem of the noise can be identified and remedied. The noise elimination section will outline some of the components you can implement for the particular type of noise discussed in each section.

Powerline Noise Identification

Powerline noise is one of the most common forms of audio system noise. Its presence is easily identified by a "whining" noise that fluctuates in pitch with engine speed. Sometimes referred to as "audio tach" because the frequency and volume of the whine increases and decreases relative to the position of the gas pedal.

Powerline Noise Causes

Powerline noise can be caused by several components or conditions within a vehicle electrical system. Each of these are addressed individually in the following section

These include:

1) Ground Loop Condition
2) Defective Alternator
3) Defective Battery
4) Faulty Connections

Ground Loop Condition

Ground Loop Condition Causes

Although Ground Loop Noise is generally classed in a category of it's own, the Ground Loop Condition is included with Powerline Noise because it is caused by the inadequate grounding of audio components in the audio system. Ground Loop Noise occurs when a number of components are installed in various locations in the vehicle. Because all of the components are grounded to different areas of the chassis, they may not see exactly the same electrical ground potential. When this occurs the component that has the poorer ground will try to compensate by using the negative shield of the RCA cable as an additional ground point. For example, the amplifier, with a slightly poorer ground point than the head unit, may use the RCA cable running between the two units as an additional ground. As a result the RCA cable's negative wire will have a current flowing through it. Even if the vehicle battery is operating at optimum, this current will still contain a slight amount of AC Ripple. The AC ripple will accompany the audio signal to the Audio System Components. These Components will reproduce this signal as an audible 'alternator whine'.

Ground Loop Condition Avoidance Techniques

It is very important to follow the rules of Ground Loop Condition Avoidance Techniques in every installation. A little extra care in the wiring, insulation of components and ground point testing, during the installation will save the time and grief spent attempting to rectify a Ground Loop Condition.

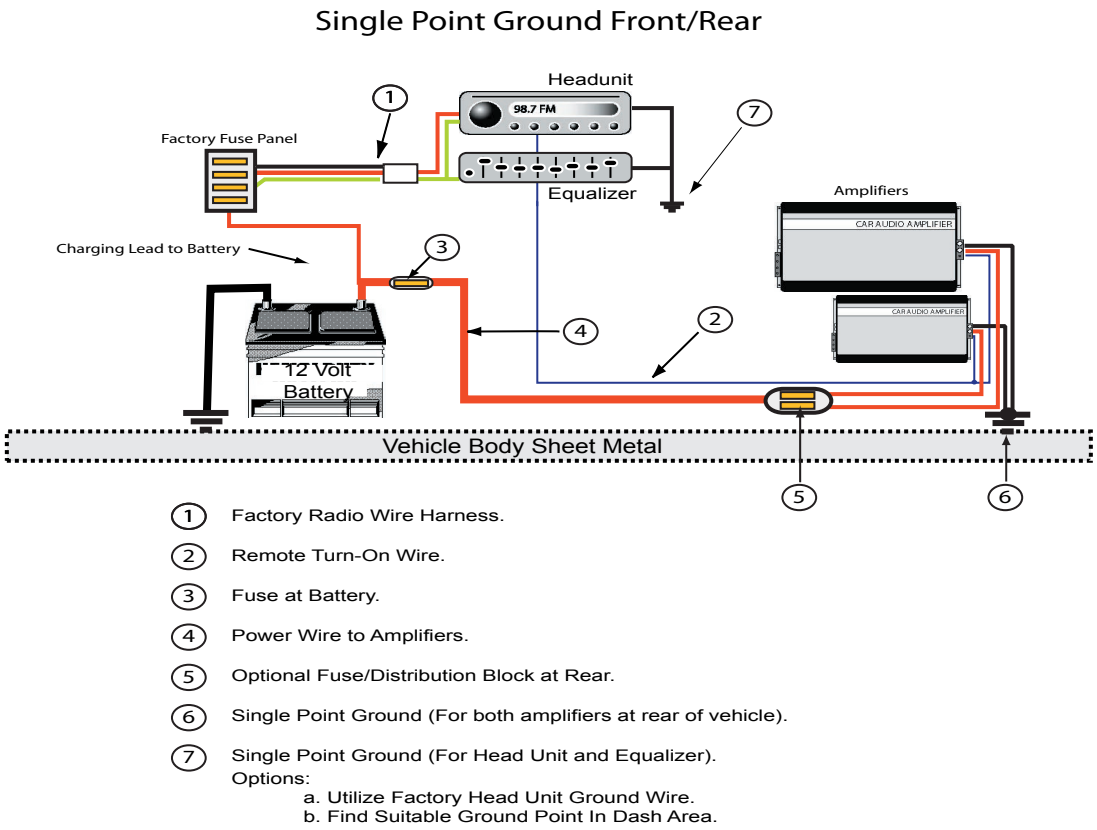


Figure 1

Installation Rules for Ground Loop Avoidance:

- Insulate all Audio Components from the chassis of the vehicle. This can be accomplished by mounting all the audio components, (amplifiers, processors, or equalizers), on some material which is not electrically conductive, such as wood or plastic. It is important to do this, as fastening an audio component directly to metal will introduce an additional ground point through the metal casing of the audio component itself. The component will now have two ground points, the negative (-) ground wire and it's own chassis, thus introducing a Ground Loop Condition within the audio component.

- Use a single ground point for all Audio Components within different areas of the vehicle. All audio components housed within the trunk, hatch or rear area of a vehicle should be grounded at one ground point. Subsequently, all audio components housed in the front area of the vehicle, such as the Head Unit, In-Dash Equalizers etc., should be grounded at one ground point. Ideally, there should be only two good ground points for all the audio components in a vehicle.

- Test for adequate ground point. It is important to test your chosen grounding point for quality. Although the majority of the vehicles' chassis is made of metal, certain areas of the chassis may make a more preferable ground point than others.

- Properly prepare your ground point. It is important to prepare the metal of the vehicle's chassis for a ground point. The metal area you have chosen for your ground point needs to be stripped bare of any paint, grease or dirt. This can be accomplished by using a fine grit sand paper to remove any of the above. A ring terminal and star washer should then be attached to this bare metal using a screw, or in cases of thin sheet metal, a nut and bolt. After the ring terminal has been attached it is advisable to apply some conductive grease to the bare metal and ring terminal to discourage corrosion in the area.

- Do not ground to an existing vehicle ground point. This is a key rule to avoiding a Ground Loop Condition. If you attach a ground wire to an existing vehicle ground point, such as the ground for a third brake light, this ground point may no longer be adequate when the brake is depressed. The third brake light may introduce a current to this ground point. When this occurs, the component, such as an amplifier, may compensate by seeking a ground path through the RCA cable for the duration of time that the brake pedal is pressed.

Ground Loop Isolation Process

If a system that you have installed, or an existing system you are working on, has the presence of a 'whining noise' you will be required to eliminate the possibility of a Ground Loop Condition first. This must be done before you can begin exploring the possibility of some other condition introducing the Powerline Noise, such as the Battery or Alternator. These two possibilities are explored in the following section. Follow the steps below to begin isolating the problem.

