

# MOBILE ELECTRONICS 101

## A Basic Introduction to Aftermarket Mobile Electronics

Mobile Electronics is a fun and exciting category of retail sales, largely because there are so many new and innovative products in the market that there is **always something new to experience**. While these attributes keep it interesting, it also presents a challenge for those attempting to get up to speed on the products themselves and what it takes to get them installed in today's vehicles. It's much more than bolting in an under dash cassette player and hooking up a couple of speakers. Today's vehicles are complex and require an understanding of both the products that will be sold and installed, as well as the installation accessories that put the whole package together. Installation accessories are often the cement that holds the whole installation together as a solid, trouble free system. While mobile electronics covers a lot of products, mobile audio is one of the most recognizable.

### Basic Terminology

First, it's pretty important to know the basic terminology that surrounds mobile electronics and, in particular, mobile audio. Equally important is knowing what certain terms mean (or don't mean) because people frequently misuse common terms because they just don't really know any better. One example is talking about electrical power or electrical demand. The terms Volts, Amps, Watts, and Ohms are commonly used and misused depending on the application. While this is a technical example, there are examples of all types including simply not knowing the name of a product and calling it a "thingy" or a "do-hickey". In the aftermarket mobile electronics world, **using the right terms saves everyone unnecessary headaches** and ensures the right product or accessory makes it into the customer's vehicle. This section covers some of the basics you need to know and subsequent sections dive into each area even deeper!

**OEM** - This means "**Original Equipment Manufacturer**" and is essentially a reference to the factory installed equipment. When electronics are discussed there are typically "OEM" parts and "Aftermarket" parts. Aftermarket parts are those that are sold in retailers whereas OEM parts (including radios, speakers, etc.) are purchased at (or through) the car dealership. When people choose to replace or upgrade their vehicle electronics, they often choose to do so with aftermarket products because they have a greater range of choice and they may also have the advantage of lower cost.

**Headunit** - (Also called "Radio" or "In Dash Unit") - This is the **main in-dash unit** where the audio system is controlled. Typically this is an AM/FM cassette or CD player. Aftermarket headunits come in only 2 common sizes whereas the original equipment from the vehicle manufacturer may have had one of several size/shape configurations. OEM headunits are sometimes so integrated into the look of the dash board that consumers assume they can't change it with an aftermarket unit. Often they can if they have the right accessories.

**Installation Kit** - (Also called a "Dash Kit" or simply "Kit") - The installation kit is a metal or plastic part specifically intended to make the aftermarket headunit **fit into the original location** of the headunit that came with the car. Since they are not always direct replacements, these installation kits allow the aftermarket part to fit as if it were a factory installed part. Some installation kits include not just plastic parts, but now many may have heater control knobs or digital "information center" displays to replicate what was removed from the original equipment.

**Installation Wiring Harness** - (Also called "Wiring Harness Adapter" or simply "Harness") - The installation harness is a necessity to make the aftermarket headunit **plug into** the vehicle. None of the vehicles on the road will plug into an aftermarket headunit without the use of this harness because each car manufacturer's original equipment is developed only to work in that vehicle. In other words, you can't plug a General Motors headunit into a Toyota and vice-versa. These aftermarket installation wiring harnesses are terminated with color-coded wires that can be connected to the harness supplied with the aftermarket headunit. In this way, the harness from the aftermarket headunit, through the use of the correct installation wiring harness, can be made so that it plugs into the original vehicle wiring just as if it were original equipment.

**Antenna Adapter** - Nearly every new vehicle on the road utilizes a **different type of AM/FM antenna connector** at the back of the OEM headunit. While this goes completely unnoticed while the original headunit is in place, when it's time to replace that headunit the AM/FM antenna receptacle on the aftermarket headunit may not mate correctly to the vehicle antenna unless the proper adapter is utilized. Vehicles such as GM, Ford, Dodge, BMW, VW, Nissan, Infiniti, Volvo, and many others require AM/FM antenna adapters to complete the connection between the aftermarket headunit and the vehicle antenna wiring.



*An OEM headunit in a Jeep 2005 Grand Cherokee*



*An aftermarket headunit shown in a Ford Focus Installation Kit*



*An Installation Harness for a GM vehicle. Note the color coded wiring. This is what the aftermarket headunit utilizes for a connection into the vehicle wiring.*



*An antenna adapter for a Volvo S80 that allows the aftermarket headunit to plug right in to the Volvo antenna*

**Amplifier** - (Also called "Amp" for short) - While most aftermarket headunits provide "built in" or "onboard" amplification, there are many outboard amplifiers that **provide more powerful sound capabilities** and configurations for multiple speakers. Typically an amplifier has a composite metal or fully aluminum **heatsink** which is the shroud that you see when you look at the amplifier itself. Inside that shroud are the electronics that amplify the sound and, in the process, create some of the heat that is dissipated through that heatsink. Amplifiers need to breathe if they are to work reliably. The other major factor of an outboard amplifier is that, because it is more powerful, it requires **heavier gauge wiring** that **connects directly to the vehicle battery (through a fuse)** rather than plugging into the existing headunit wiring or being wired in to the under dash wiring. This factor is assisted by an "amplifier installation kit" (also called "amplifier wiring kit") in which the proper size and length of wiring is supplied along with other necessary items for installing the amplifier into a vehicle. An amplifier is often something that customers choose to have professionally installed because the level of difficulty is much higher than an aftermarket headunit that has the benefit of an installation kit.



*Amplifiers generally require an additional purchase of an amplifier installation (wiring) kit to complete the necessary installation tasks.*

**Speaker** - Whether connected to the built in power of a headunit or an outboard amplifier, **speakers are the voice of the audio system**. Conceivably, more power and more speakers would lead you to the conclusion that something would be louder. While this is a reasonable assumption, it's not always that simple. There are many factors that make an audio system sound good and more is not necessarily better when it comes down to speaker choices. Speakers are divided up into segments of their intended use or frequency range so that, operating together, the sound is as true to the original sound as possible. As far as segments, speakers are usually divided into the "Low", "Mid", and "High" frequency ranges. Low frequency speakers are called woofers (sometimes they are called "**subwoofers**"). Middle of the range speakers are appropriately called **midrange speakers** (although when combined with other speakers they may also be called "**mid-woofers**"). The highest frequencies are played by speakers called **tweeters**. Ideally an audio system that plays the full range of human hearing is called a "full range" system, however no single speaker is capable of doing that in a balanced (equal sound level) form. This is why the concept of multiple speakers over dedicated frequency ranges is employed as audio systems get "better sounding". Perhaps the most noticeable enhancement to an OEM audio system would be a woofer (or subwoofer) where the lowest frequencies that seem to be missing suddenly come alive.



*This is an example of a factory replacement type speaker.*



*This is an example of a coaxial "2-way" upgrade speaker*



*This is an example of a "2-way" premium component speaker system with separate midrange and tweeter and a passive crossover network*

*This is subwoofer and these need to be enclosed in a suitable speaker box made of MDF, etc. These also require an amplifier for power. The headunit power is not enough to move these large cones!*



*RCA Audio Cables*

**Audio Cables** - These are necessary to connect headunits to amplifiers. It's what carries the audio signal between components and these cables are usually terminated in a universal plug type called an RCA plug. The name comes from the company RCA who standardized the connector many, many years ago and in doing so it became the default connector for consumer grade home and car audio products. These are commonly called **RCA cables**, which is an audio cable terminated into an RCA end.

**Speaker Cables** - (Also called "Speaker Wires") - Unlike RCA cables that carry audio signals between the electronic components, speaker cables are made of larger gauge copper wiring and are specifically intended to deliver the amplifier power to the speaker terminals. **Speaker cables generally describes thicker wiring** while the term "speaker wire" describes average sized wire that you might find behind the factory installed headunit or wired into the original equipment speakers in the car. Upgrading to new speaker cable is often **necessary when installing an amplifier** because of the location where the amplifier must be installed relative to the location of the speakers. Speaker cables are sometimes included in an amplifier installation kit depending upon the kit and its contents. Be sure to check the contents if you are not sure.

**Auxiliary Input** - (Also called "AUX IN") - this is a feature of a headunit that allows an **external audio device** such as a portable music player (like an iPod) or a Satellite Radio system to be installed in the audio system in such a way that the **audio passes into the headunit as clean and unobstructed as possible**. This is typically done via **RCA input jacks** on the headunit specifically designated as the auxiliary input (similar to connecting a VCR into your TV at home, only minus the video connection). To accomplish this task, there **may be adapters necessary** to facilitate connection yet still maintain otherwise normal headunit functions. It all depends on the headunit. Perhaps the most interesting thing about auxiliary inputs is that in addition to being a feature found on many aftermarket headunits, **they can be added to most OEM headunits too**. Remember with OEM headunits that it's usually a matter of the right adapter to do so. The benefit is better sounding audio over the other methods of connecting that external device.

**FM Modulation** - This is a lower audio quality alternative to an Auxiliary Input where the audio from an external audio device is simply broadcast into an FM channel that can be picked up (as if it were a station) by the headunit. All that is necessary is to have a functioning FM tuner and a compatible FM Modulator device for the external audio device. This is the least invasive in terms of installation, but it has **no better sound quality than the FM quality of that particular headunit**. Additionally, some FM modulators not only broadcast the music, but static or hiss as well. FM Modulation is an alternative that should be considered if there is no possibility for a more clean auxiliary input solution through RCA jacks or other inputs.

