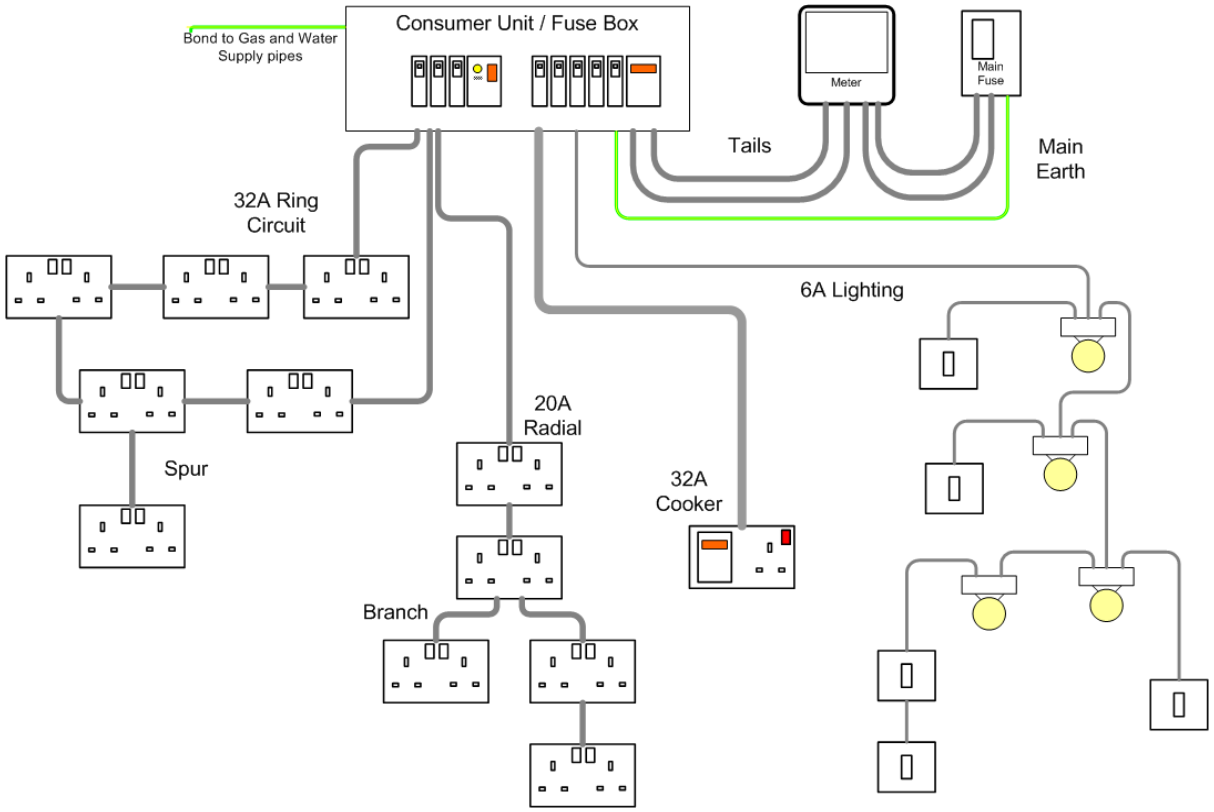
Home Electrics

- Today I hope to give you a quick insight on how your home is wired in the two major sources of electrical power we use in our homes on a daily basis.
- These are:
    - The consumer unit fuse box.
    - The ring main of power sockets.
    - The lighting circuit.



Consumer box / Fuse box

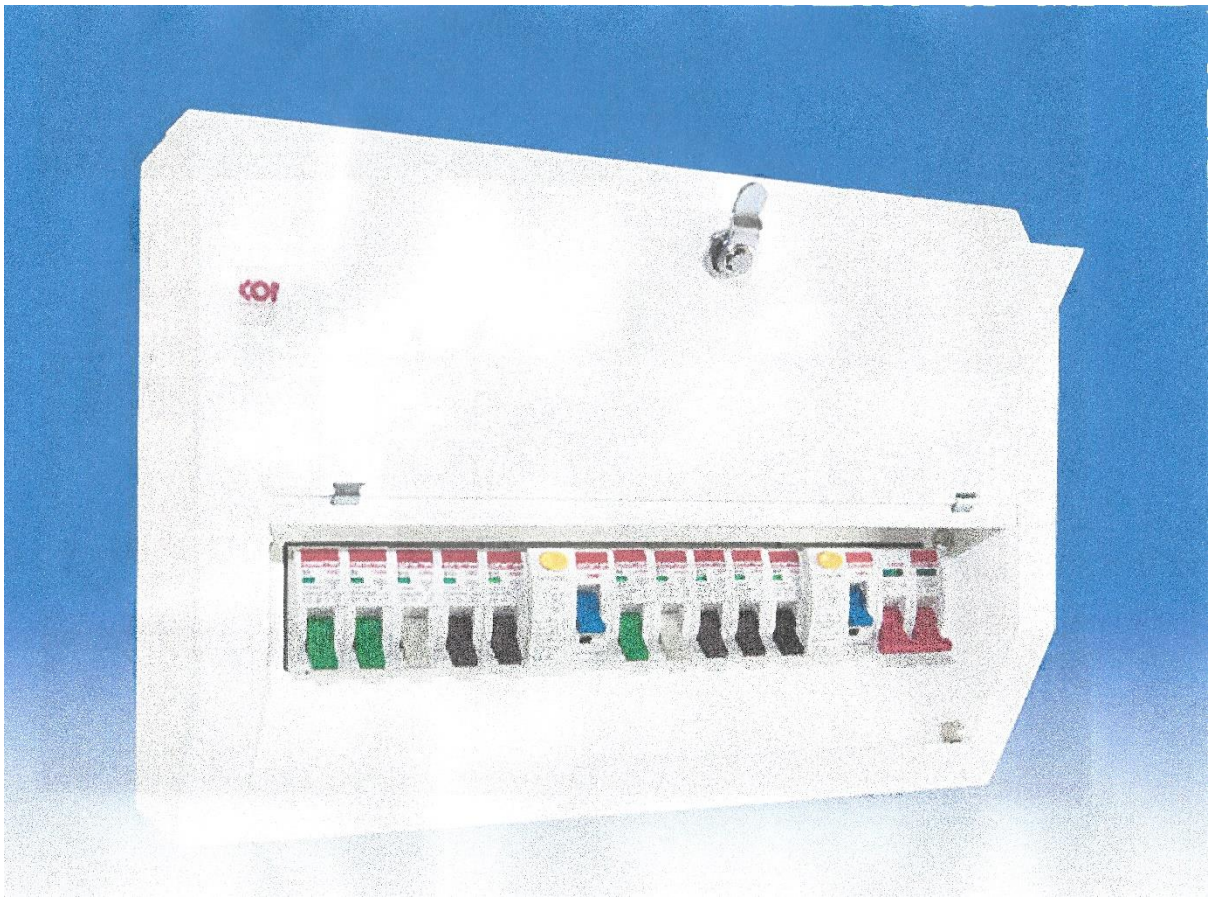
- First rule of thumb before doing any work on the electrics is to

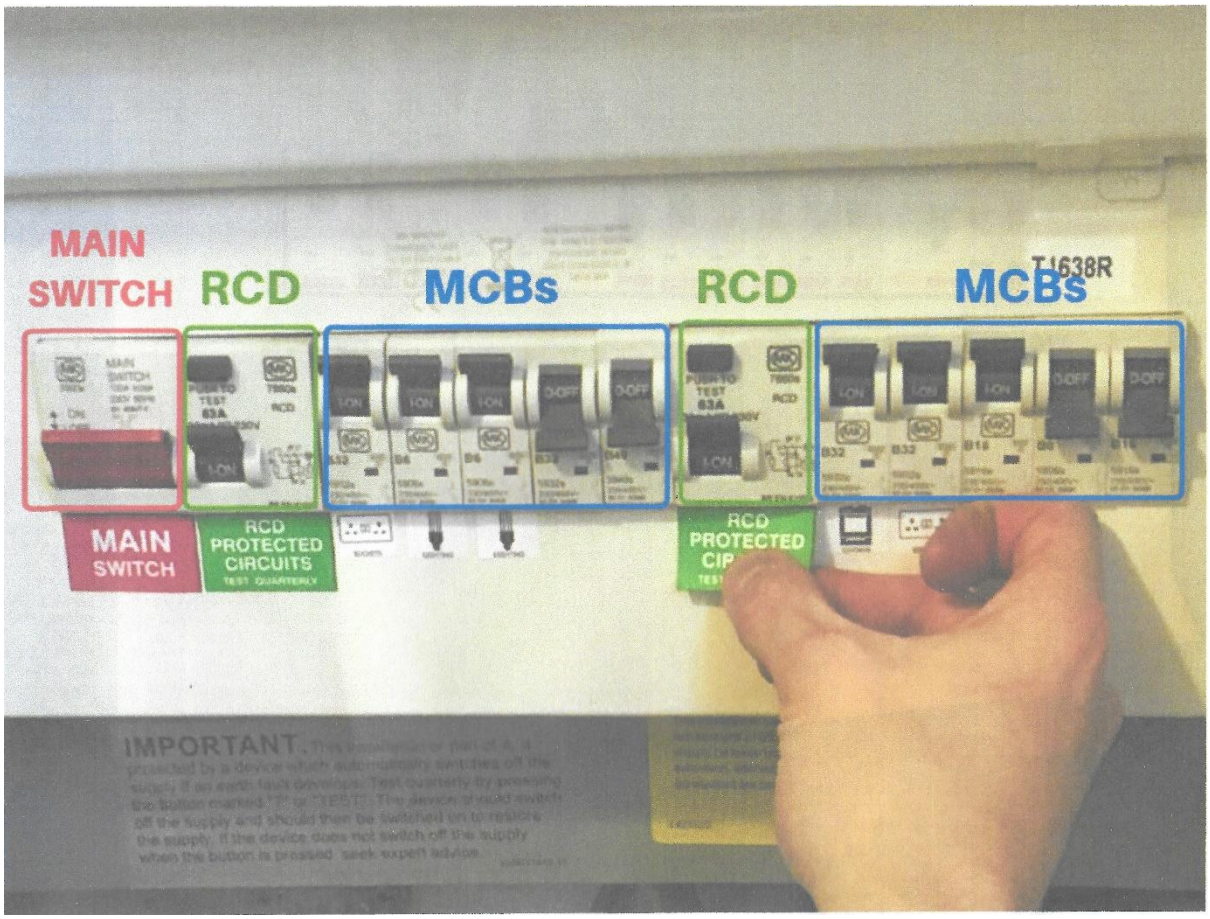
'Turn the power OFF'

- This can be done by either using the main switch in the consumer box or switching OFF the circuit you are working on.
- To turn the circuit off:

- In the case of a fuse box pull out the fuse of the circuit you are working on.
- In the case of a trip switch box just trip the switch to the off position, usually down.

