VoIP My House

How to quickly distribute a VoIP phone line to your entire house

Vonage
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TIP: Review this *entire web page* article *before* working on your house, especially the DSL warning [§20] and Disclaimer [§23].

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1. VoIP - Phone service the new way

VoIP = Voice over IP (internet)

Most of us have high speed Internet in our homes -- so why not use the Internet to connect your *whole house* directly to a new (and cheaper) phone company's network? Quite simply, that is what VoIP can do for you.

> **VoIP:** 'Voice over IP': Connecting to a newer phone company's network directly (via the Internet instead of by dedicated copper wire), providing you with a device which provides phone service (a dial tone).

And yes, you can connect your whole house to VoIP [§8], and you can continue to use all of the phones that you are using right now. Nothing changes. You just plug your new VoIP device into a spare port on the router connected to your Internet modem.

Think of switching to VoIP as simply switching to a new *local & long distance* phone carrier.

As of early 2014, 38% of homes no longer have POTS land lines. They have switched to VoIP, or use only a cell phone. source

2. POTS - Plain Old Telephone Service

POTS, or 'Plain Old Telephone Service' (wiki info) is the old way.
There is a reason 'Old' is part of the definition of POTS.

A Telephone company ('tel co', or just 'telco') has proprietary internal high speed networks (like an Internet) connected to 'central offices' (CO). A CO building (example right) is usually a very plain non-descript brick building in your neighborhood with no

windows (for security reasons).

The CO building may have a telephone company name on the exterior of the building (but many don't for security).

These central offices then run copper wire (or even fiber, like Verizon FiOS) to your residence or business, providing your home with a phone line with a 'dial tone'.

The end of POTS is coming: When the FCC (Federal Communications Commission) blogs about the end of POTS, then that is a landmark shift in thinking *by the agency that regulates POTS* -- the end of POTS is coming.

Phone Company Exchange Building

3. The case for 'Voice over IP' (VoIP)

More Features / Lower cost: VoIP phone service has tons *more features*, and is usually *much cheaper* than POTS. You really can save a lot of money. Plus, you can take your VoIP device with you when you travel -- and anywhere you can plug into the Internet, you have a dial tone and *your* phone service.

High Quality: I have been using Vonage since 2005 and I can tell you first hand after using my VoIP device all over the country, that call quality is 'excellent' -- often times better than the local phone company.

If VoIP does not work well for you (as in poor call quality), it is almost certainly caused by a bad high-speed Internet connection. Look for a new internet provider.

> **TIP:** If you consider your Internet connection 'reliable', then VoIP service should also be 'reliable', with excellent call quality. In one house, Internet via 'cable' was horrible (constantly going up and down). But after switching to DSL, Internet access has been rock solid and 'always up' ever since. If you have poor cable/DSL Internet access, consider switching from cable to DSL (or from DSL to cable).

Linksys PAP2 VoIP device

Vonage V-Portal VoIP device

TIP: Look into Walmart's BasicTalk, which is just Vonage -- without most advanced features -- so it is rock bottom inexpensive!

4. The case against 'Voice over IP' (VoIP)

Reliable Internet: Since VoIP works via your high speed Internet connection, your VoIP call quality will be totally dependent upon the quality of your high speed Internet connection. The great

news is that virtually all high speed Internet connections today are excellent for VoIP.

Power failures: But, if your internet connection goes down for any reason (technical problems, poor quality, power failure, etc), so does your phone line -- you lose dial tone and the ability to call out.

> But, you do NOT miss incoming calls because with VoIP you can configure a 'rollover number' (like your cell phone) for when your VoIP company can not reach your VoIP device.

911: Be aware that on VoIP, 911 service is usually provided via something called E-911. View Vonage 911 information. You must provide (and keep current if you move) the physical address of where you are using your VoIP device, if you want 911 emergency vehicles to properly dispatch to you.

Alarm systems: Given these 'failure' reasons, a VoIP phone line is not appropriate as a phone line providing service to an land line based alarm system [§13]. This concern does not apply if you are *adding* a second (VoIP) phone line to a home that already has a land line servicing the alarm. But a great workaround is to switch to a cellular based alarm system.

5. Telephone "Network Interface"

Were you aware that your local phone company already only provides your house with a single phone jack (details in next section) which feeds your entire house?

> Your entire house is already plugged into a single phone jack from the local phone company.

So why not switch phone companies and go VoIP, and save some money?

Network Interface Device

Network Interface Device: Most homes will have a gray box on the outside of their house called a Network Interface Device, or NID (see photo right), also known as a "Phone Demarc Box". It is usually located near other utilities (cable, electricity) entering your house.

Telephone Network Interface: The gray box may be imprinted with "Telephone Network Interface" (photo right).

Customer Access: The Demarc box contains a 'customer' side and a 'phone company' side. Don't worry, you usually can not access the 'phone company' only side of this box (custom tool required to open), so the part that you can open is meant to be opened by you, and is clearly labeled "Customer Access" (see photo immediate right).

> In fact, if you are having phone line problems, often times, the phone company support representative will want to isolate the problem to

Telephone Network Interface

the 'phone company' or the 'customer premises wiring'. You do this by taking a corded phone out to the demarc box, unplugging the line in the phone jack, plugging in the corded phone, and testing the line. If you don't get a dial tone in the telco jack, then there is a problem with the phone company wiring. If you do get a dial tone that works, then the problem is with the wiring inside your house.

Network Interface: In some older homes, there may be a single Quad/CAT5 running from the Demarc box outside the house to a "Network Interface" jack inside the house (see photo right).

All of the house telephone wiring is then connected to a junction box, which in turn plugs into the network interface modular jack via a small cord with modular plug (electrically connected to the posts inside the junction box).

Network Interface inside house

Network interface box (left) with junction box (right)

6. Phone Jack from Phone Company

After opening the customer side of the demarc box, you will likely see (1) a bunch of wires (coming from all phone jacks in your house) and (2) one (or several) line modules similar to what you see in the photo to the right. Each 'line module' provides a single phone line to your house.

If you have an alarm system, be sure to review the alarm system [§13] information. Or, if you have DSL, review the DSL warning [§20]

Phone Company 'Line Module' for L2

Line Module: The phone jack in a module is the dial tone from the phone company that feeds your entire house. This jack is connected from behind to the 'telco' access only side of the demarc box. The phone cord (black in photo), with 6P2C modular plug, runs to the back of the module and connects to the red/green posts. Finally, the red/green screw posts are where you add wires to connect your entire house to the phone company.

> The local phone company simply provides your house (or business) with a single phone jack -- which is exactly what a VoIP company does as well.
>
> VoIP does this via a portable device (that you can take with you) instead of a plastic box permanently attached to the side of your house.

The phone jack from the phone company usually supports a REN [§10] of 5.0 (same as VoIP).

Another Line Module Type: Or, you may see a line module like you see in the photo to the right. In this case, you pinch the orange plastic tabs together and then pull open the hinged cover.

In the process of opening the module cover, you can see that the cover is what makes electrical contact inside the jack and feeds the dial tone to the rest of the house via the red/green screw posts.

Line Module Closed

Line Module Open

In summary: The line module jack is the phone line (dial tone) from the phone company, which connects to the red/green posts, which connect to the rest of your house via posts.

7. Phone Jack from VoIP Device

A VoIP device also provides you with just a single phone jack, just like the phone company!

A VoIP phone device plugs into the Internet via your router and provides you with a phone jack (dial tone).

These two connections can be clearly seen in the photo to the right of a Linksys PAP2 (white=phone cable; blue=connection to router/Internet).

Connections on back of Linksys PAP2 VoIP device

The phone jack from the VoIP device usually supports a REN [§10] of 5.0 (same as local phone company). Read your VoIP users manual to confirm.

