

# How to Hide the Wires

## ■ What do you need to know about in-wall wire?

### Local building codes may require special wire types and methods

Every city and county in the United States has its own building code. Each town may choose to include the regulations of the National Electric Code (NEC) or they may rewrite them to suit their own requirements. Make sure that any wire and cable you purchase is “up to code” for your area, before installing it in your walls and ceilings. Call your municipal offices to check on your local regulations.

### Wire for in-wall installation must be UL-rated for safety

To reduce the risk of fire spreading via flammable wires, the NEC specifies that wire used inside walls and ceilings be rated by the Underwriters Laboratory. The UL looks at:

- Heat generated from current flowing through wire.
- How quickly the cable will catch and spread fire when exposed to a flame.
- Susceptibility to damage from external stresses, such as pressure, moisture and abrasion.

How do you find the wire rating? Check the product descriptions on the Crutchfield website or in our catalog. Or you can read the jacket of the wire. You’ll see something like this: UL listed CL-3R.

Any “CL” rating offers the safety you need for a single-family home. You will find that the additional protection that comes from plenum or riser rated wire is expensive. Most building codes specify CL-2 or CL-3 rated wire for single-family homes. Plenum- and riser-rated wire is often required for multi-family or commercial buildings.

Here are the CL ratings you might encounter:

- CL-3 is general purpose wire, rated for more than 300 volts.
- CL-2 is general purpose wire, rated for up to 299 volts.
- CL-3P and CL-2P are rated for plenums (the air space above ceiling tiles).
- CL-3R and CL-2R are rated for risers (a vertical shaft running between floors).
- CL-X, although theoretically a residential wire, is the only type we don’t recommend, because some building inspectors don’t allow it.

### Speaker wire – what gauge do you need?

The smaller the American Wire Gauge (AWG) number, the thicker the wire. The gauge of the wire you use in a multi-room system is important because significant power losses occur over long wire runs. Use the following chart as a guideline for wire gauge selection:

Distance from speaker to amplifier	Gauge
Less than 80 feet	16
80 to 200 feet	14
More than 200 feet	12

You may see in-wall speaker cable identified in shorthand that indicates its gauge and its number of conductors. For example:

- 16/2 is 16-gauge wire with two conductors
- 14/4 is 14-gauge wire with four conductors

### TV cable

For RF TV cable runs, we recommend UL-rated quad shield RG-6 cable. Although single- or dual-shield cable might work, your cable TV company may refuse to connect to it. They may insist upon running their own cable, tacked to the outside of your house. It might pay to ask what their policy is before you install your own cable.

### What if you need to run wire under ground?

Should you need wire run to a pool house, garage or workshop that is detached from your home, you will want to bury the wire. The wire must be protected from moisture and temperature extremes. There are two ways to approach this:

1. Use normal wire enclosed in PVC conduit.
2. Use cable rated for direct burial.

Using conduit has the advantage that the wire is protected from damage by gardening tools. However, it is certainly more work to install. Direct-burial cable is rated to survive the moisture and temperature extremes found outdoors, underground. However it is not armored to withstand a shovel. Either way, the NEC asks for a trench 24 inches deep at a minimum.

### What if you don’t want to run wires inside your walls?

Crutchfield offers flat, paintable wire that conceals easily under carpets or attaches to your walls just above the trim carpentry. These “Invisible Out-of-Wall” wires from Monster Cable may be perfect if you’re simply looking for an easy and attractive way to wire a pair of surround speakers.

## ■ Pre-wiring your new home

### Can you do it yourself?

Have you ever installed AC wiring in a new home? If so, then you probably already have the skills and tools you’ll need to install low-voltage wiring for your audio/video gear. We’ll give you some pointers on how to get good results with speaker wire and TV cable.

If you have no wiring experience, then you may want to hire a professional to pull and label the wires. Then you can save money by installing the speakers, volume controls and other devices.

Low voltage by itself won’t kill you, but low-voltage wiring is no joke! A short between the AC circuits and the low-voltage wiring can cause a fire or deliver a deadly shock. And improperly installed wiring can affect the structural integrity of your home. So please be serious about safety, and research the correct materials and prac-

tices for your location. And watch your step – you are working on a construction site!

You need to be skilled in the safe use of power drills, hand tools and ladders. Large drills have the power to break your wrist, if the bit jams.

Recognize that this is a lot of plain old-fashioned hard work. You will be drilling holes for hours on end, then pulling and dragging heavy wire and cable through all the holes. You'll be working on ladders, crawling in dirty crawlspaces and bending over at odd angles for the whole job. You'll need to be in good shape.

You need a helper, friend or a spouse with you to get it done efficiently. Most of the tasks of pre-wiring go much faster with two people.

Once again, if you are handy with tools and have some experience wiring and building, and you are in good physical condition, this is a good project to undertake. If you have little or no experience with tools and construction sites, don't plan to do the physical work yourself. You can design the system, plan the whole job, hire out the hard labor, and still save money and get the job done right!

### Is it legal?

In most locales, a homeowner is allowed to install his own low-voltage wiring. However, check with your local building inspector to be sure.

Most states don't allow anyone who is not licensed to do wiring for money. Nor will they let you work on a building considered to be "commercial." Unfortunately, most jurisdictions define a duplex as "commercial". If you are building a duplex, you may be able to do the work yourself if you can find a licensed electrician willing to supervise your work.