- A Live & Neutral phase (supply) is presented at the consumer box via your meter. The case of a fuse box it will have various sizes of fuses ranging from 5 to 60 amps or in the case of a RCD trip switch box it will have trip switches ranging from 6 to 63 amps.
- RCD stands for: Residual Current Device.
- A consumer box is really just one big Junction box distributing the electrical circuits throughout the house.





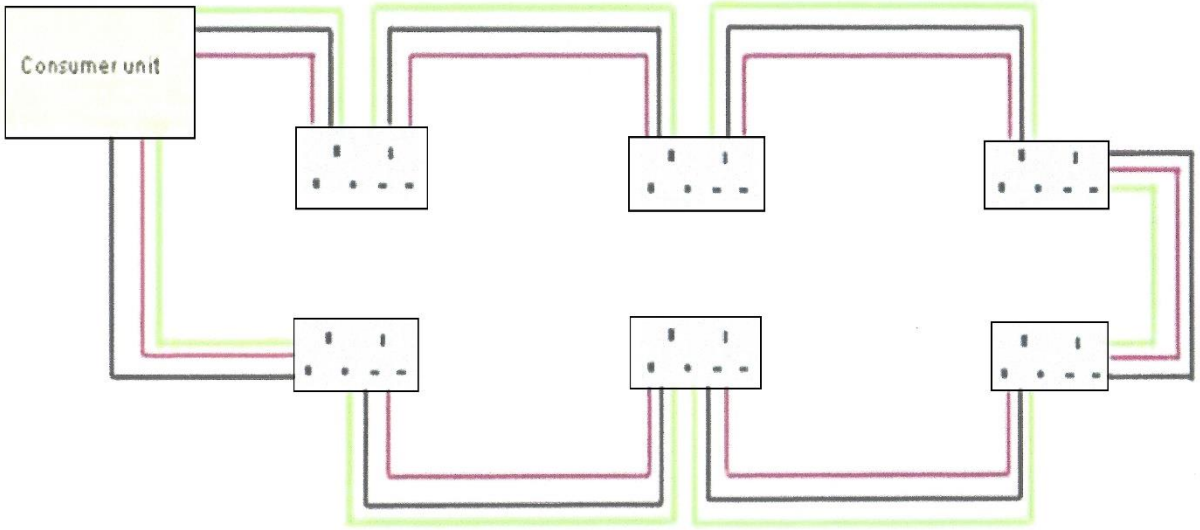
Colours & sizes of the wires

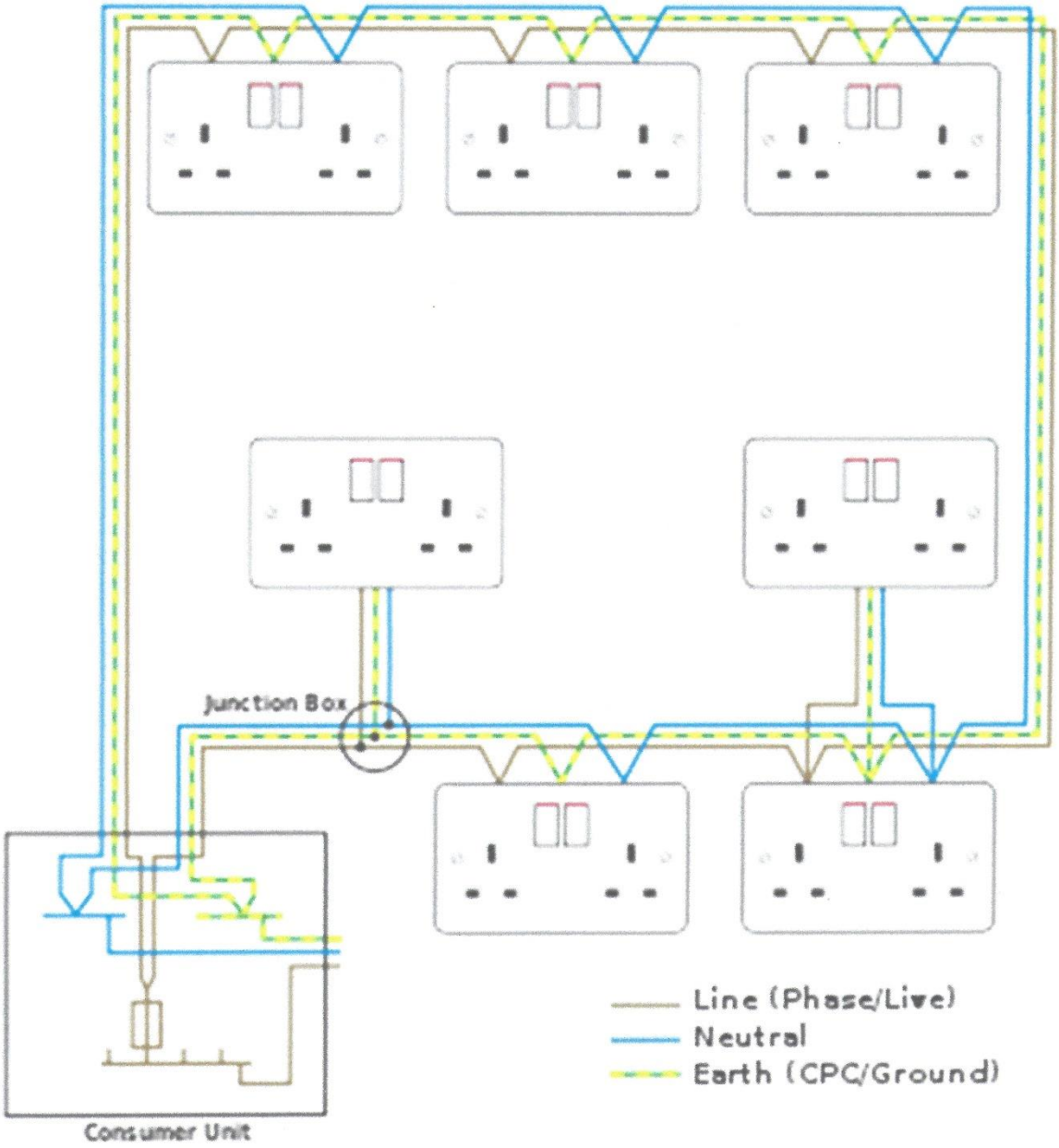
	OLD CABLES	NEW CABLES
LIVE WIRE	RED 7029 or 3029	BROWN 2.5mm or 1.5mm
NEUTRAL WIRE	BLACK 7029 or 3029	BLUE 2.5mm or 1.5mm
EARTH WIRE	GREEN WIRE 3029	GREEN/YELLOW 1.5mm

	Pre-1977 IEE	Pre-2004 IEE	Current IEC
Protective earth (PE)			
Neutral (N)			
Single phase: Line (L)			

The Ring Main Circuit

- A ring main circuit is the main power source to operate all electrical appliances i.e. computers, televisions & cleaning equipment etc and consists of a cable that runs out of the consumer box, connecting all the plug sockets up in the house.
- Then from the last socket, the cable runs back to the consumer box forming a ring circuit. The connection of the two cables at the consumer box should be connected by a qualified electrician.
- Ring main circuits are wired in 2.5mm cable which has one strand of copper wire conductor in each of the brown, blue & earth wires.
- However be aware of old cables that have been used mainly wired in older types of properties which have been cabled in 7029 cables which have 7 small strands of wire for the red live wire, 7 small strands of wire for the black neutral wire & 3 small strands of wire for the earth wire.
- Ring mains circuits are protected either by a 30 amp fuse in the consumer box that has fuses, or a 32 amp circuit breaker in a consumer box that trip switches (RDC).

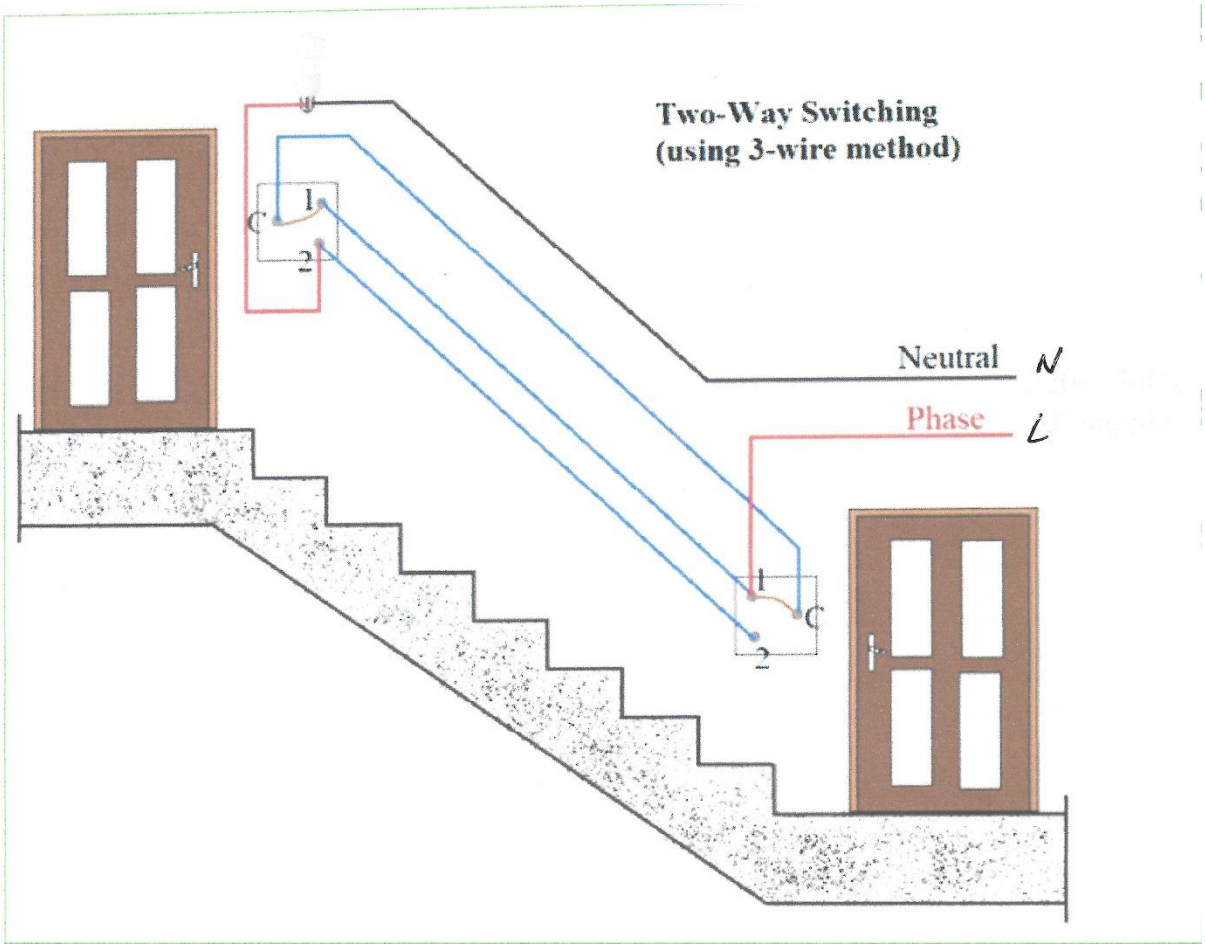




Lighting Circuits

- The lighting circuits for all the lights in the property have just one cable that runs out from the consumer box connecting all the ceiling roses up in each of the rooms in the house.
- Unlike the ring main circuit there is **no** return cable on this circuit back to the consumer box.

