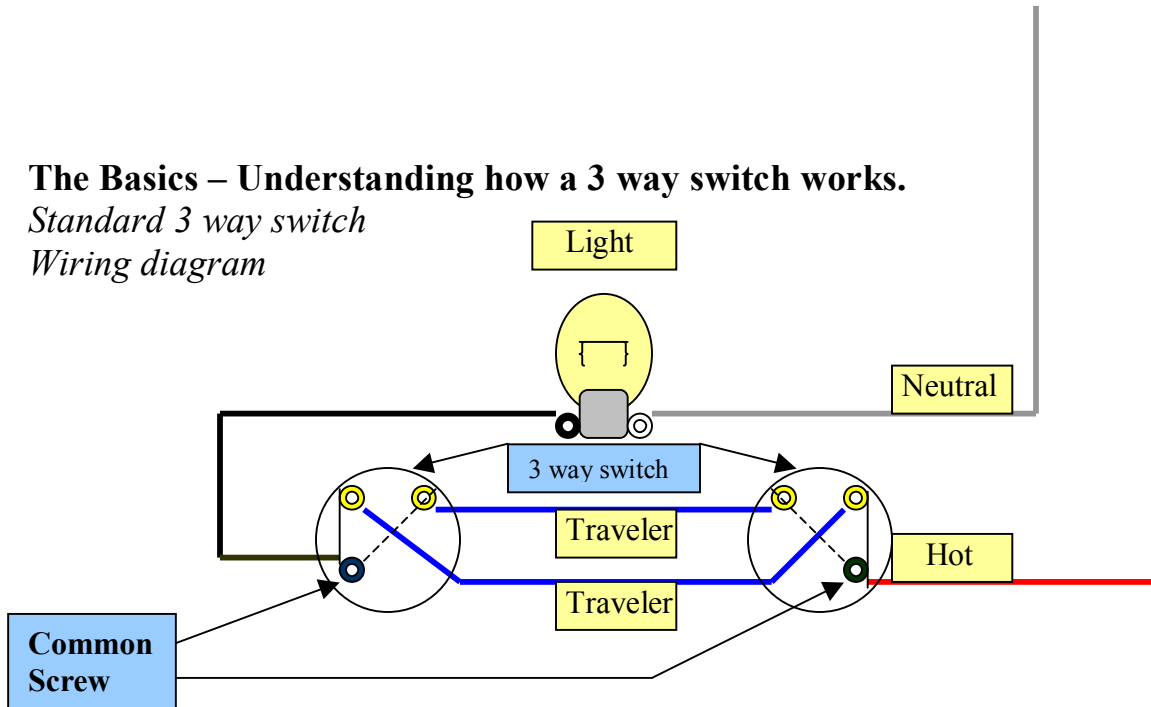


Troubleshooting 3 way and 4 way switches with wiring diagrams

I do not recommend anyone other than a qualified electrician perform any electrical work. This is for information purposes and for understanding how this type of electrical system works. If you choose to do electrical work be sure to turn the power off. Electricity Kills!

The Basics – Understanding how a 3 way switch works.