1. Disconnect the antenna from the Head Unit. A poorly grounded antenna may cause a Ground Loop Condition. Occasionally the antenna may have a bad ground at the point where it is attached to the body of the vehicle. This is typically caused by corrosion, but in some cases, the points of the vehicle where the fender attaches to the chassis may be corroded, causing a poor ground path from the fender to the chassis of the vehicle. If the noise has gone away, when the antenna is unplugged, check the negative lead of the antenna connector for an appropriate ground using your meter. If the ground shows an unacceptable reading on your meter, then check the mounting point of the antenna for corrosion or looseness. If corrosion is the case, clean the mounting area of the antenna. In the case of a loose antenna, tighten the antenna appropriately. If you find that the fender where the antenna is attached displays an inadequate ground when referenced to the rest of the vehicle grounds, then it advisable to attach a grounding strap from the inside of the fender to the firewall of the vehicle. If the noise is no longer present then do not continue with the Ground Loop Isolation Process. If the noise remains, reconnect the antenna and continue with step 2.

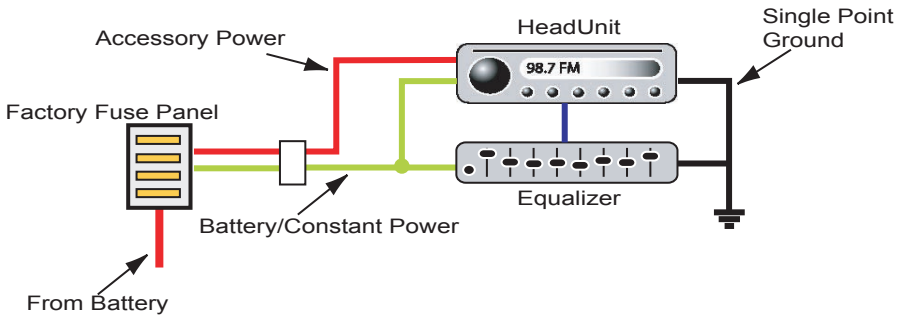
2. Detach any Audio Component that is attached directly to metal. If you have followed the Avoidance Techniques correctly, then you have insulated all your Audio Components away from the metal of the vehicle. In the case of an existing installation, check that no Audio Components are attached directly to the metal of the vehicle. If this is the case, detach the component from it's mounting location by removing any mounting screws and insulate the component temporarily from the metal of the vehicle by placing the component on a blanket or cardboard. If the noise is no longer present then do not continue with The Ground Loop Isolation Process.

3. Test Ground Points of all Audio Components. Test the ground points of each of the Audio Components in the system. If the noise is no longer present then do not continue with The Ground Loop Isolation Process. If the noise remains, continue with step 4.

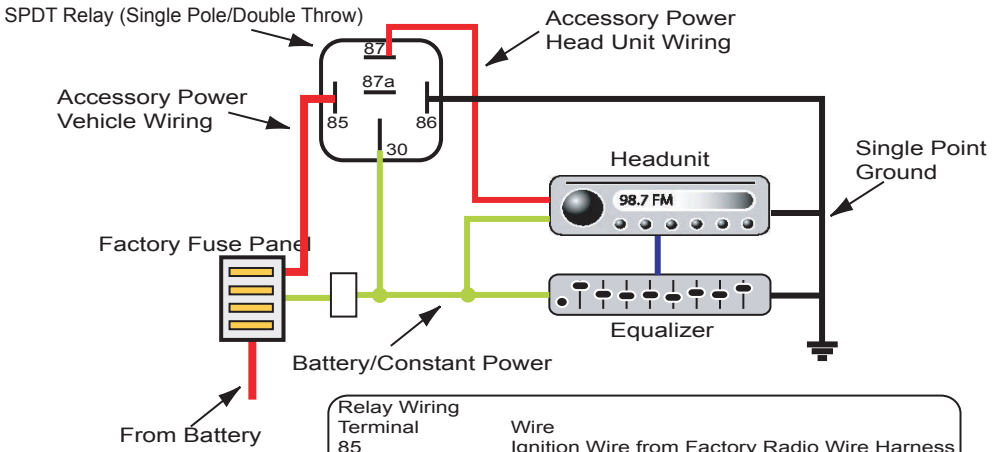
4. Choose a single point ground for all Components in the rear area of the vehicle, and a single point ground for all the Components in the front area of the vehicle. This step involves grounding all of the audio components in the rear of the vehicle to a single ground point. Components in the front area of the vehicle should also use one common grounding point. Ensure that you have prepared your single ground point correctly and a meter test has confirmed the integrity of the ground point. If the noise is no longer present then do not continue with The Ground Loop Isolation Process. If the noise remains continue with step 5.

5. Power the Audio System from One Source. The final step involves connecting a fused power line to the positive terminal of the vehicle battery and attaching this power lead to every component in the audio system, including the battery and accessory power leads of the Headunit. Doing this ensures that all the components in the audio system are receiving their power from one source, thus eliminating the potential for voltage differential between the components in the audio system. This procedure involves extending the single power wire from the battery to the individual components of the audio system. This wire need not be run inside the vehicle, as it is much easier and time efficient to run the wire on the floor of the install bay outside of the vehicle. You may attempt to reconnect the accessory wire of the Headunit back to its original Accessory source. If the noise does not return then this is acceptable. If the noise returns it may be necessary to use a relay to activate the accessory wire of the Headunit.

Typical Head Unit/Equalizer Wiring



Single Power Source Relay Switched Ignition Power



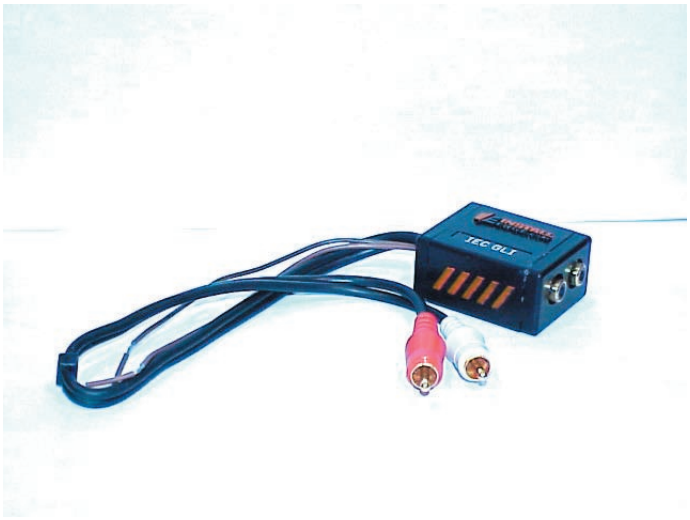
Relay Wiring Terminal	Wire
85	Ignition Wire from Factory Radio Wire Harness
86	Ground Wire
30	Battery Wire from Factory Radio Wire Harness
87a	Unused
87	Ignition Wire from Head Unit Wire Harness

Figure 2

If the noise persists after these steps have been completed, then the problem is one of the other forms of Powerline Noise that will be covered next.

Ground Loop Elimination Accessories

A number of accessories exist to deal with Ground Loop problems. The most useful and effective component is the Ground Loop Isolator. A Ground Loop Isolator, works by 'Isolating' the signal ground (-) wire on the RCA cable. This ground isolation blocks the audio component from accessing a supplementary ground through the RCA cable, thus eliminating current flow through the RCA cable. This is an effective remedy as the current flow through an RCA cable may contain the noise creating AC signal. There is, however a penalty associated with using a Ground Loop Isolator. A Ground Loop Isolator somewhat diminishes the audio signal traveling to the audio component. The most audible difference detected will be a reduction in the bass of the audio system. It is advisable to use Ground Loop Isolators only on smaller audio systems. Typically they are used on systems to remedy a problem as a 'quick fix'. It is preferable to remedy the actual source of the noise as Ground Loop Isolators are used more as a 'band-aid solution'. Follow the wiring instructions that are supplied with your Ground Loop Isolator. Below is an image of a typical Ground Loop Isolator.



