FUNDAMENTALS OF CAR AUDIO TRAINING PROGRAM

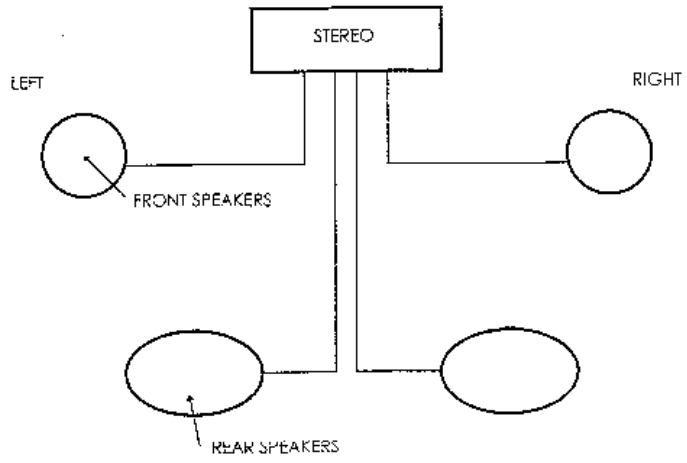
People love music, they have for hundreds of years. People also love their cars so it's no wonder that car stereo systems are better than ever and more and more people get "bitten" by the car stereo bug. Car stereo systems come in all shapes and sizes, some supplied from the factory, others purchased after the sale of the car, and many which contain parts of both. Whatever the scenario, there is always one thing that remains the same. "The audio system will only be as good as it's installation". That's a fact.

In this training program, we will look at car audio from the OEM perspective (Original Equipment Manufacturer) and from the Aftermarket perspective. Scosche industries supplies installation accessories in a variety of applications that "bridge the gap" between what is supplied OEM and what gets installed aftermarket. The aftermarket is a broad range of retailers that contain everything from Large Mass Merchants and chain stores (like Wal-Mart, Sears, Montgomery Ward, K-Mart, Etc.) to Consumer Electronics Chains (like Circuit City, Best Buy, Sound Advice, Good Guys, Etc.) to Automotive based Retailers (like Kragen, Trak Auto, Chief Auto Parts, Etc.) to Electronics stores (like Radio Shack, Etc.), Mail Order (like Crutchfield and QVC) and finally Mobile Electronics Specialists. Each segment has a customer base which makes up the bulk of their sales in car audio. Typically the entry level customer might be shopping in a Large Mass Merchant or Consumer Electronics Chain while an advanced car audio enthusiast might stick to a Mobile Electronics Specialty Retailer. In either case, if something is sold, it will require installation into the car. Scosche products attempt to make the installation go easier, have more integrity, and look better which makes the purchase of a car stereo that much more enjoyable.

TAKING A LOOK AT OEM CAR AUDIO SYSTEMS:

Over the last 10 or 15 years, the stereo systems that come WITH the car right out of the factory (the OEM System) have been getting better and better. There are many luxury and performance cars which now come with complete systems already installed. These systems are often referred to as the Upgrade, Premium, or "top of the line" systems. With features and technology also comes price. In today's world, now more than ever, you don't get something for nothing. The premium sound systems generally come at an average to above average market price. There are, of course, still many vehicles out on the road with what we'll call the Basic System. This is primarily a source (the stereo itself) that contains amplification within it's chassis that directly drives front and rear speakers. That's really it. Very straight forward, not a lot of difficult bells and whistles, just a powered stereo that plays (usually) 4 speakers.