- **The lighting circuit** is wired in 1.5mm cable, although nowadays some of these circuits have been wired in 1mm cable due to the lower wattage of bulbs we now use.
- This cable also has one strand of copper wire conductor in each of the Brown, blue & earth wires
- Again be aware of old cables wired in **<u>3029</u>** cables mainly used in older types of properties. This type of cable will have 3 small strands of wire for the red live wire, 3 small strands of wire for the black neutral wire & three small strands of wire for the earth wire.
- These circuits are protected by either a 5 amp fuse in the consumer box that has fuses, or a 6 amp circuit breaker in the consumer box with trip switches (RDC)
- The earth wires in all these cables are bare wire within the cable itself and will have to be protected with a green/yellow sleeve when connecting the earth to a socket.



Light bulbs – Lumens vs Watts

BRIGHTNESS IN LUMENS	220+	400+	700+	900+	1300+
STANDARD	25W	40W	60W	75W	100W
HALOGEN	18W	28W	42W	53W	70W
CFL	6W	9W	12W	15W	20W
LED	4W	6W	10W	13W	18W

Types of light bulb fitting

Safety first

- **<u>Any property that has 7029 or 3029 cables must be replaced a.s.a.p.</u>**

- In a property with two (or more) floors and requires two (or more) ring mains and two (or more) lighting circuits, the **best practice** is to split both these circuits across the two (or more) floors.
- Should one of the circuits go out due to a faulty bulb or faulty appliance, then you are not completely without power or lights on any of the floors.
- To calculate how much load to have on any one particular wiring circuit, multiply the voltage by the amperage which will give the wattage, this is expressed as:

v x a = w

- For example on a ring main that is protected by a 30 amp fuse in a consumer box = 7,200 watts and on a lighting circuit that is protected by 5 amp fuse = 1,200 watts.
- On a consumer box that has circuit breaker switches, a ring main that is protected by a 32 amp trip switch (RDC) = 7,680 watts and on a lighting circuit that is protected by 6 amp trip switch (RDC) = 1,440 watts.
- If the fuse blows or the circuit breaker switch trips out and cuts off the power to that circuit, this has happened in order to protect the wiring from overheating because there could be too many appliances running on the same circuit.

AMPS

Amperage is a way to measure the amount of electricity running through a circuit. Amperage is the "rate" that current is flowing through the circuit or the number of electrons moving through the wire.

You might come across amps if you look inside your home's consumer box. You'll see different circuit breakers listed as 6amps 15 amps, and 32 amps. The larger the amperage, the more electricity can flow through the circuit. Again, large appliances like air conditioners, washers and dryers will be connected to 32-amp circuits, while most outlets in a home will be powered by 6-amps or 15-amp circuits.

The unit is named after French physicist André-Marie Ampère, one of the fathers of electromagnetism.

VOLTS

Voltage is a measurement of the electric potential or "pressure" at which electricity flows through a system. Voltage is also described as the speed of individual electrons as they move through a circuit and is measured in units called volts.

Volts are named after the Italian physicist 'Alessandro Volta', who built one of the first batteries in the 1800's.

WATTS

Of all these different units of electricity, wattage is probably the most familiar. For years, you've been buying 40 & 60 watt light bulbs. A light bulb of 60-watt is generally understood is brighter than a 40-watt bulb.

Wattage is the amount of power an electric device consumes. Another way to think about wattage is "electricity at work" — the power it takes to actually do something, whether it's running a vacuum (400 to 900 watts), ringing the doorbell (2 to 4 watts) or illuminating a light bulb (40 to 75 watts).

To calculate wattage, you simply multiply voltage (pressure/speed) by amperage (volume), expressed as **V x A = W**. The faster each electron moves through the circuit and the greater the volume that the circuit can hold, the higher the wattage.

Wattage is named after James Watt, the Scottish engineer who popularized the steam engine.

OHMS

Circuits are made up of wires and wires are not always perfect conductor’s electricity. Most electrical wiring in the home is made of copper and both of those materials have a certain amount of resistance or friction, which slows down the flow of electricity. When electricity passes through electrical devices and appliances, they also apply their own resistance built in these devices and appliances.

Therefore this resistance is measured in ohms, which are named after the German physicist and mathematician Georg Simon Ohm.

UK Wiring Colours – The Old and the New

Have you checked the colours of the wiring in your home? Are you planning on rewiring your home or taking some electrician courses? Electrical wiring colours were changed in 2006 and it's important to know what to look for.

New vs Old Wiring Colours

In 2006, Amendment 2 of the 17th Edition BS7671 Wiring Regulations saw a change to "harmonise" the UK colours with the European cable colours for consistency and to avoid confusion. It's important that properties get their wiring checked, to see if the wiring colours are out of date, have deteriorated over time, and to check if they comply with the 18th Edition of BS7671 Wiring Regulations.

Some properties across the UK still rely on the old cables, which can be dangerous if not tested. Old cable colours could be due to the age of the property or the wiring system, which simply hasn't been monitored or tested as regularly.

	Pre-1977 IEE	Pre-2004 IEE	Current IEC
Protective earth (PE)			
Neutral (N)			
Single phase: Line (L)			

Credit: Wikipedia

How have wiring colours changed in the UK?

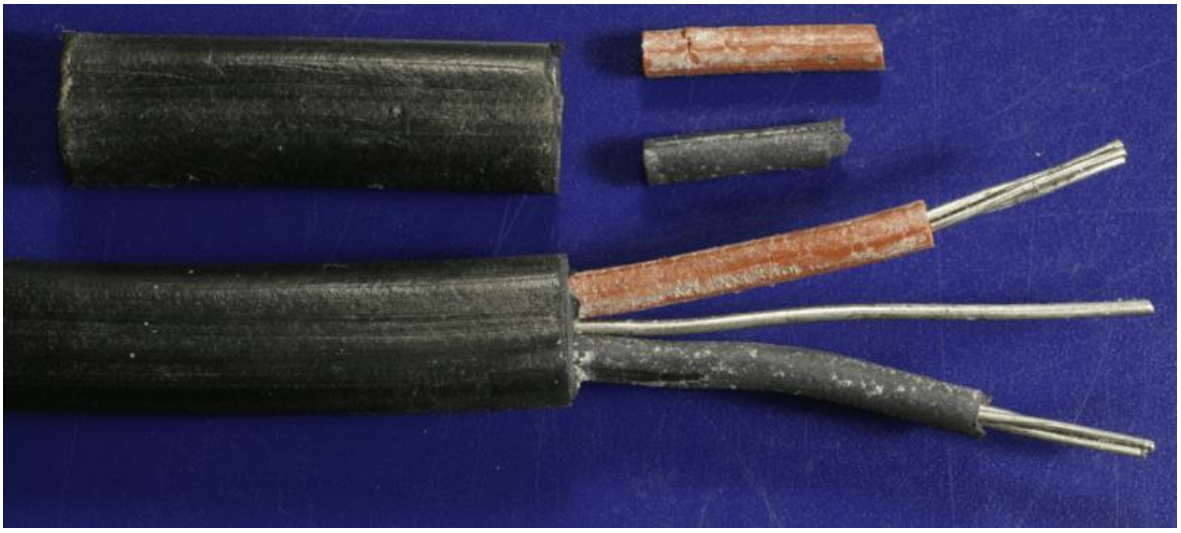
- The neutral black has been replaced by blue.
- The line red and has been replaced by brown.
- The earth is still identified by green and yellow.

Condition of Wiring Cables

If you're moving into a new home, or you are renovating your current one, make sure you carry out visual checks on the electrics, specifically looking at the colour and condition of the wires.

If you have the previous colours, red, black and green earth (or bare earth – very dangerous!), we would recommend you have an electrician test to check the integrity of the cable as it could be more than 50 years old and unreliable.

You should also be looking at the condition of cables, as well as the sheathing of the cables. The average lifespan of electrical wiring is 30-40 years and will deteriorate over time, especially if your home uses one of the aged styles of cable sheathing, which are highlighted below.



Tough Rubber Sheathed cables

Before pvc-insulated cables became common in the 1960s, most cables in the home were tough rubber sheathed (TRS). This type of sheathing is recognised by its black exterior.

Vulcanised rubber insulated cables (VRI) also grew in popularity during this time. With this cable type being over 55 years old, it has become obsolete in domestic dwellings. We recommend, if this applies to you, that you get an electrician immediately for a full rewire.

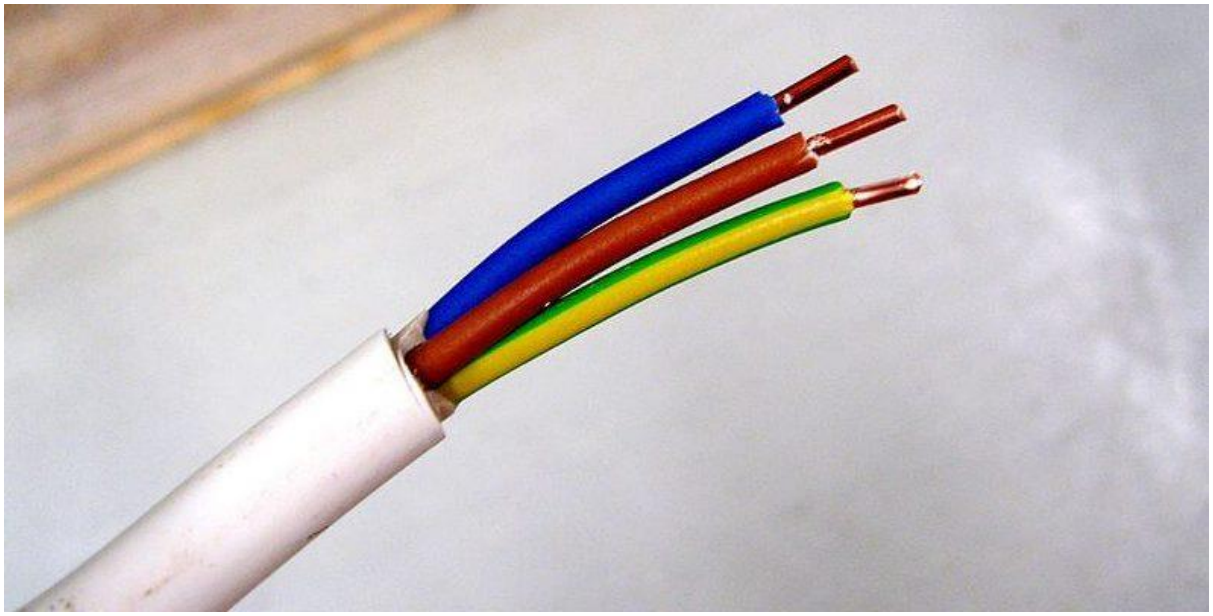
Insulation and sheathing can deteriorate with age, but also with excessive temperatures and overloading, as well as the rubber deteriorating if it has been exposed to direct sunlight.