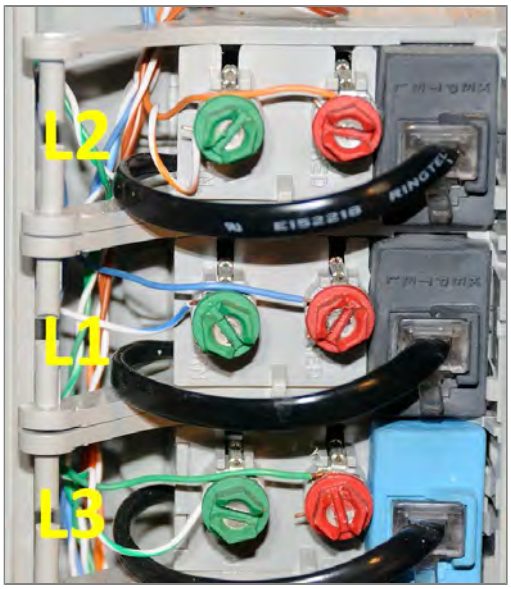
8. Whole House VoIP - the solution

Last chance: An easy way out, go wireless: If this paper intimidates you, just go wireless! Buy a DECT 6.0 cordless phone system with multiple extensions. The base unit plugs into your VoIP device, and the extensions are placed around your house.

GOAL: Disconnect your house from the POTS phone jack (the phone company), and connect your house to VoIP.

Do NOT replace an active DSL phone line. DSL Warning [§20] Do NOT plug a VoIP device into a phone line (jack in wall) while that phone line is still connected to the local phone company. Doing so may fry your VoIP device. VoIP (nor this 'simple' wiring solution) is NOT for you if an alarm system is on the VoIP phone line (more below on Alarms [§13]). Review the 'ringer load' (REN below [§10]) before adding VoIP whole house.

All phone jacks in your house are electrically connected to each other *and* to the phone company. So it does not matter (for simple phone service; excluding alarm support) where a dial tone originates -- either from the phone company at the Network Interface, or from a jack inside the house. In either case, the dial tone will be distributed through your entire house because all jacks are electrically connected to each other.



Select a line to replace: Decide what phone line (L1/L2/L3/L4; see photo right) you are going to 'take over' whole house for the new VoIP phone line. If your house was wired following industry color coding standards [§14], those colors will allow you to quickly identify line numbers. Most homes are wired for at least two to three lines. If you have DSL Internet, don't replace that line (instead, replace a truly unused spare line)!

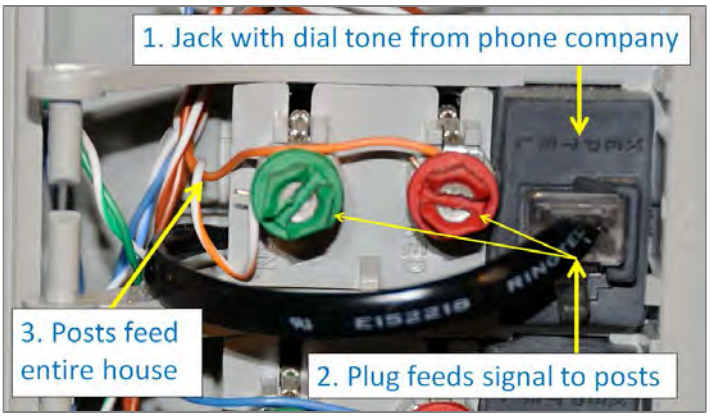
The bottom line: So to switch to a VoIP phone line, simply disconnect your house from the phone company in the NID for a particular line, and plug in your VoIP device into that line in a phone wall jack (anywhere in the house). It really is that simple.

Just follow these steps...

STEP 1: Disconnect your house from the

POTS phone jack:

Select *ONE* of the following two options...



Phone Company phone jack

Option 1: Decide what line to use and unplug the phone cord (modular plug) from the phone jack in the phone demarc box (seen right). Just make sure you unplug the correct line (your house may have multiple phone lines, some unused) AND that the line does not get plugged back in later (see 'ounce of prevention' [§9] below).

Option 2: Decide what line to use and disconnect all of the wires from the red screw post and splice [§18] them together. Then, disconnect all of the wires from the green screw post and splice [§18] them together. Even if a single wire, splice to 'nothing' to prevent the end of the wire from touching anything metallic in the demarc box and shorting out the phone line. All jacks in the house are now still electrically connected to each other, but not to the phone company.

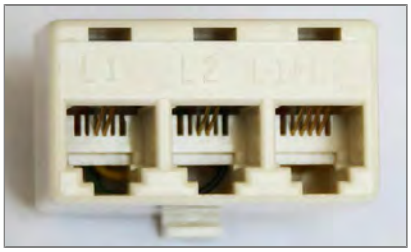
The phone jacks in your house should now be electrically disconnected from the phone company dial tone (for the one phone line you selected).

STEP 2: Plug in VoIP:

Next, take a phone cord (modular plug) and plug one end into the back of the VoIP device, and the other end into the line (L1/L2/etc) in any phone jack in the house.

Now all phone jacks in the house for that line have the VoIP device dial tone.

TIP: If you need to connect the VoIP device to 'Line2', just use a telephone line splitter in the house jack and connect the VoIP device to L2 of the splitter.


Phone Line L1/L2 Splitter

WARNING: If you are distributing both telco *and* VoIP phone lines whole house, take great care to plug your VoIP device into the correct line in the modular jack in the wall. Don't plug the VoIP device into a line that is still connected to the telephone company. That might fry your VoIP device. Tape a note to the end of the VoIP phone cord to help you remember this.

Polarity: Using an ordinary phone cord to connect VoIP to the wall jack will almost certainly *reverse* the polarity [§17] of the phone signal throughout your house. But the good news is that virtually all modern phone devices don't care about polarity. If you find that one phone device does not work (or if you just want to be 100% correct), you should make (or purchase) a RJ11 straight cable. One source is SmartHome, or search Amazon for "RJ11 straight cable".

9. An ounce of prevention / save your VoIP device

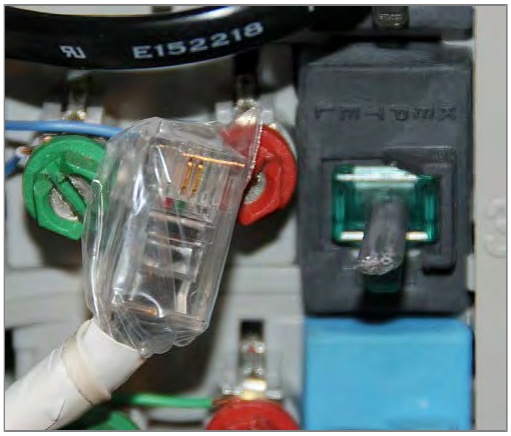
GOAL: Prevent your house wiring from being connected back into the phone company's telephone jack -- *because you must prevent your house from being connected to both the phone company and your VoIP device, at the same time.*

This section mostly applies if you selected 'Option 1' above, where the modular plug was unplugged from the modular jack in the demarc box.

After hooking up your VoIP device to the whole house, take steps to prevent the house from accidentally being hooked back up to the local phone company. Here are some simple preventative steps to take...

Step 1: Tape a note to the inside cover of the demarc box about the new VoIP line feeding the house from the inside. sample note

Step 2: Cut off the modular plug from an old unused phone cord and insert into the phone company's jack. A simple 'do nothing' placeholder (serves no functional purpose) should raise serious questions with anyone poking around your demarc box (see photos right).



Step 3: Cut the corner off a ziplock bag, enough to cover the end of the modular plug, and electrical tape the bag corner over the end of the cord (see photo right).

Result: To inadvertently hook up the house to the local phone company -- while your VoIP device is still connected inside the house -- someone would have to (1) not read your note, (2) remove a 'do nothing' plug, (3) remove electrical tape, and (4) plug the modular plug back in. This can no longer happen simply by accident -- but must be purposefully done.

This is enough preventative measure for me, but if not for you, continue reading below. If you are willing to spend a little more time and a little rewiring, there is an alternative way to hook up VoIP whole house and avoid the possibility of both the phone company and the VoIP device being hooked up to the house at the same time.

You are done! You have just distributed a VoIP phone line / dial tone throughout your entire house without any rewiring.