### Will your builder let you work on the construction site?

Don't assume that it will be OK with your builder for you to work on "your" construction site. Many builders have insurance policies that prohibit unlicensed subcontractors from working on sites they supervise.

Another issue for you and your contractor to consider is the potential for delays. What if your work is inspected and found unacceptable? All of the other subcontractors will be delayed while you fix your work.

Speak sincerely to your builder about your determination to do a good job. Many custom builders and a few tract-home builders will allow a homeowner to do the work, provided you guarantee you will not delay or interfere with other contractors.

### Who can you hire to do the work?

Before you hire anyone, you need to have a well-documented wire plan. If you haven't written anything down, it will be harder to find someone to do the work for you.

Use the design worksheets found on pages 30-31 to detail your home wiring plan. Then, speak to your general contractor or builder. Many builders will insist that you use the electrical or security contractor who is scheduled to do the other pre-wiring work on your home. If not, you can shop around.

If you want to be in charge, then you may have to agree to:

1. Assume responsibility for the correctness of the wire plan.
2. Provide copies of the wiring plan to all of the workers involved.
3. Walk through the site with the workers to discuss the plan before they begin work on it. A second walk-through may also be required for approval of the work after it is completed.
4. Provide all materials (J-boxes, brackets, wire and fasteners) for the job.
5. Pay the subcontractor an hourly rate for the workers involved.

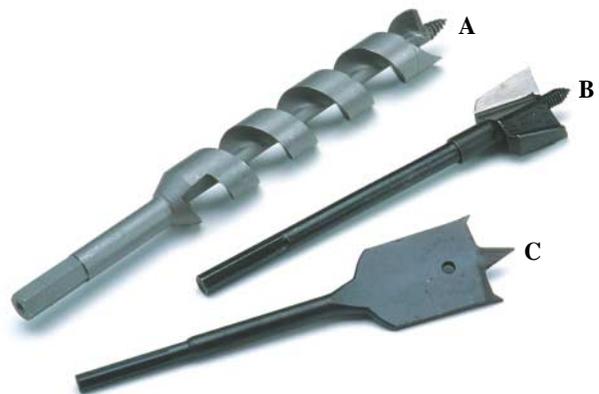
Should you want the subcontractor to assume more responsibility (you would like your plans checked, or you would like them to supply the right wire, etc.), you should hire a contractor with experience doing A/V installations. A good qualifier is that the company is a member of the Custom Electronic Design and Installation Association (CEDIA).

You can get referrals to CEDIA members from their website ([www.cedia.org](http://www.cedia.org)) or their toll-free phone (1-800-669-5329). You should expect a CEDIA member to charge for design services as well as the installation labor. Some CEDIA firms will not install a system unless they design it from scratch and sell you all of the components. Some are willing to help a do-it-yourselfer.

### What tools do you need?

#### Hand tools

- Screwdrivers – Phillips and flat-head in sizes #1, 2 and 3
- Wood chisels – 1/4", 1/2", 3/4" and 1"
- Hammer
- Tape measure
- Small level
- Linesman pliers
- Wire cutter/strippers (for the wire gauges you'll be working with)
- Chalk line



**Drill bits:** A. Auger bits really "pull" through the wood. B. Less-expensive wood-boring bits also have a self-feeding screw point to help draw the bit through the wood. C. Spade bits are fast.

## Drills and bits

Count on using a 1/2" or larger electric drill. If you are wiring more than four rooms or have a home larger than 1,500 square feet, consider renting a larger right-angle drill. Large homes have been wired with battery-powered drills, it just takes longer!

You will need a standard set of twist drill bits for pilot-hole drilling. For the wiring holes you'll need a set of spade bits from 1/4" to 1 1/2".

Professional installers use auger and hole-saw bits because they make the job easier. Since these bits are expensive, think twice about purchasing them for one-time use.

You will need grounded extension cords of sufficient length to reach from the contractor-supplied central electrical supply to anywhere you want to drill. You shouldn't join four 25-foot cords to make a 100-foot cord. The wasted power may lower voltage to the point that a loaded drill may be damaged permanently.

You will also need step ladders and extension ladders of sufficient height to reach every wiring location in your home.

You will need eye protection, good boots, knee pads, gloves and protective clothing. Some job sites require a hard hat.

A broom and vacuum cleaner will enable you to clean up the wood shavings and debris you create. If you don't clean up after yourself, someone else will have to.

## Besides the wire, what other parts will you need?

- Wire labels – The best way to label the wires you install is a wrap-around label. You write your notation on a paper label that is then protected by clear tape wrapped around it. Look for these in an electrical supply store.
- Electrical tape
- Wire ties and attachments – Wire must be supported every 4 1/2 feet and no more than 1 foot away from any junction box. The staples electricians use will damage low voltage cables, so wire ties and wire-tie clamps are used to support the wire.
- Nail plates – Whenever you drill a hole 1/4" or less from the surface of any wooden part of your house (a stud, joist, plate, block or brace), you must protect the cable with a nail plate. The nail plate prevents a nail or "sinker" from piercing the cable.
- Cable hooks and hangers – If you are planning to use an attic or basement crawlspace for most of your long runs, plan to support the large bundles of cable with cable hooks or hangers every 4 1/2 feet.
- 2 3/4"-deep wall boxes – Wall boxes (often referred to as "J-boxes" or junction boxes) are used to mount volume controls and other in-wall devices, such as infrared sensors. Wall boxes are strong enough to support heavy volume controls. But most wall boxes are too shallow for volume controls and IR sensors. Look for wall boxes that are 2 3/4" or more deep.
- Backless brackets (also known as "plaster rings" or "mud rings") – When you are simply terminating wires at a wall plate for speakers, televisions or telephones, you don't need the structural strength of a



*If you're using half-inch dry-wall, install your J-boxes so that they protrude a hair less than half an inch from the front of your studs. When the walls go up, the boxes will be positioned perfectly.*

wall box. Backless brackets provide the minimum structure you need for a wall plate.