When cables deteriorate, it means they lose their insulation and flexibility, becoming dry and more like to crumble away and break.

Lead Sheathed cables

Pre-1950s saw lead-sheathed cables (see above) being used more in domestic dwellings. They are rubber insulated, copper conductors, with an outer sheath of lead. Just like TRS cables, lead sheathed cables deteriorate over time as they are rubber insulated.

Lead sheathing is still used in some older properties and could be gradually deteriorating without you knowing. If you spot any lead sheathed cables, please be warned that these cables are past their expected working life and should be inspected by an electrician immediately for safety.



PVC-insulated Sheathing

PVC-insulated sheathing became popular from 1960s onwards, and it is now the most common form of sheathing. However, you can still find TRS and lead sheathed cables in period properties today.

Make sure your home is safe and using sheathing that will not deteriorate over time. Ensure your cable colours comply with the current standard set by BS7671 Wiring Regulations and that they are tested regularly for faults.

If you think your home has the old wiring colours installed, then take a look at our guide that answers your questions about rewiring a house.

If you're interested in electrics, have you considered taking on electrician courses? Go to our homepage to find out more about the UK's leading practical training centre and the courses we offer!

Does my house need rewiring?

Rewiring a house has many factors to consider such as cost, how long it will take and how the work will affect your day-to-day life whilst the project is ongoing.

To uncover what is involved during the rewiring of a home, we have compiled a guide to help answer any questions that you may have before you agree to allow someone to alter your wiring system.

How much does it cost to rewire a house?

The most popular question asked by people when considering rewiring their home is “how much will it cost to rewire my home?”

The price of the rewire depends on a number of factors, such as: whether the house is occupied or vacant, how many bedrooms there are, the overall size of the property, the age of the property, where you live in the country and who you hire.

The average cost to rewire a 3 bed semi detached house is £3,200 and can take up to 10 days to complete. This can act as a handy rule of thumb, with prices typically varying by £1,000 per bedroom.

As always, prices may vary depending on your regional location. Time is entirely dependent on the job: the bigger the job, the longer it will take to complete.

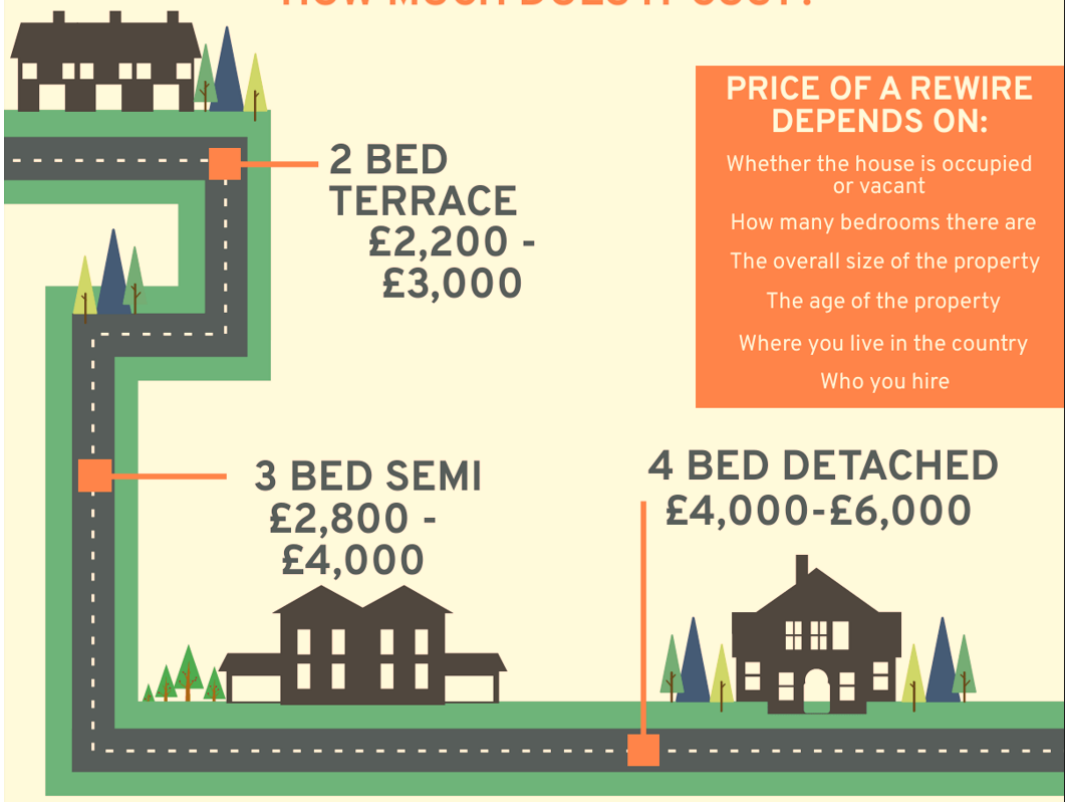
Included in the price of your house rewire, you can expect that previously old fittings and wiring will be removed, and also a new metal clad consumer unit installed. To comply with current regulations, all new installations are to have metal consumer units installed, due to increased fire safety measures.

DOES MY HOUSE NEED REWIRING?

Follow our guide to help answer any questions that you may have before you agree for someone else or yourself to alter your electrical wiring.

Rewiring a house has many factors to consider such as cost, how long it will take and how the work will affect your day-to-day life whilst the project is ongoing.

HOW MUCH DOES IT COST?



PRICE OF A REWIRE DEPENDS ON:

- Whether the house is occupied or vacant
- How many bedrooms there are
- The overall size of the property
- The age of the property
- Where you live in the country
- Who you hire

To share our 'Does My House Need Rewiring?' infographic on your website, simply copy and paste the embed code below:

<a href="https://electriciancourses4u.co.uk/useful-resources/does-my-house-need-rewiring/ img src="https://electriciancourses4u.co.uk/wp-content/uploads/rewiring-house-infographic.jpg" alt="Does My House Need Rewiring" class="aligncenter width="auto" height="100%" border="0" />

Want to rewire your home yourself?

We have a course that has been designed specifically for anyone looking to become a domestic installer quickly at an affordable price. After completing the course you can either join a Government approved Part P scheme (depending on your experience), which will allow you to sign off your house rewire and other notifiable work or you can go through your local Building Authority.

If the only piece of notifiable work you are completing is your house rewire, then it might be easier to go through your local Building Authority and submit an application to perform the notifiable work. After submitting the application and carrying out the work, a registered electrician will be sent to certify that it complies with the regulations and sign it off.

What needs rewiring in the house?

The main reason for rewiring a house is due to out of date or faulty wiring. Faulty wiring can be very dangerous, causing 12,500 fires and 750 serious accidents in the home each year.

It is therefore essential that, if you spot a common fault, you get it tested and rewired by a qualified electrician. Some of the most common faults for you to check are:

- A consumer unit with wooden backing, cast iron switches, a black electricity cable or no labeling. This is evidence that your consumer unit is out of date and you should have it replaced
- Having less than two plug sockets in each room, broken or cracked sockets and rounded entries as opposed to 3-pin varieties can indicate that your plug sockets are out of date. Another thing to take note of is if the plugs ever feel hot, this will need to be inspected as soon as possible
- Flickering lights or lights which require frequent light bulb changing are another sign that your wiring may need to be changed as most bulbs should last from months to years depending on how often they are used and the type of bulb. For example, some LED lights can last for up to 50,000 hours. Rounded light switches are an indication of pre 1960 lighting and should be rewired with modern switches

If you're going to have repairs made to your electrical systems at home, make sure that all of the wiring in your fuse box is also checked. If it is slightly out of date it is better to have it all rewired at once to ensure a safer home.

Finding the right person for the job

It is essential to hire a fully qualified electrician to rewire your house. Electricians in England and Wales are legally obligated to comply with the Part P building regulations. In order to be covered by insurance and not be a part of illegal activity you need to know what to look for when hiring an electrician. Some key tips are:

- Make sure they show you their qualifications before hiring them and make sure they are under a competent person with a provider such as NICEIC or ELECSA
- Have the electrician show you their public liability insurance and a warranty policy in case you need cover should anything does go wrong whilst they perform the job
- Once the work is complete you must make sure they give you a certificate from Building Control confirming that what they have done meets Part P of the Building Regulations

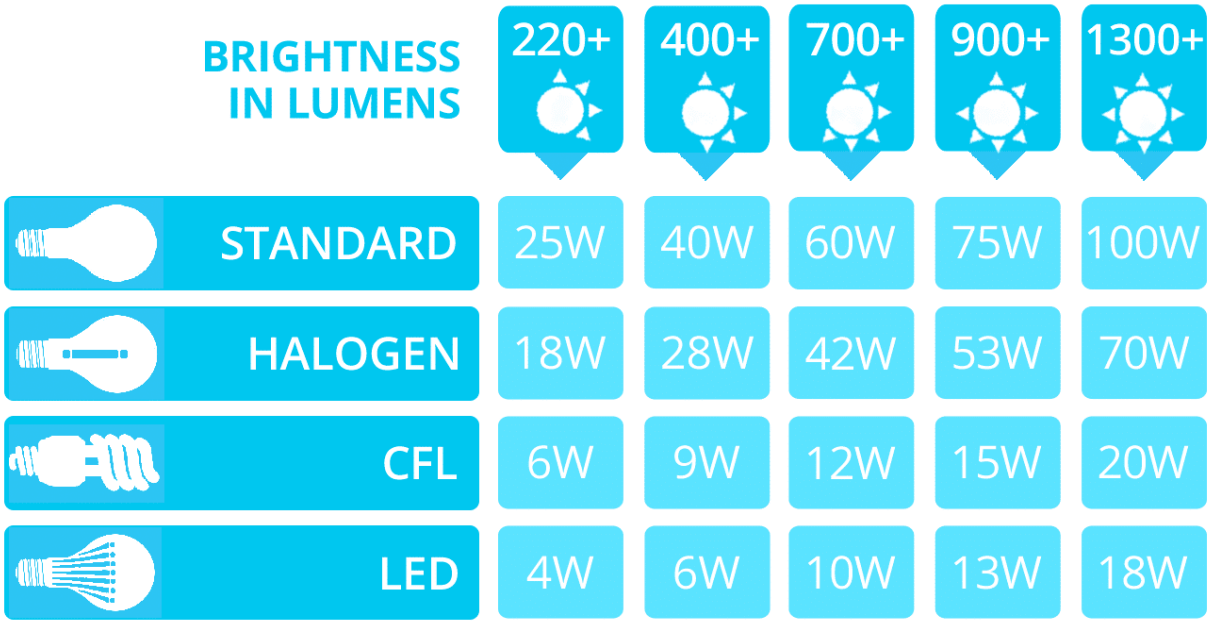
If you're on a budget, alternatively, you can train to become a domestic electrician and rewire your own house! We understand expensive quotes can be quite daunting. Come and train with us to gain your electrical qualifications and get started!

We offer intense electrician courses for people in all situations, from complete beginners to those from associate traders. Take a look at our Domestic Electrician Course today!

