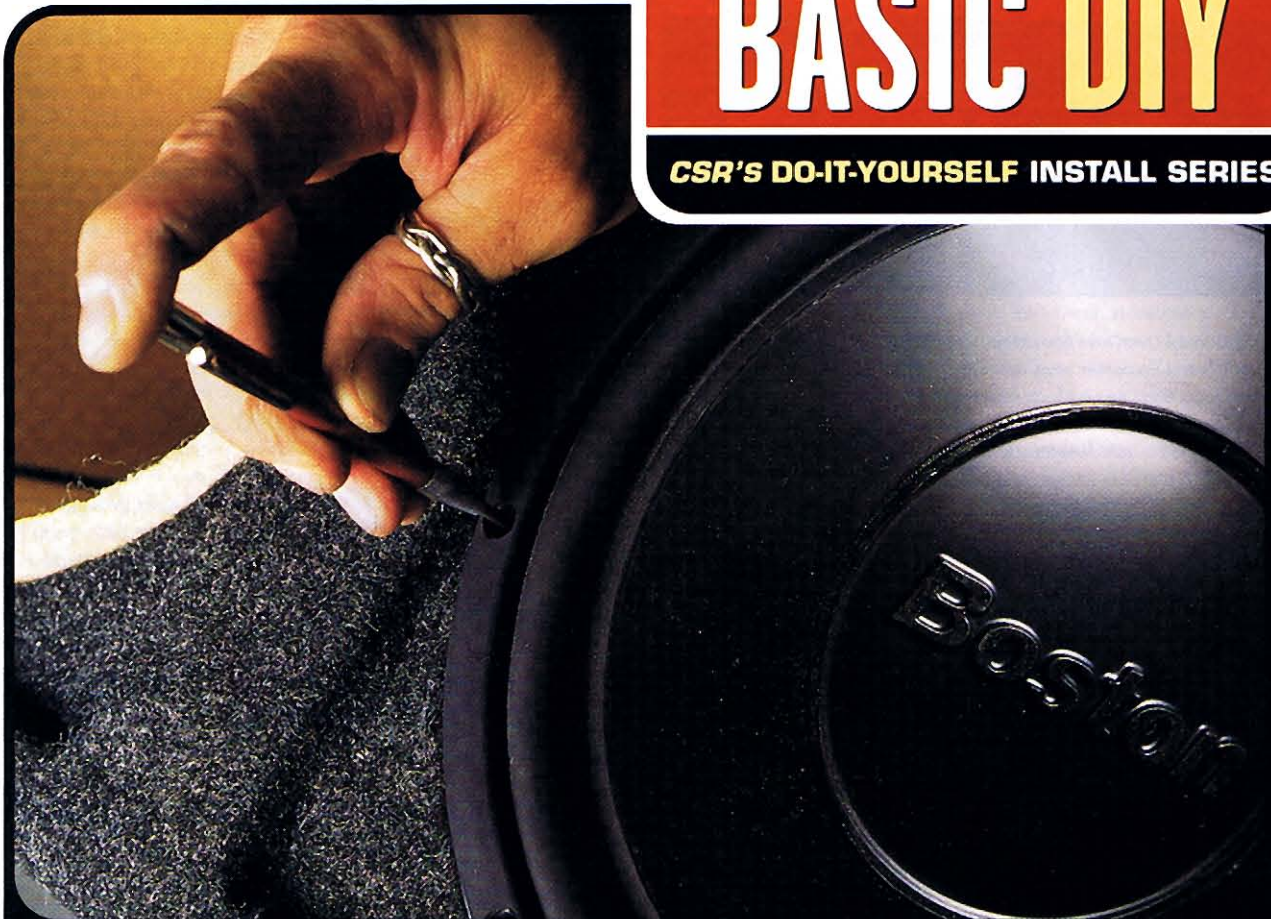


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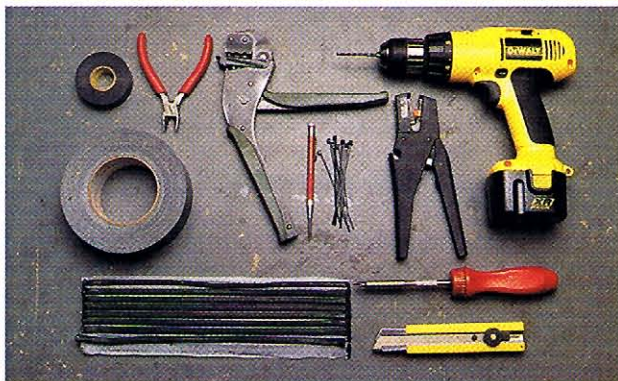


PART FOUR OF FOUR: THE BIG WOOF

HOW TO PROPERLY INSTALL A SUBWOOFER SYSTEM.

BY MICAH SHEVELOFF

TOOL TALLY: For this final DIY round, you'll need (clockwise from top left) electrical tape, flush cuts, a crimper, a spring-loaded center punch, wire ties, a wire stripper, a cordless drill with a 1/8-inch bit, a Phillips-head screwdriver, a razor knife, strip caulk, and black duct tape.



PHOTOS BY JIM RAYCROFT

READY TO VENTURE BACK into the realm of self-achieved sonic nirvana? If you've been practicing what we've been preaching during the first three installments in CAR STEREO REVIEW's basic do-it-yourself install series, then you've already installed a CD receiver ("Head Start," August 1999), added a multichannel power amplifier and proper wiring ("Amplify Your Life," September 1999), and upgraded your front and rear speakers ("Speakers in the House," October 1999). Now the only thing standing between you and absolute sonic satisfaction is the absence of some low-end *oomph*—i.e., the need for a kick-ass subwoofer system. But before we get our hands dirty in the install bay, let's get some deep background, so to speak, on what a subwoofer system does.