# Choosing and Installing Headunits

## Feature Packed and Full of Choices

Although many people breeze over headunits as a category of similar products once you look at one from the other, there are subtle features that may suit one customer better than another. One of the greatest challenges in any technology item is getting the user to **READ THE OWNER'S MANUAL**. As the person selling (perhaps even installing) the headunit, you may be able to show customers the most beneficial ways to use their headunit without "pushing buttons" or "adjusting parameters" that end up with a negative result. What it comes down to is product knowledge that is deeper than the information provided in the manufacturer's literature or on their website. Since most aftermarket headunits are feature laden with many, many parameters to adjust, it's important to know the reasons behind each feature so it is a useful benefit.

One area that is constantly changing among manufacturers of headunits is the terminology (also called nomenclature) of their user adjustable features. Just by taking a sample of products offered in 2006, you can find over 12 different names for an adjustable bass equalizer. There are also plenty of names for sound enhancement specifically for compressed audio formats such as MP3 and WMA. The point is that you have to be aware of what the feature actually does to be able to assess whether it benefits a customer or not. And with today's headunit prices being as competitive as ever, it's important that you help the customer choose a product that they will be comfortable operating and looking at in the dashboard opening while still allowing you to suggest the right products that allow the necessary control and flexibility for a great audio system.

## Key Building Blocks

Two of the key building blocks of a headunit are the **preamp outputs** (how many and what features can be routed to these outputs) and **what media sources can this unit play** (or what can be connected to it as an auxiliary input). Preamp level outputs are the **key building block** necessary to add aftermarket amplifiers with no additional parts or audio conversion devices. The physical type of connector on most preamp outputs is the RCA connector which is the standard audio connector for nearly all consumer audio devices. It's common to have at least one pair, but many units have two or three (typically Front, Rear, and Subwoofer) and sometimes even more than that. The media sources are things like a CD player, perhaps the ability to connect (and control) a CD or DVD changer, connect an **AUX input** for a generic "carry in" source such as an MP3 or portable CD player, and even product specific inputs for devices like the Apple iPod. Will it play CD-R discs or MP3 "digital music" encoded files? **MP3, WMA, and AAC** are popular compressed media formats. The more media sources the unit can control, playback or provide input for, the greater its flexibility for the end user will be. Remember that these days people want to take their music with them everywhere they go and if their car headunit can play it, all the better!



Many headunits have front panel AUX inputs to connect carry in audio devices easily. Rear panel RCA AUX inputs are also found on some models.

## Features for the User

As far as features adjustable on the front panel are concerned, there are a number of things to consider for the intended user. Many aftermarket headunits are so feature laden that the buttons are small, the menus are complex, and the displays are difficult to decipher while driving down the road. With some simple system designs or "technology challenged" users, it's better to keep things simple where adjustments are concerned. Often there's a wireless remote control for ease of adjustment on frequent parameters like volume, track, song, station preset, etc. The less frequently adjusted parameters are generally accessible directly on the front panel and through various menus or button sequences. Even setting the clock can be a challenge because, like most adjustable parameters, no two manufacturers design their user interface the same way. With each make and model it's like learning a new routine.

Some of the things that sales associates rarely consider are the things that the customer will have to live with every day. Since the headunit is prominently located in the dash or its control is initiated in the dash, it's something the customer interacts with constantly so it should be intuitive, ergonomically suitable, and look like it belongs as much as possible. Here are some of the things to consider from the customer's point of view?



- Will the headunit's illumination color match the vehicle's dash lighting color? Some headunits have adjustable color choices while others are fixed as is. You may want to think about that because customers won't usually express objections until it's already installed in their vehicle. Some aftermarket headunits offer a selectable illumination color scheme which would benefit the customer if they have hard to match dash lighting colors.

- Is there a knob or buttons for volume? If you look at all the OEM headunits out there you are going to find that most feature an intuitive knob adjustment for the volume control. While some customers do not have a preference, others definitely prefer one style over the other.

- Is the display easy to read and is it adversely affected by direct sunlight? Some displays are so complex and stuffed with information that it's like looking at the downtown "Lights of Tokyo" which can be distracting, even frustrating for some users. Conversely, other users prefer a display that has more than just song and artist information, but also animated "screen saver" type graphics that keep the pace moving. And with either preference, you always have to consider how the display is affected by direct sunlight because that's at least half of the time the unit is typically in use.

- What are the security features and are they easy to use? Many in-dash headunits feature a detachable face plate, but if it also opens up to access a

CD slot (for example) does that create a difficulty for the customer to correctly reconnect that face plate upon returning to their vehicle? Incorrect face plate positioning can cause strange display problems, intermittent operation, and other annoying problems that may not be outwardly obvious to the customer. If the unit has a security feature, it should also be easy to use. You don't want returns for things that were hard to use.

- What will the expectation be for the difference in SOUND QUALITY? Since the headunit will likely be taking place of the OEM headunit, you have to consider what benefits the customer is expecting to HEAR, not just see and interact with on the front panel. Often the sales associate makes the mistake of assuming that enhanced features are enough to satisfy a customer's expectations for their investment. What the reality is that for all other things being relatively equal in output power and source media, adding speaker upgrades to a headunit installation will make a more noticeable sound quality difference than a headunit alone will almost every time. Think about it, when you change from a factory CD player to an aftermarket CD player, not adding any amplifiers or changing/adding any speakers – just how different do you think it's really going to sound. Remember, speakers make the biggest difference you can hear while the headunit makes differences that are tactile, things you "experience". Both are important for great sound!

## Planning for Great Sound

When you have the consideration of sound quality on your list of goals to achieve in an audio system installation, you may find that some of the on-board sound adjustment features of an aftermarket headunit present somewhat of a double edged sword. Although it's great to have the power of total adjustment over every possible sound parameter, **if your customer does not understand the features and how to best use them, it can create more displeasing sound than anything else.** Add to that the fact that most of the sound quality related adjustments still have limited effects with low system power (what's "built-in" to the headunit) and you have to really **think of the headunit as one of the building blocks in a much bigger system.** The ideal system (regardless of how powerful and how many amplifiers and speakers are installed) should have the following 3 sound quality attributes:

- 1) It should be **loud** enough to **overcome road, wind, and mechanical noises** of the vehicle while driving. This may even include additional noises brought on by aftermarket low profile tires, aftermarket exhausts, and engine upgrades.
- 2) It should be **dynamic** enough and have enough power to **respond to the subtle (and not so subtle) changes in the music** to which the customer listens. This doesn't have to be so much power that they go deaf, but enough to become aurally "intoxicated" by the audio entertainment.
- 3) It should be **balanced** enough to be able to reproduce a bandwidth of **20Hz-20kHz** with as little deviation as possible (typically +/-3dB). This does not mean the end result is a "flat" system response curve, **it just means that all frequencies in the human hearing range should be equally represented** to allow the features of the sound adjustment parameters to be effective at pleasing the individual listener's tastes.

**Loud, Dynamic, and Balanced.** Once a system can achieve all of those elements, the rest is just connecting the dots (so-to-speak) and observing the proper installation techniques to make sure that what is planned is what is executed. Any one parameter is not, all by itself, going to ensure a great result. It is the compromise of design philosophies shaped by all three parameters that put you on the road to a great system design. So in summary, a great audio system is responsible, in part, to an overall consideration to the design. Plan your work and then work your plan.

## Physical Installation Considerations

When you are helping the customer consider the installation challenge of physically putting the unit into a dash opening, you should understand both the standards for the headunit size and the opening into which it is going to be installed. The following are some of the standards you will encounter in the installation of aftermarket headunits.

- **DIN (7 $\frac{1}{8}$ " wide x 2 $\frac{1}{8}$ " high):** This is the most common aftermarket headunit chassis size. The acronym DIN means "Deutsches Institut für Normung", which is a German based group that sets standards for manufactured products. Originally the DIN standard created the template for a consistent dashboard opening for headunit manufacturers to target in European vehicles. It soon spread to the aftermarket when car CD players came out in 1982-83. Aftermarket DIN headunits are actually 7" x 2" and slide into a DIN opening that accepts a  $\frac{1}{8}$ " larger mounting sleeve. Due to the origin to the DIN standard, there have been many OEM DIN sized headunits including Porsche, Mercedes-Benz, Saab, pre-1996 BMW, most VW, and older Jaguar vehicles. Other applications include some Fords from 1987 and later, most pre-2000 Hondas, and some Mazdas. While DIN is still the common size of the aftermarket headunit, these days DIN openings are disappearing from modern dashboards in favor of unique, more ergonomic shapes.