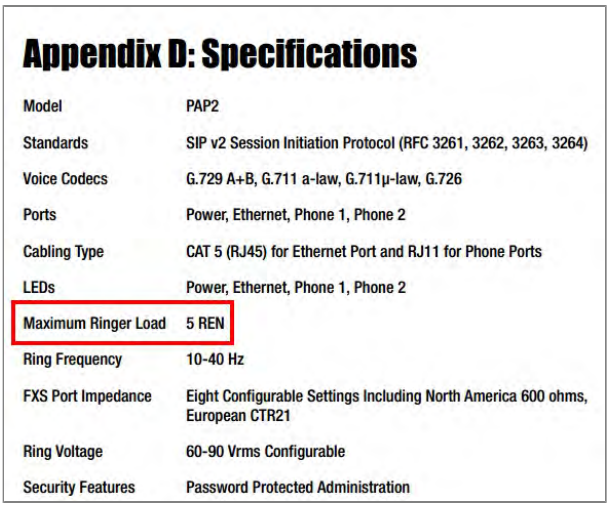
TIP: I would strongly recommend that anyone using VoIP whole house spend $15 and go buy an inexpensive surge suppressor power strip -- *but one with telephone jack surge suppression*. My VoIP device (and other electronics in the house) was destroyed after lightning hit (or nearly hit) my house (I saw the flash of light and heard the crack of lightning at the *same* time). The VoIP device was already power protected, but the phone jack was not protected. My best guess is that the lightning strike induced a voltage on the phone wiring. So, isolate your VoIP device from the house wiring via a protected phone jack in a surge suppressor power strip. And while I have no way of knowing if the $15 device would have saved my VoIP device, I am willing to the spend the $15 as insurance that it might have.

Surge Protector with phone jack

10. REN (Ringer Equivalence Number)

The issue: How many telephones in your house can you hook up to a VoIP device?

REN, or Ringer Equivalence Number, is a measurement of the 'load' a phone device (telephone, fax, etc) places on the phone line. The phone company (and most VoIP devices) usually supplies enough current on a phone line to support a total REN load of 5.0.



Appendix D: Specifications

Model	PAP2
Standards	SIP v2 Session Initiation Protocol (RFC 3261, 3262, 3263, 3264)
Voice Codecs	G.729 A+B, G.711 a-law, G.711μ-law, G.726
Ports	Power, Ethernet, Phone 1, Phone 2
Cabling Type	CAT 5 (RJ45) for Ethernet Port and RJ11 for Phone Ports
LEDs	Power, Ethernet, Phone 1, Phone 2
Maximum Ringer Load	5 REN
Ring Frequency	10-40 Hz
FXS Port Impedance	Eight Configurable Settings Including North America 600 ohms, European CTR21
Ring Voltage	60-90 Vrms Configurable
Security Features	Password Protected Administration

Review your VoIP manual for a Ringer Load (REN)

Review the manual that came with your VoIP device and you should find the REN number (example seen right).

So, just go to each and every device plugged into phone jacks around the house and look under each device -- you should see a REN number. Add up the REN number for all devices and the total should be less than 5.0 If under 5.0, you are fine. If over 5.0, you have overloaded the phone line.

Most corded phone will have a REN around 1.0 and most AC-powered phones will have a much lower REN (some as low as 0.1, like some vtech cordless models). The maximum REN load from your local phone company is usually 5.0, which is usually the same as the REN maximum load from a VoIP company device. REN info from Wiki

If you are over a REN total of 5.0 you have a couple of choices. Simply remove some rarely used phone extensions, or buy some newer lower-REN phones, or buy something called a 'ring booster' that supports a higher REN load.

If you overload the REN, some phone may not ring properly, caller id may not always function, etc.

11. Twisted Pairs - why are they twisted?

Twisted Pair: A single phone line requires a single 'twisted pair' (two conductors). So each 'twisted pair' is potentially a single phone line.

CAT5 Twisted Pairs

Why Twisted?: The wires are twisted together because that helps to cancel out electromagnetic interference (EMI) -- from other pairs and elsewhere. For example, crosstalk -- the ability to faintly hear a phone conversation on line two, while on line one. More info from wiki.

> **'Twisted' high quality cable really does make a difference:** We *used* to have Verizon Guardian protection on our (two) phone lines years ago. Since 'crosstalk' was so bad in our old house, Verizon decided to replace all of the phone wire in our entire house. So, the Guardian service paid for itself, right? Well, the only problem was that crosstalk was reduced, but not eliminated. Years later, I needed more phone lines, so I rewired our entire home with high quality CAT5e cable and all of the crosstalk disappeared! We immediately cancelled Verizon Guardian. Verizon had actually taken a lot of time to rewire our house but failed to use quality twisted pair wire!
>
> If you only have ONE active phone line in your house, you are not going to notice 'crosstalk' issues and will probably not notice any EMI issues.

Number of Twists: A little known fact, even amongst professionals in the field, is that the number of twists per foot varies from pair to pair in a high quality CAT5 cable (EMI protection). For one

cable examined, the twists/foot were (approx): brown=16; blue=18; green=22; orange=28. Look closely in the photo to the upper right and you can actually see the different number of twists (easiest to see when comparing brown to orange).

Do NOT untwist the twisted pairs: The entire purpose of 'twisted pair' is so that there is greatly reduced EMI interference (like crosstalk, etc) on the phone line. The photo that you see to the right was taken from the Internet of a 'self-proclaimed expert' in phone wiring showing an example of his work -- where he *incorrectly* untwisted the pairs.

Do NOT split pairs: Do not use one wire from one pair and a second wire from a second pair to create a phone line (pair). You must only use two wires that are twisted *together with each other* to create a phone line. Otherwise you will eliminate all of the benefits of reduced EMI.

Stranded

Solid

Stranded vs Solid: Most phone cords (and CAT5 patch cables) are made from stranded copper wire. This makes the cable very flexible. All phone wire made for 'in wall' installation use is 'solid core' wire.

You get what you pay for: Beware of very inexpensive, or 'no brand' CAT5 cable. If the supplier can not tell you the cable's vendor (eg: Belden), or if the Vendor is an unknown name, stay away from the supplier. There is a lot of very cheap (very poorly made) wire coming out coming out of the US that is simply 'not to spec'. In the past, I have used Belden 1700A CAT5e, which is a very high quality 'bonded-pair' design rated for use to 350 Mhz. Today, it is probably best to install CAT6 in new homes.

> I was in a new home where the RG6 cable had a manufacturing defect that the installer failed to notice. The defective cable had to be used since the house was finished and the wire was in the walls. The center copper core of the coax cable was 'off center' within the dielectric core, which certainly was 'not to spec' and possibly affected signal quality a little.

BEWARE 'CCA' Category 5e/6 cable: Avoid extremely 'cheap' Cat5/Cat6 cable, that almost certainly is "CCA", or "copper clad ALUMINUM" wire (example seen right), which is NOT compliant with TIA 'category' standards (which *requires* solid copper wire), violates the National Electrical Code (requires bare copper), and violates the UL (Underwriter Laboratories) 444 safety standard (requires copper) -- and therefore is NOT actually Category 5e/6 cable! The (extremely cheap) cost of the cable will be a huge tip off. Just Google "CCA Counterfeit" to see lots of articles on this issue.

> **WATCH OUT:** Even the big boy retailers can fail to catch issues. In 2013, Home Depot, issued a recall of cable that did not actually meet "fire resistance standards for riser cable".

12. Structured Wiring and Home Runs

Wire nut

Phone wiring is easy to understand (once you know how it works): There is nothing special about phone wiring! All wiring techniques just electrically connect all 'red' (ring) wires to each other and all 'green' (tip) wires to each other for all phone jacks for a particular phone line -- repeated for each phone line in your house. That is all that both the RJ45 distribution panel (seen immediately below) and the punch down block (seen far below) are doing!