WHERE'S THE BASS?

When listening to your car-stereo system, you may have noticed that the drums and bass guitar often seem to disappear behind a curtain of engine and road noise. The reason for this aural in-car phenomenon is that road noise has a very pronounced low-

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tured here, the low-pass crossover is built into the Nakamichi PA-506 6-channel amplifier, but external crossovers are also available.) These components work together to deliver the bottom portion of the music that's so easily masked. A subwoofer not only enhances the performance of the rest of the sound system, it makes the entire listening experience *exciting*, and who wouldn't want that?

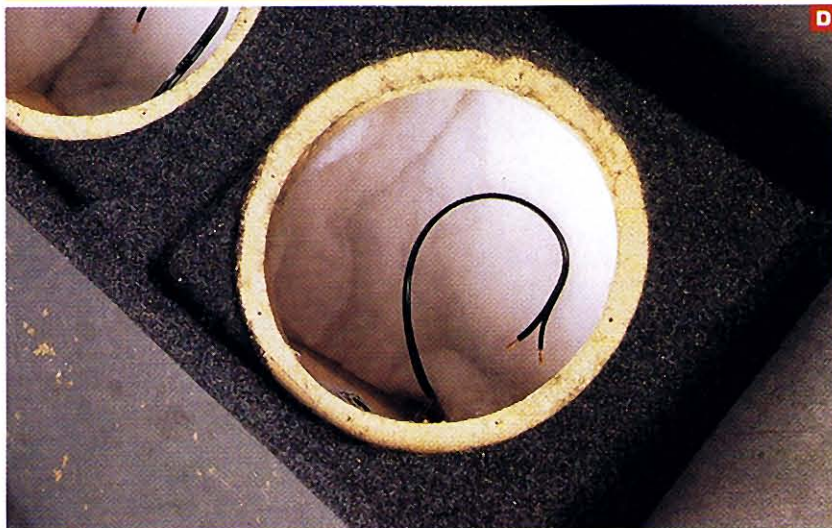


frequency component that tends to mask or drown out the low frequencies in your favorite music. Though your front and rear speakers are doing the best they can to reproduce the low end, they aren't designed to go really low and play really loud, and therefore can't overcome such a noise-induced masking effect. The best way to compensate for this sonic anomaly? Install a subwoofer system.

