Car Audio FOR DUMMIES®

by Doug Newcomb

Foreword by Mike Mettler
Vice President/Editor-In-Chief, *Sound & Vision* magazine

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About the Author

Doug Newcomb has been writing about car audio since 1988. He was editor of the trade magazine *Installation News* (now called *Mobile Electronics*) from 1988 to 1989 and managing editor of *Car Audio and Electronics* magazine from 1989 to 1995, and editor from 1995 to 1997. He served as executive editor for *Car Stereo Review*, which became *Mobile Entertainment,* and then *Road & Track Road Gear*, from 1997 to 2005.

As a freelance writer, Doug's work has appeared in numerous national publications, including *Rolling Stone*, *Playboy*, *Men's Journal,* and *Road & Track*. Doug has appeared on national television several times as an expert on in-car electronics, and he is frequently asked to speak at consumer electronics and automotive industry conventions as an authority on the subject.

Doug is currently a fulltime freelance writer whose work appears regularly in such publications as *Car Audio and Electronics*, *Sound & Vision*, *E-Gear,* and *SEMA News* and online for MSN Autos and MSN Tech & Gadgets.

Doug's love for music and cars started in the late 1970s when he installed his first stereo — a Craig eight-track tape player and two Sparkomatic 6x9s — in his first car, a 1968 Ford Fairlane. More than 30 years later, driving and listening to music is still one of his favorite activities.

He resides in Hood River, Oregon, with his wife and two children.

Dedication

I dedicate this book to my wife Gretchen, for her tireless support throughout this project, her always insightful advice, her eagle-eye proofreading, and for enduring all of those times over the years when I cranked the car stereo, even when she didn't like my "wiry" music. I would also like to thank my kids for their support and understanding during all those times when daddy was writing and couldn't play, and for sharing my love of cruising and listening to music. Finally, I'd like to acknowledge my parents, James and Ruby Newcomb, for teaching me the values and virtues of hard work.

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Contents at a Glance

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Foreword

I’ve been able to drive some pretty sweet cars over the past two decades, thanks to my former job as a car audio journalist — Ferraris, Lamborghinis, Porsches, Mustangs, Corvettes, you name it. But you want to know a secret? As cool as it was opening it up behind the wheel of all of those slick vehicles, I was more interested in cranking their car stereos.

To me, there’s nothing like zipping down the open road in a sweet ride with your favorite tunes at your fingertips, and there’s no one better to tell you how to maximize that experience than Doug Newcomb, the author of *Car Audio For Dummies*. Doug and I have logged many hours on the road together, traveling in tandem on numerous road trips, highway adventures, and cross-country caravans. Even now, many of our conversations begin with a most familiar question: “Guess what I listened to in the car today?”

This book will show you how to plan, design, and build a great car stereo from the ground up and enjoy it every time you turn on the ignition. Sure, a lot of people are content with the stock systems that come with their vehicles, and it’s true that factory stereos have come a long way since the days of tape decks. But if you simply stick with stock, you’re missing out on all of the great aftermarket upgrades available. Can you add better speakers and more bass without breaking your lease or tearing up your car’s interior? Absolutely. Is it possible to get sound quality equal to that of the best home stereo systems? Sure it is. What about video, satellite radio, and iPod integration? Yes, yes, and yes. You can do it all, and more.

I can honestly say that I’ve heard car stereo systems that sound better than some of the most elaborate home theater setups out there (and I now evaluate the latter every day). The first time the mobile audio bug bit me, I spent two years auditioning speakers for my car. I’m not saying you need to go to that extreme, but you owe it to yourself to see what’s out there and find out how much fun it can be to put together a great car stereo system. And *Car Audio For Dummies* is the key to helping you achieve sonic nirvana on the road.

There are few things Doug and I love doing more than listening to music in a car. So hop in and join us for the ride, won’t you? An endless road of car audio possibilities awaits you inside.

Mike Mettler

Vice President/Editor-In-Chief, *Sound & Vision* magazine and former Editor-in-Chief, *Car Stereo Review*, *Mobile Entertainment*, and *Road & Track’s Road Gear*

Introduction

Welcome to *Car Audio For Dummies*! My goal in writing this book is to provide you with all the information you need to build the car audio system of your dreams. Whether you want a car audio system that makes it seem as if your favorite band is performing right on top of your dashboard, one that can keep a carload of passengers entertained with music and movies, or one that lets you bring your entertainment media into the car in any way you choose, this is the place to start. This book covers everything from planning your system, to shopping for the components, getting them installed, how to get the most out of your system, and how to maintain and protect it. Think of it as your personal guide to the exciting world of car audio.

About This Book

Although there are certain steps to follow when putting together a car audio system, there's no one-size-fits-all formula. Some people may want to simply upgrade their stock stereo system with better speakers and an amplifier, or just change out the radio or *head unit.* Others want to chuck all of the stock components and start from scratch. Still others may only want to add mobile video to their cars or Bluetooth hands-free-phone capability. Still others want to add all of the above.

Consequently, this book was written in a manner that allows you to get whatever you want out of your car audio system. As such, it's structured so that you can turn to the section that's most applicable to your situation, or read the entire thing to go from a complete beginner to a very knowledgeable newbie.

How This Book Is Organized

This book is divided into six parts, each focusing on a different aspect of the car audio experience: what you need to know and think about before starting to put together a car audio system; various ways you can go about shopping for and installing car audio components; how to select the best components; things you'll need to complete your system and accessorize it; how to best protect your sound investment (and your ears); and, finally, some quick and helpful tips on getting good sound, getting a good deal, and more.

Although I discuss the basics and what's involved with installation of a car audio system, I won't provide step-by-step instructions. That's beyond the scope of this book. I'm also a strong advocate of professional installation. If you have lots of experience with car audio or you know your way around cars and are handy with tools, you *may* want to go it alone. (But hey, if that's the case, you're probably not reading this book!) But modern cars are so electronically complex that one false move could blow an air bag or disable an ABS braking system—and you'll end up spending more repairing your car than you would have on paying a pro to install your car audio system.

Part I: Starting with Sound Advice

Somewhere there's probably a graveyard of abandoned car audio equipment that people bought but later had no use for. That's because they didn't have a clear idea of what they wanted and why they wanted it. It makes me think of the old saying, "If you don't know where you're going, any path will take you there." You want to make sure the road to your dream car audio system is not a dead end!

Like any purchase, you have to consider whether the car audio components you buy are worth your hard-earned money, of course. But there's the added complication of whether the stuff you buy will fit in your car. After all, a 15-inch subwoofer looks mighty impressive, but installing it in your vehicle may be impractical or even impossible. There's also the matter of whether it'll work with other car audio components in the system and whether it's compatible with future additions to your system. It also comes down to your budget. And you have to think about whether the features you're paying for are worth the money and whether you really need them or will even use them.

It starts with knowing what you want from your car audio system and knowing what kind of mobile music listener you are. You'll also need to consider what types of media you'll be listening to, whether it's CDs or MP3 — or a combination of the two — for example. Maybe you can simply keep your stock radio and add aftermarket car audio components to get great sound with less money and hassle.

Don't discount the idea of staying with a stock system: They've gotten surprisingly good over the last several years. So I look at staying with a stock system as an option for getting to your car audio goals.

To start with, you also need to know what constitutes good sound. I define sound-quality concepts such as frequency response, imaging, and staging so that you know what to listen for. Plus, I recommended some high-quality recordings that help you establish an audiophile reference.

Part II: Shopping for a Great System

Today there are more places than ever to buy car audio components: car audio specialty shops, *big box* retailers, even some auto-parts stores. And, of course, the Internet offers almost anything you want with the click of a mouse. But there are advantages and disadvantages associated with each route, which I detail in this section. I also cover warranties and returns and the option of going with used equipment.

Unlike most consumer electronics that you simply plug into a wall and patch together with a few cables, a huge part of car audio is installation. For one thing, car audio equipment runs on the 12-volt power supplied by a car's electrical system, and wires have to be snaked throughout the car. There's also the issue of how installing car audio equipment affects your warranty.

One of the biggest choices you'll make is whether to have a professional install your gear or attempt to do it yourself. Regardless of your decision, this book tells you where to go and the right questions to ask to get the job accomplished.

Part III: Selecting the Best Components

Selecting your car audio components and installing them is both the most exciting and the most difficult aspect of the car audio experience. It doesn't help that there are hundreds of options to choose from, and every component in a system — from the head unit to the amplifiers to the speakers — has its own unique set of features. But fear not: I break it down so you can make effective and informed choices, and I give you insight on what it takes to get your components properly installed.

Part IV: Tying It All Together

Individual car audio components have to be connected, and different wires in a system do different things. I take the mystery out of car audio cabling and also help you decide whether you need audio *jewelry* or if regular wiring will do. I'll explain why you may — or may not — need power-management accessories such as capacitors, back-up batteries, and high-power alternators. I also cover the importance of other accessories, such as sound-deadening material, and I touch on must-have DIY tools. Finally, I teach you how to tune your system so that you can get the most out of it, and how to keep annoying noise from getting between you and your tunes.

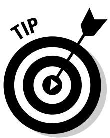
Part V: Protecting Your System and Yourself

If you've done all of the work to plan, shop for, buy, and install a car audio system, you want to make sure you do everything you can to protect it. This includes not only securing your system with an alarm system or some other means, but also making sure that your insurer understands the value of the system should the worst happen: if someone steals it or the car is involved in an accident. In this section, I explain how to enjoy your system but also protect your hearing, as well as protect your life and those around you by not becoming distracted while behind the wheel.

Part VI: The Parts of Ten

In this section, I provide easy-to-remember advice for getting great sound in your car and questions to ask your car audio salesperson or installer when shopping for and installing your system. I also provide steps for you to follow to insure that you'll be enjoying your system for years to come.

Icons Used in This Book



This icon calls attention to pointers to help you in your search for the perfect car audio system.

This icon warns that I'm about to dive into some of the finer points of car audio tech. But don't be intimidated by it: I use easy-to-understand language and terms to break it down.

Although car audio enhances your enjoyment of your car, there's always a potential for harming your car audio components and your ride if things are not done properly and safely. This icon indicates that you should play close heed if you want to avoid any potential problems or mistakes when putting together your car audio system.

This icon signals car audio truisms and important points that you'll want to remember.

Part I

Starting with Sound Advice

The 5th Wave By Rich Tennant

In This Part . . .

In this part, I help you decide which type of car audio system is best for you based on your musical tastes, your car, your needs, and your budget. I also take a look at the advantages — and drawbacks — of stock car audio systems, as well as why and when it makes sense to keep the factory system or add on to it. I also define sound quality and how to know when you hear it, and point you to recordings to help you reference it.

Chapter 1

Exploring the World of Car Audio

In This Chapter

- Deciding what kind of listener you are
- Getting the tunes you want
- Knowing your and your car's limits
- Understanding upgrade options

If you're like me, some of your most treasured memories are listening to an awesome audio system in an automobile. Picture this: It's a beautiful day on a fun road and you're behind the wheel of your car, jamming to your favorite music. Now think of the same situation if you were driving in silence. It's just not the same.

Music makes a good drive even better, a long road trip more fun, a daily commute more bearable. Think of your best times behind the wheel, and chances are there's a soundtrack that goes along with it.

After all, cars and music go together like . . . well, cars and music. Just think of all the great rock, pop, and rap songs that have been written about cars: from The Beach Boys "Little Deuce Coupe" to Prince's "Little Red Corvette" to The Game's "How We Do." In this chapter, I set you on the road to a great car audio system: I cover how to decide what kind of system you really need and want, how to factor in your budget, and how to make the most of what your system already has.

Taking the Car Audio Plunge

For my money, there's no better place to listen to music than in a car. When you're listening at home, the phone always rings or someone tells you to turn it down. Even with headphones, distractions occur and the music is all in your head, so to speak. But the car is like your own private listening room: a mobile sound cocoon that isolates you from the outside world. You can turn it up as loud as you want (as long as you're not disturbing others) and feel the visceral impact that comes from the music pulsing around you.

I've been fortunate enough to hear some ultra high-end home-audio systems and I've been in state-of-the-art recording studios and witnessed some amazing live performances. But none of these live up to the feeling I get while listening to a well-designed car audio system in a cool car on a fun road. Music just seems to sound better when asphalt is flying under your feet!

The best time ever for car audio fans

There's never been a better time to be a mobile music lover. Not only have components such as amplifiers and speakers reached an apex of performance and offer more bang for the buck than ever, but the recent explosion in media options has made the DVD radios that were state-of-the-art a decade ago seem almost antiquated now. The advent of MP3 has freed music from a disc-based format so that now you're able to carry your entire music library on a small portable player such as an iPod. Alternatively, you can load hundreds of songs onto a single disc or even a USB thumb drive. Satellite radio has gained ground against traditional terrestrial radio, while high-definition (HD) radio promises to make AM and FM better and offer more content. Plus, in just a few short years, mobile video has turned "Are we there yet?" to "Are we here already?"

Your roadmap to awesome car tunes

Consider *Car Audio For Dummies* your roadmap to awesome car tunes. You know that there's this wonderful world of car audio out there, but you don't know how to get started planning a sound system, shopping for components, or installing everything, let alone getting the most out of your system, protecting it, and fully enjoying it. In this book, I take you through each step of the process so that you can make informed decisions without wasting time and money and so that you'll ultimately end up with a car audio system that will give you years of listening pleasure.

You've come to the right place

You probably heard someone's car audio system — a friend's, your older sibling's, or maybe one at a car show — and now you want something similar. You used to think your car's system sounded pretty good, but now that you've heard something better, it just doesn't stack up. I've always referred to this as the *ice cream theory*. After you've tasted Ben & Jerry's, for example, you can't go back to the grocery-store brand. It's just not the same.

You know what you want, or at least have a vague idea in mind. You just don't know how or where to get it. The fact that you're reading this book means that you're off to a solid start!

Deciding What Kind of Mobile Music Listener You Are

One of the first things you'll need to determine is how you like your car tunes. Do you like to crank the bass so that people can hear you coming down the road for blocks? Or do you like to hear every subtle nuance of a Mahler symphony? Do you like to be blown away by every note of a great rock-guitar solo and feel the bass drum beating against your chest? Or do you want your system to sound as if Norah Jones and her piano were sitting on your car's hood? Maybe you want your system to do all of these things. The cool things about car audio is that you can have it almost anyway you choose.

Deciding what kind of music listener you are helps you determine a starting point. Most people have wide-ranging musical tastes, and it is possible to put together a system that bangs out the bass in a rap song and produces the subtle sound of a symphony. Defining those parameters will help you when planning your system.

Besides thinking about what kind of music you mostly listen to, you should also consider how you like to listen to it. Do you mostly drive alone during a daily commute? Or do you want a system that you can crank when you're out driving with your friends? Most people will want a little of both.

Also think about what type of media options you'll want. Do you keep all your music on an MP3 player, or do you mostly listen to CDs? Are you an FM radio listener or do you like to tune into AM talk radio? Thinking about these things can help you pick out the best components and hopefully avoid some potentially costly mistakes down the road.

In the not-too-distant past, you had just a few choices in music formats: AM, FM, CD, or cassette. But MP3s, the iPod, and satellite radio have changed the way people listen to music in the car. And now it's not uncommon for in-dash radios to sport USB drives or even SD card slots that allow you to play dozens of digital music files on these handy devices. Plus, it's possible to burn as many MP3 and WMA tracks on a single CD as a clunky old CD changer once held on multiple discs. Now, devices such as phones and portable media players (PMPs) that use Bluetooth Advanced Audio Distribution Profile (A2DP) technology to wirelessly wing music to a compatible car radio are starting to become available.

With so many different ways to bring your tunes on the road, it pays to think long and hard about how you'll listen to music in the car. It's a way to hopefully future-proof your car audio system so that you're not shut out from using new technology or having to do expensive upgrades later on.

Finally, creating a car audio system can be an extension of your personality, in much the same way that customizing your car says something about you. After all, if you wanted to be like everyone else, you'd just keep your stock stereo system. Car audio is about creating a system that sounds the way you like it, plays the media that you choose, and looks the way you want it to.

Knowing Your Car, Your Needs, and Your Budget

It's not uncommon to start out with grand expectations when fantasizing about your future car audio system. It's nice to dream, and it's free! But when it's time to come down to reality, you'll need to accurately assess your car, your needs, and your budget to determine what works best for you.

Your car

Although you may want a wall of 18-inch subwoofers that will blow away the boys (and girls) down at the local hang site, if you're driving a Ford Focus, such a scenario is obviously unrealistic. Even if you drive a large SUV, you probably can't fill it up with bulky amplifiers and subwoofers if you use it to transport stuff like kids, groceries, or tools for your work.

You'll also need to consider how long you plan to keep your car. If it's yours for life, you can probably go crazy and turn it into the ultimate sound machine. But if you plan to trade it in or sell it in a few years, keep in mind that prospective buyers may not be as thrilled as you are about the custom car audio system. In fact, contrary to what you may think, a mega sound system sometimes *detracts* from the value of a vehicle.

This is especially true of cars that are traded in at the dealer level. The last thing they want to see is a bunch of non-factory authorized accessories "hanging off of a vehicle," as one auto insider once told me. Consequently, you'll take a big hit on the value. And if you're driving a leased vehicle, you'll want to tread *very* lightly when adding car audio components or any accessories that may alter the car. Otherwise, you could be hit with a penalty at lease end.

Your needs

Have you ever bought something and went with all the bells and whistles and later found out that you don't need them all? Shopping for a car audio system is not much different. You'll want to make sure you get what you need and aren't buying stuff you don't. Although a car's physical space will dictate how much car audio equipment you can install in it, your appetite for the latest and greatest doesn't have such built-in limitations. Consequently, it can sometimes be difficult not to go overboard and overspend on items and features you don't need or will never use.

Think about your listening habits and media preferences as well as your own aesthetics preferences. For example, although it may be cool to buy a head unit with a display that offers 1,000 different colors, is it really worth the extra money you may spend? Or will a subwoofer with lights that blink to the beat really add anything in terms of sound quality — or improve your image on the street? These are questions only you can answer, and you should ask.

Your budget

I like to think of a budget as a self-correcting system. Although anyone can come up with an awesome car audio system on paper — and many enthusiasts both experienced and inexperienced often do — when it comes down to plunking down your cash, writing a check, or whipping out your credit card, the reality of your financial situation takes over.

Therefore, it's essential to take stock of what you can afford and plan accordingly. One of the great things about car audio is you don't have to buy everything at once and you can add on to your system as funds become available. You can start off with a head unit, for example, that powers the factory speakers, and then add aftermarket speakers later on. After that, you can add an amplifier and maybe a subwoofer.

If you do splurge and go for the whole system at once, it's important to allocate your money wisely. For example, you don't want to blow your wad on a super-duper head unit and then skimp on the amplifiers and speakers if you later have to replace them. That's counterproductive and wasteful.

Although there's no magic formula on how to spread a given amount of funds on a car audio system, here's a general guideline on the percentage you should allocate to a given area:

- Amplifier(s): 40%
- Speakers: 30%
- Head unit: 20%
- Accessories: 10%

Use this as a general guideline when you start planning your component-buying budget, but take it with a few grains of salt. You may, for example, decide to spend more on a high-end head unit and less on amplifiers and speakers.

If you don't plan to install your system yourself — and the fact that you're reading this book should indicate that you probably will not — remember to allot a large percentage of your funds to cover professional installation. Installation generally absorbs up to 40 percent of your overall budget, so adjust your planning accordingly.

I've heard too many stories of over-eager enthusiasts maxing out their credit cards and damaging their credit ratings to get a car audio system they couldn't otherwise afford. As badly as you may want a system for your ride, think long-term and don't do anything stupid. You can add to your system as you have the dough, and many reputable independent car audio shops will work with you if they know you're in it for the long haul and will be back to buy more. They may even cut you a great deal on used or discontinued equipment. So before you go into debt to get that system, think about whether its worth it in the long run.

Choosing between Mild and Wild

For many people, car audio is as much about show as it is about sound. After all, chrome wheels won't make your car go any faster, but they look good, they're fun, and they tell people you care about your car. Nothing wrong with that. After all, people have been pimpin' their rides for years.

If you want a flashy car audio system, go for it. Just keep in mind that there are trade-offs. If your car is a daily driver and you use it to haul people and other things, then going with a flashy system may be impractical. For instance, I once put a *show* system in my 1996 Chevy Impala for a cross-country promotional trip I did for a magazine. It was the first time I installed a huge system in my own personal car after nearly 10 years in the car audio business. Although the interior was kept pretty low-key except for custom door and rear-deck panels for the speakers, the car's trunk was turned into a veritable car audio show-case. It included five amps in a rack in the floor and three 10-inch subwoofers in a bandpass box with a see-through Plexiglas panel under the rear deck. A massive 100-disc CD changer was installed against the driver's side trunk wall, with a bank of capacitors and power-supply accessories on the other. It was all trimmed with custom vinyl-covered wood and Plexiglas panels.

It sounded great and looked awesome. The car was a hit at the shows I attended and my neighbors would bring their friends over just to see it and listen to it. It was covered in magazines several times, and it was cool to have a celebrity car.

But the car didn't handle and accelerate the same due to all that extra weight from the car audio components. About a year or so later, after my first child was born, my wife and I couldn't even fit a baby stroller in the trunk because of all the car audio gear.

TIP

The reason I relate this story is to show you both sides of the coin. You can go with a mild system, like the one shown in Figure 1-1. Or, go nuts with a system like that in Figure 1-2. If you want that showy system, by all means, you should have one. But a great-sounding but more discreet system can usually serve the same purpose. Plus, with a showy system you run the risk of attracting the wrong kind of attention: from thieves.

Figure 1-1: A *mild* system can sound good and leave you with trunk space.

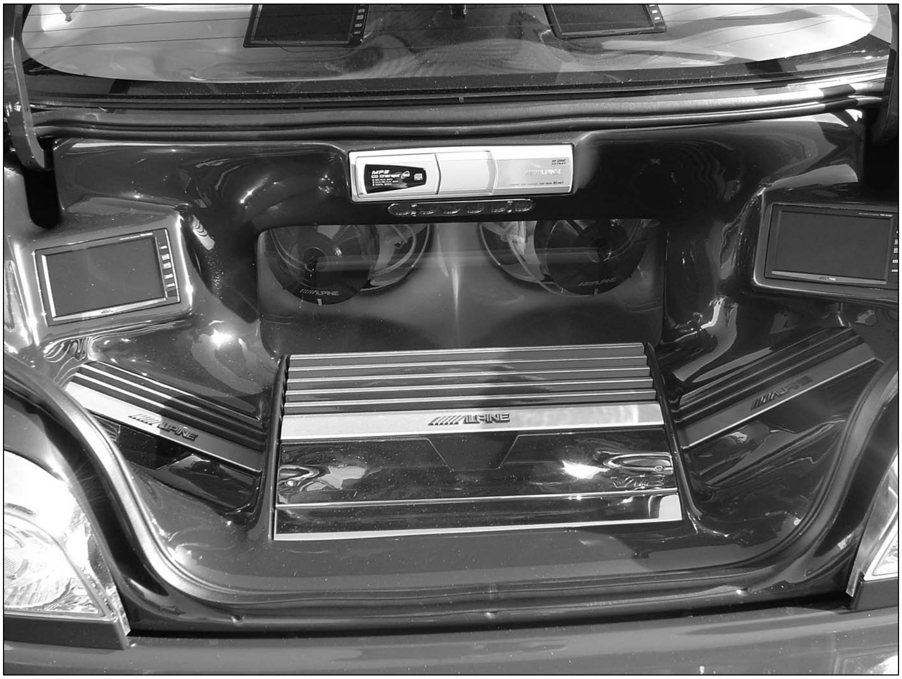


Figure 1-2: A *wild* system looks great but can leave you with no trunk space.

Upgrade your factory-installed system

If you really want to stay on the mild end of the scale and keep from altering your car too much — as well as protect against theft — you can keep the factory radio and add components such as amplifiers and subwoofers. Inversely, you could always change out your factory radio and keep your factory speakers intact.

I did this in one of my own vehicles, a 1997 VW Eurovan Camper that's a family-mobile. After talking it over with my installer, we decided I could get the sort of performance I needed in the vehicle (after all, my wife mostly drives it, and I can't really crank it up with the kids around) just by swapping out the radio. This also gave me the option to add satellite radio and an auxiliary input that allowed me to easily jack in an iPod. And I could always decide to upgrade the speakers and add an outboard amplifier later.

TIP

There are several options for upgrading your factory audio system. You should consider these first if you're primarily looking for better sound. The easiest and least expensive path to better sound is to swap the factory speakers for higher quality aftermarket ones. Many car audio manufacturers offer *drop-in* speakers that are specifically designed to fit factory provisions in a vehicle with a minimal amount of hassle and little to no modification. Often it's just a matter of taking out the factory speakers and *dropping* in new ones. This approach generally offers the most bang for your buck because many stock car audio systems use cheap and poor performing speakers, and even inexpensive aftermarket speakers can offer a dramatic difference in sound quality.

Keep your factory radio

When most people think of a *car stereo,* they think of the thing in the dash with buttons and a display. But such *head units* are just part of the system, although a major part. They generate an audio signal, let you select among various music formats, show what's playing, allow you to crank the volume, and sometimes include some signal processing functions, such as equalization, which tweaks the sound to better suit the car's interior space.

Then they send a signal on to the speakers in a system and sometimes to amplifiers in between to boost the signal. Truth is, many modern stock head units do this quite well, and they are getting harder and harder to extract from the dash. Some are oddly shaped or control other functions of the car, such as climate controls. So it isn't always practical — or even necessary — to replace the radio in some vehicles.

Understanding OEM upgrade options

The increasingly difficult-to-replace head units are why a growing trend in the car audio industry is to leave the factory head unit intact and add components *downstream* in the audio signal path. This is happening for the reasons I mentioned earlier in the chapter, as well as the fact that many people lease their vehicles these days and are reluctant to modify them in any way. Because of this, the aftermarket car audio industry has started to respond with a growing number of components specifically designed to allow upgrading a stock stereo system.

Almost all stock head units have only amplified *high-level* outputs that are designed to drive speakers, not amplifiers, which usually require an unamplified *low-level* signal. That's why it's typically easier to add speakers to a factory system than amplifiers. Some aftermarket amplifiers do, however, accept both high- and low-level signals, making them ideal for OEM (or Original Equipment Manufacturer — meaning the equipment that came with the vehicle) upgrades. And as with drop-in speakers, adding an amplifier is a surefire way to improve the sound of an anemic stock system.

But it isn't always that easy. More and more stock systems, particularly *premium* systems, also incorporate proprietary signal processing that's designed to work only within the *closed* system. When aftermarket components are added, it can actually make the sound worse because they aren't compatible with the system's signal processing.

But the aftermarket has been performing end-runs around the carmakers for decades. Being the resourceful bunch that they are, car audio manufacturers have responded to being locked out of such systems with products specifically designed to drop a signal from a stock head unit down to line-level *and* filter out any signal processing. Many of these also have an auxiliary input that also allows you to add an iPod or some other audio source to a factory system. If a stock system doesn't use proprietary signal processing, a simple *line-level* output converter will knock a high-level signal from a stock head unit down to *line* or a low-level so that an amplifier can be added.

Regardless, a savvy specialty car audio retailer will be able to help you upgrade your factory system so that you can add almost anything you like to it.

Chapter 2

Considering Stock Systems

In this Chapter

- Taking stock of stock systems
- Surveying the brands available
- Discovering how stock systems are getting better

If you had told me even a few years ago that a high-end stock system (one that has been originally installed by the automaker) could seriously compete with an equivalent aftermarket system in sound quality and features, I would probably have laughed in your face. But automakers' optional *premium* systems and even some systems available as standard equipment can now rival some aftermarket systems. But make no mistake: Aftermarket systems still offer the ultimate in sound quality, features, and flexibility.

Yet the automakers are quickly closing the gap, particularly with high-end brands such as Mercedes, BMW, Lexus, Infiniti, and Acura. For years, the car companies didn't take audio seriously and their systems were added to vehicles almost as an afterthought. But they've learned, especially in the luxury segment, that it's one way to distinguish a vehicles from its competitors. Regardless of whether large numbers of car buyers shelled out extra bucks for the optional systems, having a *marquee* name on the dash gives the automaker instant audio credibility. Such systems have caught the attention of the general public, however, and the exposure to better sound has raised expectations of how music can sound in a vehicle. And that's a good thing.

In this chapter, I cover the advances that have been made to stock systems in the past few years, and why they can sometimes compare favorably to an aftermarket system. In this chapter, you find out everything you need to know to decide whether sticking with stock is right for you.

What Bose Hath Wrought

The revolution in stock system quality all started in 1983 when GM first began offering premium Bose-branded systems in three of its upscale vehicles. Although this change signaled an improvement over the lackluster stock stereo systems of the day, the early Bose systems weren't the ultimate in sound quality and power. Partly because Bose premium systems represented a threat to the nascent aftermarket car audio industry, they were derided in enthusiast circles as a lowest-common denominator example of quality car audio.

Bose was also the first to use proprietary signal processing and electronics in a stock car audio system, which meant, unlike the standard car stereos of the day, Bose systems couldn't easily be taken out of a vehicle or upgraded. The system architecture was such that they caused headaches for installers.

For example, once while I was covering an installation for a magazine at a car audio shop in Vancouver, Canada in 1989, I witnessed the FM radio in a Cadillac with a Bose system continue to play even after the head unit was taken out of the vehicle! It took installers an hour or so just to locate the *phantom* tuner before they could start in on properly upgrading the vehicle's sound system.

Soon after Bose began to gain traction at car dealers and among consumers, another duo of well-known brands from the home-audio world also entered the stock car audio arena: JBL, in the 1985 Lincoln Continental, and Infinity in the 1986 Dodge Daytona. For years, Bose offered systems in GM vehicles and later branched out into other domestic and import makes. JBL could be found in Ford and later in some import brands (most notably Toyota), and Infinity appeared in Dodge/Chrysler/Plymouth vehicles. These three brands pretty much dominated the U.S. premium stock stereo market into the 1990s.

But it wasn't until Lexus partnered with Mark Levinson, a brand largely known only by high-end home audio enthusiasts (and by then part of Harman International, which also owns JBL and Infinity), that stock car stereo began to seriously compete with the aftermarket in terms of sound quality. And although Mark Levinson wasn't a household name, it's exclusivity immediately set it apart and caught the attention of other luxury carmakers and their discerning customers.

Partly because of the success of the Lexus/Mark Levinson partnership, more high-end home audio brands have since hit the highway, most recently Bang & Olufsen in Audi and B&W in Jaguar. Acura even went to the trouble of creating its own exclusive brand from scratch, ELS Surround, named after and with input from famed music producer Elliot Scheiner. And both BMW and Lincoln have tapped theater-sound specialist THX to create systems for their vehicles.

Aftermarket and Stock: Playing Both Sides of the Fence

In the intervening years, more and more well-known aftermarket brands have been appearing on stock systems. Rockford Fosgate, for example, is now available on some Nissan and Mitsubishi vehicles. (Figure 2-1 shows a Rockford system in a 2007 Mitsubishi Outlander.) Boston Acoustics systems come in some of Dodge and Chrysler's modern-day muscle cars, such as the Charger and 300C. And Alpine has been associated with Jaguar for a number of years, and now the company's products are also available in some Dodge trucks. Even Kicker, long known for their subwoofers in the aftermarket, have cut a deal with Dodge and Chrysler so that subwoofer systems can be added to vehicles as either a factory- or dealer-installed option.

Truth is, many of the major players in the car audio aftermarket have been supplying components to automakers for years, albeit without prominent branding. Clarion, Pioneer, and Alpine all have major OEM divisions that are an important part of each company's overall sales. (OEM stands for *original equipment manufacturer,* which is auto-industry speak for a company that supplies original parts for production cars.) But it's only in the last few years, as aftermarket sales have declined, that many of these manufacturers have blatantly offered *branded* system on vehicles.

Figure 2-1: A Rockford Fosgate system in a 2007 Mitsubishi Outlander.

Staying with Stock

Just as it would have been unheard of to compare a high-end stock system to a high-end aftermarket setup just a few years ago, I wholeheartedly feel that it's now no longer blasphemous to recommend a stock system as an alternative for some car audio lovers. In the past, stock systems were usually over-priced for the sound and features they offered, whereas the aftermarket provided better sound and better features for less money and maximum flexibility. But the value proposition of stock systems has improved dramatically and the carmakers are closing the gap on features as well.

TIP

So (gasp!) it sometimes makes sense to go with a stock system rather than installing an aftermarket one. Ask yourself the following questions when trying decide which route to take:

- **Do I planning on leasing or buying the vehicle?** If it's a leased vehicle, modifying it could cost you big time at the end of your lease, but if you're buying it you can pretty much do what you want.
- **How long do I plan to keep the vehicle?** If you plan to sell it within a couple of years, having an extensive aftermarket system could cost you, because it could detract from the resale value.
- **What features are most important to me?** If you value stereo controls on the steering wheel over sound quality, a stock system may be for you.
- **Do I want to take the time to shop for and have an aftermarket system installed?** Some people don't want the hassle of shopping for a system or don't want to wait to get it installed, so going with a stock system is instant gratification.
- **Do I want to possibly permanently alter my car?** Although an aftermarket system can be installed without permanently altering the car, with a stock system you don't take that chance at all.
- **Do I want to pay for the system all at once or have it spread out over the life of the loan or lease on the car?** One convenience of a premium stock system is that the payments can be spread out over the terms of the loan or lease, whereas with an aftermarket system you usually have to pay for it all at once.

If you're only looking for good sound and don't need every format and feature under the sun, a stock system could make sense for you. On the other hand, if you want something unique and customizing your ride is one of your main motivations, don't check off the premium audio option when you buy the car. Basically, if you don't want the hassle of bringing your vehicle to a car audio shop, picking out components, waiting for the installation to be completed — and you prefer to have the cost of the system built into your monthly car payments — you're a good candidate for a stock system.

Stock mobile video systems

Carmakers have also gotten into the mobile video business as frazzled parents seek ways to keep their kids entertained on long trips. Many car companies offer rear-seat entertainment systems that consists of either an overhead console with a video screen and a built-in DVD player, separate screens in the back of each rear-seat headrests tied to a DVD player elsewhere in the vehicle, or even a screen that flips out of the back of the center console in some sedans. Like aftermarket video systems, these typically come with wireless headphones so that the kiddies can watch cartoons in the back seat while adults listen to car tunes up front.

As with audio systems, the aftermarket can usually beat the OEMs on price, features, and flexibility in the video category. So it's usually better to skip the car dealer's option and buy a video system from the aftermarket. Like aftermarket systems, many stock mobile-video setups have auxiliary inputs that allow Junior to plug in a video game. The fact that mom and dad can roll the cost of the system into their monthly payments is also an advantage for the OEMs.

Stock Systems: Getting Better All the Time

I've been listening to and writing about a lot more stock systems lately, and I've been consistently impressed with their ever-increasing quality. Even the non-premium systems have improved. Another traditional weakness of stock systems is that they're often slow to adopt new technology because the auto industry is tied to multi-year product planning cycles. For this reason, the aftermarket has always been able to adopt new technology much more quickly than the auto industry, but car companies have closed that gap as well.

It took automakers years, for example, to offer iPod integration or even add simple auxiliary inputs so that a portable media player could be jacked into a stock audio system. But Bluetooth capability for hands-free mobile phone use in a vehicle began to appear from the factory even before aftermarket car audio manufacturers began to offer the feature.

As carmakers get more savvy about what consumers want — and align with technology companies the way Ford recently partnered with Microsoft for the Sync system — expect to see stock audio systems offering more technology that consumers are seeking. Although all of this doesn't bode well for the car audio aftermarket, it is better overall for the average consumer.

Chapter 3

Knowing What Sounds Good

In This Chapter

- Understanding sound-quality concepts
- Defining audiophile terms
- Determining a sound-quality reference
- Trusting your own ears

You've probably heard a car audio system and was blown away by how great the music sounded — the bass was forceful but tight, the guitars sounded lifelike, and you could hear every nuance of the singer's performance. The bottom line is you noticed a dramatic difference in the sound quality of that system and others you may have heard, and you want to recreate something like it in your own system. But how do you get it if you don't even know what *it* is? In this chapter, I talk about what *good sound* means. After all, you can't get a great system until you know what *great* is, right?

Understanding What Constitutes Good Sound

Great sound is one of those indescribable traits that, like great art or beauty, is in the eye (or in this case, the ear) of the beholder. Yet there are certain qualities that can be indisputably attributed to a great sounding system: clarity, dynamic range, frequency response, and tonal balance. (Don't worry if you don't know what these terms mean — I explain them in the upcoming sections.) Some attributes, such as frequency response, can be measured objectively (by instruments) as well as evaluated subjectively (by ear), whereas others, such as dynamic range and tonal balance, are purely subjective. Sound quality is also very personal: What sounds great to you may sound horrible to someone else.

It's important to design and build your system to suit *your* tastes. After all, it's your car and your money. So if you want a system that's bass heavy, so be it. Or if you want a system with screaming highs, that's cool too. (Just don't ask me to listen to it!) And although you should always build and tune your system to your own sound-quality standards, as with manners, it's better to know what's proper — or, in this case, what proper sound quality is — before you deviate from it.

I've often been asked why I've never competed in *sound-off* competitions, in which car audio enthusiasts go head-to-head to determine who has the best system. (Sound-offs, also sometimes called *crank it up* competitions, can also include SPL, or sound-pressure-level competitions, where the loudest system wins.) My glib response was always that I didn't care what other people thought about my car audio system because it was for my enjoyment. That was only half true, however. I do like to get people's opinions on my system if I feel that they can offer some insight and advice. But I always keep in mind that the system is ultimately for my ears and it's my opinion and enjoyment that matters most.

That said, it's also important to listen to *reference* systems to establish a benchmark. (Reference systems are discussed more in the section "Finding a Reference" later in this chapter.) But first you have to know what you're listening for.

Discovering Aspects of Sound Quality

Remember: Audiophiles can go on and on about the finer points of sound quality in the same way that oenophiles can go on and on about the qualities of wine. (Although you'll never hear an audio fan brag that his system is "nutty, with a hint of raspberry.") My intent is not to turn you into an audio snob spouting esoteric terms, but to help you grasp a few key concepts when it comes to evaluating a car audio system's sound.

The four basic food groups of sound quality are

- Clarity
- Dynamic range
- Frequency response
- Tonal balance

Clarity

Clarity is the ability of a system to produce the original signal as intended, without distortion. Although this is all but impossible except for the best systems, it's an ideal to strive for. Distortion can be caused by numerous things — from a head unit that's not level-matched with an amplifier to an amplifier that's *clipping* or being overdriven and sending a distorted signal to the speakers. And distortion can come from any component in a system.

TIP

To get a sense of a system with exceptional clarity, you'll need to listen to a reference system (discussed later in this chapter) and compare it to a system with unexceptional clarity. A good test is to listen to cymbals, which can have a brassy and off-putting sound when distorted. High-pitched female vocals are also difficult to reproduce and can reveal distortion rather easily.

Achieving clarity and therefore avoiding distortion and is all about proper system design and tuning. It's making sure components are of sufficient quality and compatible with one another and that signal levels are well matched between electronics. It also involves using a component as it was intended and not pushing it past its design limits.

Dynamic range

Dynamic range refers to the ability of a system to reproduce loud and soft passages in music with the same level of detail. When you're at a live concert, a singer may wail and then whisper or a drummer may hit a drum head with brute force and then back off a bit. Each extreme is an important part of the performance.

If the performance is recorded and reproduced by an audio system, the loud and soft parts should be delivered with the same detail and accuracy. But often a system tends to suppress soft parts and emphasize loud ones, meaning you lose the subtleties of the performance.

A related concept is *linearity*, which refers to a system's tendency to lose detail when the volume is turned down. It isn't especially difficult for a system to sound great with the volume cranked. But a system has great linearity if it can retain the same detail at a low volume.

Frequency response

Every sound you hear, from the low rumble of thunder to the high-pitch wail of a siren, is caused by a vibrations in the surrounding air that occur at certain frequencies. These vibrations are measured in hertz (Hz), which refers to the number of times per second these vibrations occur.

TIP

A good way to grasp this concept is to think of a guitar string. When a low E note (the largest string) is plucked on a guitar with a standard tuning, the lowest possible frequency it can produce is at about 80 Hz. That means that the string (and hence the air around it that produces the sound) vibrates 80 times a second.

Humans can hear frequencies roughly from 20 to 20,000 Hz. Our ability to hear high frequencies drops off with age and hearing damage, and women typically have better high-frequency hearing than men. Low bass frequencies are felt as much as they are heard, and that's why you feel bass from a passing *boom* car audio system sometimes before you hear it.

A car audio system's frequency response represents how much of the audible frequency spectrum it can reproduce. The frequency response of a car audio system can be measured by an instrument known as a real-time analyzer (RTA), which consists of a microphone attached to a processor with a display that has a graph that shows a system's response.

To measure frequency response, *pink noise*, which sounds like static and contains equal energy across the entire frequency range, is played through the system. Then the system is measured with an RTA, which shows the system's frequency response, usually called the frequency response *curve,* on its display. (See Figure 3-1.)

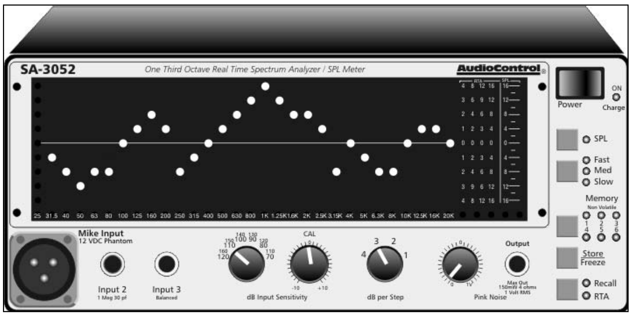


Figure 3-1: A real-time analyzer displaying a frequency response curve.

Courtesy of AudioControl

The response is described as curved because every system emphasizes or deemphasizes certain frequencies, which is indicated by a rising above or falling below the center line of the frequency response graph. The amount that the response is above or below the line reveals how many decibels (dB), a measure of amplitude or volume, a given frequency range is accentuated or deficient. For example, the frequency response of a system without a separate subwoofer would drop off dramatically below about 75 Hz, whereas a system with too much treble would rise in the high frequencies.

Tonal balance

Ideally, a car audio system would uniformly reproduce the entire audible frequency spectrum from 20 to 20,000 Hz. Although such a *flat* frequency response is theoretically possible, it's practically impossible in the real world because no system — at least while playing music — is perfect. Music is dynamic, meaning that some parts are loud and some are soft, so a system will naturally have *dips* and *peaks* in its frequency response.

Although a system can have these peaks and dips in frequency response, it needs to have good tonal balance — a relatively equal amount of sonic energy across the frequency range — to sound good. Subsequently, system designers and tuners often measure frequency response to gauge which frequencies may need to be *boosted* or *cut* as opposed to trying to achieve a flat frequency response. This can be done with an equalizer, although it's best that the system is designed in such a way that it has good tonal balance to begin with.

Experienced ears can often tell where a good system is lacking in tonal balance just by listening to it, and it's generally easy for most people to discern, for example, when a system lacks response in bass frequencies or if it over-emphasizes treble frequencies. That's why radios have bass and treble controls.

More Advanced Sound Quality Concepts

Although the four sound quality concepts discussed above are the most fundamental, there are a few other SQ attributes that are also important:

- Timbre
- Tonal accuracy
- Staging and imaging

Timbre

Timbre refers to a system's ability to recreate the sound of an instrument as it was originally intended to be heard. An acoustic guitar is usually a good test for this because most people have heard an acoustic guitar. Does the sound have that warm, slightly resonant quality that the instrument is known for, or does it merely sound like a low-resolution reproduction of that signature sound? In other words, does a system reproduce the true timbre of an instrument or a poor imitation of it?

And this doesn't just apply to acoustic instruments. Although some would argue that it's not possible to know the *true* sound of a Roland 808, a popular synthesizer for creating the deep bass sound in many rap recordings, the producer had a sound in mind when he cut the track. How close a system comes to reproducing that sound reflects how accurate it is in timbre.

Tonal accuracy

Tonal accuracy is used to describe how faithful a system is in general to the original recording. It can apply to instruments as well as vocals. The more accurate the system is while playing a good recording, the more you feel as if you are there, listening to a live performance as opposed to a recording.

Tonal accuracy can also apply to the *ambiance* in a recording. Ambiance refers to the *space* in which a recording is made. Most modern recordings are made in a sort of vacuum, with individual instruments recorded separately or, in the case of some rap music, the individual parts are sampled from other recordings. But many older recordings, some modern ones, and almost all live albums capture the environment in which the performance was recorded. In fact, certain recording studios and performance spaces are known and revered for their *sound,* which give a recording or performance a specific ambiance.

Think of timbre and tonal accuracy as the reproduction of how close you get to the actual performance or how the producer intended for it to sound. Whether it's the sound of Miles Davis's trumpet, Jimmy Page's guitar, a Dr. Dre beat, or the ambiance of Carnegie Hall, whether a system can reproduce it the way it went down in a studio or concert hall determines the difference between a good system and a great one.

Staging and imaging

Staging and imaging are related concepts that go back to the heyday of stereo, and therefore don't always apply to modern music. The basic idea is that when you're listening to a stereo recording, the system should recreate the illusion of the stage on which the performance is occurring, and you should be able to pinpoint the sonic *image* of the individual performers and instruments within the stage. (See Figure 3-2.)

Think about the example of a basic rock band that includes a singer, guitarist, bass player, and drummer. In this instance, you should be able to close your eyes and picture the singer at the center of the *stage,* the guitarist to the right, the bass player on the left, and the drummer center and behind the singer. Keep in mind that this is an ideal that sound quality systems should approach if not achieve. With rap and many pop-music recordings, the vocalist will be centered, but the concept of a band playing on a stage doesn't exactly apply.

If you ever go to a sound-off competition or read reviews in car audio magazines, you may hear judges or writers mention something like, "The stage was a bit low and imaging was fuzzy." What this means is that the stage in the car was below, say, dash level and the listener was unable to clearly distinguish the individual performers within the stage. Ideally, the soundstage in a car audio system should be high, wide, and deep, and imaging should be as pinpoint as possible. In a vehicle, sonic images are often *pulled* to one or the other side (or both) because speakers are usually mounted in a car's doors.

Speaker placement has a dramatic effect on staging and imaging, and hardcore enthusiasts often go to great lengths to position their speakers for the best possible results. This includes rebuilding door panels or kick panels to better position speakers. Some have even build elaborate mechanisms to mount speakers in or raise them above the dash in order to achieve better staging and imaging.

Finally, no discussion of sound quality would be complete without mentioning interior acoustics. A car's interior is a huge part of the audio system and plays a dramatic role in a system's response. Beyond the shape and size of a car's interior, it also has reflective surfaces such as glass and absorptive materials such as upholstery. And almost every car interior is different. Therefore, even if you install the exact same components in your Toyota Camry that your friend has in his Chrysler 300C, the systems will sound very different.

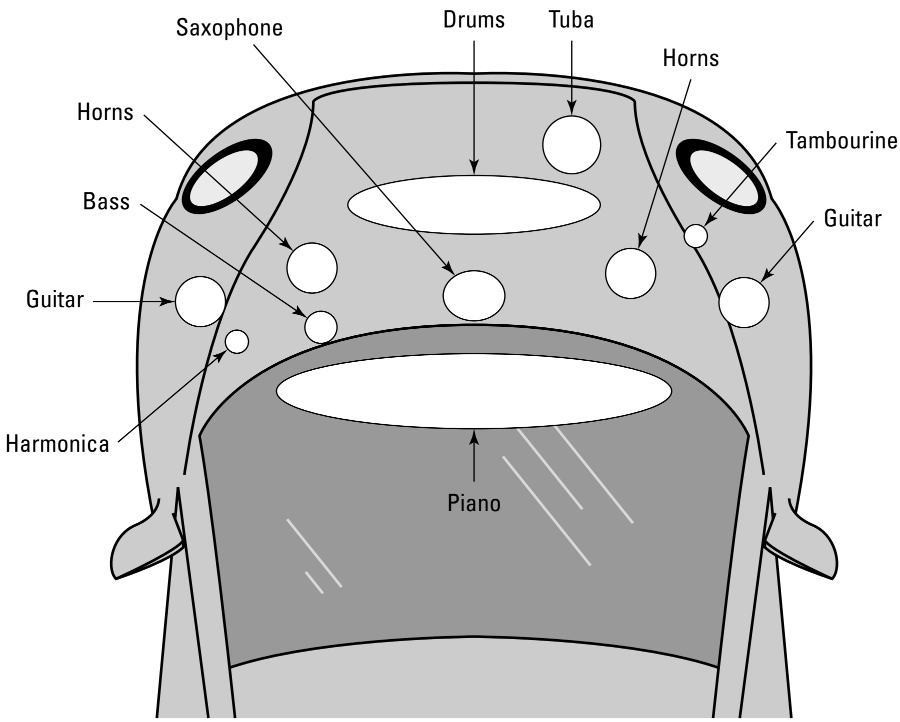


Figure 3-2: An example of staging and imaging of a car audio system.

Courtesy of IASCA

Finding a Reference

Okay, so by now your head is probably spinning with all of this audiophile mumbo-jumbo and you're wondering how you can put it into a practical application. You need a reference. You need to go find the best system possible and listen to it so you know what good sound is and how to apply all of the sound quality concepts discussed previously.

High quality sound systems

TIP

One of the most appropriate references is to go to a sound-off near you and ask to listen to some of the best cars there. But you may want to wait until the judging is completed because competitors may be a little reluctant, and a bit nervous, about cranking up their systems until they know how they've done that day. Plus, if you wait until the awards ceremony, you'll know which vehicles are best.

Another way to go about this is to visit a local car audio shop and ask to hear one of their award-winning vehicles. Still another way is to sit in a car with a high-end stock system, such as the Lexus LS 460 with a Mark Levinson Premium system.

TIP

To get the best reference possible, visit a high-end home stereo store. They will likely have a demonstration system made up of expensive components. Ask to listen to it with well-recorded music and you'll hear music like you've never heard it before. But be careful: Great sound is a highly addictive pursuit, and you may be tempted to blow tens of thousands of dollars on high-end audio gear!

Test and sound quality CDs

In addition to just listening to the reference system, you also have to make sure to play high-quality recordings on them. A car audio shop or home audio store will likely have some of these on hand. Make note of what they are. It's easy to find reference recordings these days, thanks to the power of the Internet.

The following is a list of several well-known test and sound-quality CDs for evaluation and listening purposes. Some also contain test tones and other such tools that can be used in tuning a system:

- ***IASCA Official Sound Quality Reference CD:*** This CD from the International Auto Sound Competition Association, which sanctions sound-off events around the world, contains 42 music tracks for evaluating accuracy, linearity, and timbre, and test tracks for channel and phase verification, noise evaluation, and more (`www.iasca.com`).

- **Telarc:** This is one of the premier audiophile labels in the US and offers a wide variety of recordings in genres ranging from pop to blues to classical (`www.telarc.com`).
- **Reference Recordings:** This is an audiophile label that offers jazz and classical recordings (`www.referencerecordings.com`).
- **Chesky Records:** Another audiophile label, although its classical, jazz, and world-music recordings aren't as stuffy as those of other audiophile labels (`www.chesky.com`).

Personal favorites

Over the years, I've developed my own stable of recordings that I use to evaluate hundreds of systems. I know these recordings so well that they allow me to instantly pick out deficiencies in a system. (Plus I seem to never get tired of listening to them.) Some are out of print, but you may be able to find used copies online or at your local library:

- ***Bluesiana Triangle* (Windham Hill Jazz):** This is my all-time favorite, a one-off recording featuring pianist/guitarist/vocalist Dr. John, horn player David "Fathead" Newman, and the late great jazz drummer Art Blakey. It features fun jazzy-blues jams that are impeccably recorded with incredible dynamics. I listen for the accuracy with which a system reproduces the timbre of Newman's saxophone, Dr. John's piano, and Blakey's dynamic drums. The nine-minute, mostly instrumental track "Shoo Fly, Don't Bother Me" is also perfect for checking soundstaging: Newman's flute solo should image in the center of the dash and Blakey's cymbal rides should be positioned high within the soundstage. Blakey's bass drum is also good for checking out a subwoofer's dynamic range and a system's tonal balance.
- **Luka Bloom, *Turf* (Reprise):** This Irish singer has a deep, resonant voice that sends the midbass in many systems into distortion, and his high-pitched acoustic guitar makes it easy to pick out problems with high-frequency response and timbre. Bloom's voice should image smack-dab in the middle of the dash and have a tangible quality.
- **Red House Painters, *Ocean Beach* (4AD):** This band's acoustic music is also great for evaluating midbass and treble tonal balance and accuracy as well as dynamic range. If a system can faithfully reproduce the thick midbass barrage in the song "San Geronimo," it passes my test.
- **Joan Armatrading, *What's Inside* (RCA Victor).** This CD kicks off with a deep-bass throb that sends many systems into distortion. Plus, Armatrading's voice ranges from masculine lows to girlish highs, and the deeply layered and well-recorded music allows checking for tonal accuracy, staging and imaging, and dynamic range.