- Optional "hole-saving" brackets – Brackets for in-wall and in-ceiling speakers can be installed in the pre-wire or rough-in stage. These brackets save a lot of time by forcing the drywall installer to cut the opening for the speaker (as they do for all of the lighting). Hole-saving brackets are included with some in-wall speakers, but are optional for others and must be ordered separately.

## Working on a construction site

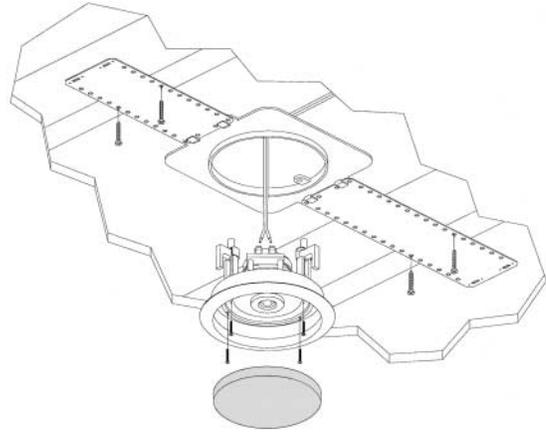
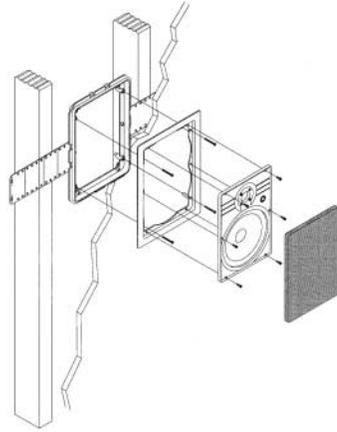
Rule Number 1: Stay in contact with your builder. The construction schedule puts your A/V installations in a narrow time frame.

Your builder has set a tight schedule to complete the construction of your home. However, in the early stages of house construction, weather can delay a project. Likewise, circumstances may make the schedule go faster than planned. Keep in close touch with your builder to avoid unpleasant surprises.

House construction proceeds in stages. Here's how we think you should schedule your work around the builder's tasks (your steps are shown in bold):

1. Foundation
2. Framing and roof
3. Plumbing
4. Electrical
5. **A/V pre-wiring**
6. Drywall installation
7. Trim installation
8. Floor installation
9. **A/V speaker grille and frame installation** (if you want the grilles painted)
10. Paint
11. Final electric and plumbing
12. **Install in-wall and ceiling speakers, controls and wall plates**
13. Final Inspection (all holes, boxes and brackets must be closed)
14. Move-in!
15. **Final A/V component hook-up**

**Hole-saving brackets:** Why are they called "hole-saving" brackets? They don't save holes, but they do save you from having to cut holes! Install them before your walls go up. Your drywall hanger will cut the holes for your in-wall and ceiling speakers.



You want to install all A/V wires after the electrician has finished pulling wires. This is critical, because you have to avoid the electrical wires as much as possible. After the AC power wires are run, the electrician may still be on-site for a day or two installing switches and terminating. If your builder is on a tight schedule, you may have to work while the electrician is still on-site. Sometimes your builder may be able to delay the next stage until the following week, giving you the weekend to work.

#### Working successfully with other trades on the site

You will find the subcontractors on the job site much more cooperative if you follow some simple guidelines while you are on their turf. Remember, they are making their living by completing their work on schedule.

- Try to work in rooms and areas where no other work is going on.
- Keep your tools, ladders and extension cords organized and neat.
- Don't borrow tools from subcontractors.
- Clean up after yourself.

#### How do you route your wires?

Because wire costs money, you would like each wire run to be as direct as possible. However, in order to avoid AC power wires or keep from drilling too many holes in one stud or joist, you will probably have to compromise. The trick is to minimize your work, not your wire length.

Although it may seem like wasting wire, your attic, basement or crawlspace can provide you with wonderful wire raceways, where you don't have to drill, you simply hang your wire in clamps and brackets. Plan to utilize attics or crawlspaces as much as possible, even if it means a much longer length of wire. The time you save not drilling studs and joists can more than compensate for the longer wire runs.

#### How close can you get to AC power wires?

AC power wires produce an intense field of electromagnetic interference about 4 feet in diameter. If the A/V wires are run directly adjacent to the AC wires for a significant distance, this interference can generate hum in speakers, TV picture distortion, and problems with

infrared repeater systems. Here are the best ways to keep your system's performance clean:

1. AC and low-voltage wiring can cross at right angles without any problem.
2. Don't install your wires right beside AC power lines for more than 5 feet. When you have to run your wire beside an AC line for more than 5 feet, keep at least 2 feet away from the power line throughout the entire length of the run.
3. Never use the same hole to feed both an AC wire and one of your wires.