Faulty Alternator or Battery

Faulty Alternator Causes

An overused, defective, or older alternator may experience failure in one of its rectifiers. When this occurs the alternator's ability to filter an AC signal to a DC signal, which the battery and the rest of the vehicle's electrical system utilizes is diminished. As a result the electrical system, which includes the audio system, receives a DC signal with an AC signal riding on top of it. This combined AC/DC signal is then digested by the audio system and the AC signal is heard through the speakers as an increasing and decreasing whine when the alternator spins faster and slower with the RPM of the motor.

Faulty Battery Causes

An overused, defective, or older battery may not have the ability to filter any small amount of residual AC signal sent by the alternator. The battery may have a defective cell within its array of 6 cells or all of the cells may be weakened by repeated charging and discharge conditions. Either condition will weaken the ability of the battery to filter any AC signal received from the alternator.

Faulty Alternator or Battery Avoidance Techniques

As an installer you cannot do anything to change the condition of a defective Alternator or Battery prior to the installation. It is however, advisable to perform a quick visual inspection of the condition of the Battery, the related connectors and wiring, as well as wiring leading to the alternator prior to each installation. If you notice any loose connections, corrosion or damaged wires, contact your supervisor and ask whether you should address the problem before the installation. Fixing problem areas prior to the installation may eliminate future noise problems.

Faulty Alternator or Battery Isolation Process

A quick test for Powerline noise is to temporarily supply power to the audio system from an outside power source. If a Ground Loop Condition has been eliminated and the noise remains, it is likely caused by Radiated Noise. Radiated noise will be discussed in a later section.

The possible causes of Powerline Noise are the four component conditions which have been discussed earlier in this section; The Alternator, Battery, corroded wire or loose connection. It is therefore important to implement a process of elimination to determine the root cause. Following the steps below will assist you in determining the cause of the noise.

1) The first (and easiest) elimination technique is to inspect the power and ground connections on the battery and alternator. All connectors should be tight and free of corrosion. Check the wires themselves for any visible corrosion or damage.

2) If you detect any loose connections or corrosion, tighten or clean the offending area and test the vehicle for noise. If the noise is no longer present the problem has been solved. If the noise is still present the following steps need to be completed.

3) The next step is to test the condition of the Battery and Alternator.

4) If the battery voltage is below acceptable attempt to charge the battery and check for noise. If the noise is no longer present the problem has been solved. Suggest to your supervisor that the customer's battery should be serviced.

5) The final step is to power the system from an external power supply. It is important to keep the audio equipment you have installed into the vehicle in its present location. The testing should be performed in the following manner.

   - Disconnect the power lines (including battery and Accessory power on the Headunit) from all the audio equipment you have installed.
   - Extend these power lines allowing them to be connected to the power supply unit on your bench. Fuse this power wire at the source.
   - Connect these wires to the + lead on the bench unit.
   - The negative lead on the bench unit then needs to be extended using a wire to connect to a ground point on the vehicle.
   - Start the vehicle (be careful that your wires are clear of any moving parts in the engine compartment).

• Close the doors on the vehicle and turn on the audio system. It is important to keep the volume level very low for this test. With the volume level low, press and release the accelerator several times to increase and decrease the engines RPM. Try turning on all vehicle accessories during this test.

• If no noise is detected then you have eliminated the possibility of a Radiated Noise or a Ground Loop condition. The cause of the noise is likely a problem with the vehicles battery or charging system. There are temporary solutions available for the problem of Powerline noise. The best solution to this problem, however, is to contact your supervisor and give him or her the opportunity to suggest to the customer that he or she have their vehicle charging system inspected by a qualified mechanic.

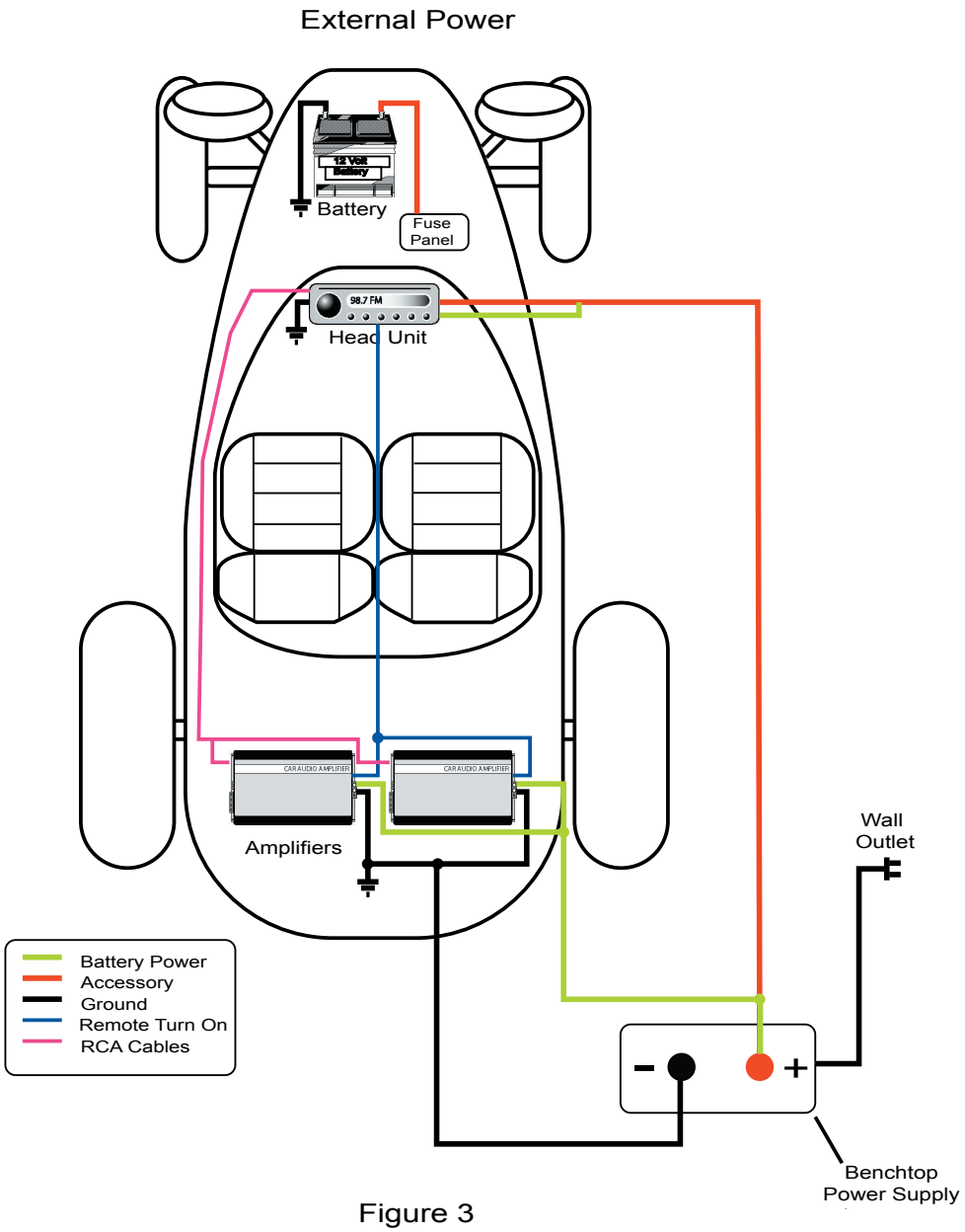


Figure 3

Noise Elimination Accessories

Noise Suppressor: An effective temporary solution to the problem of Powerline Noise, which is caused by a Battery or Alternator problem, is to use an inductor style noise suppressor. The suppressor is installed in line with each of the positive power leads entering a component. The suppressor may be placed on the HeadUnits accessory power and battery leads, on an equalizers power lead or on an amplifier's power lead. Most inductor style suppressors cannot handle current draw of more than 10 amps, therefore it is not advisable to suppress the power lead of an amplifier, which has a fuse larger than 10 amps.