If you enjoyed this post, take a look at our History of Wiring Colours to find out what warning signs you should look out for in your home!

Changing light bulbs

LED Lumens To Watts Conversion Chart



Lumens are the new unit of measurement for light bulbs

For decades, we've been buying light bulbs according to wattage. But as energy-efficient, low-watt light bulbs like CFLs and LEDs have become readily available, watts have become an unreliable metric for selecting bulbs. Instead of focusing on wattage, which measures power or energy use, manufacturers are indicating the brightness of their energy-efficient bulbs according to lumens, which measure light output. So while we may be accustomed to shopping for bulbs according to wattage, lumens are actually a more accurate measurement of how bright your light will be.

Converting Lumens to Watts

How many lumens are in a watt? Because lumens measure brightness and watts measure energy output, there is no simple method for converting wattage to lumens. With energy-efficient lighting like LEDs and CFLs, how many lumens are in a 60W bulb or 100W bulb depends on the lumen output of the bulb, not its energy use.

Don't despair! Measuring and labelling light output instead of energy use actually makes it easier for you to find the right energy-efficient bulb for your space. Use this chart to determine how many lumens you'll need from your next light bulb. For example, if you typically purchase 60W incandescent bulbs, which produce about 700-800 lumens, consider purchasing a lower energy alternative like a 42W halogen bulb, 12W CFL, or even a 10W LED bulb to achieve the same brightness.

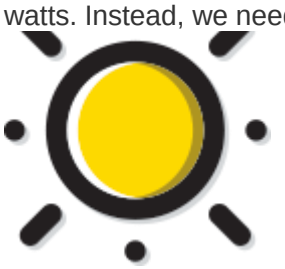
Lumens To Watts Conversion Chart: Choose The Right LED Bulb

The old days of choosing light bulbs by wattage are over. With today's modern LED bulbs, we instead need to focus on lumens. But what is a lumen? We'll explain that, and then you can use our lumens to watts conversion chart to select the right LED bulb every time.

How to Convert Lumens to Watts

Step 1: Understand Watts

Watts are a measure of energy consumption. When we pay our electric bill, we pay for the number of watts we use. A 60-watt bulb consumes 60 watts of energy. Since we used 60-watt incandescent bulbs for so many years, we associated a certain level of brightness with 60 watts. But we can't do that anymore, since LED technology produces more light while using fewer watts. Instead, we need to use lumens.



Step 2: Understand Lumens

A lumen is a measure of visible light energy. The higher the lumens, the brighter the light. All lighting manufacturers are starting to tell us how many lumens are produced by each of their products. We see these lumen numbers on the **Lighting Facts labels** found on all new LED bulb packages. It may take a while to get used to using lumens instead of watts, but it's important in order to make the best lighting choices.

Step 3: Understand Efficacy (Lumens/Watt)

Now that we understand watts and lumens, we can use both terms to come up with lumens per watt or “efficacy” (or “luminous efficacy”). This is a measure of how well a light source converts energy (watts) into light (lumens). The old technology of tungsten incandescent bulbs only had an efficacy of about 15 lumens/watt. Depending on the bulb and the manufacturer, LED technology typically produces 75-110 lumens/watt. So, LEDs are generally about 7 times more efficient at producing light than incandescent bulbs. Use a 7:1 ratio as a rough guide when selecting an LED bulb to replace an incandescent bulb.
For example, if you wanted to replace a 60-watt incandescent bulb, what wattage LED bulb would be roughly equivalent? Using the 7:1 ratio, simply divide 60 watts by 7 to get roughly 9 watts. But efficacy varies greatly from manufacturer to manufacturer, so it’s best to check the Lighting Facts label and try to match lumens. Also, a label will sometimes (but not always) tell you that an LED bulb has an equivalent brightness. Refer to the charts below for a ready reference. Finally, please note that all VOLT® **outdoor LED light bulbs** have the incandescent or halogen equivalent wattage displayed on their product pages. We make switching to LED **landscape lighting** easy!
Want to know more? **Learn all about outdoor light bulbs** and then calculate how much you can **save by switching to LED**.

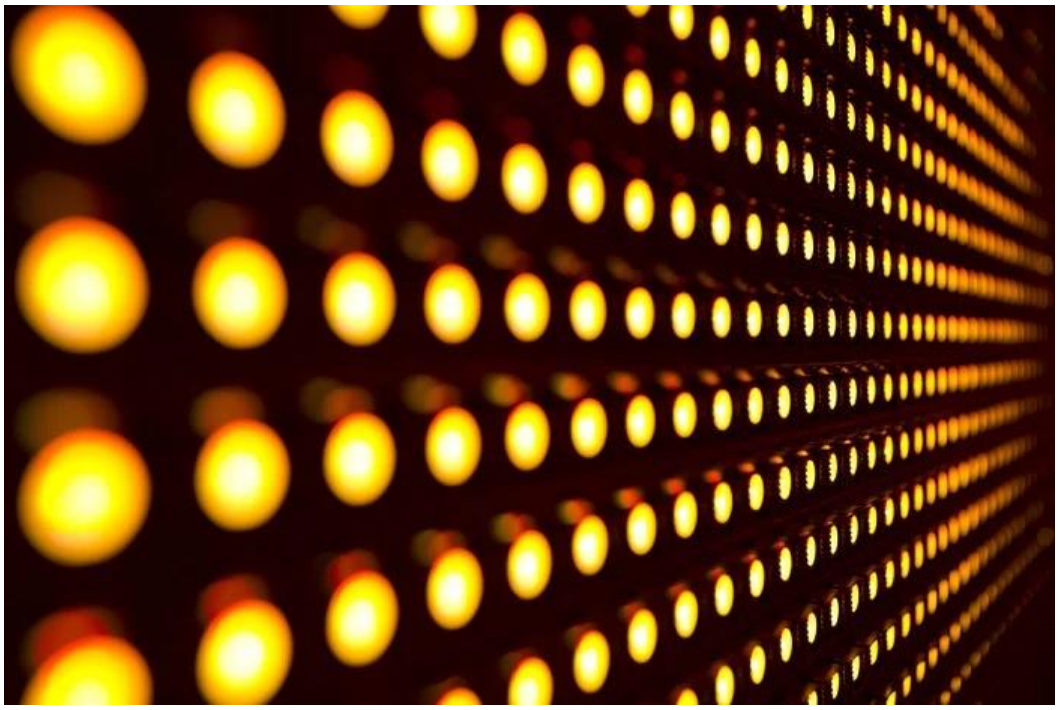
Lumens to Watts Conversion Chart

Lumens	Incandescent Watts	Halogen Watts	LED Watts
100	7	6	2
375	25	20	4
450	30	25	5
800	60	45	9
1100	75	60	12
1600	100	90	17
2600	150	145	27
3000	200	175	32

Luminous Efficacy	
Light Source	**Luminous Efficacy (Lumens/Watt)**
Incandescent	12-18
Halogen	10-20
LED	75-110

The Definitive Guide to LED Light Bulbs and Spotlights

10 October 2017



Looking for more information about LED light bulbs and spotlights? You've come to the right place. Our product experts have compiled this comprehensive guide to help you find the perfect LED bulb or spotlight for your needs. We cover everything from Kelvins to Lumens, Voltage to Wattage, so you can make the savvy switch to LED lighting with complete confidence. So, let's get started.

What is an LED light?

Let's get back to basics. LED stands for 'light emitting diode' and is a semi-conductor device that turns electricity into light. This device is then encased within a lamp or fixture, thus becoming an LED light you can use in your home. LED lighting is relatively new on the market. Rudimental LED lighting was first developed in the 1960s, approximately 100 years after the invention of the original incandescent bulb, but it wasn’t until the 90s that they became widely-known for their lighting capabilities. Their efficiency, lifespan and versatility are significantly higher than traditional lighting methods, such as incandescent and fluorescent, but we have more of that later.

The different types of LED lighting

Fundamentally, there are three different types of LED technology that are used in LED lighting – DIP, SMD and COB.

Dual In-Line Package (DIP) LEDs

DIP LED Lights

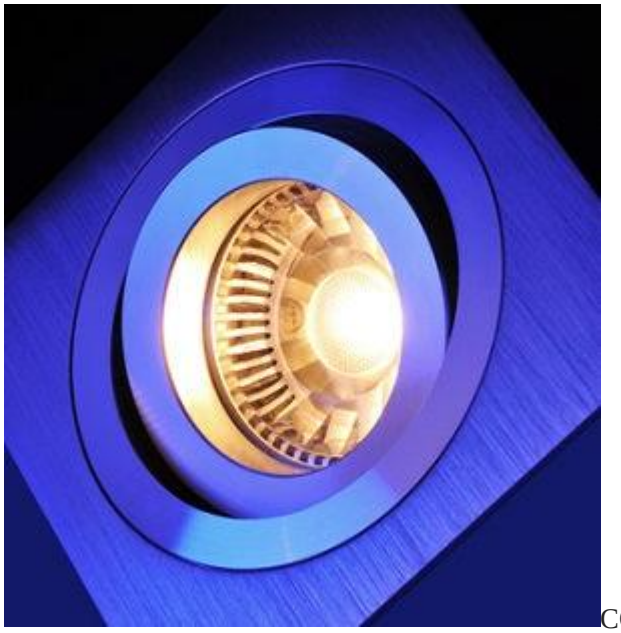
DIP LED chips are the original LED chips and what many recall when they think of LED lighting. While they're older than their younger counterparts, DIP LED chips are still in use today and are more often found built-into electronics due to their diminutive size. They're not very powerful though, and can only emit a limited amount of brightness.

Surface Mounted Diode (SMD) LEDs

SMD LED Spotlight Bulb

These are mounted and soldered onto the circuit board, and are probably the most common type of LED chip available. They are brighter than their DIP predecessors and are also smaller, so even more versatile when it comes to encasing them within smaller electronics or across different types of lighting, such as strip lighting. You can put three diodes on a single SMD chip, which means you can create a range of different colours, offering consumers greater variety. This has been a massive development in the LED market. The two most common types of SMD chip sizes are SMD 3528 and SMD 5050 – the former is 3.5mm wide and the latter is 5mm.