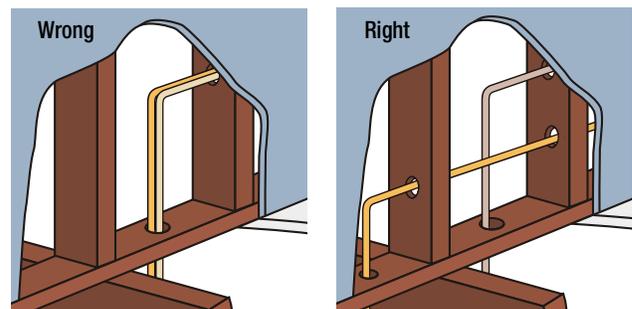
#### Will other low-voltage wire interfere with audio and video?

No, you can safely run audio and video in the same bundle as security, phone, control and any other low voltage wire. It is OK to share holes and run wires side by side for hundreds of feet.

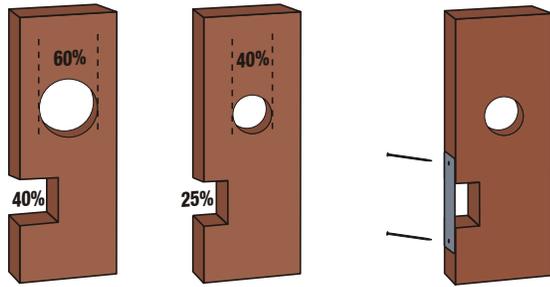
#### What are the rules for drilling holes in the structure?

Wood-frame houses are not all built the same way, but it's typical to see 2" x 4" wall studs, 2" x 10" floor joists and 2" x 6" (or larger) ceiling joists. Typically, these are spaced 16 inches, center to center. In some new homes, spacing for joists may be 24 inches, center to center. In older homes, spacing can be completely random. The architect sizes the wooden structural members to compensate for the holes accommodating wires and pipes.

You should make yourself familiar with the terms used to describe the structure of your house. When you have any doubts about whether you should drill here or there,



**Proper routing near high voltage wires:** Don't run high and low voltage wires side by side (left). Let them cross at right angles and keep them 2 feet apart when they run parallel for more than 5 feet.



**Holes and notches:** In a non-bearing wall, left, holes can go up to 60 percent of the stud thickness and notches can go up to 40 percent. In a load-bearing wall, right, holes can't exceed 40 percent and notches can't exceed 25 percent.

**Nail plates:** Affix a nail plate to any stud or joist with a wire closer than 1¼" from the face of the stud or joist

ask your builder for advice! Local building codes incorporate the general principles we are going to talk about, but some cities, counties and states restrict and amend these principles because of the risk of earthquakes, hurricanes, snowfall or tornadoes.

Studs that support joists are called "bearing" or "load bearing." A non-bearing stud is typically found in some interior walls that divide one room from another. Non-bearing stud walls are your preferred wire routes, since they can have larger holes drilled into them.

Here are some other general rules:

- Joists – Keep all holes centered vertically in the joist. Don't allow a hole to be drilled within 2" of the top or bottom of the joist. The extreme ends and the middle third of the span of the joist carry the load, so avoid making holes there if possible.
 

You are limited to a hole that is a third of the measured depth of the joist. A 2" x 6" joist actually measures 5½", so you can drill a 1¾" hole. You can drill multiple holes rather than one very large hole when many wires need to go one way.
- Engineered roof and floor trusses or wooden "I" beams – These often have open "web" space for wiring so that you don't need to make holes. Consult your builder for maximum hole sizes, if you need to drill. Generally, for such "TJI" trusses, smaller holes are allowed near the ends, and larger holes are allowed in the middle.
- "Glue lams" or headers – You cannot make any holes in laminated support beams or headers. Your wire routes must avoid these structural members at all costs, even if it means a large detour.
- For your wires to pull easily, the diameter of a hole should be at least twice as big as the total diameter of all the wires in the bundle. Since hole sizes are limited, you will have to plan your wire routes to use multiple holes. We recommend that you limit your hole size to 1½", to accommodate a ¾" bundle of cables.

### What if your house is steel framed?

Steel framing normally makes wiring go much faster. Steel frames and joists have large pre-made openings for wire.

You can buy a punch to make more openings. All holes must be in the center of any steel member and cannot be any closer than 1½ feet to another hole. Holes can be larger than wood framing. However, punching limits you to a fairly small size. If you must make new holes, ask your builder to approve a maximum hole size.

The edges of pre-made or punched openings can be very sharp. You'll need plastic grommets from an electrical supply house to fit inside the openings to protect the wire.

### Pre-wiring your house, step by step

1. Bring all your tools, parts and wire into a room that is not occupied by other workers. Try to set up near a hallway or an entrance. That makes it easier to lay out long lengths of wire and tape them into a bundle, so you can pull them all at once.
2. Using a large, bright felt pen or crayon, walk through your house and mark all of the speaker, bracket and box locations according to your wiring plan. Be systematic. Start with the most distant room and work your way back "home."
3. You and your helper can split up and start drilling holes and installing boxes and brackets. Drilling quickly becomes tiring, so switch from one task to the other periodically.