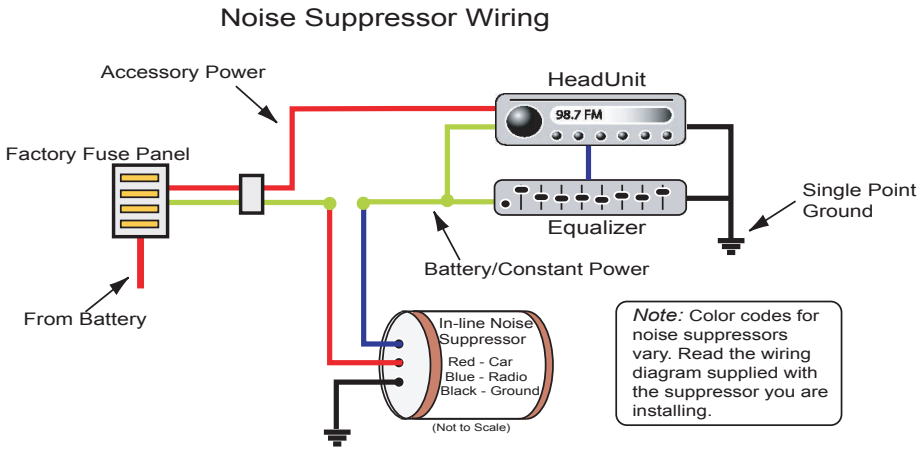


Figure 4

Capacitor: A capacitor in parallel with a component's power cable will also assist in reducing Powerline noise. This form of suppression will require you to connect the proper capacitor (Polarized 16v 4700 µf,) in parallel with the offending power cable.

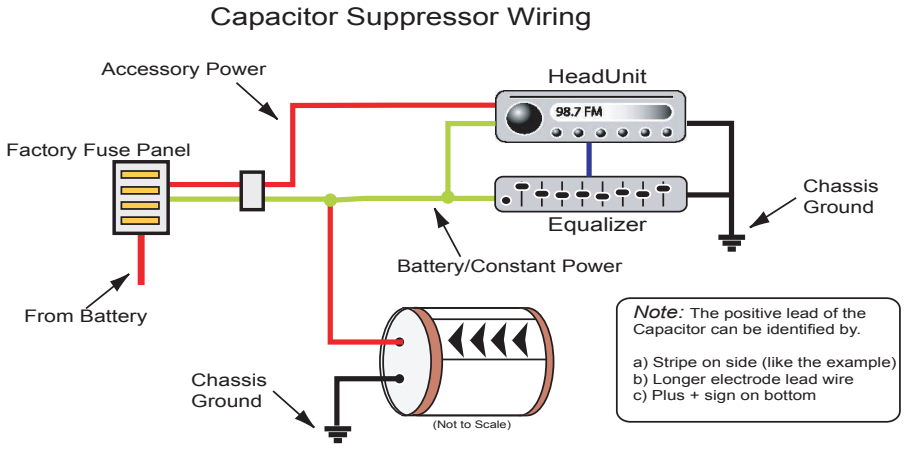


Figure 5

Faulty Connections

Faulty Connection Causes

Faulty Connections are another common cause of Powerline Noise. These may be connections relating to the audio system or connections within the vehicle's electrical system itself. A faulty or improper connection within either of these systems may cause the audio system to experience Powerline Noise. The main causes of faulty connections include, corroded connectors, corroded wiring, improper connector attachment, corroded fuse holders, and loose connectors or wiring.

Faulty Connection Avoidance Techniques

Prior to performing the installation of an audio system into a vehicle it is advisable to perform a quick visual inspection of the condition of the battery's connectors and wiring, as well as the wires leading to the alternator. If you notice any loose connections, corrosion, or damaged wires, contact your supervisor and ask whether you should address the problem before the installation. Fixing the problem area prior to the installation may eliminate future noise problems. Creating proper connections and utilizing the proper gauge wiring in your audio system installation will reduce the chances of Powerline Noise being introduced into the system. Following the rules below will reduce the chances of Powerline Noise.

1. Use proper size crimp connectors and ensure that they are crimped properly using the correct crimping tool.
2. Remove paint, grease or dirt from any areas that you will be using as a ground point for your audio components. Use a medium grit sand paper to remove any paint.
3. When connecting two wires together ensure that the connection integrity is high (eliminating the possibility of the connection coming apart in the future).
4. Verify that the power and ground cables that you are using are of sufficient gauge to accommodate the current draw of the system.

Faulty Connection Isolation Process

If the vehicle into which you are installing an audio system exhibits Powerline Noise characteristics, and you suspect Faulty Connections as the cause, please complete the following steps.

- Perform a quick visual inspection of the condition of the Battery's connectors and wiring, as well as wiring leading to the alternator. If you notice any loose connections, corrosion or damaged wires, contact your supervisor and ask whether you should address the problem before the installation.
- Check to see that the wiring used in powering the audio components is sufficient to accommodate the current draw of the audio system.
- Inspect the grounding points for all the audio components for tightness, corrosion, or damage.
- Check for integrity of wiring connections. A common cause for a faulty power cable is the cable being 'pinched' by some part of the vehicle, such as the rear seat, panel clip, or a screw that the previous installer had reinstalled into the vehicle. It is advisable to take care when reinstalling parts of the vehicle that may come in contact with any cables that have been installed.
- Check all fuse holders for tightness and corrosion.
- If any of the above conditions exist, attempt to remedy the problem. The Powerline Noise may still be present, indicating that the noise is being caused by one of the other Powerline Noise Conditions. However, fixing any problems with the wiring or connectors in an Audio System will allow the system to perform to it's full capacity and will increase it's

longevity.

Radiated Noise Identification

Radiated Noise (also referred to as induced or coupled noise) shares many of the same characteristics as Powerline Noise. Like Powerline Noise, Radiated noise can appear as a 'whining' noise that fluctuates in pitch with engine speed. However, Radiated Noise can also be present when the vehicle's engine is not running. This condition is easier to identify as Radiated Noise because Powerline Noise will not be present with the vehicle's engine turned off. With the vehicle's engine off and the ignition key in the "on" position, the presence of a humming, ticking, or static noise may indicate a Radiated Noise problem.

Radiated Noise Causes

Radiated Noise is caused by certain factory equipment or wiring within a vehicle which emits Electromagnetic Radiation (EMR). The two sources of EMR are explained below.

Factory Wiring Harness: EMR may be caused by any wiring harness that carries current. As current flows through a wire, a magnetic field is created around the wire. The higher the current flow through a wire, the larger the magnetic field. If an audio component, power wire, or RCA cable is installed within this magnetic field it may inherit any noises that may be present in the source of the EMR.

Factory Components: Factory components such as clocks or Engine Management Systems may emit EMR. This is due to a lack of shielding of the factory component. It is advisable to avoid installing equipment or wiring close to the Factory Equipment listed in 'Factory Equipment commonly Responsible for Radiated Noise Conditions' below.

Radiated Noise can be a frustrating noise to pinpoint, however this form of noise can be successfully avoided with the implementation of proper installation techniques. Radiated Noise may be caused by any of the conditions listed below. Each condition is covered individually. This section of Noise Avoidance is structured a little differently from the previous and following sections. This is necessary because of the unique relationship between certain conditions of this type of noise.