Although you should acquaint yourself with what a good system sounds like, you should ultimately learn to trust your own ears. And the more you listen to high-quality systems, the more you'll become good at picking out deficiencies. If you are going to the trouble of putting together a car audio system, chances are you love music and listen to a lot of it. Ultimately, use what sounds good to you as a guide for creating the sort of system that you'll enjoy for a long time.

Part II

Shopping for a Great System

The 5th Wave By Rich Tennant

"He rattled off some nonsense about timbre, linearity, and dynamic range, and before I knew it, I was buying the 'Big-Box-O-Boomin-Bass' package."

In This Part . . .

Shopping for the components for your car audio system can be a fun and yet frustrating experience, and everything has to be installed in your car before you can even begin to enjoy it. In this part, I walk you through the various options available for buying car audio equipment and explain the different routes you can take to get it installed.

Chapter 4

Finding the Right Retail Experience

In This Chapter

- Working with a specialty retailer
- Considering *big box* options
- Surfing the Web for car audio components
- Making sense of warranties and returns
- Searching for used equipment

Shopping for your car audio components should be a fun and exciting experience. You've dreamed of putting together your system and scrimped and saved your money to purchase your first round of components. Or maybe you're lucky enough to buy all your gear in one fell swoop. Now it's just a matter of walking into a store or going onto the Internet, picking out your components, getting them installed, and hitting the road.

Well, it's not that easy. But it doesn't have to be difficult either. Finding the right retail experience can make the difference between getting off to a great start or getting frustrated right off the bat in your search for a great car audio system. Every retail route has its advantages and disadvantages and ups and down. It's not that one is better than the other, but one may be better for you for various reasons. And there's no rule stating that you have to do it one way or another. In fact, you may want to blend several different methods to make sure you get the best deal — or at the very least find out what each one is all about and which is best for you. In this chapter, I cover your retail choices, and give you some pointers about how to select one that will meet your needs.

Car Audio Specialty Stores

Specialty shops are to the car audio what gourmet restaurants are to the dining. Just as a fine restaurant will have high-quality ingredients and expert chefs, a car audio specialty store is where you'll find the best equipment and the most skilled installers. It's where innovation usually springs from and sometimes where enthusiasts gather to show off their systems and to see the latest and greatest ones.

Most likely, the first car audio specialty shop was started by someone who was an enthusiast themselves, as opposed to someone who was just out to make a buck. Unlike electronics stores that sell everything from washing machines to computers, a car audio specialty shop, as the name implies, is in business for only one reason: to help consumers create the sound machines of their dreams.

Unfortunately, the number of car audio specialty shops has dwindled quite drastically in recent years. This is not only because factory audio systems have gotten better, but also because there are many more options for getting car audio equipment, such as on the Internet. Also, as with most consumer electronics, prices for head units in particular have fallen in recent years, and the small mom-and-pop car audio shops have had a harder time competing with mass-market retailers and price-slashing Internet e-commerce sites. But chances are you still have a specialty shop or two in your town, and they are still the place to go if you want the best equipment, the best advice, the best service, and the best installation.

Where the experts are

A specialty shop is where you'll find the sort of people who have made car audio their life's work. Hence, it's where you'll find the most knowledgeable and passionate people in the car audio biz. Unlike businesses that sell other electronics or even car parts and accessories, a car audio shop succeeds or fails on the equipment it sells and the service it provides, so they better know what they're doing.

TIP

You can look in the Yellow Pages for a list of car audio specialty shops in your area; they're usually listed in the automotive section. But a better way to start your search is to ask a friend or acquaintance who has had a nice system installed for a recommendation. Better yet, attend a local *sound-off* competition or car show and take a look at the cars there. Many times, a show car will have a sign announcing who installed the system, or the shop may have a representative in attendance.

When you visit the shop, check their attitude. Because you'll likely be working closely with the employees of a specialty shop, it's important to make sure it's a good fit. Unfortunately, sometimes shops can have a bit of a snob or clubby appeal. Make sure they take the time to listen to you and answer your questions. If they are inattentive, rude, or condescending, walk out and find another shop. What the shop provides is a service, after all, and if they can't provide that, find one that will. But also don't waste their time with a million questions if you're not serious about doing business there.

Here are some things to look for on your first visit:

- A friendly, helpful attitude
- A clean and well-organized appearance
- A well-stocked product display board
- A photo album or slideshow of the shop's work
- Awards or trophies from car shows and sound-off competitions

And here are some questions to ask:

- Do you have the products I'm interested in currently in stock?
- Can I see some of your work?
- Can you give me references to contact other people you've worked with?
- Have you ever worked on the make, model, and year of car that I own?
- Do you keep a record of the work you do for insurance purposes or so that it's possible to reference previous work if there's a problem?
- Do you carry insurance?
- Do you plan to drive my car?
- Will you tune the system when the work is completed and is it part of your fee?
- Will you retune the system in six months when speakers break in and periodically after that?
- Can I bring my own equipment and have you install it?

And here are some questions they should ask you:

- What kind of music do you listen to?
- What kind of car do you drive?
- How long do you plan to keep the car and is it a leased vehicle?
- What sort of system do you want?
- What are your expectations for a system?

You should also bring in some of your favorite music and ask to listen to it on one of the shop's demo vehicles.

What they can offer

The salespeople at a good car audio shop should be very knowledgeable about not only the products they sell, but also brands they don't carry. They should be able to tell you why one brand is better than another, or even why products within a certain brand's line differ from one another. And they should be able to explain in detail the products they sell. They shouldn't bad-mouth brands they don't carry, however.

Many car audio shops carry exclusive and high-end lines of equipment that can't be found in other outlets, as well as more mass merchant brands you'll find elsewhere. With the high-end lines, specialty shops often have exclusive-territory arrangements with manufacturers that stipulate that the same products can't be sold in another store in the vicinity. Manufacturers who supply the top gear also typically make sure the salespeople and the installers are well trained so that the products perform at their best.

A car audio specialty retailer can provide you with personalized, one-on-one service that you can't find anywhere else. They will usually take the time to fully understand you, your needs, and your car. Sometimes they'll take a fledgling enthusiast under their wing and may even give you a break on the price of equipment and installation. Or, they may be willing to give you a package-price discount if you buy lots of equipment and have it installed there.

What it will cost you

As you can probably guess, the expertise and exclusive product offerings of car audio specialty shops also come at a premium price. Although they can often offer the best equipment, installation, and service, they also usually charge more for it. Plus, because they don't buy equipment in huge volumes the way large retailers do and they have higher overhead costs than Internet sites, they either have to charge more or make less profit. But they will also usually work with a customer on price if, for example, they know he is a potential longtime customer.

REMEMBER

Specialty shops also have the highest installation-labor rates because they usually have the best installers. Depending on your location, you can expect to pay anywhere from $50 to $110 per hour for installation at a specialty shop. They may also be able to offer different rates for different levels of work. For example, if you just want to replace your speakers, they may have a junior person work on it at a lower hourly labor rate, whereas custom work will be done by a very experienced installer and will cost more.

A specialty shop can also help you put together a custom system just for your car. Want a subwoofer box that fits in the floorboard of the passenger-side front foot well? No problem. And they'll be there when you're ready to upgrade your system.

Finally, they'll be there after the sale and installation to help with any problems or questions. At least you hope so, and they do too. One of the downsides of a specialty shop is, being small and independent, there's no guarantee that they'll survive. As mentioned, specialty shops have become something of a rare breed. One I worked with after recently moving to a different state, for example, went belly up after I'd paid them a few visits. It's a chance you have to take. But you can usually gauge a shop's longevity by how busy they are and based on their reputation.

Big Box Options

In the last few decades, consumer-electronics retailing has become dominated by *big box* stores such as Circuit City and Best Buy. (I could never figure out if they are called that because the stores themselves usually look like big boxes, or if it's because they usually have stacks of boxes around the store.) You probably have one near you if you live in an urban area or even in a good-sized town, and you've probably seen their ads in the paper or on TV. Car audio equipment is also sold through mass merchants like Wal-Mart and Sears as well as some auto-parts stores.

Good prices, but . . .

The biggest advantage of shopping at one of these mass-market retailers or chains is price. Because they buy in such huge quantities, large retailers usually have the best prices. Some even offer to beat the price of any other retailer if you find it cheaper elsewhere.

TIP

The big box stores also usually have a wide selection of equipment and brands. In fact, in the past few years, some brands that were formerly found only at specialty retailers, such as Alpine and Rockford Fosgate, are now available in the big box store as manufacturers have had to choose between making a few large profits with specialty stores or a lot of small profits with the big retailers. And the dwindling specialty market has help accelerate this change.

Another advantage of big box stores is that they usually have a finance program that you can sign up for on the spot. So if you have decent credit, instead of paying for your system all at once or even putting it on your credit card, you can spread it out over months. Plus, while some specialty shops also offer financing, most mass merchant retailers also offer interest-free financing for up to a year to sweeten the deal.

But with a big box retailer, you also won't get the personalized and expert service that you can get at a specialty retailer. Chances are the sales clerks won't be steeped in car audio experience the way they are at a specialty shop. The emphasis is usually on moving large amounts of products as opposed to customer service. And while you can rest assured that the big box retailer will be around, the person you work with may not be because there's typically higher turnover in the sales staff. Whereas many employees at a specialty shop live and breath car audio, for employees of a big box store, it's simply a job.

Installation issues

Some big box stores have an installation department, and they've done a great job of improving their service and reputation over the last few years. For example, some Best Buy installers are now certified through the Mobile Electronics Certification Program (MECP), which tests installers' knowledge and skills, and the stores offer a Lifetime Workmanship Warranty. But mass merchants usually have a higher turnover of installers than specialty retailers and they don't attract the most talented installers to start with.

If you are going with a simple to moderate system, a big box store can be a good alternative to a specialty retailer. But they usually can't handle custom work and theirs is more of a one-size-fits-all approach. If you want a truly custom system, a specialty retailer is the only choice.

Buying Online

The Internet has opened up a whole new way to shop for car audio. You can sit at the computer in your underwear while shopping for a subwoofer, for example. (Wearing nothing but your underwear to shop at big box store is generally frowned upon, but you knew that, right?) Plus, it allows you to compare prices at several sites and locations easily, whereas back in the day, you'd have to drive or call all over town to get the same info.

As the Internet has become the place that more people shop, the options for buying car audio products online has also increased. Many of the big box retailers have an online sales department, and a few specialty retailers have also added an e-commerce component to their business. Some manufacturers also have direct online sales. Basically, you can get almost anything you want with a click of a mouse.

Why you can't get everything you want

Okay, you can get *almost* anything you want, but not quite. Some of the high-end car audio companies — such as Focal and Genesis — don't allow their products to be sold online. In fact, they have strict policies against online sales and will not honor warranties if their products are purchased on the Internet. Plus, they want to be able to control as much as possible how their products are installed, because installation can make or (literally) break components and has a profound effect on their performance.

Pimp my browser

If you do decide to shop on the Internet, here are two places to consider:

- **Crutchfield:** This longtime mail-order company has a sterling reputation, great selection, and excellent customer service. Their Web site (`www.crutchfield.com`) also has a helpful Outfit My Car section that shows what will fit in your vehicle, and a Crutchfield Advisor section where you can learn about car audio components and concepts.
- **SoundDomain:** This was one of the first and is still one of the best car audio e-commerce sites (`www.sounddomain.com`). The site offers a wide selection of car audio equipment and brands (as well as other car performance and cosmetic accessories), installation accessories, a fit guide, pictures of installations, and an active forum where users post questions on everything from car electronics to iPod integration.

Although shopping on the Internet is convenient and sometimes saves money, one downside is you may have to pay for shipping, and you don't get that instant gratification on getting the components the same day you pay for them. Plus, you don't get to see and feel the components you are purchasing. And if you have a problem with a component, you can't just bring it back into a store, the way you can with specialty and mass-merchant retailers. Finally, there's just not the same face-to-face customer-service experience online.

Understanding Warranties and Returns

Like any consumer product, car audio equipment usually comes with a manufacturer's warranty. But unlike most consumer products, car audio equipment has to be installed in a vehicle for it to work. And as mentioned earlier, some manufacturers protect themselves from damage caused by improper installation by extending the warranty only if their products are installed by an authorized dealer. That way they can be assured — and you can too — that the products will perform the way they are intended.

JL Audio, for example, a well-respected manufacturer of subwoofers, speakers, amplifiers and accessories, for years offered only a 90-day warranty for some of its products if installed by a do-it-yourselfer or by an unauthorized dealer, whereas the warranty went up to two years for amps and a year for subs if installed by an authorized dealer or if "the system design and installation integrity are evaluated and approved" by an authorized dealer.

A defective or broken car audio component has to be taken out of the vehicle before it can be replaced or sent back to a manufacturer for repair. A potential bummer is that in some cases the customer has to pay to have the equipment taken out and put back into the car by the dealer. Although some specialty shops and big box stores will eat the labor cost and not bill the customer if the product is still under warranty, others will charge their usual rates to take the component *and* put it back in again. But it's rare for high-quality car audio equipment to break or malfunction, and failure rates are in the five percent range.

Regarding returns, a few manufacturers offer over-the-counter returns through an authorized dealer, meaning the retailer will swap out the component for a new one on the spot. But more commonly, the component will be sent back to the manufacturer or a service center for repair, which could take anywhere from a few days to several weeks. Depending on the retailer you choose, they may decide to replace a busted component with a new one from their stock or wait till the repaired component comes back from the manufacturer.

Here are some important questions to ask regarding warranties and returns:

- What is covered under the warranty and what it not?
- How long is the warranty?
- Will you replace or repair the component?
- Will it be an over-the-counter exchange, or will the component have to be sent out?
- If it's sent out, how long will I have to wait for the repair, and will you provide me with loaner component while I'm waiting?
- Who will do the repairs, and where will the component be sent?
- If the component is repaired or replaced, will the warranty be extended?
- Who will pay to remove and re-install the component?

Shopping for Used Equipment

One way to save some bucks on your car audio components is to buy used gear. People upgrade components in the car audio system or change cars all the time, and when they do, they usually want to get rid of their used car audio components.

There are some excellent deals out there if you know where to look and what to look for. But you have to carefully consider whether it's worth it versus the money you save. Used equipment usually comes without warranty and the transaction is the epitome of *caveat emptor*: buyer beware. You can never be sure what you're getting.

TIP

As a general rule, components without moving parts — amplifiers, equalizers, tuners, and such — are the safest to buy used, although amplifiers often take a lot of abuse and are more prone to failure than the others mentioned. Head units with fold-out screens are also known to malfunction with some regularity. With speakers, the rule of thumb is that the ones with cones that move more frequently — such as tweeters as opposed to subwoofers — get more wear and tear, although subwoofers, like amps, tend to get more mistreatment by people who try to bang out more bass or power than the components are designed to deliver.

Of course, you should check for obvious signs of wear and tear. Even though you can't inspect circuitry inside a component, the outward appearance should give you some indication of whether it was taken care of. Dents, chips, and such should be a red flag. With subwoofers, check for metal shavings attached to the magnet: These could get into the voice coil of the sub and cause past or future damage. With head units, check all of the buttons and knobs to make sure they operate smoothly. Ask the owner for any manuals or accessories that came with the component. Finally, check the serial numbers. If they are missing or scratched off, the unit is likely stolen, and you won't be able to have it repaired.

Compatibility isn't a huge issue with car audio gear, but keep in mind that one manufacturer's head unit often doesn't work with another's CD changer, and sometimes they aren't compatible even it they are made by the same manufacturer. Also make sure to check whether a component needs a proprietary cable or plug.

There are several sources for buying used car audio equipment. The best place to start is among friends and acquaintances because there will naturally be a higher level of trust. Another good place to start is with your local classifieds. That way, you can at least inspect the equipment before you buy it to make sure it's in decent shape. And if you install it and have a problem, you can hopefully return it pretty easily. Regardless, ask the seller to give you a short-term warranty, say, 30 days, so that you have time to get the component installed and make sure it's in good working order.

WARNING!

If you're going to meet someone who has car audio equipment for sale, do it in a public place or bring along a friend. Although it's probably legit, you don't want to take the chance of meeting a stranger while you're carrying lots of cash. Better yet, ask if you can pay with a check.

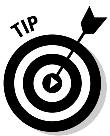
Pawn shops can also be a good source for used car audio equipment, but have an idea of the value of the gear so you know whether you're getting a good deal. Also ask about the warranty so that you have time to install the component to see if it works the way it's supposed to.

Many car audio specialty stores have used equipment in their stock room they are usually willing to part with. Ask the salesperson if they have anything that will work well in the system you're planning and chances are they'll give you a good deal on it, and maybe even a short warranty.

The Internet is a vast source for used car audio gear and there are several useful sites that have a used car audio gear sections, such as `www.sounddomain.com` and `www.automotix.net`. Newsgroups such as `www.caraudioforum.com` and `forum.elitecaraudio.com` have hundreds of listings for used car audio gear too. You can search for the specific components you want or post a WTB (*Want to Buy*) message for something in particular.

eBay and other online auctions sites are also a great place to shop. But you'll first have to familiarize yourself with the going rate for the equipment you're most interested in. A good way to do this is to check auctions that have already closed to get an idea of what similar equipment sold for. Make sure to find out who pays the shipping charges before the auction ends. Sellers have been know to inflate the shipping fee to squeeze a little more profit out of the deal.

Protect yourself by reading the auction site's safety guidelines. You can also use a third-party escrow service or PayPal to handle transfer of funds. If the seller insists on being paid with a money order or cashier's check, use a U.S. Postal Service mail order because this involves the Postal Service in the deal — and makes it a federal case if the seller commits fraud. Never, ever pay cash when using an online auction site and always check the seller's rating.



With the right research and timing, you could score a killer deal on some great used equipment. Just remember the old saying: If it's too good to be true, it probably is.

Chapter 5

Installing Your System: Going Pro or Going Solo

In This Chapter

- Considering modern car systems
- Understanding your warranty rights
- Going with a professional installation
- Deciding to go the DIY route

If you buy just about any kind of consumer-electronics product, you take it home, plug it in, maybe run a few wires, and you're good to go. Not so with car audio equipment. In fact, you can't even listen to any of the components you bought until you get them installed in your ride. (Unless, that is, you want a car battery in your living room.)

The installation is one of the most important parts of a car audio system. Some would say it's *the* most important part. In fact, an old adage in the car audio world is that the worst gear installed correctly will often sound better than the best gear that's incorrectly installed. Beyond performance, there are also safety issues involved with the installation of car equipment, especially as cars have become more laden with electronic safety gadgets. And by installing additional electronics in your car, you could be taking the chance of voiding your vehicle's warranty. In this chapter, I cover the pros and cons of doing it yourself versus hiring a pro. I also cover everything you need to know to find the right installer, if you decide to go that route, or how to find installation help if you decide to take the plunge and install your own system.

Understanding Modern Car Systems

Today's cars are more complex than ever. Used to be that you could easily slide a radio out of the dash and replace it with a like-sized one. But these days the radio is sometimes embedded in the dash in such a way that it's difficult to take out without doing major surgery.

Removing a radio can also sometimes disable or cause problems with other systems in the car. More and more factory car radios control electronics systems such as climate controls, navigation, and others. And even mid- to low-priced cars feature steering-wheel audio controls that you lose if you replace the radio. Even if the car doesn't have any obvious attachments to the radio, swapping out a radio can still cause problems.

A few years ago, for example, I put a sizable system in a 2001 VW Passat wagon I owned, and I replaced the radio with an aftermarket head unit. The next time I brought my car in for service, the dealership informed me that the shop couldn't diagnose the problem with my car because the diagnostic codes are read through the radio.

So I had to go to my installer to take out the aftermarket head unit and reinstall the stock radio just so I could have the car serviced. Then I had to go back to the stereo shop and have my head unit reinstalled. But this time my installer added a *pigtail* to the radio, which is a piece of wire with the necessary factory connection so I wouldn't have to go through that hassle again.

Modern cars also have much more sensitive and sophisticated electronics onboard than did older models. When I started in the car audio industry in the late 1980s, no one had to worry about blowing an airbag or causing a fault with the ABS braking system. These days, making a mistake when installing your own car audio system can not only be costly but deadly.

Warranty issues

When doing it yourself, you also have warranty and lease issues to consider. Although you can install anything you want on your car, if it's under warranty the dealer may — and often will — try to blame the aftermarket car audio parts for the problem. I've seen it happen with everything from alarm systems to amplifiers. Even if that new subwoofer system you installed, for example, has nothing to do with why your transmission fell out, it will immediately be suspect in the eyes of the service writer at a dealership.

Magnuson-Moss Warranty Act

The good news is that you have the law on your side. The Magnuson-Moss Warranty Act of 1975 was passed to protect consumers from being wrongfully denied warranty coverage by new car dealers for various reasons. Of particular interest to car audio enthusiasts is that, under the act, aftermarket equipment added to your vehicle does not automatically void a vehicle manufacturer's original warranty unless

- The warranty clearly states that it does
- It can be proven that the aftermarket add-ons were the direct cause of the problem

Rules and regulations that govern the interpretation and enforcement of the Magnuson-Moss Warranty Act state:

"No warrantor may condition the continued validity of a warranty on the use of only authorized repair service and/or authorized replacement parts for non-warranty service and maintenance."

And: "... a warrantor cannot, as a matter of law, avoid liability under a written warranty where a defect is unrelated to the use by a consumer of unauthorized' articles or service. This does not preclude a warrantor from expressly excluding liability for defects or damages caused by such 'unauthorized' articles or service; nor does it preclude the warrantor from denying liability where the warrantor can demonstrate the defect was so caused."

REMEMBER

What this means in plain language is that the car dealer must prove that the car audio equipment you added to your vehicle directly caused the need for repairs before denying warranty coverage. If a dealer is trying to weasel out of servicing your vehicle under warranty because you installed, say, a different head unit, speakers, and added an amp, that's one thing. But if you add a high-output alternator to your engine so that you have enough juice for your mega system in your new Hyundai and it causes the engine to catch on fire, the dealer is probably within his rights not to honor the warranty and drop in a new engine.

Using the earlier example of my VW Passat, a dealer can also refuse to service your car if the aftermarket parts you added prevent it from doing so. And they are within their rights to charge you the extra labor required to perform the service because of the addition of aftermarket parts. For example, they could have charged me to install the radio back in the car so that they could perform the diagnostics.

SEMA and CEA on your side

Besides the Magnuson-Moss Act, you also have the Specialty Equipment Market Association (SEMA) and the Consumer Electronics Association (CEA) to back you up. SEMA is the trade group for the aftermarket auto-parts industry, whereas CEA is the trade group for, you guessed it, the consumer electronics industry. Both lobby Congress on behalf of consumers being able to add car audio equipment to their vehicles. Click on `www.sema.org` and `www.ce.org` for more info.

"Lease" is the word

REMEMBER

If you leased your car, aftermarket installations get sticky because you signed a piece of paper saying you wouldn't permanently modify the vehicle in any way. But fear not. I've seen some pretty sweet systems installed in leased car in such a way that the vehicle can be returned to its stock condition.

Although you may not be able to install a 10-inch subwoofer in each door, you can probably find a pair of drop-in speakers that fit in without modification. And you can add a prefabricated, amplified sub box to get some decent bass. Some shops will even install a custom system that leaves no trace after the components are taken out, although you'll have to weigh whether going to such an extent is worth it given how long you have the car.

Exploring the Advantages of Going Pro

It's my opinion that professional installation is the way to go for beginners. Heck, these days, I think it's the way to go for all but the hardcore and experienced do-it-yourselfers. I've spent considerable time scrunched underneath dashes swapping out radios and curled up in trunks installing speakers, and even I now leave installation to the pros. (And it's not just because I'm too old to contort my body like that!)

As mentioned earlier in the chapter, modern vehicles are too complex to poke around in if you don't know what you're doing. You could easily end up ruining your car audio components as well as your car. If you drive an older car and aren't concerned with this, you may want to go the DIY route. If you do plan to have your system professionally installed, it will add to your overall budget and cash outlay, of course, but it will probably be worth it in the long run.

Here are some advantages of going pro:

- The system will be installed more quickly.
- The installation will likely come with a warranty.
- Your equipment warranty may be extended.
- There's less chance you'll void your car's warranty.

A professional installer also has better access to information, such as product updates and technical support from equipment manufacturers. Plus, they have all of the tools to make the job go smoother and faster. Finally, they usually know tricks to make a system sound better and can tweak and tune a system for optimum performance.

Most people have their equipment installed at the same place they buy the equipment, but that's not always the case. Whereas some shops install only what they sell, others charge a standard labor rate to install just about whatever equipment you bring in. Make sure you check first.

Typically, a specialty shop can offer the best installation — and the best installers — whereas big box stores generally handle only the most basic installations, such as installing a new head unit or speakers. So if it's a complex system you're after, go to a specialty store. But if you just want new speakers, that's something a mass merchant's installers can do.

MECP certification

Because cars have gotten so complex, car owners want to be assured that the person installing audio and video equipment has some experience and credentials. And as car audio equipment has gotten more sophisticated, car audio manufacturers want to be assured that their equipment gets installed correctly so that the customer is happy with their purchase.

Because of this, car audio manufacturers and installers got together in the early 1990s to create a way to test and certify installers. The Mobile Electronics Certification Program is administered by the Consumer Electronics Association (CEA), which tests and certifies installers on installation techniques and knowledge.

Certification levels include

- Basic Installation Technician
- Advanced Installation Technician
- Master Installation Technician

Installers are required to pass a written exam and meet experience criteria, and they are recertified every two to four years depending on their level.

TIP

If you plan to have your system professionally installed, one of the first things you should look for in a car audio shop is the MECP logo, as shown in Figure 5-1.

Figure 5-1: The MECP logo.

But there are other things you should look for, including

- A clean and well-equipped showroom and installation area
- Examples of the shop's work, either in the form of a photo album or computer slideshow
- Letters of recommendation from previous customers that may be framed and hung on the wall

- Plaques or stickers showing that the shop is an authorized dealer for the brands it carries
- Business license or tax certificates
- A demo vehicle that lets you see the shop's work and listen to one of its systems

Questions to ask

Remember that you are interviewing the shop and its personnel to determine whether you want to work with them and give them your money. Here are some of the questions you'll want to ask:

- Are your installers MECP certified?
- What kind of training do your installers have, and how long have they worked here and as an installer?
- Can you provide references or names of previous customers I can call?
- Are you insured so that I'm covered if something happens to my vehicle?
- Will you be driving my vehicle and, if so, why?
- What are your installation rates?
- Do you provide a warranty on your installations? If so, for how long?
- Do you guarantee a noise-free installation, so that it doesn't create alternator *whine* or other types of interference?
- What's your service policy if a component breaks?
- Will you give my factory stereo or my old aftermarket car audio components back to me when you're done?
- Do you use wiring harness adapters so that I can re-install my factory stereo if I choose? And how much modification will you do to my car?
- Do you make wire connections using T taps, solder, or crimp connectors? (Avoid an installer that uses T taps: They're unsafe because they don't provide a secure connection. They can loosen and therefore cause a short circuit and possibly damage your components and vehicle. Crimps are okay if done properly, but solder is the best method.)
- How do you determine what factory wires to tap into? A good shop uses a computer program to tell which wires to use for an install, and they'll verify the wires using a digital meter.

REMEMBER

If an salesperson or installer seems evasive or even arrogant, you should head for the exit right away. Even if a shop does great work but treats you poorly from the beginning, the relationship will only go downhill from there. They should be there to help you, or they may not be in business long, which is another reason to go elsewhere.

On the other hand, if they take the time to answer your questions thoroughly and courteously, you've probably found the right shop. You should also ask to see the installation bay. If it looks neat and organized, that's a good sign. And if they are working on nice cars, that's another positive sign.

Installing It Yourself

If I haven't intimidated you yet and you still want to install your system yourself, there are some things you need to know. Although car stereo installation started out as a DIY hobby, cars have changed significantly since the late 1970s when I installed my first radio and rear-deck speakers in a 1968 Ford Fairlane.

Know your car and your limitations

If you're driving a 1971 Chevelle, you probably won't encounter too many problems: Its electrical system is pretty simple and straightforward. But if your car is a 2006 Honda Civic, you'll want to proceed cautiously because the car will have some rather sophisticated electronics. Cars today have onboard computers, for example, and frying one while installing a head unit can cause big headaches.

REMEMBER

As I mentioned earlier, a vehicle manufacturer can't void your warranty simply because you installed aftermarket car audio gear unless it can prove that the equipment led to the malfunction for which you're claiming warranty coverage. But even if your car is not still under warranty, you still want to tread carefully.

You'll have to pull off panels to install components and runs wires, and professional installers have special tools just for this purpose. If you try a DIY install, keep in mind that you risk damaging your vehicle or at the very least not being able to put it back together the way it was before. If you're willing to take that chance with your car, you can save a little money and learn something too.

TIP

Besides knowing your car, you should also know yourself and your limitations before starting on a DIY install. Do you love to get your hands dirty and find out how things work? Or do you get easily frustrated and tend to focus on the end result instead of the process? Do you like challenges and learning by trial and error? Or do you prefer to just pay someone else to do the hard work so you can enjoy the benefits?

There's certainly no shame in having someone else do your dirty work when it comes to car audio. I stopped doing my own install years ago when I determined that others can do it much faster and better than I can. It's important to really be honest with yourself before installing your own car audio system.

If you do decide to take it on, here are two DIY projects that shouldn't present too much difficulty, could save you a few bucks, and will help you get your feet wet:

- **Drop-in speakers:** Ideally, you should be able to just swap out the factory speakers for aftermarket ones. The trick may be in getting to the speakers, because you may have to remove the door panel. In older cars, removing a speaker grille is easier. Then it's just a matter of unscrewing and disconnecting the factory speaker and doing the opposite with the new one.
- **Single-DIN head unit swap:** If you're doing a straightforward install of a new single-DIN head unit (one that's the standard size, 7" wide by 7" deep by 2" high) and the radio isn't tied into other systems in the car, the degree of difficulty isn't too high. It's usually a matter of removing the radio or removing a dash panel or two to get at the radio for removal. An installation kit, also known as a *fit kit* to keep the radio snug in the dash, may be needed. You should use a vehicle-specific wiring harness adaptor (available from a car stereo store or online) to make it easier to connect the radio's wiring to factory wiring.

Manufacturers' warranties

All manufacturers offer a warranty on their products, although some significantly shorten it if the products are not installed by an authorized dealer. If you buy low-end to *mid-fi* equipment, this may not be a big deal because the warranty on these products is often the same no matter who installs them. But if you invest in high-end gear, the stakes are much higher because the manufacturer will only warranty the product for a very short time, if at all. In that case, it usually pays to pay for professional installation. In any case, make sure to check the warranty on the products you buy, and read the fine print!

Where to Get Help

TIP

If you do decide to go it alone, you're not *really* alone. There are people and places you can turn to for help with your DIY installation questions. Chances are you didn't become interested in car audio in a vacuum and have friends who are also into the hobby. Few things are as fun and satisfying as hanging out with your buddies and working on your cars. Find someone who will mentor you or at least answer your questions. Sometimes the shop you bought the equipment from will offer some help or advice. A professional installer may be willing to help you out if you get into a jam.

The 'Net effect on DIY

The Internet has changed everything, of course. Now information is just around the next Web page and it's usually free. Car audio enthusiasts are typically a helpful bunch and don't mind sharing their knowledge — and opinions — with the world. Just remember: Advice is usually worth what you pay for it.

Before the Internet, the only way to get DIY help was to hook up with a friend or buy a book or magazine. But now the Internet is crawling with help on Web sites and forums. Some even have detailed installation instructions and diagrams. Some to check out include

- Crutchfield, `www.crutchfield.com`
- CarStereo.com, `www.carstereo.com`
- Basic Car Audio Electronics, `www.bcae1.com`
- Car Audio Help, `www.caraudiohelp.com`

Several online forums also provide installation advice and tips. Some of the best and most active ones include

- rec.audio car, `www.mobileaudio.com`
- CarAudioForum.com, `www.caraudioforum.com`
- SoundDomain, `www.sounddomain.com`
- Termpro, `www.termpro.com`

Of course, one of the things that makes the Internet such a great place to get info is its collaborative nature. Anyone anywhere in the world can contribute info, and they usually do. But that's also one of the downsides of the Internet: The information isn't always useful. At online forums, you'll get tons of opinions and advice, for what it's worth. If you follow the discussions, you can learn a lot and, after a while, generally be able to separate the wheat from the chaff.

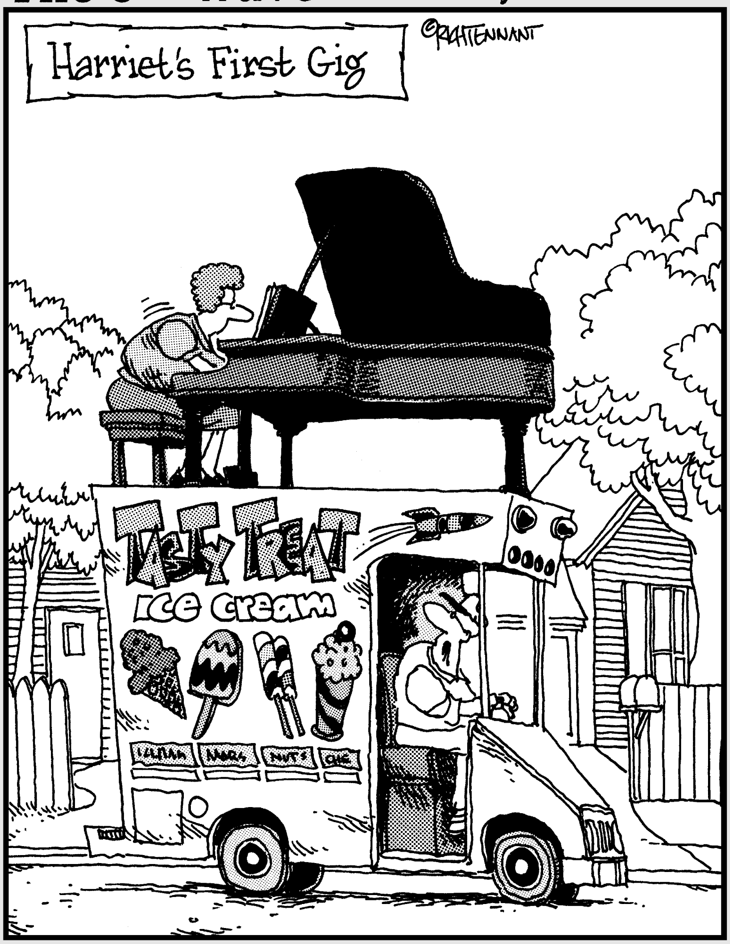
Magazines

Finally, some car audio magazines offer DIY help, but these are generally of the high-end variety. *Car Audio and Electronics* magazine, for example, taps some of the best installers in the business to do step-by-step installation stories. But these tend to be focused on advanced projects such as building custom door panels or subwoofer boxes. Still, it's good to see what sort of work goes into a project if you are thinking about going the DIY route.

Part III

Selecting the Best Components

The 5th Wave By Rich Tennant



"C'mon! Allegro vivace! Allegro vivace! We're selling ice cream not coffins!

In This Part . . .

A car audio system is made up of individual components that together equal more than the sum of their total, and each piece is critical to overall performance. These days, you have more products than ever to choose from, but that also means that buying the best components can be challenging. In this section, I detail all your options so that you can make informed decisions when shopping for components.

Chapter 6

Starting with the Head

In This Chapter

▶ Choosing a disc-based head unit

▶ Discovering how the iPod has changed mobile music listening

▶ Understanding MP3 and WMA options

▶ Going disc-less when buying a head unit

Say the term *car stereo* and most people think of the thing in your dash with knobs and lights that you stick a disc into. But the in-dash part of a car audio system is only a small, if important, part of the whole. Also known as a car radio or a *head unit* in car audio industry parlance (because it's at the head of a system), the head unit is the most visible part of a system and one of the only components you regularly interact with. Because of this, it has to be easy and safe to use when you're motoring down the highway.

The head unit is also the only part of a system that generates an audio signal and it's a conduit for various media options. Only a few years ago, you had just a few choices when it came to media: AM and FM radio, CD, cassette, and maybe DVD. But in the last few years, there's been a huge proliferation of new mobile-media options that allows you to bring music and video into the car in myriad ways.

MP3 and other digital music file formats forever changed how people store music, whereas the iPod phenomenon revolutionized the way people access and carry it. Now you can burn hundreds of files onto a CD or carry your entire music collection on a portable media player (PMP) like the iPod. And you can also store dozens of digital music files on SD cards or a USB drive, and now even on your mobile phone. That doesn't even include the latest over-the-air music options, such as satellite and HD radio.

In this chapter, I look at all the different head unit options that are available to help you decide which is best. So whether you're a CD collector, MP3 maven, iPod aficionado or some combination thereof, you'll get the head that's right for you.

Choosing CD or DVD

The majority of car audio head units currently available are either AM/FM/CD or AM/FM/DVD receivers, with CD-based heads outnumbering DVD-based heads by a considerable margin. Which you choose will largely depend on your music collection as well as your budget because DVD receivers are a bit more expensive. But you should also look beyond the disc and consider the other media options a head unit will provide.

TIP

If you mostly listen to CDs, a CD receiver is the obvious — and least expensive — choice. But because even budget-priced CD receivers now come with the option to add external sources, such as an iPod, satellite radio, or USB drive, you don't necessarily have to be restricted to CD-based entertainment. And with CD becoming somewhat of a dinosaur format, even if you do buy a CD receiver, you'll want to give yourself other media options. (More on CD obsolescence later in this chapter.) If you anticipate that your system will be part of a larger car audio/video system, a DVD receiver is the obvious choice.

After DVD was introduced in 1997, it quickly became the most successful consumer electronics product ever, as people abandoned their clunky old VCRs for DVD players and the more robust but familiar-looking DVD. The format also kick-started the mobile video boom of the last few years because it finally created a convenient way to bring video into a vehicle.

If you do plan to make video a part of your system, you'll definitely want to consider a DVD receiver. Although it may be more expensive, a DVD player adds features not found on a CD-based head unit beyond video capabilities. It can store many more music files, such as MP3, for example. It also offers the option to play DVD music discs, which have a higher resolution (hence better sound) than standard CDs. Finally, DVDs offer multi-channel surround-sound formats that let you hear your music in a whole new way.

REMEMBER

But the main reason to go with a DVD-based head is for its video capabilities. Many DVD heads have what's known as *dual-zone* capability. This means that a DVD head unit can send a video signal to, say, screens in the rear of the vehicle and allow passengers to listen to the audio portion of a video on wireless headphones. And the DVD head can simultaneously be playing another non-disc source, such as radio or an iPod, over the speakers for front-seat occupants. In this way, the car has two *zones* of entertainment, and two sets of happy people. This works especially well for families, so that the kids can be kept entertained in the back seat while the parents listen to music up front.

Some DVD players also offer DVD-Audio playback. This high-resolution, multi-channel format (not to be confused with lower-resolution DVD music discs) offers the ultimate in sound quality and has bonus features like those found on DVD videos. Unfortunately, this format never really caught on with the public and record companies never fully supported it either.

Before PMPs like the iPod took off, it looked like DVD would dominate the audio/video world, and this has pretty much been the case in home entertainment, where CD players are about as popular as VCRs. But CD has hung on as a significant if slowly dying force in the car audio world, mainly because CD-based heads are cheaper than DVD head units. But if you can afford to go with DVD instead of CD, the extra features and flexibility are worth it.

How the iPod Changed Everything

When DVD first started to take off in the late 1990s, I spoke with an engineer in the recording industry who predicted that DVD would be the last disc-based music format for consumers. This was in the early days of MP3 and a couple of years before the iPod was introduced in 2001. Now, that person's prescient prediction has pretty much come to pass. I just hope he bought Apple stock!

No one could have predicted how Apple's iPod would change the way people store, listen to, and carry music. Although MP3-based PMPs had already been around for a few years, with its elegant yet simple design, intuitive interface, and Apple's straightforward iTunes software, the iPod became a phenomenally popular product the likes of which the consumer electronics industry has never seen.

Now we think nothing of carrying our entire music collection on a device that conveniently fits in a pocket or purse, instantly allowing access to tunes anywhere and anytime. Where normally you'd have to carry dozens of clunky, easily damaged, and space-consuming discs on a long road trip, now you can bring enough music for the journey (and then some) easily on your iPod.

Ever since the iPod hit critical mass, people have demanded a way to bring it on the road, and car audio companies and automakers were all caught behind the curve. The first aftermarket and OEM iPod solutions didn't appear until early 2003. Since then, a whole cottage industry has sprung up to provide iPod integration to vehicles, and now the iPod is only one way to bring massive amounts of music into the car.

Although CD is still the most widely available format among car audio head units, its days are undoubtedly numbered. CD sales are in a steep decline as people are abandoning the disc in droves for music formats that are more convenient and less costly.

REMEMBER

DVD is still the preferred medium for movies, but for how long? With movies now available on iTunes and through other online services and with the ability to watch them on non-disc-based players, DVD's dominance is being challenged and the format could go the way of the CD soon.

Disc-less digital music files are undoubtedly the wave of the future and CDs and DVDs will one day be regarded with the same sort of nostalgia that the vinyl LP is viewed today. But this is also a boon for the car audio enthusiast: Not having to deal with bulky discs that are easily damaged will make the mobile music experience more convenient and potentially less costly.

Music files go mobile

MP3 is the computer music-file format that let the digital genie out of the bottle by essentially freeing digital music from the disc. Instead of record companies deciding what music you could have on a CD, now people who already owned the music on CD — and some who didn't and obtained files on peer-to-peer file-sharing sites like Napster — could rip MP3 files onto their computer's hard drive and then burn them in any combination they chose onto recordable CDs. This also allowed storing hundred of songs on a single recordable CD, a technology that went hand in hand with MP3s. It took the concept of the mix tape into the digital age.

TECHNICAL STUFF

MP3, which is short for MPEG-1 Audio Layer 3, was first coined as a file extension (.mp3) for music files in the early days of the Internet and soon became the gold standard for moving music from CD to the computer. MP3 is a *lossy* compression algorithm that reduces the amount of data needed to represent an audio recording, yet still sounds like a faithful reproduction of the original uncompressed sound to most people's ears. The compression removes parts of the sound in a recording that cannot be heard by most listeners and, as a result, much less space is needed to store an equivalent-sized music file.

Space versus sound

The downside to MP3 is that there's an inherent trade-off between file size and sound quality. When creating an MP3 file (while ripping files from a CD, for example), the user can typically select a bit rate that specifies how many kilobits the file may use per second of audio. The lower the bit rate, the smaller the file size. A small file size means that more files can fit on a hard drive or disc, but the sound quality will be lower. Conversely, the higher the bit rate, the higher the quality, but the larger the file size and the fewer songs you can fit on a hard disk or CD. So the choice comes down to storing tons of tracks at lower sound quality on a CD, for example, or a lower number of tracks at a higher sound quality. A 700MB CD should hold about 150 four-minute MP3 songs ripped at the nominal rate of 128 kbps.

When converting a file to an MP3, bit rate can be varied from 32 to 320 kilobits. *CD quality* MP3s are typically converted at 128 kilobits per second, although more demanding music recordings can require encoding at 192 kilobits per second or higher. Most MP3 encoders, however, simply use one bit rate for an entire file to make the process easier and faster.

You can also create files in which the bit rate changes throughout, and these are known as variable bit rate (VBR) files. In any piece of music, some parts will be easier to compress (such as quiet passages or silence), whereas others will be more difficult (complex musical passages). The overall sound quality of the file can be increased by using a lower bit rate for the less complicated parts and a higher rate for the more demanding ones.

With some MP3 encoders, the user can specify a given quality and the encoder will vary the bit rate accordingly. This way, users can select one value when encoding their music without having to hassle with determining the correct settings for their entire music collection and selecting one rate for everything.

Doing Windows

In 1999, Microsoft introduced the WMA (Windows Media Audio) digital-file format to compete with MP3. WMA files are encoded in much the same way as MP3s, but Microsoft claims WMA has a higher sound quality than MP3 and other lossy file compression formats. (The claim has been both refuted and substantiated in numerous *double blind* listening tests.) Regardless, all you need to know is that WMA, along with MP3, is a file format supported by most car audio manufacturers. Also, keep in mind that many people use the term *MP3* generically to describe all types of digital music format.

The reason you need to know all of this is that many CD and DVD receivers in both the aftermarket and in stock systems now supports MP3 and WMA playback. This means you can potentially burn hundreds of music files onto a CD or DVD and then take it into your car.

Many MP3-capable heads also support ID3 tag info. ID3 is metadata (information about a particular file) attached to a music file. The metadata enables the radio's display to show artist and track info, for example, when a music file is playing.

The disc-less drive

It would have been difficult to imagine a car audio head unit without a disc drive only a few years ago, but now it's looking like the future. Alpine and Clarion concurrently introduced the first disc-less head units at the Consumer Electronics Show in January 2007.

Alpine was the first car audio manufacturer to add iPod integration to an aftermarket head unit, so it's not surprising that the forward-thinking company would be the first to offer a radio specifically designed to accommodate the iPod. An iPod connects to the iDA-X001 (see Figure 6-1) with a supplied USB cable for access speed equal to that of the player itself. The head unit's controls and displays mimic that of the iPod, allowing access to files by playlist, artist, album, song, genre, and more. The iDA-X001 also has a 2.2-inch high-resolution screen that makes text and menus easy to read at a glance and it also displays full-color album art. And 24-bit digital-to-analog converters and Alpine's proprietary MediaXpander processing enhance the sound of compressed-audio formats.

Figure 6-1: Alpine's iDA-X001 head unit doesn't have a disc drive and is designed specifically to work with Apple's iPod.

Courtesy of Alpine Electronics

Clarion's FB275BT head unit was another disc-less model introduced at the 2007 Consumer Electronics Show. Instead, it has a slot for an SD card behind its fold-down faceplate. ID3 tag information such as artist and song title is displayed on the FB275BT's color display.

With the CD going the way of the cassette in the car, look for more manufacturers to introduce head units without a disc mechanism. This is not only of benefit to music lovers in the MP3 era, but it also means that in-dash head units will have fewer moving parts and are therefore potentially less likely to break.

Chapter 7

Carrying All Your Tunes

In This Chapter

- Understanding the impact of the iPod
- Integrating an iPod into a car audio system
- Using other MP3 players
- Accessing music on a USB drive
- Discovering in-dash hard drives

Bringing lots of tunes on the road with a CD changer and lots of bulky discs is now *sooo* twentieth century. In the late 1990s, I installed a 100-disc CD changer in the trunk of one of my cars for a cross-country trip. At the time, it was the only way to bring a ton of tunes along. But I knew something was amiss when it took an hour or so just to load up the thing. I've since taken the mega-changer out, and now I can carry 10 times as many tunes on my iPod, which is one-tenth of the size.

MP3 players such as the iPod have irreversibly changed the way people carry music into the car. The advent of the MP3 has especially been a boon to mobile-music lovers because it's now easy to take thousands of digital tunes on the road. Although disc-based head units still dominate, most now offer some way to let users have access to their large libraries of digital music files.

Today more than ever, the way you carry your music files on the road — be it with an MP3 player like the iPod, burned onto a disc, loaded on a USB drive or SD card, or even on a hard-disk drive — will determine what sort of car audio head unit or system you choose. You can even have several different portals for access to your tunes within a single car audio system. These days, the digital-music options are only limited by your imagination and budget.

In this chapter, I explore ways in which you can bring your entire music collection on the road . . . without installing a dozen 100-disc CD changers in your ride. Because Apple's iPod dominates the MP3 player market, most of the ways to integrate an MP3 player into a car stereo are iPod-specific. But we'll also look at other MP3-friendly portals, such as USB drives and hard-disc drives.

Invasion of the iPod

Apple's iPod wasn't the first MP3 player. Others were around several years before it. And it wasn't the least expensive by a long shot. But the iPod was the MP3 player that captured millions of music lovers' hearts and minds, music collections, and pocketbooks. The iPod quickly became a status symbol as much as a phenomenally popular product, and, in the process, it changed the way people buy, listen to, and store music.

The iPod also changed the way people access music in the car. In just a period of a few years, it's made the CD changer virtually obsolete. Why bring a half dozen discs or more along for the ride when you can carry your entire music collection in your pocket? It didn't take long for the consumer-electronics industry, the car audio aftermarket in particular, and even some carmakers, to respond to the growing number of iPod owners who wanted to take their iTunes on the road.

Today, there's a billion-dollar industry based just around iPod accessories, and car accessories form a large chunk of this lucrative market. iPod integration has also become a driving force in the aftermarket car audio industry because the desire to use an iPod in the car has driven more consumers into car audio specialty shops and other car audio outlets.

Just as CD changer controls were popular features on car audio head units in the 1990s, now many heads have an auxiliary input for an iPod or even full iPod integration. Carmakers have also gotten into the act as consumer demand for pimpin' a ride with an iPod has increased.

Today, you can access an iPod from behind the wheel in a wide variety of ways:

- FM modulators that send a signal to a car's FM radio
- Aftermarket head units that have direct iPod input and controls
- Aftermarket adaptors that can add iPod integration to factory stereos
- Auxiliary (aux) jacks in aftermarket or stock stereo systems
- Aftermarket amplifiers and processors with aux inputs
- Kits available from car dealers that integrate an iPod with a factory stereo and the car's controls

FM modulators

FM modulators have been used for years to add a CD changer to a factory stereo system, or even in aftermarket systems where a direct-connection between the head unit and the changer isn't available. The concept is simple:

The audio signal from the CD changer is fed into an FM modulator, which converts it to an FM signal. The head unit's antenna lead is fed into the FM modulator and a separate antenna lead from the FM modulator — which now carries the AM and FM signals, along with that of the converted signal from the CD changer — is plugged into the head unit.

The FM modulator lets you choose an FM frequency on which to tune in the CD changer, which is usually in the 88.1 to 89.5 range. When the car's FM receiver tunes to that frequency, which is hopefully empty, it picks up the signal from the FM modulator the way it would a regular radio station.

Wireless FM modulators that don't have to be hard-wired into a vehicle are now available. Instead, the FM modulator simply sends a wireless signal to the FM tuner, and it's picked up as a radio station. Wired FM modulators provide superior sound quality, however.

TIP

FM modulators offer a quick, easy, and inexpensive way to integrate an iPod into an existing car stereo, whether stock or aftermarket. A variety of aftermarket FM modulator products are available, ranging from simple to complex. Most will also charge your iPod at the same time. But FM modulators have two major drawbacks:

- Your music will only sound as good as the best FM reception, which is way below CD quality.
- If you live in or you're passing through an urban area, it can be hard to find an empty spot on the FM dial, and even if you do, you can easily get interference from adjacent stations.

TIP

It's a good idea to look for an FM modulator what allows you to select from a variety of FM frequencies, such as Monster Cable's iCarPlay Wireless Plus, shown in Figure 7-1. That way, if one FM frequency is occupied or filled with static, you can tune to another one.

Testing, testing . . .

Here's a good test to determine the quality of the FM modulator for your iPod (or any other MP3 player). Connect the MP3 player to the FM modulator and find a blank station on the FM dial for the signal. Then pause the iPod, turn radio all the way up, turn on the car's engine, headlights, and rev the engine and listen for noise. A high-quality FM modulator is relatively quiet, whereas a low-quality one produces more noise.

Figure 7-1: Monster Cable's iCarPlay Wireless Plus sends an iPod's signal to an existing car stereo.

Courtesy of Monster Cable

Aftermarket head units

Full iPod integration in an aftermarket head unit offers much better sound quality than FM modulators because the audio signal is fed directly into the head unit. And it also allows easy access to the music on the iPod through the head unit's own controls and provides information on the head unit's display. This way, you never have to touch your iPod after you hook it up to a head unit, which is a huge safety advantage as well as a major convenience.

TIP

But not all iPod–ready head units are created equal. Most offer basic controls that allow accessing music just as you would on an iPod: by artists, albums, songs, and playlists. And the head unit displays the corresponding info visually. One of the biggest factors you should think about when considering iPod integration is access speed.

Alpine, for example, advertises its latest-generation iPod integration products as *full speed,* meaning that the rate at which you can access tunes on an iPod via one of the company's head units (see Figure 7-2) is about the same as if you were operating the iPod itself. Kenwood, Pioneer, and Clarion also offer high-speed iPod access. Plus, most head units with iPod integration also charge the device while it's connected.

Figure 7-2: Alpine's CDA-9883 offers *full speed* access to music on an iPod.