DIAGRAM OF A "BASIC" 4 SPEAKER CAR AUDIO SYSTEM

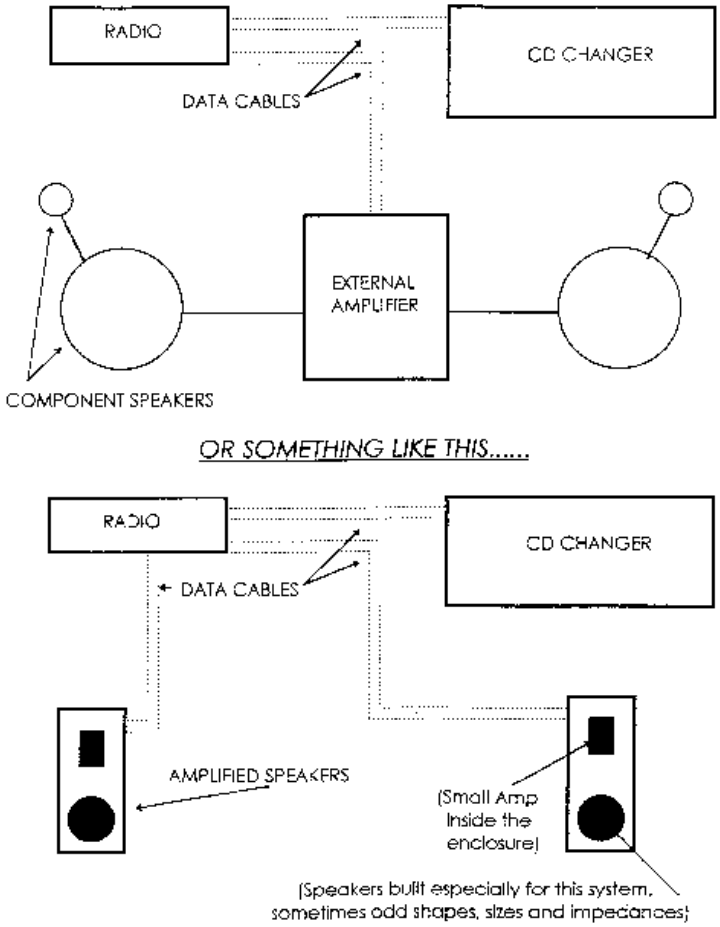


The Basic System is pretty simple. Often times there may be a variation or "twist" put on the Basic System to enhance the performance, but its physical layout remains primarily the same. Some twists might include a preout "loop", which is basically a plug (or a plug in port) on the backside of the radio to allow for easy add on factory upgrades like CD players, CD changers, Cellular Telephones, Processors, and Equalizers. The other twists may be component speakers rather than a single unit. For example, there may be a midrange in a lower door or kick panel location while a tweeter sits atop the dash or in the window corner (sail panel) separated by

FUNDAMENTALS OF CAR AUDIO TRAINING PROGRAM (Cont'd)

passive crossover components. This type of layout, as you can see, offers many variables without much physical modification to the cosmetics of the vehicle. The idea of the Basic System is that the difficulty of going from the cheap radio and speakers to the nice radio and speakers really involves nothing more than putting better components in the SAME locations. No modifications, nothing custom, just pull out, replace, and plug back in. Car dealers (and manufacturers) don't make things any harder for their mechanics than they have to.

DIAGRAM OF A "PREMIUM" O.E.M. CAR AUDIO SYSTEM



As you will notice, with the Premium Systems, there isn't one traditional method of the top of the line sound. The variations we saw in the diagrams on page 3 simply illustrate 2 of the most common methods, but certainly not the only ones. Each vehicle with a Premium System generally has the system built as a one of a kind to best suit that particular vehicle. To try and transplant a Premium System from one type of vehicle to another is virtually impossible without extreme electrical, not to mention physical and cosmetic modifications. It would be like putting Porsche fenders on to a Cadillac Seville. What's the point?

WHAT'S SO GREAT ABOUT FACTORY INSTALLED SYSTEMS ANYWAY?

If we ask ourselves the simple question of "why" we put stereos in cars, the answer should be very simple as well, because we like to listen to music. Now going on that small bit of information, how come OEM stereos aren't enough for every person who listens to music in a car? Well the answer is not as easy as it seems. For some the sound isn't LOUD enough and for others it isn't GOOD enough. Don't confuse loud music with good music. The two are very different. One refers to quantity while the other refers to quality. Most OEM systems fall short on one or both of these areas which is why people find themselves turning to the Aftermarket to satisfy their personal tastes in music. Of course there's always the possibility that an OEM system just isn't packed with enough user features, but that's rare. Generally stereos, amplifiers, and speakers get installed to make things louder, better, or a combination of both.

FUNDAMENTALS OF CAR AUDIO TRAINING PROGRAM (Cont'd)

The first drawback of most OEM systems is the listening level. Every car has what's called a NOISE FLOOR. The noise floor of a car is simply the level of ambient noise that is allowed to penetrate the sheetmetal and glass of the car. This is usually measured in DECIBELS. Decibels are units of sound intensity, the louder the sound, the greater its value in decibels. Decibels are also commonly abbreviated as dB's or just plain dB. If someone was to play a portable radio at a reasonable volume 5 feet from a car whose windows were down and doors open, we could likely hear the music pretty clearly. Now that same car with the doors shut and windows closed would likely make it more difficult to hear the music playing outside, but there will still be some trace of noise coming from the outside. This is the concept of noise floor. To some degree, each vehicle is susceptible to outside noises on the inside of the car. Now the problem with OEM stereo is that each OEM System is capable of only going so loud, especially the Basic Systems. With a small cheap car being fairly noisy on the inside (high noise floor) and its audio system operating to limited volume levels (without audible distortion) there is a pre determined limit to which the audio system can operate and be loud enough to overcome the floor noise of the car.