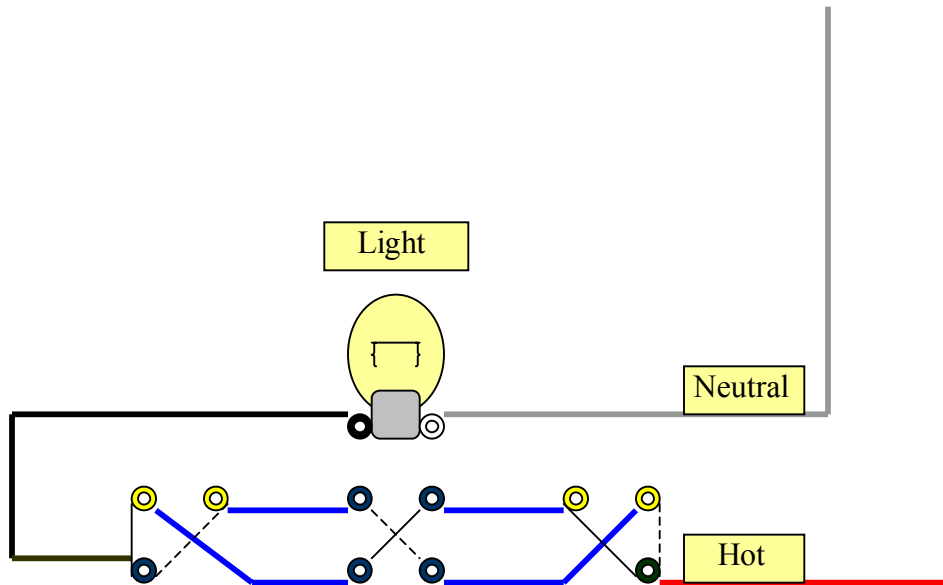
*Standard 3 way switch
Wiring diagram*



It is very important to first understand exactly how a 3-way system operates. If you follow the simple line drawing above you can see that by following the solid line from the hot wire all the way to the light it makes a **complete** circuit. The solid line in the switch represents the switch being in one position while the dotted line shows the alternate position the switch can be turned to. You can see by flipping either switch the circuit would open and the light would turn off.

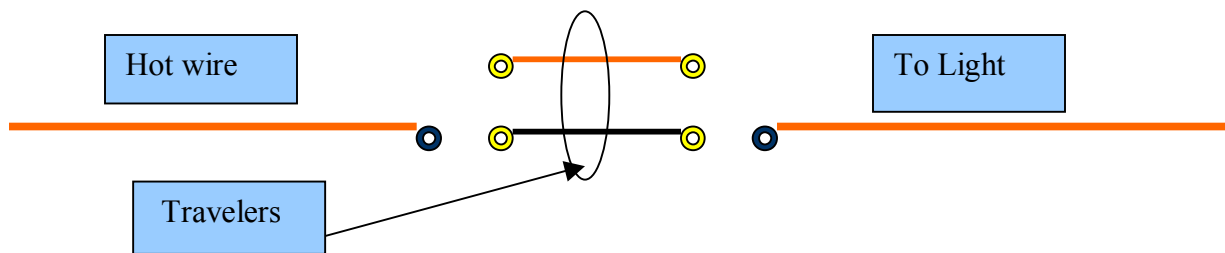
This is a simple schematic and does not show how the actual wires would run. I will show some of those in the following diagrams. In some cases there may be more than 2 locations to turn on a light or lights. When 3 or more switches turn on the same light or lights a 4-way switch is required.

To add a 4 way switch into this diagram see the following illustration.



In the wiring diagram above we can see the 4-way switch installed between the two 3-way switches. You can put multiple 4-way switches in between two 3 ways. Notice in this diagram you can see the actual operation of the switches. The solid line is the actual switch position while the dotted lines show the alternate position.