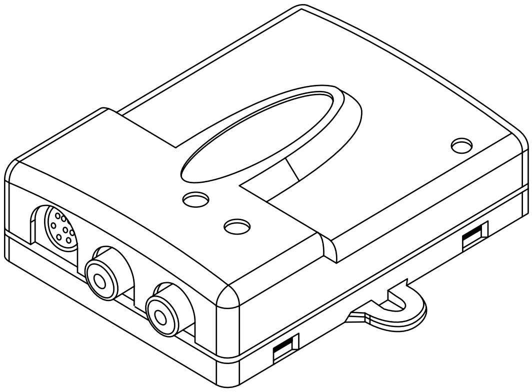
Courtesy of Alpine Electronics

Aftermarket iPod adaptors

Leave it to the car audio aftermarket to give the people what they want. These days, what people want is to use their iPods while they're on the road, no matter what car they drive or whether they have an aftermarket head unit. Some people may not be willing or even able to change out their radios because of cosmetic or cost concerns or lease restrictions. That's where innovative car audio accessory companies such as Blitzsafe, PAC, Peripheral, PIE, and Scosche have come to the rescue.

Such companies may not be household names or even have the marquee value of other large and well-known car audio brands, but they are renowned in the car audio industry for providing solutions, largely to car audio specialty dealers, that integrate aftermarket electronics into almost any kind of vehicle. In the case of iPod integration, these companies offer adaptors that tap into a vehicle's factory wiring and electronics so that the popular music player can be added without high costs or hassles.

Scosche's AXIPTA, for example (see Figure 7-3), fits many 2004 and up Toyota, Scion, and Lexus vehicles and allows control of an iPod from the stock head unit, which also displays all of the control and track info. Such adaptors are also non-invasive, meaning they can be taken out and the car can be returned to stock condition.



Courtesy of Schosche

Figure 7-3: Scosche's AXIPTA allows adding iPod control to many 2004 and up Toyota, Scion, and Lexus vehicles.

Auxiliary inputs

Auxiliary inputs designed for plugging in a separate audio source have been around a long time, and they usually pop up like mushrooms after a rain storm when a new audio format comes on the scene. They were somewhat prevalent when CDs were still rare in car audio, for example, and people wanted to a plug a portable CD player into their car's cassette-based head unit. A car audio system I put together in the late 1980s, for example, had an aux-in on the back of the head unit, into which I plugged a portable CD.

TIP

Today, many aftermarket car audio head units sport aux inputs, as do an increasing percentage of new cars. Car manufacturers have recognized this as a feature that more and more consumers want. Although most are 3.5mm *miniplug* jacks (see Figure 7-4), which fit the same connector that an iPod and other MP3 player use, a few use RCA-based aux inputs like those found on most car and home audio components (see Figure 7-5).

An aux-in jack is an easy and affordable way to jack an iPod (or any MP3 player or auxiliary audio source) into a car audio system, but you still have to fumble with the device to control it, which isn't very convenient or safe while behind the wheel. And it's not iPod-specific, which means you can plug in any outboard audio device.

Figure 7-4: A *miniplug* 3.5mm auxiliary-input jack in a Nissan Xterra.

Figure 7-5: RCA aux-in jacks in an Infiniti M35x.

Some car audio companies that don't make head units have also gotten in on the aux-in act. They allow an iPod or other MP3 player to be added into a system's signal chain on an amplifier, equalizer, or some other component (see Figure 7-6).

Figure 7-6: Blaupunkt's GTA 480 amplifier has an aux input.

Courtesy of Blaupunkt

Car dealer kits

BMW launched the first iPod integration application among carmakers in mid-2004, with a dealer-installed option that allowed owners of certain Bimmer models to control the device via steering-wheel audio controls. Information such as artist, album, and song can be displayed on the in-dash head unit. Since that time, fourteen more auto manufacturers have begun offering iPod integration kits. (You can see a complete and updated list at `www.apple.com/ipod/carintegration.html`.) The obvious advantage of this approach to iPod integration is that you can keep a factory look.

Sync and the future

As the iPod becomes more entrenched and widespread and other portable players come on the scene to challenge its dominance, look for more car-integration solutions to appear. Ford recently unveiled its Sync system, for example, which was developed in conjunction with Microsoft. It allows complete control of a portable music player via voice commands and steering-wheel switches, as well as cool features such as a “play similar” command that will automatically cull a playlist based on your music preferences.

USB in the Dash

An MP3 player syncs to Ford’s Sync via a USB port, which has become as common as clover on all sorts of electronic products. Originally found on computers, USB (which stands for Universal Serial Bus) has quickly migrated to all sorts of electronics products as a quick way to transfer information. Now car audio systems, both aftermarket and stock, are beginning to sport USB ports.

Another way in for the iPod

One of the primary applications for USB drives in cars has been as a way to integrate an iPod. Because it’s also the way an iPod syncs to your computer, a USB connection provides the best possible sound quality as well as slightly faster access to music on an iPod. Consequently, most of the major car audio manufacturers that offer iPod integration use a USB connection to dock an iPod and transfer information to and from the device.

Thumb drives

Car audio head units have also begun to sprout USB drives on their front panels (see Figure 7-7). This allows easy and quick access to digital music files loaded on a USB *thumb* drive, a small flash-memory device that is about the size of a person’s thumb. Depending on the capacity of the USB drive (which is measured in megabytes or gigabytes, with higher being better), it’s possible to store dozens of songs on a drive small enough to fit in your pocket.

Figure 7-7: A Kenwood head unit with a USB port and a thumb drive attached.

Courtesy of Kenwood

In the Cards: SD and MMC

Yet another way to carry MP3 files on the road is with Secure Digital (SD) and MultiMediaCards (MMC). You're probably familiar with these if you own a digital camera because many use the removable cards to store pictures. As with USB drives, the larger the capacity of the SD or MMC cards, the more tunes you can store on it, and the more expensive the card is. And because they are even smaller than USB drives, SD and MMC cards are a convenient way to carry dozens of MP3s on the road.

SD and MMC cards actually predate the presence of USB drives in the car audio world by several years, and SD cards have proven to be the dominant format. A few manufacturers — including Clarion, Dual, and Jensen — now offer SD card slots on their head units, typically behind a fold-down faceplate. And Audi, Mercedes, and Honda offer SD card slots in the dash on the OEM side.

Hard Disc Drives: Burn, Baby, Burn

Higher-capacity iPods and similar MP3 players are simply data storage devices with functions that allow you to access your tunes, whereas USB drives and SD cards are simply flash drives for temporarily storing your music files. But chances are you also store all of your tunes on your computer's hard drive and transfer it over to a hard-disc MP3 player or flash-memory device.

So why not install a hard-disc drive (HDD) into your car and just dump all of your tunes on it? Well, several car audio manufacturers had the same idea a few years ago, about the time the whole iPod craze kicked in. But by that time, most people didn't want to go through the hassle of downloading their music to a hard drive in the car, which involved the tedious task of ripping songs from CDs one disc at a time, when they could have all the music on their iPod or other MP3 player. Subsequently, HDD head units never really caught on. There are still some around (like the Alpine HDA-5460 shown in Figure 7-8), and you can probably get a killer deal on one.

Some high-end head units these days use an HDD for the mapping database and operating system for GPS navigation because it offers fast access time. Pioneer and Eclipse (see Figure 7-9) also offer nav-based head units with an HDD, with part of the disc space used for storing music.

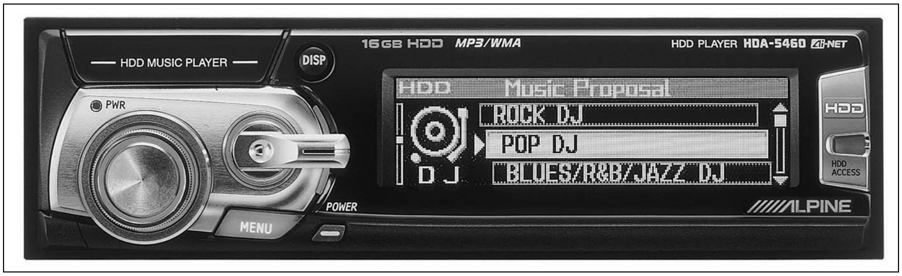


Figure 7-8: Alpine's HAD-5460 contains a hard-disc drive for storing music files.

Courtesy of Alpine Electronics

Figure 7-9: The Eclipse AVN5495 has a hard-disc drive that's used for navigation as well as storing music files.

Courtesy of Eclipse Electronics

The HDD has also found a home in some stock car audio systems. Cars from Cadillac, Chrysler, Dodge, Infiniti, and Lexus offer in-dash HDDs for storing hundreds of digital music files.

Chapter 8

The Golden Age of Wireless

In This Chapter

- Beaming into satellite radio
- The second coming of terrestrial radio
- Getting HD Radio in your ride
- Getting to know Bluetooth technology

The very first entertainment technology to hit the road was radio — and for years it was the only one. AM and later FM provided music, news, weather, and other info to enhance cruising around town and to break the boredom of a long road trip. After other formats began to allow drivers to listen to what they wanted instead of what the DJ wanted to play, radio lost some of its supremacy as king of the road.

But in the last few years, modern technology has breathed new life into this age-old format. Satellite radio offers CD-quality sound and hundreds of commercial-free channels of music, news, sports, weather, traffic, and more. HD Radio also has CD-quality sound and *hidden* sub-frequencies that offer alternative, largely commercial-free programming. Plus, unlike satellite radio, HD radio is free.

And there's a new wireless technology increasingly creeping into cars: Bluetooth. Originally designed for hands-free mobile phone use behind the wheel, Bluetooth's Advanced Audio Distribution Profile (A2DP) promises to issue in a new era in wireless entertainment.

In this chapter, I delve into the latest in radio, including satellite and HD Radio, and how you can get it into your car. I also take a look at how Bluetooth is expanding from mobile phone to mobile music applications and what it means to the car audio enthusiast.

Music of the Spheres: Satellite Radio

The introduction of satellite radio in the early part of the twenty-first century was the most significant change to the medium since FM became popular in the 1970s. It was also the first time people were asked to pay for radio, which up until that time been free.

Analogies were made to the launch of cable TV in the 1970s, which has since proved to be wildly popular. Although satellite radio hasn't experienced the pervasive popularity of cable TV, it has changed the way people think about radio and what the medium can offer — and racked up millions of subscribers in the process. And satellite radio makes a lot of sense for the car: Besides entertainment programming and news, the service can also provide up-to-the-minute and accurate traffic information.

XM Satellite Radio (see Figure 8-1) launched in late 2001, offering 100 channels of basic programming for $9.99 per month. Sirius Satellite Radio (see Figure 8-2) entered service about six months later, with a basic subscription charge of $12.95 per month and the same number of channels. (XM now charges $12.95/month for 175 channels and Sirius the same for more than 130 channels.)

Figure 8-1: XM Satellite Radio's logo.

Courtesy of XM Satellite Radio

Figure 8-2: Sirius Satellite Radio's logo.

Courtesy of Sirius Satellite Radio

Soon after these companies were born, aftermarket car audio companies began siding with one satellite radio provider or the other to offer tuners that could receive the service. XM and Sirius also aligned with car companies as part of their marketing plans to take the service mainstream.

XM has since partnered with Acura, Buick, Cadillac, Chevrolet, Ferrari, GMC, Honda, Hummer, Hyundai, Infiniti, Isuzu, Lexus, Lotus, Nissan, Pontiac, Porsche, Saab, Saturn, Scion, Subaru, Suzuki, and Toyota. Sirius has linked with Audi, Bentley, BMW, Chrysler, Dodge, Ford, Infiniti, Jaguar, Jeep, Land Rover, Lexus, Lincoln BMW, Maybach, Mazda, Mercedes, MINI, Mitsubishi, Nissan, Scion, Subaru, Toyota, Volkswagen, and Volvo.

Both companies offer a free trial period for buyers of new cars equipped with their respective services, hoping that after these drivers have a taste of satellite radio, they'll continue with their subscriptions. According to industry sources, the *take* rate on continued subscriptions has been a little more than 50 percent.

But the car audio aftermarket is the source for adding satellite radio to an existing car or system, and there have never been more options for getting the service. Plus, more car audio companies have become non-partisan towards satellite radio and now offer ways to get either or both services using their equipment. For example, some of Alpine and Pioneer CD head units can now tune in one or both services.

Plus, when satellite radio was first introduced, a bulky tuner box and a large, unsightly antenna was needed to access the service. But today, the tuners are often built into a head unit with the addition of a tiny chip, and antennas have shrunk significantly as well. Plus, there are numerous portable options that can be easily added to a vehicle's sound system. For example, both XM and Sirius offer portable radios that you can use anywhere, just like an MP3 player (in fact, some have built-in MP3 players) in a home while docked into an entertainment system, or anywhere else while docked in boom box. These portables can be integrated into a vehicle as well.

In the latest development, the two satellite radio companies, XM and Sirius, are seeking to merge to form one company, pending government approval. Regardless of the outcome, satellite radio is yet another way that the modern car audio enthusiast can enjoy hours and hours of great music, entertainment, news, weather, sports, and traffic info behind the wheel.

What's the Frequency, Kenneth?: HD Radio

HD Radio (see Figure 8-3) probably would have come to pass even if satellite radio didn't begin to pose a threat to traditional terrestrial or land-based broadcasters. But from the beginning, HD Radio was heavily promoted as a "free" alternative to satellite radio. The mobile-music listener is the real winner in the radio wars because it all boils down to better sound and more choices for in-car listening.

Figure 8-3: The HD Radio logo.

Courtesy of HD Radio

What HD Radio is

With HD Radio, a digital signal *piggybacks* onto regular analog radio broadcasts. Because the HD Radio signal is digital, FM can potentially sound as good as a CD and AM as good as FM. Plus, there's virtually no static, drop-offs, hiss, or the other noises or reception problems associated with analog radio broadcast.

An HD Radio station can also offer *multicasting,* meaning it can broadcast separate programming on a sub-frequency of its allotted spot on the dial, which can only be picked up by an HD tuner. Most stations use the sub-frequencies to broadcast largely commercial-free programming that's much like satellite radio. For example, a country station in Portland, Oregon provides a sub-frequency that broadcasts blues programming, whereas a smooth jazz station in Miami offers classical music as its multicasting option.

Another advantage of HD Radio is that information such as artist name and song title as well as weather and traffic alerts and even stock quotes can be sent with a signal and shown on the radio's display. And HD Radio promises to provide many other features in the future, including

- Real-time traffic reports
- Surround sound
- Store-and-replay functions that allow rewinding a song or even recording an entire program to play back later
- On-demand news and information
- *Buy* buttons that allow purchasing everything from music to products advertised on a station

Where you can get it

HD Radio is available in the top 100 media markets in the U.S. and in 188 markets altogether. For a listing of the stations that carry HD programming, go to `www.hdradio.com` on the Web.

How you can get it

Alpine, Eclipse, JVC, Kenwood, Panasonic, and Sony offer aftermarket HD Radio products. Some have HD Radio built into their head units, whereas others allow you to add it to a head unit with the addition of an extra-cost tuner box. Directed Electronics' Car Connect HD Radio (see Figure 8-4) is a tuner and display/controller with an FM modulator that can be added to any vehicle. Automotive electronics supplier Visteon also offers two add-on options. So far, only BMW offers HD Radio as a factory-installed option on the OEM side, but Jaguar, Mini, and Hyundai will offer it on 2008 models.

Figure 8-4: Directed Electronics' Car Connect HD Radio tuner can be connected to any existing car radio.

Courtesy of Directed Electronics

Linking in with Bluetooth

You've probably heard the term *Bluetooth* and may even know what it means. But you probably didn't know that it was named after a medieval Scandinavian king who reportedly had a penchant for eating blueberries.

Bluetooth is the strange name (coined by the Swedish mobile phone company, Erricson, which developed the technology) for technology that uses a short-range network to wirelessly connect electronic components. It's been a huge hit in the mobile-phone market because it allows hands-free operation. You probably best know it from people you see walking around with those futuristic-looking headsets, seemingly talking to themselves. But it has expanded into everything from computer printers to photo frames that display digital pictures.

But it's in the car for hands-free mobile phone use that Bluetooth has really caught on with consumers because it's a natural for safe mobile-phone use behind the wheel. But in some states it's more of a requirement than a convenience if you want to talk while driving. At the time of this writing, Connecticut, New Jersey, Utah, Washington, and California (starting in July 2008) have all banned handheld phone use by a driver. Washington, D.C. has also outlawed drivers yakking on handheld cell phones, as have many municipalities. More are sure to follow, which bodes well for Bluetooth.

Bluetooth head units

With more mobile phones including Bluetooth these days, it's become standard equipment or an option on many new cars. It's also a popular add-on car accessory. Aftermarket Bluetooth kits that add hands-free mobile phone capability to a car range from simple plug-and-play kits that can move from vehicle to vehicle, to fully wired applications that automatically mute a car's audio system when a call comes in and plays the call over the car's speakers (see Figure 8-5).

Figure 8-5: Parrot's MK6100 Bluetooth kit will automatically answer a call and has A2DP capability.

Courtesy of Parrot

Bluetooth is also increasingly available as a feature on many car audio head units. It can either be added on via a separate adaptor or built-in. Bluetooth is now available in high- to middle-end car audio head units, but the feature will eventually trickle down to lower-priced head units (see Figure 8-6).

Figure 8-6: Parrot's RK8200 is a car audio head unit with Bluetooth built in.

Courtesy of Parrot

TIP

But Bluetooth isn't just for phones anymore. Several accessories manufacturers offer products that allow adding Bluetooth wireless capability to iPods and other MP3 players so that they can play over aftermarket and even stock car audio systems.

Bluetooth A2DP

As more Bluetooth mobile phones, PDAs, and smart phones double as music players (such as Motorola ROKR with iTunes built in), and more MP3 players begin to incorporate Bluetooth, the technology is poised to break into the music business. That's if A2DP catches on with consumers, which allows music from a compatible device to be sent wirelessly to an A2DP-compatible stereo receiver.

Wireless Bluetooth speakers for home stereos with A2DP technology have started to appear, and now car stereos are starting to cut the cord as well. The latest Bluetooth head units from Pioneer (Figure 8-7) have built-in A2DP capability, which allows for hands-free phone use as well as wireless streaming of music from an A2DP device. This could be just the beginning of a larger trend because more people are bringing phones and portable media players (PMPs) — or a combination of the two — into their vehicles, and Bluetooth is catching on like wildfire. If these trends continue, and they should, expect to see A2DP become more widespread, offering the ability to cut the cord between a car stereo and a PMP or a mobile phone/MP3 player with A2DP onboard.

Figure 8-7: Pioneer's Premier DEH-P790BT offers built in Bluetooth capability with A2DP music streaming.

Courtesy of Pioneer

Chapter 9
Moving Pictures

In This Chapter

- Choosing a DVD player
- Considering other video options
- Videogaming on the road

I remember back in the 1970s, while I was at a Little League baseball game one evening, a friend had a small black-and-white TV in his dad's car that was powered by a cigarette lighter and connected to a small antenna clipped to one of the car's windows. It also happened to be the night of the Major League Baseball All-Star game and a bunch of people stood around the car watching it on the little B&W set.

The crowd around the car grew to the point where someone suggested that the TV be turned off because the audience for the game on the screen was larger than the one for the game on the field! My friend's dad's response was to crank up the car and drive away. I still remember the bluish light from that little B&W TV in the backseat as they drove away. At the time, that was state-of-the-art in mobile video, but now it seems as quaint as eight-track tapes.

Today, you have many different options for watching movies on the road, thanks to the advent of the DVD. In this chapter, I cover all of your options for getting the show on the road. I look at the DVD-based system in every permutation and at which features are most important. I also discuss portable options and videogaming on the go.

Drivin' Movies

TIP

Today, you can not only watch almost anything you want in a vehicle — in color and with surround sound — and even have separate screens showing separate programming, with wireless headphones that allow passengers to listen to the audio without disturbing others in the vehicle.

Starting in the late 1990s, mobile video became a dominant force in the car audio aftermarket, which had a lot to do with the advent of the DVD player. Although there were videocassette players and video monitors available for cars before the introduction of the DVD, it took the ability to bring movies and other entertainment into the car on a small shiny disc to kick-start the mobile-video craze. Although mobile video is still dominated by DVD, today you can get mobile video into your vehicle in a variety of ways, including on hard drives and via satellite.

And there's a huge array of choices in video screens — everything from stand-alone monitors that you can mount anywhere to complete video console systems that include a screen, a DVD player, wireless headphones, and more. You can even get systems that allow you to add mobile video without permanently altering your vehicle. Basically, you'll find a system to fit every car and budget.

In-Dash DVD Players

When car DVD players first appeared on the scene, they were expensive, but through the miracle of consumer electronics, prices have steadily dropped in the decade since the first DVD players appeared. In fact, you can now get a budget-priced DVD-based head unit for about the price you'd pay for high-quality CD head unit. Name-brand in-dash DVD receivers can be had for as low as $200. Apart from budget, your main concern when shopping for a DVD player should be deciding which configuration will work with your particular vehicle and needs. In the next few section, I cover the options.

Double-DIN head units

Think of double-DIN units as *super-sized* head units. DIN stands for Deutsches Institute für Normung, which in English translates to "German Institute for Standardization." It's simply a worldwide standard, which in this case refers to the size of a typical in-dash radio: 2 inches high, 7 inches wide, and 7 inches deep. Double-DIN simply means that the head unit is twice the height of a single-DIN unit, 4 inches high, and is meant to fit a corresponding stock opening in the dash (see Figure 9-1).

TIP

Car makes that have double-DIN openings include Ford, GM, and Toyota. If you want a double-DIN head unit in your dash and you only have a single-DIN stock opening, you can always modify your dash to make it fit. But you could be facing a lot of expensive and time-consuming modification in the process.

The main advantage of a double-DIN DVD head unit is that it has more front-panel real estate for a large screen, as well as more area for buttons and controls. And most head units have fixed screens, whereas single-DIN audio/video head units usually have a screen that folds out of the unit via motorization, which are more prone to failure and can block air vents, controls, or other parts of a vehicle.

Double the DIN, double the functions

Some double-DIN DVD heads double as navigation systems and even have separate DVD slots for navigation and entertainment, such as the Eclipse's AVN6610, shown in the following figure. This makes it easier to switch out navigation DVDs directly from the head unit, as opposed to in the trunk or under a front seat for an outboard nav system. (This isn't much of an advantage if you have one of the latest DVD navigation systems that includes navigation mapping for the entire U.S. on a single DVD: You never have to go to the trouble of switching those discs unless you leave the United States anyway.) But the biggest advantage to having the nav system built into a DVD head unit is that it's less costly and complicated to install compared to a system that uses a separate DVD navigation drive.

Other double-DIN DVD heads, such as Eclipse's AVN5495 and Pioneer's AVIC-Z2, shown in the following figure, include navigation systems that use a hard disk drive (HDD) for storage of operating and mapping software. This provides even faster response times than DVD-based nav systems that are integrated into a head unit. And these two HDD units also use part of the hard disk space for music storage.

(continued)

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Fold-out screens

Single-DIN DVD head units don't have room for a large screen on their front panels, so many use a motorized fold-out screen. At the press of a button, the screen slides out of the head unit, as shown in Figure 9-2. Press again and it folds in.

WARNING!

Although the motorized screen saves space, they are typically more expensive than a comparable double-DIN DVD head. Plus, they are also more prone to malfunctioning due to their extra complexity. Ask friends or check Internet forums such as `www.sounddomain.com` for single-DIN DVD players with fold-out screens that are reliable and less prone to malfunctioning.

All in-dash DVD players with a built-in screen are sold with a *lock-out* circuit that prevents video from playing on the screen while the vehicle is in motion. These are usually tied to the parking brake or a navigation system. This is included as a safety precaution to prevent drivers from watching a movie when they should be watching the road.

WARNING!

Unscrupulous installers and DIYers have devised ways to circumvent such circuits, but putting lives at risk on the road so that you can watch a video just isn't worth it. Save it for the backseat or when the car is parked. Plus, it's against the law to have a video screen within view of a driver in all 50 states, with the exception of using it for navigation purposes.

Figure 9-1: Kenwood's DDX8019 is an example of a double-DIN head unit.

Courtesy of Kenwood

Figure 9-2: A 6.5-inch screen slides out of the Alpine IVA-D105 DVD head unit.

Courtesy of Alpine Electronics

Players only

Some in-dash DVD players don't have built-in screens, but can send a video signal out to a monitor or monitors elsewhere in a vehicle. Many single-DIN in-dash DVD players without a screen have what's known as *dual zone* capability, which I explain later in the chapter. And some in-dash single-DIN DVD players have small screens, such as Jensen's VM8012 (see Figure 9-3).

Figure 9-3: Jensen's VM8012 is a single-DIN head unit with a 3-inch screen.

Courtesy of Jensen

Keep in mind that DVD players can also play CDs, but not the other way around. Plus, most DVD players can also play MP3 and WMA music files, control an iPod, and receive USB input. But the main reason to buy a DVD head unit is, of course, for its video capabilities.

DVD-Audio

DVD-Audio is a high-resolution, multichannel music format that was introduced a couple of years after the DVD-Video made its debut in 1997. In the same way that DVD-Video made watching movies on videocassette effectively obsolete, DVD-Audio initially promised to do the same to CD.

But unlike its phenomenally popular predecessor, DVD-Audio never caught on with consumers and was never fully supported by the music industry. Plus, it came out just before the iPod took off, and most people were more concerned with the quantity of tunes they could bring into the car rather than their sound quality.

Although DVD-Audio is still a staple in high-end stock audio systems in some luxury cars, the format is all but dead in the aftermarket. Only Alpine and Pioneer currently offer DVD-Audio head units in the aftermarket, and they are both run more than $2,000 as of this writing.

If you can find (and afford) an aftermarket DVD-Audio head unit for your car, it'll give you the best of both worlds because you can also play DVD-Video discs (although DVD-Video players can't play DVD-Audio discs). But you'll also need a 5.1 surround-sound system with two front channels, a center channel, two rear surround channels, and a subwoofer in order to make the most of the format's multichannel capabilities.

DVD Head Unit Features

DVD head units have many features that overlap those of a CD head unit, so in the following sections I detailed features that are exclusive to DVD heads. (For more on CD head unit features, flip to the next chapter, Chapter 10.

Dual-zone capability

This is the ability to send signals to two separate entertainment *zones* within a vehicle. A dual-zone head, for example, can send a video signal from a DVD to a screen or screens in the rear of the vehicle, while the audio signal is sent to wireless infrared headphones. This allows a vehicle to have two separate entertainment zones: one in the front and one in the back. For example, while backseat passengers are watching a DVD on separate screens and listening to the DVD on headphones, the driver and front-seat passenger can be listening to FM or satellite radio though the speakers in the vehicle.

Video output

A video output is an jack on the back of a DVD head unit that allows you to hook up extra screens. The video signal is taken out of the head unit, for example, and sent to screens elsewhere in the vehicle.

Auxiliary audio/video inputs

Auxiliary inputs allow you to add an external audio or video source, such as a videogame console or portable media player. In this way, for example, those in the front seat can listen to a CD while those in the back play videogames or watch programming from a portable DVD player or a portable media player. Some newer systems even allow hooking up a video iPod.

DVD Beyond the Dash

There are many more ways to get video into your vehicle than adding a DVD head unit, although they are primarily for backseat-viewing purposes. And some of these can be much more affordable and practical than building a car video system from scratch around an in-dash DVD player.

Headrest monitors/DVD players

In the early days of car video, a headrest monitor was a custom-installed item that required hours of labor because installers had to mount screens in headrests by hand. Today, however, you can buy a headrest with a video screen and even a DVD player already imbedded in it that not only fits your vehicle, but also perfectly matches the upholstery.

All-in-one headrest systems have become a particularly popular option for people who only want to add backseat video to their vehicles and not a full-blown car audio/video system. VizuaLogic, for example, offers headrests systems (shown in Figure 9-4) that fit more than 7,000 vehicles. They also install easily, with no permanent modification to the vehicle, and they can be taken out when the vehicle is sold or the lease is up. Such systems come in one of two configurations:

- Two headrests, each with a screen, and one with a DVD player that is shared by both screens.
- Two headrests, each with its own DVD player.

Many headrest DVD video systems also come with an FM modulator so that audio from a DVD can be played over a vehicle's existing audio system, and wireless infrared headphones can be added for private listening. Some systems also allow jacking in iPod video or music or media from other MP3 and portable media players.

Overhead video consoles

An overhead video console is another popular video add-on option in the form of an all-in-one console that can be attached to the ceiling of a vehicle (see Figure 9-5). An overhead video console usually contains a screen, a DVD player, an infrared transmitter, and wireless headphones. Some even have separate screens and dual DVD players so that backseat passengers can enjoy separate movies (see Figure 9-6).

Figure 9-4: This VizuaLogic headrest DVD system fits the 2007 Ford Edge.

Courtesy of VizuaLogic

Figure 9-5: Audiovox's VDO122 is a ceiling console with a DVD player and 12.2-inch screen.

Courtesy of Audiovox

Figure 9-6: The Advent ADV285 comes with two 8.5-inch screens and two DVD players.

Courtesy of Advent

Raw monitors

You can also buy a *raw* standalone monitor (Figure 9-7) and mount it anywhere you want. Although this offers the most flexibility and a custom look, it also requires a lot of labor — either your own or a custom installer's.

As the name implies, a standalone monitor has to be tied to another component, such as a head unit, in order to play video. But the latest products from Alpine and Kenwood allow you to plug an iPod video into a standalone monitor.

TIP

There's a whole slew of stand-alone video monitors available, in all sizes and price ranges, so you'll be able to find one that works for just about any application you can dream up. But there's an equally wide range of quality — and you get what you pay for. So it's wise to stick with a reputable brand that will stand behind its products.

Portable options

WARNING!

With all of the portable video systems available, going this route can also make sense for your car video needs. But you want to make sure a portable doesn't become a UFO (unsecured flying object) in case of an accident. A variety of portables that attach to a seat or center console are available specifically for the car. These *video-in-a-bag* products can then be unattached and moved to another vehicle (Figure 9-8).

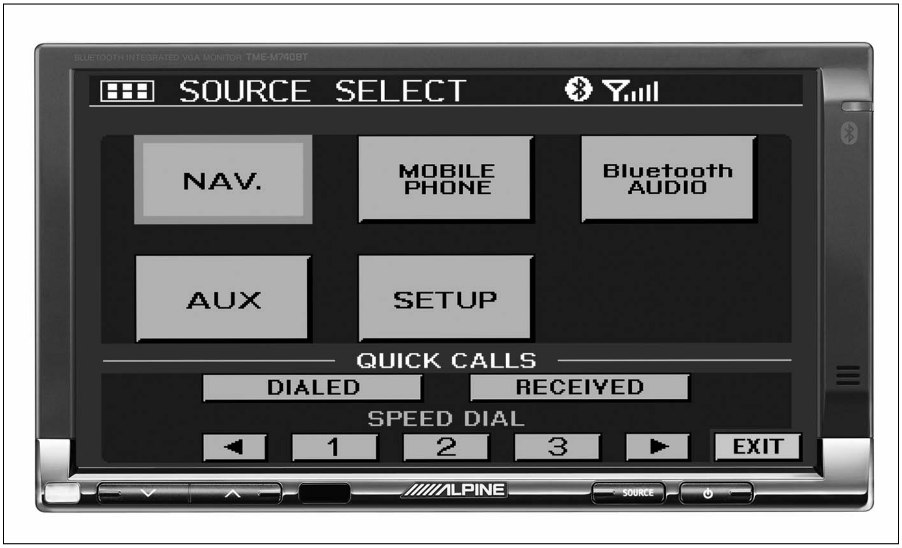


Figure 9-7: An Alpine *raw* monitor.

Courtesy of Alpine

Figure 9-8: An Audiovox video-in-a-bag product.

Courtesy of Audiovox

Other portables offer more flexibility — and more places where they can be used. Audiovox's DVD Shuttle System (Figure 9-9) consists of a series of portable players with screen sizes of 7, 8.5, or 10.2 inches that can be popped into optional dock stations for the car or home.

Directed Electronics' Portable Entertainment System (Figure 9-10) combines a portable DVD player with a docking station that mounts on the ceiling of a vehicle. The docking station also houses a slot for an optional digital-video recorder (DVR) that can store hours of video. And the same slot also accommodates a video iPod.

Videogaming on the Go

Videogames can also keep backseat occupants occupied for miles. Although there are plenty of handheld videogame solutions, they don't allow head-to-head competition. (I still haven't decided whether this is a good thing or a bad thing.) Many car audio/video systems can easily be upgraded with an A/V aux-in jack that allows you to add in a videogame console, or any other A/V source for that matter. Even some stock stereo systems have this feature, as well as a 110-volt outlet for powering a videogame console (Figure 9-11).

Figure 9-9: Audiovox's DVD Shuttle System makes it easy to move a screen and DVD player between vehicles.

Courtesy of Audiovox

Figure 9-10: Directed Electronics' Portable Entertainment System docks into a ceiling mount.

Courtesy of Directed Electronics

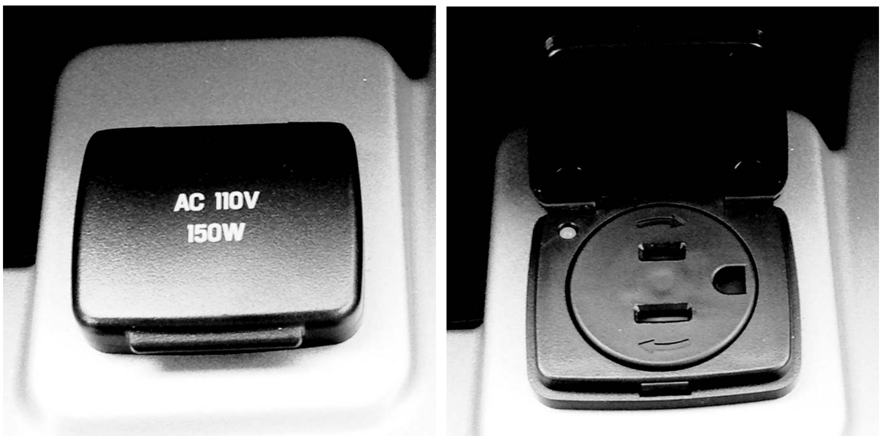


Figure 9-11: A 110-volt outlet in a Ford Escape.

It isn't that expensive to have a shop add a 110-volt inverter to your car, and handy DIYers can handle the job on their own. Finally, several aftermarket video-component suppliers have even started to package videogame systems with their product offerings as a value-added feature.

Chapter 10

Considering Head Unit Features

In This Chapter

- Understanding head unit features
- Exploring cutting edge features
- Installing a head unit
- Considering the installation accessories you'll need

Buying a head unit is likely one of the biggest purchases you make when putting together a car audio system, and not just in terms of the amount of money you spend. Unlike the other components in your car audio system, a head unit is the one you interact with most often and it's also loaded with the most features. Choosing the right head unit can make the difference between loving every minute of your car audio experience or ultimately feeling frustrated as you fumble with poorly designed controls and confusing displays.

Beyond the type of format you choose — typically either CD or DVD — your choice likely comes down to features. Almost every car audio head unit is a part of a manufacturer's broader line. The disc mechanism and other essentials are usually the same in each head unit, but the features are what separate each one by price. Head units with lots of desirable features come with a higher price tag than the more basic models. In this chapter, I cover the basic head unit features you can expect to find, as well as some not-so-basic bells and whistles you might want. I also give you the run-down on how to install a head unit.

Comparing Basic Head Unit Features

Your decision when buying a head unit all comes down to which features are important — and which ones are not. Only you can decide this: What may be an essential feature to you may be frivolous to someone else, and vice versa.

Unless otherwise stated, the features mentioned here apply to both CD and DVD head units. I'm intentionally ignoring cassette head units because they are basically obsolete in modern car audio systems.

High power

Most head units have a built-in amplifier, but don't make the mistake of thinking that most manufacturer's claims of "high power" are enough to drive a decent car audio system. Look for an RMS or *continuous power* spec, not a *peak* power spec.

RMS stands for *root mean square* and is a complicated mathematical formula for determining how much power an amplifier can deliver on a continuous basis. You don't need to know how RMS power is calculated, but you should know that RMS or continuous power is more of a *real world* measure of how much power an amplifier can produce. Peak power, on the other hand, is usually a measure of the highest amount of power an amplifier can deliver in short bursts — and if it runs in that state for very long, the amplifier or speakers its powering can be damaged. Therefore, an RMS or continuous power spec is the one that you want to pay attention to.

Usually when you see a head unit advertised as high power with, say, a 50 watts x 4 amplifier, it's a peak-power spec. The continuous power spec, if not given, will be about half of that. This may be sufficient to power, say, one or two speakers at modest volume, but it is not enough to produce quality sound or drive a subwoofer, for example. Some head unit manufacturers give both a continuous and a peak spec, but most simply list a peak so that a given head unit compares favorably with all the others that have only a peak spec.

Recently, some manufacturers have been including a CEA-2006-A specification for head unit power. This is a standard for measuring amplifier power that was developed by the Mobile Electronics division of the Consumer Electronics Association, the trade group for the consumer-electronics industry. It provides a way for consumers to compare legitimate amplifier specs between products. CEA-2006-A is a voluntary standard and so far only 21 car audio manufacturers have signed on to abide by the standard.

TIP

A high power head unit will usually have enough juice to moderately drive up to four speakers, but for a true high-power car audio system, you'll need to add a separate amplifier. Plus, a head unit's power isn't typically as *clean* as that of an outboard amplifier and it usually has more distortion. A good strategy when you're starting out (and your funds are low) is to use a head unit's built-in amp to power your front and rear speakers. Then later, when you add an amplifier, you can run the front speakers (which are more crucial to sound quality) off of the amp and use the head unit to power the rear speakers only.

REMEMBER

Unfortunately, many companies inflate their head unit's power output to appear competitive. If you see anything over, say, 35 watts, you know it's probably an exaggeration. Better yet, look for the CEA-2006-A logo, which indicates that the manufacturer is abiding by a standard for uniformly measuring amplifier specs.

Preamp outputs

A preamp output is a pretty common feature on most head units (and is the opposite of the amplified outputs described above) because most car audio amplifiers can only accept a preamp (un-amplified) or *line-level* signal. Preamp output refers to the signal before it's been amplified. Some head units also have multiple preamp outputs, up to three, which allows you to easily hook up more than one amplifier and retain front-rear fading capability when adding a subwoofer, which means you can adjust the level of sound between the front and rear speakers.

High-voltage output

Not to be confused with a head unit's high-level or amplified output, the high-voltage output refers to the preamp output of a head unit that feeds an amplifier. A high voltage output allows the amplifier to run more efficiently. Also, the higher the voltage of the preamp output, the better it can reject noise. This is especially important when you consider that the preamp signal often has to travel through the car from the head unit in the dash to amplifiers in the trunk or under a car's seats. As it travels through the car, a preamp signal can pick up noise from a variety of sources: electric motors (for power windows and seats), relays, switches, and power wiring. Most lower priced head units typically have a line-level voltage of between 500 and 1,000 mV (0.5 to 1 volt), but higher end head units have preamp voltage in the 4 to 7 volt range.

Auxiliary input

This is typically in the form of a 3.5-inch *miniplug* jack and allows easily jacking an MP3 player or any other auxiliary audio source into the head unit. Some heads have a front-panel aux-in jack, whereas others are on the back. The latest head units even have a sensitivity-level control so you can better match the signal level of the auxiliary source (using the volume on an iPod, for example) with that of the head unit for better sound quality.

iPod integration

iPod integration goes a step further than a simple aux-in jack by allowing control of Apple's ubiquitous music player directly from the head unit itself, and displaying info such as artist, album, song, and playlist on the head unit's display.

USB port

Instead of (and sometimes in addition to) an auxiliary input, some car audio head units now feature a USB input, which allows you to attach a USB thumb drive or other flash storage device for storing MP3 files. When used for iPod integration with a compatible head unit, a USB port also allows for better sound quality and slightly faster access speed than any other means of hooking up an iPod to a head unit.

MP3/WMA capability

MP3/WMA capability means that a head unit can read discs (CDs or DVDs) with MP3 or WMA music files burned on them, or can read files via a USB drive or other means. Many such head units can also decipher ID-3 tag metadata that contains artist and song title info so that it can be shown on a head unit's display.

Satellite radio control

Many head units let you easily add XM or Sirius satellite radio so that you can tune in stations via the head unit and read station information on the display.

Remote control

A *credit card remote*, so-called because it's roughly the same size as a credit card, lets you easily access features on a head unit without taking your eyes off of the road. Even better is a remote that mounts on the steering wheel.

Skip protection or memory buffer

Even when a disc skips, skip protection keeps the music flowing by storing a few seconds of music in a memory buffer.

Dual zone

The dual zone feature is found on DVD head units and allows setting up two different entertainment *zones* in a vehicle. For example, a video signal from the DVD player can be sent to screens in the rear and an audio signal can be sent to wireless headphones, while front-seat passengers listen to a different source, such as FM or satellite radio.

Auxiliary audio/video input

Also found on DVD head units, auxiliary audio/video input allows you to add an outside A/V source, such as portable DVD player or a videogame console, to the system.

Station presets

Presets allow you to store a certain number of radio stations so that you can push a button to instantly access your favorites. Most head units have several preset *banks,* typically one for AM and two or three for FM. Higher-end head units allow you to mix AM and FM presets in one bank. Many head units also have a feature that automatically loads the strongest stations in an area into a preset bank.

Seek and scan tuning

Seek tuning finds the next strongest station on the dial when you hit a button, while scan finds the next strongest station and stops at it for a predetermined length of time (usually 10 seconds or so) before moving on to the next strongest station on the dial. When you hear a station you like, you hit the scan button again to stop the process. Some head units have preset scan that only scans your preset stations.

Local/distant tuning

Local/distant tuning allows you to adjust the sensitivity of the seek or scan functions so that the tuner only looks for strong local radio stations or weaker distant ones.

Mute and Attenuation

Mute and Attenuation is a button on the head unit or the remote (or both) that lets you instantly mute the audio rather than turning the head unit off if you quickly need quiet. Attenuation is similar but turns the volume down to a certain level instead of muting the system entirely.

Loudness control

Loudness control boosts certain bass frequencies to help overcome noise in the vehicle as well as to compensate for the ear's inability to hear such frequencies at low-volume levels.

Detachable faceplate

You can remove a detachable faceplate from the head unit when you leave the car so that someone will be less inclined to steal it — and if they do, they won't be able to use it.

Subwoofer crossover and/or subwoofer-level control

This feature allows you to select different crossover settings for the subwoofer, as well as adjust the level of a subwoofer's output from the dash. A *crossover*, also sometimes called a *filter*, is a circuit that limits certain frequencies, measured in *hertz* (Hz), in an audio signal, allowing some to pass through and others to be blocked. The *crossover point* is the frequency at which the signal becomes attenuated or turned down — or in car audio parlance, *rolled off.*

For example, with a head unit that has a subwoofer crossover with an 80-Hz crossover point, the signal going to the subwoofer will start to be decreased or rolled off above 80 Hz. This means that the subwoofer will only receive the portion of the audio signal from 80 Hz and below, which means it will play only the lowest bass notes.

Some head units with subwoofer or *low-pass crossover* allow you to choose between several crossover points — such as 50, 80, and 125 Hz — so that you can adjust the sound to your liking or to suit different types of music. A higher crossover point on a subwoofer, for example, will give the bass a *boomier* sound. Some head units also let you adjust the volume level of a subwoofer. Subwoofer crossover/level control is only available when using a separate amplifier to power a subwoofer, however. A few high-end head units also have high-pass and bandpass crossovers for adjusting midrange and high frequencies.

Bass, treble, balance, and fader

Bass, treble, balance, and fader are basic controls found on all head units. The former are simple tone controls that allow you to cut or boost bass and treble frequencies. Some head units also include a midrange control. This latter allows you to adjust the level of sound from left to right (balance) and front to rear (fader).

Equalizer

An equalizer built into a head unit allows *boosting* or increasing the volume and *cutting* or decreasing the volume of certain frequencies. Some heads include graphic equalizers that let you cut or boost frequencies within a set range. Others include more sophisticated parametric equalizers that not only allow cutting and boosting certain frequencies, but also varying the frequency ranges that are affected. Some head units also have *soundfield* equalizer settings that attempt to replicate the sound of a space such as a concert hall or stadium.

CD-Text

Many CDs come with artist, album, and song info embedded on the disc, and compatible head units will display the information when the disc is played.

Repeat and random or shuffle play

Repeat, as the name implies, allows you to repeat a disc or track, whereas shuffle lets you mix up the order of the tracks on a disc.

CD-changer controls

CD-changer control used to be an essential feature, but in the age of the iPod, CD changers are about as desirable as car phones. But many head units still have this feature and it usually doesn't cost extra.

Multicolor and multifunction displays

You need to be able to quickly and clearly see information on a head unit while driving down the road, and manufacturers have done an amazing job of making bright and easy-to-read displays. But you'll have to decide if you really need a display with 700 different colors or one that shows animated dolphins jumping out of the water. Some even allow you to upload a digital picture that can serve as a screensaver or wallpaper on the head unit's display.

Clock

The clock, well, lets you know what time it is. (But I'm guessing you knew that already, right?)

Seeking Out Cutting-Edge Features

The latest and greatest features are the ones that you will have to spend extra money on, so you need to decide if they're worth the dough. Usually such features start to trickle down to less expensive head units as the years go by, until they eventually become standard across a manufacturer's line.

Bluetooth

Bluetooth technology allows you to use a mobile phone hands-free. A compatible phone syncs with the head unit, and when a call comes in, it's automatically answered and the audio system is muted. The caller's voice is broadcast over the car's speakers and your voice is picked up by a small microphone inconspicuously installed in the vehicle. When the call is over, the audio system resumes. Bluetooth's Advance Audio Distribution Profile (A2DP), found in the newest head units, also allows streaming music from compatible mobile phones, PDAs, and MP3 players. See Chapter 8 for more on Bluetooth.

HD Radio

HD Radio offers digital-quality sound and multicasting, meaning that stations can broadcast alternative and largely commercial-free programming on sub-frequencies. You'll need an optional tuner to receive it. To find out more about HD Radio, check out Chapter 8.

SD Card slot

Some radios allow access to tunes via an SD Card, which, depending on their size, can hold as many as hundreds of MP3 music files.

Inspecting the Specs

TIP

When shopping for a head unit, you should also look at certain specs, if they're listed, to compare performance among the various products you're interested in. Although car audio manufacturers are not required to publish specifications and they can even *massage* specs to make them look perhaps better than they really are, just the fact that a manufacturer goes to the trouble to provide some of the more esoteric specs says something about their reputation — and the worthiness of the specs.

Below are some of the most important head unit specs to scope out. Although not all head unit manufacturers list all of the specs listed here, look for the ones that are most important to you. For example, if radio reception is a paramount concern, zero in on a head unit's tuner specs.

- **Amplifier power rating** is the amount of power a head unit's amplifier is able to produce, such as 16 watts x 4. But it should be accompanied by impedance, supply power, and distortion specs, such as 16 watts x 4, into 4 ohms (impedance) @ 14.4 volts (supply power) with 1% total harmonic distortion (THD).
- **Signal to noise ratio** refers to the strength of a head unit's output signal relative to the level of noise present and is measured in decibels (dB). A higher number is better.
- **Total Harmonic Distortion (THD)** refers to the amount of distortion in the audio signal generated by a head unit. The lower the number, the better.
- **Dynamic range** refers to the ratio of maximum to minimum loudness in an audio signal. The higher the number, the better.
- **Frequency response** refers to the frequency range a head unit is able to reproduce, such as 5 to 20,000 Hz, +/- 1 dB. In this example, the head unit can reproduce frequencies between 5 and 20,000 Hz, with a tolerance, or margin of error, of plus or minus 1 dB. The wider the frequency range is, the better, and the narrower the tolerance, the better.
- **Channel separation** refers to an AM/FM tuner's ability to eliminate *crosstalk* or leakage between radio stations that are in close proximity on the dial. Crosstalk refers to a station on one frequency *leaking* into the frequency that another station occupies. The higher the number, the better.
- **Capture ratio** refers to the ability of an AM/FM tuner to distinguish between a stronger station and a weaker station occupying the same frequency. The higher the number, the better.
- **Alternate channel selectivity** is a measurement of a tuner's ability to reject an interfering signal. The higher the number, the better.

Installing Your Head Unit

Installing a head unit in a dash isn't what it used to be. Back in the day, swapping a stock head unit for an aftermarket one was pretty straightforward. But both cars and head units have gotten far more sophisticated in the last decade or so. And while the basics of installing a head unit haven't drastically changed, there are many more things involved these days.

Modern cars can be very complex. Many have safety features such as ABS brakes and advanced airbags that were uncommon just a few years ago, and even some economy cars now include sophisticated onboard computers and electronics. Plus, factory head units are often tied into other systems in a vehicle, such as climate controls, navigation, and onboard diagnostics. One false move with a pair of wire cutters or a screwdriver, and you could be looking at thousands of dollars in damage. Head units are far more sophisticated as well. Although a simple CD radio is pretty straightforward to install, Bluetooth head units and multimedia DVD head units with navigation and a video monitor require additional wiring. One false move and you could fry your new head unit.

Most stock radios are a standard shape, either DIN (2 inches high x 7 inches wide) or double DIN (4 inches high x 7 inches wide) and some instances DIN-and-a-half sized (3 inches high x 7 inches wide). If you have an odd-shaped radio, however, such as those in some Nissan and Infiniti vehicles, you should seriously consider having a professional install your head unit.

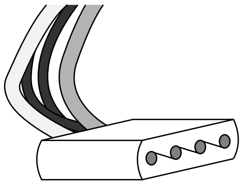
If you've thought about it and still feel confident proceeding with a do-it-yourself job, there are some rather basics steps required in any head unit installation. First, it's always a good idea to disconnect the battery when working on any electrical components in a vehicle. Simply disconnect the ground lead from the battery. If you have an aftermarket alarm system, sometimes you'll need to reset the alarm when the battery is reconnected. On some higher-end cars, the dealer may need to reset the computer when power is restored.

Removing the stock radio

Before you begin an installation, the stock head unit must first be removed. To do this, you may have to remove the trim around the radio. Carefully pull or pry off the trim. Most stock radios are secured with three or four bolts, and some European cars require a special "key" to remove the radio, which you can purchase from the dealer or online. After detaching the radio, slide it out through the front of the radio opening.

A factory radio is usually connected to the factory wiring with a plug called a *Molex connector,* shown in Figure 10-1. Disconnect this plug and the stock head unit should be home free. If you plan on keeping your factory radio, remember that some require a code to work properly when you plug it back in. Make sure you have it or ask your dealer for it before you remove the stock radio.

Figure 10-1: A Molex connector.



After unplugging your radio, you may want to reconnect the battery and start the engine just to make sure everything is working properly and to check whether you've lost any of your vehicle's functions before proceeding. For example, removing a radio on some Hondas can disable the keyless entry function, and on some GM cars, you can lose OnStar services. If you do lose a factory feature, many aftermarket accessories companies make an adaptor that can tie the function into the car's electrical system. Check with a local car audio specialty retailer about it.

Wiring the new head unit

After you remove the old unit, you'll need to wire your new head unit into the car. Avoid cutting the factory wiring at all costs! Instead, purchase a wiring harness specifically made for your vehicle that plugs into the factory Molex connector on one end and connects to wires of the aftermarket head unit on the other.

You can purchase a wiring harness from a specialty car audio retailer, an electronics store such as Fry's, or order one online from a site such as `www.installer.com`. Both brick-and-mortar retailers and online stores, such as Crutchfield, sometimes include the wiring harness with the head unit. A wiring harness typically comes with a wiring diagram that's specific to the car so that you know which wires to connect, such as power, ground, ignition, illumination, and antenna and speaker leads.

Make sure that when you buy a wiring harness you get one specifically made for not only your vehicle, but also for the *type* of system in your vehicle. For example, wiring harnesses are different for vehicles that have, say, navigation or satellite radio from the factory.

Match the wires of the head unit and those on the harness exactly as indicated by the instructions that come with the harness. Sometimes the colors on the harness or on the radio won't match up perfectly, so always go with the instructions provided with the harness if there's a discrepancy. Also, pay close attention to matching the positive and negative wires.

As you match the wires of the harness to those of the aftermarket radio, keep in mind that the radio may have more wires than you need. For example, the new radio could have a wire that ties into the factory wiring that dims the lights in the dash, but the factory radio may not have that feature, so there won't be a wire for it. There's also a 50 percent chance you'll need an antenna adapter to mate the new head unit's antenna lead to the vehicle's antenna wire. An antenna adapter can also be obtained from a specialty retailer, electronics store, or ordered online.

You'll want to connect the wiring from the factory radio to the wiring harness outside of the car so you have plenty of room to work. Crimp or solder the connections between the two for a solid connection. Never use wire nuts, T-Taps, or electrical tape. Crimping requires a crimping tool that you can get at any hardware store. Crimp connectors can also be obtained at any electronics or hardware store.

After you've matched up all the wires, it's just a matter of plugging the wiring harness into the factory plug for the radio and sliding the radio into the slot in the dash. When you put the radio in, make sure the wires are not pinched and move them out of the way. In fact, if there is excess wiring, it'll be difficult to slide the radio into the dash. If the wires of the new head unit are too long, you'll want to trim them using wire cutters before connecting them to the wiring harness.