> I have even seen 'old school' electricians install home runs to a central location, but

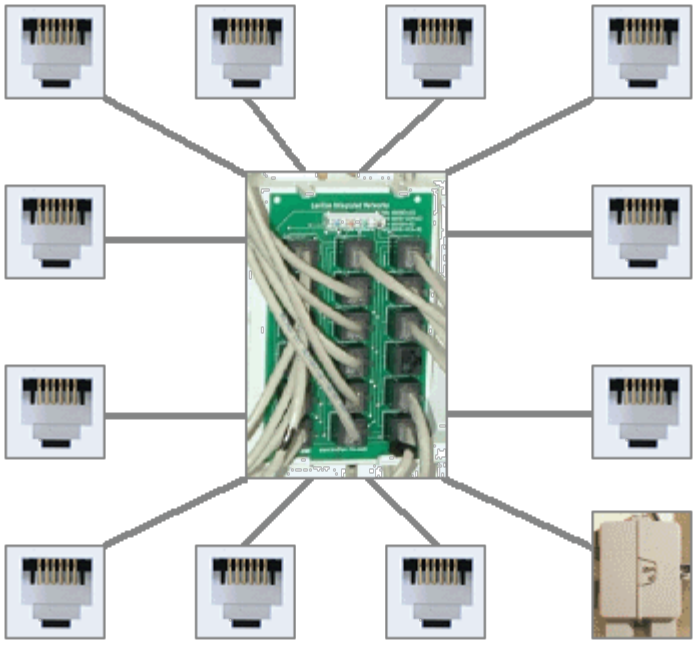
then use a twist on wire connector (wire nut; seen right) to electrically connect the wires. Very crude, but it does work -- and reinforces that the only requirement for a phone line is that all 'ring' wires are connected to each other and all 'tip' wires are connected to each other.

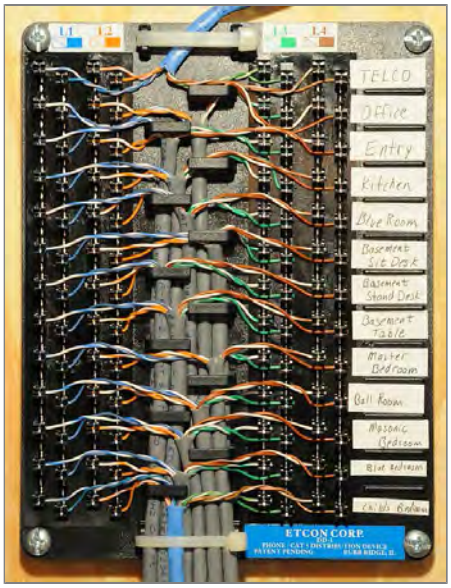
Structured Wiring: A method where *all* phone, CATV, Internet, etc cables are run from each jack to a *single* location in the house (no more CATV and phone messes on the exterior of a home exposed to the weather). All cables are very high quality with the future in mind. Often times, spare cables are run. All cables are implemented via dedicated 'home runs' (a single cable goes to a single jack, not multiple jacks).

> I recently added CCTV video distribution via TV channels to a house. This was made possible only because the house was wired using 'structured wiring' techniques - so there were extra wires in the walls for me to utilize.

4-Line Phone Distribution
via RJ45 distribution panel

The best - Home Runs: The ideal wiring situation is a modern home where all cables to phone jacks are 'home runs' -- where each jack location has a separate cable (possibly with a spare) running from the jack back to a *single* central location. The phone network then implements a 'star topology'.


BEST: Phone Network with 'Home Runs' -- Star Topology



4-Line Phone Distribution
via 110 punch down block

The Good: In modern homes, all phones jacks will have 'home runs' to a central location using high quality CAT6A, CAT6, or CAT5e cable (4 twisted pairs; 8 conductors). This provides the ultimate in flexibility since an unused pair (and there may be a lot of them) can be used for other purposes in the future. Also, there are several home runs from the Phone Company Demarc box into the central wiring location.

See the photo to the far upper right of a modern 4-line telephone distribution with 8P8C (wiki info) termination to 16 locations (the 17th is the telco feed).

The Bad: In somewhat older homes, you may have 'homes runs' with only CAT3 cable (two or three twisted pairs). Or, your home may have CAT3 cable, but something called 'daisy chaining' -- where a cable runs to one jack, is tapped into, then runs to another jack, etc:

BAD: Phone Network with "Daisy Chaining" -- Bus Topology

Daisy Chaining is the least flexible because there are virtually no spare pairs, and a fault in the cable affects all jacks 'downstream' from the fault.

The Ugly: In very old homes, you may only have 'quad phone wire' (4 conductor; two pairs; little to no twists). Sadly, I have also seen this old quad wire installed in brand new homes where the electrician apparently knew nothing about recent standards and CAT5 cable. If you start to use both phone lines at once (L1 and L2) , you may experience crosstalk issues.

The Worst: And I have seen (modern) CAT5 run (in old-style) 'daisy chained' (no home runs) from one jack to another -- which is the worst because it means the home builder knew about CAT5 but was too cheap (probably only saved $50) to install it properly as home runs.

13. An Alarming Question...

Q: Can you use VoIP for the phone line connected to your (landline based) house alarm system?

Alarm Keypad

Can you? Maybe: A home security system calling alarm central over a VoIP phone may work. It depends upon how your security alarm actually works. But in real life, this is not a very wise configuration.

> I connected my alarm system to a VoIP phone line and put my alarm system into test mode -- and intentionally set the alarm off multiple times. I then called alarm central to see if they had received all alarm events. THEY HAD NOT. After this test, I concluded that VoIP and alarm systems do not mix.

Should you? NO: If the power goes out, so does your VoIP phone, and the ability for your alarm system to call out.

And even if you go buy a UPS (Uninterruptible Power Supply), how long will that last? If power goes out for a couple of days, just how big of a UPS will you need? And even with a UPS, will the high speed connection to your home (cable/dsl) still function after an extended power outage?

> **UPDATE (Feb 2015): *Your internet provider is the weak link during a power outage*:**. I have a UPS on my modem/router/VoIP, and during a power outage, my modem/router/VoIP were all still up and running, but Internet connectivity (via Comcast) went down after 90 minutes!
>
> A Motorola SB6121 cable modem uses 9W. A Netgear JNR3210 router uses 18W. A Vonage V-Portal uses 20W, for a total of 47W. Let's use 50W as a safety margin. At 50W, all UPS's that cost up to several hundreds of dollars, only give you a maximum of several hours of protection. Now figure the cost for extending that to days.
>
> Now, what about your high speed Internet (DSL/cable)? During an extended power outage, will your phone/cable company even provide high speed Internet to you? They may for very short periods of time (as their systems are on simple UPS's) but I would rather doubt they will after days.

An alarm system is only as strong as its weakest link -- and if you are already spending the money

for an alarm system for break-in and fire protection for your house -- do you really want to be unprotected in out-of-power situations?

Telco's spend a lot of money on infrastructure and power backup, which is why you can still place phone calls from your house, *even when the power has been lost for a long time* (this is one reason that POTS is now so expensive).

A much better alternative -- go cellular: Most alarm systems have a 'cellular' option for making the call to alarm central via 'wireless' instead of a land line. This may cost a little more in upfront installation fees, plus monthly fees. There are some alarm systems where 'wireless' is the *only* method of contacting alarm central -- meaning that there is no land line involved at all. Vonage recommends alarm.com.

A great alternative / SimplSafe: I personally switched one house from a telco-based alarm system to a cellular only based alarm system (SimpliSafe) -- so we could switch the landline to a VoIP system. SimpliSafe was easy to install, worked great, and therefore I highly recommend it. We not only cut our phone bill in half, but interestingly, also cut our security monitoring bill in half as well! You buy the SimpliSafe system up front (as low as $230), and then pay low monthly monitoring fees (starting at $15/month) for monitoring. Please note that SimpliSafe is an 'install it yourself' system (with NO wires to run). Contact us [§24] and provide your email address for a 10% off coupon.

But if you still want to hook up your house and alarm system to a VoIP phone line (remember, *not* recommended), then implement the Safest [§15] wiring technique described in a later section. This safest method accounts for how alarm systems are typically wired into a house.