1. Wiring Technique
2. Equipment Location
3. Defective Grounding Point
4. Ignition System Noise

Factory Equipment commonly Responsible for Radiated Noise Conditions.

- Engine Management System (computer)
- Digital Clocks and Gauges
- Factory Wire Harnesses
- Ignition System (coil, spark plugs, rotor)
- Fuel Pump
- Wipers
- Electronic Dimmers

Wiring Technique

Follow the Rules of Proper Wiring

Following some simple rules when installing audio system wiring is essential in reducing and even eliminating the possibility of Radiated Noise.

Wire Routing to Avoid Radiated Noise

Radiated Noise can be successfully avoided with the implementation of proper wire routing techniques. A little extra care in wire routing during the installation will ultimately save the time spent attempting to rectify Radiated Noise after the vehicle is reassembled. It is important to follow the wire routing rules outlined below.

Installation Rules for Proper Wire Routing:

1. When running RCA cables to the rear of the vehicle, determine which side of the vehicle has the smaller 'factory' wire harness running to the rear of the vehicle (usually the passenger side) and install the RCA cables on this side. The RCA cables should be tucked into the carpeting as far away from the factory wire harness as possible.

2. Install Power Cables running to the rear of the vehicle on the opposite side that the RCA cables are installed. Tuck the Power Cables into the carpeting as far from the factory harness as possible.

3. Avoid installing Power and RCA cables parallel to each other. If the RCA and Power cables must be crossed over each other attempt to cross the cables at a 90 ˚ angle. See Figure 6

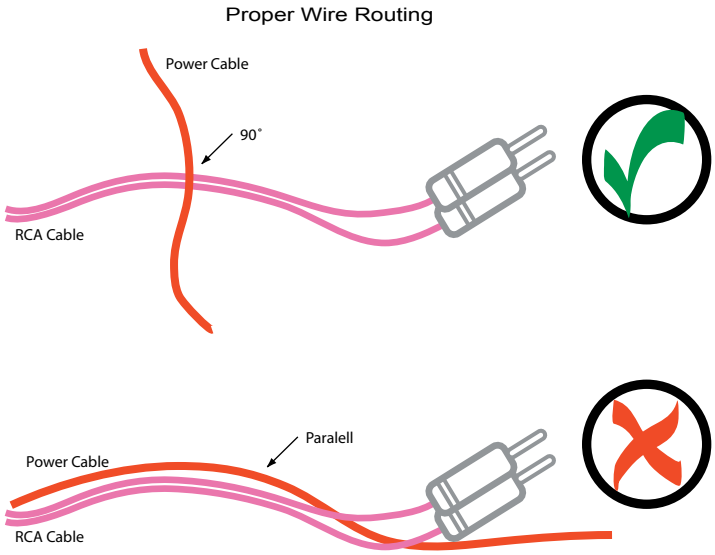


Figure 6

4. Avoid wire tying Power or RCA cables to any existing power harnesses below the dash area of the vehicle. If you must, use the technique in figure 6.

5. Avoid routing RCA cables near Gauges or Clocks within the dash area of the vehicle.

Equipment Location

Follow the Rules of Properly Locating Equipment

Following some simple rules when installing the audio system's equipment is essential in reducing and even eliminating the possibility of Radiated Noise.

Locating Equipment to Avoid Radiated Noise

To successfully avoid Radiated noise when installing audio equipment it is essential to locate the equipment in an area of the vehicle that has the least amount of Radiated Noise. Some areas and equipment in the vehicle emit more Radiated Noise than others and avoiding the placement of components in these areas is encouraged.

Installation Rules for Proper Equipment Location:

Proper Equipment Location. Installing your audio equipment in a 'quiet' area of the vehicle is essential in eliminating the possibility of Radiated Noise. Please follow the guidelines listed below.

1. Do not install Crossovers (passive or active) near any of the equipment mentioned on Page 12 (Factory Equipment Responsible for Radiated Noise Conditions).

2. When installing amplifiers and processors in the trunk area be careful to place them a safe distance from any factory equipment housed in the trunk. (Generally a safe distance is 8"-12"). Remember, high current devices have larger radiated noise patterns than low current devices.

3. Avoid installing processors (equalizers, crossovers) in or beneath the dash of the vehicle. In most vehicles this is a very noisy area.

4. Avoid installing amplifiers or processors on any existing factory equipment that may be housed beneath the seat area of the vehicle. If possible choose a seat that has no factory equipment mounted beneath it.

Noise Isolation process for Wiring and Equipment

The Isolation Process for Radiated Noise can vary depending on the condition that is introducing the noise. Below are three examples of isolating Radiated Noise problems that may be caused by Equipment Location or Wiring Location. These examples will give you a general idea of how to use the 'process of elimination' to rectify a particular Radiated Noise problem. Although we cannot discuss every variable and system design in this text the three techniques below can be adapted to your particular situation.

Example A: RCA Cable/Amplifier Location

The system in a vehicle may have two amplifiers. Amplifier 'A' powers the front speakers and Amplifier 'B' powers the rear speakers. The elimination process would be as follows.

1. Listen to the front speakers only (if possible, use the fader)
2. Listen to the rear speakers only (if possible, use the fader)

If the noise is present on just the front or just the rear speakers then it is easy to eliminate one

of the amplifiers. Having eliminated one of the amplifiers, you now know which amplifier is causing the noise. The cause of the noise, therefore, is either that amplifier's RCA cable or the location of the amplifier itself. We can now continue with the following steps.

3. Remove the fasteners holding the amplifier in place and move the amplifier at least 1 foot away from its present location. If the noise is no longer present, then the area in which the amplifier is mounted is emitting a Radiated Noise and the amplifier should be relocated. If this does not solve the problem proceed to step 4.

4. Disconnect the RCA cable from the amplifier and from behind the Headunit or Processor where the RCA cable originates. Do not physically remove the RCA cable from the vehicle. Plug a new RCA cable into the Headunit and the Amplifier. This RCA cable should be long enough to allow you to run the cable on the outside of the vehicle. This will ensure that the cable is not near any Radiated Noise sources. If this solves the noise condition then the cable installed inside the vehicle is receiving Radiated Noise from some source close to where you installed the cable. Attempt to reroute the cable to a quieter area. If this does not solve the problem then the noise may be another form of System Noise covered in this lesson.

Example B: RCA Cable /Amplifier Location

The system in your vehicle may have two amplifiers. Amplifier 'A' powers the front speakers and Amplifier 'B' powers the rear speakers. The elimination process would be as follows.

1) Listen to the front speakers only (if possible, use the fader)
2) Listen to the rear speakers only (if possible, use the fader)

If the noise is present on the front and rear speakers, it is possible that both of the amplifiers are in a noisy location OR both the RCA cables are installed in a noisy area. If this is the case follow steps 3 and 4 in example A. The problem may, however be with the Headunit itself. Please refer to "example C" below.

Example C: Head Unit location

If you suspect that the Head Unit is in an area emitting Radiated Noise it will be necessary to remove the radio from it's present location. With the radio removed from the dash cavity, move the radio away from the area where it was mounted. If the noise goes away then the radio is in an area that is saturated with Radiated Noise. Radiated Noise is typically caused by Electromagnetic Radiation (EMR). In this particular case, the noise may be emanating from one of the sources detailed below.