A subwoofer is intended to handle the frequencies below those that can be reproduced by a woofer. More specifically, a subwoofer is designed to play the much-desired low-frequency information in music at volumes that can be heard above such things as the sound of your vehicle's tires rolling over pavement. Typically speaking, subwoofers are most effective in the 20-to-150-Hz frequency range. They create sound by displacing or moving large quantities of air within the listening area—i.e., the cabin of your car. A subwoofer's large-diameter cone moves in and out like a piston (the distance that the speaker cone travels is known as excursion), creating a "wave" of air. This wave represents a specific audio frequency or musical note. The deeper the note, the longer the wave.

But the subwoofer itself is only part of the overall sub system. A sub system is comprised of a subwoofer, an enclosure, a low-pass crossover (which allows only the bass information to reach the speaker), and an amplifier. (In the install pic-

SEAL OF APPROVAL: Concerned that the trunk-liner material that covered the entire sub box would prevent the speaker basket from sealing tightly to the box's MDF mounting surface, installer Samudosky carefully cuts away the portion of material that would reside underneath the subwoofer's mounting flange (A). After the MDF mounting surface was exposed, Samudosky places one of the Boston Acoustics subs in place and marks and dimples the MDF where each of the subwoofer's mounting holes will be by using a spring-loaded center punch (B). Samudosky next drills a pilot hole for each mounting screw (C), then fills both of the enclosure's chambers with fiberfill and runs the interior speaker wiring (D).



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ENCLOSURE DISCLOSURE

When shopping for a sub system, it's necessary to consider how much of your vehicle's cargo space you're willing to sacrifice and what level of performance you desire. Are you looking for subtle reinforcement of bass, or do you want a high-impact system that packs a nasty wallop? Either way, your local retailer should be able to present you with several options in numerous price ranges and performance levels to suit your needs. But there are a few things you should know before you start looking at gear.

There are basically two ways to install a subwoofer in an automobile: by using an infinite-baffle configuration or by using a separate subwoofer enclosure. In an infinite-baffle mounting scheme, the vehicle's trunk cavity itself acts as the en-

closure. The sub is mounted in such a way that it either fires up through the rear package shelf or through the back of the vehicle's rear-passenger's seat. A sturdy baffle board (the speaker-mounting surface) must be fashioned for the sub so that its cone energy is thrust forward into the passenger's compartment and not wasted. This is accomplished by making sure that the woofer is sealed to its baffle board and that the board is mounted securely. The baffle board must also create a sonic barrier between the air space in the trunk and the air space inside the passenger's cabin. If you don't isolate the trunk (the sub's enclosure) from the pas-

senger's compartment, your sub system can suffer from cancellation; in other words, the sound radiated from the back of the speaker will adversely affect—or, in essence, cancel out—the sound radiated from the front of the speaker.

Implemented correctly, an infinite-baffle system can be very effective. Such installs may require a little custom work, which can be expensive, but they take up much less cargo space than the second option: using a separate sub enclosure.

Separate sub enclosures give subwoofers an ideal environment in which to function. Speakers are engineered to have a certain amount of air pressure behind them for proper operation. The air inside an enclosure—i.e., behind the subwoofer—acts like a shock absorber in an automobile. It supports the back of the speak-



GETTIN' LOADED: Once the fiberfill settled, a generous bead of 3M strip caulk is applied to the entire perimeter of the speaker opening (E). Now it's time to mount the subs! Samudosky inserts the bare end of the speaker wire from inside the box into the gold-plated clamp-type posts on the subs (F). Once the wires are terminated, the subs are set in place and secured via the supplied mounting screws with a hand-driven screwdriver (G).



er's cone, insuring that the cone will be pushed to its operating limits but won't "jump the track," so to speak, and fly right off of its frame. The optimum volume and type of enclosure is usually specified by the speaker manufacturer; refer to the owner's manual or ask your retailer for more details. Paying close attention to an enclosure's design parameters as set forth by the speaker manufacturer is critical to maximizing the overall sound of the subwoofer system.