How alarm systems are wired into a house: In an alarm situation (break-in, fire, etc), the alarm panel needs to be able to take full control of the phone line (or 'seize' the line). Because of this, alarm systems are *always* wired 'first in line', usually like this:

Phone line: Phone Company » Demarc Box » Alarm System » Demarc Box » House

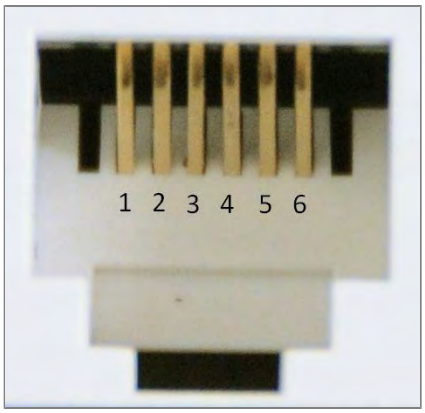
Namely, a phone line from the Demarc box (1) goes to the alarm system *and back* and then (2) is distributed to the rest of the house. That way, the alarm panel can take full control of the phone line (cutting off the rest of the house), as needed, in order to call alarm central.

So, if you have an alarm system, you can bet that the wires attached to the red/green screw posts in the demarc box feed *only* the alarm system first. Follow the wires into a Quad/CAT5 cable. Then you can bet that there is a return pair (the phone line returned from the alarm panel) in the *same* cable that is spliced to wires that feed the rest of the house.

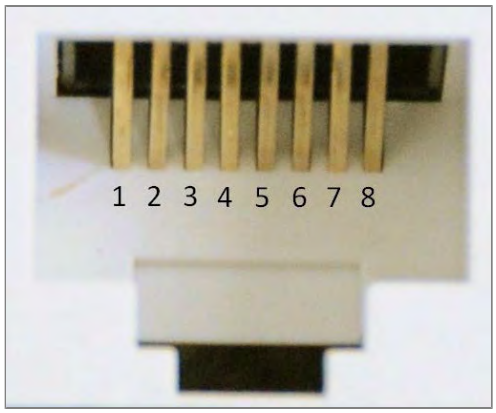
In the alarm system CAT5 cable, you *may* see the extra twisted pairs spliced together strangely (like 'ring' connected to 'tip' in a single twisted pair). That is actually normal and an anti-tampering security feature -- so that if the alarm CAT5 cable is cut, the alarm panel detects this, setting off the alarm.

14. Telephone/CAT5 Color Coding Standards

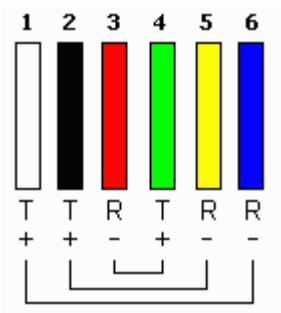
Luckily, color coding standards have been in place for a very long time -- so it is very easy to look at most any phone installation and see what phone lines 'should' be there *(I say 'should' because some 'bad' installers may not follow industry standard color codes)*. The pin layouts are left to right *as you look at the jack in the wall*, or as you hold a modular plug ready to insert into a jack in the wall.



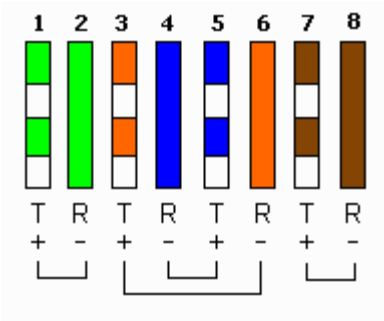
Telephone RJ14 Wall Jack



CAT5 RJ45 Wall Jack

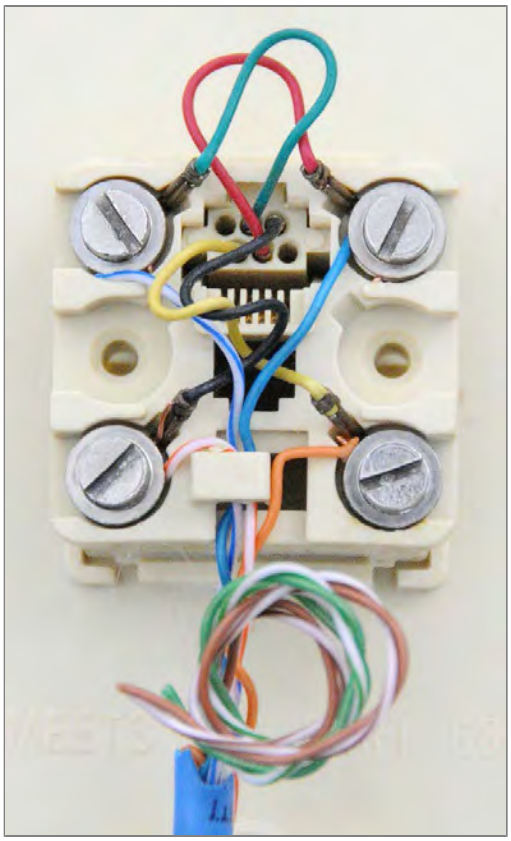


Old telco colors/pairs



T568A CAT5 colors/pairs
(best for PHONE L1/L2 compat)

Phone Line color coding			
	Phone	**CAT5**	**Burial**
Line1			
Line2			
Line3			
Line4	(na)		
Line5	(na)	(na)	


2-line CAT5 to old style jack wiring

For historical reasons, in a phone line twisted pair, one wire is designated as 'ring' (R) and other is labeled as 'tip' (T). When mixing phone/CAT5 twisted pairs, just always connect 'ring to ring' and 'tip to tip'. So for phone color coding, 'ring' is red/yellow/blue. In CAT5 color coding, 'ring' is always the 'solid' color (blue/orange/green/brown/gray).

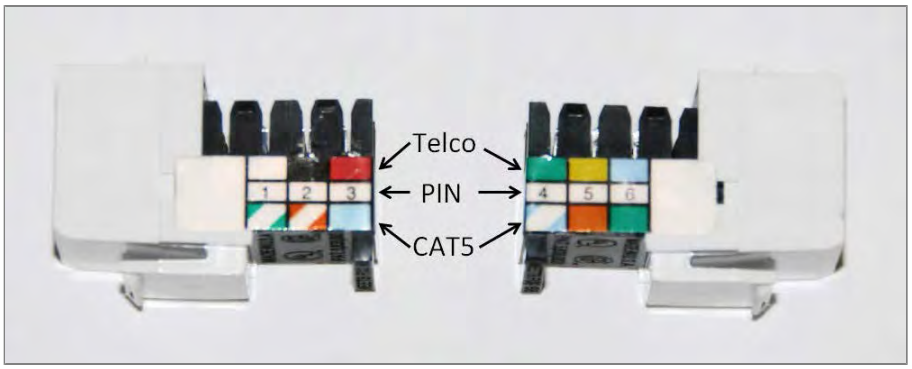
So in the photo to the right, the CAT5 'ring' (solid colors blue/orange) connect to the Phone 'ring' (red/yellow). Easy to see once you know the color coding standard.

Warning - two wrongs make a right: I was in a new house (but with old quad phone wire installed) diagnosing a phone issue and looked inside a wall plate and noticed that the polarity (red/green) was reversed. So I fixed it. Only later did I realize that the original installer for some crazy reason had reversed the polarity on both ends of every single run. Namely, if both ends of a run are reversed, the net result is a run wired correctly (but certainly not following color coding conventions).

A knowledgeable phone installer will always follow color coding standards. But be

careful, because color coding standards may not have been followed by your original installer.

Where to start? Remove any phone wall jack and look for 'telco' red/green. On an older style jack (photo above right), you will see screw posts with colored wires. On a modern 110-style punch down jack (photo below), you will still both old (telco) and new (cat5) style color coding present:



RJ14 110-punchdown color coding -- Leviton QuickPort

Whatever twisted pair is connected to red/green on a jack is L1 for that jack. And whatever is connected to yellow/black is L2 for that jack. It is rare for anything to be connected to L3 (blue/white) on a jack.