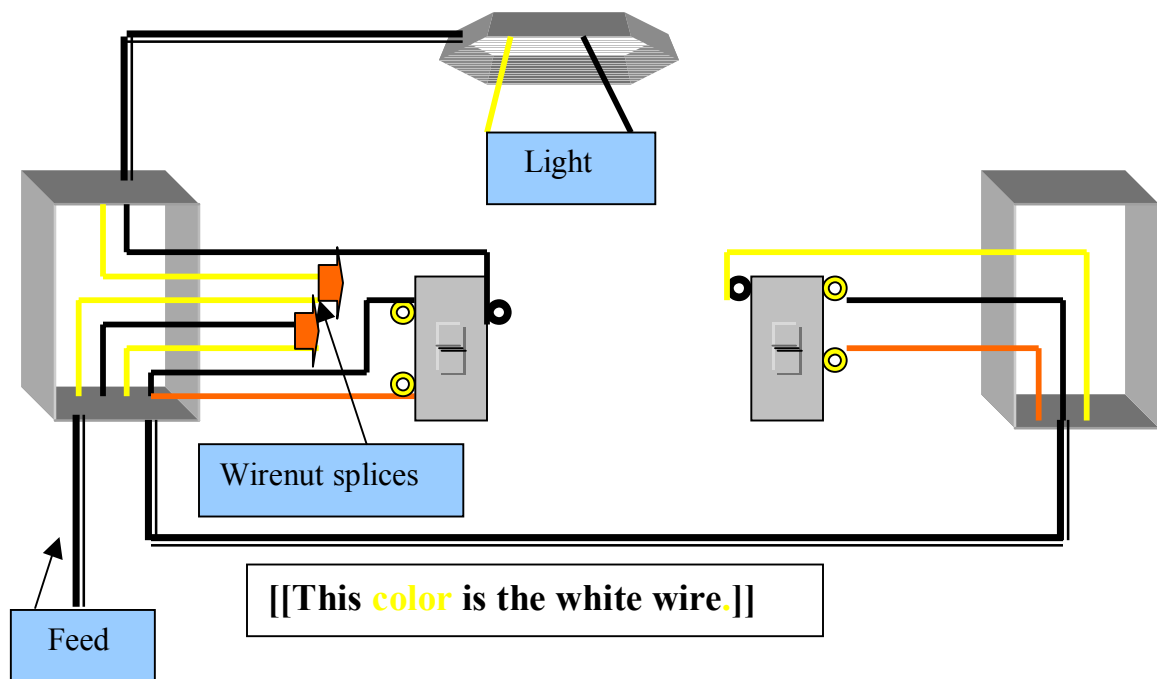
With a 3-way switch system there is a number of variables that make troubleshooting very difficult for a novice. The most common mistake is made when a switch is simply replaced. The common screw on a 3 way switch has to be connected to the proper wire or the system will not work correctly. The basic premise is always the same. In the diagram below you can see one common is the hot wire and the other common goes to the light. It doesn't matter on which switch these go but they must go to the common screw. On most 3-way switches this is the black screw with the other two screws being brass colored. The two traveler wires go only from one switch to the other. It doesn't matter which of the two screws they go to on each switch as long as it is one of the 2 brass colored screws.



Do you understand the basic concept? If not I can explain it this way.

Sometimes, to make it easier to visualize how this works, try to imagine the simple wire diagram as a series of pipes. In order for the water to flow through the pipes they must all be connected so the water can flow from point A to point B. The switches are valves that prevent or allow the water to flow.

Now the confusion generally comes when you remove the first switch and see 7 wires in the box. You have to keep in mind there are a lot of combinations when it comes to wiring a set of 3-way switches and they will all work properly. For that reason it is very important that you first understand the basic theory as seen in the above diagrams before you can troubleshoot the system. Let's look at some scenarios.