A DIN sized headunit in a 95 BMW 3 series means direct replacement



Aftermarket units install with only the mounting sleeve and installation wiring harness

OR



For non-DIN cars installing an aftermarket headunit, use an installation kit to mount the sleeve



Then the headunit is installed in the kit and the kit gets installed in the dash opening



An ISO DIN application in a 2001 Toyota Corolla



A Double DIN application in a 2003 Ford Mustang



A GM M2000 style headunit in a 2002 Pontiac Firebird



A GM Oversize style headunit in a 2004 Chevrolet Truck



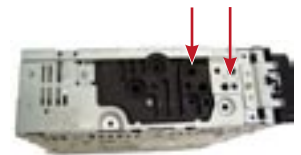
A Chrysler "Rounded Corner" style headunit in a 2002 Jeep Liberty



This 2003 Infiniti G35 dash is one of many unique shaped headunits found in cars today

• **ISO-DIN:** The ISO-DIN factory installed headunit has a slimmer width front panel (sometimes called the nosepiece) that usually mounts into or through an opening and has a dash trim panel that fits over the front. An aftermarket headunit that can be ISO mounted needs to have the ability to have the surrounding trim ring removed so **only the nosepiece protrudes through the headunit opening**. Sometimes the nosepiece sticks out far enough that you can still use the trim ring after the dash panel is installed, other times the nose piece sits almost flush with the dash so the trim ring is not needed. Most fixed front panel headunits can be ISO mounted.

Headunits with a detachable faceplate sometimes cannot be ISO mounted. It depends on the headunit's trim ring and whether it's fixed or removable. In a true ISO-DIN installation, the mounting sleeve is not used and instead the factory bracket assembly is used. OEM ISO-DIN vehicle applications include Toyota, Mitsubishi, Geo, Suzuki, Isuzu, older Nissan, and some Mazdas. You will notice many aftermarket headunits have **threaded holes designated "T" or "N"** (for Toyota or Nissan) that are intended to line up with factory bracket holes in those vehicles that apply.



Sides of aftermarket headunits have threaded holes for ISO-DIN factory mounting brackets.

• **Double DIN:** Double DIN is a single chassis that is the same as **two DIN units stacked one on top of the other**. Double DIN could also refer to an opening in a dash panel, which will allow for two DIN radios to be stacked or a single Double DIN unit. Many aftermarket headunits incorporating a fixed front panel video screen are this configuration.

• **Double ISO-DIN:** Much like a Double DIN chassis, the Double ISO DIN is meant to accommodate two stacked DIN headunit chassis, although it could also be a single chassis, double-sized. The key difference between a Double DIN and a Double ISO-DIN is the **size of the nosepiece**. These openings are found in Toyotas, Mitsubishis, Geo/Suzuki, and Nissans. If you stack two aftermarket units in this type of opening, you must still fabricate some kind of trim panel to address any small gaps in the middle of the two units.

• **GM "M2000" Chassis (8<sup>1</sup>/<sub>8</sub>" wide x 3<sup>5</sup>/<sub>8</sub>" high):** This is the industry name for the headunit opening dimension found in many General Motors vehicles. Depending on the vehicle, the depth of these headunits is often very shallow, sometimes barely 5" deep. This can make aftermarket headunits difficult to install without modifications for limited depth or specialty installation parts. **Installation kits for aftermarket radios are widely available** to fit nearly every GM-M2000 chassis application. To accommodate the depth limitations (where limited depth is a problem), there are "nosepiece extensions" either molded into the kit panel or that can be snapped on to space the depth out further. Although the extension panel is not always the best cosmetic choice, some installation facilities have limited capabilities to modify sub-dash areas to allow for the additional 2-3 inches of depth required by the aftermarket unit and the accompanying cables.

• **GM "Oversize" Chassis:** GM has put a slightly larger-size radio chassis into several of the luxury GM cars and trucks since model year 2000 (actually Cadillac Seville STS as far back as 1992). These include some Chevrolet, GMC Truck, Buick, Oldsmobile, and Cadillac models. The opening is nearly Double DIN size and in most applications does not have any severe aftermarket depth limitations.

• **Chrysler Chassis (7<sup>3</sup>/<sub>4</sub>" wide x 3<sup>1</sup>/<sub>2</sub>" high):** The Chrysler chassis fits most U.S.-made Chrysler, Plymouth, Jeep, and Dodge products. It looks about the same as the GM M2000 opening. Chrysler vehicles since the late 1990's use the same chassis with **"rounded corners"** on the headunit face. Installation kits for aftermarket headunits are available for most Chrysler chassis applications. **The very newest Chrysler products may not use this style at all**, but rather a hybrid 2 knob style CD (or LCD screen navigation) headunit as in the 2005 Magnum, Durango, Dakota, and 300.

• **Non-DIN Ford Chassis:** In recent years, many new Ford and Lincoln-Mercury products also feature a newer and larger chassis size. It is similar to the Double DIN size dimensions. Since 1998 it is found in nearly all Ford trucks, Lincoln vehicles, and progressively in many other Ford vehicles as vehicle and interior platforms are redesigned.

• **Unique Shapes:** There are an increasing number of vehicles using proprietary **Integrated Control Panel (ICP)** headunit designs. What used to be limited to a few exotic or luxury vehicles has become more main stream. Today, manufacturers such as Ford, Dodge/Chrysler, Honda, Mitsubishi, Toyota, Acura, Audi, Lexus, Volvo, Mercedes Benz, Cadillac, Infiniti, BMW, and Nissan all have several vehicles with unique dashboard shapes and **integrated entertainment/navigation/HVAC control assemblies**. In addition, many of these vehicles incorporate an LCD screen to facilitate driver information such as interior temperature, rear view cameras, and OEM diagnostic functions. With these challenges to consider, some vehicles are clearly a candidate for OEM integration with the factory source unit so that other functional elements of the dashboard remain intact.

For most popular vehicles there are installation kit panels that allow aftermarket headunits to work in an OEM application. The cost and availability of the installation kit panel depends upon the overall complexity to manufacture and how new the vehicle application is in the marketplace. Sometimes when the vehicle is a brand new model, there may not be an off-the-shelf mounting solution available. So it's important to **do the homework** of knowing into which vehicle your customer intends to install the headunit before settling on the choice to replace (or install) the headunit at all.

## Electrical Considerations

When you move on from the physical attributes to the electrical and audio attributes, the most prominent question is always centered upon the claims of a headunit's "built-in" power. These ratings are frequently overstated to the point where **people become confused about whether they need a separate, external amplifier** to really achieve their sound system goals. And when you compare power measurement claims, **you really want to make sure you're comparing apples to apples.**



The Consumer Electronics Association published standard CEA-2006, "Testing & Measurement Methods for Mobile Audio Amplifiers" in May of 2003. This is a voluntary standard that advocates a **uniform method** for determining the RMS power and signal-to-noise ratio of **any** mobile electronic audio amplifier, **built-in to the headunit or external**. This means CEA-2006 ratings apply to both external amplifiers and the amplifiers built-in to the headunit. Basically, apples to apples comparison of power!

For CEA 2006, the amplifier's RMS output power is measured into a 4-ohm impedance load at a supply voltage of 14.4 volts at a level of 1 percent Total Harmonic Distortion plus noise (THD+N). The specification covers a frequency range of 20 Hz to 20,000 Hz unless the amplifier is intended to be **ONLY** a low frequency (subwoofer amplifier), which is then 20-200Hz bandwidth. Signal-to-Noise ratio is measured in weighted absolute decibels (dBA) at a reference of 1 watt into 4 ohms.

CEA-2006 is intended to allow consumers, sales persons, technicians, and system designers to be able to compare mobile audio amplifiers and in-dash "powered" headunits on an **equal basis**. Manufacturers who choose to abide by the voluntary standard are able to stamp their products with the CEA-2006 logo on the packaging. This gives you a level playing field by which to compare power ratings rather than "Max" power ratings.

The other concern about headunit electrical connections is an adequate power supply and noise-free chassis ground connection. Through the use of the standardized "wiring harness adapters" that are available, most headunit installations utilize an adapter that has a mated receptacle to fit into the **same plug that was removed from the factory headunit**. These wiring harness adapters make it almost plug-n-play! The other major considerations are specific to the vehicle and **MAY** include these points to consider:

- 1) **Antenna Adapters**
- 2) **Premium Audio System Interface**
- 3) **Steering Wheel Control Interface**
- 4) **Telematic System (such as "On Star") Interface**
- 5) **Navigation System Interface**
- 6) **Vehicle Diagnostics Interface**



*Adapters and interface modules are often required for some feature packed vehicles*

In summary, the focus of this headunit installation section is mostly about understanding the features and benefits, along with the installation compatibility, of the headunit the customer wishes to purchase and/or install and how that choice measures against the OEM headunit's performance and integration. It is also important to consider how the new headunit helps address any specific goals of an overall audio system design. You have to make sure what the customer chooses (and what you recommend to install) makes a **better difference** for the sound system. Different is not necessarily better, **it needs to be a BETTER difference.**

## What are MP3, WMA, and AAC files?

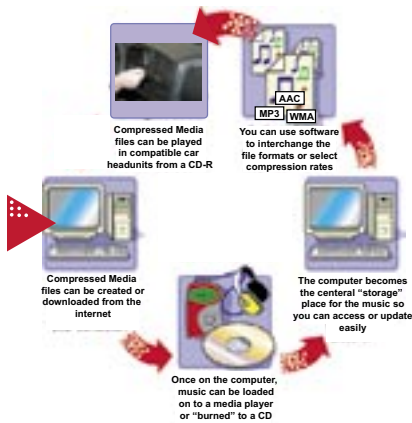
Whether it is called MP3, WMA, AAC, AIFF, or any other music file type, the main thing you need to know about these is that the **digital audio signals are compressed down** so that the actual space it takes up on a hard disc or CD is a **fraction of the original** music file size. Whereas you could fit only 74 minutes of traditional stereo music on a CD (for example), using compressed media formats such as MP3 or WMA, you could fit literally 5 or 10 times that amount. It all depends on the compression **file format** and the **"rate" of compression**. The more compression that is used to shrink the file sizes, the more music you can fit into a given amount of storage space. The trade off is that music that is more compressed does not sound as good as less compressed music. Of course there is a different threshold for everyone and that is kind of the trick to enjoying the benefits of compressed music without any of the drawbacks.