Wall Jack Lines vs House Lines: A single RJ14 wall jack has positions for L1, L2, and L3. How the house phone lines (L1/L2/L3/L4) are hooked up to the wall jack lines totally depends upon the original phone installer. It could be wired any way at all. It is best to open up one jack and look, rather than making assumptions. Here are likely situations that you will find:

Single Jack: Seeing a single jack in a wall plate is usually easy. Jack L1 is typically wired to house L1. And jack L2 *might* be wired to be house L2. Jack L3 (if even present) is likely not wired to anything. However, please note that in some cases, a single jack in a wall plate labeled as 'fax' is very likely not house L1, but rather some other house line (L2/L3/L4).

Double Jack: Seeing a double jack in a wall plate could be wired any which way. Top jack L1 is usually house L1. And top jack L2 (if wired) usually house L2. But the bottom jack wiring is up for grabs. If the house has only two phone lines, the bottom jack L1 is likely house L2. If the house is wired for 4 phone lines, then the bottom jack L1/L2 typically house L3/L4.

15. The safest VoIP wiring alternative

GOAL: Extend the phone jack on the back of your VoIP device (located somewhere inside the house) all the way back to the demarc box -- and plug the whole-house phone cord into that.

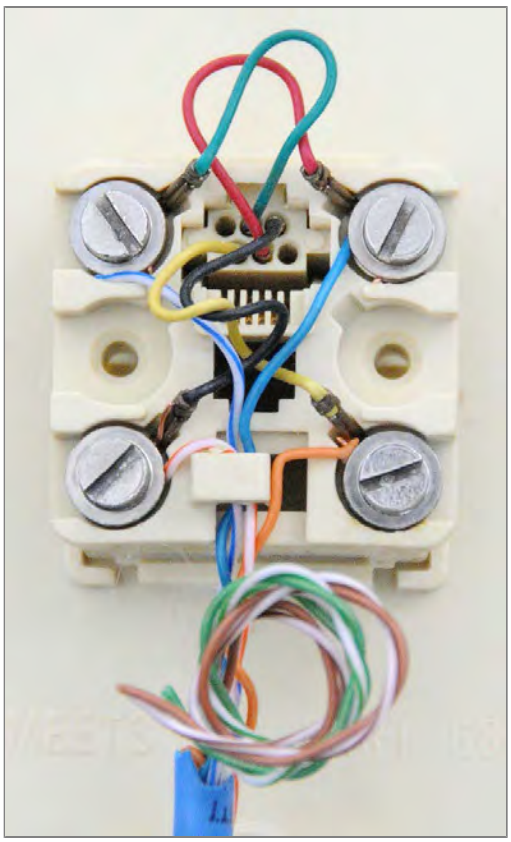
The safest way to distribute VoIP whole house (for alarm system support), but it requires some rewiring. In a nutshell, you want to extend the VoIP device phone jack all the way back to the central 'home run' wiring location (often times, the demarc box) by utilizing a spare twisted pair run.

Why safer? In the 'simple' VoIP whole house distribution technique described above, no matter how careful you are, there is still the (very unlikely) possibility of someone coming along (your son; a phone company employee) and opening your demarc box and plugging the whole house back into the local phone company -- which has the possibility of frying your VoIP device -- since it is also plugged into a phone jack in the house.

Your whole house may be plugged into either (1) your VoIP device, or (2) the phone company jack -- but not both at once.

With a little more work and a little rewiring, you can all but eliminate this possibility from happening. But only if your house is wired using 'home runs'.

1. Find a spare 'home run' twisted pair from a jack near the VoIP device to the demarc box:



Open a wall phone jack near where you will place your VoIP device (see photo right).

Look to see if you can determine if there is a spare twisted pair running all the way to the demarc box (in the photo right, there are two spares: green and brown).

Hopefully you can find an unused pair -- otherwise confiscate a working pair.

In the photo to the right, you can see:

L1 = red/green = CAT5 blue/blue+white
L2 = yellow/black = CAT5 orange/orange+white
L3 = UNUSED = CAT5 green/green+white
L4 = UNUSED = CAT5 brown/brown+white

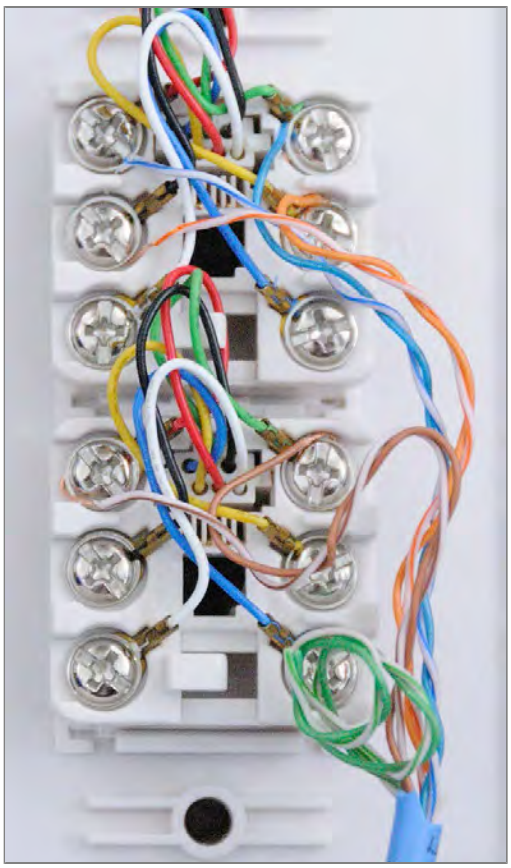
Since green may be used in the future whole house for a 'line3', we will take over the unused 'line4' brown twisted pair.

Note that the brown twisted pair will be taken over for this one jack only. In the future, brown *can still* be used in other jacks in the house for a future 'line4' -- just not at this one phone location.

2. Rewire one interior phone jack

Buy a new dual jack (if you don't already have one; seen immediate right).

Hook up phone lines 1 and 2 back up to the top jack (see top half of photo far right). Notice in the photo (right) that L1 has been hooked up with reversed polarity.



Wire the spare/confiscated twisted pair onto the bottom jack as line1 (see bottom half photo far right) and label as 'VoIP feed'.

The result is that you still have Phone Line1/Line2 on the top jack, and a new lower jack with an unused CAT5 brown/brown+white wired up to line1.

This brown twisted pair is now your VoIP feed to the phone demarc box.

3. Add jack onto end of twisted pair in demarc box, disconnect phone company, plug into VoIP feed:

Option 1: Use this option if you have full access to the line module jack in the demarc box. Use 'Option 2' below if the line module has a cover over it.

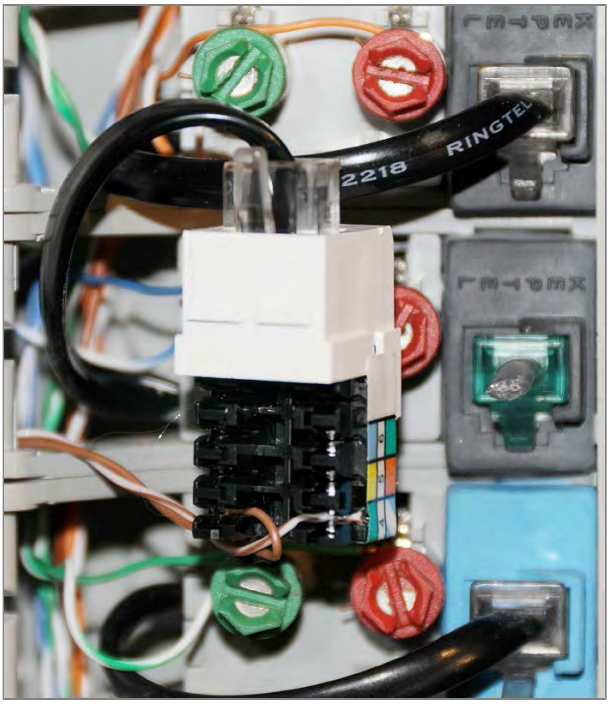
In our example above, we found an unused twisted pair (brown). We now need to find the end of that ONE twisted pair in the demarc box. Use a tone generator to find the pair.