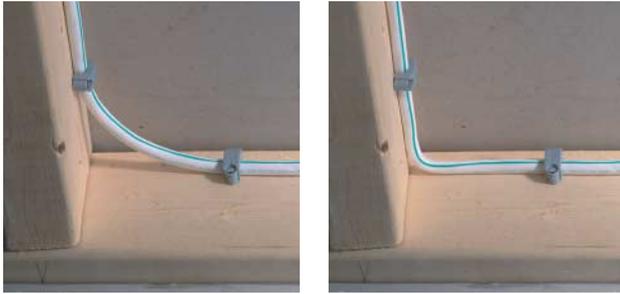
When you have a long run of holes to drill through studs or joists, snap a chalk line against the face of the studs/joists to line up your holes perfectly. As you drill, work backward so that you can always see the holes you just made. Lined-up holes make pulling wire much easier. Always drill in the center of the stud or joist at least 1¼" away from the edge.

Volume controls are usually located 44-48 inches off the floor. They will look best if you measure and match the height of your wall switches. Do not attach low-voltage boxes for volume controls to light switch boxes. Wall plates are typically aligned with the AC wall receptacles (12-18 inches off the floor).

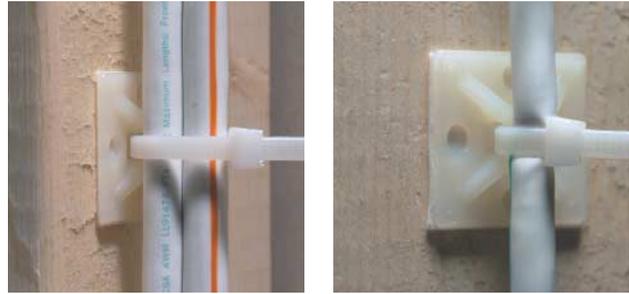
4. Installing hole-saving brackets for in-wall and ceiling speakers saves work later and allows you to position the speakers relative to door and window frames and lights. Snapping a chalk line from light fixtures helps you align ceiling speakers with lights.
5. Now it's time to measure, cut, label, and pull the wire. Start with the longest runs first, while you are fresh. As you tire, the wire runs will get shorter and easier. On the other hand, if you are unsure about estimating wire lengths, start with the short runs from the speakers to the volume controls. As you gain confidence, start pulling the longer runs.

Measure the first segment of the wire run by pacing it. Count each floor-to-ceiling run as four paces. Allow at least two extra paces at speaker ends, one pace of extra at volume controls or wall plates. Total your paces.

Pace off the distance from your spools (or coils) of wire and place a marker (you may have to walk out into the yard on long runs). Pull one wire from



**No sharp bends:** When you turn a corner, use a gradual bend. Sharp bends can damage the wire.



**Don't tie your wires too tightly:** Wires at left are tied down securely, but not so tight that they are pinched. Wire at right is tied too tightly.

a spool to the marker, then cut. Label each end of the wire for source and destination before pulling and cutting another wire.

Don't try to pull wire right off the spool. It will not save time.

To pull more than one wire through a hole at once, first bundle the wires with electrical tape at the leading end. Stagger the ends, so that the bundle gets progressively thicker.

Don't pull too hard! Stretching the center conductor and/or dielectric can damage your wires. Carefully move the wire bundle to the starting point for your run. Have your assistant keep the wire from getting hung up as you move it. Feed the wire through the holes and pull it to your destination. Whenever the wire binds, stop pulling, find the point of friction, and ask your assistant to ease the wire past that point as you continue pulling.

Don't kink the cables or attempt to make your corners tight. Cable should not be bent sharply. Kinks or tight turns change the electrical characteristics of the cable.

When running wire in a basement or attic crawl-space, do not simply lay the cable on joists. Fix cable brackets (for really large bundles use cable slings) every 4½ feet.

6. Once the wire has been pulled, you must dress it. Support the wire every 4½ feet with a wire tie or clamp. Do not use wire staples! Wire staples compress the dielectric and ruin the performance of your wire. Wire ties should not be over tightened! It is important that nothing you do changes the shape of the wire.

If you pull wire to a location for a wall- or ceiling-mount speaker, but you are not using a hole-saving bracket, dress 6 feet of speaker wire in a loop between the studs or joists. The drywall will cover up your wire, so photograph or measure the location so that you can find the wire after the drywall is up.

7. Affix a nail plate to any stud or joist with a wire closer than 1¼" from the face of the stud or joist.
8. Wrap the ends of cable bundles with plastic bags and tape to prevent moisture from entering wires. Wire can rot from paint and plaster moisture. Make sure labels are protected.

9. Inspect every room twice. Tomorrow, the drywall installers will cover up everything you've done today. Take pictures of any concealed wiring and take careful notes. Clean up each room, check that you have everything you came with and head home for a well deserved rest.

Once you've completed the wiring, you still may need to make as many as three separate installation visits to your home over the next few weeks.

### Speaker grille and frame installation for painting

If you would like to have any of your in-wall or in-ceiling speakers painted, be sure to schedule a trip to install them before the painters begin work at your home. With some speakers you must install the baffle and driver assembly along with the frames and grilles. Others let you simply install the frame and grille, keeping the expensive portions of the speaker safely at home until the house is finished.