Wait a minute, how about we START the car and drive it at 55 mph. Now we have the engine roaring, the tires humming, and the wind howling. Yep, you guessed it the noise floor of the car just went up and our audio system still hasn't gotten any louder. In fact, it actually appears to have gotten quieter with all the extra noises added in. This makes the range between the NOISE FLOOR and the MAXIMUM UNDISTORTED OUTPUT OF THE STEREO very small. This range is actually called the Dynamic Range of the system. The dynamic range of most modem OEM systems is sadly very little once out on the open road. So that's the first major OEM drawback.

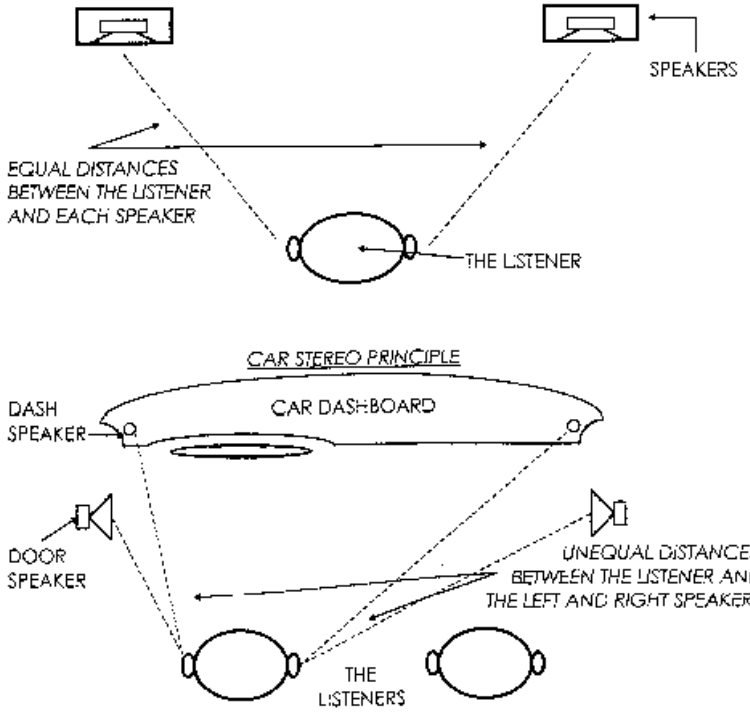
Now the second major compromise in OEM audio is Frequency Response. That is how much of the audible spectrum of sound the car stereo system can actually reproduce. Each note in music is a particular FREQUENCY. Frequencies are often referred to in Hertz or simply abbreviated as Hz. Sound that our human ears can hear falls between about 20 Hz up to 20,000 Hz. Frequency multiples of 1000 are many times abbreviated as Hz, so 20,000 Hz is abbreviated as 20Khz. The lowest frequencies (what we might call bass) are denoted by low Hz numbers while mid range frequencies (where many instruments and vocals are) sit in the hundreds and low thousands of Hz, and high frequencies (like the crash of a cymbal, high notes on a flute, etc.) are in the tens of thousands. A good stereo at home is pretty good at reproducing 20 Hz to 20 Hz without too many "holes" or "weak spots". OEM car stereos fall short of good Frequency Response many times because of location and equipment constraints. You see there isn't one perfect speaker that will reproduce 20 Hz to 20Khz all on its own. This is the same reason most good home stereo speakers use more than one driver in the cabinet to get the full range of sound. OEM car stereo speakers (as well as the cassette and AM/FM sections of an OEM headunit) have a limited frequency range they can play in. They usually leave something out on BOTH the bottom and top end. This is why a person may find OEM car stereo to lack the "sizzle" and "muscle" of a nice home audio system. What's the alternative, better (usually more) speakers to do the job of good Frequency Response?