Once found, add a Leviton QuickPort RJ14 phone jack (seen below right; available at Home Depot and elsewhere) onto the end of the spare/confiscated twisted pair -- so that 'brown' is wired as Line1 (red/green) in the jack.

TIP: If you don't have (can't borrow, or just don't want to buy) a tone generator, just "plug in your VoIP device" (as per below), and then add the RJ14 onto any (brown) twisted pair in the demarc box. Plug a phone in and see if you get a dial tone from the VoIP device. If you do, you have found the pair. If you don't keep trying until you find the pair. This works if you KNOW the house is wired with 'home runs'. Within a couple of minutes you should be able to find the correct twisted pair.

Home Depot sells a 'LAN Tester' that can also tone out phone lines for around $39.

In the demarc box, disconnect the phone company wiring from the house wiring by removing the cord from the phone company jack -- and instead plug it into your new VoIP feed jack, as seen in the photo above right.



VoIP jack in demarc box now feeds house

Option 2: Disconnect all of the wires from the red screw post and splice [§18] all together with the solid brown VoIP feed wire. Disconnect all of the wires from the green screw post and splice [§18] all together brown+white VoIP feed wire.

4. Plug in VoIP device:

You have just created a 'VoIP feed' from the inside of the house to the outside demarc box. Go inside the house and add a phone cord from your VoIP device, to the 'VoIP feed' jack.

Take great care to not plug the VoIP device into the L1/L2 jack. It must only be plugged into the 'VoIP feed' jack. Tape a note (or something) to the end of the VoIP feed phone cord to help you remember.

And assuming that in the demarc box that 'line1' to the house has just been replaced with VoIP, you can plug a phone into the 'L1+L2' jack and get the VoIP device dial tone.

5. In summary, how this all works:

1. Your VoIP device has a phone jack with dial tone
2. A phone cord connects your VoIP device to the 'VoIP feed' jack
3. L1 on the 'VoIP feed' jack is connected to a spare brown twisted pair
4. On the other end of the brown twisted pair (demarc box) is another jack (L1)

5. The line module cord plugs into your new jack
6. The line module posts in turn feeds your entire house

> This is safer because the cord in the line module (feeding the entire house) can only be plugged into one jack at a time -- Either (1) your new jack (VoIP feed) or (2) the phone company jack -- but not both.

17. A note on Phone Line Polarity

Most modern phone devices today (telephone, fax, answering machine, etc) don't (or should not) care about the 'polarity' of the phone signal, but in rare circumstances, you will find a device where polarity matters.

I was in a brand new home with a DSL modem that was not working in one jack in the house (but was working in all other jacks). Line polarity was the problem. Correcting the polarity allowed the DSL modem to immediately function properly. Very strange. Because prior to this incident, I thought *all* modern phone devices didn't care about polarity.

> **Polarity:** Red is wired to red, and green is wired to green (correct polarity) all the way from the phone company, to your house, through jacks, through cords, and to your phones.
>
> **Reversed Polarity:** Red is *somewhere* wired to green, and green is wired to red (which reverses the polarity).
>
> **Warning:** I have even seen homes where the phone company test jack in the demarc box has the incorrect polarity -- now that is a very sloppy phone company!

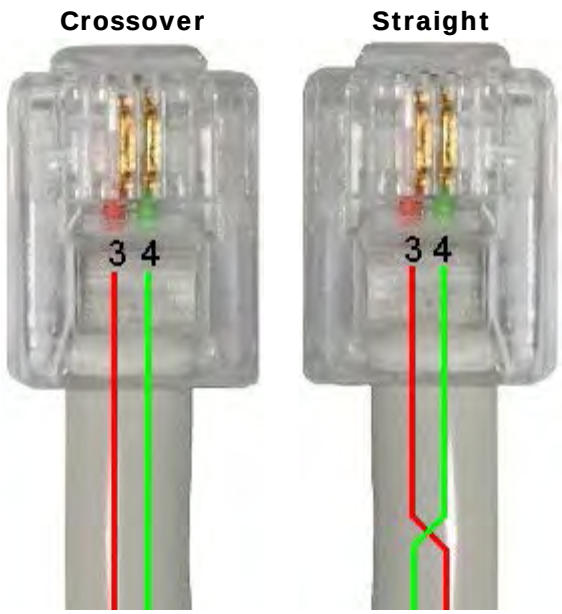
There are very simple polarity testers available, and here is one such example (a free model from RadioShack from the 1990's):

Phone Line Polarity Tester

Or, a simple phone line tester can be found at Lowes, Home Depot, or local hardware stores for under $10. Or, search the Internet for "Phone Line Tester".

Crossover vs Straight: Phone cables are 'named' based upon how the PINS (in the modular plug) on both ends of the cable connect to each other. And you can tell this by examining the colored wires in each modular plug. *All standard phone cables in your home are 'crossover' cables.*

But there are also 'straight' cables. To visually see this, look at the color coding of the wires in the modular plug (photo right) for the two cable types. Numbers in the photo refer to pin numbers. Also, see phone color coding standards [§14].



TIP for remembering: Note that no matter how long you make a standard (crossover) phone cable -- for example by connecting ten phone cords together via nine 'coupler's (immediate right) -- that the 'red'

Coupler

wire always 'stays on the left' and the 'green' wire always 'stays on the right' -- all the way from the wall jack to your phone.

VoIP Whole House Correct Polarity: After disconnecting the local phone company from the house, you can connect your VoIP device to the whole house by plugging it into any phone jack in the house. But if you do so, you will be reversing the normal phone polarity. With all modern phone devices, this should make no difference at all. Just be aware that in this configuration (VoIP to wall jack) that if you want the correct polarity requires the use of a 'straight' RJ11 cord (from VoIP device to wall jack). Either make the correct cable yourself, or buy one.

Crossover
Red: Pin 3 » 4
Green: Pin 4 » 3

Straight
Red: Pin 3 » 3
Green: Pin 4 » 4

18. Splicing: When required, do it correctly

Only when required: Splicing into the middle of a telephone cable should never be done, but sometimes you may need to repair a cut phone cable. In an ideal world, the entire 'home run' should be replaced, but if that is not possible, you will need to splice the two ends of the cable together.

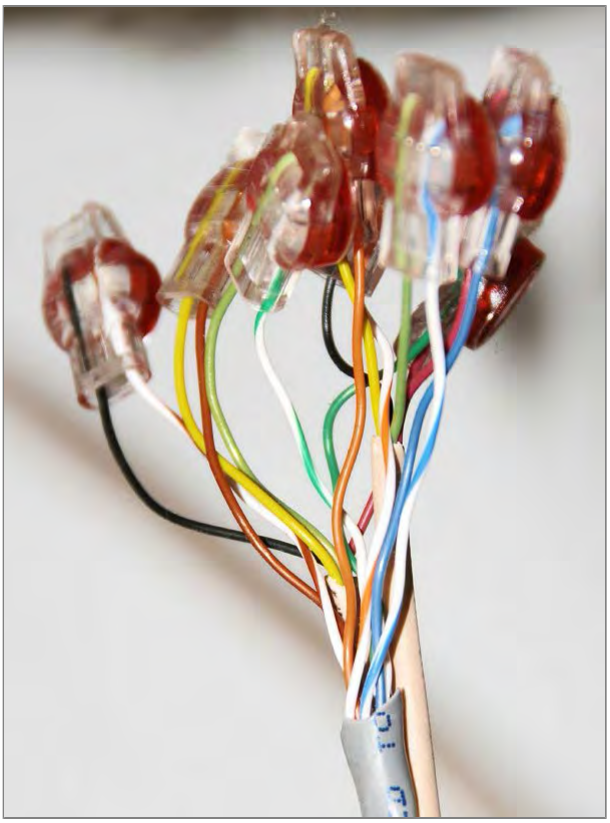
UR Butt Splice

Protects wire from the weather: Or, if your house has phone 'home runs' to the telco demarc box, instead of trying to connect all wires to the 'posts', usually a quality phone installer will splice all the ends together and run a single wire to the 'posts'. In doing so, this protects all the 'home run' phone wire ends from the weather.