**MP3** is an audio file format developed by the Moving Picture Experts Group (MPEG). The format is actually **MPEG-1, Audio Layer 3**.

**WMA** is an audio file format developed by Microsoft. It stands for **Windows Media Audio** and plays in all the "Plays for Sure" media devices.

**AAC** is an audio file format developed by Dolby and used by Apple (especially in their iTunes program). It stands for **Advanced Audio Codec**.

When you talk about compressed music "files" in the world of mobile electronics, **there are several things that are already assumed to be in place** when the customer expects these formats to work in their car.



- 1) The assumption is that **the customer has a computer** on which they can either upload their CD's or download music they purchase, either of which can be one of several compressed media formats.
- 2) The assumption is that the compression rates are selected to allow **good sounding play back on actual speakers** (like those in the car). Playback on headphones can allow much more compression because you don't notice the subtle differences as you would with speakers in a car or a room.
- 3) The assumption is that the customer either **knows how to "burn" songs** on to CD-R or RW discs for playback or they **know how to "rip" songs** to their personal player (such as the Apple iPod or Creative Zen players). The terms "Burn" and "Rip" are really just the fashionable names for "**Transfer**".
- 4) The final assumption is that the customer has a **CD player that will play back their "burned" CD** in the first place, and then that it will recognize the file format. Some players will play MP3 files for example, but not WMA or AAC files. You will need to know this if they ask because it could ultimately send them into a state of confusion about what file plays in what CD player. This is why reading the manual is nice!

Of course it does not matter what type of player the customer has if they are "carrying in" their media player (such as an Apple iPod). The only major importance then becomes the way in which audio from the player can get into the audio system through the headunit. See the next section.

## Adding External Devices (Satellite Radio, iPod, etc.)

Many basic installations include adding a simple FM modulated satellite radio or compressed audio player to the factory audio system. When you install something that's FM modulated, you are literally putting a device on between the vehicle's AM/FM antenna and the headunit itself. In doing so, the FM modulator can take an audio input and "modulate" that signal on to an FM station. These generally use stations lower in the FM band that aren't otherwise used such as 87.9 or 88.1. When you tune in the factory headunit to that particular station and activate the modulator, the audio you hear is coming in from the device you've connected – such as satellite radio or an MP3 player. Although there are other ways these devices can be connected, any vehicle with an FM tuner is a candidate for the FM modulated system. RCA type "AUX" inputs are also somewhat common on aftermarket headunits that have multiple preouts and several upgraded features. This is the preferred way to bring audio into the system if available.

With additions like satellite radio, there is some additional hardware necessary like the satellite radio antenna, the satellite radio controller box or "brain", and the station/text display. Each of those components is generally plug and play with specific plugs on the satellite radio brain so it's really not a high level of difficulty. Other "carry in" devices like compressed audio players simply rely on the audio output plugging into the FM modulator and the rest of the control is done on the device itself. In those applications, a mount of some type must usually be fashioned so that the user can easily control their device without causing too much distraction to the vehicle operation.

## Satellite Radio Antennas

If you are going to be selling and/or installing a satellite radio package, regardless of how it's controlled or connected into the audio system, you will need to know a few things about what's required for mounting the antenna. First off, satellite radio antennas are **actually two antennas in one**. The first antenna is set up to receive signals from the satellites, but the second antenna is set up to receive a secondary signal from terrestrial (land based) repeaters. Although there are several types of satellite radio antennas, it's important to select the most appropriate one for the application and install it following the manufacturer's instructions. There are some that have a mast type antenna and others that are a flat pod or disc **the size of a hockey puck (most common)**. Some antennas are affixed with adhesives while others are magnetic. The important thing is to follow the installation guidelines (or remind your customer to follow the guidelines) to ensure optimum satellite radio reception.



*Remember to make sure your customer understands they require a small antenna to receive satellite radio signals, regardless of the satellite radio system they choose.*

Antenna cables are typically pre-terminated and range in length from 14 to 21 feet. It is important that these cables are not cut and/or spliced. Any alteration of the cables will result in signal degradation. The main focus should be on positioning the antenna, mounting it properly, and then carefully routing the cable to the satellite radio tuner box, controller, or headunit.

## Other Headunit Installation Challenges

With more and more vehicles taking on unique dashboard shapes and integrating more vehicle functions into the headunit's user interface, there are additional challenges that often require both **research and complex integration parts** to allow the aftermarket and OEM devices to work together. Whenever you come into contact with customer that has a brand new vehicle that you have not yet encountered, it is always important to leverage your research resources to find out if there are any known challenges for which you will require additional parts and/or installation time. Since most all installation shops work with anticipated times for each job, an unexpected challenge that adds even 30-45 minutes could send a Do-it-Yourself customer back to the store for an unnecessary return because they did not understand which parts were required for the job. For that reason or for the prospect of delivering "in house" installations on time to the customer, **always do a little investigation about the vehicle before suggesting which parts are necessary to complete the installation**. Scosche provides a complete resource of information for all these types of inquiries. Simply place a call to 1-800-621-3695 for assistance.

# Choosing Better Speakers

## Speakers Make A Big Improvement

Speakers are literally the voice of the audio system. No matter how feature laden the in-dash headunit may be, the most audible benefit of a factory sound system upgrade (where the car already has an OEM CD player) is to improve the existing speakers. Upgrading the speakers addresses the system design parameter of balance with regard to covering the audible sound spectrum (between 20Hz-20kHz) better than the factory installed speakers did. If a car does not have a CD player or have digital music capabilities, then speakers are #2 on the list of upgrades behind the headunit.



3.5" Dual Cone



6.5" Coaxial



6.5" and Tweeter  
Component Set (with  
Passive Crossover)



12" Subwoofer

Replacement speakers can range from simple dual cone speakers (which are just **barely** on par with the factory speakers) to coaxial 2 way speakers that offer a **wider frequency response** and are manufactured using more advanced materials. At the top end of the spectrum are component separates (midrange and tweeter systems) that have **external passive crossover networks to separate the high and low frequencies** and route them to the appropriate speaker. These not only have the benefit of wider frequency response and advanced materials, but also have **greater power handling** because of the additional passive crossover component. The use of component speakers is generally recommended only with external amplifiers because of the increased power requirements.

Of course once replacement speakers are installed to improve the mid and high frequencies, the next range to improve is the low frequency (or "sub bass") range by installing a subwoofer. And once you consider making that kind of upgrade you are using speakers that have larger diameters and heavier moving parts that require higher power levels than the "built-in" power from headunit is able to provide. Sure, you could run large subwoofers with a headunit's power, but you completely lose the idea of maintaining a "balanced" frequency response because the headunit power will barely get the bass speakers moving. So when you consider speaker upgrades that involve more than replacing existing factory speakers you begin to design power amplifier upgrades in unison with those low frequency solutions. Subwoofers need amplifier power!

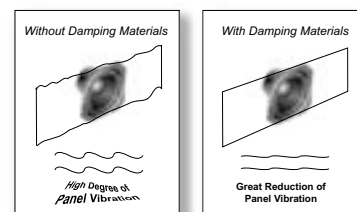
You always want to make sure that speakers of mid and high frequency ranges are installed in **identical pairs for left and right channels**. It would not be suitable to have a different speaker (even if the same size and shape) on the left versus the right. You are seeking speakers that have a matching "nominal impedance" so the balance of sound energy is similar from left to right. You would never have a situation where the left front speaker is an 8 Ohm speaker when the right front is a 4 Ohm. That is never done. Additionally, when speakers break it is often wise to **replace them in pairs** as the age and duty that a speaker has accumulated would upset the balance if one new speaker was paired with an old one. So, the same nominal impedance and the same age gives the best results for that left to right balance of sound energy. Since speakers for factory replacement and premium upgrades are packaged as pairs, it is really not a problem. Now you know why!

Another element of speaker upgrades that affects the speaker is the surrounding mounting surface and the cavity in which the speaker is mounted. Most speaker locations are in doors, dashboards, rear side panels, or rear parcel shelves. In almost every instance, the speaker itself has many surrounding sheet metal and plastic surfaces that are light, highly reflective to sound, and easily vibrated. **The addition of sound deadening materials greatly reduce the probability of undesirable vibrations** and, instead, allow the vibration to propagate air movement which adds to the overall SPL. When you think about it, think about this; A speaker normally moves air, but it's much easier to move flimsy panels and lightweight metal or plastic. If you damp those panels from unwanted vibration, you really enable the speaker to do its job better. And that's what adding better speakers is supposed to accomplish.