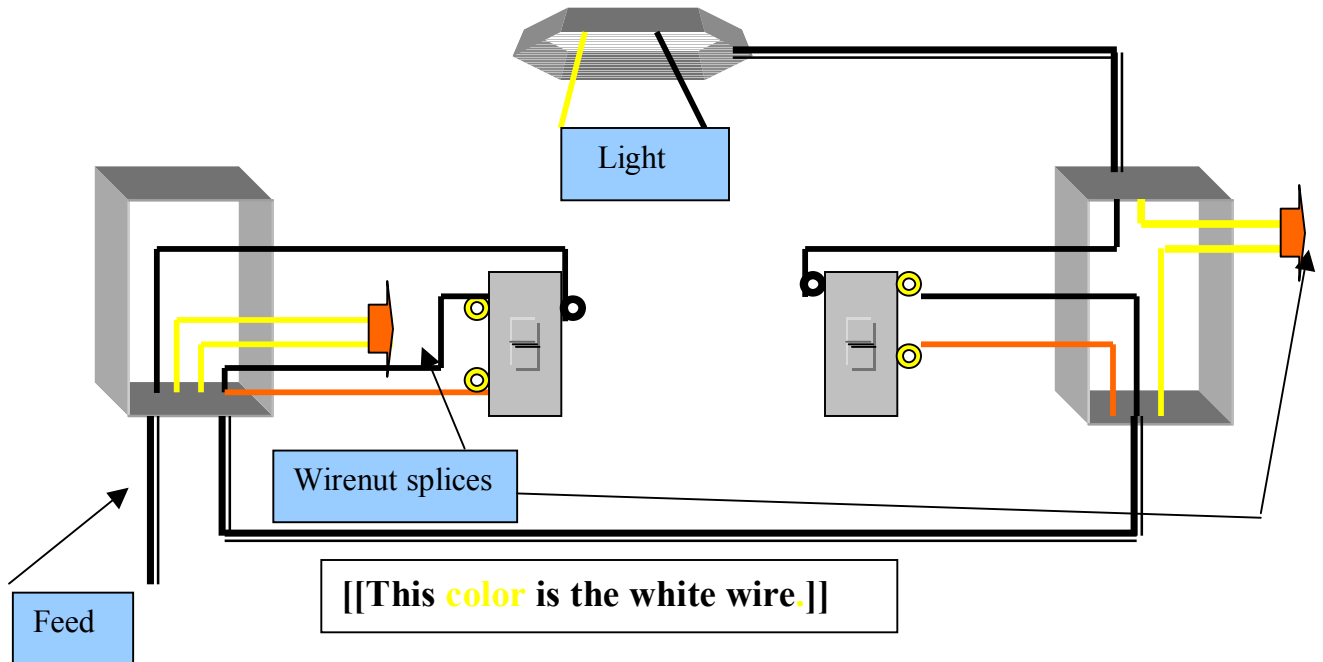


In this case we have the 2 wire feed, the 3 wire cable going to the other 3-way switch as well as the 2 wire cable going to the light, all in the first box. The second switch box has just one 3 wire cable and the light box has just one 2 wire cable. In most cases when a 3 wire is used from one 3 way switch to another you will find the white is used as the common. This has been a standard practice for years. A piece of black electrical tape denoting the white wire as hot is a good idea here.

In the first box notice the neutral or white from the feed is spliced to the neutral or white from the light. The black or hot from the feed is spliced to the white on the 3 wire cable. The red and the black on the 3 wire cable are the travelers.

One important thing to remember. Never assume anything when it comes to wiring. The wiring may not have been done properly and things may not be what they seem. I have seen many times when the neutral is the switched wire meaning at the light, even with the switch off, the wire at the light is hot all the time. Always use a voltage tester to check which is which. On that note always make sure your tester is working on known live circuit before assuming that it works, they do fail.