The third major drawback of OEM car audio is the lack of many important sound quality cues such as Image, Stage, and Ambiance. These are cues which have an effect on music exactly as they describe. First off, Image - This cue gives the listener an imaginary point to pinpoint a particular instrument or vocalist in front of them. Second, Stage - This gives an imaginary "stage" where this music is being played from. The width and depth of the stage illusion help to recreate the third cue, Ambiance. Ambiance is what really gives the feel of the original place, mood, and character of the sound when it was recorded. Have you ever listened to a "Live" album on a car stereo only to be miserably disappointed with how "Un-Live" it ended up sounding? No doubt, that car stereo lacked some degree of Image, Stage, and Ambiance. The 3 of these put together is what creates the illusion of "being there" in person.

Fourth for the downfalls of OEM car stereo is called Side Biasing. This one is easy to understand and is a problem that is related to the relationship between the listener and the physical location of the left AND riqht speakers. Think about it (or just check out the diagrams below), the "home stereo sound" places the listener equally between right and left speakers. Since we don't sit in the middle of our cars (except for the McLaren F1 that is) we are physically biased toward one side of the car and further away from the opposite side.

FUNDAMENTALS OF CAR AUDIO TRAINING PROGRAM (Cont'd)

HOME STEREO PRINCIPLE



Side Biasing is when one speaker always sounds louder than the other because it is physically closer to the listener than the other. That effects Stage and Image.

SUMMING UP O.E.M. CAR AUDIO

At this point you should have a grasp on the "why" of OEM car stereo limitations. Fundamental points that lack in all OEM systems, to some degree (some more than others), are summed up as .....

Noise Floor - *Most cars are plagued with an interior noise level that makes the car stereo fight for the ability to be heard clearly. Noise control materials for BOTH Damping and Absorption of exterior noise are commercially available to help lower the Noise Floor in a vehicle.*

Dynamic Range - *The range between the Noise Floor and the loudest undistorted output volume of the car stereo system comprises the Dynamic Range of the system. Lowering the Noise Floor or increasing the Maximum Output Level (M.O.L.) of the system are the ONLY ways to increase Dynamic Range in a car stereo system.*

Frequency Response *- How much of the audible spectrum of music (that is music or notes human ears can actually identify) is present in a system determines its Frequency Response. Since there isn't one perfect speaker that will reproduce 20Hz - 20Khz, a car with good Frequency Response probably has SPECIFIC SPEAKERS which handle their own ends of the frequency range. If a car has only 1 speaker per channel, it is definitely lacking a complete frequency response.*

Image - *If you can "imagine" or "vision" an instrument or vocalist being somewhere in your immediate area during a song, that is the concept of Image. A simple description of Image is that it gives a 3 Dimensional effect to the music.*

Stage - *This the imaginary stage that the image moves on. The stage is ideally comprised of BOTH Width AND Depth. This also helps to achieve a 3-D effect on blending all of the images simultaneously to appear as they were during recording. The ideal car audio stage is at ear level and extends beyond the boundaries of the side and front glass.*

FUNDAMENTALS OF CAR AUDIO TRAINING PROGRAM (Cont'd)

Ambiance - *The "little details" that were present during the recording of the music is the Ambiance content. If the little cues like Echo, Reverb, and Delay are reconstructed EXACTLY as they were during recording, the music should sound the same as it originally did. Ambiance is often more pronounced in live and concert hall recordings where there is a minimum of mixing done afterwards.*

Side Biasing - *As we described in the diagrams on page 40, Side Biasing is the relationship of the physical distance from EACH speaker to the listeners ears. When you sit in a car, you're naturally closer to one side speakers than the other which will make the closer speaker SEEM louder even if the volume of both is the SAME. For a true home stereo type of sound, the distances of each speaker should be the SAME to the listeners ear, or at least as close as possible.*