Kits and fits

Besides a wiring harness, you may also want to get a radio kit that's made specifically for your vehicle to help hold the head unit snug in the dash as well as fill in any gaps between the dash and the head unit. A dash kit (see Figure 10-2) comes with instructions on how to mount the radio in the kit and the kit in the dash. Even with a kit, you sometimes have to be creative and trim parts of it off with a file to ensure a good fit.

If you can't find a kit for your car, you'll have to get creative. You can build a support out of wood, for example, to secure the head unit to the dash. This isn't usually a problem, though: Ninety percent of the time, you'll be able to find a kit.

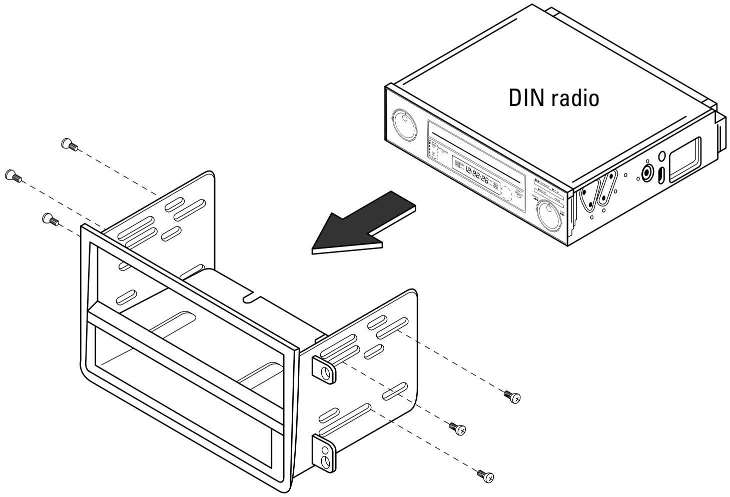


Figure 10-2: An installation kit for a DIN-size head unit.

Chapter 11

Pumping Up the Volume

In This Chapter

- Powering up your system with amplifiers
- Increasing sound quality through higher power
- Understanding amplifier ratings and specs
- Demystifying amplifier classes

Power has an addictive quality. Whether in politics or car audio, the more power people get, the more they usually want. Just as power in politics helps you get what you want, power in a car audio system helps you get the sound you want. And in both scenarios, you'll never be satisfied, and you'll always crave more.

In this chapter, I discuss the benefits of adding more power via an amplifier beyond just making your music sound louder. I also help you make sense of all the confusing amplifier specifications and the different *classes* of amps.

Powering Up with an Amplifier

An audio signal generated by a head unit doesn't have enough power to drive car speakers. The signal has to be amplified before it can move a speaker's voice coil and subsequently the speaker's cone, and the larger the cone, the more power is needed to move it. That's why tweeters require very little power and subwoofers require a lot.

Amplifiers take the low-level audio signal generated by a head unit and run it through circuitry that turns it into a high-level or amplified signal. Although most car audio head units have built-in amplifier sections that use integrated-circuit (IC) technology to produce power, they are limited by the current supplied by the car's charging system, about 14 volts, and can only supply at most, about 200 watts max, although the true RMS or continuous power it puts out is much less than that. (RMS stands for *root mean square* and is a mathematical formula for determining how much power an amplifier can deliver on a continuous basis.)

Separate or outboard amplifiers are, of course, also limited to the current supplied by the car's charging system. But they have dedicated switching power supplies that are too large to fit inside a head unit and generate too much heat to be installed in a vehicle's dash. A switching power supply significantly boosts the voltage available from the car's charging system to provide higher power to the speakers.

Using the amplifier built into a head unit may be fine for smaller systems, and you can even use it to power smaller speakers in large systems that also include outboard amplifiers. But without a separate amplifier, your system will never achieve significant volume levels and high performance.

The power from a head unit's built-in amplifier isn't as clean as that of a high-quality outboard amplifier and typically has higher distortion, particularly at high volume levels. This means that your music won't sound as good with only head-unit power as opposed to using a separate amp. Therefore, separate power amplifiers not only pump up the volume, but also improve the quality of the sound.

The ample power provided by a separate amplifier can improve the sound of the system by

- **Decreasing distortion:** When an amplifier is pushed past its design limits, it begins to clip the audio signal. All sound is made up of waves, so think of a sound as a wave with a point on the top. When an amplifier reaches its limits, it *clips* the top part of the sound wave (in the form of an electrical signal), in essence cutting off parts that it can't accurately reproduce. This in turn creates distortion (the original sound wave is now distorted), which is reproduced by the speakers. A head unit's built in amplifier begins to clip much sooner than a separate, high-quality amplifier, and therefore causes distortion.
- **Improving dynamic range:** A good system reproduces the loud and quiet passages of music with the same level of detail. Although an under-powered system may perform satisfactorily with the more subtle parts of a musical passage, it will have a hard time reproducing the louder parts. A system with adequate amplification, on the other hand, can handle both extremes with equal detail. This is also sometimes referred to as *dynamic headroom*, which more specifically describes the ability of an amplifier to provide high levels of power in short bursts to accommodate peaks in music. Otherwise, an under-powered system runs out of gas when such peaks occur.

Knowing How Much Power Is Enough

So you know you need power, and you don't plan to go into politics. When shopping for an amplifier, the question becomes, "How much power is enough?" This is a question only you can answer. In this section, I take a look at some parameters that will help you decide how much power is right for you and your system.

You'll need at least enough power to capably drive all of the speakers in your system. Speakers come with power ratings, usually given as *maximum* (sometimes called peak power), which is the most power a speaker can safely handle, and *nominal*, which is how much a speaker can continuously handle. A good rule of thumb is to add up the amount of nominal power all of the speakers in your system will need and add 10 percent to arrive at how much power you will need. This is for listening to music at an average volume, however. If you will be cranking it way up, you'll need more.

Sensitivity training

One factor to consider when deciding how much amplifier power you need is the sensitivity of your speakers. A speaker's sensitivity specification tells how much power it needs to achieve a certain volume level, and serves as an indication of how loud the speaker will play when provided a certain amount power. Speakers with a higher sensitivity rating (also sometimes called an efficiency rating) need less power to play loud, and those with lower sensitivity need more. So when shopping for an amplifier, it's good to know the sensitivity rating of the speakers in your system so that you have an idea of how much power you'll need to achieve the volume level you desire.

Manufacturers obtain the sensitivity spec by supplying a speaker with 1 watt of power and measuring the output in decibels (dB), with a microphone 1 meter away. Hence, a sensitivity spec usually looks like this:

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91 dB (1watt/one meter)
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This means that the speaker puts out 91 dB of sound-pressure level (SPL) measured 1 meter away when fed a 1-watt signal.

In addition to matching the amplifiers to your speakers, you'll also need to match the amplifier to your car's charging system. One way to do this is to add up the current draw of all of your amplifiers, and then find out how much current your alternator provides. You can sometimes find this info in your car owner's manual or on the alternator itself. If your amplifiers draw more current than your alternator can produce, you need to back down on the amount of amplifier power you add to your car or beef up your charging system, which is expensive.

Keep in mind that your car's alternator is designed to supply all of the car's electrical components with enough power, plus have some in reserve. Adding a low-powered amplifier or two and listening at moderate to high volumes will not have an adverse effect on the car's charging system. But adding multiple mega-watt amps and constantly blasting bass will. Keep this in mind when figuring out how much amplifier power you'll add to your car's audio system.

As mentioned earlier, music is dynamic, with loud and soft parts. Therefore, your amplifiers won't be continuously drawing their peak-current demands. During loud passages, such as when a bass note hits or during a high-pitched rock guitar solo, amplifiers send more power to speakers. At these times, an amplifier puts out peak power — and your car's electrical system is maxed out.

Vehicle noise

Another factor that has a bearing on how much amplifier power you need is how noisy your vehicle is. If you drive a quiet luxury car like a Lexus or Cadillac, you may not need as much power as someone who drives a Jeep, pickup, convertible, or sports car.

How loud you like to play music is another consideration. If you listen to, say, smooth jazz at moderate volume levels, you can get by with less power than if you listen exclusively to rap and rock. If you're building a car audio system to get as loud as possible or even enter SPL (sound pressure level) competitions, you'll need much more amplifier power as well.

The diminishing returns of increased power

Acoustical power is measured on a logarithmic scale. This means that you don't get twice as much sound pressure when you add twice as much power. In fact, doubling the power gives you much less than double the sound pressure. All things being equal in a given audio system, a doubling of amplifier power represents approximately a 3 dB increase in volume. To put this in perspective, say that with 250 watts, your system will play at 100 dB of SPL. With 500 watts, it will play at 103 dB. Doubling the power from 500 to 1,000 watts only increases SPL output to 106 dB. As you can see, you can quickly reach a point of diminishing returns on money invested in power amplifiers. And, as in politics, power doesn't come cheap.

A substantial increase in power not only drains your wallet, but also your car's electrical system. As you increase amplifier power in your system, you increase the load on your car's electrical system, which was never designed to handle a bunch of car audio amplifiers in the first place. Some people with mega-watt systems resort to adding extra batteries and high-output alternators, although that's only for the most extreme systems. High-watt systems also need larger cabling and more fusing, which increases the system's cost and complexity.

For most people, a well-designed system with around 400 to 800 watts will be sufficient to create good, clean sound. Power will be split between the subwoofers and the rest of the speakers, with the lion's share going to power-hungry subwoofers and much less going to the midranges and tweeters. In a system that includes, say, 600 watts of amplification powering four midranges and tweeters and a single 12-inch subwoofer, you may have 150 watts (300 total) going to the two pairs of midranges and tweeters and the remaining 300 watts powering the subwoofer.

Power per channel

All amplifiers are measured in watts per channel. A *watt* is a means by which electrical power is measured, and amplifiers are rated by the number of watts they can deliver per channel. (Think of a channel as left and right speakers when listening to a stereo recording.) A two-channel or stereo amplifier with a rating of 50 watts per channel provides 50 watts into each of the right and left channels. This spec is often represented as 50 watts × 2.

Making Sense of Specs

When shopping for amplifiers, power per channel is just one specification or *spec* you'll want to scope out, if not the most important one. There are more specs you'll need to inspect.

A spec of 50 watts × 2 doesn't tell you much unless it includes the impedance at which it was measured. Impedance in this case is that of a speaker, and speakers are rated with different impedances. In car audio, however, most speakers are rated at 4 ohms, although subwoofers can be rated at anywhere from 8 to 2 ohms. For our purposes, and to avoid getting too technical, just think of impedance as opposition to the flow of current from an amplifier, or the speaker *pushing* against the current being delivered to it by the amplifier. All things being equal, the lower the impedance, the higher the current flow, meaning the less the current is being pushed back towards the amp. The higher the impedance, the lower the current flow.

The reason impedance is important is that most car audio amplifiers output more power into lower-impedance loads. Theoretically, an amp's power output doubles with each halving of impedance, although this isn't always the case due to inefficiencies of amplifiers. Because an amplifier has to work harder with a lower impedance — and is being pushed harder — some of the power is dissipated as heat.

An amplifier's power output spec will typically look like this:

```
50 watts x 2 into 4 ohms and 100 watts x 2 into 2 ohms
```

You may be wondering why everyone doesn't just use low-impedance speakers to get more power out of amplifiers. A lower impedance increases distortion, which isn't always a bad thing with subwoofers, but is always bad for midranges and tweeters. Subwoofers, which produce low bass, do a better job of masking or covering up distortion, and their larger voice coils — the mechanical *engine* of the speakers — can handle more power and distortion. But with mids and tweets, distortion not only degrades sound quality but can also harm the speakers. It's always important to match the impedance of the speaker with that of the amplifier. Otherwise, you could end up damaging the amplifier and the speaker.

Bridging to mono

Another power spec you'll often see is *bridged power*. *Bridging* an amplifier means combining two stereo channels to create a more powerful single mono channel, usually for powering a subwoofer. Sometimes bridging is accomplished by flipping a switch on an amplifier or, more commonly, by the way the subwoofers are wired to the amp. (The owner's manual for most amplifiers will specify how to wire the amp in mono.) Regardless, an amplifier will typically more than double its power in bridged mono mode.

So the specs for the same amp above when bridged would look like this:

```
200 watts x 1 into 4 ohms
```

And if the same amplifier can run in a 2-ohm bridged *load,* it would produce even more power. But running an amp at a lower load than intended can cause damage to the amplifier and the speakers it is powering.

High-current amps

Some amplifiers are specially designed to run at low-impedance loads so that they can squeeze more power out of the limited amount of current that a car's electrical system provides. Called *high current* amplifiers, they produce their maximum output power into 2-, 1- or even 0.5-ohm loads. A high current mono subwoofer amp may have a power spec that looks like this:

```
300 watts x 1 into 4 ohms
500 watts x 1 into 2 ohms
800 watts x 1 into 1 ohm
```

About now you're probably wondering, "So why don't I just buy a high-current amplifier so that I can get as much power as possible?" Well, for one thing, high-current amps are usually more expensive than standard amps, and they draw much more current than most cars' alternators are designed to provide. Adding several to a car audio system could necessitate an upgrade to a car's electrical system, which is as dicey as it is pricey.

High-current amps are also not as *musical* as other amps. They may be fine for bass-heavy music, but if you use a high-current amplifier to, say, pump up the volume of your favorite chamber music, the sound quality will likely suffer. That's because high-current amplifiers are primarily intended for brute-force power, usually to drive subwoofers.

In fact, high-current amps were originally designed for crank-it-up competitors looking for an edge in the competition. Car audio competitions are divided up into power classes, such as 0-150 watts, 151-300 watts, and so forth. In the early days of car audio competition, it was all about who had the loudest system, and in SPL (sound-pressure level) competitions, it still is. So a high-current *cheater* amp would allow a competitor to gain an advantage — that is, until everyone else in the class also started using high-current amplifiers.

Unless you plan to compete or just want the loudest system possible, a high-current amp may not be worth the extra cost and hassle. And if you do decide to go high-current, be prepared to make changes to your car's charging system — or at least be ready to experience your headlights dimming every time a deep-bass note hits.

More amp specs

Two more amplifier specs that are important to pay attention to are power-supply voltage and total harmonic distortion. *Power-supply voltage* is the amount of current that is used to generate the spec. Many manufacturers use a standard 14.4 volts, which is supposed to represent the typical voltage provided by a car's electrical system, although real-world voltage is usually around 13.5 to 14 volts. Nevertheless, it's important when comparing amplifiers to know the power-supply voltage that was used to obtain the spec.

All amplifiers generate distortion, some more than others. *Total harmonic distortion* (THD) is a measure of how much distortion an amplifier produces at a given rated output. THD of 1% or less is considered to be high fidelity, and a lower spec is always better.

Look for the CEA logo

If an amp doesn't have a total harmonic distortion (THD) spec — or even a power supply voltage — you should be suspicious. It's not uncommon for some manufacturers to greatly exaggerate the power output of their amplifiers. For example, if you're shopping and you see an amp with "1000 WATTS MAX POWER" printed on its case, you should be suspicious — as you should be with any marketing claims. As with many other product categories, marketing plays a crucial role in selling car audio products, and marketers have figured out that bigger always looks better to a consumer. That's not to say the amp won't produce 1,000 watts . . . with 16 volts of input power, at 10% THD, and with a stiff tailwind behind the vehicle. If you find a so-called 1000 watt amp that costs $100, you can be pretty sure it's not the one you need to power your 15-inch subwoofers.

Such claims are the reason the Mobile Electronics division (which is made up of car audio manufacturers) of the Consumer Electronics Association (the trade group for the consumer-electronics industry) got together and came up with the CEA-2006-A standard (which provides a way for consumers to know that an amp's specs are legit). CEA-2006-A is a voluntary standard that provides a uniform method for determining an amplifier's power. The standard requires using a power-supply of 14.4 volts into a 4-ohm impedance and achieving THD of 1 percent or less. So far, 21 car audio manufacturers have signed on to abide by the standard and many use it (and the CEA-2006-A logo) in their marketing efforts. Look for the following CEA logo to be sure the product you're buying meets their standards.

The Consumer Electronics Association (CEA) is the preeminent trade association promoting growth within the $148 billion U.S. consumer electronics industry and boasting more than 2,200 member companies. CEA efforts include legislative advocacy for consumers and member companies, market research, technical training and education, industry promotion, and the fostering of business and strategic relationships. CEA also sponsors and manages the International Consumer Electronics Show (CES), where entertainment, technology, and business converge. Find the CEA online at `www.CE.org`.

Power output and THD are two of the most important specs to consider when shopping for an amplifier, but there are others:

- **Damping factor** refers to the ability of an amplifier to control unwanted movement of a speaker. A higher damping factor indicates greater control and less unwanted movement (that is, distortion from the speaker). An amplifier's damping factor will also decrease as the speaker's impedance decreases.
- **Signal-to-noise ratio** compares the strength of the signal to the level of potential background noise in the signal and is measured in decibels (dB). A higher number is better.

- **Frequency response** is the measure of an amplifier's ability to reproduce sound across the audible audio spectrum, and is often given with a tolerance. For example, a frequency response spec of 20 to 20kHz +/- 1 dB means that the amp can reproduce frequencies from 20 Hz to 20,000 Hz without deviating (lowering or increasing output) more than 1 dB within that range.
- **Input sensitivity** refers to the range of input-signal strength that an amplifier can accept. In order to get the most performance from an amp, it should be able to accept as high an input signal as possible, which is why a head unit with a high output voltage is desirable. The greater the range of input sensitivity to match the varying ranges of head units, the better. A spec of 0.5 to 4.0 volts for example means that an amp can accept from 1/2 volt up to 4 volts of input voltage.

Class warfare

No discussion of car audio amplifiers would be complete without covering amplifier classes. There's a lot of misconceptions over the various amplifier classes available in car audio and their advantages and disadvantages.

The differences in amplifier classes mainly has to do with their efficiency: how well they take input power (from the car's electrical system) and turn it into output power (for the car's speakers). But amplifier classes also relate to sound quality. Some amplifiers are more efficient at turning input power into output power without wasting some in the form of heat dissipation, but have lower perceived sound quality. Others are less efficient but offer better sound quality.

An amp's circuitry design determines which class it falls into, and each class has its advantages and disadvantages:

- **Class A** amplifiers are considered best for sound quality, but are highly inefficient. Pure Class A car amplifiers are rare, and even amps advertised as Class A are typically Class A/B amps.
- **Class A/B** amplifiers are the most common, are more efficient, and run cooler than a pure Class A amp, yet still provide relatively low distortion (hence good sound quality).
- **Class D** amplifiers draw less current from a car's electrical system than Class A and A/B designs and are very efficient and run cooler, making them ideal for car audio applications. But they also produce higher distortion. Because this distortion occurs at high frequencies, it can be removed by a low-pass or subwoofer filter, which is why you'll find many Class D mono or *subwoofer* amps. But Class D technology has improved significantly on full-range amplifiers used to power midranges, tweeters, and subwoofers, so you can expect to see more Class D amps in the future.

- **Class T** amps are rare but offer the sound quality advantages of Class A/B designs along with the efficiency of Class D designs.

There are a few other exotic classes of amplifiers, but Class A/B and Class D are the technologies you'll run across most often when shopping for amplifiers.

While your head is spinning from trying to absorb all of this information, keep in mind that most car audio amplifiers from reputable manufacturers will provide good power for years to come. So don't sweat the specs and techie stuff *too* much. Just go with an amplifier with a good rep, and you'll be as happy as a winning politician on election night.

Chapter 12

Choosing the Right Amplifier

In This Chapter

- Deciding between stereo, multichannel, and mono amplifiers
- Understanding amplifier features
- Keeping your amplifier safe
- Considering amplifier cosmetics

Compared to, say, a car audio head unit, an amplifier is a pretty simple device in that all it does is provide power to speakers. But when you consider all of its inputs, outputs, features, and controls, an amplifier can still be a rather complex component. And perhaps because it does its job quietly and mostly out of view — unlike speakers that you hear and see, and head units that you see and touch — amplifiers seem to engender a sense of mystery and awe among car audio enthusiasts.

You're faced with a lot of different choices when it comes to buying an amp, and it can seem overwhelming and confusing to a car audio newbie. Not only do amplifiers come in a wide variety of configurations, but they're usually loaded with features and controls you may not be familiar with. In this chapter, I cover your options and give you some points to ponder as you're making your decision.

Choosing the Right Type of Amplifier

The first thing you'll have to decide is what type of amplifier or amplifiers you will need for your system: stereo, multichannel, or subwoofer. (Or more specifically, in what combination you will need these types of amplifiers, if you build a bigger system.) A stereo amplifier has two channels, a multichannel amp has more than two channels, and a subwoofer or *mono* amp has only one channel. Each type serves a specific purpose within a car audio system and the design of your system will dictate the type you choose and use.

Stereo amplifiers

Two-channel amplifiers are also called *stereo* amps (see Figure 12-1), and they are essentially left and right mono or single-channel amps on one chassis. In a typical car audio system, one channel powers a speaker on the right and the other a speaker on the left. A stereo amp's two channels can also be *bridged* or combined to form a single channel to power a subwoofer.

Multichannel amplifiers

As the name suggests, *multichannel* amps have multiple channels — or at least more than two (see Figure 12-2). Just as a stereo amp is essentially two channels of power on one chassis, a multichannel amplifier is essentially several different channels on a single chassis. They can have as few as three channels or as many as six.

TIP

The main advantage of multichannel amps is that the same amount of power produced by, say, three separate stereo amplifiers can come from a single six-channel amplifier that takes up much less space and sometimes costs less money. A multichannel amp can also help cut down on the complexity of wiring because the installer only needs to run one set of wires to a six-channel amp instead of three to a trio of stereo amps.

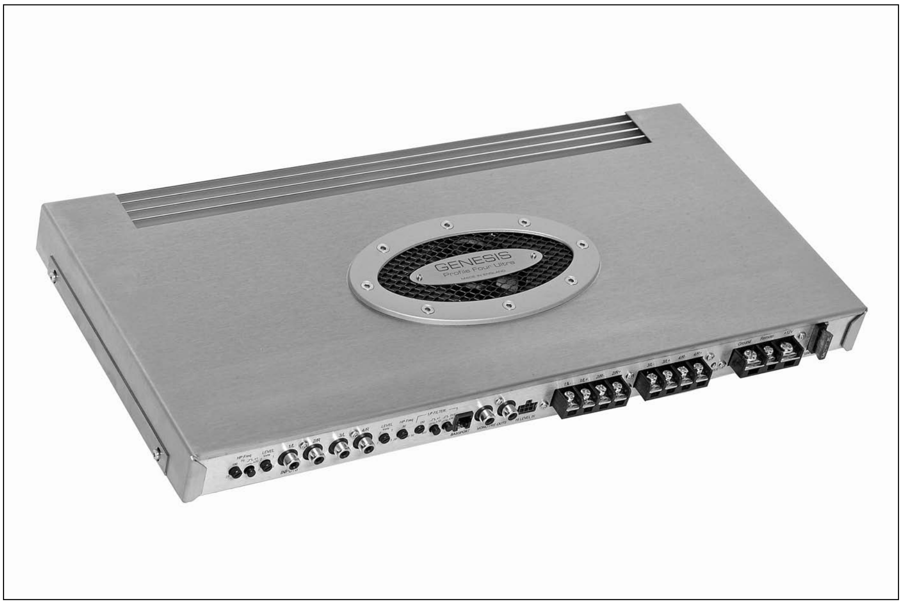


Figure 12-1: A Genesis stereo amplifier.

Courtesy of Genesis Ltd.

Multichannel amps also offer a lot of flexibility. You can usually bridge two individual channels into one mono channel to power a subwoofer, and many already have a dedicated mono subwoofer channel just for that purpose. A five-channel amplifier, for example, may have specs that look like this:

```
50 watts x 4 into 4 ohms and 100 x 1 into 4 ohms
```

In this case, the four 50-watt stereo channels can be used to power speakers in the front and rear of a vehicle, whereas the single 100-watt mono channel can be used to drive a subwoofer.

Subwoofer amplifiers

Subwoofers require the most power in a car audio system because it takes a lot to move their larger cones. That's why it can be a good idea to have a single large amplifier (or amplifiers) dedicated solely to the sub (or subs) in your system (see Figure 12-3).

Figure 12-2: A Phoenix Gold multichannel amplifier.

Courtesy of Phoenix Gold

Figure 12-3: A Kicker subwoofer or mono amplifier.

Courtesy of Kicker

Subwoofer amplifiers are also called *mono* or sometimes *mono block* amplifiers because they usually consist of just a single monaural channel. Mono power is usually used with subwoofers because the human ear can't distinguish the difference between stereo and mono at low frequencies.

Considering the Different Features of an Amp

Home audiophiles consider any bells and whistles on a power amplifier extraneous. But car audio manufacturers (thankfully) add all sorts of features that give you more control over your system and help cut down on the number of components. Some also help the amplifier deal with the harsh environment of the car, where temperatures can range from more than 100 degrees to below zero, and the power supply for the amp can fluctuate.

In the next few sections, I cover some of the more common features found on car amplifiers.

Crossovers

Think of crossovers as signal-traffic cops: In a car audio system, a crossover ensures that the appropriate speakers get the appropriate signals — that the tweeters aren't woofing and the woofers aren't tweeting. This also protects the speakers because a massive bass note could easily fry a small tweeter.

Some speakers come with passive crossover networks that do the same thing. Although passive crossovers have power flowing through them (from the amplifier), they don't need power going to them from the car's electrical system, and that's why they're called *passive*. The electronically powered crossovers built into amplifiers do the same thing, but actively, meaning they need power from a car's electrical system to do their thing. Hence they are called *active* or *electronic* crossovers. Although outboard active/electronic crossovers are available, having one built into an amplifier can save money in your wallet and space in your car.

Crossovers built into amplifiers come in configurations such as *low-pass*, *high-pass,* and *bandpass*. As the name indicates, a low-pass crossover (also called a subwoofer crossover) only allows low frequencies through for subwoofers, whereas a high-pass crossover allows high frequencies through and blocks all others flowing to tweeters. A bandpass crossover allows a predetermined *band* of frequencies (usually in the midrange) to pass though and blocks frequencies on either side.

Crossover *points* on amplifiers can either be set or adjustable. For example, a subwoofer crossover may have a set frequency of 80 Hz or allow adjustment between 50, 80, and 125 Hz. Other amps can have *continuously variable* crossovers, meaning that the crossover point can be set to any frequency within a range, say 50 to 125 Hz (see Figure 12-4).

Crossovers have a *slope*, or the rate at which the signal rolls off or is attenuated past the crossover point. This is always in increments of 6 decibels (dB), and the higher the decibels, the steeper the slope. (See Figure 12-5.) A steeper slope is not necessarily better and the rate of the signal roll off depends on such factors as the speakers used in the system and the owner's sound-quality preferences. Although some amplifiers have a fixed crossover slope, others allow a choice between several slopes, such as 12, 18, or 24 dB. This allows more flexibility in tuning the system to your liking.

The more options you have in both crossover points and slopes, the more flexibility you'll have in tuning a system. Multiple crossover points and slopes let you try out different variations and tweak your system to determine what sounds best.

Figure 12-4: An amp with a continuously variable crossover, like this one from JL Audio, lets you vary the crossover points.

Courtesy of JL Audio

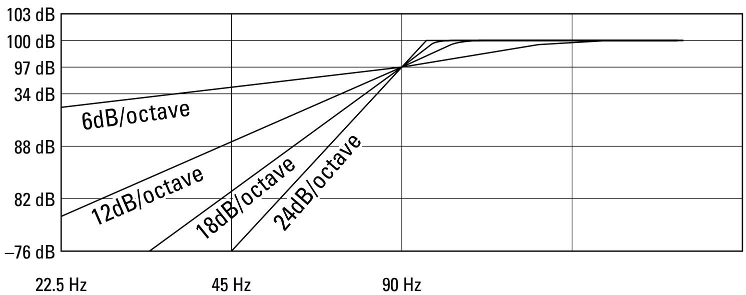


Figure 12-5: An example of a 6-, 12-, 18-, and 24 dB-per-octave crossover slope of a high-pass filter.

Bass boost or equalization

Some amplifiers include circuitry that boosts lower frequencies between about 40 and 90 Hz. Some bass boost circuits allow you to vary the frequency at which the boost occurs as well as the amount of boost in increments of dBs. Bass equalization circuitry on amplifiers sometimes includes an infrasonic filter, which filters out unwanted and potentially damaging low-bass frequencies.

Remote subwoofer control

A remote subwoofer control is, in effect, an extension of the bass boost circuit on an amplifier and allows adjusting the level of bass on the fly for different kinds of music or to suit your tastes. Some amplifiers come with a remote subwoofer control, but more often it's an add-on and extra-cost accessory.

Gain control

Gain control is as important on an amplifier as a volume control is on a head unit, and many people mistake it for the same thing. Gain control isn't used to increase the overall volume of a system, but to match the output from the head unit to the amplifier's input to get the highest signal level with the lowest amount of noise. If the gain is too low, the amplifier will produce less power but the overall system will have less noise. If the gain it too high, the amp can produce more power but with more distortion and hence noise.

High-level inputs

Most amplifiers need a low-level, preamp (unamplified) signal from a head unit because an amplified signal will seriously overdrive an amp's input section. But amplifiers also have high-level inputs that allow direct connection to a stock head or even aftermarket head unit's amplified outputs. The high-level inputs are essentially tied to what's known as a *line-output converter* that's built into the amp and reduces the amplified signal to preamp level before it enters the amp's internal circuitry.

Preamp outputs

TIP

Some amps also offer preamp or *pass-through* outputs so that a signal can be sent to other amplifiers in the system. This is useful when you have several amplifiers and don't want to run a separate preamp signal from the head unit to each one and can save on wiring costs and complexity. Such a setup is called a *daisy chain* and often allows using the crossover functions of an amplifier so you can send a filtered signal out to the other amplifiers in the chain.

Gold-plated RCA input connectors

Gold plating is used on the RCA or low-level connectors to ensure a better connection as well as reduce the chance of corrosion.

Balanced inputs

Balance-line technology is borrowed from the recording industry. Balanced inputs are used in place of standard RCA inputs to reduce noise that can enter a system through wiring. The term *balanced* here refers to a method of connecting each wire — at the signal source and the amplifier — to identical impedances at each end. The amplifier at one end compares the two signals, and any noise that has been added is rejected. Use of fully balanced inputs in car audio amplifiers is rare, but *differential* balanced inputs are more common. Differential balanced inputs are a variation on balanced inputs. Differential balanced inputs don't connect part of the audio signal to the chassis ground, which is the common method of grounding a non-balanced amplifier and may induce noise.

LED status indicator

Some amplifiers have lights, typically LEDs, that give visual indications of certain functions on the amp, such as on/off status, clipping, and protection-circuitry indicators.

Getting Input on Inputs and Outputs

Every amplifier has inputs and outputs (which is not to be confused with an amplifier's *internal* input and output sections). Inputs are where the signal from a head unit goes into the amplifier, and the outputs are where it leaves the amplifier for the speakers. Plus, there are connections for power-supply input, ground, and the 12-volt turn-on wire that tells an amplifier to wake up when a head unit is turned on.

Inputs are usually RCA jacks that are typically gold-plated to ensure a good connection and guard against corrosion. But as mentioned above, inputs can also be of the balanced-line variety.

Outputs can be one of two general types. The most common is a screw terminal (see Figure 12-6) or *barrier strip*. The screw for each terminal is loosened, the speaker wire or a connector attached to the wire is placed under the screw, and then the screw is tightened.

The other type of output is a *capture-wire*. Capture-wire outputs come in a variety of styles. Some have holes into which a stripped or bare speaker wire is inserted and then a hex-head screw or some other fastener is tightened. Another is a spring-loaded connector; a part of the connector is pushed to open the hole into which the bare wire is inserted (see Figure 12-7). Still another uses a removable capture-wire application that can be detached so that connections can be made outside of the vehicle.

Figure 12-6: Screw terminal speaker connectors.

Figure 12-7: Spring-loaded speaker connectors.

Courtesy of JL Audio

Keeping Cool with Protection Circuitry

Given the extremes of hot and cold, constant vibration and shocks, dust and dirt, and fluctuating power, the car is a harsh environment for any type of electronic component. Amplifiers have it particularly rough because they give off heat as a byproduct and they are usually stuffed in out-of-the-way places, sometimes with poor ventilation. And they are often asked to perform at the extremes of their design limitations. That's why manufacturers build in a variety of protections to keep an amp running smoothly and safely — and not ending up as an expensive paperweight.

Not all protection circuits work in the same way. Some shut an amplifier completely down, whereas others simply lower the operating parameters of the amp until the dangerous situation passes.

Thermal protection

Protection from heat is one of the most essential forms of protection an amplifier can have. Because heat is a major source of failure in amps, manufacturers build in circuitry that senses when heat rises to a dangerous level and shuts down the amp. After the temperature returns to a safe level, the amplifier fires up again.

Cooling fans

In addition to thermal-protection circuitry, some amplifiers also have cooling fans built in. The fans will either run continuously (which can be a source of unwanted noise), or they'll kick on when the temperature inside the amp reaches a certain threshold. Installers and DIYers will also often add fans to an amp rack to blow air across amplifiers' heatsinks (the part of the amp, usually with fins, that dissipates heat away from the circuitry).

Short-circuit protection

When positive and negative power wires touch or a power wire is pinched and is grounded to a car's metal chassis, a short circuit can occur, which can damage an amplifier. To prevent this, many car audio manufacturers build in a circuit that detects a short-circuit situation and shuts the amplifier down before any damage can occur.

Impedance protection

A drop in impedance can damage an amplifier by placing too heavy of a load on it and making it work too hard. Some amps have circuitry that senses an impedance drop and shuts down the amp or lowers its output to prevent damage.

Connection shroud

Some amplifiers come with a shroud that covers the connections to the amps to protect them from, say, spare change that falls under the seat that could touch the controls and cause a short circuit.

Low-voltage protection

If the supply voltage drops below a certain threshold, rather than the amp working harder to compensate and potentially damaging its circuitry, low-voltage protection kicks in and dials the amp back or shuts it down entirely.

Keeping It Pretty: Cosmetic Considerations

REMEMBER

Part of having a car audio system is being able to show it off to your friends. If that wasn't the case, all car audio amplifiers would probably be plain, utilitarian black boxes. Instead, you'll find amplifiers in all manner of shapes, colors, and finishes. Some are large and flashy (see Figure 12-8), whereas others are compact and subtle (see Figure 12-9).

TIP

Of course, the cosmetic style you choose in an amp depends on your taste and budget, but you'll generally want to follow the aesthetics of your car and system. For example, if you drive an understated European vehicle, you'll probably want a more elegant-looking amplifier. But if you drive a chrome-dripping sports compact or tricked-out pickup, you'll want to go with something more showy.

In a system with multiple amplifiers, an installer will often build a custom rack to create a show of power. A popular option is to mount amplifiers on a subwoofer box, although the vibrations from the subwoofers can cause damage to an amplifier's circuitry.

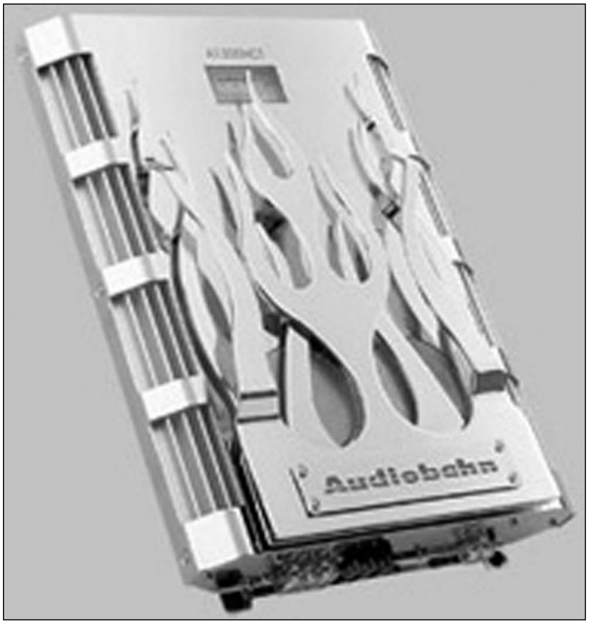


Figure 12-8: An example of flashy amplifier cosmetics.

Figure 12-9: An example of subtle amplifier cosmetics.

Courtesy of JL Audio

If multiple amps are mounted together, as on a rack, some manufacturers offer cosmetic *links* that join multiple amplifiers together to make them appear as one. Many manufacturers also have *end caps* on their amplifiers to hide the connections for a cleaner look.

Chapter 13

Installing an Amplifier

In This Chapter

- Picking the best spot to mount an amplifier
- Wiring an amplifier
- Putting safety first with fusing and a good ground

You can think of an amplifier as the heart of a car audio system. All of the wires that tie together a system lead to and from the power amplifiers. And just like your ticker, you have to take good care of your amp — or, in the case of your amp, ensure that it's installed correctly — to keep it pumping out juice. When something goes wrong with your heart, it affects not only your circulatory system, but your entire body, too. Likewise, if something goes wrong with your amplifier, particularly if it's not installed correctly, it can have dire consequences for not only the amp and other car audio components, but also your car.

In this chapter, I cover the most important aspects of installing an amplifier and whether you should do the installation yourself or seek professional help from an installer. I also direct you to Internet resources that can help you if you do decide to go the DIY route. I also explain how an amplifier affects a vehicle's charging system so that both your car and your amplifiers don't run out of juice

In addition, I detail the best places to mount an amplifier, where not to mount one, and why some locations are better than others. I also discuss the role wiring plays in installing an amplifier and the importance of proper fusing. Finally, you find out why keeping an amplifier grounded is so important.

Gathering the Facts Before You Amp Up

Amplifiers are the most daunting car audio components to install correctly. First, you have to decide where to mount your amps. Some components have really obvious locations. For example, head units have a stock slot in the dash that they fit into, and speakers typically mount in predetermined factory provisions. Although many stock premium car audio systems come with separate amplifiers, they are usually small, nondescript silver boxes designed to fit inconspicuously in a vehicle.

But you'll probably want show your amps off, and they'll need to be somewhat accessible in case you need to make adjustments to the amps' controls. There are also other, more important considerations when you're deciding where to place an amplifier in a vehicle. Proper ventilation and routing of wires are crucial factors to consider.

Amplifiers are the most complex car audio components to successfully and safely integrate into a vehicle. While most speaker installations are pretty straightforward and many head units can be installed by do-it-yourselfers, amplifiers present a unique set of install challenges, and the job may be best left to a professional.

If you botch a speaker or head unit installation, you may damage those components or an adjacent part of your car. But with a faulty amp install, you can end up shorting out your electrical system or even setting your car on fire.

If you're determined to take on the amp installation challenge, make sure you have two things: lots of patience and a good grasp of the way your vehicle's charging system works. I can explain a bit about the charging system, but you're on your own with the patience.

Here are the things you need to consider before undertaking the installation of an amplifier:

- **The complexity of the system:** If you are comfortable working on cars and you're installing, say, only one simple two-channel amplifier, the task may not prove too difficult. But if you plan to have multiple amplifiers running a barrage of speakers, you may be better off paying a professional to do the job.
- **The complexity of the car:** If you're installing an amp or two in, say, a 1984 VW Rabbit, the installation should be pretty straightforward. But if you plan to pimp out your new S Class Mercedes with the mother of all car audio systems, complete with a rack of amps, you'll need to tread very lightly and know exactly what you're doing.

- **Knowing watts what:** Before installing an amplifier, you should have a good grasp of how a car's charging system works. If you don't know a grommet from a ground cable, for example, it's probably best to find a good professional car audio installer or at least an experienced DIYer. But if you comprehend the complexities of your car's electrical system, know the difference between voltage and resistance, and can handle running wires and taking your car apart and putting it back together again, you can consider going the DIY route.

  Just remember that many car audio amplifier manufacturers offer a longer warranty — two to three years instead of one — if their products are installed by an authorized dealer.

Getting Comfortable with Your Car's Charging System

To your car's battery, a car audio amplifier is just another current-consuming device, just like your windshield wipers or power-window motors. Auto manufacturers design a vehicle's electrical system to handle the total load that all of the car's electrical device can place on it, and then some. Not only do they engineer in a margin of error for those days when you may be, say, running your air conditioner at full blast, operating the windshield wipers on high, shining the high beams, and blowing your horn all at the same time, but they also know people will likely add aftermarket accessories, such as car audio systems.

But at what point does your car's electrical system say enough is enough? That depends on how much you demand of it. Fortunately, music is transient in nature, meaning there are lulls that don't require a lot of extra power and there are crescendos, as well as peaks — or in the car audio sense, ground-pounding bass notes — that do. It's during these transient peaks that a car's electrical system can be taxed to the max.

The amount of current drawn from the electrical system depends on the amplifier. But say you have a typical stereo amp that's rated at 100 watts x 2 channels. Such an amp would draw between 15 and 30 amperes of peak current. No big problem there, but say you install four of these bad boys. Then you're asking your charging system to supply on average between 60 and 120 amperes of peak current. That's when things start to get tricky.

As long as you're listening to talk radio at moderate volume, it may not be a problem. But if you're bumping the latest bass-heavy CD, you're amplifiers may not receive enough current and begin to *clip* the audio signal. This causes distortion that can blow the speakers. In some cases, you even find your headlights dimming to the beat. Although you may think that this is kind of cool, your car won't, and your alternator may wear out much faster under these conditions.

Deciding Where to Plant Your Power

Although speakers have their own critical placement issues having to do with sound, amplifiers have different location concerns. A good salesperson or installer at a car audio specialty store will know whether a certain amp can work well in the location you're thinking about installing it, or you may be able to find out via an online message board which amps are best for questionable locales. Most amps, for example, will perform just fine when mounted under the front seats of a vehicle and will get enough airflow to keep cool. But in this location, making sure the amp has enough clearance and that it doesn't interfere with the seat moving back and forth is the main concern.

Many people also choose to mount their amplifiers on the back of a big subwoofer box. Although this is an easy and space-saving solution that also looks cool, the constant vibration from the deep bass can potentially harm the internal components of an amplifier.

Keep these important points in mind as you decide where to install your amplifier:

- **Ventilation:** Heat is a byproduct of an amplifier generating power. That's why all amplifiers have some sort of heat-dissipation scheme built in: either *heat sink* fins or internal cooling fans, or sometimes both. But even with these chill features, the heat produced by an amp still needs somewhere to go — particularly if the amp is stuffed in a hot trunk on a sweltering summer day.

  You never want to

  - Install amplifiers in a small enclosed area, such as a stock storage compartment, unless you provide adequate ventilation or add a cooling fan.
  - Cover an amp with carpeting or anything that will trap heat.
  - Mount an amplifier upside down, unless the amp's owner's manual says it's okay.

  • Install an amp near heat-generating components or in direct sunlight.
  • Custom paint an amplifier: A paint job may interfere with heat dissipation.

  If an amp does get too hot, most will (hopefully) go into a thermal-protection mode and shut down before any damage occurs to the internal components. Bottom line: You never want to install an amplifier in a place where there's not decent airflow.

- **Accessibility:** All amplifiers have gain controls that need to be adjusted, and many have built-in crossovers, bass boost circuits, and other controls that have to be tweaked when the system is initially tuned, and perhaps from time to time after that. So, if possible, you'll want to consider mounting your amp in a location that allows you to easily reach it — without contorting your body like a circus performer or scraping your hands trying to reach controls. However, if you're a set-it-and-forget-it type of person, after an amplifier is installed and your system is tuned, you may never touch it again.
- **Aesthetics:** Displays of power are as old as the Sphinx, and most car audio enthusiasts understandably want to impress people with their awesome car audio power arsenal. So consider a spot in your ride where amps will have good ventilation and accessibility, but still allow you to wow the crowd in the parking lot or at your favorite hang-out spot. Many pro installers and some DIYers even build elaborate racks to exhibit their power to the people (see the "Rack it up" sidebar in this chapter).

Getting wired

An amplifier is the one component in a car audio system that directly ties to all of the others. It taps power from the car's battery, gets an audio signal from the head unit, and sends an amplified signal to the speakers. The way that the amplifier connects to these other system components is through wires.

Rack it up

Some high-end car audio systems sport an amp rack on which multiple amplifiers can be mounted. Racks can be as simple as a piece of wood covered in carpet or as elaborate as a metal or fiberglass sculpture-like creation complete with lights, motorization, mirrors, and, in some extreme cases, even waterfalls. Beyond the showmanship of a rack, professional installers and the best DIYers find that having multiple amplifiers on a single structure makes it easier to organize wiring and the amps' attendant power-supply accessories, such as fuse and power-distribution blocks.

So, the constraints of wiring also play a role in where you mount your amplifier. With all of the wires running to and from an amp, you'll want it in a location that's relatively accessible for making those connections. But at the same time, unless you're planning on building an elaborate system that's as much for show as for sound, your amps will probably need to be out of the way to make room for more mundane things like groceries and luggage. So the set-it-and-forget-it logic often applies for the majority of casual car audio enthusiasts.

Most people tend to mount amplifiers in the trunk — on the floor, on one of the side walls, or the front wall. In hatchbacks and SUVs, they likewise go in the cargo area, and in trucks behind the seats. But you can't just stick amps anywhere because they need a solid surface to mount on.

TIP

Any solid metal surface of the car will work for mounting your amp, although one school of car audio thought believes it's unwise to mount an amplifier's chassis directly to metal since there's a slight chance that it can introduce noise into the system via a ground loop. A *ground loop* is a current that occurs between two grounding points — in this case the intentional ground and the unintentional ground caused when the amplifier's chassis touches metal — that usually causes noise. To eliminate this problem, professional installers often create a mounting board for the amplifier out of wood that is in turn attached to the metal of the car.

Allowing for inputs and outputs

Every amplifier has inputs and output, sometimes on opposite ends and sometimes arrayed together. *Inputs* are where the un-amplified signal from the head unit goes in, and the *output* is where the amplified signal goes out to the speakers.

The inputs will include RCA jacks that accept a low-level or un-amplified audio signal, although some amplifiers will also have inputs for high-level or amplified outputs from a stock head unit. There's also usually a connection for a remote turn-on lead from the head unit to tell the amp to *wake up* when the system is turned on. This wire (usually blue in color) is almost always small (18 gauge), has to be snaked to wherever the amplifier is mounted, and is usually terminated at the amplifier alongside the power cable. Besides telling the amplifier that it's time to wake up and pump juice to the speakers, this turn-on scheme also ensures that your amplifier is not sucking power from your battery when the head unit isn't on.

The outputs of an amplifier feature terminals connected to wires to send power to the speakers, which are usually grouped with controls for gain adjustments, crossovers, bass boost, and sometimes for bridging two amplifier channels into one. Some amps also have a separate subwoofer-volume control with a wired remote that can be placed at arm's length in the passenger compartment so that adjustments to the bass level can be made on the fly.

REMEMBER

You want to make sure you mount an amp so that it's easy to get to the inputs and outputs, but it's also important to position an amp in such a way that the wires running to and from it are out of the way so that they won't be subject to abuse and possible damage.

Structuring Wire Runs

One of the most daunting tasks of installing a car audio system is running all of the wiring to and from the amp — and doing it correctly and securely. Snaking power wires from the battery, around the engine compartment, through the firewall that separates the engine compartment from the interior, and then though the interior — behind trim panels and under carpets — until they all end up at the amplifier is a task that calls for skill, resourcefulness, and a cool head. It also requires taking parts of your car apart and putting them all back together again. Check out Figure 13-1 for an example of a wire's route through a car.

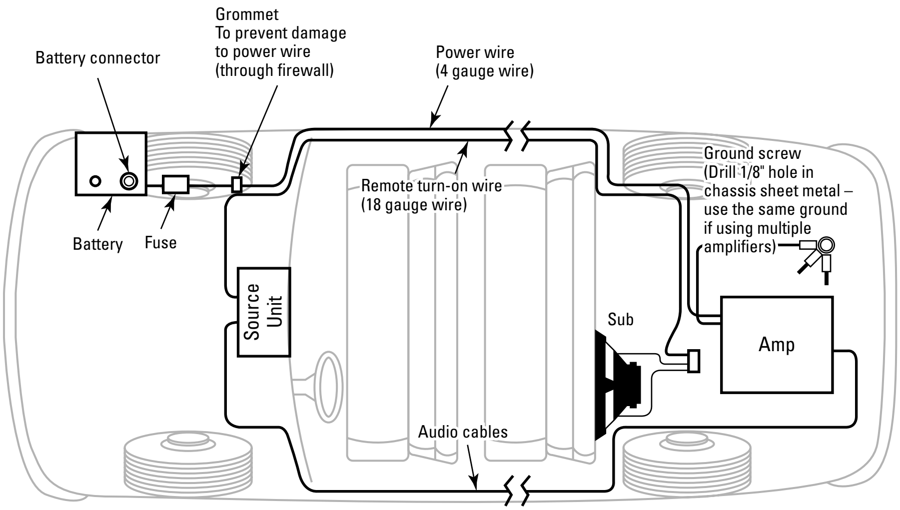


Figure 13-1: One path your amp wire might take.

On top of this routing obstacle course, you have to make sure that all of the wiring is routed in a way that ensures it won't get damaged or pinched. If you're installing multiple amplifiers, wiring accessories such as power-distribution blocks, grounding blocks, and fuse blocks will help organize and distribute the various wires and fuses that are needed. These are often mounted as close as possible to the amplifiers they service.

Before you take on wiring up an amplifier for the first time, you should know what you're getting into. Seek advice from a professional installer or experienced DIYer, or turn to one of the forums and users groups available online.

When you speak with an experienced installer, be sure to ask the following questions:

- Where and how will you mount the amplifier so that it doesn't interfere with my use of the car (for example, carrying groceries, luggage, and so on)?
- Can you install the amplifier in such a way that I can take it out when I sell the car or when my lease is up?
- What's the manufacturer's warranty if the amp is professionally installed versus if I do it myself?
- If I bring my car in for service and the mechanic has a question about the amplifier installation, how can I get in touch with you?

If I haven't scared you off and you decide to install your own amplifier, check out online forums or users groups for advice. I suggest starting with `http://forum.elitecaraudio.com`, `www.audiogroupforum.com/csforum`, and `http://caraudioforum.com`.

Making a Fuss over Fuses

An amplifier gets its power from a car's battery, which is part of your car's electrical system. If you decide to install the amp yourself, it's of paramount importance that you understand the principles of proper fusing. A *fuse* is a component of an electrical system that protects the circuit, or more specifically the components — the equipment and wiring — within the circuit. Short for *fusible link,* a fuse usually contains a small metal wire or strip that melts when a higher current than it can handle flows through it, thereby opening the circuit so that the excess current can't flow through. All amplifiers require an external fuse to protect them from an electrical short. Such fuses are sometimes supplied with the amplifier and may plug directly into it.

Getting in-line

But even more important than an external fuse is the in-line fuse on the power wire that runs from the car's battery to the amplifier. (*In-line* means that the fuse is *in line* with the wire; that is, the wire is cut and the fuse is inserted into the space between the two cut ends of the wire.) Although the in-line fuse also protects the amplifier from a short in case something happens to the wire, more importantly, it safeguards the automobile and its electrical system. Think of the in-line fuse as a fire break: In the case of an accident, when a short circuit creates an electrical *fire,* the fuse opens the circuit to prevent current from continuing to flow.

You can buy an in-line fuse from your local car audio shop, an electronics store, or online. Most all-in-one amplifier wiring kits also come with an in-line fuse. A circuit breaker can also be used in place of a fuse, although this option isn't very common.

Most professional installers place the amplifier power cord's in-line fuse as close to the car's battery as possible. That way, if there's a short, the *fire* doesn't travel far. Just imagine how far the *fire* would travel before it's automatically put out if, say, you decided to mount the in-line fuse in the trunk!

Respecting the fuse ratings

Paying attention to the rating of the fuse is as critical as placing it in the right location. One of the cardinal rules of car audio is that you must *always* use the proper fuse for a given wire size. That means never substituting a fuse or replacing a blown fuse with one of a higher rating. Inversely, never replace a wire supplied or recommended by a car audio equipment manufacturer with a smaller gauge wire. Otherwise, you risk damaging your components and your car. The rating of an in-line fuse should be as large or slightly larger than the one for the amplifier. For example, if you have a 30-amp fuse protecting the amp, you would want a 30- or 40-amp fuse on the amp's power wire.

TIP

The owner's manual for an amp usually specifies the fuse rating required for the amplifier and its wiring. And if you are using multiple amps, add up the fuse ratings for each to come up with the size you need on the power wire.

REMEMBER

Although substituting fuses may be tempting when you're ready to rock and roll and don't have the correct fuse handy, remember that its purpose is to protect your equipment. The amplifier manufacturer specified the fuse for a reason. Ignore it, and you may find out why. Just consider what it will cost you to replace a fried amp as opposed to a 50-cent fuse.

Separation of power

One of the most common sources of unwanted noise in a car audio system comes from RCA cables carrying low-level audio signals coming into close proximity to parts of the vehicle that radiate Electromagnetic Interference (EMI). Some of the biggest culprits are components that require a lot of juice: motors for power seats, power windows, and convertible tops. The list goes on and on. Factory power cables can also introduce noise into a system. That's why it's important to route signal cables as far as possible from potential noisemakers. Of course, car audio power wires also radiate EMI, so it has become standard operating procedure for installers to route signal cable on one side of a vehicle and power wiring along the other, so that they are as far apart from one another as possible.