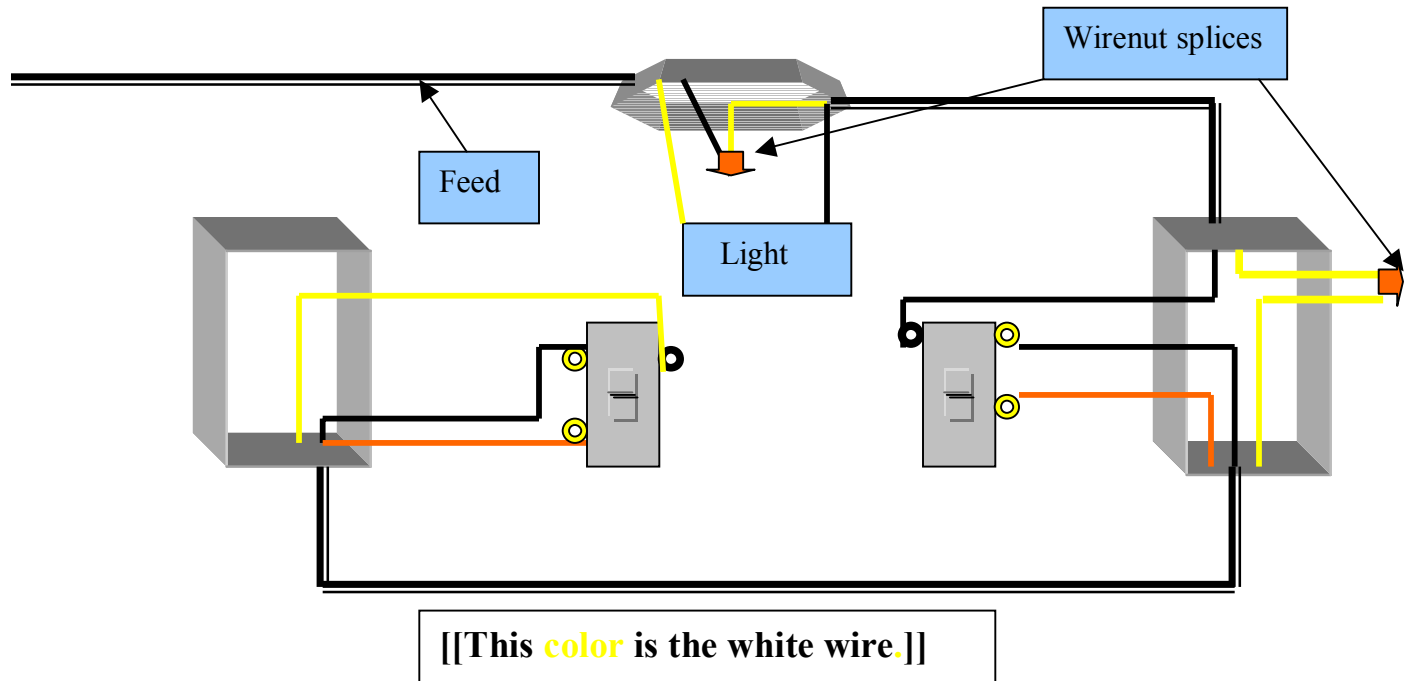
Okay let's look at another scenario.



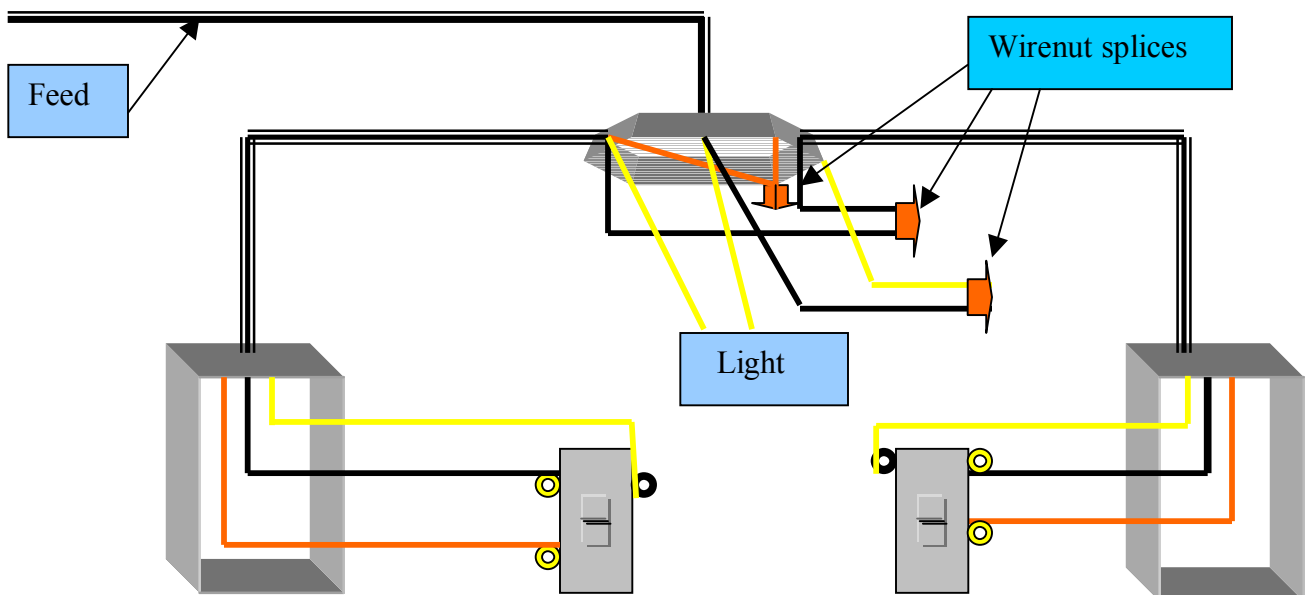
In the above diagram we have the 2 wire cable going to the light from the other 3 way switch. In this case the feed wire is connected directly to the common on the switch in the box on the left. The neutral or white wire gets spliced to the white in the 3 wire cable that goes to the other box with the 3-way switch and then that gets spliced to the white going up to the light. That carries the neutral to the light. The black wire from the light is connected to the common on the 3-way switch on the right. Again I want to emphasize that the wire colors I am giving are the standard in the electrical industry. You could very well encounter different color wires.