OPEN OR CLOSED CASE

There are two basic types of sub enclosures: sealed and vented. Just as the name implies, sealed enclosures are completely enclosed boxes. That is, the sound radiated from the back of the speaker is completely separated from that radiated from its front. The woofer uses the air in the chamber as its suspension, allowing the speaker's cone to be controlled as it thrusts back and forth. The movement of the cone excites the air around it, reproducing low frequencies. By altering the

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size of a sealed enclosure, the response can also be altered. A slight increase in box volume can increase low-frequency extension, yet reduce SPL (sound-pressure level, or volume, in decibels).

Vented enclosures utilize a length of pipe (called a port) or a flexible membrane (a passive radiator) to assist the sub's cone in creating bass. The mass of the air within a port is made to resonate due to the changes in pressure within the enclosure caused by the movement of the sub's cone. This type of box allows designers to "tune" an enclosure to emphasize or de-emphasize certain frequencies, reducing the workload of the driver's cone. This can be used to create an equalized effect without needing any supplemental electronic equalization devices.

them may look like they have an extra subwoofer on board. The passive radiator is a cone, but no electrical signals travel to it; it simply reacts to the changes in pressure within the enclosure that are caused by the movements of the real subwoofer cone.

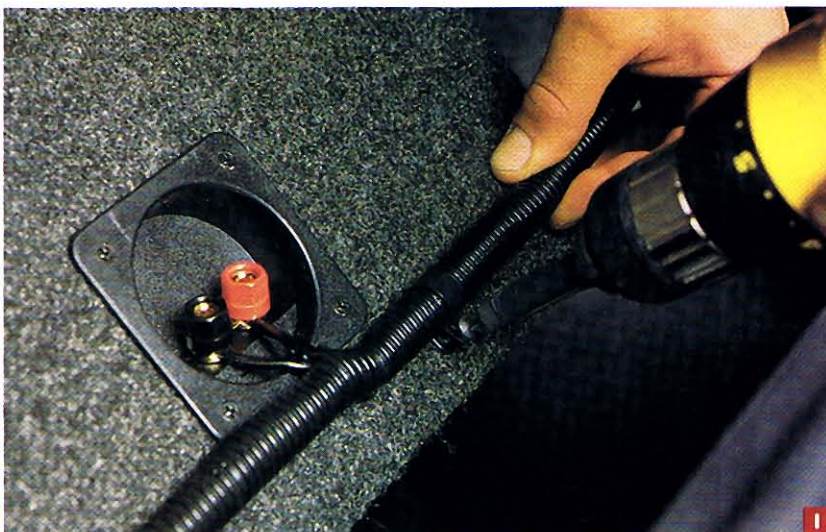
A bandpass enclosure is another type of sub box, although it's one that I'm reticent to talk about here. In a bandpass environment, the subwoofer is placed in a dual-chamber enclosure in which both chambers have a profound effect on the system's performance. Typically, one chamber is sealed and the other is ported.

ance. Of course, electronic equalization can also be used to fine-tune the subwoofer to the acoustic environment in your vehicle.

BOX OPTIONS

After you've decided which type of enclosure is best for your vehicle, you need to choose whether you want to go the custom design-and-build route or buy a prefabricated box that's all ready to go straight off the shelf. Since prefabs are the easiest to install, let's start with them.

Prefabricated enclosures come pre-assembled from the factory, and are available either with the subs already in place (loaded) or not (unloaded). After some basic install preparation, prefabs are meant to be dropped into your vehicle's



FRUIT OF THE LOOM: Once both subwoofers have been successfully mounted in the enclosure, Samudosky runs the exterior speaker wire from the binding-post connectors on the back of the enclosure to the amplifier. Here, bare wire is inserted into the clamp-type binding post on the back of the box (H). The external speaker wires were run inside a protective covering called split-loom, which is secured to the outside of the enclosure using loop-type wire clamps and black anodized mounting screws (I).