1. Wiring Harness: A wiring harness near the radio may be causing the EMR. The wiring harness may need to be moved away from the vicinity of the radio. The wires in the harness can be extended and rerouted individually away from the radio. It is advisable to reroute the larger gauge wires first because these wires will likely be emitting the highest amount of EMR. (A wire with a higher current capability will typically emit more EMR). Reroute each of the bigger wires individually until the noise is eliminated.

Note:
Do not attempt this when the vehicle is equipped with an airbag. There is a danger of deploying the airbag if an airbag sensor or power wire is cut. If the customer insists on having this procedure done on an airbag-equipped vehicle, inform your supervisor that a licensed mechanic must carry out this procedure.

2. Gauges or Clocks: A Head Unit near a gauge or a clock may be susceptible to Radiated Noise. In this case it may be necessary to move the Headunit, Clock, or Gauges to another location. If this is not possible the only option (which may or may not be effective) is to shield the radio from the offending noise source. This can be accomplished by installing a grounded shield above or below the radio, depending upon the origin of the noise. This shield has to be ferrite rich to absorb the EMR and then shorted to ground through the ground wire. A metal called MU metal is a suitable shield material.

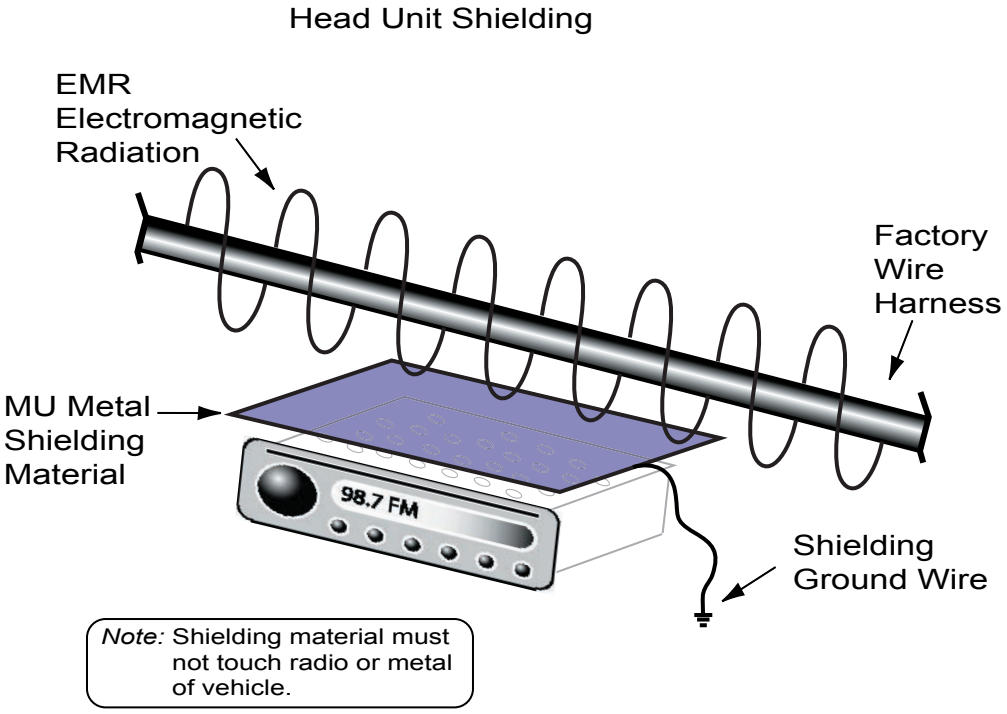


Figure 7

Defective Grounding Point

Reasons for a Defective Ground Point

Another common source of Radiated Noise is a defective ground wire on the hood of the vehicle or a fender, which, as a result of corrosion, is no longer properly grounded to the chassis of the vehicle.

Defective Ground Point Avoidance Techniques

A Defective Grounding Point is a condition of the vehicle itself and as a result, the installer can do little to avoid this condition prior to or during the installation.

Corrective Measures for a Defective Ground Point:

1. Faulty Hood Ground. The hood of a vehicle acts as a good shield for any Radiated Noise emanating from the engine compartment. The source of this noise may be factory Wire Harnesses, Ignition System (coil, spark plugs, rotor), Fuel Pump, Wipers or Electronic Dimmers. Each hood is grounded to the chassis of the vehicle by a ground strap attached to the firewall. If this ground strap breaks, the hood is no longer grounded and therefore no longer acts as an effective shield. If the audio system is experiencing Ignition Noise, it is a wise

first step to check for the presence of the hood ground wire and test it's integrity. If upon fixing a damaged hood ground wire the noise is no longer present, then the problem has been eliminated. If the noise is still present the possible cause is "Ignition System Noise".

2. Faulty Antenna Ground. A faulty antenna ground may be caused by the corrosion of the fender's mounting points to the chassis of the vehicle or corrosion of the antenna mounting point to the fender. Antenna noise is characterized by a ticking or static noise. This noise is usually more noticeable on the AM band of the radio. With the ground of the antenna compromised, the antenna's ability to reject radiated noise is compromised. Using a DMM test the ground of the antenna lead at the radio. If the ground is not adequate proceed by testing the ground of the fender to the chassis of the vehicle. If the ground at the fender is not adequate install a ground strap from the fender to the firewall of the vehicle. The area to which the antenna is mounted should be free of any corrosion or dirt. Removing, cleaning, and reinstalling of the antenna may be necessary. If the DMM is still showing an antenna ground problem then the antenna may be defective and may need to be replaced.

Ignition System Noise

Ignition System Noise Identification

The final Radiated noise to examine is Ignition Noise, which is characterized by a popping or ticking noise. Much like Powerline Noise, Ignition Noise also varies with engine speed. Ignition Noise can be present in any vehicle except for vehicles with a diesel engine. Diesel engines utilize glow plugs instead of spark plugs and ignition coils. Ignition Noise may be attributed to one of the following.

Ignition System Noise Causes

1. Faulty Hood Ground. (See information on 'Defective Ground Point')

2. Faulty Spark Plug Wires. Older or damaged Spark Plug Wires may introduce Ignition Noise into the audio system. A careful visual inspection of the spark plug wires is recommended to determine if the wires are responsible for the noise. Check the spark plug wires for tightness to the spark plug tips and ignition coil, visible cracks, dryness of the outer shield, and the possibility that the spark plug wire is being pinched by an object within the engine compartment.

3. Damaged Ignition Coil or Ignition Module. An older or damaged Ignition Module or Coil may introduce noise into the Audio System. As with the faulty spark plug wires a visual inspection of these Ignition Components is recommended.

4. Upgraded Ignition System. High performance ignition systems (such as MSD, Mallory, etc...) occasionally introduce Ignition Noise into an Audio System.

If you find fault with any of the above components outlined in points 2, 3 and 4 it is advisable to contact your supervisor about the particular situation. Your supervisor may choose to advise the customer to have the vehicle inspected by a qualified mechanic.

Radiated Noise Elimination Accessories

A number of accessories exist to deal with Radiated Noise problems. It is recommended to fix

the noise problem at its root, however the following components may be utilized to temporarily fix a Radiated Noise condition.

- Antenna Suppressor. In certain cases an antenna suppressor works well in eliminating Radiated noise entering through the antenna cable. The antenna suppressor is plugged into the antenna receptacle of the Headunit and the antenna is then plugged into the appropriate end of the antenna suppressor. Antenna suppressors however, tend to deteriorate the radio signal, particularly on the AM band. It is advisable to test both the AM and FM reception of the radio after installing an antenna suppressor.