Chip on Board (COB) LEDs

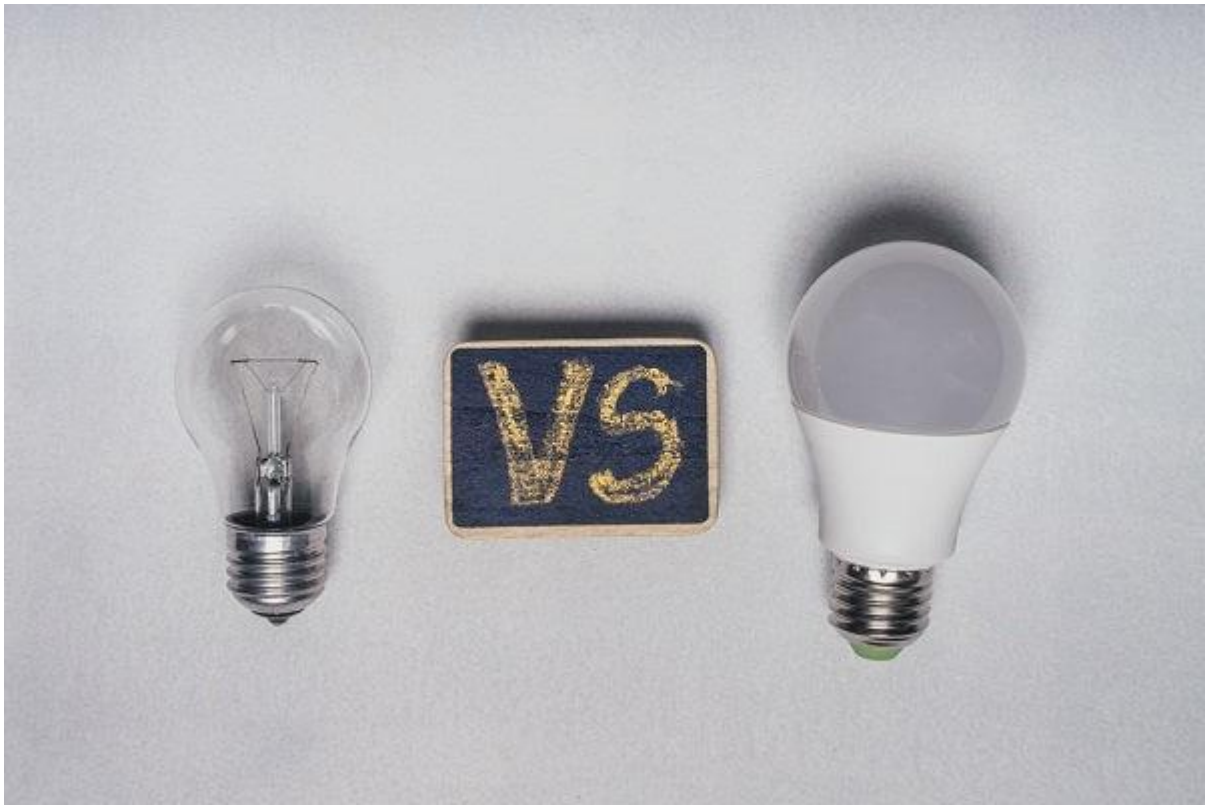


COB LED Spotlight Bulb

These chips represent the latest development in LED technology. COB LED chips are the brightest out of the three, typically being able to pack nine or more diodes onto a single chip. What does this mean for LED lighting? Well, firstly, it improves the brightness-to-energy output, thus increasing lighting efficiency. This also means they can be used across a wide range of different types of lighting. However, it's worth noting that due to the circuitry makeup of a COB LED chip, they're unable to emit an eclectic range of different colours.

Benefits of LED lighting against traditional lighting

The LED lighting industry is predicted to explode over the next few years. Their popularity among consumers and businesses alike is set to sky-rocket, not least from the impact of a proposed ban on incandescent and halogen bulbs set to come into play imminently. Why are the EU proposing such a ban? Well that comes down to the many benefits LED lighting has over their traditional counterparts: halogen and incandescent.



Firstly, LED lighting uses up to 90% less energy than incandescent and halogen bulbs, and up to 60% less energy than CFL bulbs – which were the first energy-efficient bulbs to be widely sold. This can vary according to the type of fitting chosen, but the LED remains the leader when it comes to efficiency. LED lighting is far greener than traditional lighting, helping domestic and commercial properties lower their carbon footprint and improve their green credentials and energy ratings - a great advantage for businesses who are being pressured to meet government incentives and energy quotas. With increased efficiency, comes lower energy bills – something everyone can benefit from. Lighting is one of the highest consumers of electricity in your household. Switching all of your lighting to LED will help you save hundreds of pounds per-year. Below is a comparison between typical LED and halogen bulbs:

	Halogen	LED
Lifespan	2,000 hours	25,000 hours
Consumption	50W	5W
KWh consumed over 10,000hrs	500	50
Typical cost of electricity over 10,000hrs	£75.00	£7.50

And the savings don’t stop there either. LED spotlights and bulbs last far longer than halogen, incandescent and CFL bulbs. While older lighting often lasts barely a year, if not just a few months, LED lighting has a 15-year average lifespan, giving you far better value for money and saving on replacement

bulbs too. LEDs are also becoming a favourite of interior designers, both amateur and professional alike. This is because of how many colour options you get with LED that you simply don't get with traditional spotlights and bulbs. The light that LEDs beam come in a variety of shades of white light – which is measured in Kelvins (sit tight...this is something else we'll get onto later). This means you can pick different shades of light to match different rooms, styles and decors – so you can really personalise living and work areas to your own tastes.

Types of LED bulb fittings

In the past, LED bulbs weren't always available in the same fittings as traditional bulbs. This has completely changed. Now they're available in a variety of fittings to suit your needs, so everyone can benefit from energy-saving LEDs. And you often don't even need the help of an electrician to fit them. Here's a quick guide to see if the bulb fitting you need is available with LED technology.

E27 (Edison Screw)

E27 bulbs are the most popular around. They're also known as 'Edison Screw' bulbs or simply 'ES'. They're used widely across the UK and also over the Atlantic in the US. They measure 27mm, which is the same as a halogen or incandescent E27, so you can simply pop an LED E27 into an existing E27 fitting – it's completely hassle-free.

E14 (Small Edison Screw)

The screw on an E14 bulb is identical to an E27 but for one thing: it's smaller, measuring just 14mm in diameter, which is why they're often used in small fittings for decorative or purely practical purposes – such as chandeliers and appliances.

B22 (Bayonet)

Another popular bulb across the West is the B22, or Bayonet, light bulb fitting. It measures 22mm in diameter and is often found hidden behind lamps and lamp shades.

B15 (Small Bayonet)

A smaller alternative to the large B22 bulb, the B15 bulb measures just 15mm in diameter to accommodate smaller fittings.

R50

R50 bulbs – also known as reflector bulbs – feature an E14 Edison screw fitting, but are shaped differently at the top to accommodate different lamp fixtures and uses.

R63

The R63 is a reflector bulb designed with a protruding bulb-cap to accommodate different lighting fixtures, but features a standard E27 Edison base fitting.

PAR38

The PAR38 is a bulb that kicks-out a lot of lumens (brightness). It comes with a screw fitting and is often used for workshops, security and commercial lighting.

LED Smart Bulbs

LED lighting is ever-evolving and getting smarter too. Now you can fit your home with 'Smart Bulbs', which are incredibly convenient and versatile, and allow you to remotely manage your lighting through voice-control or from a mobile device. The Philips Hue Smart Bulb system allows you to control up to 50 bulbs from your mobile device or through a voice-command system such as Amazon Echo. Through the

Philips Hue app, you can: • Switch bulbs off and on remotely and from anywhere in the world • Choose from 16 millions shades of white light to really set the mood across multiple rooms in your home • Dim the lights to create the perfect ambience • Control up to 50 bulbs from a single area • Set-up motion sensor technology to save even more money on your energy bills

Types of LED spotlight fittings

Spotlights are incredibly popular in the modern household. They can be used to highlight decorative items in a stylish way, and are also practical thanks to a flat shape and narrow and wide beam options. Like with the modern LED bulb, the LED spotlight is equally versatile and can often be fitted without additional help from an electrician.

GU10

The most popular spotlight fitting around. They're often dimmable and can be used anywhere in the home, from the bathroom to workspaces where you want a little extra focus. Like with an older, less efficient halogen GU10, the LED GU10 features two little pins – or legs – at the base, which means in most cases they can be retrofitted into existing halogen fixtures.

MR16

Another popular household spotlight, but not always quite as convenient, the MR16 is the same as the GU10, but features two pins at the base that are slenderer in shape. It's important to note that when replacing halogen MR16s with LED equivalents that your existing transformer – which sends a current to the LEDs – may have a minimum load requirement (the minimum amount of wattage that needs to be loaded through the transformer). This is because LEDs consume so much less energy than halogen. In these circumstances, we'd recommend upgrading to a compatible LED transformer so you don't risk any potential damage to the fitting, the lifespan or the quality of the light.

G9

G9s are smaller and are often found in appliances and electronics. They cast a dimmer light, often only beaming a maximum of 300 lumens.

G4

G4s are similar to G9s, and are often used in appliances or smaller light fixtures. Like with MR16 spotlights, G4s may require a specialised LED compatible transformer if you're switching over from halogen.

Ceiling lights

Ceiling lights – also known as downlights – are larger spotlight fittings that are often found in more industrial or commercial settings because they are available with higher lumen values. More advanced models come with a PMMA diffuser that helps to create an even light output, which is particularly useful for lighting up larger areas.

Fire rated Downlights

Fire rated downlights offer an 'all-in-one' solution, with a fitting and spotlight both included. These downlights also offer extra peace of mind because they've been tested to fire safety standards to prevent fire from penetrating surrounding areas, such as ceilings and loft spaces above.

Do you need an LED transformer for LED bulbs

Most LED spotlights and bulbs are 'retrofit'. This means that when replacing a halogen or incandescent bulb you can simply pop, screw or clip your LED bulbs into your existing light fittings without the need for an electrician. There are however certain bulbs and spotlights – most notably MR16 and MR11s – that need a constant power supply to operate effectively, so they run off what's called a 'transformer'. A transformer is essentially a power-pack that's used to power your lighting. 12 Volt transformers that are used to power halogen MR11s and MR16s have a minimum load requirement – this is the minimum amount of voltage the transformer needs to power the bulbs they're connected to. Because LEDs use such a small amount of power, they often don't meet this minimum load requirement. While they may still work, it can detrimentally affect the lifespan of the bulbs. So it's advised that you invest in an LED compatible transformer for your new LED bulbs to maintain the quality of their light and their lifespan.

Dimmable bulbs

Looking to set a bit of mood lighting? Then you're in luck, because LED bulbs can also dim when fitted with a compatible dimmer switch. You need to ensure that the bulb you purchase has a dimming function, but they will state this on the specifications. The main thing to consider is whether your current dimmer switch can operate an LED bulb, or whether you need an LED compatible dimmer. Most leading edge dimmer switches – which are the most popular for dimming halogen bulbs – have a minimum wattage load of 60W – which is far too high for energy efficient LEDs. If this is the case, you'll need an LED dimmer switch.

LED Filament bulbs (and why interior designers love them!)

Bulbs are now trendy. I'll repeat that: bulbs are now trendy. Thanks to the ever-growing variety of styles available, interior designers are not just taking into account the quality of light that they use in their designs, but also the shape and style of the bulb itself. When you're next at an inner-city bar, cast your eyes around and you'll see a range of glistening filament bulbs hanging exposed from industrial-style pendant fittings. It's a look that's become very much in vogue. When people are renovating their homes, or looking to upgrade their lighting, the filament bulb remains incredibly popular. Traditionally, it was only older fluorescent lighting that was available with a filament. The filament being the flame-like column that glistens from the centre of the bulb and is largely responsible for the actual light it casts. Now LEDs have got in on the act. Those who still want that authentic, vintage look can find it in more modern and efficient LED lighting that can mimic the look to great effect. They're available in many shapes, sizes and fittings, and also have all the energy and money saving capabilities of LED technology.