Such tuning flexibility is one of the advantages of the vented box. Ported boxes are usually wood enclosures similar to the sealed variety; however, they have an exhaust hole cut in one wall and a length of pipe (usually PVC) inserted in the hole. The pipe must be a specific length and diameter (determined by the specifications of the woofer) in order to function as desired. Even slight variations in the size of the port can dramatically alter performance. Passive radiators use the same technical theory as the port, but the mass of the air in the port is replaced by the solid mass of the radiator, which is a diaphragm that reacts to changes in pressure. Enclosures with a passive radiator in

Bandpass enclosures can provide the benefits of both the sealed and vented enclosures; that is, they can create deep, low-frequency extension and amazing SPL. Nevertheless, they can't be designed without the aid of a computer, and they're usually harder to construct than a standard enclosure. In my opinion, tackling a bandpass enclosure is probably not a good project for a greenhorn DIYer. I'd suggest you get more hands-on experience before going this route.

In addition to the size and type of enclosure being used, the build quality of the enclosure—how well it's designed for the sub being used and how well it's constructed—will also affect speaker perform-

trunk or cargo area with little or no effort at all. The most common type of prefab box is the wedge-shaped enclosure (like the box that we're using here in part four). Wedges come in various shapes and sizes, though they're mostly very similar. There are skinny wedges made for placement behind the seat in pickup trucks and compact ones designed for cramped areas that come with mounting brackets to facilitate quick installation and removal. Although the classic wedge-shaped subwoofer enclosure is the easiest and least expensive to install, it's definitely the most obtrusive and, thus, will take up the most cargo space in your vehicle.

If you're looking for a pre-fab box

that's a little more unassuming, you'll want to take a look at vehicle-specific sub enclosures, or VSSEs. These pre-fab boxes are custom-designed to fit a particular make and model car without significantly compromising the vehicle's inner sanctum. VSSEs typically fit into the vehicle's nooks and crannies that are considered to be wasted space. These enclosures are so unassuming, in fact, that they're often mistaken for factory-installed original equipment. While their intrusion factor is much less than that of wedge enclosures,

GETTIN' DOWN TO BUSINESS

So, with all of that deep sub-system background in mind, we chose to outfit our project vehicle, a '99 Saturn SL2, with Q-Logic's QLH.6510D (\$90), a prefabbed wedge that handles two 10-inch drivers. Since this dual-chamber sealed enclosure comes unloaded from the factory, the speakers we picked were a pair of Boston Acoustics ProSeries 10.5LF 10-inch 2-ohm subs (\$270 each, or \$540 total).

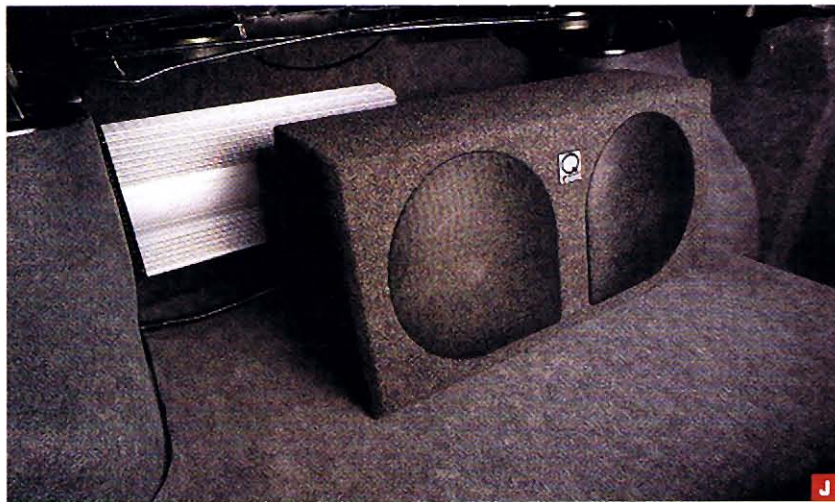
Sticking to his routine, installer extraordinaire James Samudosky, the stylish