One additional detail about adding sound deadening materials (either adhesive sheet form, compressed barrier foam floor pads, or spray on material), the process is called "**damping**" which means adding mass to an object to change its resonant property. **Many people mistakenly refer to this as "dampening" – which is incorrect.** Dampening is something you do to a shop towel or a sponge by adding water.

With speakers there would appear not to be too much concern on the topic of electrical connections, afterall there are only two. Nothing could be further from the truth. Since speakers move out and in (a series of pressure and vacuum), you can either have those speakers working together or working against each other. Speakers are said to be in "absolute phase" when they are all working together acoustically. This yields the most focused placement of instruments, singers, and sound effects as they were originally recorded and allows for the most accurate low frequency response. When one or more speakers are "out-of-phase" with other speakers, the result is destructive interference (just like that air leak problem when mounting, only the interference isn't between the front and back of one speaker, it's from opposing speakers "fighting" each other).

There are really only two ways to connect factory replacement speakers. The correct method would be to connect the headunit's positive speaker wire to the corresponding positive terminal at the speaker on that side of the vehicle. The headunit's negative speaker wire would then connect to the corresponding negative terminal at the speaker. This is called wiring the speaker in "correct polarity", with the term correct indicating positive goes to positive, negative to negative as you would expect. When the speaker is mistakenly (or purposely) wired the opposite way, it's called "reversed polarity"



or “inverted polarity”. The acoustic effect of wiring one speaker correctly and one inverted creates the out-of-phase condition. One speaker cone is moving out while the other is moving in – so it’s a wash. They are essentially trading energy so there’s not much left to produce impressive sound. So even though there’s only two wires to worry about at each speaker, you can see how getting it backward can really make a negative impact on what is supposed to be better sound. Once additional speakers are added, including subwoofers, the importance of absolute phase only increases.

Even the best speakers will not perform well if the conditions of a rigid mounting surface, good mounting seal, vibration free panels, and correct absolute polarity are not observed. So with speakers, as with most other aftermarket mobile electronic products, the way they are installed DOES make a difference.

## Important Facts About Amplifiers

### Amplifiers make a BIG difference in sound quality over “deck power”!

If speakers are the voice of a good audio system, then the amplifier is the lungs. Without enough steam behind the notes, music will just be noise instead of entertainment. Amplifiers that are outboard (meaning those not built in to a source unit) have several distinct advantages over the built in power contained in most headunits.



*Always use the appropriate sized power and ground wiring for the amplifier's power supply inputs and connect the power lead DIRECTLY to the battery through the appropriate fuse!*

All outboard amplifiers should have a separate, dedicated power supply input. This power supply input is a very critical part of the amplifier's overall performance because it allows the amplifier to consume electrical power directly from a high current connection point (i.e. the vehicle battery) and develop the audio output power that drives the speakers. Without this dedicated power supply and the high current connection point at the vehicle battery, the amplifier's power output would be limited by the vehicle circuit into which it is connected. By connecting directly to the battery with high current wiring, the amplifier can operate “wide open” without concern of limitation by other vehicle circuits. For example, you would not want to connect the amplifier's power connections to the cigarette lighter plug wiring or the wiring that powers the key switch. None of these circuits are designed to handle an additional high current load like an amplifier. **So the first rule of amplifiers is that, regardless of brand or other features, the power supply connections are VERY important.**

Besides the dedicated power supply, amplifiers also have a way to “power up” or turn on so they're not consuming current all the time. This is the function of the **amp turn on connection** of the headunit. The actual name

of the circuit at the headunit can vary by manufacturer, but the function is that it's powered whenever the headunit is turned on. That wire, in turn, tells the amplifier to turn on. On most aftermarket headunits with two blue wires, this will be the **blue/white wire**, unless there is only one blue wire, in which case it would likely be solid blue. Check the headunit installation manual to be sure. Sometimes it's labeled “REM”, “REMOTE TURN ON” or “REMOTE AMP” depending on the way it's characterized by the manufacturer.

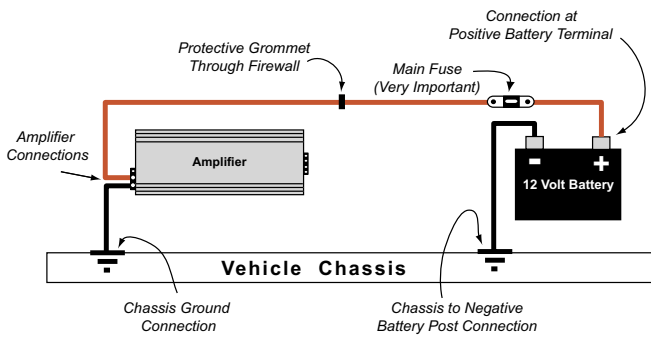


*Connect the headunit's “Remote Turn On” wire to the corresponding terminal at the amplifier.*

When the amplifier is turned on, the dedicated power supply input begins to draw current. Current is the movement of electricity that makes the light bulbs light, the starter motor “crank”, and the other electronics in the car work. Consequently, when there is not enough current available (such as a low battery or exhausted electrical system) that's when the vehicle is hard to start and lights dim with the demand of the current draw. The current draw in an amplifier can range anywhere from idle current (typically 1 ampere or so) all the way to maximum current (varies according to output power specifications). Idle current is found when the amplifier is on but not actually reproducing any audio signals (i.e. the volume of the headunit is all the way down). **Maximum current is volume at or near maximum volume.** Since most amplifiers only see these two extremes part of the time during regular operation, the middle ground (or “average” current draw) is much different. **The second rule of amplifiers then, is that the current draw expectations must not exceed the vehicle's electrical capabilities.**

To put this rule another way; **if the vehicle can't supply 1000 watts of electrical power to an amplifier, there's ABSOLUTELY NO WAY it will be able to make 1000 watts of power into the speakers!** Since amplifiers are never 100% efficient and some of the energy conversion is lost in heat, you know that the vehicle must be able to supply MORE electrical power than the expected amplifier output power so that you are accounting for the amplifier's inefficiencies. This is a critical step than many technicians, sales people, and consumers never consider until the vehicle experiences electrical system problems due to current demands beyond the capacity of the electrical system. Some people just assume you can hook an amplifier to the battery and there's an unlimited supply of electrical power, no matter how powerful the amplifier may be rated. This is simply not true.

For the power supply connections to have maximum effectiveness, **both the positive and negative wiring must have equal current carrying capacity.** For most technicians, the rule simply means that the wire gauge used on the positive wiring should be the same gauge that is used for the chassis ground wiring. This is true – though it extends a little deeper. What you want is the negative part of the amplifier's power supply to have “equal electrical potential” to the positive part. Most technicians understand that a dedicated wire connected to the positive battery post through the appropriate



circuit protection is the best direct line to the high current connection point. Since the modern vehicle is a negative ground electrical system, the electrical “return” path in almost all vehicle circuits is made through the conductive metal of the body and chassis. This allows a shorter run of wiring for the negative side of the amplifier power supply – just long enough to make good contact with the conductive metal parts of the vehicle (called a “**chassis ground point**”). Where most technicians leave off though, is the conductivity between the chassis ground point and the negative battery post. The conductivity of the chassis or body panel itself as well as the current carrying capability of the cable that joins the body to the negative battery post are typically the points overlooked. Something as simple as doing a body to negative battery post wiring upgrade

can help the current carrying capacity of the circuit tremendously. **The third rule of amplifier installation then is to upgrade the ground at the battery to reflect the current requirement of the amplifier. Usually adding an additional wire (of equal size to the positive wiring) between the negative battery post and the body or chassis will do the trick.**

Besides power supply connections, an amplifier has audio input and output connections as well. Beginning with input connections, there are two common types present on aftermarket mobile audio amplifiers, low level (or “preamp” level) RCA jacks and high level (or “speaker” level) inputs. You choose either one or the other type (but not both) to bring signal into the amplifier. Both are considered analog inputs because they directly carry audio signal. Low level audio inputs are intended to connect to the headunit’s preamp outputs and this is typically accomplished with a connecting cable terminated with RCA plugs on either side.

The vast majority of mobile audio amplifiers are using red (for right channel) and white (for left channel) RCA preamp level input jacks. RCA type digital audio connections (which are orange in color) are rare in mobile audio, especially on amplifiers. In general, the analog low level RCA connection is the preferred audio input connection type because of its clean, unaffected signal path and the commonality of the RCA type plug.



Many amplifiers feature both RCA and Speaker Level type inputs for increased flexibility.

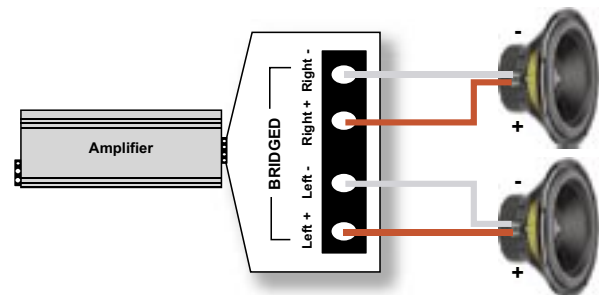
The other audio input type in use is the high level input, also analog, which is configured to accept signals normally intended to drive speakers. This is the least preferable type of input (as a general rule) because the audio quality of the high level input circuitry built into the amplifier may be the limiting factor of an audio system’s overall sound quality. While some specialty amplifiers feature high quality circuitry to accept a wide range of speaker level signal from many types of OEM headunits, this is not always the case.