AFTERMARKET CAR AUDIO SYSTEMS

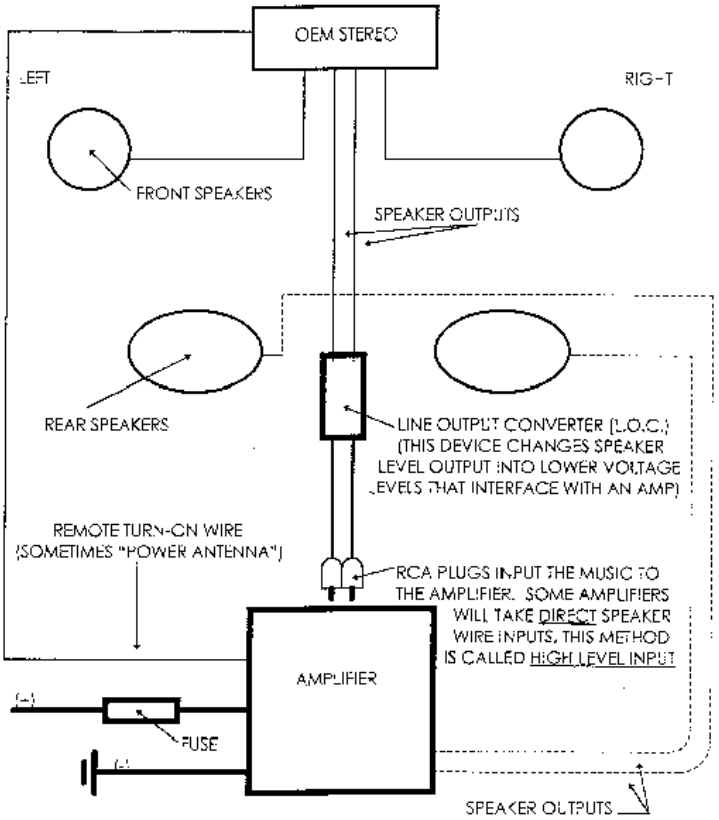
Now that you are up to speed on OEM car audio and the components of sound reproduction in the car, let's look at the Aftermarket. This is where you go when OEM car audio isn't making the cut. Adding onto OEM audio is the most common "first step" in the world of the Aftermarket. Some new vehicles come from the factory with a Delete Option which means the car comes with NO OEM AUDIO whatsoever. There are also customers who prefer to remove and replace ALL of the OEM components entirely and start from scratch. In those cases the system is ENTIRELY Aftermarket. This usually isn't the case in most of the average day to day installs since most people shrug at the thought of throwing money they've already paid for their OEM audio system completely away. Additions and upgrades to OEM systems with aftermarket equipment are the bulk of the installations being done in the Aftermarket.

Everyone who sells car audio components in the Aftermarket is competing with some segment of OEM car audio. Typically you will find that Mass Merchants and Consumer Electronics Chains challenge to make Basic OEM Systems better, while Mobile Electronic Specialists are more equipped to go head to head with the Premium OEM Systems and come out on top. The idea of any aftermarket addition is that it be an improvement over what it replaced made up for the lack of in the OEM System. Some upgrades and additions are able to be handled by the "Do-it-Yourselfer", depending on the car and quality of the installation accessories, while other upgrades are best left for professional car stereo specialist installers. You see, if the aftermarket equipment is not installed to look AND perform correctly, it may never be any better than the OEM stuff it replaced. In fact, it may likely be worse!

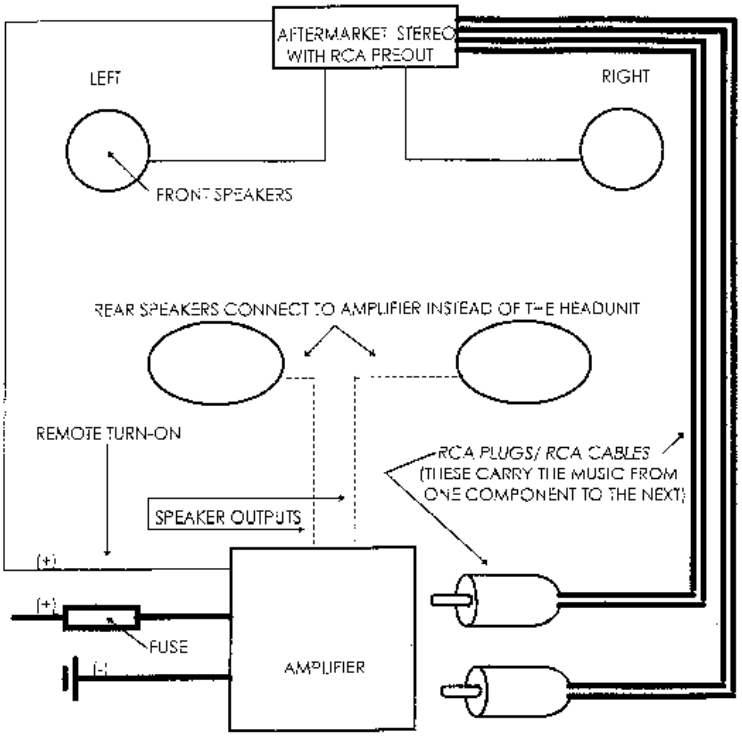
Basic add-on's to an OEM system range from adding a subwoofer to replacing the headunit to adding amplification and even switching from single speakers to component separates. Those are most common, but don't think for one minute that those are the only things that get done. An upgrade can be as simple or as involved as the customers musical tastes and budget dictate. On the following pages we will cover the 5 most common upgrades to an OEM and basic aftermarket car audio systems. Each upgrade has variations as well as finished cost difference to satisfy the level the customer looks to achieve. Many upgrades are simplified in BOTH cost and installation by fundamentally choosing the appropriate installation parts and accessories for the job. You've heard the term "use the right tool for the job", well think of the proper installation accessories like tools that make the job go faster, easier, look more professional, and perform better. The installation makes ALL the difference.