Discuss painting the speakers with your painter and your builder. Place the grilles for each room's speakers in that room with notes attached identifying the grilles as speaker grilles to be painted. Plan to return to the site as soon as the grilles are all painted to install the grilles into the frames. Don't expect the grilles to stay clean and unscratched if you leave them laying around the construction site. Install them as soon as you can. Since the grilles simply friction-fit into the frames, it is typically a quick visit with a ladder and no tools.

### Covering all holes before your final inspection

Your last visit before you move into your new home is to install all of the speakers, volume controls, infrared sensors and wall plates in your system. All of the holes in your home must be covered for your builder to get final approval for you to move in.

### ■ Wiring your existing home

Wiring an existing home usually means tackling one discrete project, such as hiding your surround speaker wires or adding a TV outlet. In many respects, these projects are less daunting than wiring a new home from scratch. For one thing, you won't have as much planning to do.

Because the walls are in place, wiring an existing home can be more challenging and time-consuming than pre-wiring a new home. But you won't have to work on a

tight schedule, like you do with new construction. You can do one room at a time on your own schedule.

### Can you do it yourself?

To fully appreciate the challenges you face in wiring an existing home, you need to understand the concepts we covered in the new-home wiring section, which begins on page 1. If you are confident you can safely tackle the tasks we describe for new construction, then you will probably be OK with what follows. It helps if you are experienced with the following:

- Installing new light fixtures, switches, and power receptacles in your existing home.
- Patching and repairing drywall.
- Touch-up painting.

### Who can you hire to do the work?

If you'd rather hire someone to do the wiring, look for an electrician, security installer or audio/video contractor who is interested in doing work by the hour. Once the wires are in place, you can save money by installing the speakers, volume controls and other components yourself.

For this kind of help, your best bet may be a one-man shop. Many of the larger custom installation shops will not take on your job without selling you the components. See page 2 for advice on how to find a CEDIA member.

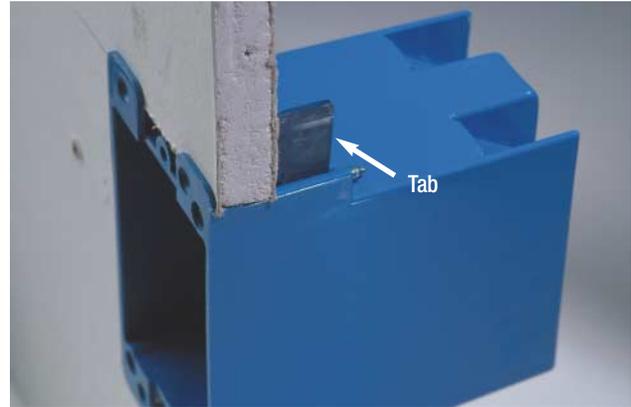
### What tools and materials do you need?

In addition to the all of the tools described in the new construction tool section on pages 2 and 3 you may also need:

- Flashlight
- Drill-bit extension attachment
- Fish tape (for some tasks you need two of these)
- Stud sensor
- Utility knife
- Drywall saw (or keyhole saw)
- Drywall for large patches
- Drywall joint tape
- Joint compound
- Drywall repair compound
- Paint and painting equipment



Tools you'll need to wire an existing home include a fish tape (bottom right) and a drywall saw (center).



**Retrofit J-box:** Flip-out tabs sandwich the wall board when you tighten the screws. Volume controls require boxes that are at least 2<sup>3</sup>/<sub>4</sub>" deep.

- “Retrofit” wall boxes – Wall boxes (J-boxes) designed for installation into an existing wall incorporate flip-out clamps that secure the box to the wall. These boxes are strong enough to support heavy volume controls and IR sensors. Look for closed-back wall boxes that are at least 2<sup>3</sup>/<sub>4</sub>" deep or open-backed boxes.
- Low-voltage mounting brackets – Although these brackets do not enclose a volume control like a wall box, the NEC approves them for use with low-voltage devices like wall plates for speaker wires. For custom installation in existing construction they are inexpensive and quick to install. Metal brackets install by cutting a hole in the drywall, bending the metal tabs behind the wall, then locking the tabs in place with screws. Plastic brackets are also available.



**Low-voltage mounting bracket:** For installing wall plates. Cut a hole in the drywall, bend the metal tabs behind the wall, then lock the tabs in place with screws. Then attach the wall plate to the bracket.

### How to safely find out what's behind the wall

Always inspect as much as possible without making a hole. Explore your crawlspace or the ceiling in any unfinished segments of your basement. Try to detect which way joists run and where empty stud bays might be. By inspecting from your crawlspace or attic, you can identify what wall locations are empty of water pipes and electrical wires.

In the end, you still can't know what is behind the wall with absolute certainty. You must be prepared to cut and then patch exploratory holes. You should always go easy when drilling your pilot holes, so you don't plunge your bit through a pipe.

## Why you should avoid routing wire through exterior walls

Be careful about planning to use exterior walls for your installation. There are three reasons that exterior walls can slow down your installation.