After the MDF mounting surface was exposed, Samudosky set out to prepare the box for the dual speaker install. Samudosky set one of the Boston subs in place and marked and dimpled the MDF where each of the subwoofer's mounting holes will reside using a spring-loaded center punch. He then drilled a pilot hole for each mounting screw. Why pilot holes? Because forcing the screws into the MDF with a powered screwdriver might crack the wooden mounting surface and ruin the box—one hell of an expensive lesson to learn.

Samudosky next prepared the speaker wiring inside each of the enclosure's chambers. Q-Logic outfitted the enclosure with dual-side binding-post connectors; that is, there's a binding post on the inside and a reciprocal one on the outside of the box. These connectors are flush-mounted through the back of the enclosure, one set for each subwoofer. After crimping tab connectors onto a short length of speaker wire, Samudosky plugged the tabs into the binding posts inside the enclosure and stripped a quarter-inch of insulation from the other end of the wire. Samudosky then lined the inside of each chamber with a layer of fiberfill, a pillow-like fluff material that helps prevent unwanted standing waves that cause uneven bass response.

Once the fiberfill settled, a generous bead of 3M strip caulk was applied to the entire perimeter of each speaker opening so that the subwoofers would have an airtight seal to the wooden baffle. Warning: As noted above, this step should *not* be overlooked. If the subwoofer is designed for a sealed enclosure and the air leaks around the edge of the speaker, its performance will be greatly affected, and your bass will be sloppy and uncontrolled. In many cases, this can also cause overexcursion of the subwoofer's cone because of too little air pressure in the chamber, which can eventually shorten the life of the speaker.

Now it's time to finally mount the subs. Samudosky inserted the bare end of the speaker wire from inside the box into the excellent-quality gold-plated clamp-type posts on the Boston Acoustics subs. Bare wire is good in this application because it's soft and crushes easily inside the clamp-type connector, thus providing a large contact area for the copper speaker wire. Once the wires have been terminated, the subwoofers can be set in place and



BOOM TOWN: The final step—Samudosky sets the enclosure in the trunk and mates the two sets of quick disconnect plugs (J). Bada-boom! Bass time!

VSSEs are more expensive and more difficult to install, and, thus, I'd suggest that only experienced DIYers take this path. [For more on VSSEs, see "VSSE Street," October 1999, our special test of four VSSE models made specifically for a GM extended-cab pickup—Ed.]

Finally, you could create a custom enclosure that's "tuned" to the acoustic environment of the car and matched to your specific listening needs. An experienced box builder can construct such an enclosure that maximizes the available space in a trunk or hatchback and provides deep, accurate bass response. Subwoofer manufacturers provide specifications for which type of enclosure will result in the best performance from their product. To design custom enclosures, many installers turn to sophisticated computer-software packages (such as *Bass Box 6.0* and *TERM-PRO*) that allow them to maximize the response from the limited physical space inside the vehicle. However, it takes a lot of time and skill to build a custom box, and it's really not an undertaking for someone with limited experience.

gentleman who's assisted me in the other three installments in this series, began the install by (of course) tidying up his installation area and also the Saturn's interior, paying very close attention to properly hoovering the vehicle's trunk. After all was neat and tidy, Samudosky took a close look at both the Q-Logic enclosure and the pair of 10-inch Boston subwoofers. Although the Q-Logic box was well built out of medium-density fiberboard (MDF), Samudosky was concerned that the trunk-liner material covering the entire box was also covering the sub's actual mounting surface around the two speaker holes. This was a problem. It's always critical that the speaker basket be tightly sealed to its mounting surface; in this case, the trunk liner prevented the metal basket from making direct contact with the MDF surface. To remedy the situation, Samudosky deployed his trusty razor knife and carefully cut away the trunk-liner material that would reside underneath the subwoofer's frame. With the trunk liner out of the way, the subwoofer would now make a solid seal.

then secured via the supplied mounting screws. As mentioned back in part three, I suggest tightening each speaker's mounting screws little by little with a hand-driven screwdriver. This will help ensure that the basket of the subwoofer isn't warped in the process—another costly lesson, if learned on your own.