FUNDAMENTALS OF CAR AUDIO TRAINING PROGRAM (Cont'd)

ADDING AN AMPLIFIER TO A BASIC O.E.M. SYSTEM



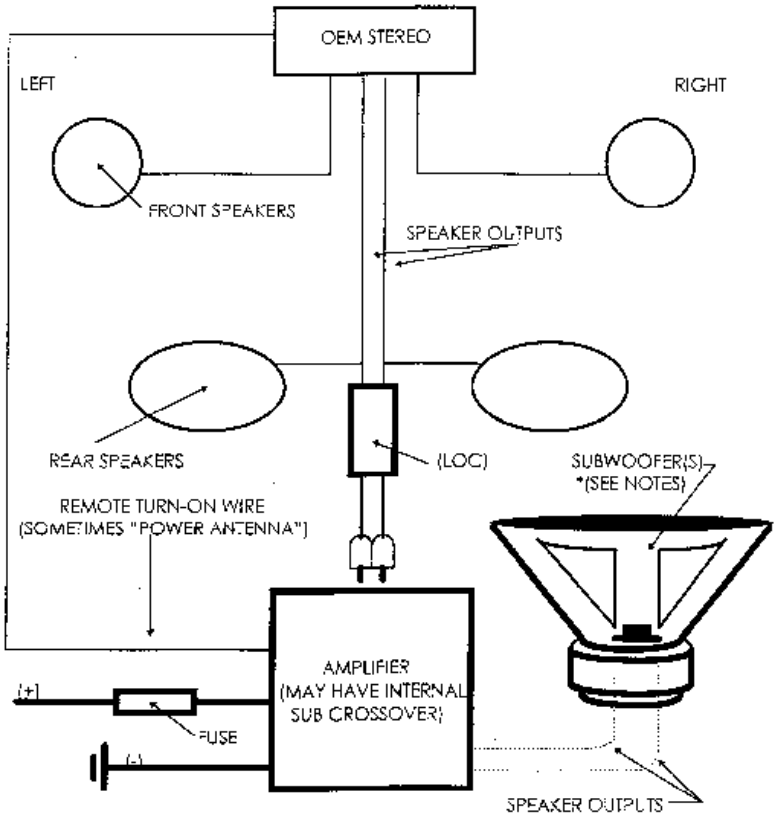
ADDING AN AMPLIFIER TO A BASIC AFTERMARKET SYSTEM



An amplifier needs a connection DIRECTLY to the positive post on the car battery with the appropriate size of wire. The remote turn on lead tells the amplifier to turn on when the stereo turns on.

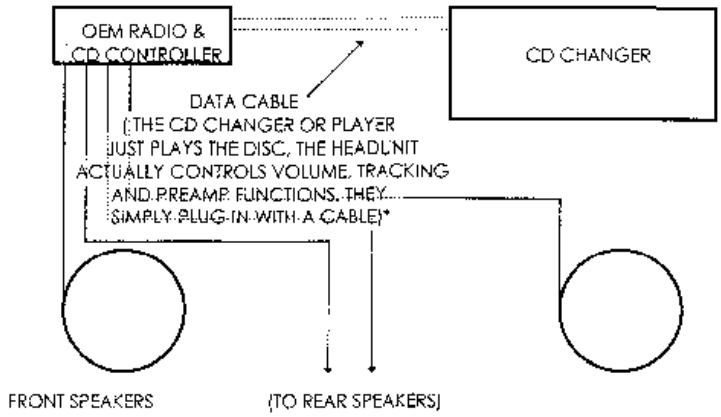
FUNDAMENTALS OF CAR AUDIO TRAINING PROGRAM (Cont'd)