Pulse Noise

Pulse Noise Identification

Pulse noise occurs when one of the vehicle's accessories is activated, such as the brake pedal, turn signals, or wipers. Pulse noise is a high-energy transient spike caused by the opening of a switch or the activation of a relay. In the case of a switch, this is a high voltage spike that occurs when the switch is closing. Before the switch is completely closed a spark jumps from one contact to another, much like the spark on a spark plug. This high voltage spike then travels throughout the electrical system of the vehicle and eventually enters the Audio Equipment. When this occurs a loud 'snap' is heard from all of the speakers. Pulse noise as a result of a relay being activated is similar, however the cause is the coil side of the relay being deactivated. This noise occurs regardless of whether the engine is running or not. A pulse noise can be an extremely annoying noise, as it may occur each time the customer applies the brake or turn signal.

Pulse Noise Causes

1. Switch Induced Noise
2. Relay Induced Noise
3. Ground Path Noise

Switch Induced Pulse Noise

Switch Noise Causes

Switch Noise is caused by a high-energy transient spike that occurs when the contacts of a switch are open and closed. Switch Noise is extremely high in harmonic content and causes a snapping noise heard throughout the entire audio system. This only occurs when a particular switch is activated.

Switch Noise Avoidance Techniques

Switch Noise is inherent to the vehicle's electrical system. Therefore, as an installer there are no options for avoiding the switched noise. It will either be present or not. There is however, an effective solution to Switch Noise, which is covered below.

Switch Noise Isolation Technique

Determine Source of Switch Noise. It is necessary to find the switch responsible for the Switch/Pulse Noise. This is a very easy process, as it will be the switch for the accessory causing the noise, such as the brake or the turn signal. A capacitor is an effective remedy for switched noise. A capacitor, when installed, will allow this spike to be grounded in a controlled manner through the capacitor itself.

The capacitor acts as a path of least resistance for the spike and therefore it will not travel to the rest of the system. Find the location of the switch, and proceed with the step below.

Switch Noise Capacitor Installation

- Locate the switch responsible for the noise.
- Locate the Battery wire for the switch.
- Locate the Switched wire for the switch. (Only live when switch is on)
- Attach the + lead of the capacitor to the Switched Wire. (See Figure 8)
- Attach the - lead of the capacitor to a clean ground point on the chassis of the vehicle.
- Turn the audio system on and test the Accessory for Pulse Noise. If attaching a 4.7µf capacitor does not eliminate the problem, try a 47µf capacitor, and so on.

Switch Noise Accessories

The most widely used accessory for solving a Switch Induced Pulsed Noise is a Polarized 16v 4.7µf capacitor. If this capacitor does not produce the desired effect try a 47µf capacitor and so on. This capacitor should be installed according to the steps outlined above in 'Switch Capacitor Installation'

Switch Capacitor Wiring

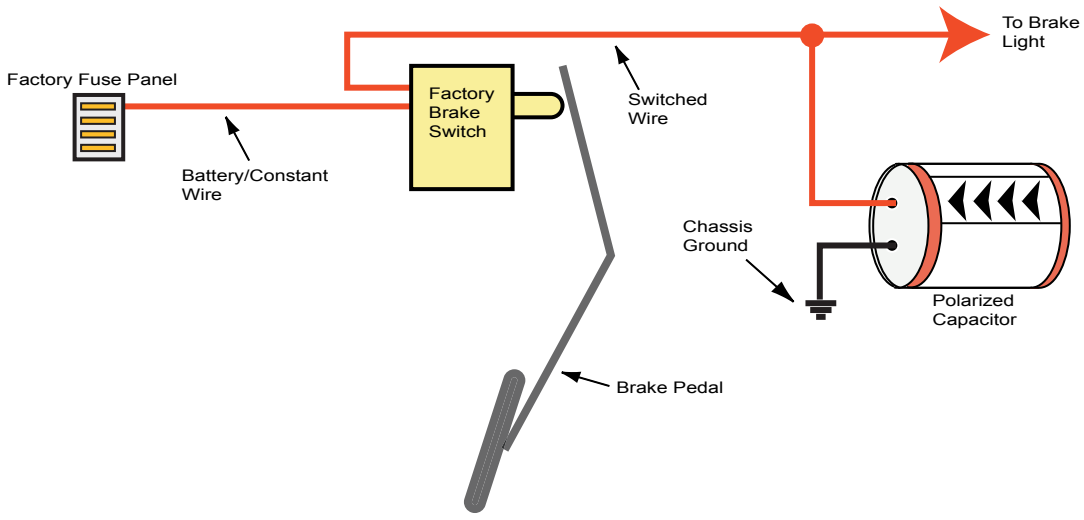


Figure 8

Relay Induced Pulse Noise

Relay Noise Causes

Relays and coils produce a similar spike. The activation or deactivation of the coil in a relay may cause a voltage spike of up to thousands of volts.

Relay Noise Avoidance Techniques

As is the case with Switched Noise, Relay Noise is inherent to the vehicles electrical system.

Therefore, an installer has no options for avoiding the Relay Noise. It will either be present or not. There is however an effective solution to Relay Noise which is covered below.

Relay Noise Isolation Technique

Determine Source of Relay Noise. It is necessary to find the accessory responsible for the Relay Noise. This is a very easy process, as it will be the Relay for the accessory causing the noise, such as the wipers or the turn signals. An effective method for finding the relay that controls an accessory is to listen for the clicking of the relay itself. When a relay is activated it makes a sound that can be heard if you are within the vicinity of the relay. Typically relays are housed somewhere on the fuse panel. Relays may also be found in a special relay bank somewhere beneath the dash of the vehicle or possibly in the engine compartment. If, for example you wanted to locate the headlight relay, you would place your head in close proximity to the fuse box beneath the dash or near the relay box located in the engine compartment. Ask a fellow installer to activate the headlights. When the headlight switch is activated you should hear a relay clicking. Isolating the particular relay in this manner is quite common. It is then necessary to 'clamp' this relay. Clamping is the installation of a diode between the 85 and 86 terminals of the relay. These terminals are the + and - terminals of the electromagnet within the relay causing the Pulsed Noise. A diode, when installed correctly will short the high voltage pulse to ground. This occurs so quickly that the audio system is not aware of the spike occurring at all. Follow the instructions below to 'clamp' a relay.

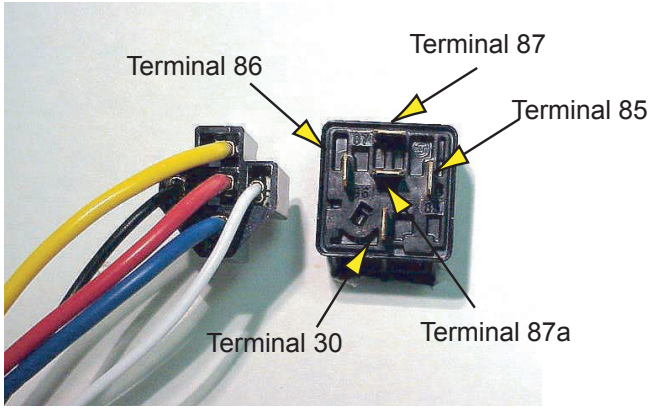
Relay Diode Installation

- Determine the + terminal on the trigger side of the relay. It will be either terminal 85 or 86. (See Figure 9 for further instructions.)
- Attach the Cathode end of the diode to the + terminal.
- Attach the Anode end of the diode to the - terminal.
- Reinstall the Relay and test for Pulse Noise.