On the topic of connections, the mechanics are extremely important when it comes to electrical connections. Splices should be twisted tight with no spaces, but not so tight the wire breaks. Screws should be secure and tight as well. I frown upon using those push in connections on the back of switches and receptacles. The contact they make is poor and tends to cause problems.

Now let's see another example.

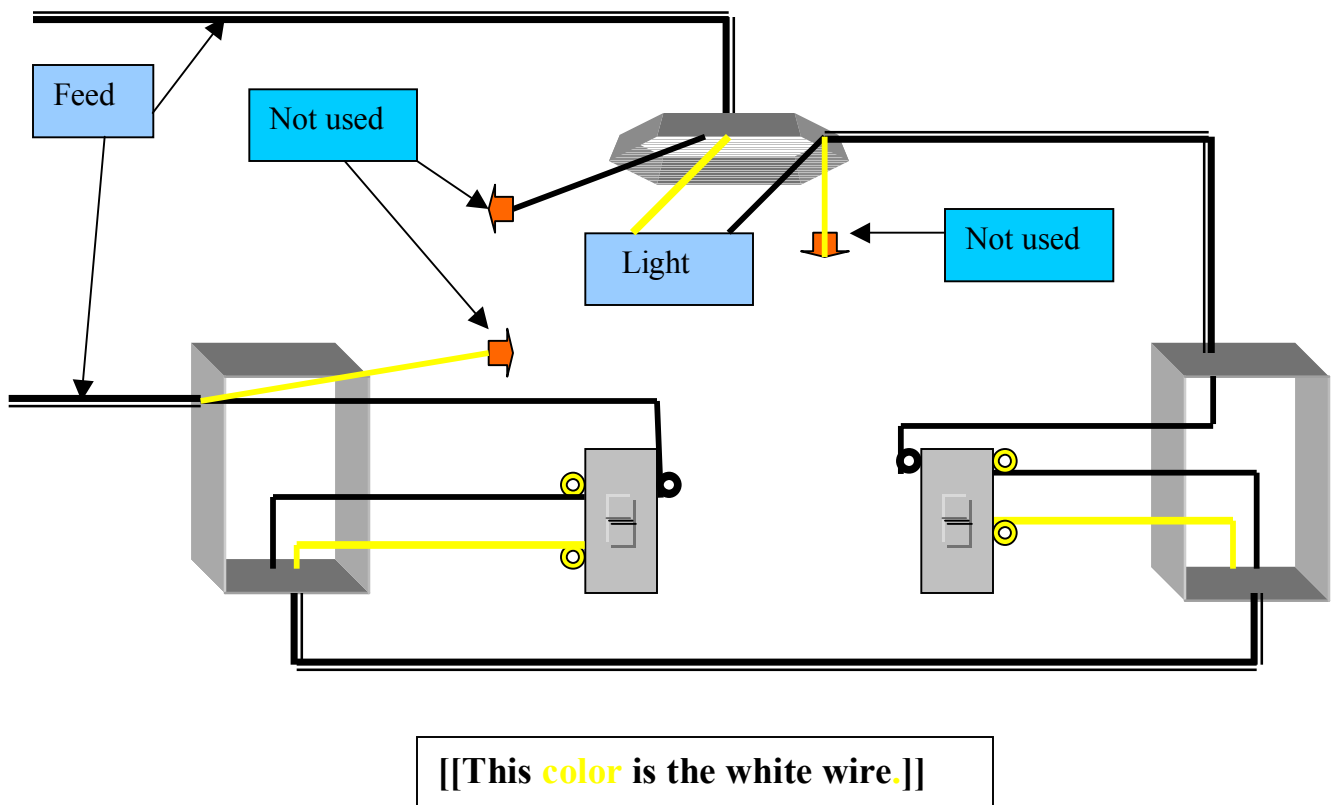


In the above diagram we have the feed entering at the light box. In this case the neutral gets connected directly to the light. The black or hot wire is spliced to the white going to the 3-way switch box. Once at this box the wire is spliced to the white going to the next 3-way switch box and connected to the common. The black going to the light is connected to the common on this 3-way. Now let's look at a fairly common scenario.