Once both of the subs were successfully mounted in the enclosure, Samudosky ran speaker wire from the binding-post connectors on the back of the enclosure to the Nakamichi amp. Unlike the way it was done inside the box, bare wire was inserted into the clamp-type binding post on the back of the box to make a solid connection. The external speaker wires were run inside a protective covering called split-loom to prevent any loose items inside the trunk from snagging or piercing the speaker wire. (That would sure put a serious crimp in your system's bass response.) The loom was then secured to the outside of the enclosure using loop-type wire clamps and black anodized mounting screws to help provide strain relief for the speaker wire in the event that the split-loom is pulled or gets snagged on something. The other end of the speaker wires were fitted with quick-disconnect tab connectors so that the entire enclosure can be unplugged and removed from the trunk if additional cargo space was needed.

For the final leg of this procedure, Samudosky dove back into the Saturn's trunk. His mission was to recover the left and right subwoofer output wires that

were run from the Nakamichi amplifier back in part two. As you may recall from that installment, these wires had been tucked away behind a carpeted trim panel and were already outfitted with reciprocal quick-disconnect tab connectors. Samudosky set the enclosure into the Saturn's trunk and mated the two sets of quick-disconnect plugs. Samudosky and I then adjusted the Nak amp's gain and crossover settings for optimal sonic performance. Bingo! The Saturn's sound system was finally fully and completely ready to rock its owner into sonic nirvana.

OVERALL CONCLUSIONS

Well, we made it to the finish line, and we only crept a tiny bit above our initial \$2,500 budget. The total cost (not including labor) came to \$2,550.91—\$340 for the Sony head unit, \$925.91 for the Nakamichi amplifier and wiring, \$635 for the Boston Acoustics front and rear speakers, and, finally, \$650 for the Q-Logic/Boston Acoustics sub system. Not bad, eh?

Overall, I think we achieved the goal we set for this project. While the DIY route isn't for everyone, it can be a lot of fun for car-stereo enthusiasts looking for hands-on adventure—and reward. However, it's not always going to be an easy road. Professional installers face tough challenges every day, and you should expect the same. Be careful and take your time. While I wholeheartedly encourage those with the time, focus, and tools to forge ahead with the install techniques that we've highlighted throughout this four-part DIY series, remember that there's more than one way to do these installs, and input from other skilled installers should always be welcome.

And thus ends our four-part Basic DIY series. If you have any suggestions for future DIY projects you'd like us to tackle in CSR, email the mag at CarSteRev@aol.com or email me at the address below. Whatever path you choose, here's to happy DYing!

Micah Sheveloff can be queried about car-stereo matters at popdoggie@aol.com. You can also visit his shop on the Web at audiocoupe.com.

REQUIRED TOOLS

- Electrical tape
- Black duct tape
- Strip caulk
- Wire ties
- Wire stripper
- Flush cuts
- Crimper
- Cordless drill w/ 1/8-inch drill bit
- Ratcheting Phillips screwdriver
- Razor knife
- Spring-loaded center punch

PARTS & COST FOR BASIC DIY, PART FOUR

(1) Q-Logic QLH.6510D dual-chamber 10-inch subwoofer enclosure	\$90
(2) Boston Acoustics ProSeries 10.5LF 10-inch subwoofers	\$540
Miscellaneous (caulking, connectors, etc.)	\$20
TOTAL	\$650



Time to roll up your sleeves and Do It Yourself! Enter the CSR DIY Sweepstakes, and you'll be eligible to win the car-stereo system featured in this series—including all components, cables, accessories, and tools (approximate minimum retail value \$2,600). We supply the gear, sized to fit your vehicle, and you supply the install!

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