Relay Noise Accessories

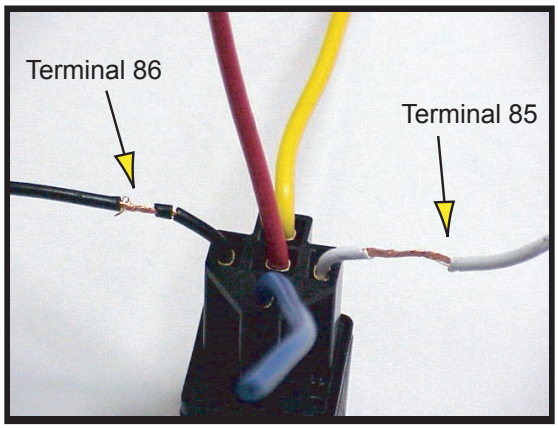
The other accessory is used in conjunction with an existing Relay causing a pulsed noise. The accessory we use for 'clamping' a relay is a model 1N4001 diode. Refer to 'Relay diode Installation' above and see Figure 9 on the following page.

Relay Diode Clamping Procedure

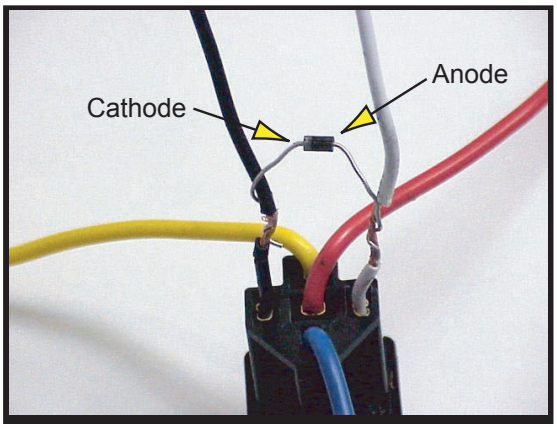


Relay with Plug.

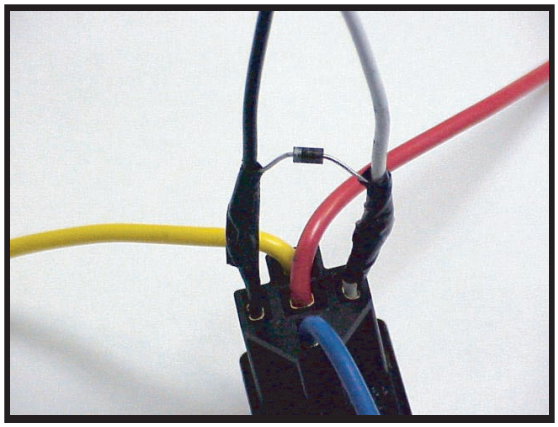
Note: * Not all Relays are alike! *
The Cathode must be attached to the positive terminal of the relay. The positive terminal of the relay you are using may be EITHER 85 or 86. It is imperative to check the relay you are using with a DMM to ensure that you have the proper positive terminal. In our case the + was terminal 86.



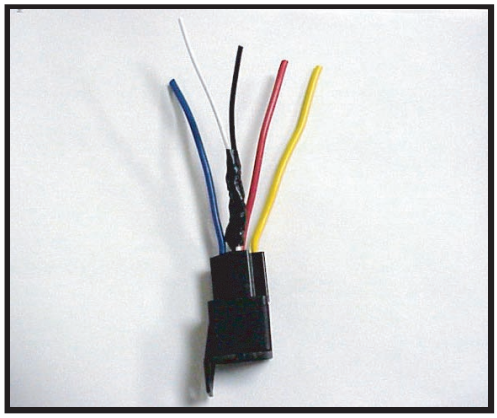
Strip Terminal 85 & 86 wires.



Attach diode to wires. Cathode - Terminal 86 +
Anode - Terminal 85 -



Tape connection between diode and wires.



Final wire dressing.

Figure 9

Ground Path Noise

Ground Path Noise Causes

Ground Path Noise is caused by an audio component sharing the same ground path with an accessory in the vehicle. This may be a brake light or turn signal ground path.

Ground Path Noise Avoidance Techniques

Ground Path noise can be avoided during the installation. It is important to locate an audio system component ground away from any factory ground points. You should never ground audio components to any factory ground point as this may introduce Ground Path noise.

Ground Path Noise Isolation Technique

In the case of ground induced Pulse Noise, simply relocate the ground wires to any audio equipment that may be sharing an existing vehicle ground. If the Pulse Noise occurs as a result of the ground path then moving the existing ground away from its present location may remedy the problem.

System Noise

System Noise Identification

System Noise is identified by a “hissing” noise that is present whether the vehicle’s engine is running or not. This type of Noise is easily identified, as it will rise and fall with the level of the volume control.

System Noise Causes

System noise is commonly due to the mismatching of different audio components. Mismatched audio components may have different Signal to Noise (s/n) ratios or incompatible preamp level inputs and outputs (component mismatch). We will address each of these individually

1. Low Signal to Noise Ratio
2. Component Mismatch

Low Signal to Noise Ratio

The Signal to Noise ratio specification

An audio component’s Signal to Noise ratio is an important specification to consider when matching multiple components in an audio system. Signal to Noise ratio is the ratio of audio signal to noise. It is preferable to have a higher s/n ratio, as this indicates that the percentage of signal (clean sound) to noise is higher, making the noise less audible. Most current audio equipment will exhibit a s/n of 100db or higher. This specification indicates that Signal to Noise will have a ratio of 100 to 1.

The ‘Weakest Link’

When selecting audio equipment for an audio system it is preferable to use equipment with a similar s/n ratio. If the audio system you are building consists of a Head Unit, Equalizer and an Amplifier the component with the lowest s/n ratio will dictate the s/n for the whole system. If the Head Unit

has an s/n of 100db, the Equalizer has a s/n of 90db and the Amplifier has a s/n of 110db then the entire system will have a maximum s/n of 90db. A common example may be that a customer purchases a higher quality Head Unit and Amplifier from your store but supplies an older Equalizer. This older Equalizer may have a lower s/n and will dictate the level of System Noise in the entire system.

System Noise Avoidance Techniques

An installer must be aware of the s/n of the equipment being installed. If the system installed exhibits a 'hissing' noise then the knowledge of the products s/n may assist an installer in explaining to the customer why this is occurring. It may however be helpful to reduce system noise by adjusting the gain controls on the Equalizer and Amplifier.

System Noise Accessories

The s/n ratio is a specification, which is inherent to the product and cannot be modified by the installer, therefore no accessories exist to change or modify this specification.

Component Mismatch

Component Mismatch Causes

Input and Output sensitivity or "gain" of the individual components of an audio system are important in the avoidance of audible system noise. A higher voltage preamp signal from the Headunit allows an amplifier to reproduce the signal more efficiently and generally with less s/n hiss because it is reproducing a cleaner, stronger signal.

Component Mismatch Avoidance Techniques

A common source of component mismatch noise is when the HeadUnits preamp output voltage does not match the amplifiers input preamp voltage. For example, the Headunit may have a fixed preamp output voltage of 1.8V. Typically an amplifier or equalizer will have a variable preamp voltage input. It is important to match this input to the output of the Headunit. An example of variable input voltage on an amplifier may be between 200mV and 6 volts. These specifications can be found in the owners' manual.

System Noise Accessories

A very useful accessory for dealing with Component Mismatch is called a line driver. A line driver is installed between the Headunit and the Equalizer or Amplifier. The line driver allows the installer to increase or decrease the voltage from the HeadUnits preamp level. This allows the installer to boost the voltage from the Headunit entering the Equalizer or Amplifier. Refer to the installation procedure supplied with the line driver you are using for wiring instructions.