If an OEM headunit must be used with an aftermarket amplifier, a device called a Line Output Converter (LOC) is the recommended way to connect an aftermarket amplifier. These are also categorized generally as “OEM Interface Devices”. The LOC takes high level (speaker level) inputs and converts those signals to low level (preamp level) RCA inputs. Just like the high level sections of amplifiers, the circuitry involved in the Line Output Converter varies with brand, model, and (especially) the application. If you were connecting an OEM headunit in a Scion xB to an aftermarket amplifier, it would require a much simpler LOC than adding an amplifier to a premium Bose audio system in a Cadillac Escalade. **So, the fourth rule of installing amplifiers is knowing what your options are for getting the cleanest possible signal into the amplifier’s audio inputs.**

After you bring an audio signal into the aftermarket amplifier and the power supply has the electrical connections to “amplify” the audio signal, the signal must then be routed to the speakers. That’s where the speaker output terminals come into play. There are many physical possibilities (barrier strip, wire insertion, Molex type plugs, etc.) but they all have **dedicated + and – terminals for each channel**. So a two channel amplifier has four terminals (one each Left +, Left -, Right +, and Right -). As the number of channels in the amplifier increase, so do the speaker output terminals. It is not uncommon for amplifiers to have 4, 5, even 6 or more output channels. Mono and 2 channel amplifiers are referred to as such. Amplifiers with 3, 4, 5, 6, or more channels are commonly called “multi-channel” amplifiers.

Nearly all aftermarket mobile audio amplifiers are capable of **bridging channel pairs to create one single, more powerful channel**. This is done most often with subwoofer applications because the combined (left plus right) audio signal is undetectable at low frequencies and therefore can be combined into a mono channel that is as much as 4 times more powerful than a single (stereo) channel. For example, an amplifier that has 25 watts per channel for 2 channels could be “bridged” to create 100 watts of power into a single channel. For subwoofers that have large magnets and cones to move, the increased power can really make a difference. Remember though; if the amplifier is configured to be more powerful, that means the vehicle electrical system must be able to supply that power!

**Power is not magic, it has to come from somewhere.**



*When connecting speakers to amplifiers, always observe correct polarity. In other words, double check that the positive is connected to the positive and the negative to the negative on each channel. Mistakes on this part of amplifier installation are perhaps the most common and can cause the sound to be less pleasing than expected.*

# Navigation Systems

There are many types of navigation systems available, each with attributes that suit a particular application. Besides “navigation” system, these are also called “route guidance” or “GPS” systems. There are many styles available depending on the application in which it will be used (automotive, marine, commercial trucking, etc.) One of the most versatile navigation system types are portable navigation systems because they allow the user to take the unit with them in multiple vehicles or when they travel and rent cars. All navigation systems use the Global Positioning System (GPS) to plot their point of reference and digital maps to move from that point of reference. **You can think of it as GPS and digital maps getting you between “Point A” and “Point B”**. The customer for these products may not be a mobile audio customer at all, so it’s important to know the product and how it all works.

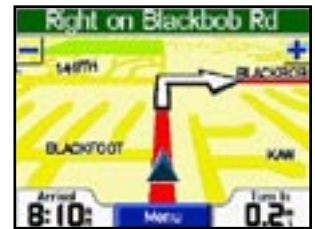
## The Global Positioning System



There are 24 GPS satellites in orbit around the earth

The **Global Positioning System (GPS)** is a worldwide radio navigation system formed from a constellation of **24 satellites** in orbit around the earth. There are also **ground stations** that relay the signal up to the satellites from the control station based in Colorado. Finally, the third piece of the system is the **GPS receivers with “on board” digital maps** that are sold in retail stores throughout the country. GPS uses the satellites as fixed reference points to calculate positions anywhere on the planet with and accuracy in a matter of feet, usually 50 feet or less! Think of your GPS position as “Point A”. In a sense it’s like giving every square meter on the planet a unique address. The integrated digital mapping inside the GPS device is what really provides the navigation aspect because it allows the guidance system to direct you over a route based on maps (not just a straight line between Point A and Point B). In this way the digital mapping is really the component that helps get you to Point B. In between the GPS signal keeps you on track (or it can signal the guidance system to re-route you because it knows you have gone off course).

GPS receivers have been miniaturized to just a few integrated circuits and so are becoming very economical. That makes the technology accessible to virtually everyone and it continues to be easier to use. It is the receiver that collects data from the satellites and computes its location anywhere in the world based on information it gets from the satellites. **There is a popular misconception that a GPS receiver somehow sends information to the satellites but this is not true, it only receives data.** These days GPS is finding its way into cars, boats, planes, construction equipment, movie making gear, farm machinery, even laptop computers. Soon GPS will become just another technology that consumers use every day like cell phones and satellite TV.



Digital maps display the route at street level and things like the time of day, distance to destination, & next turn ahead

## More than just Digital Maps



Points of Interest Menu

Within the mapping, there are also many other bits of data that can be integrated into the guidance system. Things like locations of gas stations, restaurants, ATM's, emergency services, local attractions, and other **“Points of Interest” (POI)** are cataloged in the memory of the navigation system to allow the user to choose a location of the POI and tell the system to route you there. Essentially the system knows (via digital maps) the most appropriate route and can even **perform routing functions based on your preferences**. Perhaps you want to take surface streets only, or freeways only, or you want to stay off of toll roads, no problem. Most navigation systems allow you to select these routing preferences so you are presented with a route and directions that suit your needs. It's really quite amazing.

## What about cars with Factory Installed Navigation?

Vehicles that come from the factory with navigation systems usually have a large 6” or so LCD screen in the center of the dash. Sometimes it’s integrated into the headunit whereas other times it’s a stand alone screen elsewhere in the dash. Either way, when a customer has a factory installed navigation system **it’s almost certain that they will not want to change that**. In addition, there are other functions that may display on the LCD screen like an integrated On-Board Computer or Integrated Telephone system. When factory navigation is present, it would be a mistake to remove it without first understanding that there are many functions that are tied into that factory system that will be lost if it’s removed. For these purposes, a portable navigation system may not be as valuable to a customer for their car, but they may have gotten to appreciate having it and consider a portable for travel in rental cars while on business trips, outdoor activities (hiking, biking, off roading, etc.), and even use in other cars within the household. The benefit of the aftermarket units are usually that the Points of Interest and digital mapping database is much larger than the one contained in their factory installed system.



A BMW 7 Series with Factory Installed Navigation. More and more vehicles offer factory installed navigation as an option

## Improving the Audio with a car that has Factory Installed Navigation

These vehicles will require interfacing into the factory system so that the owner can retain all of the original functionality yet improve the sound of the audio system. This usually involves one or more special application interface devices, then the addition of better amplifiers and speakers. This is a task where **professional installation is highly recommended**. If you have questions about special application interface products, give the technical support staff at Scosche a call toll free at 1-800-621-3695.

# Vehicle Security Systems

## It's more than a noise maker!

Security systems have two primary functions in a vehicle. One is to protect the vehicle itself from being stolen and the other is to protect the contents of the vehicle as appropriately as possible. No matter what you install, there will always be a thief who is clever enough to find methods that will defeat your security measures, but a good installation can make it very difficult for them to do so. It's important that you understand what true security system installation in a vehicle means. It means that the security measures that are installed and configured attempt to do the best job of protecting the vehicle and its contents without being easily located, seen, and/or defeated.

Technicians who have been installing security systems in vehicles for many years have the advantage of experience and have refined their approach to make a thief's job increasingly more difficult. In addition to understanding the wiring (which is what intimidates most new technicians), the experienced installation professional really knows how to hide things and make connections in such a way as to make them appear as factory installed items which only further complicates a thief's job. Although this section covers basic security system installation and many of the considerations taken for high security and reliability, there is no substitute for experience in the field. Over time while installing security systems, you will continue to gain exposure to a wider range of vehicles and be able to integrate security system components electrically and cosmetically with the highest degree of stealth and reliability. And that's what a customer really needs in a security system; something that's there when they really need it but otherwise transparent to the user. It cannot be said enough that **professional installation is highly recommended for vehicle security systems.**



*A real security system should protect the car AND the components inside!*

## Key Components of a Security System



*A vehicle security system with a control unit and connected components*

Security systems typically incorporate a **main control unit** (sometimes called "**the brain**") and wiring harnesses that extends from the control unit to connect various inputs and outputs. Unlike audio wiring harness connectors for the headunit, security system wiring color codes are not necessarily the same from brand to brand, so it may be necessary to take a good look over the installation AND owner's manuals so you have a better idea of what a particular security system contains. There are also components like the **siren, LED, "Valet Switch", and usually one sensor (typically an impact sensor)** that also connect to the control unit. There is usually a **starter interrupt relay** whose purpose is to electrically interrupt the starting operation while the vehicle is attempting to start. In addition, within the main wiring harness there is a connection to electrical power for the control unit and this is of particular importance because, without power, the security system cannot protect the vehicle.