In the previous diagram we see the feed enters the light box. In this case we have a 3-wire cable from the light to each 3-way switch. The red and black traveler wires get spliced through in the box at the light, black to black and red to red, being sure they are the wires from the two 3-wire cables. The white or neutral from the feed is connected directly to the light. The black or hot wire is connected to the white on one of the 3-wire cables and is connected to the common on the 3-way. The white in the other 3-wire cable is connected from the common on the switch to the light. Repeating what I said earlier, when using a white wire as a hot leg, it should be marked with a piece of black tape to signify it is, or could be hot.

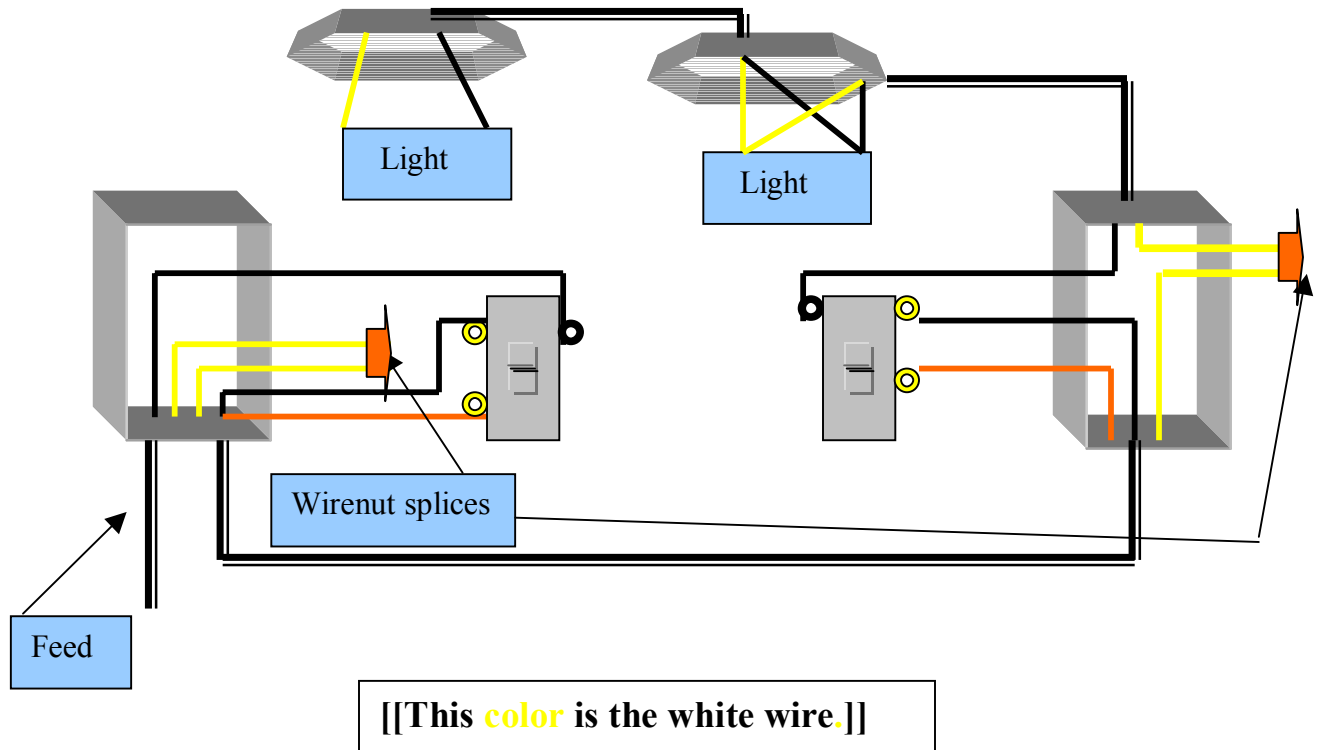
The next diagram is something you may see but it is not the correct way of doing this. It is a shortcut I have seen in older installations.