> Does weather really matter? Yes, especially in high humidity ocean-side (salt water) environments. Will you notice wire damage in one year? Maybe not. Will you notice wire damage in 20 years? Yes, absolutely. I have seen it first hand.

UR Butt Splice: The correct way to splice a phone cable is with a small *gel filled* plastic device called a "UR Butt Splice". Note that there are many variations (2-wire; 3-wire; tap; etc). With all, trim any bare copper wire off the ends of the wire and insert the three (or two) wires into the UR device and then squeeze the device closed with a pair of pliers. The device pierces the insulation of all wires and makes electrical contact between them.

Do NOT strip insulation: What makes these so



4-line CAT5 to Quad (2) Splice

easy to use is that you *don't* need to strip any insulation from the wire before using. In fact, you want only wire *with* insulation inserted, so trim bare copper wire off first. That way the connectors protect the ends of the wires from moisture penetration.

> I was at an old (beach) house where all the wires went directly to the posts and all the wires had severe weather damage. Using these gel connectors all but eliminates weather damage on the ends of wiring.

Inexpensive: Since a package of 25 of these can be purchased at Home Depot (and elsewhere) for $5 (or less), you might as well know how to 'do it right'.

19. Does Verizon Suck?

Verizon makes customers pay for Verizon's own mistakes.

Phone calls not forwarded to me for over a month:

> Since I travel a lot, the 'normal' call forwarding Verizon offered did not work for me (normal forwarding must be done from 'home'). So I signed up for Verizon's "Ultra Call Forward", which allowed me to set the call forward number for my phone number via an 888 phone number *from anywhere* (not just 'from home').
>
> For nearly a year, it worked great, but then all of sudden it stopped working. Verizon acknowledged it was their problem and said it was because they had to 'reset' the entire 'Ultra' system. Verizon said I needed to 'go home' to reconfigure Ultra Call Forwarding. I explained that I was 'on the road' and already using Ultra Call Forward and that I would not be home for another month. Verizon REFUSED to help me.
>
> After *several hours on the phone* with Verizon support, I finally got a supervisor in the local home office who I was told could help me. After explaining my story, she absolutely refused to help -- telling me I had to 'go home' to configure Ultra Call Forward all over again (from my home phone). Telling her I had already done that a year ago, and was currently 'on the road' made no difference. Verizon had 'reset' the 'Ultra' service and wanted me to 'go home' to set it up *again*.
>
> She even went so far as to tell me that she was the only person who could fix this, and that she would absolutely not fix this. Talk about 'getting the finger'. She then went

further and said that if I got off the phone with her and found someone else within Verizon willing to help, that the 'fix it' request would come back to her, and that she would NOT implement the fix. I guess I just 'got the finger' on both hands at the same time.

And so, my phone calls were not forwarded to me for over a month.

Bad choice. I dumped Verizon and switched the phone line to Vonage and now use that all the time instead.

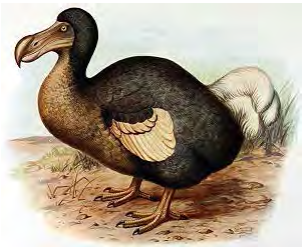
Refusal to credit for cancelled service that Verizon did not cancel:

I actually had Guardian service, where Verizon will service the wiring *inside* your house if there were any problems. There were two phone lines with terrible crosstalk problems. Verizon replaced ALL the phone wire in my house, but that did not totally fix the crosstalk problem. So I eventually rewired the entire house with high quality CAT5 (and in the process moving from a house with 2 lines to 4 lines), and I fixed the problem. Verizon had a chance to fix the crosstalk problem in my house, but failed because they used low quality (quad?) phone cable. So I called Verizon and cancelled Guardian service on my two phone lines.

Much later, I noticed that Guardian was still on one of my phone lines. I called Verizon and explained that I had cancelled Guardian on both phone lines, and would they please credit me for their charges/mistake. I immediately received a credit for the past six months, but was forwarded to a 'supervisor' to get credit for the rest of the time.

The supervisor was Emily. She refused the credit -- and actually told me that she would only have been credited for one month instead of the six I had already received.

I asked Emily to review the original recorded phone conversation to verify I had cancelled on both phone lines. Emily refused, saying the recording 'probably' no longer existed.


Dodo

After several more minutes on the phone with Emily, she said there would be no credit and if I wanted to follow up, to write a letter to "Verizon Customer Relations PO Box 1400 Salisbury, MD 21802-1400"

And so, Verizon forced me to write a letter to obtain a credit for Verizon's own mistake.

Bad choice. Since Verizon clearly does not want my money, I transferred my phone number to Vonage, slashing my monthly phone bill by 60%. Verizon has lost me as a customer for life.

Verizon Attitude:

Verizon still conducts business like they still have a monopoly on local phone service. They don't. VoIP is changing the phone service business. Will Verizon survive? If they keep pissing off their customer base, absolutely not. Only time will tell.

Am I alone? Search Google for Verizon Sucks and decide for yourself.

If you don't like how your local phone company treats you, show them you mean business and take your business elsewhere.

20. DSL Warning

A *single* twisted pair phone line to your house can potentially provide your house with *TWO* different services, a (1) a dial tone, and (2) DSL high speed internet service.

So even if you port the phone number (associated with your DSL service) to a VoIP company, you will/should still have DSL service on the existing 'line' in the house with your old phone company. *DSL service will be present on the line and the line may or may not have any dial tone*.

For this reason, if you have DSL, you MUST NOT use the techniques described in this paper to *REPLACE* your DSL line (because you still need the DSL signal to get to your DSL modem to get Internet service). Instead, use these techniques to *ADD* a phone line to your house, replacing an truly unused line in the house, like 'Line 2' (or Line 3 or Line 4).

Dry loop: Please note that a twisted pair phone line with a 'phone number' and only DSL internet service, but NO dial tone (no ability to place phone calls) is typically called a 'dry loop' by the phone company.

21. The hidden cost of "always on" devices

The Q+D estimate: Very few people think about how much a device costs (a modem; a router, a switch, etc) to operate each year -- in electricity. But there is an incredibly quick and dirty way to estimate the costs for any device that is on year round. Just put a dollar sign in front of the watts consumed to obtain an estimate of the yearly cost in dollars.

Power Supply Watts: Many devices only disclose power supply Volts and Amps. Calculating (maximum!) Watts given just those two pieces of information is easy:

Watts = **A**mps × **V**olts (W=A×V)

The trick for easily remembering this formula is the WAV acronym (first letter of each word).

Power consumption: Look in the manual for your device, which sometimes will disclose the maximum power consumption for your device, in Watts.

Kill A Watt

Measure Watts consumed: There are very well known "Kill A Watt" devices that can very accurately measure actual Watts consumed.

Why/How this estimate works: Because if we assume electricity costs 11.42¢/killowatthour (find average electricity costs for your State) the formula for cost/year is:

$/Year = Watts / 1000 × 11.42¢ / 100 × 24 × 365

Which simplifies to just Watts × $1.00. For a more accurate multiplier for your State (other than the $1.00 estimate), simply divide your State's 'cents per killowatthour' by 11.42.

Example: The multiplier for California's 17.04¢/kwh is 17.04/11.42, or $1.50.

Conclusion: I find that most people are surprised to learn that a 100 Watt lightbulb kept on for a full year would cost around $100 (or $150 in California).

22. Other Sources of Information

Here are some other sources of information on the subject:

- Vonage - Do-It-Yourself Home Wiring Guide
- How to Distribute VoIP Throughout a Home

23. Disclaimer

There is NO warranty on the contents of this web page. However, this web article describes how I *successfully* added VoIP into many homes in the United States. I believe it to be accurate, but there might be errors. Each home is a unique situation with potentially unique non-standard wiring, and hazards I have not foreseen, and so YOU must take full responsibility for any consequences that arise from working on your own home. Namely, if you break or damage anything, get shocked (or worse), fry your VoIP device, burn down your house, etc -- it is *your* responsibility.

24. Questions / Comments / Feedback

Use this contact form to contact the author of this paper, Jerry Jongerius.

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