Staying Grounded

Besides a power wire, your amplifier also needs a ground wire, which is usually black. The ground wire needs to be the same size as the power cable and has to be attached to a solid metal part of the car. It also should be as short as possible so that it doesn't add electrical resistance; as resistance increases, the ground becomes less effective and the amplifier works less efficiently. A short ground wire also reduces the chance that the wire will pick up electrical interference and therefore introduce noise into the system. See the sidebar, "Separation of power" for more information on the introduction of unwanted noise.

If you mount your amplifier under the front seat, for example, you can attach the ground to one of the seat's anchoring bolts. In the trunk, the ground can be attached to part of one of the shock towers or another metal structure.

But if there's no easy grounding point nearby, you can create your own by drilling a small hole into a metal part of the car — just make sure you know what's on the other side before you start drilling — and then inserting a sheet metal screw along with a star washer that the ground wire can in turn be attached to. You may need to scrape paint or some other factory coating off to get down to bare metal for a good ground, and if you live in a rust-prone area, you'll want to treat the area with rust-proofing or undercoating when you're done.

Chapter 14

Sounding Off with Speakers

In This Chapter

- Examining how a speaker works
- Considering different types of speakers
- Making sense of speaker specs
- Listening to and shopping for speakers

Speakers are the final components in the signal chain in a car audio system — the end of the line. Thus, they play a very crucial role in the ultimate sound of the system. You can use the very best components in a car audio system, but if they're hooked up to lousy speakers, you get lousy sound. Conversely, you can have average components leading up to the speakers, but if you have great speakers, you get above-average sound.

Speakers are the only components in a car audio system that turn an electrical audio signal into mechanical energy (that is, sound waves) that you actually hear. Speakers have to do this in a way that accurately reflects the original audio signal generated by the head unit, which is no small feat.

In this chapter, I detail the different parts of a speaker and explain how speakers work. I also provide a list of the various types of speakers available. Finally, I explain speaker specifications, tell how to shop for speakers, and what to listen for when comparing different speakers.

TECHNICAL STUFF

Although there are myriad speaker technologies available, the *moving-coil* or *dynamic* loudspeaker is still the most popular and reliable for use in car audio. For this reason, I focus the following discussion entirely on dynamic loudspeakers at the expense of the more esoteric varieties, such as planar and ribbon speakers. Although some of these other types of speakers have been used in car audio systems over the years, they've never gained a foothold, and the good ol' moving-coil loudspeaker invented more than one hundred years ago still rules the car audio roost.

The Anatomy of a Speaker

Dynamic loudspeakers are made up of eight main parts (see Figure 14-1):

- A *frame* or *basket* that supports the various components of a speaker.
- A *cone* or *diaphragm* that pushes air to create sound.
- A *surround* that attaches the cone to the frame but is pliant enough to allow the cone to move freely.
- A *voice coil*, usually a thin coil of wire attached to the cone that the electrical signal from an amplifier runs through.
- A *voice-coil former* that the voice coil is wrapped around.
- A *motor structure*, consisting of a magnet, pole piece, and a top plate or front ring, which energizes the voice coil when an electrical current runs through it.
- A *spider* that holds the voice coil in place and the cone in alignment.
- A *dust cap* that sits in the middle of the cone.

The surround and spider are called the *suspension* of a speaker because their job is to not only hold the cone in place and in alignment, but also to provide a resistive force to the free-floating cone or diaphragm.

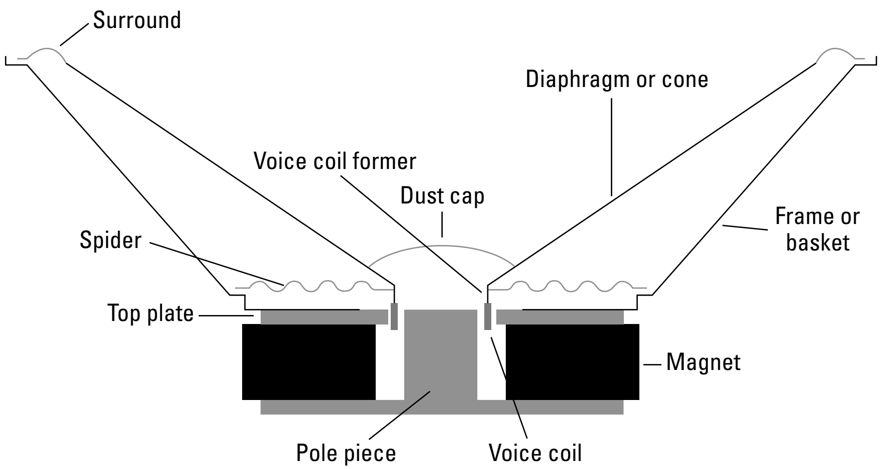


Figure 14-1: The various parts of a dynamic loudspeaker.

Discovering How Speakers Speak

Speakers are supplied with juice from an amplifier via two wires or *leads*. One sends a positively charged current to the speaker, whereas the other returns a negative current to complete the circuit. The speaker moves back (on the negative cycle of the signal) and forth (on the positive cycle) in response to the electrical impulses that alternate from positive and negative voltages supplied by the amplifier. This alternating current (AC) supplied by the amplifier, which is analogous to a musical signal, causes the speaker to create varying degrees of air pressure and reproduce various frequencies. When all of the speakers in a system do this, the result is music to your ears.

From the speaker's input terminals, which the amplifier's leads are attached to, the electrical signal is transferred to the speaker's voice coil. The voice coil sits in a narrow magnetic field, called the *voice coil gap*, that's created by the speaker's motor structure. When the voice coil receives an electrical impulse from the amplifier, a force is created by the current flowing through the wire that either repels or attracts the wire to the fixed magnetic field inside the voice coil gap. Because the voice coil is attached to the tapered end of a speaker's cone, as it moves, so does the speaker's cone. The movement of the cone in turn creates sound waves by moving air, and hence creates music. The surround helps the cone move fluidly on the front end, whereas the spider serves a similar function on the other end, where the voice coil is located.

This is an oversimplified version of the anatomy and function of a loudspeaker. For example, car audio tweeters usually have domes instead of cones, and they don't have spiders and baskets, but they work in much the same fashion.

The highs and lows

In a perfect world, one speaker could accurately reproduce the entire audible frequency spectrum from 20 to 22,000 Hz, without distortion. While we're in fantasyland, this ideal speaker would also be cheap and wouldn't require lots of power. Of course, we don't live in a perfect world and we don't have perfect speakers. Although there are a few so-called *full range speakers* available (speakers that are intended to reproduce the full range of the audible frequency spectrum), no true high-performance car audio system can solely rely on them.

Instead, you have to rely on different speakers to do different jobs. And this is why you see different speakers reproducing different frequencies — and requiring different power and mounting configurations — in a high-performance car audio system.

These different types of speakers include

- **Subwoofers** that reproduce the lowest bass frequencies, roughly from as low as 30 Hz up to about 120 Hz. They typically have large cones that push large volumes of air, and they also require more power to do this. Subwoofers range in size from 8 to 18 inches (see Figure 14-2).
- **Midranges**, also sometimes called *woofers*, reproduce midrange frequencies, roughly from 120 Hz to about 4,000 to 5,000 Hz. Because midranges are asked to handle a pretty wide range of frequencies and can tend to distort at the lower end when over-driven (asked to perform beyond their capabilities), some systems also include midbass drivers to handle the lower end of the range. Midranges don't require as much power as subwoofers, and they range in size from around 3.5 to 8 inches (see Figure 14-3).
- **Tweeters** that reproduce the high end of the frequency range, usually from around 4,000 or 5,000 up to 22,000 Hz. They are typically about 1 inch in diameter or smaller and require much less power than midranges and subwoofers. The output of tweeters is also very directional, meaning that they *aim* their sound more than subwoofers and midranges do; therefore, their placement is more critical (see Figure 14-4).

Figure 14-2: A JL Audio 10-inch subwoofer.

Courtesy of JL Audio

Figure 14-3: A JL Audio 6.5-inch midrange.

Courtesy of JL Audio

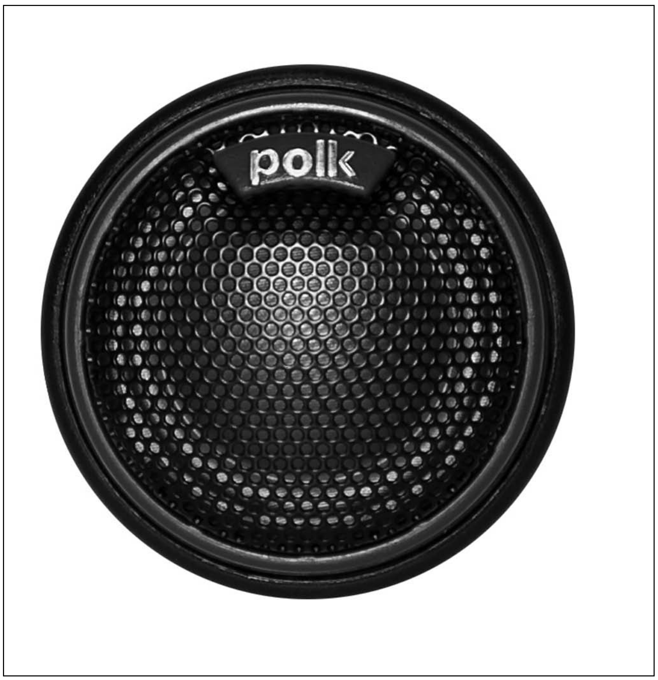


Figure 14-4: A Polk Audio 1 inch tweeter.

Courtesy of Polk Audio

TIP

A suggestion about speaker nomenclature: Don't be overly concerned with what a speaker is called. Just consider what it does. I've been in raging debates over what to call speakers. One editor I worked with at a magazine hated the term *midranges* and insisted that such speakers be called *woofers* instead. I used the term midrange mainly out of habit . . . and later just to annoy my colleague. Because I was above him on the magazine's masthead, I got final say and would change his wording of *woofers* back to *midranges* every time.

I relate this story not to be pedantic or point out editorial pettiness, but to illustrate a classic conundrum in semantics: Different people call the same thing by different names. Just because you call the thing we drive around in — and install audio components into — a car and I call it an automobile doesn't change what it does. It's the same thing with car speakers: You call it a woofer and I call it a midrange, but it does the same thing by any name.

Components and coaxials

Although midranges and tweeters are sometimes sold separately, more often you'll find them grouped together. Subwoofers are sold separately, but subs are so complex, requiring specialized enclosures and power requirements, that I cover them in Chapter 16.

Midranges and tweeters come in two basic configurations:

- **Coaxial speakers** consist of two or more *drivers* or speakers mounted together on the same frame (see Figure 14-5). This type of configuration is somewhat erroneously called *coaxial* because the term refers to speakers that are aligned on the same axis so that the sound emanates from the same point for improved sound. Realistically, the speakers in most coaxials are off axis with one another. Although this isn't ideal, few people can hear the difference anyway, particularly in a car in which each passenger typically sits close to one speaker and far away from the others. Coaxials are typically sold in pairs and one of their biggest advantages is that you can essentially mount two or more speakers in one hole. This also makes it easier to run wires to the speakers.
- **Component speakers** (also sometimes called *separates* because the speakers are separated from one another), on the other hand, are like coaxials, only the speakers aren't on the same frame and are mounted in individual locations (see Figure 14-6). Some components, however, give you the option of mounting the speakers *coaxially* if you choose. In the early days of car audio, separates were less common than coaxials, when many cars had only one factory-speaker location in, say, each front door. Today it's more common for cars to have a separate midrange and tweeter location, but components can be more labor-intensive to install and usually cost more than coaxials. The advantage of using components is that they typically sound better than coaxials because the midrange

and tweeter are separated from each other and there's less chance of interference or *coloration* among the output of the two speakers, meaning one speaker affects the sound of the other.

Figure 14-5: An Infinity Kappa 6.5-inch two-way coaxial.

Courtesy of Infinity

Figure 14-6: A JL Audio 5.25-inch component speaker set.

Courtesy of JL Audio

A third type of mid-tweet speaker is more a true coaxial and is sometimes called a *point source* speaker because the tweeter is mounted in the center of the midrange speaker so that the two drivers are on the same plane (see Figure 14-7). This design is intended to solve the off-axis problem of coaxials.

Crossover artists

REMEMBER

Because you need to use speakers that are specialized at producing certain frequency ranges, you also need a way to make sure each speaker gets the frequencies it reproduces best. This is the job of crossovers or filters: devices that block certain frequencies that would not only be inappropriate for the speaker to reproduce but may potentially harm it. For example, powerful low-bass frequencies intended for a larger subwoofer can easily fry a small tweeter.

Passive or active

Crossovers come in two varieties — passive and active — but they basically do the same thing, and passive and active crossovers are often used in conjunction with one another. One major difference is active or *electronic* crossovers require electrical power, whereas passive crossovers don't.

Figure 14-7: A Morel point source two-way speaker with a tweeter mounted in the center of the midrange.

Courtesy of Morel

Another big difference is that active crossovers filter the audio signal while it's still at *line* level, or *before* it's amplified. Therefore, electronic crossovers come before an amplifier in the signal chain, and many times an electronic crossover is built into an amp (where it still filters the signal before it's amplified).

TECHNICAL STUFF

Passive crossovers, on the other hand, come *after* the amplifier in the signal chain and *before* the speaker. Passive crossovers almost always come with speakers that include more than one driver, such as coaxials or components (see Figure 14-8). With a coaxial speaker, the passive crossover is usually a small and simple component called a *capacitor* that filters out the lows going to the tweeter.

TECHNICAL STUFF

Component speakers or separates usually have outboard or stand-alone crossover networks that contain capacitors to filter out the lows going to the tweeters as well as inductors to filter out the highs going to the midranges. Some also have settings that allow you to adjust the crossover point (the frequency at which the incoming audio signal starts to be filtered or *rolls off*) and crossover slopes (the rate at which the filtering or roll off occurs).

Figure 14-8: A JL Audio passive crossover.

Courtesy of JL Audio

In more sophisticated car audio systems, a separate electronic crossover or an amplifier's built-in crossover may divide the *full range* signal, containing the full frequency range, coming from the head unit. Then a component speaker set's passive crossovers further divide the signal between the midranges and tweeters in the system.

Some experienced car audiophiles use active crossovers to filter the signals going to all the speakers in a system. However, unless you have lots of experience with crossover points and slopes, using the passive crossovers that come with a set of speakers is usually preferable because they are optimized to work with those speakers.

Crossover types

Crossovers come in three basic configurations:

- **Low-pass crossovers** (also called subwoofer crossovers) filter out all but low frequencies for subwoofers.
- **High-pass crossovers** filter out all but high frequencies for tweeters.
- **Bandpass crossovers** filter out all but a predetermined *band* of frequencies, usually in the midrange area.

Electronic crossovers can include all three types of crossovers, whereas passive crossovers usually just include a low-pass and/or high-pass section.

Speaker Specs

As with head units and amplifiers, you should be aware of a number of specifications that manufacturers give that allow you to compare various speakers when you're shopping.

Frequency response

Frequency response is a measure of the frequency range that a speaker can accurately reproduce. For a 6.5-inch component speaker set, a frequency response spec may look something like this: 65 Hz to 27,000 Hz. Although you may not use the speaker set to reproduce that frequency range (because you may have a subwoofer to reproduce the lowest frequencies and you won't be able to hear anything above about 20,000 Hz anyway), the spec shows the entire frequency range that the speaker set is capable of reproducing.

Power handling

This is a measure, in watts, of how much power a speaker can handle and gives you an idea of how much amplifier power you'll need to *drive* the speaker. For the same 6.5-inch component set, the spec looks like this: peak power 330 watts, continuous power 110 watts. This means that 330 watts is the maximum amount of power the speaker set can handle, and above that the speaker could distort or get damaged (*blown*). And 110 continuous is the average amount of power the component set can handle and the best gauge of how much power you'll need to drive the set efficiently.

Car audio manufacturers have been known to *massage* specs to make them look better or compare more favorably with competitive speakers. To make it easier for consumers to compare legitimate speaker specs, the Mobile Electronics division of the Consumer Electronics Association, the trade group representing the consumer-electronics industry, came up with the CEA-2031 standard. It stipulates that participating manufacturers obtain speaker power-handling specs using a uniform method, as dictated by the standard, so that consumers can compare apples to apples.

REMEMBER

CEA-2031 is a voluntary standard and only a handful of manufacturers have signed on to the program at this point. But look for the CEA-2031 logo if you want to be absolutely sure that a speaker's power-handling spec is legit.

Sensitivity

Sensitivity (also sometimes called efficiency) is a measure of how much power a speaker needs to achieve a certain volume level, and is an indication of how loud the speaker will play when provided a certain amount of power. Speakers with a higher sensitivity rating need less power to play loud, and those with lower sensitivity need more.

TECHNICAL STUFF

The spec is obtained by supplying a speaker with 1 watt of power and measuring the output in decibels (dB), with a microphone 1 meter away. A sensitivity spec usually looks like this: 89 dB (1watt/one meter). This means that the speaker puts out 89 dB of sound-pressure level (SPL) measured 1 meter away when fed a 1-watt signal.

REMEMBER

Sensitivity plays an important role in how much amplifier power you'll need to drive a speaker. If you have a low-powered system (using the amplifier built into the head unit to power, say, four speakers), you'll want speakers with higher sensitivity, whereas if you have a high-powered system, you can go with less sensitive speakers.

Listening Carefully

The best way to shop for speakers is to simply trust your ears. As mentioned earlier, speakers are the only components in a car audio system you can actually hear, so you'll want to spend considerable time auditioning them.

TIP

The typical way you'll do this is on a car audio retailer's display board. There are usually dozens of speakers installed in a store's display board and you'll be able to switch among them. First, bring along music that you're intimately familiar with to try out speakers. That way, you'll have a reference point of what the music sounds like and you'll be able to tell how each speaker affects the sound.

Keep in mind that the way a speaker sounds on a display board is very different from the way it sounds in a vehicle. The interior of a vehicle is like an enclosure and each vehicle's interior will have a different effect on a speaker's sound.

TIP

If possible, ask for an audition of speakers in a car, ideally one like yours. The dealer may have a *demo* vehicle with the speakers installed, or, if you have a friend with the same speakers in his car, you can take a listen to his setup. Another way to audition speakers is to go to a car show or sound-off and ask competitors using the kind of speakers you're interested in if you can listen to their systems.

REMEMBER

The bottom line is that your ears will know the difference between various speakers and will help you determine what sounds good and what doesn't. Be prepared to spend time listening carefully to different speakers to find the ones that are best for your car, your system, and your musical tastes.

When auditioning speakers, listen for

- **Bass detail:** Does the bass sound full and rich, or boomy and distorted? Although smaller speakers can't be expected to bang out the monster bass on a rap record, 6.5-inch speakers should be able to muster a respectable amount of low end. Pop or rock music with lots of bass can be useful in assessing a speaker's bass capabilities.
- **Smooth high frequencies:** Do the highs have a smooth and sweet sound, or are they harsh and grating? Cymbals and high-pitched female vocals are a good test for tweeters, and it's fairly easy to tell when a tweeter isn't performing well because the highs will having a brittle and irritating quality.
- **Accurate midbass:** This is the Achilles heel of many speakers because good midbass can be difficult to accurately reproduce. Does the midbass sound smooth and clean, or is it distorted or over-emphasized? Well-recorded acoustic guitar, deep male vocals, and spoken-word recordings are a good test of midrange quality.

You gotta keep 'em separated

Speakers need to be in some sort of enclosure or solid baffle (a panel in which a speaker is mounted) to isolate the front wave from the back wave. The output from the *front wave* of the speaker (when a cone moves out or forward) is the acoustical opposite of the *back wave* (when the speaker moves in or back). If the two waves aren't isolated from one another, they cancel each other out. The result is reduced output from the speaker and poor performance.

When shopping for speakers, you'll find cones made of various materials, such as paper, plastic, and metal. The ideal speaker cone would be stiff, light, and well damped, which means it wouldn't produce unwanted resonances or vibrations (and thus unwanted sounds, such as distortion). In the real world, however, there's no ideal cone material, and you're faced with a series of trade-offs.

Paper cones are light and well damped, but are not very stiff. Plastic cones are light, but the stiffer they become, the less damped they are. Metal cones are stiff and light but have poor damping. Consequently, many speaker cones are made of a combination of materials, or a composite. For example, a paper cone may be treated with a combination of materials, such as some form of plastic, to create a cone that's light and well damped, but also stiff.

Chapter 15

Installing Speakers

In This Chapter

- Calculating speaker sizes
- Dropping speakers into factory locations
- Adapting speakers to fit stock openings
- Putting speakers where you want them

What do restaurants and car audio speakers have in common? Their ultimate success depends on three things: location, location, location. Car manufacturers have gotten better over the last several years at placing speakers in locations where they create good sound rather than just sticking them in places that fit more with the overall interior design and aesthetics of the vehicle. But most car interiors are still not designed with great sound in mind, and creating custom speaker locations can be costly and time consuming.

In this chapter, I cover the most common speaker locations in cars, and I list the various sizes that car speakers come in. These two factors, of course, affects what size speakers you can install in your car and where you can install them. But you can also install speakers that may not fit in a factory speaker *cut-out* or opening by using an adaptor. Or, you can go custom and install speakers anywhere you want them.

Common Speaker Locations and Sizes

REMEMBER

From a car audiophile perspective, the best thing to do is to take a good-better-best approach when installing speakers: Start with factory locations for good sound, and then consider modifying them to get better sound. Finally, you can create custom locations for the best sound. Your system could even include some combination of the three.

Like head units, speakers have specific places that they fit in a vehicle, and the locations are usually a predetermined size.

Speaker locations

In most vehicles, speaker locations are typically found

- In the front and rear doors (see Figure 15-1)
- In the lower-front corner of the front windows, sometimes called the *sail panel* because these small triangles resembles sails (see Figure 15-2)
- On top of the dash: usually in each corner and sometimes in the middle (see Figure 15-3)
- In the side panels on either side of the rear seat (see Figure 15-4)

Figure 15-1: A front-door speaker location in an Infiniti G35.

Figure 15-2: A tweeter in a sail panel in a Ford Expedition.

Figure 15-3: A speaker in the center of the dash in an Infiniti M35.

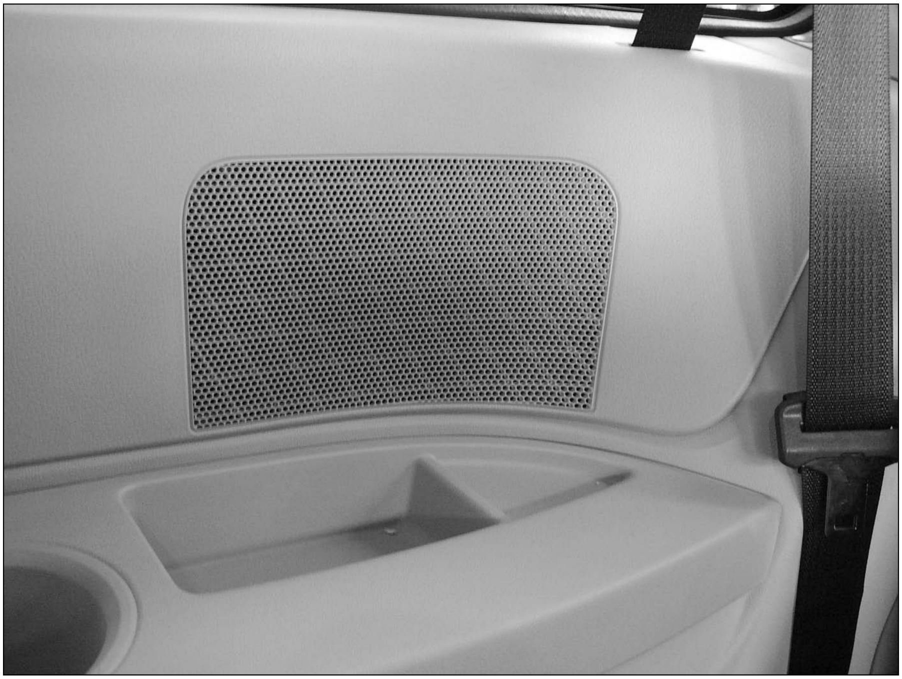


Figure 15-4: A speaker in the rear side panel of a Dodge Caravan.

- In the rear deck in cars with trunks or the *package shelf* in hatchbacks (see Figure 15-5)
- In the A pillars (the section of a vehicle's body that separates the windshield from the driver-side and front-passenger windows, see Figure 15-6), and the B pillars (in some trucks, the section that separates the driver-side and front-passenger windows from the rear window)

Speaker sizes

These locations feature stock speaker *cut-outs* or holes of several standard sizes. Aftermarket car audio speakers, of course, conform to these stock-speaker sizes. These include

- **6.5-inch**, which is a common speaker size in many Toyotas, Chevys, Hondas, and many other vehicles
- **6.75-inch**, which is also called an over-sized 6.5-inch and is becoming more common in vehicles from Acura, GM, Chrysler/Dodge, Nissan, and others
- **5.25-inch**, which is a common speaker size in VW, Suzuki, Mercedes-Benz, and other vehicles

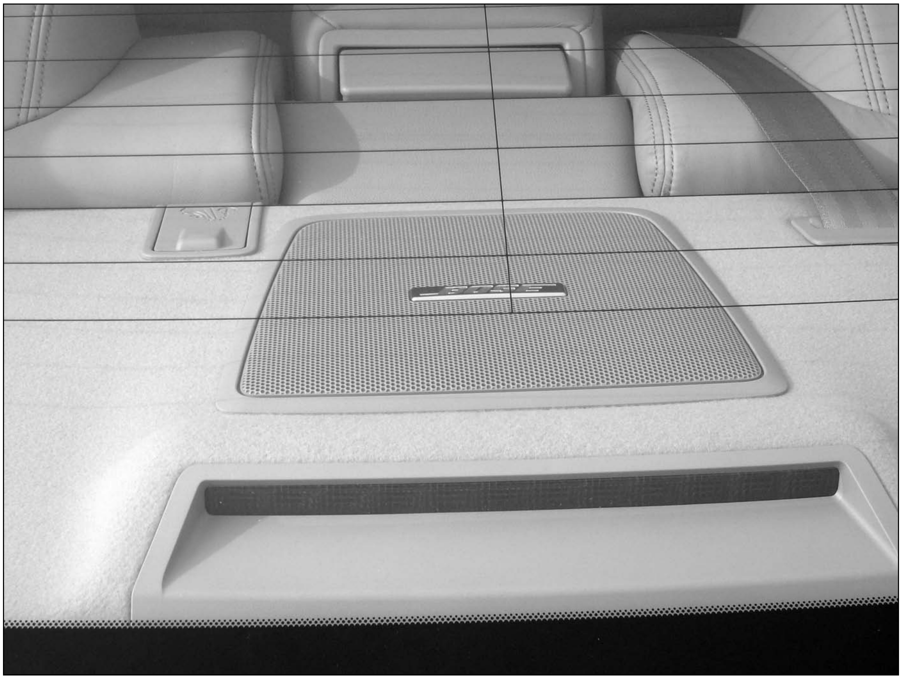


Figure 15-5: Rear deck speaker in a Volvo S80.

Figure 15-6: A-pillar speaker in a Buick Enclave.

- **5 x 7-inch**, which is a common speaker size in Fords, Chryslers, Nissans, Toyotas, and others
- **6 x 8-inch**, which is another common speaker size in many Fords, Lincolns, Mercurys, and Mazdas
- **6 x 9-inch**, which is a common speaker size in Chryslers, Hyundais, Fords, Toyotas, and many other vehicles
- **4 x 6-inch**, which is a speaker size found in BMW, GM, Jeep, VW, and other vehicles
- **4-inch**, which is used in Chevy, Honda, Nissan, Volvo, and other vehicles
- **3.5-inch**, which is used in Audi, BMW, Toyota, GM, and other vehicles
- **1-inch**, which is the most common size for a tweeter in many vehicles

Although the French speaker manufacturer Focal makes an 8-inch car audio coaxial, and some enthusiasts have been known to use an 8-inch speaker in their doors as a midbass driver, these applications are pretty rare. Most of the speakers and speaker openings you'll find are of the sizes described in the preceding bullet list.

Fitting In or Adapting: Using Stock Openings

TIP

Because the sizes of aftermarket speakers and stock-speaker openings so conveniently match up, one of the fastest, easiest, and least expensive ways to upgrade a factory audio system is to simply swap out the speakers. In fact, some aftermarket speaker companies specifically sell *drop-in* speakers designed just for such applications (see Figure 15-7).

TIP

But sometimes you'll find that the speaker you want to install won't fit the hole you want to put it in. If the speaker is smaller than the stock hole, adaptors are available to hold the speaker in place (see Figure 15-8).

If the speaker is bigger than the stock location you want to put it in, on the other hand, things are not so simple. Although virtually anything is possible in the car audio world, where custom is king, modification usually equates to time or money — or more likely both. Enlarging a stock speaker opening usually requires cutting away some of the sheet metal of a door, rear deck, or other part of the car that the speaker mounts to.

WARNING!

These types of modifications require the proper tools and patience and are best left to professionals. It also requires a willingness to irreparably modify your car, which is a no-no if you leased it, so proceed with caution.

Figure 15-7: The Boston Acoustics SL65 is a *drop-in* 6.5-inch coaxial.

Courtesy of Boston Acoustics

Figure 15-8: An adaptor from Scosche that allows you to mount a 6.5-inch speaker in a factory 6 x 9-inch opening.

Courtesy of Scosche

Putting a Speaker Exactly Where You Want It

One of the cool things about car audio is that you can do virtually whatever you want. In fact, that's what launched the billion-dollar car audio industry — the desire by mobile-sound enthusiasts to have their tunes their way in their vehicles.

Although there are no rules and you can put your speakers anywhere you want them, there are guidelines to follow if you want your system to sound decent. Also, certain government authorities won't be too thrilled if, say, you remove your steering wheel's airbag to mount a speaker in its place. But creative installers can and do find ways to mount speakers anywhere you want them.

Beyond the gaudy and (thankfully) passé practice of simply putting as many speakers as possible into, say, a door or rear deck, your goal should be to install speakers in a way that creates the best possible sound quality.

Most of what I cover in the next few sections focuses on front speakers because rear speakers aren't as critical to sound quality — at least not to front-seat passengers anyway. Rear speakers in a high-end car audio system usually provide only *rear fill*, a subtle sense of music coming from behind you that doesn't detract from the impression of the front *soundstage*. Some people even claim that rear speaker are not even necessary. Regardless, mounting speakers in stock locations in the rear door or a rear deck should suffice in most vehicles and systems, while keeping those in the backseat happy.

Here are two primary rules that apply for placement of front speakers:

- The midranges and tweeters should be evenly spaced from one another. Otherwise, staging and imaging — the illusion that the musical performance is taking place in front of you — suffers. You also don't want the tweeter mounted too far away from the midrange; otherwise, sound quality suffers.
- As much as possible, you also want to mount the speakers at an equal distance from the front-seat occupants' ears. This creates equal *path lengths*, the distance the sound travels from the speakers to your ears, so that the sound from the left and right speakers arrives at your ears at the same time. Although this is very hard to do in most vehicles because you're sitting next to the left-side speaker while driving, it hasn't stopped innovative installers from trying.

Years ago, for example, a hot trend in car audio, especially among sound-off competitors, was kick-panel mounting of speakers. (Kick panels are the plastic panels in a car's foot wells that run between the floor and the bottom of the dash.) Installers began custom installing speakers in kick panels so that the speakers were mounted as far away as possible in an effort to equalize the path lengths.

TIP

Although kick-panel mounting started out as a custom application, today you can buy replacement kick panels for certain vehicles, and they even come with cut-outs for speakers (see Figure 15-9).

Figure 15-9: A Q-Logic replacement kick panel enclosure.

Courtesy of Q-Logic

Another custom speaker location is in the A pillars of a vehicle. (A pillars are the sections of a car's body that separate the windshield from the driver-side and front-passenger windows.) Placing tweeters as high as possible in a vehicle can improve staging and imaging, and A pillars provide a perfect location for this. In fact, some vehicles now come stock with A-pillar speakers (see Figure 15-6).

Installing Speakers

When using stock-speaker locations, installing car speakers is a pretty straightforward process. As mentioned, if you are simply swapping out stock speakers for aftermarket ones, try to find speakers that install with a minimal amount of modification and hassle. You can even use the factory speaker wire to avoid having to run speaker wire — and to save a few bucks.

Here are some general tips for installing speakers:

- **Get proper clearance:** Your new speaker may fit into a stock opening, but you'll also want to make sure it doesn't impede on parts of the car. For example, check to see whether the back of a door speaker interferes with the window mechanisms or anything else inside the door.

  TIP

  The same goes for running wires to the door speakers: Make sure that the wires are not going to get pinched by, say, the power-window mechanism. With rear deck speakers, you may have torsion bars to contend with. Make sure the speakers are not in the way.

- **Avoid bad vibrations:** When installing speakers in a door or rear deck, it's best not to mount them directly to the metal body of the car because this can creates unwanted *resonance* (vibrations that are transferred from the speaker to the body of the car). Some speakers come with gaskets to prevent this, or you can order them from installation-accessory companies such as Metra and Scosche or even make your own.
- **Damp it:** One way to cut down on unwanted resonances is to use *damping material*, a substance that's usually applied in self-adhesive sheets to the metal parts of the car. (See Figure 15-10.) Damping material adds *mass* or weight to whatever it's applied to, and lowers the *resonance frequency*, the point at which the object (in this case the part of the car the speaker is mounted to) tends to vibrate. Damping material is also used to create a quieter car interior.
- **Secure that speaker:** Think about how often you and others who ride in your ride slam the doors. Now think about the speakers in the doors and how often they get violently jostled. Car speakers take a lot of abuse over the long haul, so make sure they are secure.

TIP

You can use nuts and bolts instead of the usual screws to secure a speaker. Also, you can apply a bead of liquid silicone to create a solid seal between the speaker and mounting surface.

Figure 15-10: Dynamat damping material applied to the interior of a door.

Courtesy of Dynamic Control

A DIYer's Guide to Door Speaker Installation

The following is a general step-by-step guide to installing door speakers, which are typically the easiest to get to and the speakers you'll most likely change first. Although I focus on door speakers here, the procedure is generally the same for speakers in other locations. Keep in mind that, depending on the vehicle you're installing the speakers in, you may come across different situations and challenges. If you think you're not up to the task or if you get in over your head, seek out a professional installer or someone with installation experience.

Getting to the factory speaker

You first have to take the existing door speaker out to install the new one, and just getting to it can be one of the most difficult parts of the entire job. Years ago, carmakers used removable grilles and it was simple to just pop them off to get to stock speakers. But now most cars have speaker grilles integrated into the door or other interior panels where speakers are located. Consequently, you usually have to remove the entire panel to get to the speaker.

Various door panels are secured in different ways. Some use special fasteners that you'll need a special tool to remove, and others use plugs, bolts, and screws — or some combination thereof. The most important thing is to take your time and figure out the right way — and there's usually only one right way — to remove a door panel. Sometimes this entails just figuring out which direction the panel has to go to be removed.

You can check Internet forums for information about a given vehicle or ask someone who has worked on one.

Disconnecting the factory speaker

Most speakers are held in by screws, so detaching the speaker is usually just a matter of unscrewing the speaker and disconnecting it from the factory wiring. Speakers are usually attached to factory speaker wire with connectors. If you're using the factory speaker wire, you'll need to cut off the factory connectors because these connectors probably won't mate up to the aftermarket speakers.

Wiring up the new speaker

After you cut off the factory speaker connectors, chances are you won't have enough length to connect it to the new speaker. So you'll have to add a *pigtail,* a short length of speaker wire, to act as a bridge between the factory speaker wire and the new speaker. You'll need to strip part of the insulation off of the factory-speaker wire to get to the bare wire, and then do the same thing to both ends of your speaker-wire pigtail.

Splice together the bare-wire end of the factory speaker wire and the bare wire of one end of the speaker-wire pigtail. Then secure the connections with *crimp* connectors, which clamp down on a wire connection, More experienced do-it-yourselfers can also solder the two wires together. If you do use crimp connectors, cover the connection with heat-shrink tubing or electrical tape to protect the connection.

Connecting the new speaker

After you've done the wiring, it's simply a matter of attaching the other end of the pigtail to the speaker's *terminals*, which are the ear-like tabs that the speaker wire connects to. Professional installers will often solder the bare speaker wire directly to the speaker terminal to ensure a rock-solid connection. But you can also use special speaker-terminal connectors that slide over a speaker's terminal. These are available at a car audio specialty retailer or can be ordered online.

The mail order and online retailer Crutchfield (`www.crutchfield.com`) offers speaker wiring harnesses for some of the speakers the company sells. The harness mates to the factory speaker connectors and then to the new speaker.

Accentuating the positive, and the negative

When making the connections to the speaker terminals, make sure to connect the positive lead to the positive terminal of the speaker and the negative lead to the negative terminal. They are usually marked. Otherwise, the speaker is wired *out of phase,* meaning that it will move out when it's supposed to move in and vice versa. And if the other speakers in the car are wired in phase, the outputs from the speakers cancel each other out. The result is reduced volume and poor sound.

Running wires

If you're not using the factory speaker wire, you'll have to run the wire from either your head unit or amplifier. This requires a little more time and a lot more patience.

The two most important aspects of running wires in a vehicle is to make sure they are well protected and well hidden.

Much of running wires is common sense, and you never want to approach it with an out-of-sight, out-of-mind attitude. For example, you need to be aware of where wires may come in contact with moving parts in a vehicle. If a speaker wire gets pinched and *grounds* to the metal chassis of a car, it could cause a short circuit that may damage the speaker or the amplifier — or both. So be extra careful when running wires under seats or other such moving parts of a vehicle.

You can usually run wires under carpet and behind removable body panels to hide them. By removing a vehicle's door sills and seats, you can access under-carpet areas. Removing a car's back seat to run wires, if you have an amplifier installed in the trunk, is usually pretty straightforward.

When you lift a vehicle's carpeting, you'll usually see other factory wiring. You can run speaker wiring with the factory wiring and even in the same wire *loom* or sheath. Getting speaker wiring into doors can be tricky, but you can follow the same path as the factory wiring through looms and grommets (small holes lined with rubber) in the door jamb.

TIP

Most speaker wire is 16-gauge (a measure of the diameter), which is fine for most applications. But if the distance from the amplifier to the speaker is unusually long, such as in a large van, you may want to use a slightly thicker 14-gauge wire.

After a speaker is installed and wired up, you'll want to double-check your connections before putting everything back together. You may even want to fire up the system to make sure everything is working properly. Then put the door panel or other body panels back in the same manner that you removed them.

TIP

Before you replace a door or body panel, check to make sure there's nothing blocking the speaker's cone so the sound comes through loud and clear. Some car manufacturers put material over speaker grilles so that they aren't as noticeable and to make the vehicle's interior more aesthetically appealing. But this can impede the sound. If this is the case with your vehicle, carefully remove the material between the speaker and the grille.

Securely crossing over

Most component speaker systems and even some coaxial speakers come with passive crossovers that route the appropriate frequencies to the appropriate speakers. Mounting and securing the passive crossovers is just as important as doing the same with their companion speakers. But vehicles don't have an allotted space for passive crossovers the way they do for speakers.

You can mount passive crossovers inside a door with speakers if there's room and if you won't need to make adjustments to them. But many passive crossovers allow for tweaking the crossover points and tweeter level, so it's wise to install them in a location that's easy to get to, such as next to an amplifier in a car's trunk.

Chapter 16

Going Low with Subwoofers

In This Chapter

- Getting low bass in a vehicle
- Choosing a prefab subwoofer box
- Understanding enclosure types
- Wiring a subwoofer
- Building a subwoofer enclosure

When most people think of subwoofers, they likely think of the boom cars that pass by pounding out bass and rattling windows. And while that's a significant if often unpleasant part of the car audio experience, there's much more to subwoofers than just annoying an entire neighborhood.

In this chapter, I cover all of the options for getting bass into a vehicle. I'll explain readymade options such as prefabricated subwoofer boxes, including some that have amplifiers built in. I also detail what's entailed with buying a *raw* or stand-alone subwoofer and matching it with the right enclosure. And speaking of enclosures, I guide you through their myriad variations — and discuss the advantages and disadvantages of each — as well as demystify the often confusing array of subwoofer wiring schemes. Finally, I teach you how to build your own simple sealed subwoofer enclosure.

Choosing a Subwoofer

Low bass is an integral part of high-fidelity music reproduction. Think of the last time you heard great live music. Whether it was an orchestral performance or a rock concert, chances are you *felt* the impact of the bass drum and other low-frequency instruments as much as you heard them. Bass, whether produced live by instruments or reproduced by a high-fidelity sound system, has a visceral quality. That's what a subwoofer adds to a car audio system.

In addition to low bass's tangible impact, instruments such as a bass drum, bass guitar, and synthesizer all create sounds as low 30 Hz or more. If you only have midrange speakers that can only effectively play as low as, say, 75 Hz, you're missing out on an important part of your tunes. (Some would argue *the* most important part.) So the only way to go low is to add a subwoofer to your car audio system. But you'll be faced with many and often confusing options. But don't fear. I'm here to help you get the bass you want and need.

Shopping for a subwoofer can be one of the most daunting tasks of putting together a high-performance car audio system. First, there are so many choices: everything from prefabricated subwoofer boxes to *raw* or standalone subwoofers that require an exact-size enclosure.

But that's also the good news. With so many options to choose from, you're bound to find something that works for your budget, vehicle, and musical tastes. You also have to figure out how to power your subwoofer system: Subs require more juice than any other speaker. This can be done with a separate *mono* or single-channel subwoofer amp, a dedicated mono channel of a multichannel amplifier, or by *bridging* or combining two channels of a stereo amplifier into a single mono channel.

Why is a box needed for bass? I go into this later in the chapter, in the section "Going with a raw sub," if you want to skip ahead. But suffice to say that, as with any speaker, the output from the front of the speaker caused by the cone moving forward has to be isolated from the output from the back of the speaker caused by the cone moving backwards. Otherwise, the sound waves caused by the movement of the cone, which are mirror opposites sonically speaking, effectively cancel one another out.

But with subwoofers, it's a bit more complex than that, which I'll also go into in more detail later in the chapter. Subwoofers are designed to work in certain sizes and certain types of enclosures. Therefore it's of paramount importance that the subwoofer and enclosure are properly matched. That's why the simplest approach, if you're just starting out, can be to simply buy a prefab box either with or without a subwoofer.

Prefab bass

The easiest route to good bass is to go with a prefabricated box (as shown in Figure 16-1). You buy a box with a sub already mounted in it, or you can buy a subwoofer and a box separately. Many car audio manufacturers sell preloaded sub boxes, and some offer *unloaded* boxes that are designed for one of their subwoofers. Other companies offer *universal* boxes that can fit a variety of subwoofers.

Figure 16-1: A Polk Audio prefabricated subwoofer box.

Courtesy of Polk Audio

Matching a subwoofer to the right size enclosure is crucial. Placing a subwoofer in too small or too large a box will seriously degrade its performance because the subwoofer won't perform optimally. It would be like dropping a 500-horsepower engine into an economy car: The transmission and other parts of the car aren't designed to handle the respective engine.

Simply buying a sub and box together as one unit takes the guesswork out of it, and the manufacturer will have undoubtedly matched the sub precisely to the box. Even if you do match a raw sub to a universal box, you still have to mount the sub inside it. For novices, buying a box with the sub already mounted inside is the best way to go.

After you've decided to go the prefab route, you can narrow down the type of enclosure that's best for you. You should consider the kind of music you listen to, what your goals are for the system, and how much power you'll need to drive it. Do you want to pound the pavement, or do you just want good bass to punch up your music? Bassheads will want to go with the largest number and size of subwoofer possible to create the bumpin' sound they crave. Those looking more for sound quality can get by with smaller subwoofers and fewer of them. For example, a high-quality box with a single 10-inch subwoofer works for most people who only want to add some low-end to their tunes.

Prefab subwoofer boxes come in a large variety of sizes, shapes, and configurations. You can get one that will completely fill up the hatch of your Honda Accord or will fit neatly in one corner. Prefab sub boxes come in shapes ranging from squares to rectangles to wedges to tubes, and they come with your choice of one, two, or three or more subwoofers. Before buying a prefab box, start by determining how much space you have in your vehicle to accommodate it.

Driving your sub

You should also consider the type of amplifier with which you'll be driving your sub system. Both under-driving a subwoofer (feeding it too little power) and over-driving a subwoofer (feeding it too much power) can cause it to distort and possibly fry. Make sure you match the power requirement spec of the subwoofer with the appropriate amount of amplifier power.

You may also be faced with the choice of whether to buy a sub box with a 2-ohm, 3-ohm, 4-ohm, or 8-ohm subwoofer with either single or dual voice coils. I cover this in-depth later in this chapter, but suffice it to say that dual-voice-coil subs offer greater flexibility.

Brand and build

There are dozens of prefab sub boxes to choose from, of varying quality and finishes, but I recommend that you stick with a reputable manufacturer. That's not to say that a sub box from a brand you've never heard of won't perform well and last for years, but if you come across a sub box that's super-cheap compared to other comparable models you're considering, chances are there's a good reason why — and it's probably not because it's an incredible bargain. Just remember the old adage that you get what you pay for.

Beyond a recognizable brand name, you'll want to pay attention to a prefab sub box's build and construction. Although you won't always be able to see inside a box, ask the salesperson at a store or the person you're buying the box from how it was constructed. What are the materials (wood, plastic, or fiberglass) and how is it held together (screws, nails, glue, or some combination of these)? Medium-density fiberboard (MDF) is the material of choice in construction of many subwoofer enclosures, and the thickness of the wood is also important. Look for sub boxes that are built with wood that's at least 5/8 of an inch thick. Ask to make sure that the interior of the box is *braced* or reinforced so that the walls don't flex.

You should also want to check out the type and quality of the terminals, where wire from an amplifier connects to the box (and hence the subwoofer). Some prefab boxes offer simple spring-loaded terminals, which you push down on to insert a bare speaker wire from an amplifier, whereas others provide higher quality gold-plated binding posts.

The finish on the outside of the box doesn't affect how it sounds, but it does affect how it looks in your vehicle's interior. Most prefab boxes are finished in automotive carpet, but some have cosmetic flourishes of fiberglass, vinyl, and other materials. Some prefab boxes also feature a see-through Plexiglas panel that allows a look at the sub inside. Prefab boxes can come with or without grilles, so ask if a grille is included. In general, it's always a good idea to have a grille to protect the subwoofer's cone from damage.

Power hitters

You can also get a prefab subwoofer box that comes with a built-in amplifier (as shown in Figure 16-2). Although these rarely sound as good as a custom sub box or even a good prefab box matched to a separate amplifier, they are a quick way to add bass to almost any ride.

Figure 16-2: Infinity's BassLink T powered subwoofer box.

Courtesy of Infinity

The advantages of amplified sub boxes are

- **Cost:** An all-in-one amplified subwoofer box is usually cheaper than buying a separate subwoofer box and an amplifier.
- **Convenience:** Amplified sub boxes are usually plug-and-play devices, so you don't have to hassle with installing an amplifier and then wiring it up the subwoofer. You typically just need to supply an amplified sub box with 12-volt power from the car's electrical system and a signal from an audio system. Some amplified sub boxes even have *high-level* or amplified inputs that allow them to be added to any stock stereo system. Plus, amplified sub boxes can be easily removed and moved to another vehicle.
- **Size:** Amplified sub boxes are typically compact and can fit easily into almost any car.

Space-specific subs

One of the challenges of adding a subwoofer box to a space-stingy vehicle such as a compact, sports car, or pickup is finding space for it. That's why companies started providing vehicle-specific sub boxes that fit snugly in a predetermined spot in a car interior. Some come with a subwoofer already loaded into the enclosure and some come without a sub. Whether it's behind the seat of a pickup truck or in the trunk or hatch of a car, vehicle-specific subwoofer boxes are perfect for those who want bass without taking up too much space, as well as a low-key appearance (as shown in Figure 16-3).

Figure 16-3: A JL Audio Stealthbox designed to fit in the hatch of a Chrysler PT Cruiser.

Courtesy of JL Audio

Going with a raw sub

In the early days of high-performance car audio, if you wanted low bass in your car, you had to find a *raw* or stand-alone subwoofer and figure out how to build an enclosure for it. Today, if you want the best possible bass in your ride, well, you *still* have to buy a raw subwoofer and build an enclosure for it. The good news is that dedicated car subwoofers are plentiful these days and you can find a huge amount of information available on how to build proper enclosures (some of it is just a click away on the Internet).

The purpose of a subwoofer box or *baffle* (a panel that holds a sub in place in a vehicle, such as a rear deck) is to separate the front sound wave (created when a subwoofer's cone moves forward) from the back wave (when the cone moves backwards). Acoustically speaking, the front wave and back wave of a speaker are mirror opposites of one another. (They are 180 degrees *out of phase*, in tech speak.) Without a box, the output from the rear wave cancels the output from the front wave, and vice versa, so you lose most of the output of the sub.

The relationship between an enclosure and a subwoofer is much more complex than just separating the front and rear waves. In the most simple terms, the air in an enclosure acts as a spring to provide resistance against the movement of a subwoofer's cone, and subwoofers are designed to work optimally within a given range of cone resistance.

The amount of air space required in an enclosure can range from less than a cubic foot to several cubic feet. In addition, certain subwoofers are designed to work best in certain types of enclosures. A sub that's designed to work, say, in a small sealed enclosure won't perform as well in a large vented enclosure. But the general trend in car audio has been to design subwoofers that work well in small enclosures so that they can better fit into a vehicle.

Discovering the Different Types of Enclosures

Several different enclosure types are used to house car audio subwoofers, and all have their advantages and disadvantages. The type you choose largely depends on the kind of sound and bass output you want to achieve, how much amplifier power you'll have available to drive the sub system, and how much space you have in your vehicle. Subwoofers are usually optimized for one type of enclosure or another, although some can work in more than one type of enclosure.

Infinite baffle

The most basic kind of subwoofer enclosure is really not an enclosure at all. Called *infinite baffle* or *free-air* (see Figure 16-4), this mounting configuration does indeed require an enclosure, but usually it's simply a car's trunk. Typically, the subwoofer is installed in a car's rear deck or on a baffle, usually a piece of wood, behind the rear seat.

The advantages of an infinite-baffle enclosure are the following:

- Simple and inexpensive because there's no box to build
- Takes up less space

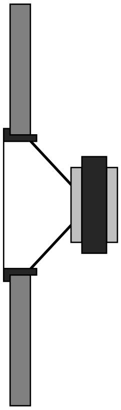


Figure 16-4: An infinite-baffle enclosure.

The disadvantages are

- Difficult to isolate the front and back waves of the subwoofer from each other because an infinite baffle isn't effectively sealed.
- Relatively larger power requirements as compared to other subwoofer enclosures, such as sealed enclosures.
- Less accurate sound because infinite-baffle configurations can sometimes sound a bit tubby (that is, not tight). *Tubby* is used to describe the sound of bass when it's not as controlled as it should be or not accurately reproduced — and you know the sound only if you know what the bass is supposed to sound like in the first place.

Sealed enclosures

Sealed enclosures (also called *air-suspension*, shown in Figure 16-5) are the simplest and easiest to construct. As the name implies, this type of enclosure is completely sealed so that the back wave of the subwoofer is isolated from the front wave.

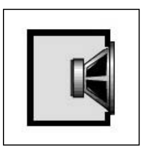


Figure 16-5: A sealed enclosure.

Courtesy of JL Audio

The advantages of a sealed subwoofer enclosure are the following:

- Simple to build
- More forgiving (enclosure size can be off by as much as 10 percent and the subwoofer will still perform well)
- Higher power handling
- Better transient response, meaning that the subwoofer can respond more quickly to changes in the music
- Smaller enclosure sizes; many of the subs that call for a small box are designed for sealed enclosures

The disadvantage is that they are less efficient, meaning that they require more power for the equivalent output of an alternative design.

Vented enclosures

A simple *vented* enclosure, also called *bass-reflex*, is identical to sealed enclosures except that it employs a *port* or hole to increase output or the amount of bass (see Figure 16-6). The rear wave of the subwoofer, as funneled through the port, is used to reinforce output or bass volume. Think of it as using both the front and back of the subwoofer's cone to help produce bass.

The port is typically a tube made of PVC plastic, and its diameter and length determines the frequency at which the enclosure is *tuned*. The subwoofer and box combination has a specific frequency at which it operates optimally, and this is referred to as the frequency at which the subwoofer system — the subwoofer and enclosure together — is tuned. If either the length or diameter of the port is changed, the tuning frequency will also change. So in a ported enclosure, it's extremely important to know the proper port dimensions — and use the proper sized port.

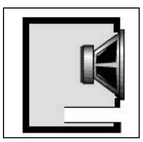


Figure 16-6: A vented or *ported* box design.