In the above diagram we see something a little unusual. I have included this because I have seen variations of this done, especially in older installations. Notice that no 3-wire cable is used and there is a feed in two locations. Are you are wondering why would anyone do this? Well there were a couple of reasons. One is they didn't have to use any 3-wire cable. When a contractor was doing a whole slew of houses the savings were

enough that I guess it was worthwhile. One really bad aspect of this method is many times the feed in one box and the feed in the other are from 2 different circuits. This causes an imbalance in the main panel.

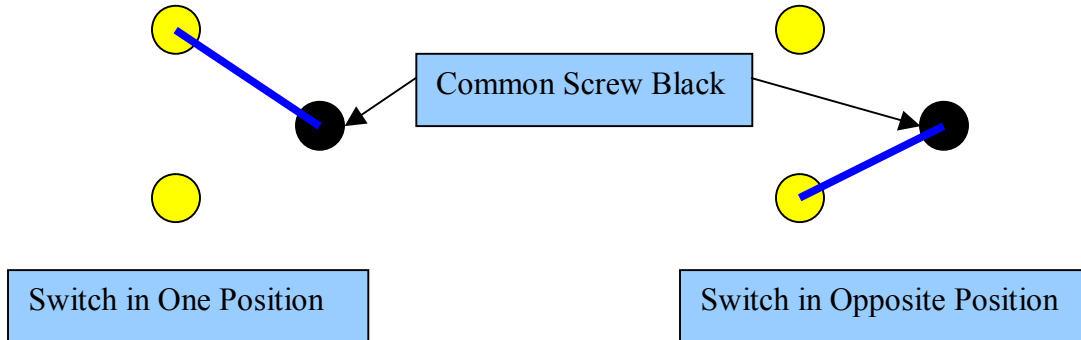
On any of these installations there can be multiple lights connected to the same set of 3-ways. They would just be paralleled with the one light. See the diagram below.



That should cover most of the different scenarios. As I said earlier there are many combinations so you may run into something unusual. If that's the case, feel free to email me with the details and I will try and help you figure it out. Before making the assumption that there is a problem with the wiring don't overlook the obvious. One is making sure the switches are all working properly. It is not at all uncommon for a switch to go bad. To check a 3-way switch it should first be removed from the wiring. You will need a continuity tester preferably with a light or beep sound. **It is important that the switch is not connected to any power or you could be seriously injured.**

One lead of the tester goes on the black or common screw. The other lead goes on either of the brass screws. If you get a light or tone switch the switch and the light or tone on the tester should go out. Now move the lead from one brass screw to the other. You should now get a tone or light on your tester. Basically you should get continuity from the common to one brass

screw with the switch in one position and the other brass screw with the switch in the other position. The way the switch works is illustrated below.



I hope this has been helpful. If you have any questions please visit my website at www.forteelectric.com or email me at pforte@forteelectric.com

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