What bulb shapes are available?

Filament-style LED bulbs are available in a variety of shapes. Here's a selection of the most popular and where they could look great in your home...

Globe bulbs

Globe-shaped bulbs are larger than most and are ideal for use in open areas. They look fantastic when suspended from high ceilings and fitted within a bare pendant lamp, so the globe is fully exposed.

Golf ball bulbs

Golf ball bulbs are best used to illuminate smaller areas, whether for practical or decorative purposes, because they're diminutive in size than their bigger globe alternatives. Ideal if space is at a premium.

Candle shape bulbs

If you're fortunate enough to own a chandelier, then candle shape bulbs are perfect. They're elegant and compact, and are also available in a frosted finish, which is perfect for use around Christmas and you want something impressive for when friends and family are around.

Flame tip bulb

Looking for something a bit more decadent? Then opt for a flame-tipped bulb. Like a candle shaped bulb, they suit chandeliers and Gothic settings, but they offer something a little stylistically different in the extra twist at the top. They – like the candle shaped bulb – are also available in frosted finishes.

Teardrop bulb

Teardrop bulbs are becoming immensely popular at the moment. They perfectly complement industrial settings and are best suited when fully exposed from a hanging pendant lamp.

Standard bulb

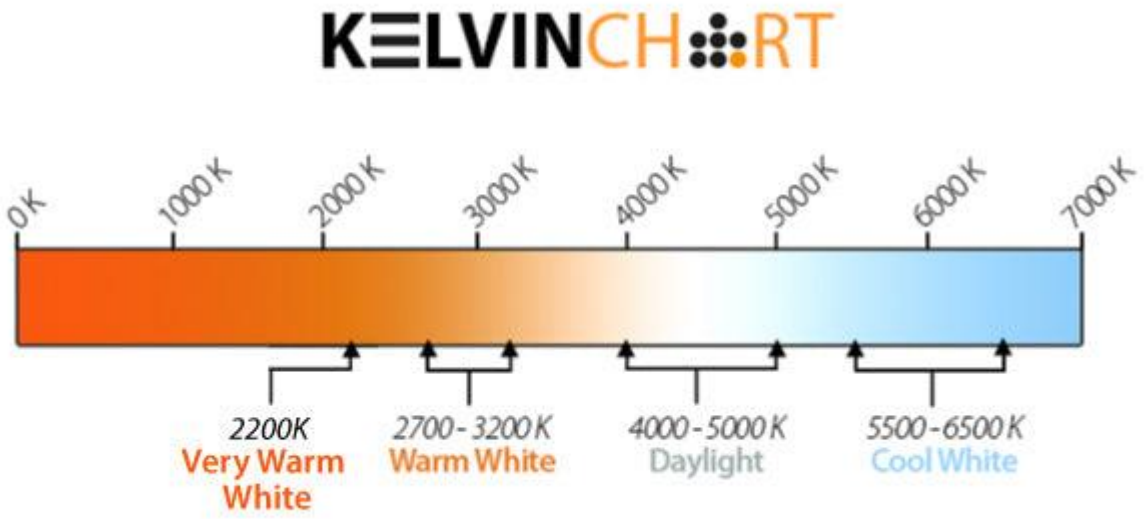
Looking for something more subtle and practical? Then never forget the standard shaped bulb. It's incredibly versatile and can be used pretty much anywhere.

LED spotlight beam angles

Beam angle is the angle at which a spotlight casts it light and, in turn, the amount of area that's covered with light. The wider the spotlight beam angle = the more area below covered with light. Halogen spotlight beam angles are restricted to approximately 40 degree angles at most. This means they can only ever offer narrow beam angles. However, LED spotlights are far more versatile. You can still get narrow beam angles which are ideal for decorative areas, but you can also get wider beam angles of 60-110 degrees that are perfect for lighting-up those larger areas, such as living spaces and dining rooms.

LED colour temperatures

As mentioned before, LED spotlights and bulbs are able to cast different shades of white light, giving you more options when renovating your home or upgrading your lighting. This is known as LED colour temperature, which is measured in 'Kelvins'. The higher the Kelvin rating, the 'whiter' or 'cooler' the light. There are 4 main colour temperatures to choose from: • Very warm white (under 2700K) • Warm white (2700-3200K) • Daylight (4000K-5000K) • Cool white (5500K-6500K)

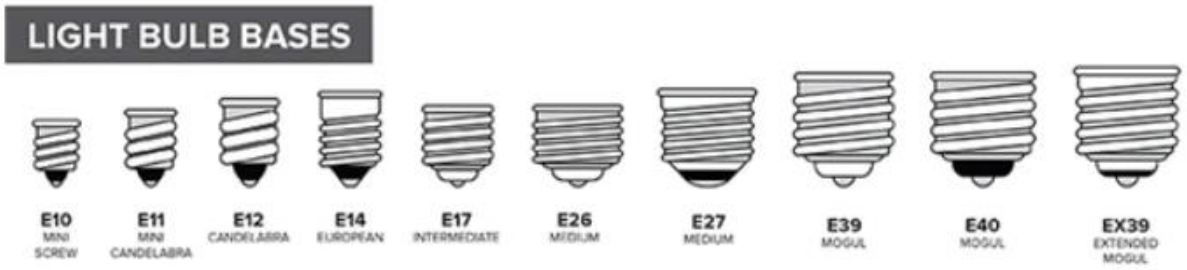


Traditional bulbs – such as incandescent and halogen – have only ever been able to offer warm white tones, so this evolution in lighting has given people far more flexibility when creating lighting plans. Kelvins, however, aren't to be confused with Lumens, which measure brightness. Which also conveniently brings us onto the next section...

Lumens vs Wattage, and what you should look out for

Traditionally if you wanted to buy a brighter bulb you'd shop for a higher wattage. However, this is very misleading, particularly when it comes to LED lighting. Instead, you need to look for lumens. Lumens are the only accurate measurement of a light bulb's brightness. For instance, an LED bulb may consume far less energy – or wattage – than a halogen equivalent, but still have the same level of brightness (lumens). For example, a 50 Watt halogen GU10 spotlight will emit approximately 400 lumens, however a 5 Watt LED GU10 spotlight will also emit 400 lumens. The only difference is that the LED GU10 consumes a tenth of the energy to reach that level of brightness. You now have everything you need to make informed purchases of LED light bulbs and spotlights. You can view our LED light bulbs here, and LED spotlights here.

Different Types of Edison Screw Bulb Fittings



What Are the Different Types of Light Bulb Fittings, Caps and Bases?

The part of the lamp or light bulb that connects into the light fitting is generally known either as the “cap” or “base”.

Caps provide the electrical contact to conduct electricity to the light bulb but it also helps to secure the light bulb into its fitting.

There are a vast variety of caps and bases that exist in order to help make sure that only the correct type of lamp is used in any given fitting. This section shows many of the most popular fittings.

Bayonet Cap

BC-B22d Cap

- Diameter: 22mm
- Diameter (Pin to Pin): 27mm
- Height: 26mm

With its familiar “push and twist” action, the “bayonet cap” (also known as BC or B22d cap) is used on most regular light bulbs. It is 22mm in diameter and with two locating lugs.

See our range of BC-B22 capped lamps.

SBC-B15d Cap

- Diameter: 15mm
- Diameter (Pin to Pin): 17mm
- Height: 26mm

The “small bayonet cap” (SBC or B15d) is very similar but only 15mm across.

Although generally used for mains voltage lamps, the SBC fitting can also be found in a very small number of specialist low voltage halogen lamps.

See our range of SBC-B15d capped lamps.

There are also many other bayonet cap variants including the 3-pin BC B22d-3 sometimes used on Fireglow lamps but perhaps more commonly on High-pressure mercury lamps for industrial applications. The BY22d is used on some low-pressure sodium (SOX) lamps.

Edison Screw Cap

Named after the pioneering inventor Thomas Edison, the Edison Screw cap or “ES” lamp fitting is used worldwide in a vast range of applications.

ES-E27 Cap

- Diameter: 27mm
- Height: 26mm

The most popular ES or E27 fitting is 27mm diameter and is widely used in UK and Europe. This cap is the standard 27mm diameter screw cap for UK 240V light bulbs – not to be confused with E26, which is a 26mm size and is designed for the 120V US market.

See our range of ES-E27 capped lamps.

SES-E14 Cap

- Diameter: 14mm
- Height: 26mm

The SES or “Small Edison Screw” cap is often used for smaller decorative fittings, chandeliers, and appliance light bulbs – It has a diameter of 14mm and is predominantly used in the UK and Europe.

See our range of SES-E14 capped lamps.

There are also many size variations, mainly for use in specialist fittings. The MES-E10 fitting is sometimes used in large chandeliers containing perhaps dozens of small lamps.

Designation	Diameter	Name	A
E5	5mm	Lilliput Edison Screw	L
E10	10mm	Miniature Edison Screw	M
E12	12mm	Candelabra Edison Screw	C

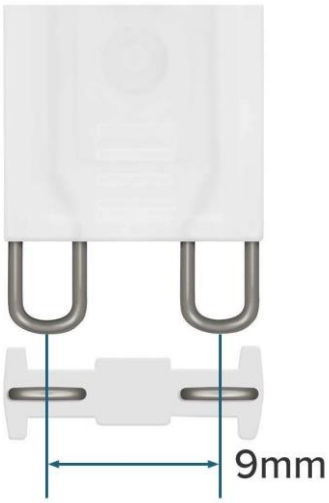
E14	14mm	Small Edison Screw
E27	27mm	Edison Screw
E40	40mm	Giant Edison Screw

Capsule Lamps

Miniature halogen capsule light bulbs are generally used in integrated fittings and appliances, such as cooker hoods and kitchen cabinet lights.

Capsule light bulbs can be identified by their miniature size and they all have 2-pins extruding out of the base of the capsule. The model of the capsule is designated by the measurement in mm between these two pins.

The different distances between the pins prevent the wrong type of capsule light bulb being inserted into the wrong fitting – such as a 12V G4 capsule being inserted into a 240V G9 light fitting.



G9 Base

- Distance Pin (Centre) to Pin (Centre): 9mm

The G9 is specifically used for 240V capsule light bulbs. The light bulb can be identified by measuring the distance between the centre points of the pins. The distance of a G9 measures 9mm.

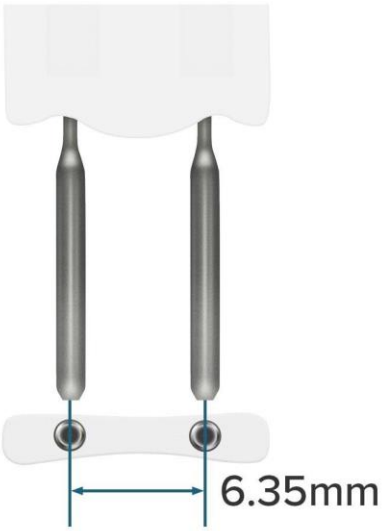
See our range of G9 capped lamps.