Some "entry level" vehicle security products incorporate all of the electronics into the siren and have just a few basic connections for wiring, which is often why they are called "two wire" or "current sensing" alarms. While these simple devices may be suitable for a Do-it-Yourself customer, a professional vehicle security system with separate components is much more likely to offer comprehensive protection of both the vehicle and its components. Of course, what makes these more comprehensive is also the fact that they are intended to be professionally installed.

One of the most fundamental circuits a security system should protect is the vehicle starter. This is why it's called starter "interrupt", because the function is to interrupt the starter circuit so the vehicle will not start. With starter interrupt circuits, there are Normally Closed (N/C) and Normally Open (N/O). Almost all starter interrupts use the same 5 terminal SPDT (**Single Pole Double Throw**) relay, but it's the way it's wired into the starter circuit and the way the security system controls it that distinguishes it as N/C or N/O. Without a starter interrupt, a vehicle with an alarm system making noise is just that, a noise maker. There is nothing stopping a thief from actually stealing it by getting it started.



*The SPDT relay is the most common used in vehicle security systems*

## Installation Guidelines Generally Assume Professional Installation

The installation guidelines inform the installation technician about necessary steps for programming the system for various circuits or devices to which it is connected. These guidelines include both wiring information and programming. As far as wiring goes, there are many of the vehicle circuits into which the security system is wired. These many include the ignition, starter, parking and interior lights, hood and trunk switches, door locks, trunk/hatch/liftgate release, and even the factory security system. The wiring descriptions in the installation guidelines only cover the security system itself. The installation technician relies upon other resources or investigative electronic analysis to determine the points at which connections are to be made. The wiring part of the job alone is monumental.

Programming is a BIG part of successful security system installations because there are many features that are selectable based on the user's preferences and the conditions the vehicle regularly experiences. For example, the duration of the siren blast (during an alarm event) is often programmable so that the security system is effective but does not disturb neighbors. Along those same lines, the siren may be able to be programmed to not sound at all during an alarm event, but instead the user may choose a paging device or some other form of "visual" reaction. Each of these

unique responses must be programmed by the installation technician and reading the manual to briefly gain an understanding of what's involved is the only way to learn how to do that. Knowing the programming options also allows you to think about leveraging those characteristics to connect other devices more effectively so that the system really serves as a professionally installed security system and not just a "car alarm". As a sales associate, if you understand what the security system can do (if installed properly) you can really do the customer the service of properly matching products with their needs.

## False Alarms?

There are many consumers who are quick to point out that they know of an alarm (or had an alarm) that is always triggering for no reason. "This thing gives false alarms all the time" they might say. The reality is that rarely are vehicle security systems giving false alarms. When they trigger there is usually a valid reason. Most often one or more sensors is set way too sensitive. Sometimes external conditions like a Harley motorcycle driving by can set one off. Occasionally there is a trigger caused by low or nearly dead battery conditions. All of these are valid events that cause the security system to trigger, but this can be alleviated by an experienced installation technician that understands how to set various trigger points so as to minimize unnecessary triggering from overly sensitive triggers. Most of the time, a false alarm is really just an installation related error that is correctable by a qualified professional.

## What About Factory Installed Alarms?

It's all too common these days where a customer visits the retail store for something such as mobile video, upgrades of speakers, or a iPod interface solution, but shakes their head insistently about a security system purchase. "No, my car came with one from the factory" is the common reply. What really did come from the factory though? Most cars actually DO NOT come with factory-supplied security, believe it or not. People often mistake a keychain remote control that operates "keyless entry" with a security function, which are two completely different things. Keyless entry, for example, HAS no security involved. That's an entirely separate function from security. Honking the horn to confirm the doors have locked doesn't make it any safer. It just makes it more convenient. Typically, that's how keychain remote controlled devices for the car are categorized, either a security function or a convenience function.



Keyless  
Entry  
Remote

While the popularity of keyless entry is indicated by more and more new vehicles having that keychain remote, it still doesn't guarantee that the vehicle has a security system at all, much less that it was done at the factory. Truth is (as many retailers already know) the vast majority of security products sold through car dealers are installed right there on the lot. The remote control in the consumer's hand has really become a false sense of security over the last several years. Whether installed at the factory or the dealer, many are simply keyless entry which MAY have a starter interrupt and a honking horn. In most cases, that's it. There are no additional sensors and may not be any other special features to deter thieves. What's more concerning is that each factory installed security device is installed in the SAME LOCATION in every one of the vehicles of that same make and model. If a thief figures out how to steal a Honda Accord or Cadillac Escalade by bypassing the factory security measures, they can repeat this on as many of those same vehicles as they want.

From a perspective of helping customers understand what they need or purchase the right product, there are actually many advantages to security systems sold and/or installed by the factory or car dealer. Consumers can spot the shortcomings of the "car dealer installed" systems with just a few prompts from an educated salesperson or installation technician. One of the many easy areas to spot a security compromise is the physical location of the brain, valet switch, and the LED. Who's surprised when you learn that the control units (brains) are ALWAYS up under the drivers side dash? LED lights and valet switches aren't far away. It's as if they are "clues" to where to find the prize, the brain. If the consumer buys their own system and has it professionally installed, locating critical components can be done with more security in mind. After all, that's the whole reason to have a security system in the first place!

Even if a customer does have some security functions already installed, there are cases where there protection could be added on to instead of completely new system being installed. Sometimes it's a similar cost, sometimes it's less, sometimes adding to a factory installed system is actually more costly than just starting with a new aftermarket security system. The point is that the customer does have options to add to their existing system or get something entirely new. Just like with mobile audio systems, people shopping for vehicle security have lots of good options too. The thing that makes a difference is a sales or installation professional who really understands what products will accurately address their needs.

## Summing Up Vehicle Security

Successful security system implementation is two fold. First, the sales person must listen to the customer's needs and, in many cases, educate them about some of the misconceptions that are covered in this section. Second, after all of the correct products are purchased comes professional installation. With modern vehicle electrical systems presenting many, many challenges to the Do-it-Yourself enthusiast, security system installation is better left to the professionals.

# Remote Starters

Whereas the security systems address security functions, remote starters are purely convenience functioning devices. Many remote starter (RS) systems incorporate similar architecture to a security system. This includes a main control unit (sometimes called “the brain”) and several wiring harnesses that extend from the control unit to connect various inputs and outputs. There are also components like the siren, LED, and “Valet Switch” that also connect to the control unit.

## What Does a Remote Starter Do?



*Remote Starters allow you to start your vehicle from inside the house.*

Essentially, a remote starter allows the user to start the vehicle by a keychain remote without anyone in the vehicle. There is no key needed to be placed in the ignition switch to remote start the car (although one is definitely needed to get in and drive away). There is usually a series of safety measures that will inhibit the vehicle from remote starting so there is a low chance of accidents (from the emergency brake being off, from the hood being open, from the throttle sticking open, etc.). The vast majority of people who choose to have remote starters installed do so because of extreme weather (either very cold or very hot climates). There are other reasons that people would choose a remote starter however. Some of these might be disabled people who need to start their vehicles to lower access ramps etc., construction or commercial equipment operators who need to start equipment from a distance, and even high profile executives who utilize remote starting to check for tampering of the vehicle before they approach. Whatever the reason, remote starters provide a unique function that many people find is useful after they've experienced the benefits of owning one.

Where a remote starter differs most from a security system as far as “parts” to install is that there is either an external relay pack that handles the high current switching or it is included on-board within the chassis of the control unit (and connected by a separate plug that has larger gauge wiring). This high current switching capability is an important part of electrically “emulating” the function of turning the key in the ignition switch. **It's particularly important that this high current wiring for the starting functions is connected safely and correctly in the vehicle.** In addition to that high current switching capability, there are also a number of low current outputs intended to “fool” the vehicle into thinking the key is really in the ignition switch and starting the car.



*This is an example of an all inclusive remote starter where all the high current connections (at left of the controller) and the low current connections are contained in one chassis. The drawback is that it's larger and may be harder to find a suitable location.*



*This is an example of a remote starter with the high current relay pack and low current wiring harness as separate items. Notice the difference of size in the control unit. The drawback of this kind of system is that there are more small components to install, but depending on space available that might be preferred.*

Finally, what also is decidedly different on remote starters is that there is a host of safety features intended to keep the vehicle from either accidentally starting or being driven while remote started. Safety inputs such as the hood pin switch, foot brake switch, neutral safety switch, and ignition switch input all monitor the remote starter so that it can shut off in the event someone attempts to drive it away. The ignition switch monitor also understands when the vehicle's ignition switch is being used normally and shuts the remote starter off to allow the vehicle to “take over” the engine that's already running. Depending on the circuits controlled by the remote starter, additional vehicle functions may become activated once the key is turned in the ignition switch. Suffice it to say that remote starters are also recommended to have professionally installed!