Courtesy of JL Audio

Vented enclosures have the following advantages:

- Above the port-tuning frequency (the frequency at which the subwoofer system performs optimally), a vented enclosure is much more efficient, meaning it takes less power to produce more sound.
- A vented enclosure also has very low distortion around the port-tuning frequency.

The disadvantages of vented enclosures are

- Below the port-tuning frequency, the subwoofer can become unstable, causing it to distort and even become damaged.
- More complex design and construction.
- Larger enclosure size, which means it will take up more room in your ride.
- The possibility of *port noise* caused by air rushing through the port.

Exotic vented enclosures

Beyond simple vented enclosures, there are more exotic vented designs called *bandpass* enclosures. Bandpass enclosures became popular in the late 1980s as a way for sound-off competitors to wring the most sound pressure level (SPL) possible out of a system. Simple sealed enclosures have now replaced these more esoteric designs.

TIP

The main benefit of using a bandpass enclosure is that the design features very high efficiency — meaning lots of bass — within a narrow range of frequencies, which is why they were a hit with the SPL crowd. The design is called bandpass because it filters out all frequencies except those in a narrow range, allowing only a certain *band* of frequencies to *pass*.

TECHNICAL STUFF

Variations of bandpass designs are called *orders*. The most basic is a *fourth-order* or *single-reflex* design, which is a two-chamber enclosure in which a subwoofer in a sealed chamber fires into a second vented enclosure (see Figure 16-7). In a sixth-order dual-reflex design, both chambers are ported (see Figure 16-8).

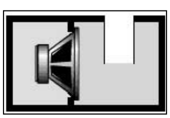
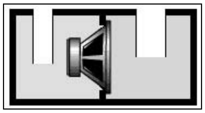


Figure 16-7: A fourth-order, single-reflex bandpass subwoofer enclosure.

Courtesy of JL Audio

Figure 16-8: A sixth-order, dual-reflex bandpass subwoofer enclosure.



Courtesy of JL Audio

The advantage of bandpass enclosures is that they offer a very high efficiency over a narrow frequency range.

Their disadvantages include the following:

- Narrow frequency response
- Very complex enclosure design
- Large enclosure size
- Decreased power handling

Checking Out Subwoofer Specs

Like many other components, subwoofers come with a list of specs that help you compare different subs when shopping. Because subwoofers also require enclosures, there's a whole slew of specs that relate to how a sub will behave in a box. Known as Thiele-Small parameters, these specs are difficult even for the most learned enthusiast to interpret and comprehend.

In the next few sections, I cover the most general and important subwoofer specs you should pay attention to.

Frequency response

TECHNICAL STUFF

Frequency response is a measure of the frequency range that a subwoofer can accurately reproduce. For a 10-inch subwoofer, a frequency response spec will look like this:

```
30 Hz to 700 Hz
```

This means that the subwoofer reproduces sounds ranging from 30 Hz to 700 Hz, although you may only use the subwoofer to reproduce sounds from, say, 30 to 100 Hz.

Power handling

This is a measure of the amount of power a subwoofer can handle, in watts, and lets you know how much amplifier power is required to effectively *drive* the speaker. For a 10-inch subwoofer, the power-handling spec may look like this:

```
Peak power 900 watts, continuous power 300 watts
```

This means that 900 watts is the maximum amount of power you'll want to supply to the sub. More power could cause the sub to distort or become damaged or *blown*. The continuous rating is the average amount of power the sub can handle and indicates how much power you'll need to efficiently drive the sub.

A subwoofer is as likely to fail from getting too little power as it is from getting too much power. A subwoofer is *under-driven* when an amplifier runs out of juice (if, for example, the amplifier is mismatched to the sub) and begins to *clip* or distort the audio signal. It's this distortion that is most likely to damage a subwoofer, so make sure you drive a subwoofer with sufficient power.

Car audio manufacturers sometimes *massage* specs to make them compare more favorably with competitive speakers. So consumers can compare subwoofer specs, the Mobile Electronics division of the Consumer Electronics Association, the trade group representing the consumer-electronics industry, came up with the CEA-2031 standard. To participate, manufacturers must obtain subwoofer power-handling specs using a uniform method defined by the standard, so that consumers can compare apples to apples. CEA-2031 is a voluntary standard and only a handful of manufacturers have signed on to the program at this point. Still, look for the CEA-2031 logo, shown in Figure 16-9, if you want to be absolutely sure that a subwoofer's power-handling spec is legit.

Figure 16-9: The CEA-2031 logo.

Sensitivity

Sensitivity or efficiency indicates how much power a subwoofer needs to achieve a relative volume level and tells you how loud the sub will play when provided a certain amount of power. Subs with a higher sensitivity rating need less power to play loud, and those with lower sensitivity need more.

The sensitivity spec is obtained by supplying a subwoofer with 1 watt of power and measuring the output in decibels (dB), with a microphone 1 meter away. A sensitivity spec usually looks like this:

```
85 dB (1 watt/one meter)
```

This means that the subwoofer puts out 85 dB of sound-pressure level (SPL), measured 1 meter away, when fed a 1-watt signal.

Sensitivity is the best indication of how much amplifier power you'll need to drive a subwoofer. Low-power amps work better with subwoofers with a higher sensitivity rating, whereas high-power amps are required with less-sensitive subwoofers.

Physical specs

A subwoofer's physical specs are also important because they tell you the size of the sub and other information. Physical specs include

- **Mounting depth or displacement:** How deep the sub's frame or basket extends into an enclosure
- **Mounting diameter:** How large a hole needs to be cut into a baffle to hold the sub
- **Enclosure volume or size:** The volume or *air space* required in an enclosure

Impedance

For most car speakers, impedance isn't usually a concern because almost all of them have a 4-ohm impedance. But with subwoofers, impedance plays a very crucial role. *Impedance* is a measure of how much resistance a subwoofer presents to the power flowing from the amplifier, and is often referred to as the *load* a sub places on an amp. Another way to think of impedance is how much a speaker restricts flow of power from an amplifier. The higher the impedance, the more the power from the amplifier is restricted, and the lower the impedance, the less the power from the amplifier is restricted.

Impedance is an important subwoofer spec because, depending on a subwoofer's impedance and the way the subwoofer is wired to an amplifier, it causes the amp to increase or decrease its power output. In general, most car audio amps produce more power with every halving of impedance — up to a point, that is.

For example, if a two-channel or stereo amplifier produces 60 watts x 2 into a 4-ohm load, it may produce around 75 watts into a 2-ohm load. When the two channels are bridged to form a single channel, meaning the two separate stereo channels are combined into one *mono* channel, the power more than doubles to about 150 watts.

But the amplifier has to be *stable* at that load, meaning it has been designed to operate at that impedance. Otherwise, the amp is being asked to perform beyond its design capabilities and either shuts down (if it has protection circuitry) or it fries (if it does not). Some amps, called *high current amps*, can drive loads as low as half an ohm (although these are usually specialized for sound-off competitors who are trying to squeeze every last drop of power out of their systems, and they often require an upgrade of a car's charging system).

The various ways in which subs can be wired to an amplifier are the determining factors of the final impedance at the amplifier's outputs, and therefore the ultimate power output of the amp. That's why you see amplifiers rated at different impedances. For example, the same 120-watt stereo amplifier mentioned earlier may have power ratings that look like this:

```
60 watts x 2 into 4 ohms
75 watts x 2 into 2 ohms
150 watts x 1 into 4 ohms
```

Almost all car audio amplifiers are designed to produce their optimum power output into a specific impedance. If the impedance goes up past that optimum point, the amp performs less powerfully and you're not getting all the power you paid for. If the amp is driven into a lower impedance than it's capable of handling, it could either shut down, if built-in protection circuitry kicks in, or become damaged, if it does not.

Another important thing to know about amplifiers in relation to subwoofers is that subs are almost always driven in mono as opposed to stereo. That's because stereo separation cannot be detected at low frequencies. That's why it's common to bridge two channels of a stereo amp or a mutichannel amp to form a single mono channel to power a sub, and why mono block subwoofer amps are often used to power subwoofers. (*Mono block* is just a fancy way of describing a single-channel amplifier, and the terminology came from the high-end home audio world, in which mono block amps are preferred for powering all speakers.) As mentioned earlier, a single bridged channel of an amp is usually about twice as powerful as two separate stereo channels if all are driving the same load, which is a good thing because subwoofers require roughly twice the power of other speakers.

Wiring Your Subwoofers

Before I get into how subwoofers are connected to an amplifier, I want to take a moment to cover how a subwoofer works. The voice coil attaches to a subwoofer's cone at the tapered end. Alternating current (AC), which is the electrical *analog* or representation of music produced by the head unit, flows from an amplifier's outputs through speaker wire to the sub's terminals, which are in turn attached to the voice coil.

As current from the amp flows through the voice coil, the electrical charge causes the voice coil to react to the magnetic field of the subwoofer's fixed magnet. Positive current makes the sub's cone move forward or outward, whereas negative current makes the cone move back or inward. The movement of the cone compresses and decompresses the air in the listening space, producing pressure waves we perceive as sound. Depending on the speed at which it moves, the cone produces sounds at various frequencies. The *frequency* or number of times a cone moves per second is measured in Hertz (Hz).

As I cover the intricacies of subwoofer wiring, the important thing to keep in mind is the impedance or load that the amplifier ultimately *sees*. In a sense, the amp doesn't really care how many subwoofers are sucking power from it, as long as it still gets the impedance it was designed to drive. The different wiring schemes are simply a way to load an amplifier so that it works at its maximum potential and reproduces an audio signal accurately and reliably.

The way to wire a single subwoofer to an amplifier is to connect the positive *lead* or wire from the amplifier to the positive terminal of the subwoofer, and the negative lead to the negative terminal (see Figure 16-10). If it's a 4-ohm subwoofer, the amplifier sees a 4-ohm load. Using the previous example of a 120-watt stereo amplifier (60 watts x 2), if the two channels are bridged to mono, the amp sends about 150 watts to the subwoofer.

If you want to hook up more than one single voice coil (SVC) subwoofer to this same amplifier, you have a couple of driver-to-driver or subwoofer-to subwoofer wiring options, known as series and parallel, which I discuss in the next couple of sections.

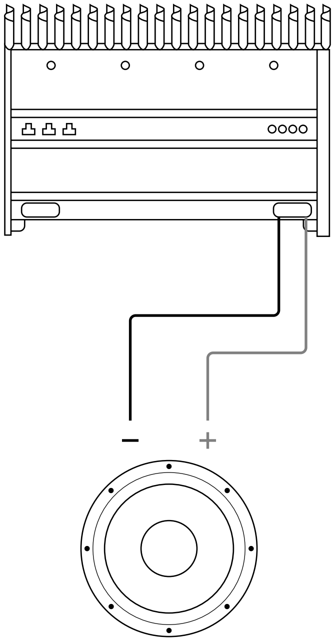


Figure 16-10: Single subwoofer wired to an amplifier.

Courtesy of JL Audio

Series wiring

With series wiring, the positive lead from the amplifier is connected to the positive terminal on *one* of the two subwoofers and the negative lead to the negative terminal of the other subwoofer, and then another wire runs between the remaining positive and negative terminals to complete the circuit. This causes the impedance to double. If you are using two 4-ohm subs, the amp sees an 8-ohm load. When possible, you should avoid series wiring between different subwoofers because it can cause non-linear behavior (for example, distortion) in certain cases.

Parallel wiring

With parallel wiring of two subwoofers to a single amplifier, the positive lead of the amplifier is connected to each of the positive terminals of the subwoofers, and the negative lead is attached to each negative terminal of the subwoofers (see Figure 16-11). This causes the impedance to be halved. If you are using two 4-ohm subwoofers, the amplifier sees a 2-ohm load.

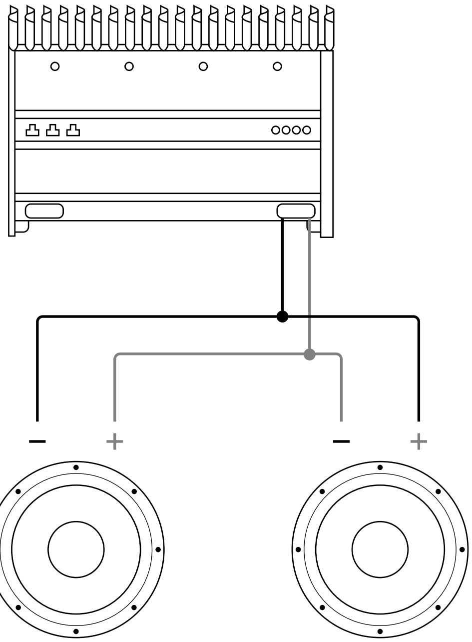


Figure 16-11: Parallel wiring of two subwoofers.

Because subwoofers come in 8-, 4- and even 2-ohm versions, by matching the impedance of the subwoofers and then wiring them in either series or parallel to raise or lower the impedance, a subwoofer system can be configured to make the amplifier perform at its optimum impedance.

TIP

In the series wiring example in the previous section, if you replaced the 4-ohm subs with 2-ohm subs, you'd end up with a 4-ohm load, which would produce more power. In the parallel wiring example, if you replaced the 4-ohm subs with 8-ohm subs, you'd also end up with a 4-ohm load.

Dual voice coil subwoofers

Dual voice coil (DVC) subwoofers offer even more flexibility. A DVC subwoofer has two separate voice coils that can be connected independently. With multiple subwoofers, DVC subs allow for not only series and parallel wiring, but a combination of the two called *series/parallel* wiring.

TECHNICAL STUFF

When a single DVC sub is wired to an amplifier in series, with the positive lead of the amplifier connected to the positive terminal of the subwoofer, and the negative lead of the amplifier connected to the negative terminal, and with a separate wire connecting the remaining two positive and negative terminals (see Figure 16-12), the impedance is doubled. For example, a 4-ohm DVC sub presents an 8-ohm load to the amplifier when the voice coils are wired in series.

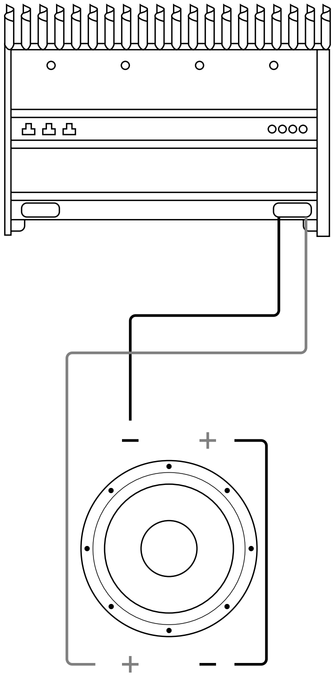


Figure 16-12: A dual voice coil 4-ohm subwoofer wired in series.

With parallel wiring of a DVC subwoofer, meaning that the positive lead of the amplifier is connected to both of the positive terminals of the subwoofer and the negative leads are connected to both of the negative terminals (see Figure 16-13), the impedance is half that of each individual coil. For instance, a dual 4-ohm subwoofer presents a 2-ohm load to the amplifier when the voice coils are wired in parallel.

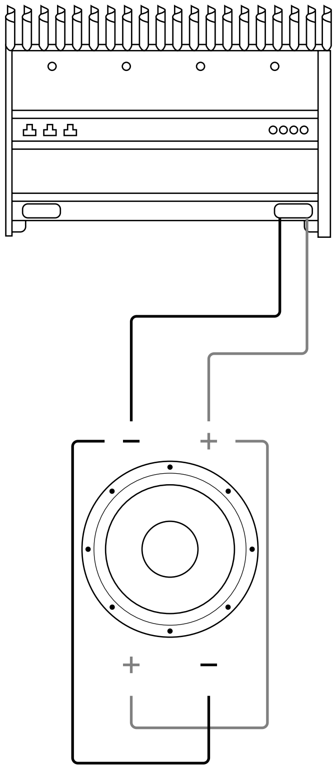


Figure 16-13: A dual voice coil 4-ohm subwoofer wired in parallel.

Courtesy of JL Audio

TECHNICAL STUFF

If you want to end up with a 4-ohm load at the amplifier, you can wire the two DVC subs in a series/parallel configuration. The positive lead of the amplifier is connected to two of the four positive terminals of the DVC subwoofers, and the negative lead of the amplifier is connected to two of the negative terminals of the subs, and the remaining pairs of the positive and negative terminals are wired together (see Figure 16-14). With series/parallel wiring with a pair of 4-ohm DVC subs, the impedance remains the same and the same dual 4-ohm subwoofers present a 4-ohm load to the amplifier.

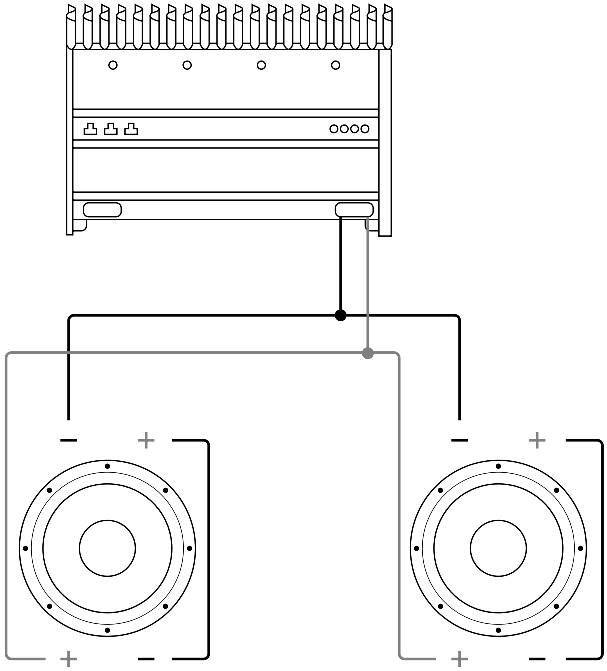


Figure 16-14: Two dual voice coil 4-ohm subwoofers wired in series/ parallel.

Courtesy of JL Audio

Why all this wiring?

Although this may seem like one big conspiracy to sell more speaker wire, the various connection schemes of DVC subs allows for flexibility when wiring subs to an amplifier. As mentioned previously, an amplifier doesn't care how many subs it's powering, as long as it *sees* the impedance that it needs to operate at its best. So the myriad connection schemes allow adding more subwoofers to get more bass without adding more amplifiers to power them.

An 8-ohm SVC subwoofer and a DVC 4-ohm sub look the same to the amp, for example. The advantage of the DVC 4-ohm sub is that it can be configured as an 8-ohm sub (with its two coils wired in series) or as a 2-ohm sub (with the two coils wired in parallel), whereas the 8-ohm SVC sub is capable of only one impedance.

If you're using an amplifier that's designed to run at higher impedances, either the 4-ohm DVC or the 8-ohm SVC sub should work fine. But if your amplifier is designed to produce optimum power at lower impedances, using the DVC 4-ohm sub and connecting the voice coils in parallel to yield a 2-ohm impedance is the way to go.

With a pair of the DVC 4-ohm subs, you can wire the voice coils of each driver in series and the subs in parallel and get a final 4-ohm impedance. Or you could wire the voice coils of each driver in parallel and the drivers in parallel for a final 1-ohm impedance. With two SVC 8-ohm drivers, you can only achieve a 4-ohm final impedance, because all driver-to-driver wiring should be done in parallel. (Remember when I mentioned earlier that series wiring between different subwoofers should be avoided because it can cause distortion in certain cases?)

Building Yourself a Sub Box

One reason to choose a simple sealed enclosure for your sub box is that you can easily build one yourself if you're handy and have the right tools. Building your own enclosure can potentially save you money, and you can build it and finish it the way you want. Plus, you'll get the satisfaction of doing it on your own and you'll learn a lot along the way.

Make sure you follow the subwoofer manufacturer's instructions on enclosure size. Otherwise, if you try to squeeze a 15-inch subwoofer into a box that's too small, or you place five 10-inch subwoofers in a box that takes up the entire bed of your pickup, you likely won't be happy with the quality of the bass!

Building the proper size enclosure means making sure it has the amount of air space inside as required by the subwoofer, per the sub manufacturer's specifications. While this takes some basic mathematics skills, you can take the guesswork out by using one of the online subwoofer-box calculators. (See the "Measuring air" sidebar earlier in this chapter.)

This basic step-by-step guide can't possibly cover everything you may encounter when building your sub box, so you may want to have someone with box-building experience help you. You can also find some great

Measuring air

How do you calculate the volume or amount of air space in a subwoofer enclosure? You can try recalling some of the basic math from high school, or, if you like doing things the easy way, just use one of the subwoofer box calculators online that even takes into account the volume of the sub.

Point your browser to Basic Car Audio Electronics (`www.bcae1.com/spboxnew2.htm`) or The 12 Volt.com (`www.the12volt.com/caraudio/boxcalcs.asp`) and you'll be on your way.

resources on the Web, such as CarStereo.com (www.carstereo.com), Basic Car Audio Electronics (www.bcae1.com), and Car Audio Help (www.caraudiohelp.com). Several online forums also provide DIY installation advice and tips, including rec.audio.car, www.mobileaudio.com, www.caraudioforum.com, and www.sounddomain.com.

WARNING!

To prevent injuries while building your box, be sure to follow these precautions:

- Always wear safety goggles.
- Never operate power tools unless you have experience.
- Consult the owner's manual and instructions for any tools or materials you use.

Gathering your tools and materials

To build a simple sealed enclosure, you'll need

- A tape measure for measuring the wood
- A pencil for drawing cut lines
- A compass for marking the speaker cutout
- A table saw, circular saw, or hand saw for cutting wood
- A jigsaw for cutting the speaker opening
- An electric drill for drilling holes
- A screwdriver for installing screws (you can also use a drill)
- A caulking gun for sealing the seams of the box
- A razor knife for trimming the finishing material

TIP

Fiberboard is the ideal material for building an enclosure, and many installers favor medium-density fiberboard (MDF). Don't mistake particleboard for fiberboard, although they are similar in appearance. The temperature extremes that occur regularly in a car can cause particleboard to warp and split. Particleboard also doesn't have the *tensile strength* (the measure of the force it takes for a material to break apart) of fiberboard. Therefore, it can't stand up to the extreme vibrations caused by a subwoofer and can add resonance or vibrations that effect the performance of the subwoofer. You can also use plywood for your enclosure. It's less dense than fiberboard, but has the advantage of weighing less.

Wood at least 5/8-inch thick is recommended, but thicker is usually better, up to a point. Unless you're constructing an enclosure that will house several subwoofers, you shouldn't need to use wood more than one inch thick.

Use screws to join the pieces of wood together instead of nails because nails can loosen over time with steady abuse and vibration. You'll also need carpenter's glue to initially attach the sides of the box and silicone sealant to seal the seams.

If you don't want a rough wooden box, you'll need to choose some sort of finishing material, such as carpeting (trunk liner carpeting usually works best), and use spray adhesive to attach it the box. You'll also need a *terminal cup*, which is a piece of hardware that fits into the box. The subwoofer's speaker terminals attach to it via speaker wire, and the terminal cup in turn attaches to an amplifier's power leads. A terminal cup can be found at Radio Shack or any other electrical supply store.

Building the box

Trace and mark each part of the enclosure on the wood before you cut it. After you've cut each section, temporarily assemble the box to make sure the pieces fit together. If everything looks okay, you're ready to assemble the box:

1. **Make sure all of the joints are free of debris and then carefully run a bead of carpenter's glue along the line for the first joint.**

   The type of joint you use isn't as important as making sure the box is airtight.

2. **Attach the first two sides of the box and join them with screws every 6 inches.**

   Drilling pilot holes before you insert the screws is a good idea to keep the wood from splitting.

3. **Assemble all sides of the box except for the baffle, which is the panel that the subwoofer will attach to.**

4. **Before installing the baffle, use a caulking gun to run a bead of silicone along the inside of each joint for an airtight seal.**

   Air leaks can reduce power handling and cause distortion. After the box is sealed, you can attached the baffle and then cut the hole for the speaker.

5. **Determine the center of the hole for the subwoofer and sketch a circle of the appropriate diameter using a compass.**

6. **Make a series of 3/8-inch starter holes with a drill and then cut out the hole for the sub using a jigsaw.**
7. **After you've cut the speaker openings, reach into the enclosure and, using your index finger, seal the inside joints of the baffle with silicone.**
8. **(Optional.) Some installers line the inside of a box with 1 to 2 inches of polyfill, which you can find at fabric stores.**

   This makes the sub think that the box is larger by absorbing or *slowing down* some of the sound waves inside the box if you inadvertently built it smaller than the sub's specs call for.

Mounting the subwoofer

Before mounting the speaker to the baffle, you need to create a hole in the enclosure's rear panel, typically at the bottom, for the terminal cup. After cutting the hole to the exact size of the terminal cup with a jig saw, slide the cup in and seal the area around it, inside and out, with silicone.

Now you're ready to install the subwoofer:

1. **Place the subwoofer in the hole in the baffle and mark the location of each screw hole with a pencil.**
2. **Remove the sub and drill pilot holes.**
3. **Be sure to remove all wood shavings and any other debris from inside the box before securing the subwoofer.**
4. **Connect speaker wire to the subwoofer, paying close attention to the polarity to make sure you connect the positive wire to the positive terminal and the negative to the negative.**
5. **Secure the subwoofer to the baffle with screws, being careful not to run any of them through the cone of the subwoofer!**
6. **(Optional.) At this point, most people cover a sub box in an automotive-style carpeting, which is available at an auto-parts store or online.**

   Auto Carpet Direct at `www.automotivecarpet.com` is one such source; Installer.com at `www.installer.com`, is another. Carpeting isn't your only choice of material for covering your subwoofer enclosure. You can get as creative as you like and use vinyl, Formica, or even mirrored Plexiglas. Spray adhesive is typically used to bond the carpeting to the enclosure, and a razor knife can be used to trim excess material.

Securing your sub

TIP

Whether you use a grille over the subwoofer is purely a matter of personal preference, although it's usually a good idea to protect the sub's cone. You'll also want to secure your enclosure so that it doesn't go flying when you make a sudden stop or a sharp turn. L-brackets, a piece of hardware that's shaped like the letter L with screw holes on each side, are great for securing a sub box. Attach one side of the L bracket to the box and the other side to the car. Just be careful when drilling holes into your car!

Chapter 17

Equalizing, Processing, and Crossing Over

In This Chapter

- Tweaking with equalizers and processors
- Using processors for OEM integration
- Understanding crossovers
- Installing equalizers and crossovers

The interior of a vehicle is one of the worst possible places in which to achieve good sound reproduction. Vehicle occupants sit too close to some speakers and too far away from others. A car's interior is made of hard surfaces, like glass, that reflect sound and soft surfaces, like upholstery, that absorb it. Add to that road noise, wind noise, and engine noise, and you have an environment that is downright hostile to high-quality sound.

Although it's possible to design a system that helps compensate for these enemies of hi-fi — by pumping up the bass to mask low-frequency road noise or locating speakers so that they don't bounce off glass, for example — the best way to alleviate if not eliminate these anomalies is by using car audio equalizers and signal processors.

Included in the category of car audio equalizers and signal processors — quite literally since they are sometimes built in — are crossovers, which direct specific frequencies to specific speakers. Crossovers can either be active or passive, and many times a high-end car audio system uses both.

Finally, a recent trend in car audio is OEM integration, which means upgrading a stock stereo system with aftermarket components. Some car owners want to keep the factory look and functionality along with their stock head unit. And because stock head units have become more sophisticated and more integrated into the dash, you can no longer simply remove a head unit and start your installation from scratch. And simply taking the *high-level* or amplified signal out of a head unit isn't always straightforward. That's where the latest generation of OEM-integration processors come in.

All Things Being Equal: Equalizers

Years ago, an EQ booster was a standard part of any car audio enthusiast's arsenal. Back before high-power amplifiers became available, an under-dash EQ booster served the dual purpose of adding a bit of extra power to a system and providing a crude means of adjusting the overall sound. But EQ boosters couldn't produce any more power than an in-dash receiver and their signal processing capabilities were very limited compared to today's high-tech equalizers, so they've fallen out of favor with most enthusiasts.

One school of thought that believes that if a car audio system is designed and installed properly, there's no need for an equalizer or processor. After all, no amount of equalization can compensate for a system that's poorly designed and installed. Instead, use of an equalizer or processor should be thought of as seasoning to a well-prepared meal and therefore used sparingly. An equalizer is designed to fine-tune a system and make small corrections, not compensate for problems caused by poor design or improper installation.

Divide and equalize

By now, you're probably wondering exactly what it is that an equalizer equalizes. Every sound you hear, including music, is part of the audible frequency range, which for humans is roughly from 20 Hz to 22,000 Hz. Below 20 Hz, you don't so much hear sounds as feel them, which is why low bass has such as visceral, body-massaging quality. Above 22,000 Hz are sounds that only animals such as dogs can hear, which explains why those silent dog whistles work. Very few adults can actually hear sounds around 20,000 Hz anyway because high-frequency hearing quickly degrades with age.

A perfect car audio system would produce the entire frequency range with a *flat,* or even, response from 20 Hz to 22,000 Hz, with no deviation. But audio equipment and particularly speakers are far from perfect. Maybe that's a good thing because a flat frequency response sounds . . . well, flat. After all, who doesn't want to crank the bass a bit every now and then even if it's not balanced perfectly with the rest of the system?

A relatively flat frequency response — one with an equal *amplitude* or signal strength across the audible frequency spectrum — is the ideal, but it does not define a good-sounding car audio system. Instead, it's an ideal to shoot for, and an equalizer, which allows *tweaking* or adjusting the frequency response of a system far beyond the simple tone controls for bass and treble found on a head unit, lets you get closer to that ideal.

Equalizers do this by *boosting* (increasing) or *cutting* (decreasing) the *gain* or amplitude of an audio signal within a *band* (range) of frequencies. Equalizers may have several frequency bands that are *fixed* or unalterable, or may allow adjusting the *center* frequency, which is the primary frequency at which the adjustment takes place.

The segment of the audio spectrum that a frequency band covers, say 50 to 100 Hz, is known as the *bandwidth*. Related to bandwidth is an equalizer's *Q* factor, which defines the way in which the range of frequencies within a band of control are affected. A smaller Q means a wider range of frequencies are affected by an adjustment of the equalizer, whereas a larger Q means a narrower range of frequencies are affected.

One more tech term you should be familiar with is *octave*. Octave is a musical term that refers to an interval between one musical note and another that's half or double its frequency. So if 100 to 200 Hz is one octave, 200 to 400 Hz is another, and 400 to 800 Hz is the next. The most sophisticated equalizers are known as *one-third octave* because their bands are spaced one-third of an octave apart, as opposed to basic EQs that spread control over several octaves and allow less precise adjustments.

Types of equalization

Beyond where they're mounted (in-dash or in a trunk), car audio equalizers are generally classified in one of three types:

- **Graphic:** These types of equalizers have a set of fixed frequency bands over which adjustment is allowed (see Figure 17-1). The term *graphic* relates to the fact that you can see a graphic representation of what the equalization curve or response is supposed to look like because the sliders or controls on a graphic EQ are set in a way that mimics the amount of boost or cut at each center frequency.

Figure 17-1: A discontinued Pioneer graphic equalizer.

Courtesy of Pioneer

- **Parametric:** Parametric equalizers (see Figure 17-2) allow adjustment not only within a certain frequency range, as with a graphic EQ, but also permit varying the center frequency at which the adjustment takes place. Some also allow varying the Q factor of the affected frequencies.
- **Quasi-parametric:** These equalizers allow adjustment of the center frequencies but do not offer adjustment of the Q factor of an equalizer (see Figure 17-3).

Types of equalizers

Equalizers are also categorized by where in the vehicle they are usually placed: the dashboard or the car's trunk.

Figure 17-2: An Audio-Control parametric equalizer.

Courtesy of AudioControl

Figure 17-3: A Kicker quasi-parametric in-dash equalizer.

Courtesy of Kicker

In-dash equalizers

For years, most in-dash equalizers (see Figure 17-1) were graphic EQs and were basically the descendents of EQ boosters. (In other words, no serious car audiophile would be caught dead with one.) But many modern in-dash EQs are of the parametric variety and offer added-value features (see Figure 17-3), such as subwoofer crossovers (which allow adjusting the amount and character of bass via the amplifier that's driving the subwoofer) and auxiliary inputs (that allow adding another audio source, such as an iPod). The biggest advantage of in-dash EQs is that they allow making adjustments on the fly.

Trunk-mount equalizers

These equalizers have their roots in the *pro* sound world, mixing for concerts and in recording studios. They are typically much more sophisticated than in-dash equalizers and allow more precise control over a system. They are also usually more expensive. Trunk-mount equalizers (see Figure 17-2) are usually one-third octave equalizers and are of the *set it and forget* variety. To adjust them properly usually requires an excellent ear or a device called a *real-time analyzer* (RTA) that measures sound, or both.

TIP

Some aftermarket and even factory car audio head units also have simple graphic equalizers built in. Although they can be helpful in tweaking a system, they are limited in their function and scope.

Signal processors

Car audio signal processors come in a wide variety of prices and offer a broad range of features (see Figure 17-4). Some do only one or two things (such as boost bass or increase the *line-level* or un-amplified signal from a head unit so that the overall system has less noise), whereas others do everything from equalization to *time alignment*, which is delaying the signal going to certain speakers so that the sound from all the speakers in a system arrives at a listeners' ears simultaneously.

Other functions you'll find on car audio signal processors include

- Surround-sound processing for movies and music
- Soundfield processing that adds effects to recreate the sound of a certain space, such as a cathedral, concert hall, stadium, or jazz club
- Crossover that sends certain frequencies to certain speakers
- Additional inputs for adding auxiliary audio sources such as an iPod or other portable music player
- Circuitry that enhances the sound of compressed-audio formats such as MP3

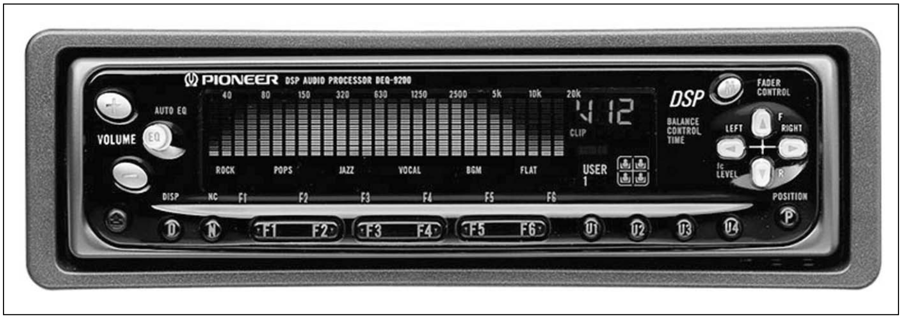


Figure 17-4: A Pioneer in-dash signal processor.

Courtesy of Pioneer

OEM integration processors

These days, more and more people want to hang onto their stock head units, because either they're leasing the vehicle and can't alter it, the head's a hassle to remove, or they don't want to lose some of the functions tied into the factory radio. The tricky part is that they still want better sound than the factory system offers. This can be accomplished by adding components *downstream* of the stock head.

Devices called *line-level converters* that can take a stock head unit's *high-level* or amplified signal and bring it down to *line* or un-amplified level have been around for quite awhile. But some of the latest OEM systems add equalization that's designed to work only with the components in the stock system. So a new generation of OEM-integration processors has become available to filter out this equalization, which can wreak havoc on an aftermarket system (see Figure 17-5). Alpine's latest OEM-integration processor, the PXE-H650H (see Figure 17-6), even comes with a microphone that *listens* for sonic anomalies and makes corrections to compensate for them.

Figure 17-5: JL Audio's CleanSweep OEM-integration processor.

Courtesy of JL Audio

Figure 17-6: Alpine's PXE-H650 OEM-integration processor, with microphone.

Courtesy of Alpine

Crossovers: Signal Traffic Cops

Not every speaker can play every frequency: Tweeters can't woof and subwoofers can't tweet. The signal that comes out of a car audio head unit is *full range*, meaning that it contains the full range of frequencies in a given piece of music or program material, from the lowest lows to the highest highs. Because a high-end car audio system usually consists of specialized speakers — subwoofers, midranges, and tweeters — that reproduce certain frequencies, there has to be a way for those frequencies to get separated and sent out to the appropriate speakers. That's the job of crossovers, which act like signal traffic cops in a car audio system.

Crossovers come in two types, active and passive.

Get active

Active or electronic crossovers are always placed *before* the amplifiers in the car audio signal chain, and divide the audio signal when it's still at line level or un-amplified (see Figure 17-7). Many amplifiers have an active crossover built in so you don't need to add a separate component. They're called *active* because electronic crossovers require a power source to work.

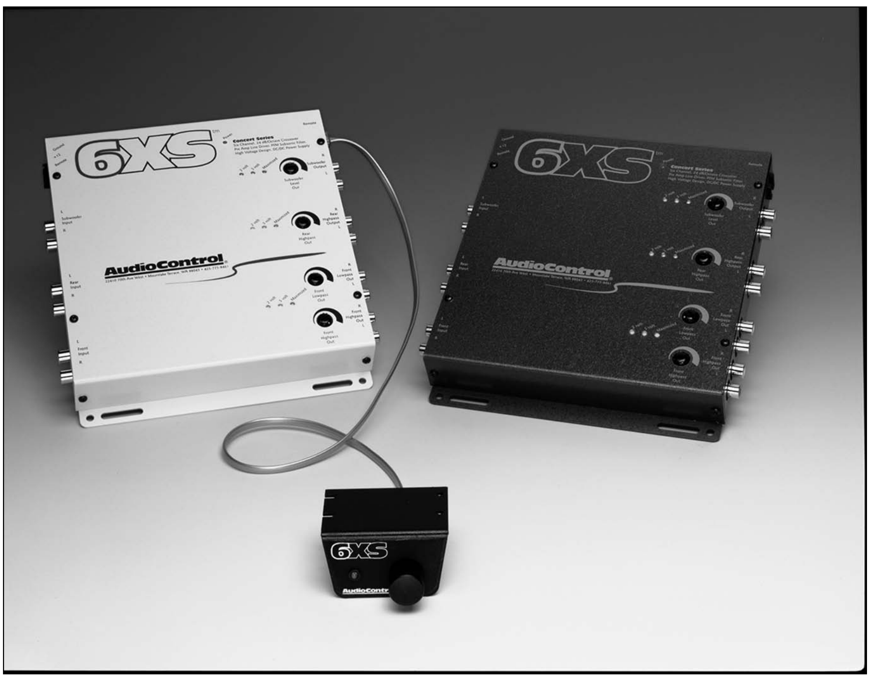


Figure 17-7: An AudioControl electronic crossover.

Courtesy of AudioControl

Passive resistance

Passive crossovers come *after* the amplifiers (but before the speakers) and filter an amplified signal. Passive crossovers are typically included with speakers that offer more than one driver, such as component sets (see Figure 17-8).

Although more expensive coaxials come with outboard or separate passive crossovers, more typically, a small and simple filter called a *capacitor* blocks the low frequencies going to the tweeters and the midrange gets a full-range signal. The passive crossover *networks* that come with component speakers, on the other hand, include components called *inductors* that block high frequencies from the midrange. Many passive crossover networks allow adjustment of the crossover *point* and *slope,* which I cover in the following section.

Points, slopes, and orders

The crossover point refers to the frequency at which a signal begins to be *attenuated* or reduced by the crossover. For example, 75 Hz is a common crossover point for subwoofers, meaning that the signal begins to be reduced at above 75 Hz.

The crossover slope refers to the rate at which the signal is reduced or *rolled off* beyond the crossover point. This always occurs in multiples of 6 decibels (dB), and the higher the decibels, the steeper the slope (see Figure 17-9). Slopes are also referred to as *orders*: A first-order crossover has a 6-dB-per-octave slope, a second-order a 12-dB-per-octave slope, and so on.

Figure 17-8: An Infinity component speaker set with passive crossovers.

Courtesy of Infinity

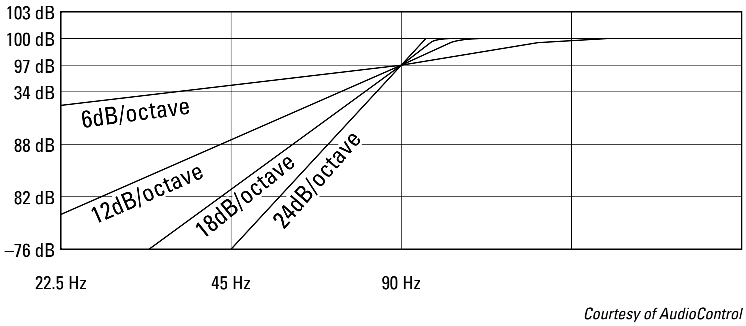


Figure 17-9: An example of a 6-, 12-, 18-, and 24-dB-per-octave crossover slope of a high-pass filter.

Many car audio systems use an electronic crossover to divide the full-range signal from the head unit to individual amps. In other systems, a full-range signal is sent to each amp that has a built-in crossover. Usually a component speaker set's passive crossovers further divide the signal between the midranges and tweeters. Very rarely are active crossovers used to entirely filter the signals in a system.

TIP

It's almost always preferable to use the passive crossovers that are included with a set of speakers because they were designed specifically for the speaker's response characteristics.

Crossover types

Crossovers come in three basic configurations:

- **Low-pass crossovers** (also called subwoofer crossovers) filter out all but low frequencies for subwoofers.
- **High-pass crossovers** filter out all but high frequencies for tweeters.
- **Bandpass crossovers** filter out all but a predetermined *band* of frequencies, usually in the midrange area.

Electronic crossovers can include all three types of crossovers, whereas passive crossovers usually just include a low-pass or high-pass section.

Installing Equalizers

Equalizers and crossovers are straightforward components to install. The hardest part is deciding where to mount them because space is usually at a premium in most vehicles.

An equalizer is always installed between a head unit and an amplifier. Some require a *preamp* or un-amplified signal, although some can accept an amplified signal from a stock head unit. Where you mount your EQ largely depends on what type it is: in-dash or remote-mount.

In-dash EQs

If you have the space, an in-dash EQ can be mounted above or below your head unit. Depending on the configuration of your dash, this could be an easy task or require hours of custom work. If you have room in your dash, some installation *kits,* which are brackets that hold a head unit in the dash, also have a slot for an EQ (see Figure 17-10). If you don't have much room, you'll have to have the equalizer custom-fitted in the dash, which is a task best left to a professional installer. Another option is to mount the EQ below the dash using an under-dash mounting kit.

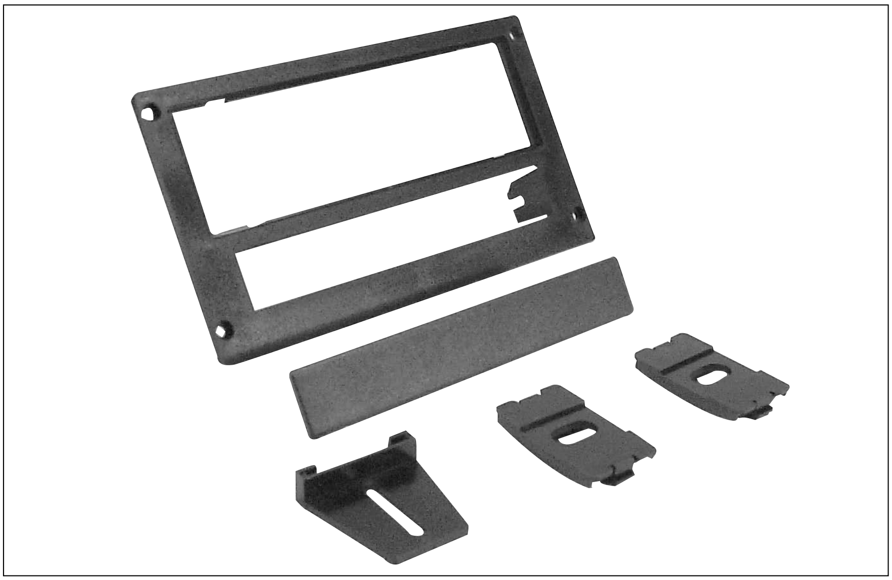


Figure 17-10: A Scosche installation kit with a slot for an in-dash equalizer.

Courtesy of Scosche

Remote-mount EQs

A remote-mount equalizer is usually installed alongside a car audio system's amplifiers. This makes it easy if you decide to add more amps later on because you can make a short wire *run* from the equalizer to the new amp — as opposed to running the wire from, say, under a seat if the EQ is mounted there to the trunk where the amps are installed. You should also locate the equalizer where it's easily accessible because you'll want to make adjustments to it.

Mounting your equalizer directly to the metal body of the car could cause it to pick up noise that radiates through a car's chassis. Instead, attach it to a wooden board that's in turn attached to the car body. Be careful where you drill holes in your vehicle and always be sure you know what's on the other side!

Installing Crossovers

How and where you mount your crossovers depends on whether you use active or passive crossovers. A good reason to use an amplifier with a built-in crossover is that you don't have to find an extra place to mount another component or run additional wires.

Electronic crossovers

Installing an electronic crossover is much like installing a remote-mount equalizer: You'll typically want to mount it with the amplifiers to make it easy to add more amps in the future and easy to make adjustments to the crossover. As with an EQ, you want to mount an electronic crossover on a board and not directly to the metal body of the car.

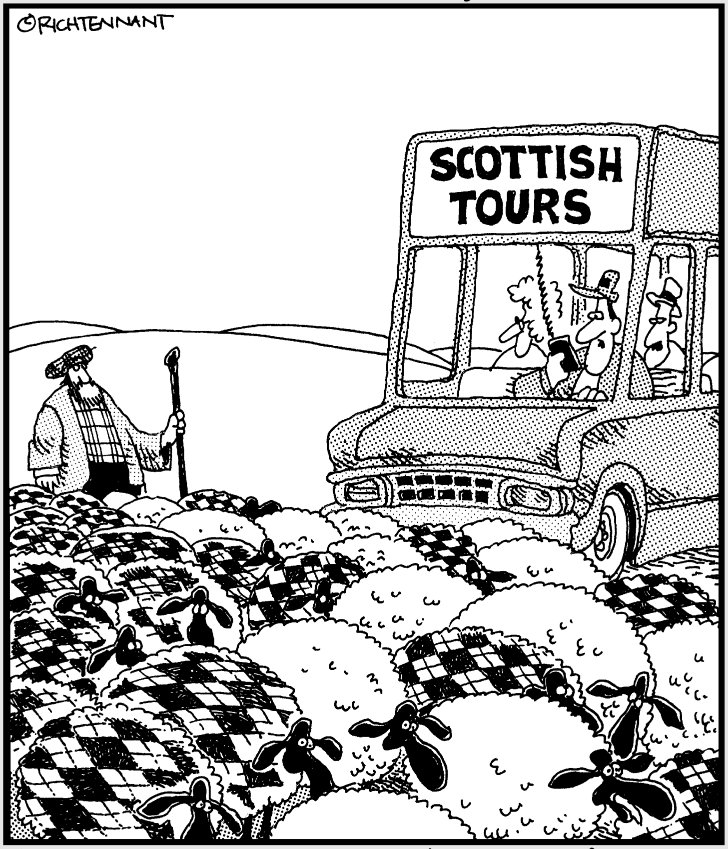
Passive crossovers

If your speakers come with separate crossovers, you can mount them along with the speakers (inside a door, for example) if there's room. But if you need to make adjustments to them, installing crossovers next to the amplifier is a good choice. As with EQs and active crossovers, avoid mounting passive crossovers directly to the metal body of the car.

Part IV

Tying It All Together

The 5th Wave By Rich Tennant



"Looks like our trip into the town of Argyll will be delayed while we let one of the local farmers pass with his sheep."

In This Part . . .

In Part IV, you discover everything you need to know to tie the components in your system together, accessories you'll need to make your system perform at its best, and how to tune your system so that it sounds its best. You also find out about common noise problems and how to tackle them.

Chapter 18

Wiring Your Car Audio System

In This Chapter

- Choosing car audio cables
- Understanding power cabling
- Considering signal cable options
- Wiring speakers

A car audio system is made up of individual components that work in concert to produce great sound. But the components need to be linked together so that the audio signal can move from one to the other, all the way down the signal chain from the head unit to the speakers. A chain is only as strong as its weakest link, so a car audio system is only as good as the wiring that ties it all together.

Some components, such as head units, come with almost all of the wiring you need, but amplifiers, processors, and subwoofers usually don't come with any at all, so you'll need cables to connect these components.

In this chapter, I take a look at the different types of cables, the role each type plays, and the important things you need to know about them. But first, I give my two cents on cosmetics versus performance as it pertains to car audio cabling.

Deciding Between Plain Jane Wire and Audio Jewelry

It's a decades-old debate in audio circles: Some people claim that if a wire is the proper *gauge* (or diameter) and made from decent materials, it accomplishes the simple task of sending signals or power, and should be good enough. But others want the very best of everything for their systems and are willing pay extra for premium cables that supposedly increase performance, or simply because they like the look that such *audio jewelry* affords. It really comes down to a matter of opinion, taste, and budget.

Practical-minded car audio enthusiasts can't justify paying extra money for wiring that they feel doesn't have an audio performance advantage. They are typically the same people that go for the least flashy components and don't show off their systems or compete in *sound-offs*.

Another more predominant school of thought among car audio enthusiasts is that cables are an essential component of a car audio system. These people can recite reasons why a wire is wound or constructed a certain way and how that benefits a car audio system. They typically have showy systems or compete in sound-off competitions.

Although companies that sell car audio cabling can give you plenty of reasons why you need to spend more money on their products, many experts on the matter feel that as long as you're using the proper wire for the job, the benefits of premium cable are generally negligible. That's not to say paying for premium cable doesn't make a difference: It just doesn't make the kind of difference that, say, buying quality speakers versus cheap speakers makes.

TIP

That said, anyone who drops a good chunk of change on putting together a car audio system usually doesn't mind spending a bit more for high-quality cables. If you are going to invest in a high-end system, you may as well connect it with quality cables. Plus, chances are you'll want to show off your system, and using quality cables and accessories is like wearing a nice pair of shoes and belt with a suit. You're simply accessorizing your car audio system the same way someone would accessorize a sharp outfit. But it is a bit of a misnomer to call cables *accessories* because a car audio system can't function without them. A better name would be *necessories*. (Hmm, I may have to trademark that.)

Breaking Down the Different Types of Cables

In general, car audio wiring can be broken down into three main categories:

- Power cable, which taps into a car's electrical system
- Signal cable, which carries an un-amplified audio signal from the head unit to the amplifiers
- Speaker cable, which sends an amplified signal from the amps to the speakers

Power Cords

Every component in a car audio system needs to draw power from the vehicle's charging system. Most draw a little, but amplifiers can draw a lot. Typically, the power wire supplied with a head unit or the one added for a signal processor is around 16 gauge, whereas power wire for an amplifier is usually larger.

Gauge relates to the diameter of the wire, as measured by a standard known as American wire gauge (AWG). The higher the gauge, the smaller the wire, and the lower the gauge, the bigger the wire. Gauge sizes run from 40 to 4/0, or *four-aught* gauge, although wire size usually runs from 10 to 1/0 gauge for most car audio applications. (See Figure 18-1.)

Figure 18-1: Stinger 1/0-gauge power cable.

Courtesy of Stinger

Finding a good gauge

REMEMBER

Using the proper gauge wire for an amplifier is crucial. If the power wire between the amplifier and battery is too small, it not only restricts how much power the amp can deliver, but it can create other problems as well. Because the amp operates less efficiently, it creates more heat, and more heat can damage of some of the amplifier's internal components.

The gauge of the amplifier power wire varies depending on how much current the amplifier demands from a vehicle's battery, as well as how far the amplifier is located from a vehicle's battery. Amplifier manufacturers usually recommend in the owner's manual that you use the minimum-gauge power wiring necessary for an amplifier. Or you can contact the amplifier manufacturer's tech support department to ask. Generally, for most amplifiers, proper wire gauge runs from 8 to 4 gauge.

TIP

If you are using more than one amplifier, you can figure out the total current draw by adding up the fuse sizes of all of your amplifiers. For example, if you have two amplifiers with 30-ampere fuses, you need a power wire capable of carrying at least 60 amperes of current. If in doubt, it's always a good idea to go a little higher just to be on the safe side.

You'll also need to determine the distance from the battery to your amplifiers, taking into account any bends or turns along the path of the wire. You don't need to measure the exact distance down to inches, but you can come up with your best estimate.

The chart in Figure 18-2 from the International Auto Sound Challenge Association (IASCA), which sanctions sound-off competitions, helps you determine the proper power-wire gauge after you know the fuse ratings of your amps and their distance from the battery.

For example, if your amplifiers are drawing 60 amperes of current and the distance to the car's battery from the amplifiers is 12 feet, you would see where the ampere rating (at the top of the chart) and distance (in the chart's interior) intersect on the chart. Then trace over to the left side of the chart to see the gauge. In this case, it would be 8 gauge.