ADDING A SUBWOOFER SYSTEM TO A BASIC O.E.M. SYSTEM



** There are several variations of subwoofer possibilities. Everything from tubes and premade boxes to custom fabricated baffle boards and enclosures are possible. It all really depends on listening preferences, volume, and budget.*

ADDING A DIRECT CONTROL CD CHANGER/PLAYER TO AN O.E.M. CAR AUDIO SYSTEM



** The idea of the CD Changer or Player add-on to the OEM system with a **Direct Connection** input is to make it a "plug-in" addition. Simple to do, a minimum of time and labor. The Direct Connection method also passes the audio of the CD in the most "pure" fashion, through the audio portion of the Data Cable. This method is what makes the system capable of the wide frequency response that CD systems have over simple cassette and AM/FM frequency response.*

FUNDAMENTALS OF CAR AUDIO TRAINING PROGRAM (Cont'd)

FREQUENCY RESPONSE BANDWIDTHS:

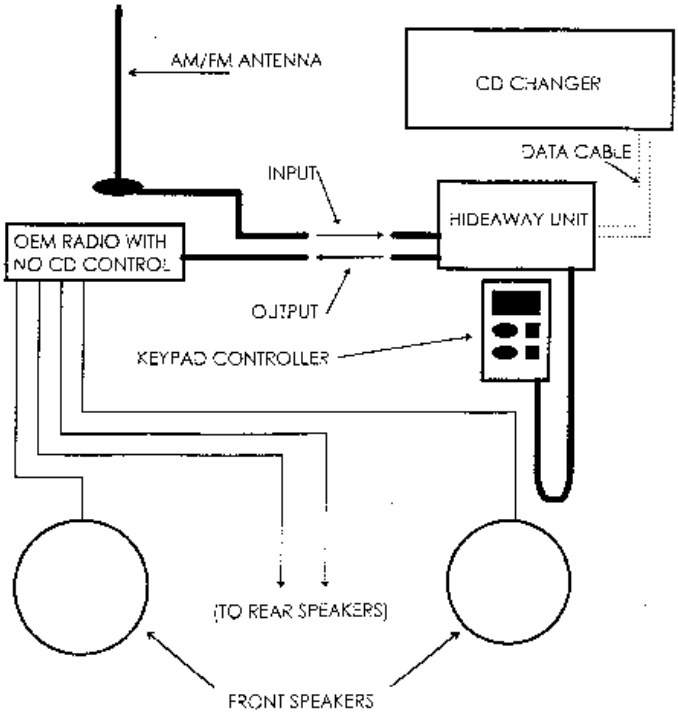
Human Hearing *- 20Hz to 20Khz if your hearing is perfect, most adults hear only up to 17KHz or 18KHz.*

CD Changers/Players *- 5Hz to +>20KHz. Basically the full range exceeds the limits of normal human hearing. That's why it sounds so good compared to tapes.*

Cassette Tape Players *- >30Hz to 12-20KHz. The quality, and therefore expense of a good tape head determines how good high frequencies will sound.*

AM/FM Tuners *- 30Hz to 15KHz. The tuner section is severely limited in the upper frequency range. This isn't too big a deal, unless you are listening to music like CD's that have a wide dynamic range. The tuner effectively "chops off" the extreme upper and lower frequency response. Some easy CD OEM add-on's employ the use of the tuner input for the audio rather than the preamp via RCA's or Data Cable to make CD upgrades "universal".*

ADDING AN FM MODULATED CD CHANGER/PLAYER TO AN O.E.M. CAR AUDIO SYSTEM



The FM Modulated CD upgrade is much more "universal" to install but often at the cost of sound quality at the upper 15KHz - 20Khz frequencies. The other Direct Connection method is generally limited to connection within the brand name family. (i.e. Clarion changers/players will NOT "plug into" Kenwood controllers & headunits). This applies to BOTH Aftermarket and OEM suppliers since many aftermarket companies often supply headunits or the CD control logic under a car manufacturers brand name.