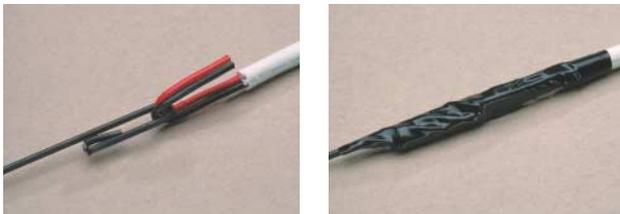
1. Fire Blocks – These prevent the spread of fire in exterior walls. They are stud-sized blocks placed horizontally at staggered, random heights within each and every stud space in an exterior wall. Fire blocks are easy to drill through if you have a large speaker cutout in the same stud space. However, if your access to the stud space is limited you will have to cut out a section of the wall, drill or notch the fire block and patch it afterwards.
2. Insulation packed between the studs makes it difficult to fish wires.
3. Restricted Crawlspace Access – Because the foundation and the slope of the roof often restrict access to the crawlspace, you cannot drill up or down into exterior walls easily. Typically, exterior walls require you to open up the drywall and notch or drill through the top or bottom plates, patching the hole afterwards.

## What if you can't avoid a hidden obstruction?

In some hardware stores and electrical supply houses, special tools (such as long, flexible bits) for drilling through hidden obstacles are sold. We do not recommend that you purchase any of these tools. They require a great deal of practice and skill to use effectively. Additionally, they are too expensive for one-time use.

When you run up against a fire block or any hidden obstruction, open up the drywall. Always opt to remove a single large piece of drywall rather than several small pieces. If you take out one piece you can use it as the patch afterwards. Here's the best step-by-step procedure:

1. Use your stud sensor to estimate the position of the fire block behind the drywall.
2. Drill small pilot holes and use an "L" shaped piece of wire to determine the actual dimensions of the block.
3. Use a utility knife to cut a rectangular piece of drywall around the obstacle. Make it large enough for you to give yourself room to drill through the block if you are running many cables.
4. If you are running one or two small cables, notch the block, cover with a nail plate and patch the drywall.



*Attaching a wire to a fish tape: Strip the jacket off the cable. Bend the conductors over the fish hook. Wrap the fish and the cable with electrical tape.*



*Stud sensor: Indispensable tool for finding the right places to mount speakers, wall plates and controls.*

5. If you are running many cables, drill a hole that is no larger than 40 percent of the stud. Remember, exterior walls are load-bearing walls.

## Cutting into your walls and ceilings

First of all, work from the speaker back – always try to give yourself the maximum advantage by opening the large holes first.

When cutting drywall, start by drilling a pilot hole. Use a handheld drywall saw, not a powered saw. Stay in control. Drywall cuts quickly. Always try to cut drywall in one piece, so that you can patch quickly and effectively, using the piece you cut out.

When a horizontal wire run along a wall is short, cut one continuous piece. For long runs it is best to cut out smaller rectangles at each stud. Use a utility knife to cut a rectangle that extends about an two inches on each side of the wall stud. This will give you enough access to use your drill. Save the pieces of drywall to use as patches afterwards.

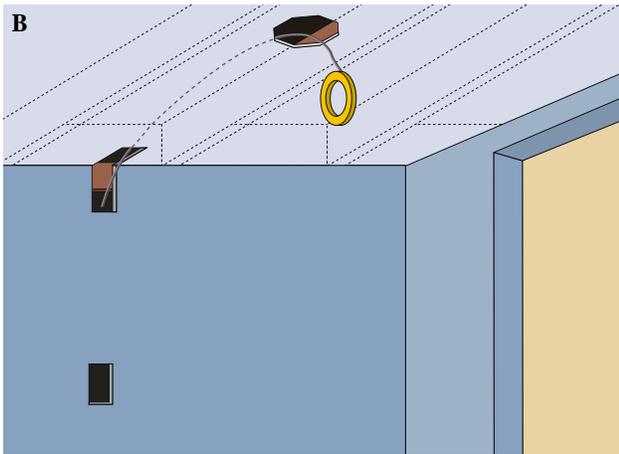
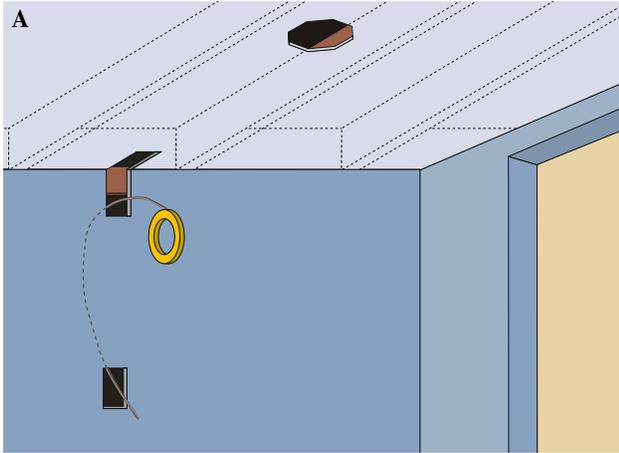
When you need to turn a corner, cut out the drywall on each side, then notch the studs with a chisel. Pull the wire into the notched channel, protect the wire with a nail plate, and patch the hole.

When cutting a plaster wall, protect the outline of the hole with masking tape. Score the plaster repeatedly with a utility knife. Cut the lath very carefully with a keyhole saw, not a powered saw. Powered saws can vibrate the lath many feet away and knock out plaster.

Ceilings are typically white, and are easily marred. Always wash your hands before working on the ceiling. The biggest danger is dust and debris in your eyes as you cut. Always wear eye protection!