Other factors

Beyond proper gauge, other factors you need to consider when selecting power wire for your car audio system are

- **Strand count:** The more strands or individual wires the cable has, the easier it is to bend around corners, and therefore easier to install.
- **Copper content:** If the copper strands that make up the conductor of a cable have a low oxygen content, they supposedly have a lower resistance to the flow of electrical current than regular copper strands. Cables with a high oxygen content can also become brittle with age. Many cable manufacturers tout oxygen-free copper (OFC) as being superior for conducting electricity and longevity.
- **Jacket material:** Car audio amplifier power wiring snakes through a vehicle in areas that are exposed to weather, temperature extremes, and potentially damaging substances such as battery acid. It's important that the jacket of the power wire, the plastic coating on the outside, be able to stand up to the elements and resist corrosion. As long as you stick with quality cable, the jacket outer coating should be suitable for the automotive environment.

Wire Gauge / Amperage	20	30	40	50	60	75	100	150	200	500	750
00							57	38	29	11	8
0						61	45	30	23	9	6
1					60	48	36	24	18	7	X
2				57	48	38	29	19	14	X	X
3			57	45	38	30	23	15	11	X	X
4		60	45	36	30	24	18	12	9	X	X
5	71	48	36	29	24	19	14	10	7	X	X
6	57	38	28	23	19	15	11	8	X	X	X
7	45	30	22	18	15	12	9	X	X	X	X
8	36	24	18	14	12	9	X	X	X	X	X
9	28	19	14	11	9	X	X	X	X	X	X
10	22	15	11	9	X	X	X	X	X	X	X
12	14	9	7	X	X	X	X	X	X	X	X

Figure 18-2: IASCA's power-wire gauge recommendation chart.

Courtesy of IASCA

Playing it safe

An important aspect of car audio power wiring is making sure that it's properly fused. A *fuse* protects the components in an electrical circuit (in this case, the car audio equipment) and the wiring tying the equipment together. Short for *fusible link*, a fuse typically contains a small metal wire or strip that melts when a higher amount of electrical current than it can handle flows through it — and, more importantly, when a higher current that the wire and component it's attached to can handle flows through it. This opens the circuit so that the current flow ceases and doesn't damage a component or wiring.

Many car audio components come with an *onboard* fuse to protect their internal circuitry, and some also have a fuse *in-line* with their power wire, which means that the fuse is inserted into the wire. But an in-line fuse, as well as power wire, isn't provided with an amplifier (although onboard fuses are sometimes supplied with an amplifier to protect its internal circuitry).

Having an in-line fuse for an amplifier's power wire is essential. It protects the amplifier, but more importantly, it also safeguards the car and its electrical system. If the vehicle is in an accident that causes the power wire to break, this can cause a short circuit, which means electrical current flows along an unintended path within the vehicle and can possibly start a fire. In this case, the in-line fuse opens the circuit to stop the current from flowing.

In-line fuses are available from your local car audio shop, electronics store, or online. Many all-in-one amplifier wiring kits also come with an in-line fuse. A circuit breaker can be used in place of a fuse, although this option is uncommon.

The in-line fuse for an amplifier's power cord should be placed as close to the car's battery as possible. That way, if a short does occur, the problem doesn't travel far. If you were to mount an in-line fuse in the trunk next to your amplifiers, for example, the errant electricity would have to travel a long distance — and could potentially do more damage — before the circuit is opened.

Staying grounded

In addition to a power wire, to complete the electrical circuit, every component in a car audio system also needs a ground wire. (The power wire is called the positive and is usually red, and the ground is called the negative and is usually black.) The ground wire provides the *return path* for the circuit, meaning that it closes the circuit.

In a home's electrical system, the ground is literally the ground, or the earth the building sits on, and electrical circuits are *grounded* to the metal plumbing that goes into the earth. In cars, electrical circuits are grounded to the car's chassis instead of running a cable for every component back to the battery. So much electrical current running along a car's chassis can create noise problems, which I discuss later on.

With most car audio components, grounding is simply a matter of running a ground cable to a part of the car that's attached to the chassis, such as the seats. But with amplifiers — which draw more power than any other car audio component and have the potential to cause more damage if something goes wrong or amplify noise if they're not wired correctly — proper grounding is essential.

Finding a good ground

An amplifier's ground wire needs to be attached to a solid metal part of the vehicle. If an amp loses its ground, it will find its own ground path, which is not a good thing. The ground path it finds could be via the signal cables that attach the amp to the head unit, which can fry your head unit.

The ground wire must be the same gauge as the power cable, and it should be as short as possible so that it doesn't add electrical resistance. As resistance increases, the ground becomes less effective and the amplifier works less efficiently. A short ground wire also lessens the chance that it will pick up electrical interference and introduce noise into the system because many other electrical components, both factory and aftermarket, use the car's chassis as a grounding point. Think of the ground wire as an antenna for electrical interference — the shorter the antenna, the less chance it can pick up interference and hence noise.

Where you mount your amp determines where you ground it. If you mount an amp under the front seat, for example, you can attach the ground to one of the seat's anchoring bolts. If your amp is mounted in the trunk, the ground can be attached to one of the shock towers (the metal casing around the shock absorbers) or another metal structure.

If there's no nearby grounding point, you can create your own by drilling a small hole into a metal part of the car, being certain that you first know what's on the other side. Insert a sheet metal screw with a star washer that the ground wire can in turn be attached to with a ring terminal (see Figure 18-3). A *ring terminal* is a small connector that attaches to the cable with a ring that the screw attaches to.

Figure 18-3: A Scosche EFX ring terminal.

Courtesy of Scosche

You may need to scrape off paint or any other factory coating to get to bare metal for a good ground. If you live in a place where vehicles are prone to rust from salt on the roads or ocean air, you'll want to treat with rust-proofing or undercoating the area of bare metal that you exposed.

Power accessories

In addition to power and ground cables and an in-line fuse, you may need other power accessories for your car audio system. These include

- **A power distribution block:** If you are using more than one amplifier, instead of running a power wire from the battery to each amp, you can run a single power wire to a power-distribution block (shown in Figure 18-4) and then an individual power wire to each amplifier. A power distribution block can also contain fuses (in case your amps didn't come with them or for ease of accessibility), in which case it's known as a *fused power distribution block*.
- **A ground distribution block:** This serves the same purpose as a power distribution block, but for the ground wires of an amplifier.
- **Power terminals and connectors:** Never use bare wire to make connections to various parts of a car audio system. Most connections call for specific terminals or connectors. For example, splicing two wires together to extend a wire run calls for a coupler (as shown in Figure 18-5).

Figure 18-4: A Stinger power distribution block.

Courtesy of Stinger

- **Battery terminals:** Because a solid connection at the battery is critical for an amplifier, some installers and enthusiasts use battery terminals made especially for car audio purposes. The terminals feature connections for accommodating large-gauge car audio power wire and may have other features, such as a Plexiglas cover and even digital displays that show the battery's voltage (see Figure 18-6).

Figure 18-5: A Stinger 4-gauge power-cable coupler.

Courtesy of Stinger

Figure 18-6: A Scosche EFX battery terminal with a digital volt meter.

Courtesy of Scosche

On the Preamp Level: Signal Cable

Except between the amplifier and speakers, audio signals usually travel from component to component at line or preamp level, meaning before they are amplified. Although some amplifiers can accept a high-level or amplified output, it’s always preferable to send signals between components at preamp level because it’s easier to match the input impedances between components, which makes for better sound quality.

Signal cable

Preamp cable is also called *signal cable*. Another name is RCA cable because the cable is typically terminated with RCA connectors (shown in Figure 18-7). Still another name for signal cables is *interconnects,* but they all do the same thing.

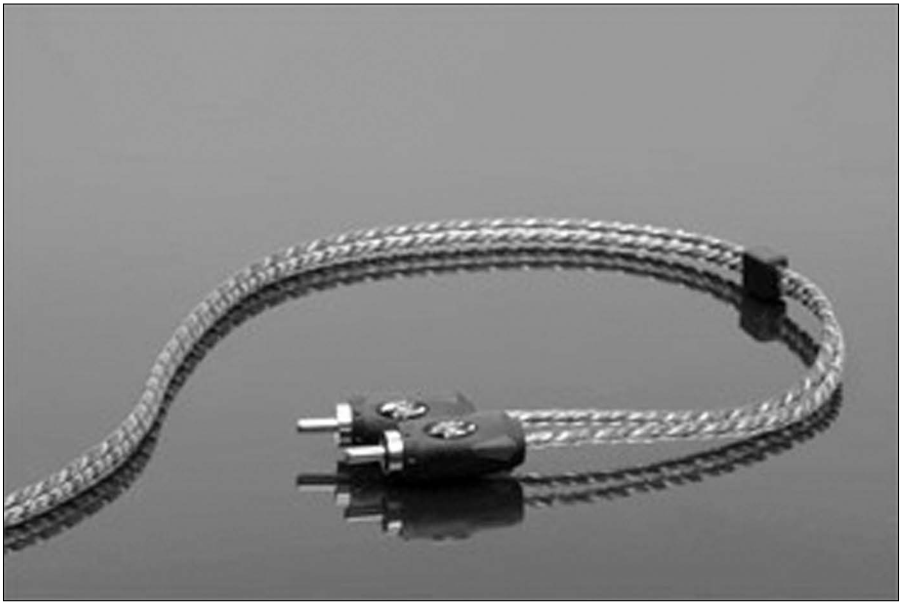


Figure 18-7: Stinger RCA or signal cables.

Courtesy of Stinger

Because signal cables carry low-level or low-voltage preamp signals, they are more susceptible to electromagnetic interference (EMI) or other noises. Signal cables should always be routed away from power cables (See the sidebar “Divide and conquer”) and also have good noise rejection. *Noise rejection* is accomplished by the ways in which signal wires are configured: The more elaborate the configuration, the more expensive the cable usually is. Coaxial cables are the most common type of RCA cable and consist of a single, small-gauge *center conductor*, the wire that carries the audio signal. The center conductor is covered by a braided cable, which is the negative return lead and shields the center conductor from noise. The braided cable is in turn encased in a plastic jacket.

Twisted-pair signal cables cost more and offer better noise rejection than coaxial cables. They feature two small-gauge center conductors that are twisted together. Because the wires carry the same signal but are 180 degrees out of phase (or the mirror opposite of each other), noise is effectively canceled out.

Signal cables are usually sold in pairs (because you need one to carry each channel of a stereo signal) and range in price from cheap to expensive. They are also sold in lengths ranging from 6 inches to 20 feet. Although some hard-core home audiophiles spend thousands of dollars on signal cables, you shouldn't have to pay more than $20 to $30 for, say, a 20-foot pair.

Other signal transfer options

RCA cables still rule in car audio applications, but there is another option to get a signal from point A to point B: balanced-line transmission. This technology is better at reducing noise that can enter a system through the low-level signal cables, but it's also more expensive.

Borrowed from recording studio technology, balanced-line transmission can be thought of as an *active* signal transmission scheme. In essence, a transmitter at one end sends the signal via a special cable to a receiver at the other end. The two signals are compared, and any noise that was picked up in between is rejected.

Various balanced-line drive schemes have been offered over the years for the car audio market, but none have ever caught on. The only true balanced-line technology currently available in car audio is from Zapco. The company's SymbiLink balanced-line transmission system (see Figure 18-8) uses one of several receivers and transmitters that can be used with Zapco and other amplifier brands.

Figure 18-8: A Zapco SymbiLink balanced-line transmitter and receiver.

Courtesy of Zapco

Carrying a Tune: Speaker Cable

Speaker cable is literally the end of the line in a car audio system. It's job is to send power from an amplifier to the speakers. Like power cable, speaker wire can carry significant amounts of power, and therefore the size of the wire depends on the amount of power it's asked to carry. Also like power wire, speaker wire comes in various gauges (see Figure 18-9).

Figure 18-9: A Stinger 16-gauge speaker wire.

Courtesy of Stinger

Divide and conquer

Unwanted noise can occur in a car audio system when signal cables are in close proximity to components that radiate Electromagnetic Interference (EMI). Lots of components in a modern automobile emit EMI, but the biggest sources are those that require a lot of power, such as power-seat and power-window motors. Large factory power cables and car audio components and cables can also introduce noise into a car audio system's signal cables.

To avoid EMI, route signal cables as far as possible from components that can cause noise — even car audio power wires. That's why installers always route a system's signal cable on one side of a vehicle and power wiring on the other.

The higher the power and the longer the wire run, the lower gauge speaker wire you'll need. Speaker cables are available in sizes from 10 to 18 gauge, but for most applications you'll likely use 12 to 16 gauge. Oxygen-free speaker wire supposedly offers the best possible sound quality, and some speaker cables comes in a twisted-pair design to improve noise rejection, although it isn't as much of an issue with speaker-level signals.

Chapter 19

Gearing Up with Accessories

In This Chapter

- Providing your system with extra power
- Keeping your car quiet
- Installing accessories
- Essential tools for DIY installers

Car audio enthusiasts just can't leave well enough alone, and you should be thankful for that. Hardcore car audio types aren't satisfied with a great-sounding system: They always think it can sound even better. This relentless pursuit of perfection has brought us accessories that help squeeze the *n*th degree of performance out of a system.

Many of these innovations grew directly out of enthusiasts involved in sound-off competitions seeking just a little bit of an edge. Now, once-novel accessories such as capacitors and sound-deadening material have become a standard part of any high-performance car audio system.

In this chapter, I look at some of the accessories that can give you more power, eliminate unwanted noise, and make installation easier.

More Power to You: Capacitors, Batteries, and Alternators

Your car's charging system isn't designed to power a high-end car audio system. Car manufacturers design a vehicle's charging system to handle the load that all of a car's electrical components — including headlights, windshield wipers, and air conditioning — place on it. Then they factor in a margin of error for those times when you may be using most of the car's major electrical devices at once, like at night, in a rain storm, during the heat of summer.

Carmakers also realize that people may add aftermarket accessories to their vehicles, such as car audio systems. At some point, the car's charging system runs out of juice if you keep placing demands on it by adding more electrical components. Fortunately, you can do a few things to get more power.

Music is transient in nature, meaning that there are loud and soft parts, so the demand a car audio system places on a car's charging system isn't constant, as it is with, say, a car's headlights. Your charging system may handle just fine music that isn't very dynamic (for example, music that doesn't have lots of loud and soft parts, such as mellow music with just an acoustic guitar and voice).

But with music that is very dynamic with lots of loud and soft parts (think of a rock, rap, or pop song), your electrical system is asked to provide power in quick bursts during the loud parts. When a deep bass note hits in a rap recording, for example, the amount of power provided by the charging system may sag a bit, and the amplifier powering the subwoofers in turn can't deliver the full audio signal without distorting it. Distortion in large quantities can even cause a speaker to *blow* or fail.

That's why innovative car audio enthusiasts have come up with ways to solve these power problems. Accessories such as capacitors, auxiliary batteries, and high-output alternators are added to a car's charging system to provide extra juice when the music in a car audio system demands it.

Capacitors

Capacitors are used in most electronic products, and it's common to see many of them populating a circuit board. These cylindrical devices store power the way a reservoir stores water. So when a circuit needs a bit of juice, the cap releases it. A capacitor is able to deliver power more rapidly than the car's charging system because the power capacitor has a lower internal resistance, which allows it to quickly discharge.

In the early 1990s, car audio sound-off competitors started adding large capacitors to their sound systems to provide instantaneous power when peaks in a musical passage demanded it. Before long, car audio-specific capacitors became available to the masses, and now they are a common sight in most high-end systems (see Figure 19-1).

Capacitors are easy to install for even a beginner DIYer. See the section, "Installation Tips for Accessories," later in this chapter for more on how to install them.

Figure 19-1: A Scosche EFX 1-Farad capacitor.

Courtesy of Scosche

TIP

Capacitors are rated in Farads, which is a measure of how much power they can store. The rule of thumb is to use 1 Farad of capacitance for every 1,000 watts of power. So if you have a 500-watt system, you would need a 0.5-Farad capacitor.

Capacitors are available in Farad ratings ranging from 0.5 up to 40 for extremely high-powered systems, and vary in price from $75 for a 0.5-Farad cap to more than $500 for a large-Farad version. Besides Farad rating and shape, capacitors also differ in features, with some sporting built-in digital voltage meters and power-distribution blocks. You can buy a capacitor from most car audio retailers, and they're available online from e-retailers such as Crutchfield (`www.crutchfield.com`).

TIP

You probably don't need a capacitor if you have a modest system without a subwoofer, but you could probably use one if your system includes at least one subwoofer. If you have several amplifiers and multiple subwoofers, adding a cap or two can definitely improve your system's performance.

Whether you need a capacitor also depends on how much current your amplifiers draw from the vehicle's charging system as well as the type of music you listen to. If you primarily listen to bass-heavy rap music and your headlights dim every time your system hits a bass note because of the strain on your car's charging system, a capacitor could help. (You should also have your car's electrical system checked to make sure it's up to snuff, however.) Or if you think the total current draw of all of the amplifiers in your system starts to exceed the capacity of your car's alternator, you'll probably want to add a *cap*.

Auxiliary batteries

Adding an extra battery to your system doesn't provide more power, but it does let you play your system with the engine off. Listening to a system, especially if it's a high-powered one, with the engine off is a sure way to end up with a dead battery. Some enthusiasts, mainly sound-off competitors, add a battery solely dedicated to providing power for engine-off listening. Because of the complexity of adding a second battery, this application is best left to the most hardcore car audio enthusiasts and installation is best left to professionals.

If you do decide to add a second or *auxiliary* battery, it's a good idea to use the same type of battery as your main one. You should also install a *battery isolator,* which is a device that electrically isolates the auxiliary battery from the starting battery. This way, if the auxiliary battery's power is depleted, it doesn't affect the starting battery. Although a battery isolator isn't required, it can prevent you from getting stuck with a dead starting battery.

Two types of isolators are available. A *diode isolator* is the most straightforward and trouble-free, but can create a slight voltage loss. This means that both batteries won't charge fully, although this is rarely a major problem. A *solenoid isolator* employs relays or switches to regulate the flow of current with practically no loss of voltage, but they are not as reliable as diode-based isolators.

Batteries made specifically for car audio applications are now available, and can be used for a starting battery, an auxiliary battery, or both. These are usually *dry cell* batteries, meaning they don't contain liquid like traditional lead-acid car batteries. They are also typically deep-cycle batteries, meaning they can be discharged and recharged repeatedly, and they recharge quickly.

High-output alternators

An alternator supplies power for all of a car's electrical components, including a car audio system, when the engine is running. At the same time, it also charges the battery, which powers all of a car's electronics when the engine is not running. As I mentioned previously, your car's charging system, and the alternator specifically, are designed to provide enough power for all of a car's electrical components and then some. Your car's standard alternator should do okay with a moderately powered system that only includes, say, a couple of amplifiers, as long as you're not constantly cranking it up.

WARNING!

But if you plan on installing a bunch of amplifiers and subwoofers, your alternator may not be able to keep up with the current demands placed on it. That's why some companies sell high-output alternators for car audio purposes (see Figure 19-2). Be warned: Upgrading your car's alternator is a major modification that affects the rest of the electrical system and is a complex and costly undertaking. It's an upgrade needed by only the most hardcore car audio enthusiast and crank it up competitors who are trying to achieve the highest sound pressure levels (SPL) possible. These folks typically upgrade the alternator in show vehicles that aren't driven on a daily basis — their vehicles are more for show than go. Upgrading the alternator just to get a few more decibels of bass from your system isn't worth the cost, hassle, and potential adverse effects on your car.

Figure 19-2: A Stinger Electronics high-output alternator.

Courtesy of Stinger Electronics

Keeping It Quiet

The car is a noisy environment for reproducing great audio. Between road noise generated by tires spinning on the pavement, wind noise caused by the vehicle cutting through the air at highway speeds, and engine noise constantly droning away, it can be difficult to enjoy a car audio system while driving down the road at the speed limit.

You may have noticed that some cars are quieter than others. The interior of a Cadillac, for example, is much quieter than that of a Chevy Lumina. That's because carmakers use more sound-deadening material in luxury cars to keep exterior noise at bay, and much less in economy vehicles.

Sound-deadening material

Because noise can rob a system of good sound, car audio enthusiasts add sound-deadening material to their vehicles to get the same sort of quiet ride found in luxury vehicles. sound-deadening material generally comes in self-adhesive sheets that can be applied to the metal parts of a car (see Figure 19-3). It's also available in a liquid form that can be sprayed on, although application of the liquid requires a power sprayer and is best left to professionals. You can buy sound-deadening material from a car audio retailer or order it online.

TECHNICAL STUFF

Sound deadening works by adding mass or weight to an object; in this case, the metal panels of a car. Every object has a resonant frequency (the natural frequency at which it vibrates), and those vibrations cause noise. A car creates plenty of vibrations: from the engine, from wind, from the road, and even from speakers in a car audio system. Adding mass to an object lowers its resonance frequency, and more energy is required to make it vibrate. It's like when, say, a table is vibrating: When you put your hand on it, it stops vibrating and stops making noise.

REMEMBER

Of course, adding more weight also makes the vehicle heavier, which can lower fuel economy. If you're only using sound-deadening in, say, your doors, this may not be a big issue, but if you're adding it to your whole car — and you race in sanctioned events on the weekend — it could be.

Figure 19-3: Scosche Accumat sound-deadening material.

Courtesy of Scosche

Besides stopping unwanted resonances, sound-deadening material also helps form a barrier that road noise and wind noise have a harder time penetrating. And it can block heat from the engine compartment. These are two reasons it's used by hot rod and custom-car builders.

Adding sound-deadening material is a modification that a DIYer can easily tackle. For detailed tips on how to do it, see the "Installation Tips for Accessories," section later in this chapter. Sound-deadening material can be applied almost anywhere in a vehicle, such as on the

- Doors (Figure 19-4)
- Floorboard (Figure 19-5)
- Roof (Figure 19-6)
- Trunk (Figure 19-7)

Figure 19-4: Dynamat sound-deadening on a door.

Courtesy of Dynamic Control

Figure 19-5: Dynamat sound-deadening on a floorboard.

Courtesy of Dynamic Control

Figure 19-6: Dynamat sound-deadening on a roof.

Courtesy of Dynamic Control

Figure 19-7: Dynamat sound-deadening in a trunk.

Courtesy of Dynamic Control

If you want to add sound-deadening to your car, start by covering the area you can most easily reach, such as the inside of the front doors. (Manufacturers of sound-deadening material even offer kits specifically for doors.) See what sort of effect this has. If it resolves the problem, you're done; otherwise, move on to harder to reach areas. In extensive car audio systems, installers will sometimes start by completely stripping the interior of a vehicle and covering every metal part of the interior with sound-deadening material to ensure a quiet environment.

Installation Tips for Accessories

Installing accessories is something even beginning DIYers can do, particularly when it comes to capacitors and sound-deadening material. But make sure you carefully follow the directions given here and those included with the products. You'd better leave installation of backup batteries, isolators, and alternators to professionals, however. And remember: Whenever you're working with a car's electrical system, disconnect the negative lead of the battery. Otherwise, you could cause a short if a *hot* power wire accidentally grounds to a part of the vehicle and fries one of your car audio components or, worse, your car's electrical system.

Capacitors

Capacitors should be mounted as close to an amplifier as possible, and they should be wired *before* the amplifier, with the positive terminal in-line with the amplifier's main power lead and the negative terminal attached to ground. Most caps come with a mounting bracket, which can be attached to the body of the car (as long as you know the screw won't potentially damage anything behind the panel). Sometimes capacitors are installed on an amp rack also.

Because capacitors can store a large amount of energy, you'll need to protect the terminals, usually located on top, because they are *hot* or carry current. Many capacitors come with a cover that protects the terminals. Use it. Otherwise, a significant spark could be generated across the terminals if they are shorted out, meaning some type of conductive material (such as metal) touches both terminals. Although this isn't particularly dangerous, it could permanently mar the terminals, which are usually gold-plated.

A capacitor also needs to be charged after it's installed. To do this, you need a resistor and a volt meter. (Most capacitors come with a resistor.) To charge the capacitor, replace the fuse in the power wire's main fuse holder with the resistor while charging the cap. With the negative power wire connected to the battery and power flowing through the amplifier's main power wire, carefully place the probes of the volt meter on the positive and negative terminals of the capacitor. After the volt meter reads 12 volts, the capacitor is charged and you can disconnect the negative wire from the battery and swap the resistor for the power fuse.

Auxiliary batteries

Auxiliary batteries are usually installed in a trunk or a hatch. If you're using a traditional lead acid battery, which has become less common in car audio applications, it *has* to be isolated from the passenger compartment, which is almost impossible in a hatchback or pickup. Otherwise, the battery needs to be in a car's trunk and vented to the outside of the vehicle with a forced-air system involving fans and vents. That's because, while charging, a lead acid battery releases flammable gases that can possibly cause an explosion.

TIP

Because of these concerns, using *dry cell* batteries for car audio applications has become more common. The advantage of using a dry cell battery is that it doesn't contain liquid, so you don't have to worry about battery acid leaking the way you would with a traditional lead acid battery. In fact, dry cell batteries can be mounted on their sides or even upside down. You just want to make sure they are secured to the vehicle.

When hooking up a backup battery to your charging system, you'll need a battery isolator, as I mentioned earlier in the chapter. The isolator goes between the batteries and the alternator, and there must be a fuse between each battery and the isolator. If the second battery is mounted in the rear of a vehicle, such as in the trunk, and the isolator is mounted in the engine compartment, you'll need two in-line fuses with the power wire, both close to the battery and close to the isolator.

WARNING!

Modifying a vehicle's charging system is best left to someone who knows what they're doing, such as a mechanic or a professional car audio installer. If you start messing with your car's charging system and you're not 100 percent competent to do so, you could cause thousands of dollars in damage to your car.

Sound-deadening material

Installing sound-deadening material is pretty straightforward, provided that you know how to take apart your vehicle's interior — and properly put it back together again.

To install sound-deadening material, you need

- Acetone and rags for cleaning the metal surfaces you'll be applying the material to.
- A razor knife or large scissors for cutting the material.
- A roller tool for getting rid of any bubbles and making sure the material is fully adhered to the metal (see Figure 19-8). A roller tool can be found at any hardware store. The original sound-deadening supplier to the car audio crowd, Dynamat, also sells them.

TIP

Before you begin, it's a good idea to lay the sound-deadening material in the sun or some other warm spot to heat it up slightly so that it's more pliable.

Here are the steps you'll need to take to install sound-deadening material:

1. **Remove the cosmetic panels of the car to expose the metal surfaces you want to apply the sound-deadening material to.**

   Most panels are held in by clips, screws, plugs, and other fasteners or some combination all of these. You may need a special tool, such as a panel tool or clip-retention tool to remove some panels. These can be purchased online at Crutchfield (`www.crutchfield.com`), Installer.com (`www.installer.com`), and other sites. Take your time to figure out the correct way to remove a door panel, and make certain you know how it goes back together.

   TIP

   Check online forums for information about how panels are removed in a given vehicle if you get stuck or you're not sure. Better yet, ask someone, such as a professional installer, who has worked on one.

2. **Clean the metal with acetone and rags to remove any dirt, grease, or anything that can affect the adhesion of the material.**

3. **Using the scissors or razor knife, cut the material into the shape of the panels you intend to cover.**

   TIP

   A paper or cardboard template is helpful in properly sizing sections before cutting the material.

4. **After you've cut the material to the proper size, peel off the liner on the adhesive side and carefully apply the material to the metal panel.**

   If you are using whole sheets on a large area, peel off the liner in sections so that not all of the adhesive is exposed at once.

5. **After the material is in place, to ensure a good bond, use the roller tool to remove any bubbles that may have formed between the sound-deadening material and the metal.**

Figure 19-8: A roller tool.

Courtesy of Dynamat

6. **In places where there are ridges, such as in the doors, make sure that the material touches the metal and doesn't just *bridge* these areas.**

   For small air bubbles that can't be removed with the roller tool, use the razor knife or scissors to poke a small hole in the bubble to deflate it and then press down on the material.

7. **Reinstall the panels of the car.**

DIY installation tools

If you're going to take on installing a system yourself — or at least parts of it — you need certain tools. You may already have some on hand — such as screwdrivers, a drill, and Allen wrenches — whereas others are designed for car audio–specific tasks. What follows is a list of some of the specialized tools, along with an explanation of what each does:

- **Panel tool:** This device comes in one of several different configurations and helps you pry off factory panels to install components and run wires.
- **Wire stripper and crimping tool:** This tool is used for stripping the insulation from wires and making wire connections, such as with factory wiring harness adaptors when installing head units and speakers.

- **Test light or digital multimeter:** A test light has a small needle that is placed against wires, or even inserted through a wire's insulation to contact the center conductor, and a light that turns on to show if the wire is *hot* or carries current. But with today's sophisticated electronics onboard a vehicle, using a test light to penetrate a wire can sometimes be problematic. For example, probing the wrong wire could cause an airbag to blow. That's why a multimeter, an electronic measuring instrument that combines several functions in one unit and doesn't need to penetrate a wire's insulation to get an accurate reading, is preferable.
- **Window and door clip remover:** Window and door handles are usually held on by special clips that can be difficult to remove, except with this particular tool.

Many of these tools are available individually, or you can buy several of them in a kit (see Figure 19-9). Car audio accessories suppliers such as Scosche and Installer.com sell them to the car audio industry, and Crutchfield sells a version of Scosche's *DIY Installer* tool kit.

Figure 19-9: A DIY tool kit from Scosche.

Courtesy of Scosche

Chapter 20

Tuning Your System

In This Chapter

- Setting amplifier gain
- Using a real-time analyzer
- Looking for trouble spots
- Avoiding annoying noise problems

So you've installed the car audio system of your dreams. You've spent months saving up for it, weeks designing and planning the system, and many days and nights installing it. Then comes that moment when you finally turn the key, hit the power button, crank it up, and . . . it sounds terrible.

How could that be? You spent good money for the best components, you installed everything properly, but it still sounds less than stellar.

Tuning In: Getting the Best Sound Out of Your System

REMEMBER

A car audio system is like a musical string instrument: If it's well designed and properly constructed, it has the potential to create great music. But like a string instrument, it first has to be tuned. With an instrument such as a guitar, it's a matter of stretching or loosening the strings to get it in tune. With a car audio system, tuning means properly matching the signals between the various components, making sure the bass doesn't drown out the treble, and fixing any annoying noise problems. And as with a musical instrument, it takes a good ear to tune a car audio system.

In fact, using measuring devices such as a real-time analyzer to tune a car audio system can be very helpful, but the final judge should be your own ears. For example, you want to strive for a flat frequency response, meaning that the system produces an equal amount of sound at all frequencies — not too much bass and not too much treble. But remember, you also want it to sound good to your ears.

Understanding what constitutes good sound

Before you can get the best sound out of your system, you need to know what to listen for. I cover this in more detail in Chapter 3, but here are some of the basic elements of sound quality:

TECHNICAL STUFF

The basic elements of sound quality are

- **Smooth frequency response:** The ability of a system to reproduce the audible frequency spectrum without emphasizing or deemphasizing one particular frequency range.
- **Clarity:** The ability of a system to produce music without distortion and other noise.
- **Dynamic range:** The ability of a system to reproduce loud and soft passages in music, and at loud and soft volumes, with the same level of detail.
- **Tonal accuracy:** The ability of a system to faithfully recreate the sound of the instruments, voices, or ambiance in a recording.
- **Staging and imaging:** The ability of a system to recreate the illusion of a stage on which a performance is occurring, in which you should be able to pinpoint the sonic *image* of each individual performer and instrument on the stage.

Points of reference

Although you may be able to understand all of these concepts in theory, you need to hear them in practice. You need a reference. You need to find the best system possible and listen to it so you know what good sound is and how to apply to your own system the sound quality concepts discussed above.

TIP

Visit a local car audio shop and ask to hear one of their best-sounding *demo* vehicles, or go to a sound-off and listen to some of the award-winning *SQ* or sound quality vehicles there.

To get the best possible reference, visit a high-end home stereo store and listen to one of their systems with well-recorded music. A car audio shop or home audio store will likely have some sound quality (SQ) recordings on hand. Make of note of what they are, or bring some of your own CDs that feature well-recorded music or just your favorite music.

Setting Gains

The first thing you'll want to do when tuning a car audio system is set the *gain* or input sensitivity of each component, which is also called *level matching*. *Gain* is the ability of a system to increase the amplitude or power of an audio signal; it is measured in volts. A good way to grasp this concept is to think of an amplifier as simply a large gain device: It takes an audio signal and increases its gain. A volume knob on a head unit also acts as a gain control.

Because a car audio system is made up of various components, with varying levels of input and output voltage, what you're trying to do when you set gains is dial in each component for maximum signal level with the least amount of noise — in other words, achieve the highest signal-to-noise ratio possible. Every component has a maximum amount of gain or signal level it can produce before it starts to *clip* or distort the audio signal, and each component has an inherent *noise floor*, which is a measure of the noise the component itself produces or picks up from other sources. In a perfect world, a component would produce zero noise, but car audio (and even home audio) components are far from perfect, and the car environment, with all of its potential to induce noise in a system, is very imperfect.

Level matching starts with the head

Level matching starts with the signal created by the head unit and is therefore irrevocably tied to the preamp signal strength of the head. That's why it's best to start with a high-voltage signal and why a high-voltage head unit output is desirable. With a high-voltage head unit, you start with a high signal-to-noise ratio, and with a low-voltage head, you start with a low signal-to-noise ratio. Your system is limited to that baseline level no matter how much you turn up the input sensitivity or gain on subsequent components.

So setting the gains in an entire system is simply adjusting the level of the *preamp* or pre-amplified signal as it moves from one component to the next in a car audio system. If the gains are set too low, you won't have the maximum amount of signal that the components in your system can collectively produce, but you'll likely have less noise. If the gains are set too high, you'll get the maximum amount of signal but you'll likely get more noise as well. What you're trying to do when setting the levels for an entire system is find a happy medium where you get the most signal with the least amount of noise.

From the head to the amp

To keep things simple, look at how gain relates to the signal between a head unit's output and an amplifier's input. The gain control of the amplifier allows you to adjust the input sensitivity, which determines how much input signal from the head unit it takes to produce a given amount of power by the amplifier before the amp begins to clip the signal. With high voltage coming from the head unit, the amplifier's input sensitivity can be set lower to achieve a specific power output before it starts to clip, and the potential for noise is lower (therefore, a higher signal-to-noise ratio). But with a low voltage coming from the head unit, the gain has to be set higher to get the same output before it starts clipping, and the potential for noise is higher (a lower signal-to-noise ratio).

The gain setting on an amplifier also has an effect on the volume *swing* of the head unit, or the minimum to maximum volume level. If you have a head unit with a high-volt output, volume can get very loud, very fast if the input sensitivity of the amp is set high. If your high-volt head's volume control ranges from, say, 0 to 30 and the amp's input sensitivity is cranked up, the system might reach full power at, say, a setting of only 10. But with the same high-volt head, you can lower the input sensitivity on the amplifier so that the head unit has a wider volume range, all the way up to 30. With a head unit that doesn't have a high voltage output, the opposite is the case. You could turn the volume all the way up to 30 and crank the input sensitivity on the amp, and still it may not play loud enough, and you'll likely get more noise.

Setting gains and crossover points by ear

Some installers use a multimeter or test equipment such as an oscilloscope or a real-time analyzer to set gains, but it's also possible to do it by ear. It takes practice and you won't get it right the first time, but it's a great hands-on learning experience on how your system works. As with everything else, the more you do it, the better you'll get at it.

The same thing goes for setting your *crossover points*, the frequency at which the signal going to each speaker begins to be *attenuated* or turned down. If your subwoofers are *crossed over* at 100 Hz and down, signals from 100 Hz and up are slowly attenuated so that the sub doesn't play them. If your midranges are crossed over at 100 Hz and up, signals from 100 Hz and down are slowly attenuated so that the speakers don't play them.

Because crossovers are usually built into amplifiers, it's convenient to set your crossover points at the same time that you set your gains. Setting proper crossover points is an equally important aspect of tuning your system for the best sound.

To illustrate how to set gains and crossovers by ear, I use the example of a system with a high-volt head unit, a five-channel amplifier (with two *front* channels, two *rear* channels and a single mono subwoofer channel) with a built-in crossover, a pair of component speakers in the front doors, a pair of coaxials in the rear deck, and a single subwoofer (see Figure 20-1). In this sample system, you would only be setting the gain on the amplifier. But with a more elaborate system that includes multiple amplifiers and processors, the procedure would be much the same. You would just have more gains to adjust.

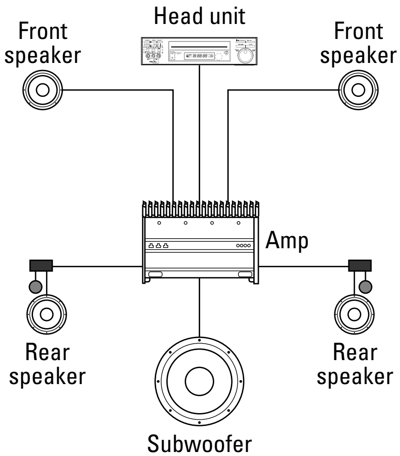


Figure 20-1: A system consisting of a high-volt head unit, an amplifier, front and rear speakers, and a single subwoofer.

Courtesy of Audio Profiles

To set the gains and crossover points by ear in this system:

1. **Turn the gains on your amplifier all the way down or to a minimal setting. The gain control will usually be marked as Input Sensitivity or Gain.**
2. **Set the crossover points at the settings recommended by the speaker manufacturer, or what you feel is best suited for each speaker set and the type of sound you're seeking.**

   This is when having crossovers built into the amp comes in handy. Regardless of whether you're using crossovers built into the amplifier or separate electronic crossovers, the crossover controls are typically labeled Frequency or Filter. Frequency adjustments are either set (say, at 50, 80, and 125 Hz for a subwoofer crossover) or variable (you can choose any frequency between 50 and 125 Hz).

   In our sample system, the amplifier's crossovers could be set at 100 Hz and down for the subwoofer and 100 Hz and up for the components and coaxials. (*Passive* crossovers, which are usually included with components and coaxials, separate the frequencies going to the individual speakers that are part of the components and coaxials.)

3. **Turn the level of the bass and treble to 0 on your head unit, set any equalization to 0 or *flat,* and turn off any signal processing, such as a loudness button.**
4. **Play very dynamic music that has full-frequency range content — meaning plenty of bass, plenty of midrange, and plenty of treble — and turn the volume up about three-quarters of the way.**
5. **At each input of the amplifier — the front channels for the front speakers, rear channels for the rear speakers, and the subwoofer channel for the subwoofer — slowly turn up the gain until you start to hear the speaker distort or *break up,* and then back it off a bit from there.**

   If you use music you're familiar with, you'll know when the sound starts to degrade. Start with the front speakers, then do the rear speakers, and continue on to the subwoofer. You should set the gains and crossover points for the subwoofer last, getting the rest of the system dialed in first.
6. **Repeat Step 5 for your crossover points, setting them higher or lower until each speaker starts to break up or you get the type of sound you're looking for, and then back it off a little.**

   At which point the sound begins to break up or distort also depends on the type of music you're using and most often listen to. With rap music or anything that has low bass, you want to be careful not to crossover your front speakers too low. Otherwise, low bass could potentially damage them.

Take your time tuning your system, and listen to it carefully. If you start to get frustrated or your ears fatigue and everything starts sounding the same, walk away and come back to it in a few hours or the next day. In fact, it may take you several tweaking sessions to get the sound right. You'll also want to go back in a week or two and tweak the system again.

TIP

You can also ask a friend or acquaintance who has experience and a good ear to help you. If you can find someone with the proper test equipment, they can tune your system much more quickly and with greater accuracy. As part of their service, many car audio shops tune your system for you if you have it installed there. But, as with a guitar, tuning a system by ear yourself is good practice and a great skill for a car audio enthusiast to develop.

Using a Real-Time Analyzer

You can try to set the frequency response (the level or volume of sounds the system reproduces within the audible frequency range) by ear, but it's difficult and you have to know what to listen for. A much better way to do it is with a real-time analyzer, known as an RTA in car audio lingo (see Figure 20-2).

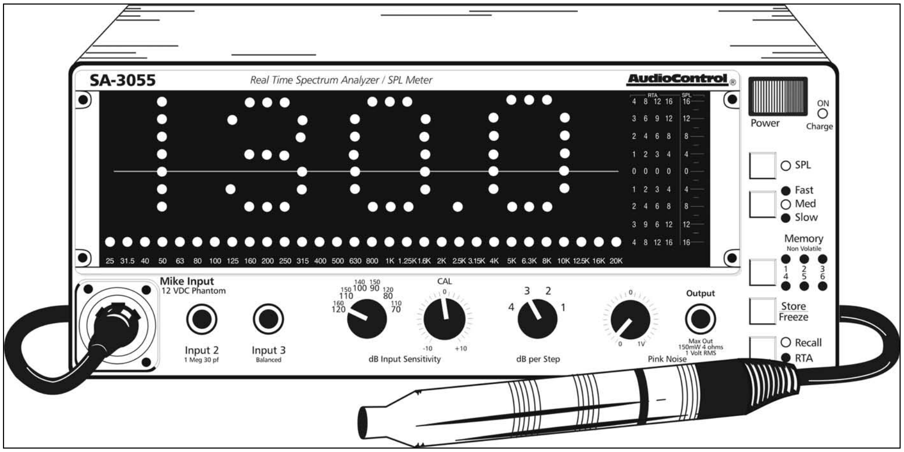


Figure 20-2: An Audio-Control SA-3055 real-time analyzer.

Courtesy of AudioControl

An RTA measures sound pressure with a microphone and displays graphically how much sound pressure there is at certain frequencies in decibels (dB). The AudioControl RTA shown in Figure 20-2 displays the amount of sound pressure level in frequencies from 25 to 20,000 Hz and in increments of up to + or – 16 dB.

In order to measure a system's frequency response, you need to play a signal that has equal SPL at all frequencies. This signal is known as *pink noise* and has a static-like sound. Test CDs such as IASCA's Official Sound Quality Reference CD (see Figure 20-3) contain a pink noise track. (You can order the CD from IASCA at `www.iasca.com`.)

To set frequency response with an RTA, follow these steps:

1. **Play pink noise at about three-quarters of the maximum volume on your head unit, with all of the tone controls set to 0 and all signal processing turned off.**

2. **Using a microphone stand, place the RTA's wired microphone close to where the driver's head would be, or wedge the mic in the headrest.**

   If your equalizers are mounted in the trunk, it's best to move the RTA to the outside of the vehicle. Not only is this more convenient, but pink noise can damage your hearing at loud levels, and at the very least is annoying. If your EQ is in the passenger compartment, you'll want to turn the volume down while playing pink noise.

3. **With the pink noise playing, look at the RTA's display to see the frequency response of the system.**

   What you hope to see is a *flat* response, with equal energy at all frequencies. But what you'll most likely see is a series of peaks and dips, with more energy at some frequencies (peaks) and less at others (dips) (see Figure 20-4).

Figure 20-3: IASCA's Official Sound Quality Reference CD contains a pink noise track.

Courtesy of IASCA

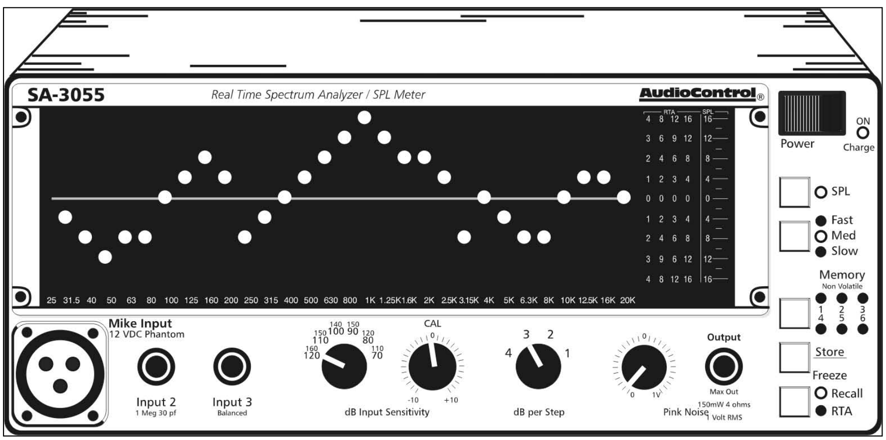


Figure 20-4: A typical frequency response curve on an Audio-Control SA-3055 real-time analyzer.

Courtesy of AudioControl

4. **Using the controls of the equalizer, start with all of the controls set to 0 dB (which is the center, neutral position) and adjust the frequency response of the system by cutting the amount of energy in the range where you see peaks and boosting it where you see dips.**

   Keep in mind that it's generally better to cut frequencies than boost them, and that as you make adjustments to one set of frequencies, adjacent frequencies are also affected.

5. **After making adjustments, take another reading with the RTA to see how your EQ adjustments affected the frequency response, and then continue tuning until you get as close to a flat frequency response as possible.**

As with setting gains, tuning with an RTA takes experience and patience, and you get better with practice. If someone with experience — and an RTA — can help you, even better. Many car audio shops have an RTA on hand for tuning customers' systems.

A flat frequency response is an ideal you want to try to achieve, but it doesn't mean that your system won't sound good if it can't achieve a flat response. In fact, quite the opposite. A flat frequency response sounds . . . well, flat. If you like the bass cranked up and see a huge peak in the region below 125 Hz, more power to you. (Literally, "more power to you": You're gonna need it for all that bass!) Measuring for frequency response with an RTA is simply a way for you to see if your system is deficient in any particular area.

If your system is deficient and no amount of tweaking can compensate for huge peaks and dips, it could be caused by a flaw in the system design, such as improper speaker locations or crossover points.

Keeping an Ear Out for Tuning Issues

After a while, you'll probably start to notice things that are amiss with your system. In fact, really experienced car audio tuners can simply listen to a system and tell where the problems lie. If you're a beginner you can't do that, but there are some things that you can listen for and correct. Here are a few of them.

Bass in the back

One of the obstacles to getting great sound in a car is that subwoofers are almost always mounted in the rear of a vehicle. The rear portion of a vehicle is usually the only place where there's room for subs and their bulky enclosures (although some hardcore car audio enthusiasts have been known to cram subs in doors or even floorboards).

Most likely, your subwoofers are behind you, whereas the speakers that take over for the subs frequency-wise, the midranges, are mounted close to you in the doors. Often this can cause a disjointed sound — the dreaded *bass-in-the-back* syndrome — in which it's very noticeable that the low bass is coming from behind you. It sounds like the bass drum and bass guitar are in the trunk, whereas the rest of the instruments are on the soundstage in front of you.

TIP

This can be a difficult problem to correct, but by crossing your front midranges' drivers as low as possible, you can sometimes minimize this effect. This also depends on the type of music you listen to. As mentioned earlier, if you listen to bass-heavy music, you want to be careful about crossing over your mids too low. Otherwise, they will distort because they're not designed to handle extremely low bass, and they could even be damaged. (Refer to the "Setting gains and crossover points by ear" section earlier in this chapter for more on how to set crossover points.)

Out of phase speaker wiring

REMEMBER

Wiring a speaker in reverse polarity or *out of phase* — meaning that the cone moves in when it's supposed to move out and vice versa — greatly diminishes sound output. When two speakers are wired out of phase with one another — say two midranges in each door, facing one another — the push-pull sound waves they generate effectively cancel each other out. The way you'll detect that something is amiss is that the speakers won't produce the volume that they should. If the front speakers are wired out of phase, the rear speakers (if you have them) may sound louder.

If you installed the system yourself, make sure the speakers are all wired correctly, with the positive wire connected to the positive speaker terminal and the negative wire connected to the negative speaker terminal. If you had the system installed at a shop and you suspect that something's not right, take your car back and ask them to check the polarity of the speakers.

TIP

Sometimes subwoofers can actually sound better when they are out of phase, although if you are using more than one sub, they must all operate out of phase if any of them do. In fact, some head units that have built-in subwoofer crossovers and controls allow you to reverse the phase of the subs at the push of a button.

Distortion

Distortion is anything that is not part of the original audio signal reproduced by a speaker, and it is noticeable when you listen to any music that you're familiar with. It could be an acoustic guitar that sounds too tinny, cymbals that sound too bright, or a bass note that sounds too *tubby* or just doesn't have the tight sound that it should. Distortion can be caused by many things, but it's mainly due to a component trying to do something it wasn't designed to do. This could include driving an amplifier past its design limits, mismatching gains, or crossing over a speaker such as a midrange too low. The list goes on and on.

TIP

The best way to isolate distortion is through the process of elimination. For example, if you hear distortion coming from your midrange speakers even at low volumes, it could be because the crossover point is too low for a midrange. So check the crossover point and make it higher. If that doesn't do the trick, make sure your gains are properly set. If that doesn't do it, maybe the amp is overpowering or underpowering the speaker. You have to rule out one potential cause before you move on to another. To check the crossover points and gain settings, refer to the section "Setting gain and crossover points by ear" earlier in this chapter. If adjusting the crossover points and gains doesn't work and you suspect that the problem is with the amplifier, you won't know unless you swap out the amp.

Troubleshooting Your System

According to Murphy's Law, things can and do go wrong. That's especially true with a car audio system. With so many separate components and so many wires running to so many places, it's surprising that car audio systems work as well as they do.

Although there are fixes for these various problems, it's always easier to take preventative measure to stop noise before it starts. (Remember the old "an ounce of prevention is worth a pound of cure" thing?) In this case, prevention means making sure your components are properly installed, wired, grounded, powered, and maintained.

But if you do run into a noise problem, there's usually a solution. The next few sections cover the most common problems that can plague a car audio system and how to fix them.

Grounding problems

REMEMBER

Most problems that can't be directly attributed to a faulty car audio component are usually due to improper grounding. With improper grounding, the connection in a circuit is not at the same potential, meaning that the circuit *sees* a different ground, and this can cause noise. (I cover grounding in more detail in Chapter 18.) Start by ensuring that you have a good ground for all of your components, particularly your amplifiers. With amplifiers, the ground wire should be connected to the chassis and the ground wire should be the same size as the power wire. In addition, power connections at the battery should be checked to make sure they are solid.

TIP

The negative battery post is never a good place to ground car audio components: It invites noise into the system.

Alternator whine

Alternator whine is the most common and one of the most difficult system noises to stamp out. It's a high-pitched whine that varies with engine speed and is usually caused by a bad ground.

TIP

You can eliminate it by grounding the offending equipment directly to the metal chassis of a vehicle instead of a factory grounding bolt. Also, ensure that your charging system is working properly and that the connections between the battery and your car audio components are secure. Another possible fix is to change your RCA cables from coaxial to twisted pair.

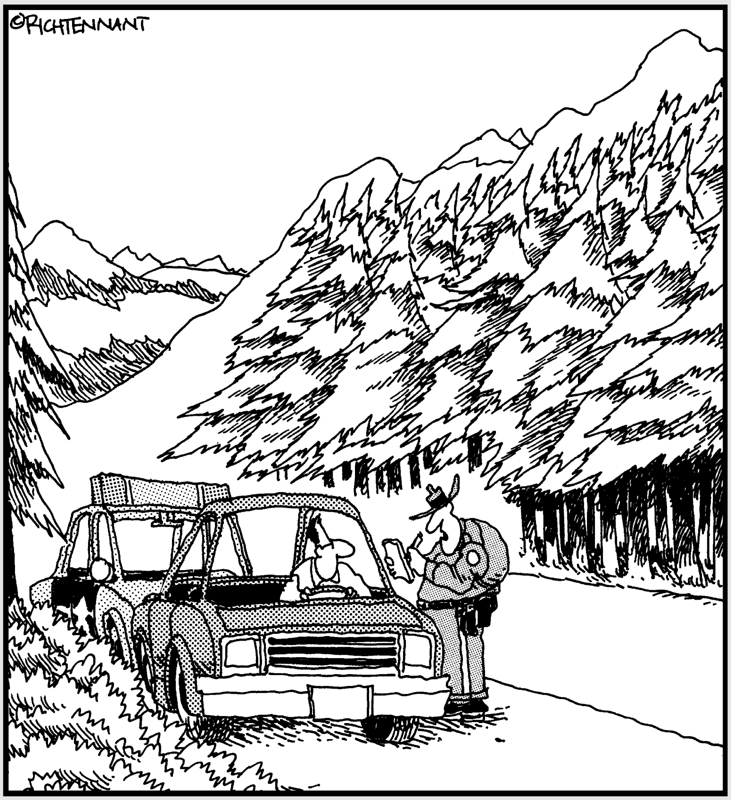
Switch pop

Any vehicle accessory that draws high current can cause a spike in voltage in the car's electrical system, which in turn seeps into the wiring of your car audio system and is heard as a pop. A switch pop can usually be traced to turning on or activating a particular electrical accessory in a vehicle: brake lights, turn signals, headlights, windshield wipers, or the air conditioning.

Professional installers typically add a small capacitor between the accessory's power wire and ground to soak up these errant power surges and hence eliminate the pop. If you sometimes hear a switch pop on your system, seek out a shop or installer that deals with such problems.

Part V
Protecting Your System and Yourself

The 5th Wave By Rich Tennant



"Sir, it's illegal for our hills to be THAT alive with the sound of music."

In This Part . . .