LET'S REVIEW THE 5 MOST COMMON UPQRADES TO AN OEM SYSTEM:

1) Adding an amplifier to an OEM headunit - *Extra's include the amplifier itself, a Line Output Converter, an appropriate length of RCA cable, the appropriate size power and ground cable, the correct size fuse, a remote turn-on wire (sometimes the power antenna wire), and enough speaker cable to run from the amp output to the speakers it will power. Average install time = about 2 hours for most vehicles.*

2) Adding a headunit and amplifier to an OEM system - *Extra's besides the headunit and amplifier include an installation kit and a wiring harness (although that is true for most cars, check with the Scosche application guide to be certain), an antenna adapter (again check applications), an appropriate length of RCA cable, appropriate power and ground cable, the correct size fuse for the amplifier, a remote turn-on wire from the headunit to the amplifier, and enough speaker cable to run from the amp output to the speakers it will power. Average install time = about 3 hours for most vehicles.*

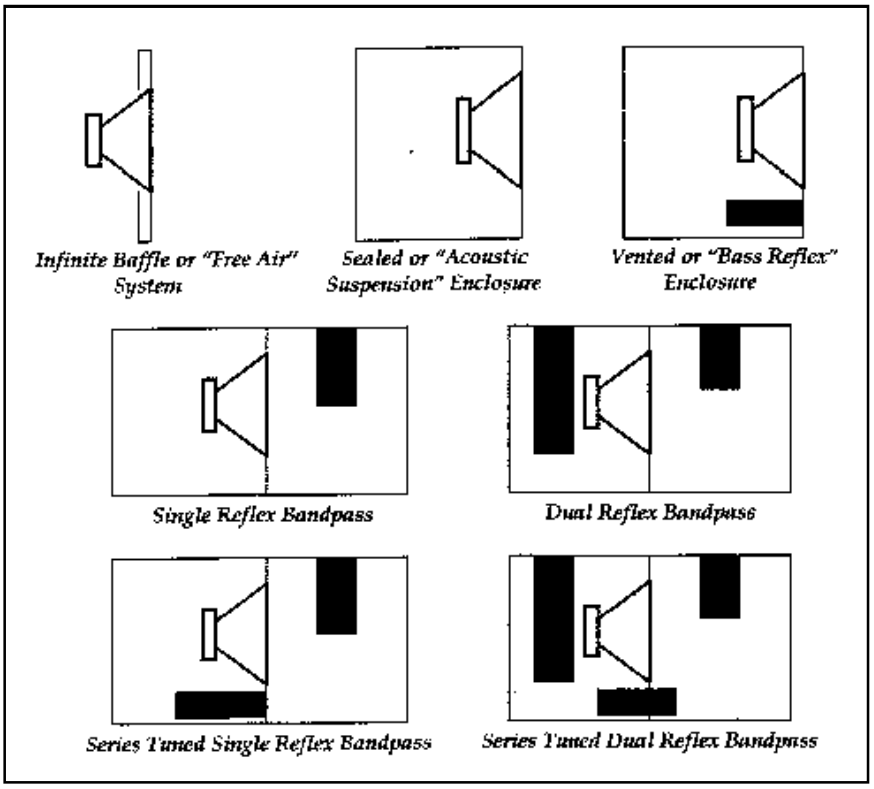
FUNDAMENTALS OF CAR AUDIO TRAINING PROGRAM (Cont'd)

3) Adding a subwoofer system to an OEM system - *Extra's include the amplifier or an "amplified" subwoofer package, an LOC, if the amp or amplified subwoofer doesn't have hi-level / speaker wire inputs, the appropriate length of RCA cable (if you used and LOC), Power & Ground cable, a remote turn-on wire (sometimes called power antenna), speaker cable (if it isn't an "amplified" subwoofer), and the subwoofer system itself.* (*see subwoofer system notes)*

4) Adding a Direct connection CD unit to an OEM stereo - *This generally involves nothing more than "plugging-in" to the back of the headunit and the data cable that links the CD with the headunit is usually supplied in the box with the CD itself. For this set up, install times can vary depending on the location and complexity of mounting involving the CD unit. Average install times = 1/2 to 1.5 hours depending on the circumstances of the car.*

5) Adding an FM Modulated CD unit to an OEM stereo - *Again, like the direct connection, not a lot of extras required except in the cases where antenna adapters are needed. In those instances BOTH input and output generally need adapters. There's also a little more install time involved hiding the "hideaway" unit and mounting or making provisions for the keypad controller. Average install times = about 1-2 hours for most cars.*

*** Subwoofer System Notes - See below some of the many types of subwoofer systems that are common in the Aftermarket.**



This section covers OEM upgrades and some of the considerations in doing them. Now on we'll look at the way that 100% aftermarket systems are set-up. Keep in mind, 100% aftermarket systems are generally cars which had the Delete Option or audiophile customers who wouldn't ever be happy with OEM.