## Things to Consider About Remote Starters

Unlike security systems that have two functions (protecting the vehicle AND the contents), remote starters have one, very simple function: **CONVENIENCE**. All of the influence the installation technician has on the installation itself **MUST** facilitate convenience if the remote starter system is to be valued by the customer. Here are some points to consider (or remind the customer to consider) when approaching the installation of a convenience device like a remote starter:

- It should operate from an acceptable range: It is not convenient for a consumer to have to get right up close to their vehicle to remote start it. Part of the reason they have a remote starter installed is so that they do not have to go outdoors to start their car in objectionable weather, which means range is important. To consumers, range establishes part of the value in the convenience of the remote starter product you install.
- Connections into the vehicle must be electrically compatible (i.e. operate as the vehicle does): It is not convenient to have electrical problems with your vehicle after having had an aftermarket “convenience” device installed. Electrical problems create warranty disputes and waste precious time for the customer. Most of all, it makes you look as if you don't know what you're doing.

- Connections must be solid and reliable: It is not convenient for wiring to come loose or become disconnected because the installer did not take the time to connect it properly. Customers do not appreciate remote starters that only work correctly “some of the time”.
- Location of components must be out of harm’s way: It is not convenient to have the remote starter control unit fall on your feet from under the dash while driving. While hiding the components is not as important as in a security related install, the components should not interfere with the operation of pedals, levers, mechanisms, or normal service operations performed by a mechanic.
- The device should be safe: At no time is it convenient to have an unsafe device installed into a vehicle in an unsafe manner. Never install remote starters without safety precautions like the foot brake shutdown or hood pin switch bypass. Additional care should be taken on manual transmission vehicles so that the vehicle can **NEVER** remote start unless it is in neutral with the emergency brake on. It is not convenient to have your vehicle remote start in gear and drive itself into a wall or person. It’s also a **MAJOR LIABILITY**. Many remote start manufacturers recommend installing them **ONLY** on fuel injected, automatic transmission vehicles because of the liability otherwise.



*A safely installed remote starter will have the foot brake, hood switch, and emergency brake positions monitored so that, in the event something changes with one of those, the remote starter can be disabled from starting or shut down automatically if the vehicle is already remote started*

- The device should be intelligent: It is not convenient to cause premature damage to the starter motor because the remote starter leaves the starter engaged too long. It is not convenient to leave the engine running for so long that the vehicle overheats. Since many remote starters rely upon accurate programming to become intelligent for the specific needs of the vehicle, the installer must be intelligent enough to anticipate these characteristics and implement them in programming and/or configuration.
- Operation should be intuitive and well documented: It is not convenient to teach a customer “the secret handshake” just so they can remote start their vehicle. Programming simple button sequences for common operational features, asking the customer about options they can select, AND explaining how the system works (by also referencing sections of the owner’s manual) is very convenient.

## Remote Starter Options



2-Way Remotes

*2-Way systems give the user the ability to have confirmation back from the system that the command transmitted was accepted*

It is popular (and cost effective) to combine remote starter and security system functions into one device. Doing so reduces the need for separate control units and redundant wiring. Many such systems are on the market today. With a combination RS/security system, it becomes important again to hide and camouflage security components and the associated wiring. Not only must the installer think one step ahead of the thief, they must also think in terms of convenience for the customer and service mechanic. This adds another layer of challenge to the remote starter installation, but patient and skilled technicians have no problems rising to this task. Once again, this is why these products should be installed professionally.

In recent years the added convenience of 2-way systems has gained popularity. A 2-way remote starter system is one in which the remote control has the ability to receive communication from the control unit (instead of just sending commands to the control unit). There is often a small LCD screen on these remote controls that has current status information about the remote starter or security system. The LCD screen on the remote is often animated to show a door open (if a door has been opened), exhaust coming from the tailpipe (when the car is remote started), and a number of other things that heighten the interaction between the convenience system and the user. As these systems are higher in cost than other “one way” RF systems, you will generally find that the remote starter is bundled with security features and several other enhancements to differentiate the system from less costly systems.

## Bypassing the Factory Security Measures

One additional thing that is often necessary is the ability to bypass factory security measures that would normally inhibit the vehicle from starting. Sometimes it’s as simple as connecting the remote starter’s factory security disarm wire to the correct vehicle circuit and other times it’s more involved than that with “immobilizer” or “transponder” systems. These systems use a circuit that locks out the ignition and fuel system. This complex, coded circuit system is comprised of two parts. The first part (called the transceiver or “antenna loop”) circles the key switch and is activated when the key is placed in the key switch or turned to the run position. Upon activation, the transceiver will power up the transponder chip embedded in the head of the key. The key’s transponder chip will then send a unique code back to the transceiver that carries it to the vehicle security control unit for evaluation. If the code matches a valid code set by the factory, the vehicle will be allowed to start. It’s the same kind of technology that is placed in products that ship to large retailers that can be “tracked” or even the automated toll collection systems such as EZ Pass. Transponder technology is all based around Radio Frequency Identification (RFID).



*This VW transponder key has a small chip in the base that “talks” to the car*



A Transponder Bypass Module

Many times there is a specific interface module required that will interface with the vehicle's own security measures so the vehicle is fooled into thinking the key is in the ignition and starting the car. These modules sometimes require the car owner giving up one of their extra keys to do so. Other times the interface module can be programmed to learn the code of the transponder key and rebroadcast id while remote starting. Some vehicles must also have the "key sense" wire powered to remote start. This is the wire that triggers the key-in-ignition beeper to remind you the keys are still in the ignition, but it also interconnects into the factory security measures in some cars. It all depends on the application and what the vehicle has for factory installed security equipment.

If the customer does not have additional keys to spare and if there is not a "code learning" bypass module available, you can get additional keys from either the dealer or from aftermarket locksmith suppliers and they must be programmed into the vehicle. Ford and Chrysler vehicles up to 2005 can accept programming if there are two keys (previously programmed) present when you want to program other additional keys. Most other vehicles that have transponder systems require key programming from expensive programming tools generally found only at the dealer or a well equipped professional locksmith. While almost all new vehicles have some kind of transponder or immobilizer system, vehicles built prior to 1995 have much simpler factory security measures and integrate remote starters much easier. Those are today's used cars.

Without bypassing these factory security measures, the installation technician could have everything else connected correctly and the vehicle will still not start – so this is an important part of remote starter installation. Please consult the remote starter manufacturer for additional assistance on requirements for transponder bypass modules and other methods of bypassing factory installed security devices. You must be prepared to sell and/or install an additional "black box" and have a programmed key (in most cases) to complete a remote starter installation successfully in the field.

### It's a Seasonal Thing



As you can imagine, there is a defined remote starter "season" when remote starter installations dominate the daily schedule of installation shops and retailers that sell remote starters. If you are located in a part of the country that experiences snow and bitter cold in the winter time, that's when remote starters are "convenient" for customers to purchase and have installed. Conversely, if you are located in an exceptionally hot part of the country during summer time, you will find a season for remote starters there as well. Winter time (between October and March) is by far the strongest overall time for remote starter installations nationwide. If you prepare yourself in advance, you will be better able to anticipate the needs of customers around these times of the year because you already know why they are asking about remote starters.

## Radar Detectors

Most people know the term "Radar" as what police use to catch speeders while they are hiding in the trees or just over the peak of some hill. The truth is that Radar is an old tried and true technology (officially called "RADio Detection And Ranging") used by many organizations besides police to determine both distance as well as speed, but the basic implementation is much the same. Basically the technology works! Besides radar, there are also new technologies of speed detection utilizing laser light detection (called LIDAR or "LIght Detection And Ranging") which also assist law enforcement in documenting speeders and writing tickets. While you can't really do anything about law enforcement having these detection technologies, many people take comfort in the "insurance" of a radar detector purchase to hopefully avoid being detected before they come within range of the device.

### What to Expect (and NOT to Expect) of Radar Detectors

Without taking sides of brands or models, a fair statement is to say that radar detectors are only as effective as their ability to detect. If the radar detector is positioned in the vehicle so that its coverage path faces forward, and the particular model only provides front coverage, then it's fair to assume that particular radar detector will not protect from a law enforcement officer sneaking up behind the vehicle with a radar. Alternatively, there are radar detectors that "go nuts" around strip malls where multiple retail stores with radar controlled entry doors are located and that means that sensitive coverage may also bring the occasional false alarm. With false alarms, people become conditioned to ignore the first few "beeps" to until they become more constant or the "signal strength" becomes greater and then they slow down. So what is important in selecting a radar detector for a particular individual is getting them to understand what features best benefit their driving style and how quickly they heed the warnings.



With different radar detectors, there are various indicators that can tell the driver that there is a radar in range. Some of the more expensive radar detectors will show the driver whether it's coming from the front or the rear of the car, the signal strength of the radar signal itself, and some even differentiate between various radar bands or even laser detection.

Typical placement of radar detectors is on or above the dashboard facing forward so that the radar detector has a clear line of sight out of the front window. Most radar detectors come with mounting brackets that have suction cups so the unit can be easily mounted and dismantled from the window. Powering the radar detector is usually accomplished by one of two methods. Either it is connected to a cigarette lighter adapter plug (usually included with the unit) or it can be "hard wired" into the vehicle's fuse panel so there are no messy cords running down around the dash panels. Either way, the radar detector installation is relatively simple and can be accomplished by most Do-it-Yourself customers who are willing to read the directions included with the unit.