You've worked hard to save up and install your car audio system, and now you have to protect it from those who want it the easy way — by stealing it. In this Part, you discover the various ways you can protect your system. You also find out how to insure it in case the worst does happen. And you discover how to protect your hearing and safely operate your system while you're behind the wheel.

Chapter 21

Securing and Insuring Your System

In This Chapter

- Understanding security systems and sensors
- Considering head unit security features
- Insuring your system
- What to do before and after a theft

One of the downsides of having a great car audio system is that your vehicle can become a target for thieves. Some unscrupulous lowlifes don't care how hard you worked for your system or how much you paid for it. If you let your guard down, they'll break in and grab whatever they can. It's happened to me more than once, and it's a frustrating and sometimes expensive experience.

But you can take steps to prevent theft of your car audio components by installing an alarm system, employing other measures to secure your car audio components, and just by using plain common sense. Even if your car does get hit, you can protect yourself financially by purchasing insurance that covers a car audio system. Finally, you can save yourself some hassle by preparing for a theft and knowing what to do if or when it happens.

Securing Your Ride with an Alarm

It sounds like a no-brainer, but if you made a substantial investment in a car audio system, you need a security system to protect it. Although any security system short of a pit bull ultimately won't stop a thief — if someone wants to break into your car badly enough they'll find a way to do it — your strategy to reduce your risk should be two-fold:

- To make it more difficult for thieves to snatch your stuff
- To make your car less attractive as a target

Thieves often take the path of least resistance, and your car may be targeted instead of another just because it's easier to break into. What you want to do is make it difficult for the bad guys to get at the goodies inside your ride.

The best way to both make your car less attractive to thieves and thwart them if they do pick your ride, is to install a security system. A security system's siren can alert you or anyone close to the car that something is up. The last thing a thief wants is to draw attention to himself.

Of course, car alarms have their limitations. With so many cars today equipped with security systems — and so many false alarms going off all the time — no one pays much attention to a car alarm siren these days unless it's their own. And you won't know if your siren is going off unless you can hear it.

The limitations of traditional car alarms are why some car alarm manufacturers have begun offering two-way keychain transmitter remotes. Along with the buttons found on traditional car alarm remotes, these transmitters also feature an LED display that can tell you about the status of a security system (see Figure 21-1). For example, the remote confirms operations such as arm and disarm, even when you're out of range of the siren. More importantly, the remote notifies you if the alarm has been triggered, and some work as much as mile away from your vehicle.

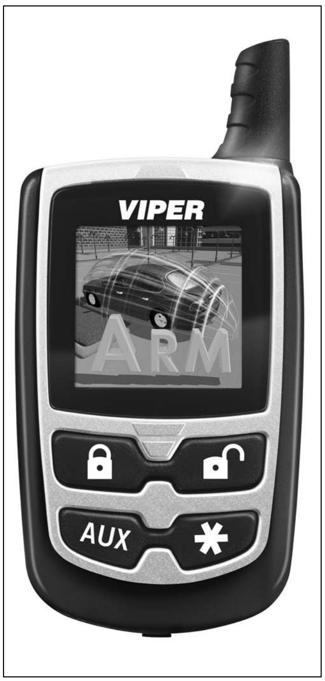


Figure 21-1: A Viper alarm remote with an LED display.

Courtesy of Directed Electronics

Never confront someone who is trying to break into your car. You never know whether they're armed, and protecting your car or your car audio system isn't worth getting harmed or killed. Instead of confronting a thief, alert the police or some other authority.

The parts of a security system

In addition to remote transmitters that remotely arm a system and an LED indicator that warns thieves of an alarm's presence, the parts of a security system you don't see are the central processing unit or brain, which is tied to outputs that control various functions and sensors that feed info to the brain about intrusion attempts.

Two types of outputs

An alarm's outputs control *relays*, which are electrical switches that activate a car's electronic components, and consist of two types:

- A starter-interrupt output that prevents a vehicle's starter from operating when activated, and keeps the engine from cranking (also called a starter *kill*).
- Outputs that remotely activate convenience features such as door locks, the dome light or headlights, the hatch latch, power windows or a sunroof, and even remotely start a vehicle so that the interior can be warmed up on cold days or cooled down on hot days.

Sensor and sirens

A starter-interrupt keeps someone from starting your car and driving it away, but sensors are the first line of defense from an intrusion. They signal to the alarm's brain that someone is trying to break in, and the brain in turn sounds the siren. Various sensors are designed to provide specific types of protection, and you can use one or several depending on the type of vehicle you want to protect and the level or protection you want or can afford.

Types of sensors include

- **Entry sensors:** To protect a vehicle's entry points — the doors, trunk, hood, or hatch — a security system ties into the *pin switches* already in place. Pin switches are the small cylindrical switches that are used to turn on the dome light, for example, when a door is opened. Because a vehicle usually already has pin switches in the door jambs as well as the hood and trunk, it's simply a matter of tying these switches into the security system. If the hood and trunk don't have pin switches, they can easily be added.

Another way a security system senses entry is through voltage-drop. When a security system is tied into the vehicle's electrical system and a dome light, trunk light, or engine-compartment lights turn on, the system senses a voltage drop and sounds the siren.

- **Shock sensor:** A shock sensor detects a blow to a vehicle, such as when someone tries to smash a window or uses force to break into a car. Many shock sensors are *dual-stage,* meaning that if a small disturbance is detected, such as when someone dings your car door in a parking lot, the sensor causes the system to emit a few chirps from the siren. In the case of a greater impact, the full siren cycle sounds. The sensitivity of a shock sensor can usually be set to determine the threshold for triggering the siren. A too-sensitive shock sensor setting is usually why you hear a system sounding a false alarm.
- **Glass-break sensor:** These sensors listen for the specific sound that occurs when a car window shatters, which is the fastest way for a thief to break in. Some even activate before a thief breaks the window and are triggered by the sound of metal scraping on glass, such as when a thief uses a *slim jim* tool that slides between the glass and the door to unlock the door without a key.
- **Pressure sensor:** When a door is opened, it causes a change in pressure inside the vehicle. A pressure sensor detects this and sends a signal to the brain to sound the siren.
- **Radar or motion sensor:** Also called a perimeter sensor, this type of sensor sends out radio waves that can detect motion within a given space. These sensors are great for protecting convertibles or any open area of a vehicle, such as a pickup's bed.
- **Tilt sensor:** Car thieves can simply use a tow truck to haul a vehicle away, so a tilt sensor is used to detect when a car's front or rear end is lifted. It's also used to keep thieves from jacking up a vehicle to steal the wheels and tires.

Other features that modern car security systems offer include

- **Anti-carjacking:** This feature is designed to prevent a carjacker from getting away with a vehicle. If a door is opened after the engine has been started, the driver must hit a switch or button to deactivate the carjack mode. If the switch isn't activated, the car's lights flash and the security system siren sounds after a period of time (usually about five minutes or so), drawing attention to the vehicle. If the thief stops the car, the starter-interrupt won't allow it to start again.
- **Valet mode:** This allows the car owners to turn off the alarm system if, for example, they are handing the vehicle over to a parking valet or mechanic.

- **Code hopping:** After thieves discovered they could use frequency scanners to capture a car alarm's arming/disarming code when sent from the alarm remote to the brain, alarm manufacturers started using *code hopping* or *rolling code transmission* so that a different code is sent from the remote every time the system is armed and disarmed.
- **Active and passive arming:** Most systems give the owner the choice between active or passive arming. *Active* arming requires an action on the part of the owner, such as pressing a button on the alarm remote, whereas *passive* arming requires no action on the part of the driver and is great for someone who frequently forgets to set the alarm. With passive arming, the alarm automatically sets within a given time period after the engine is shut off and the driver exits the vehicle. To disarm the vehicle upon returning, the driver has to perform some sort of action in order to disarm the system, such as pushing a button or flipping a switch, within a given time frame.
- **Backup battery or backup battery siren:** Some car thieves defeat an alarm simply by cutting power to the battery, and hence the security system. To prevent this, a backup battery kicks in when power is cut, or a backup battery siren sounds.

TIP

Most insurance companies offer a discount if a vehicle is equipped with a security system.

A security system is a must have for anyone who has invested a significant amount of money in a car or car audio system. A thief will most likely pass up a car with a security system and target one without one instead. But in addition to a security system, there are other things you can do to protect your system, ranging from security features built into a head unit, to installing components in a certain way, to just using common sense. I cover these other security options in the next few sections.

Head unit security

Back in the day, when car stereo theft started to became a big problem, car audio manufacturers came up with the pull-out radio. In the mid- to late-1980s, it wasn't unusual to see someone carrying around a bulky car radio attached to a pullout handle. Although this was inconvenient, it worked.

Detachable faceplates

In the early 1990s, the first detachable-faceplate radios were introduced, and it was much easier to just pop the faceplate off a radio than carry around the whole thing. Without the faceplate, the radio would be useless to a thief. The design quickly became the de facto standard in head unit security, and continues to be today.

ESN

One manufacturer that didn't jump on the detachable-faceplate bandwagon was Eclipse. Around the same time that detachable faceplates were introduced, the company came up with its ESN security schemes. With ESN, a head unit could be coded by selecting a *key* CD. If power to the unit was ever cut — when it was stolen or when the battery was disconnected for service — it wouldn't work again until the key CD was inserted. Because a thief wouldn't know which CD is the key, the unit is effectively inoperable.

The owner also has to register the unit with Eclipse. So if someone steals an ESN head unit and sends it in to be *unlocked,* Eclipse can alert the original owner and notify police to track the person who sent it in. The ESN system has been relatively successful and thieves seem to know that Eclipse head units can't be operated — and hence fenced or illegally sold — without access to the key CD. On more recent Eclipse models that have a slot for a Memory Stick, the code can also be stored on one of those flash memory devices. Also, Eclipse began offering detachable-faceplate head units, and some have ESN as well as a detachable faceplate.

Using a layered approach

TIP

An Eclipse head unit with a detachable faceplate and ESN is an example of what's known as a *layered* approach to car audio security. The idea is to put up multiple roadblocks to make it harder for a thief to steal your stuff. For example, a security system may slow down thieves, but it won't stop them from breaking into your car if they really want to. If they do breach the car's interior, you want to make it more difficult for them to steal your stuff. You can do this by solidly mounting your components and using non-standard fasteners, such as hex-head screws that require an Allen wrench, to foil *smash and grab* thieves.

Using Common Sense

TIP

The best deterrent of all is to keep car audio components and other valuables out of sight and give your system and your car a low profile. Although this may run counter to your plans for a flashy car audio system, the more you flaunt what you've got, the more your car becomes a target. Here are some tactics for keeping a low-key presence.

- **Keep it stock:** One of the best ways to deter thieves is to have them think there's nothing in your vehicle worth stealing, such as a stock audio system. If you don't want an elaborate system but simply want better sound, keep the stock head unit intact and add aftermarket amplifiers and speakers.

- **Keep it low-key:** If you do install aftermarket speakers, keep them behind the stock speaker grilles. If you use the grilles that came with your aftermarket speakers and they include prominent logos that tell the world you have expensive speakers in your ride, switch them out for nondescript grilles or remove or paint over the logos.
- **Keep it hidden:** If you're installing amplifiers or subwoofers in your vehicle, mount them in a place where they can't be seen. This may be easier in a vehicle with a trunk, but even with hatchbacks or pickup trucks, you can employ methods to keep your components hidden. For example, many hatchbacks come with a factory cover. Use it. In pickups, cosmetic panels can be built to fit over and hide car audio components.
- **Keep it quiet:** One sure way to let everyone know you have something worth stealing is to blast your system so that everyone, including car thieves, can hear it. While everyone likes to crank it up every now and then, just be aware of where you're doing it and who is around. Crank it up close to home, and thieves will know where you park your car at night. You also don't want to plaster your car with stickers from car audio manufacturers, which is like an advertisement for all the stuff you have inside that can be stolen.
- **Keep it safe:** Park in well-lit places where lots of people pass by. For example, at a shopping mall or movie theater, try to park as close to the entrance as possible and under a light. Thieves hate attention and they hate for light to be shed on their dastardly deeds.

Insuring Your System

You can do everything possible to protect your system — install a security system, install components so that they're hard to remove, keep a low profile — but sometimes the worst happens: Someone breaks in and steals your car audio thunder. After the shock and disappointment of losing your car audio system, you may be in for another shock by finding out that your car insurance won't cover your loss.

The basics parts of an insurance policy include

- **Premium:** This is the amount you pay the insurance company for coverage.
- **Deductible:** This is the amount you pay out of pocket when you have a claim or loss. A typical deductible is $500, which means if you have a $5,000 claim, you pay $500 and the insurance company pays $4,500. You can sometimes opt for a lower deductible by paying a higher premium.
- **Collision coverage:** This covers the damage that occurs to your vehicle from a collision.

- **Liability:** This covers damage to other vehicles, property, and people in the event of a crash. Almost every state requires liability insurance as a condition of licensing a driver, and some require that you carry proof of liability insurance while driving.
- **Comprehensive:** This covers damage not related to a crash but incidents such as vandalism and theft (but not always for an aftermarket audio system) or damages caused by a natural disaster.
- **Riders:** This is add-on coverage and is usually taken out by people who have items added to their cars that are not included under normal coverage, such as high-end car audio systems and custom wheels and paint jobs. Of course, you pay extra for a rider on top of the regular premium.

How much you pay in premiums depends on the type and amount of coverage you carry. Some people only carry liability as a bare-bones coverage, and they have to pay out-of-pocket to repair their own vehicle if it's involved in an accident or gets damaged.

The cost of insurance is based on many factors: your age, where you live, your driving record, and what kind of car you drive. Liability coverage is charged on a sliding scale. For example, if you want to increase coverage from, say, $100,000 in property damage to $200,000, you're going to pay a higher premium.

Most comprehensive insurance policies cover car audio equipment, but usually only if it's installed in factory locations. So a head unit and speakers would be covered, but not amplifiers and subwoofers. There also may be limits on how much you'll be compensated for the equipment. Each policy is different and each claim is handled differently, so it's important to know *before* a theft how your insurance company handles things.

Be prepared

The best way to be prepared for a theft is to work closely with your insurance agent. Find out if she has worked with people who have had their car audio equipment stolen, and if they have not, ask if someone else in the office has. Also find out how much of your system is covered — and not covered — by your policy, and what you need to do to extend your coverage if it's inadequate.

Chances are you'll have to purchase a separate rider to cover your system if it's extensive and custom-installed. But insurance companies sometimes place limits on riders and how much risk they'll willing to assume. If you have a modest system, this may not be a problem. But if you've sunk tens of thousands of dollars into a system, you may find an insurance company reluctant to offer coverage even under a rider. In this case, you should shop around for another insurance company that may be willing to offer a rider that covers more extensive systems.

TIP

You'll also want to know how much your equipment will be depreciated. An insurance company probably won't reimburse the full price you paid for the equipment because it will have depreciated, and therefore be worth less. For example, a set of speakers you paid $200 for three year ago may only be worth $75 today. Find out how the insurance company handles depreciation and how it decides the value of the equipment.

TIP

Custom installation work is another potential problem area because an insurance company probably won't be familiar with what it takes to install a custom car audio system and the costs involved. Ask your agent how custom work is covered.

You'll want to answer as many of these questions as possible before a theft occurs so that there are no unpleasant surprises when the worst happens. Here are some other questions you'll want to ask your insurance agent:

- What is the procedure for making a claim?
- How long does it take to process a claim?
- Are items such as CDs and iPods covered under the policy?
- Can I choose the car audio shop where the repair work is done?

TIP

In addition, having your car towed if it's not drivable may be covered by your policy, or you may have to pay extra for it. Find out beforehand. The same goes for renting a car until yours is repaired; find out if it's part of your coverage or an out-of-pocket expense.

Before and after a theft

TIP

Although you hope a theft never happens to you, you can take proactive steps before or after to help minimize the hassle of getting your claim processed and getting reimbursed for the loss, as well as avoid other disappointments.

Before a theft

Keep all your receipts for equipment purchases and installation expenses in one folder. That way, you can document exactly what you spent on the system.

Take pictures or a video of your system so that you have a record of what it consists of and where everything was installed. Make sure to update the pictures as you make changes to the system.

After a theft

Contact the police and file a report of the theft. Many times, an insurance company requires a police report before initiating a claim.

Contact your insurance agent and initiate a claim. Provide the agent with detailed information, including receipts and photographs, if necessary.

TIP

If your vehicle is involved in an accident and it has to be towed, find out where and how the car will be stored. The last thing you want is for a thief to have access to your damaged car in a wrecking yard. Ask that the vehicle be stored inside or in a secured area. Also find out when and if you'll be allowed to salvage the car audio components from the car.

Chapter 22

Keeping Safe and Legal

In This Chapter

- Protecting your hearing
- Knowing when to turn it down
- Keeping your eyes on the road

There's nothing quite like cruising down the road listening to your favorite tunes. When you're driving a cool car with a great car audio system on a fun road, it makes you want to reach over and crank up the volume.

It's one of the primary reasons someone would want to install a custom car audio system in the first place — and one of my favorite feelings in the world. Although it's great to crank it up, and great to own a system that lets you do that, it's equally important to know when to turn it down. In this chapter, I talk about how overdoing it can cause problems ranging from hearing loss to driver distraction.

Playing It Smart

Exposure to extremely high sound pressure level (SPL) can cause immediate damage to your hearing. But even moderate SPL at or above 85 decibels, which a car audio system is easily capable of, can cause Noise Induced Hearing Loss (NIHL) with repeated exposure. And although being aware of the SPL of a sound source is important in protecting your hearing (see Table 22-1), the distance from the source of the sound and duration of exposure are equally significant.

Table 22-1 Noise Level of Various Environments

Activity	*Noise Level in Decibels (dB)*
Rocket launching	180
Jet engine taking off	140
Hydraulic press (10 ft. away)	130
Car horn	120
Typical nightclub	110
Amplified rock music	110-130
Helicopter	105
Loud shout	90
High-performance car audio system	85-90
Electric shaver	85
Busy traffic intersection	80
Noisy restaurant	70
Washing machine/dishwasher	65
Normal conversation	60
Quiet office	50
Refrigerator	45
Public library	40
Leaves rustling	30
Threshold of sound perception	10
Threshold of hearing	0

Table courtesy of AudioControl

According to the National Institute for Deafness and Other Communication Disorders, a good rule of thumb is to avoid noises that are *too loud* and *too close* and last *too long*. Unfortunately, this sounds like an apt description of a long drive in a vehicle with a car audio system. But you can enjoy your system *and* preserve your hearing if you play it smart and know when to turn it down.

Knowing When the Music Is Too Loud

Another rule of thumb is that if you have to shout to make yourself heard, the source of the noise you're shouting over may be loud enough to damage your hearing. You'll also know that a sound is too loud if your ears hurt, and you'll know afterwards if your ears ring or you have a hard time hearing for several hours after exposure to the noise.

Exposure to high SPL damages hair cells, sensory receptors in the ear, as well as the auditory or hearing nerve. *Impulse* sounds, or quick bursts of noise such as an explosion, can result in immediate hearing loss that can be permanent and may be accompanied by tinnitus, a ringing or buzzing noise in the ears that can decrease over time. Hearing loss and tinnitus can be experienced in one or both ears due to impulse sounds, and tinnitus can continue constantly or periodically over a lifetime.

Prolonged exposure to high SPL, such as listening to music that's too loud for too long, may also damage hair cells and result in hearing loss and tinnitus. But because the process occurs more gradually than with impulse noise, the symptoms of hearing loss will also increase gradually. Over time, sounds may become distorted or muffled, and it may be difficult to understand when someone's talking to you.

Car audio systems are not the only culprits, of course. Activities such as target shooting or hunting with firearms, motorcycle riding, woodworking, and other hobbies can cause hearing loss, as can playing in a band and attending loud concerts. Even noise from lawnmowers and leaf blowers can be harmful.

The good news is that noise-induced hearing loss is preventable. To protect your hearing:

- Be aware of noise that can harm your ears, such as those at or above 85 decibels, and take steps to reduce your exposure.
- Wear earplugs or earmuffs when involved in activities that can cause hearing damage, such as attending rock concerts or using power tools.
- If you think you have hearing loss, get an ear exam.

Being Aware of Driver Distraction

Another potential hazard of enjoying a car audio system is driver distraction. According to the National Highway Traffic Safety Administration (NHTSA), between 20 to 30 percent of all motor vehicle accidents occur because of driver distraction. Some insurance industry sources place it as high as 80 percent.

Although car audio and video get a bad rap, studies have shown that the most common causes of driver distraction include

- Grooming
- Eating or drinking
- Reading
- Smoking
- Reaching for something
- Talking with passengers
- Interacting with children
- Outside distractions
- Using a mobile phone
- Objects shifting in a vehicle

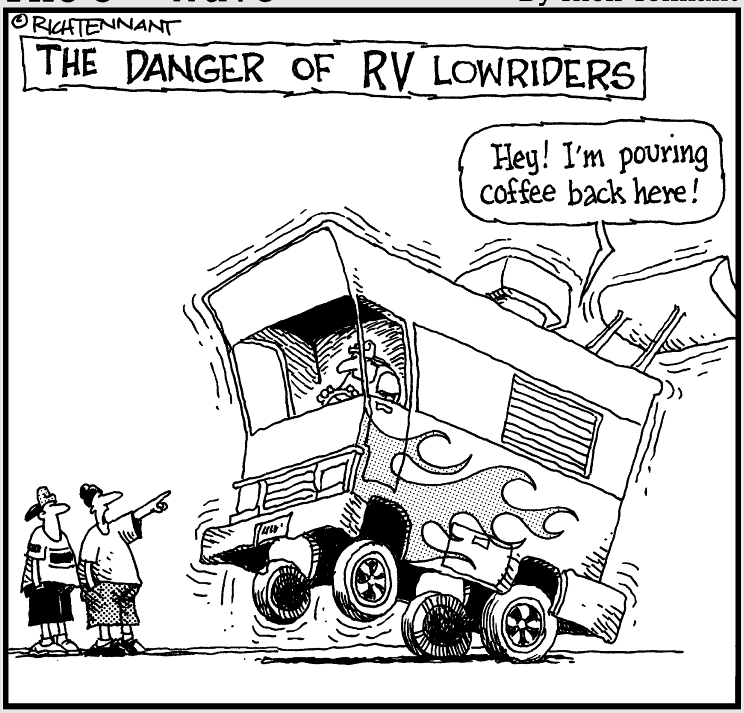
Although head unit manufacturers design their products with an eye towards making them easy to operate while driving, it's up to each individual to ensure that they are not endangering the lives of their passengers, others on the road, and themselves by fiddling with a car audio system. Now that portable media players such as iPods have become popular, they pose an even greater risk of distracting a driver.

The issue has become even more urgent with the advent of in-car video. That's one reason the Mobile Electronics division of the Consumer Electronics Association (CEA), the trade group that represents the consumer electronics industry, launched its Watch the Road campaign, which offers advice and information on driver distraction on the Web at `www.digitaldriver.org`.

The Web site provides a state-by-state listing of laws governing the use of mobile electronics and portable electronics in a vehicle, a "Road Test IQ" to test your knowledge on driver distraction issues, and tips for driving smart with consumer electronics.

Part VI
The Part of Tens

The 5th Wave By Rich Tennant



In This Part . . .

What would a *For Dummies* book be without a Part of Tens? In this Part, I list ten steps you can take to achieve great sound, the most important questions you should ask an installer or salesperson, and ten key steps to maintaining your system. I even throw in a Glossary to explain all the techie terms you may run across in your car audio quest.

Chapter 23

Ten Steps to Great Sound

In This Chapter

- Doing your homework
- Using your ears
- Trusting your instincts
- Planning ahead

It takes a lot to create a good car audio system — a lot of planning, time, and money — and it's never easy. But the reward is a system that brings out the best in your music and really enhances your vehicle and the driving experience.

Here are ten basic steps every car audio enthusiast should take on the path to great sound.

Making Up Your Mind

One of the first things you need to do is decide what type of system you want. Do you want one that can reproduce your music so that it sounds like you're at a live concert? Or do you want a system that can simply blast out a bunch of bass? Maybe you want a system that can do both. By starting with a goal in mind, you can save yourself from potentially wasting money on components or wasting time on designs and installations that don't fit your overall objectives.

For example, if you know you want a system that puts out mega bass, you'll want to focus on amplifiers and subwoofers capable of producing the highest amount of sound-pressure level (SPL) — and not spend money on high-end component speakers or "audiophile" amplifiers. On the other hand, if it's sound quality you're after, you'll want to devote more resources to high-quality speakers.

Planning a car audio system reminds me of the saying, “If you don’t know where you’re going, any road will take you there.” If you don’t know what kind of car audio system you want, you may take many different routes — and hit some dead ends — before you get something you like.

Doing Your Homework

An important part of planning your car audio system is knowing what components are available, what they do, and what they cost. As mentioned, planning a car audio system takes a lot of work, and no one is going to do it for you — or look after your best interests. Although you may find a great car audio shop that can help lead you through the component selection and system design process, you should already have solid information on the components that you want to make up your system before you even walk through the door.

Do your homework by researching which components fit your car (the size of the speaker and the factory-radio openings) and best accomplish what you want your system to do (audiophile-quality bass or massive SPL), what they cost, and where they’re available.

Information is power, and the more information you have, the more you’ll be empowered to make the best decisions on equipment and system design. With all of the resources that the Web offers for gathering information, you have the world at your fingertips. Below are a few Web sites and Internet forums that can help.

- CarStereo.com, `www.carstereo.com`
- Basic Car Audio Electronics, `www.bcae1.com`
- Car Audio Help, `www.caraudiohelp.com`
- rec.audio car, `www.mobileaudio.com`
- CarAudioForum.com, `www.caraudioforum.com`
- SoundDomain, `www.sounddomain.com`

Using Your Ears

A car audio system is a very personal thing — for your ears only. Although you may get advice from others on which components to buy, how they should be installed, and how the system should be tuned, you should be the ultimate authority on the subject. After all, you’re the one spending the money on a car audio system. It’s your car and they are your ears: They’ll tell you what kind of sound is best.

Using Your Head

Are you sure you want to install a system that costs twice as much as your car? How long do you plan on keeping the car, anyway? Do you really want to rip out the back seat to install subwoofers? What about when you want to cruise with a group of friends? Where will they sit? Or is it wise to fill up the trunk of the car with amplifiers so that you can't even carry a bag of groceries? And what will that do to your car's charging system, to say nothing of your bank account?

It's easy to get carried away when planning, shopping for, and installing a car audio system. Try to keep a level head when putting together your system, taking into account how you use your car, how long you plan to keep it, how much you've budgeted, and other such considerations. I've seen too many people make poor choices when it comes to putting together a car audio system and regretting it afterwards. So consider all the factors involved and take your time.

Finding a Friend

While it may be your system, you don't have to go it alone. Find a friend who has more car audio experience to perhaps serve as a mentor or advisor. There's nothing like a little knowledge to help keep you from making mistakes, and a friend to guide you to hopefully avoid some of the pitfalls that beginners make.

Car audio is also more fun when it's a collaborative effort. A good friend will act as a sounding board. Plus, there's nothing like sharing a cruise with a friend and cranking up your system when it's all said and done.

Trusting Your Instincts

While it's great to have a friend to help out, just because your buddy insists that you should go with one 15-inch sub instead of two 10s doesn't mean that you have to listen to him — or even that it's right for your system. You probably have a good sense of what you want from your system — if you follow the advice above about making up your mind and doing your homework — so always go with your gut if you can't decide which direction is best. Chances are you'll be dead-on with the decision.

Keeping It Simple

If you're reading this book, it probably means you've just started on this whole car audio thing. A word on advice: Keep your first system simple. Even a simple car audio system can seem very complex to a beginner, and you don't want to bite off more than you can chew. Starting with a basic system will help you get your feet wet and learn slowly rather than feeling overwhelmed by a complex system. Plus, the more components you have the more chances something will go wrong. Save complexity for when you have a few systems under your belt.

Planning Ahead

While you'll want to keep your first system simple, there's no reason you can't set your sights on something more elaborate down the road. In fact, it's always smart to plan your system with an eye towards future upgrades. If you can't afford a subwoofer for your initial system, perhaps you'll want to buy a stereo amp that can be bridged so that when you do get a sub you'll have an amp that can power it. Or even if you can't afford to add rear-seat video to your ride, you can get a head unit that has a DVD player and an auxiliary A/V output so that you can add screens in the rear later down the road.

As much as possible you'll want to *future proof* your system, which means that you don't want to paint yourself into a corner when it comes to future upgrade options. Technology changes fast and you don't want to get left behind. Look at how quickly the iPod changed the way people bring music into the car — and how people who don't have a head unit with an auxiliary input must feel.

Cranking It Up

If you want to see what a car audio component can do, crank it up. When shopping for car audio equipment, don't be afraid to play music at loud volumes to get a sense of how a speaker or subwoofer performs. Most components are made to play music at loud volume and perform their best when cranked up.

Same thing goes for after you get the stuff installed in your car. Don't hesitate to crank it up from time to time. When musicians are creating a recording in the studio, they're usually listening to the playback (when they check out what they've recorded) at loud volumes, and that's the way most music is meant to be heard. Plus, you sometimes have to crank up a car audio system just to combat road, engine, and wind noise.

Turning It Down

Of course, there is a limit to how much you want to crank it up. You don't want your system to distort. A little distortion is inevitable, but a lot can damage components, particularly speakers. When you hear distortion or a problem with a component, turn it down.

And when you're driving through a quiet neighborhood, turn it down. You also want to be careful not to crank it so loud that you don't hear sirens from emergency vehicles. And you don't want to play your system so loud that it damages your ears — otherwise you won't be enjoying music for years to come.

Chapter 24

Ten Questions to Ask Your Salesperson or Installer

In This Chapter

- Asking a shop for references
- Finding out how much training an installer has
- Asking about service after the sale
- Working with authorized dealers

It can be intimidating to walk into a car audio shop as a newbie. You don't know a lot about car audio and you're entering an environment where people (hopefully) know a lot more than you do. It may be tempting to act like you know more than you do, but put your ego aside and realize that you're at the beginning of a steep learning curve. More importantly, realize that the shop and its employees are there to serve you and answer your questions. And if they don't, find another shop.

In this chapter are ten questions you should ask a salesperson or an installer at the car audio shop you choose.

Can You Give Me References?

Any successful shop has many happy customers, and the shop is usually happy to have you contact these customers so that they can tell you how happy they are. If they don't want to give references, be suspicious: Be very suspicious. If they do give you references, ask the shop how recently these people were customers, what type of cars they drive, and what sort of systems they had installed. Look for someone who has a car similar to yours or had a system installed that's similar to yours.

When you contact the references the shop provides, ask what they like about the system and what they don't. Ask what they like about dealing with the shop and what they don't. Ask if there's anything they would have done differently and why. Also ask about service after the sale and how the shop handled it.

Can I See Systems You've Done?

As with giving references, most shops are very eager to show off their work. Most have an *installation book* in the shop that you can flip though to see examples of their work, or the shop may have a computer slideshow. Even better, ask if they have a demonstration system that they can show you and let you listen to, which most likely belongs to one of the salespeople or installers.

Examples of the shop's work give you an idea of what type of systems the shop specializes in (sound quality, SPL, small systems, big systems) and the quality of their work. Pay close attention to the details, such as how wires are run. If the shop does a sloppy job of running wires, for example, they are probably sloppy with everything else.

How Are Your Installers Trained?

If the shop you're considering will also be installing your car audio system, you'll want to know how the installers have been trained. Many installers get on-the-job training, but some also receive training from car audio manufacturers, and the best have been through the Mobile Electronics Certification Professionals program. MECP tests installers on proper installation techniques and knowledge, and MECP-certified installers are required to pass a written exam and meet experience criteria, and they must be recertified every two to four years, depending on their level.

Certification levels include

- Basic Installation Technician
- Advanced Installation Technician
- Master Installation Technician

TIP

Ask the shop if its installers are MECP-certified and look for certificates showing which installers have completed the program and at which level.

What's Your Service Policy?

Although the rate of failure in high-quality car audio equipment is relatively low, if a component does malfunction, you should find out beforehand how a shop handles it. A shop usually has to send a bad component back to the manufacturer for repair. If the equipment is under warranty, some shops don't charge for labor to take the equipment out and put it back into your car, but some do. Others simply take a new product from their stock and replace the faulty one on the spot. Ask how the shop handles such situations and find out how long the turnaround will be if a component does need to be returned for repair.

What's Your Installation Rate?

Most shops charge by the hour for installation, so ask what the rate will be, but also get an estimate of how much time an installation will take. If the install takes longer than anticipated, ask who will pay for the extra labor time. If it's a simple system, the shop should be able to give you an accurate estimate of how much time it will take and therefore what it will cost. If it's an elaborate system or includes new equipment they're not used to working with, the shop may need a little more flexibility time-wise.

TIP

While a shop usually has a flat labor rate, depending on how much you're spending and how long you've been a customer, they may cut you a deal or give you an *accommodation* rate.

Are You an Authorized Dealer?

Most specialty car audio brands are only sold through authorized dealers. This lets the manufacturer control who is selling their product as well as how it's installed. Car audio manufacturers put significant resources into product training and installation training so that they can be assured that their products are used and installed properly. Sometimes an unscrupulous dealer obtains desirable brands through the *gray market* but can't offer a warranty the way an authorized dealer can, and his installers may not be properly trained to install the equipment.

Do You Guarantee Your Work?

A reputable car audio shop stands behind its work by offering a guarantee. Be sure to ask what the guarantee covers and for how long. Some shops may guarantee their work for only a short period, such as 30 days, whereas others guarantee it for up to a year or even a lifetime. The guarantee a shop offers says a lot about how willing it is to stand behind its work.

Do You Carry Insurance?

You're entrusting one of your most expensive and prized possessions — your vehicle — to a shop. The employees may be driving it in and out of the shop. They'll be working on it with tools and tearing it apart to install car audio equipment. So you want to know that if something goes wrong — if the car is involved in an accident, if the car is damaged somehow, or even if the shop catches on fire — that you're covered. Ask the shop what kind of insurance it carries and how long they've been in business. Also ask if they've ever had an accident or damaged a vehicle.

Do You Install Equipment You Don't Sell?

Maybe you have equipment left over from a previous system, or you bought some used equipment, or perhaps you bought components from another shop or off the Internet. But if you want to have your system installed by a shop and didn't buy everything from that shop, ask how they'll handle it. Most shops only want to install what they sell because their installers are trained to work with that equipment and they have access to manufacturers' technical support for it. Some shops, on the other hand, will work with you and install equipment that you didn't buy at the shop.

Do You Help with DIY Installations?

Say that you've decided to go it on your own, but now you have a problem and need help. You have resources you can turn to, such as friends and the Internet. But you may also be able to get assistance from the shop that sold you the equipment. Some shops frown on DIY installations, whereas others will give you a hand with certain problems. Ask what the shop's policy is when you buy your gear. But don't expect them to take 20 calls a day from you with 20 questions. Also, be sure to find out if you'll be able to bring the vehicle in if you really get stuck and can't finish the installation.

Chapter 25

Ten Steps to Maintaining Your System

In This Chapter

- Keeping your system clean and cool
- Securing your subwoofer box
- Checking your antenna
- Maintaining your power

The automotive environment is a tough place for electronics. It can get brutally hot and bitterly cold. It can get sticky with humidity and brittle with dryness. Plus, components have to withstand near-constant vibration, jarring bumps, and dirt and dust. Car audio components are made for the harsh realities of the automotive environment, but they perform best and last longer if you maintain your equipment.

In this chapter, I give you ten tips to help you keep your equipment in top shape.

Keeping It Clean

Vehicles collect a lot of dirt and dust from passengers climbing in and out, gear that gets stored inside your car, and also airborne pollutants. The magnets of subwoofers and other speakers can attract small screws or other pieces of metal, which can end up in the moving parts of a speaker, damaging it. Amplifier cooling fans often suck in debris and distribute it over the amp's internal circuitry, and even a small amount of dirt in the disc mechanism of a CD or DVD player isn't a good thing. Plus, a dirty car audio system just looks bad.

First, it helps to keep you car clean. Every time you clean your car, clean your car audio components as well. Use a soft bristle brush or compressed air to clear away dirt, particularly around the disc slots of CD and DVD players.

Clean amplifiers' heat sinks with a rag, and carefully suck out any dirt and dust clogging the screens covering cooling fan with a vacuum cleaner. Video screens can be wiped off with cleaners made especially for LCD screens and a soft cloth.

Keeping It Cool

Electronics hate heat. Circuits can get damaged if they overheat, and amplifiers in particular can fail or go into thermal protection mode. Try not to hammer on your components too much on very hot days, and let the interior of your car cool down before cranking your system. Amplifiers that are mounted in the trunk may need special attention. Cooling fans that blow air across the heat sinks can help.

Turning It Down

You probably got a car audio system so you could crank it up, but pushing components past their peak for hours at a time can put a strain on them. It's okay if you crank your car audio system for short periods — as long as you're not damaging your hearing — but pushing your system too hard for too long could cause a component to fail.

Turning It Off

If you're not listening to your system, turn it off by switching off the head, which causes the entire system to shut down. Otherwise, every component in the system is sucking power from your car's charging system. It may only be small amounts of juice, but in a large system, the current draw can add up to a dead battery.

Tightening It Up

Because a vehicle is subject to so much vibration and jostling, even the most carefully installed components can get shaken loose. Check the mounting screws on your components as well as all of the connections from time to time to ensure that nothing is coming loose.

Paying Attention

After you've become very familiar with your system, you'll know if something isn't quite right. Maybe a speaker buzzes, you may hear a strange noise coming from your head unit, or a popping sound when you press the brakes or activate some other electronic accessory in the vehicle. Pay attention to these odd sounds and try to find their source before they manifest into bigger problems.

Securing Your Sub

A subwoofer box that isn't secured to the vehicle is an accident waiting to happen. If you stop suddenly or take a sharp turn too fast, a subwoofer box can go flying and harm someone in the car. At the very least, a flying box can damage the vehicle or the sub, so screw it down.

Checking Your Antenna

An antenna is often an overlooked part of a car audio system. Power antennas need to be occasionally cleaned and lubricated. Check your car owner's manual for proper care of your antenna.

Maintaining Power

Proper power is the lifeblood of a car audio system. Without it, your components will either perform inadequately or could even get damaged. Make sure your car's electrical system is working properly and is well maintained. Check the connections at the battery and keep the battery terminals free from corrosion.

Keeping Your Change

You know that pocket change that falls between the seat cushions of your car? If you have your amps mounted under the seat, a coin could potentially fall onto the amp's exposed connections or some other component and cause a short. The same goes for tools or any other metal objects that are unsecured in the trunk.

Glossary

active crossover: A crossover that requires electrical power to filter frequencies going to speakers; also called an electronic crossover. *See also crossover.*

aftermarket: Equipment that can be purchased and installed in a vehicle but did not come originally with it or from a car dealer; the opposite of stock or OEM equipment.

alternate-channel selectivity: A measurement of a radio's ability to reject an interfering signal.

alternator: A component that supplies power to a car's electrical components when the engine is running and that charges the battery.

ambiance: The *space* in which a recording is made (such as in a studio, concert hall, church, and so on), which is present in the recording and can be reproduced by an audio system.

amplifier: A component that takes a low-level audio signal generated by a head unit and uses electronic circuitry to turn it into a high-level or amplified signal.

amplifier power rating: The specification for the amount of power an amplifier is able to produce, usually accompanied by a distortion rating.

amplitude: The strength or level of an audio signal.

attenuate: To decrease the amplitude or level of an audio signal.

audio signal: The electrical signal that contains the music or program material generated by a head unit.

audio spectrum: The range of frequencies that humans can hear, roughly from 20 to 20,000 Hertz.

balanced line: A method of transmitting low-level audio signals, usually from a head unit to an amplifier, so that the impedance at each end is identical and any noise is cancelled.

bandpass crossover: A crossover that filters out all but a predetermined range or band of frequencies, usually midrange frequencies, while letting others pass. *See also crossover.*

bandwidth: The segment of the audio spectrum or range of frequencies that can be controlled by a component such as an equalizer.

Bluetooth: A technology that uses a short-range wireless network to connect compatible electronic components.

bridge: To combine two stereo channels to create a more powerful single or mono channel. *See also stereo and mono*.

capacitor: An electronic component used to store power that is connected to an amplifier in a car audio system to provide brief bursts of current for musical transients.

capture ratio: The ability of a radio to distinguish between a stronger station and a weaker station occupying the same spot on the dial.

CEA-2006-A: A voluntary measurement standard sponsored by the Consumer Electronics Association that provides a uniform method for determining an amplifier's power rating. *See also Consumer Electronics Association.*

CEA-2031: A voluntary measurement standard sponsored by the Consumer Electronics Association that provides a uniform method for determining a speaker's power-handling specification. *See also Consumer Electronics Association.*

channel separation: A radio's ability to eliminate "leakage" or "crosstalk" between two radio stations that are in close proximity on the radio dial.

clarity: The ability of a system to produce the original audio signal as intended, without distortion and other unwanted noise.

coaxial: A speaker that consists of two or more drivers or speakers mounted together on a single frame. *See also drivers and speakers.*

component speakers: A speaker set that contains more than one driver or speaker that is not on the same frame; also called *separates* because the speakers are separated from one another, and usually accompanied by passive crossovers. *See also passive crossovers.*

Consumer Electronics Association (CEA): The trade group for the consumer electronics industry.

crossover: A component that blocks certain frequencies that are inappropriate for a speaker to reproduce or may potentially harm a speaker; also called a filter.

crossover point: The frequency at which a signal going through a crossover begins to be attenuated or turned down. *See also attenuate.*

crossover slope: The rate at which the signal is attenuated or *rolled off* by a crossover beyond the crossover point. *See also attenuate.*

current: The flow of an electrical charge through a conductor or wire.

damping factor: The ability of an amplifier to control unwanted movements of a speaker.

damping material: A substance that's applied to the metal parts of the vehicle to control resonances or vibration. *See also resonance*.

decibel: A unit of measurement of sound pressure level (SPL). *See also sound pressure level (SPL).*

DIN: An abbreviation for *Deutsche Institut für Normung*, which in English translates to *German Institute for Standardization* and is a worldwide measurement standard that, in the case of car audio, refers to the size of a typical head unit (2 inches high, 7 inches wide, and 7 inches deep).

distortion: Any alteration of the original audio signal that's usually unwanted and can damage audio components.

Double-DIN: A *head unit* that is twice the height (4 inches) of a single-DIN radio. *See also single-DIN.*

driver: Another name for a speaker.

dual-zone capability: The ability of a head unit to enable two separate entertainment zones within a vehicle, so that passengers in the front can listen to one audio source while those in the back listen to another, usually on wireless headphones.

dynamic headroom: The ability of an amplifier to provide high levels of power in short bursts to accommodate transients or peaks in music.

dynamic range: The ratio of maximum to minimum amplitude or strength of an audio signal. *See also amplitude*.

electronic crossover: A crossover that requires electrical power to filter frequencies going to speakers; also called an active crossover. *See also active crossover.*

equalizer (EQ): A component that allows balancing of the frequency response of a system by cutting or boosting certain frequencies. *See also frequency and frequency response.*

filter: A component that blocks certain frequencies that are inappropriate for a speaker to reproduce or may potentially harm a speaker; another name for a crossover. *See also crossover.*

flat frequency response: The ability of a system to reproduce the audio spectrum without emphasizing or de-emphasizing one particular frequency range. *See also frequency.*

FM modulator: A device used to introduce an audio signal into a system via a car's FM radio; FM modulators can be used to add a CD changer to a stock stereo system or an aftermarket system in which a direct-connection between the head unit and the changer isn't available. More recently, FM modulators have been used to integrate an MP3 player to an existing audio system.

frequency: The measurement of the number of occurrences of a repeated event per unit of time, measured in Hertz (Hz); in an audio system, for example, it can refer to the number of times a speaker cone moves in and out per second.

frequency response: The range of frequencies an audio component or system is able to reproduce, or the measure of an audio system or component's ability to reproduce sound across the entire audio spectrum.

full range: An audio signal that contains all of the frequencies in a given piece of music or program material; an audio signal from a head unit is full range, for example, before it's divided into different frequencies by a crossover.

fuse: A component that protects an electrical circuit and/or components, and includes a thin piece of metal that melts when a predetermined amount of current passes through, thereby opening the circuit and protecting the circuit and components. *See also current.*

gain: The ability to increase the amplitude or power of an audio signal in volts. *See also amplitude.*

gain control: A rotary control on an amplifier that allows increasing the gain or input sensitivity of the amplifier to match that of the input signal.

gauge: The diameter of wire as measured by a standard known as American Wire Gauge (AWG).

graphic equalizer: An equalizer that has a set of fixed frequency bands over which adjustment is allowed. *See also equalizer.*

ground wire: The wire in an electrical circuit that provides the return path or closes the circuit.

HD radio: A form of AM and FM radio that allows a digital signal to piggyback onto regular analog radio broadcasts.

head unit: An in-dash car audio component that supplies an audio signal and heads a car audio system.

Hertz (Hz): A measure of the number of times per second an event occurs; in the case of a car audio system, the number of times a speaker, for example, moves in and out per second.

high-level inputs: Inputs on an amplifier that can accept a high-level or amplified signal.

high-level signal: An audio signal that has been amplified.

high-pass crossover: A crossover that filters all but high frequencies going to a speaker; typically used with tweeters.

impedance: A measure of the opposition to the flow of current; also called resistance. *See also current and resistance.*

infinite baffle: The mounting of a subwoofer in a vehicle's trunk instead of in a specific enclosure; also called *free-air*.

in-line fuse: A fuse that's inserted into a power wire to protect the wire. *See also fuse.*

input: The section of a component, such as an amplifier, into which the signal from the previous component is fed.

input sensitivity: The range of gain or input signal strength that an amplifier can accept. *See also gain.*

linearity: The ability of a system to retain detail even when the volume is reduced.

line-level converter: A device that's used to bring a stock head unit's high-level or amplified signal down to a line or an un-amplified level so that it can be fed to an amplifier with only low-level inputs.

low-level signal: An audio signal that has not been amplified.

low-pass crossover: A crossover that filters out all but the low frequencies going to a speaker; also called a subwoofer crossover. *See also crossover.*

Magnuson-Moss Warranty Act: A law that protects consumers from being wrongfully denied warranty coverage by new car dealers for adding aftermarket components to a vehicle.

midrange: Speakers that reproduce frequencies in the middle of the audio spectrum, roughly from 120 Hz to about 4,000 to 5,000 Hz; also called woofers.

Mobile Electronics Certification Program (MECP): A program administered by CEA (Consumer Electronics Association) that tests and certifies professional car audio installers on techniques and knowledge.

mono: An audio signal that consists of a single channel, and the opposite of stereo; also the name of a subwoofer amplifier.

multicasting: An HD radio's ability to broadcast separate programming on a sub-frequency, which can only be received by an HD tuner.

multichannel amplifier: An *amplifier* with more than two channels.

OEM (**Original Equipment Manufacturer):** A company that supplies original parts for production cars. *OEM* is also used to refer to such parts.

out of phase: When two speakers are wired in reverse polarity, causing the cone of one speaker to move in when the cone of the other speaker moves out. This greatly diminishes sound output because the sound waves from the speakers cancel each other out.

outputs: The section of a car audio component where the audio signal exits.

parametric equalizer: An *equalizer* that allows varying the *frequencies* at which adjustments can be made, as opposed to a graphic equalizer, which only allows adjustment at set frequencies.

passive crossover: A crossover that does not need electrical power to filter frequencies going to speakers. *See also crossover and active crossover.*

path lengths: The distance sound travels from the speakers to the listener's ears.

polarity: The direction of a signal entering or leaving a component, such as speakers.

power cable: A cable that supplies power from a car's electrical system to a car audio component.

power handling: A measure, in watts, of the amount of power a speaker can safely handle.

power-supply voltage: The amount of current from a car's charging system needed to generate an amplifier's power output specification.

RCA cable: A cable that carries low-level or un-amplified audio signal in a car audio system, and is usually terminated with RCA connectors; also called *signal cable*.

real-time analyzer: A device that's used to measure frequency response and sound pressure level (SPL), in decibels (dB), of an audio system.

resistance: A measure of the opposition to the flow of current; also called *impedance*.

resonance: Unwanted vibrations that are transferred from a speaker to parts of the car, or caused by some other source, such as engine or road noise.

resonant frequency: The frequency at which an object (as in the case of the part of the car the speaker is mounted to) tends to vibrate.

sealed enclosure: An enclosure that's completely sealed so that the back wave of the speaker (usually a subwoofer) is isolated from the front wave; also called *air-suspension*.

sensitivity: A measure of how much power a speaker needs to achieve a certain volume level, and in dB of SPL; also called *efficiency*.

signal cable: A cable that carries a low-level or un-amplified audio signal in a car audio system; also called *RCA cable*.

signal-to-noise ratio: A measure of the strength of an audio signal to the level of potential background noise, measured in decibels (dB).

single-DIN: The size of a typical in-dash head unit: 2 inches high, 7 inches wide, and 7 inches deep.

sound-off competition: A contest in which car audio enthusiasts compete to determine who has the best-sounding, best-installed, or loudest system.

sound pressure level (SPL): The pressure caused by sound waves, which is measured in decibels (dB).

speaker: A device in a car audio system that converts an electrical audio signal into mechanical energy to create sound.

speaker terminal: The part of a speaker that the speaker wire connects to.

speaker wire: Wire that attaches a speaker to an amplifier.

staging and imaging: The ability of a system to recreate the illusion of a stage on which a performance is occurring, in which you should be able to pinpoint the sonic image of the individual performers and instruments within the stage.

stereo: Reproduction of sound using two independent audio channels; also refers to two-channel components, such as amplifiers.

stereo amplifier: A two-channel amplifier that is essentially a left and a right mono or single-channel amplifier on one chassis.

stock: A component supplied with a vehicle from the factory or added by a car dealer; also called *OEM equipment*.

subwoofer: A *speaker* that reproduces the lowest frequencies, from roughly as low as 30 Hz up to about 120 Hz.

tonal accuracy: The ability of a system to faithfully recreate the sound of the instruments, voices, or ambiance in a recording.

total harmonic distortion (THD): A measure of the amount of distortion an audio component produces at a given rated output. *See also distortion.*

transients: Loud passages or peaks in music that require more power.

tweeter: A speaker that reproduces the highest end of the frequency range, usually from around 4,000 or 5,000 up to 22,000 Hz.

vented enclosure: A subwoofer enclosure that employs a *port* or hole to increase output; also called *bass-reflex.*

video output: A connection on a car audio component, usually a DVD head unit, that allows adding additional video screens.

watt: A unit by which electrical power is measured.

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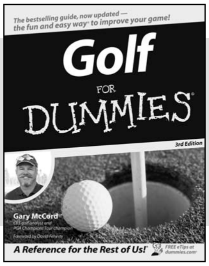
SPORTS, FITNESS, PARENTING, RELIGION & SPIRITUALITY



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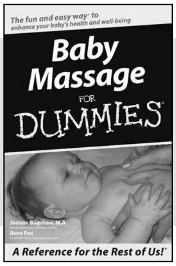

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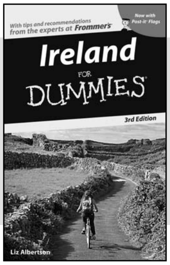

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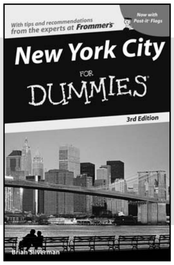

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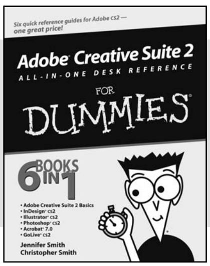

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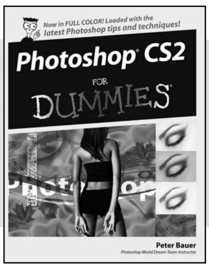

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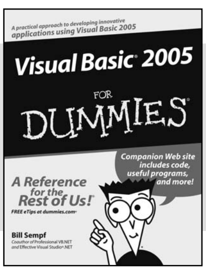

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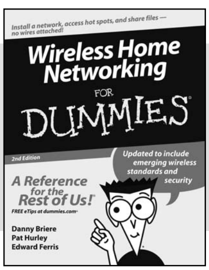

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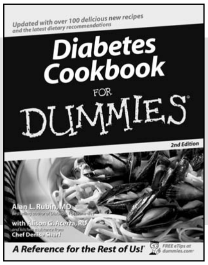

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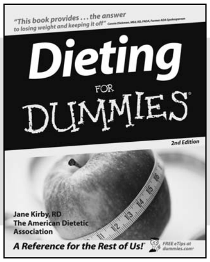

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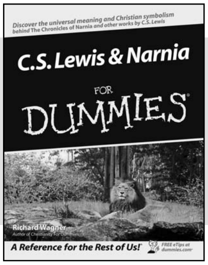

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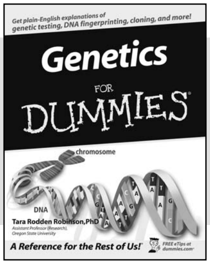

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