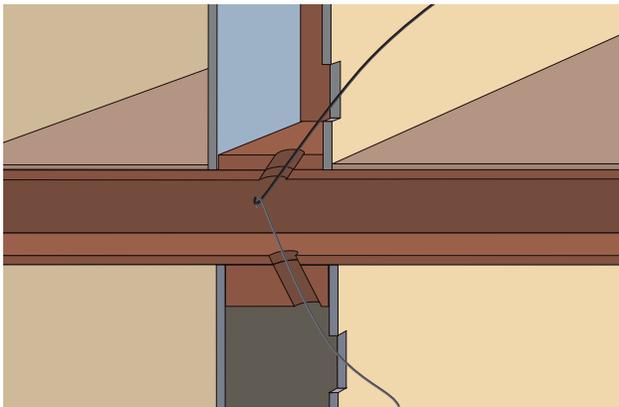
When cutting holes in a plaster ceiling, brace the ceiling with a block of wood near the cutting area to reduce lathe vibration.

When you need to get from one story to another, start upstairs. Cut a 2" x 3" opening at wall outlet height and drill through the top plate at an angle. Then move downstairs, cut an access hole from the same side of the wall and drill up at an angle through the bottom plate. Now drop a chain or fishtape down and hook it with a magnet, fishtape or coathanger from downstairs.



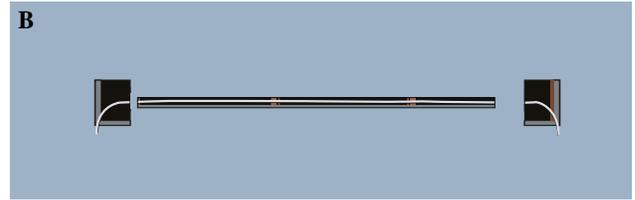
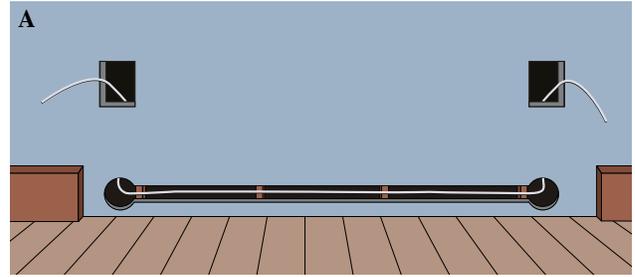
### Ceiling-mount speaker and volume control

- A. Cut the holes for the speaker and the volume control. Cut two adjoining holes at the wall/ceiling junction, exposing the top plates in the wall. Fish down to the volume control and attach the wire to the fish tape. Pull the wire to top of wall.
- B. Fish from the speaker hole to ceiling/wall hole. Attach the wire to the fish tape and pull the wire to ceiling speaker. Notch the top plates and insert the wire in the notch. Affix a nail plate and patch the holes.



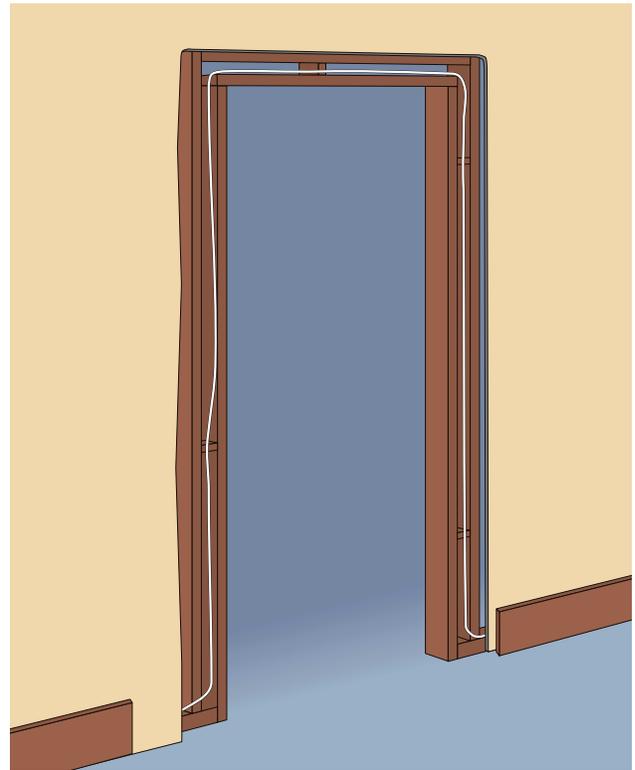
### Routing wire from one story to the next

Cut holes near the floor in the room above the near the ceiling in the room below. Drill on an angle through the bottom and top plates, into the joist space. Drop a chain or fish a tape from the hole above and pull it through from below with a coat hanger or another fish tape.



### Horizontally along a baseboard or wall

- A. **Along a baseboard:** Carefully pry off the baseboard with a small crowbar. Cut the wire channel by scoring and chiseling the studs (be sure that the baseboard will conceal the channel). Fish your tape from one hole to the other and pull the wire through. Tuck the wire into the channel and install nail plates at each stud. Re-install the baseboard. No drywall patching required!
- B. **Along a wall:** If you're working with a relatively short wire run, cut the channel in one piece, using a utility knife. Ensure that the wire channel begins and ends at stud. Drill holes in the stud with a spade bit. Pull wire and patch, using the piece of drywall you cut out. For longer runs, you'll have to cut out a separate piece of drywall at each stud.



### Around a door frame

Carefully pry the molding away from the doorway using a chisel, small crowbar or putty knife. Chisel out spacers where necessary. Run the cable between the frame and the jamb. Replace the molding.