G4 Base

- Distance Pin (Centre) to Pin (Centre): 4mm

The G4 is specifically used for 12V capsule light bulbs. These capsules require a 12V transformer or driver to operate – this is usually built into the fitting. The capsule can be identified by measuring the distance between the centre points of the pins. The distance of a G4 measures 4mm.

See our range of G4 capped lamps.



GY6.35 Base

- Distance Pin (Centre) to Pin (Centre): 6.35mm

The GY6.35 is specifically used for 12V/24V capsule light bulbs. These capsules require a 12V transformer or driver to operate – this is usually built into the fitting. These capsules are often used for task lighting. The capsule can be identified by measuring the distance between the centre points of the pins. The distance of a GY6.35 measures 6.35mm.

See our range of GY6.35 capped lamps.

LED Capsule Bulbs are now also available as an energy-efficient alternative to halogen light bulbs. The fitments on LED capsules are exactly the same as those on halogen capsules, so if you're replacing your current light bulbs with LED light bulbs and your fitting accepts one of the standard types listed here, you should be able to install them without an issue.

Linear Halogen

R7s Fitting

- Cap Diameter: 7mm
- Cap Length: 5mm
- Bulb Length: 78mm/117mm

Linear Halogen light bulbs for floodlights and up-lighters have a 7mm R7s cap at each end of a long quartz linear light bulb. All linear halogen light bulbs have the same cap but come in either 78mm lengths or 117mm length light bulbs. They also come in a variety of wattages, so it is important that a replacement linear halogen is like-for-like (same wattage, same length).

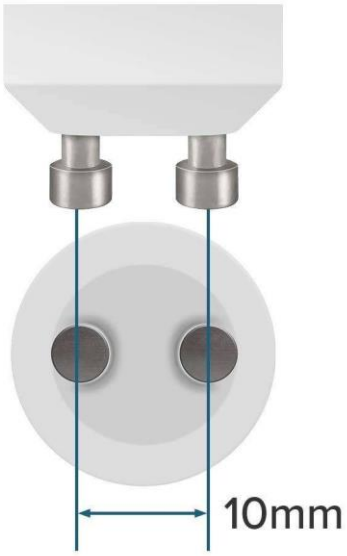
See our range of R7s capped lamps.

Halogen and LED Spotlights

The most common halogen spots are either push fit (GU4/MR11 or GU5.3/MR16), low voltage type or twist and lock (GU10 or GZ10) mains 240V versions.

Spotlight bulbs can be identified by measuring the distance in mm between the centre of the two pins that extrude from the base of the spotlight.

The different distances between the pins and the size of the pins prevent the wrong type of spotlight being inserted into the wrong fitting.

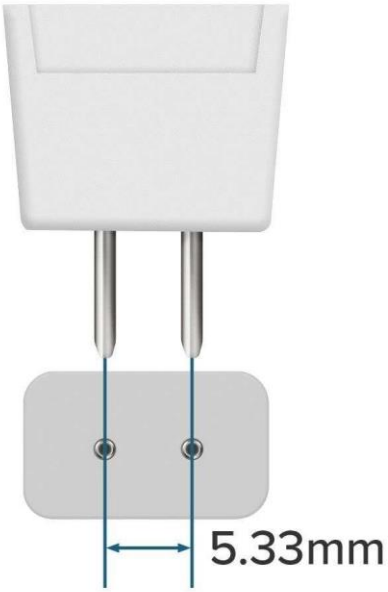


GU10 Cap

- Type: Twist and Lock
- Distance Pin (Centre) to Pin (Centre): 10mm

Featuring two pins that twist and lock the spotlight into the fitting, the GU10 is the most popular spotlights used in the UK. This spotlight is mains operated 240V and was initially developed as a halogen spotlight but is nor widely available in LED. Various wattages, colours and beam angles can now be purchased to provide lighting in many different applications.

See our range of GU10 capped lamps.



GU5.3/MR16 Cap

- Type: Push Fit
- Distance Pin (Centre) to Pin (Centre): 5.3mm

This base of this lamp is technically named GU5.3, however, the whole spotlight is more commonly referred to as an MR16. Featuring two round pins that push into the fitting, this is the 2nd most popular type of spotlight. The MR16 spotlight operates at 12V so requires a 12V transformer or driver to run- these drivers are sometimes built into the fitting but can also be purchased separately.

See our range of GU5.3 (MR16) capped lamps.

GZ10 Cap

The GZ10 spotlight looks very similar to the GU10 lamp, but there are two major differences. The GZ10 spotlight makes use of a dichroic reflector to direct all of the heat generated by the spotlight backwards, creating a cool beam spotlight. The GZ10 spotlight, therefore, features a square corner base (where the GU10 has a bevelled base). This stops the GZ10 being used in a light fitting designed for a GU10 where this backwards reflected heat could damage the fitting.

Note: although a GZ10 cannot be used in a GU10 fitting, a GU10 can be used in either a GU10 or GZ10 fitting.

Fluorescent Tubes and LED Tubes

Fluorescent and LED tubes have a two-pin fitting at both ends of the tube.

G13 Fitting

- Tube Diameter: 25mm (T8 = 8/8 inch)
- Distance Pin (Centre) to Pin (Centre): 13mm

The most common size of fluorescent or LED tube is the T8 which uses a G13 two-pin cap on both ends of the tube. The distance between the pins is 13mm and when inserted into the fitting, the tube twists to lock into place.

Also found on T10 (tube diameter: 10/8 inch) and the larger T12 (tube diameter: 12/8 inch).

See our range of G13 capped tubes.

G5 Fitting

- Tube Diameter: 16mm (T8 = 5/8 inch)
- Distance Pin (Centre) to Pin (Centre): 5mm

There is a smaller tube size – the T5 which uses G5 two-pin caps. The distance between the pins is 5mm.

This cap can also found on less popular T4 (tube diameter: 4/8 inch).

See our range of G5 capped tubes.

Now that you can identify which cap you need for your light fitting, don't forget to read our guide on choosing the right LED light bulb for you.

How to Wire a UK Plug

Download Audio

STEPS

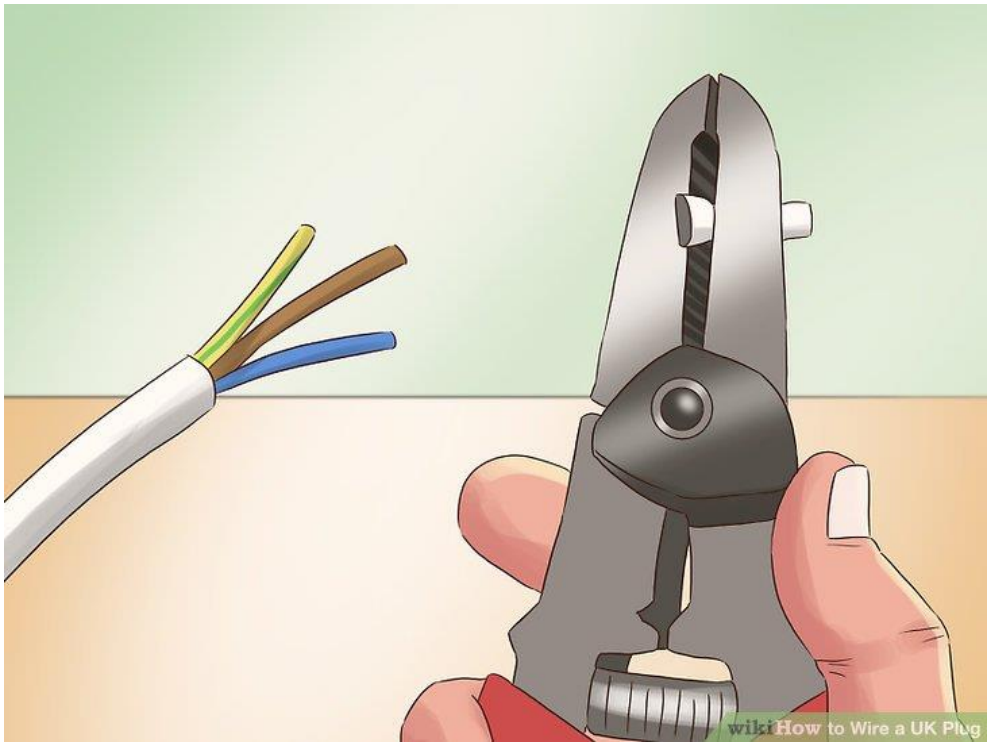
Last Updated: May 29, 2023

This wikiHow will teach you how to put together or fix a UK three-pin plug.

Steps

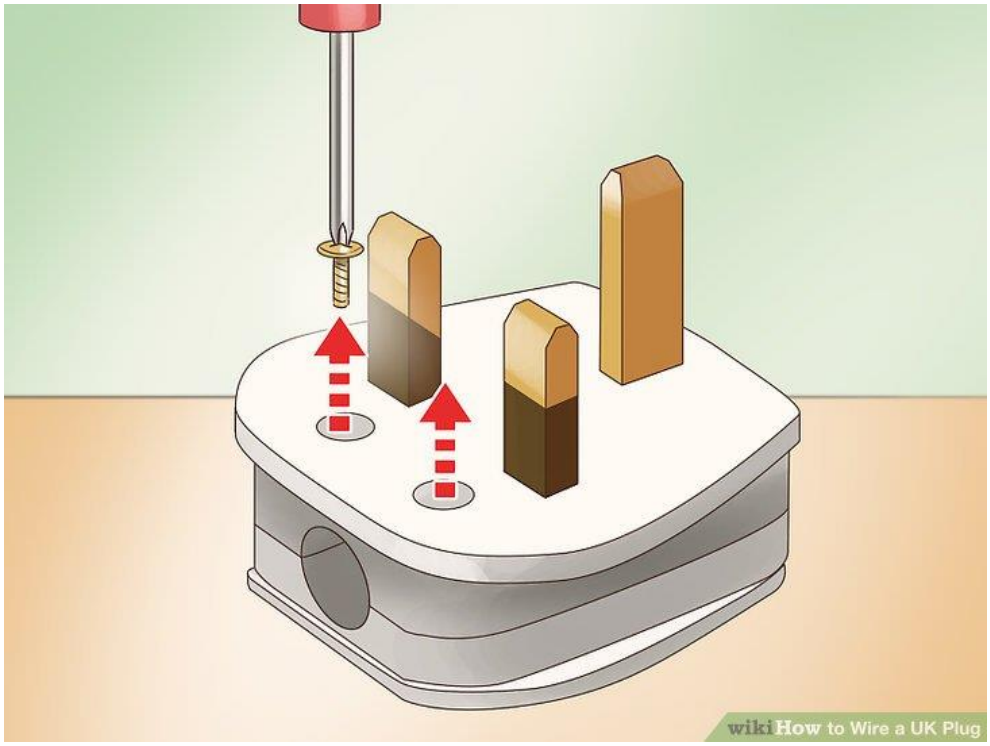
Download Audio

1



Strip the end of the thick cable coming from the appliance into the plug, using wire strippers. Take off roughly 3 centimeter (1.2 in) of white covering, leaving you with three thinner cables.[1]

2

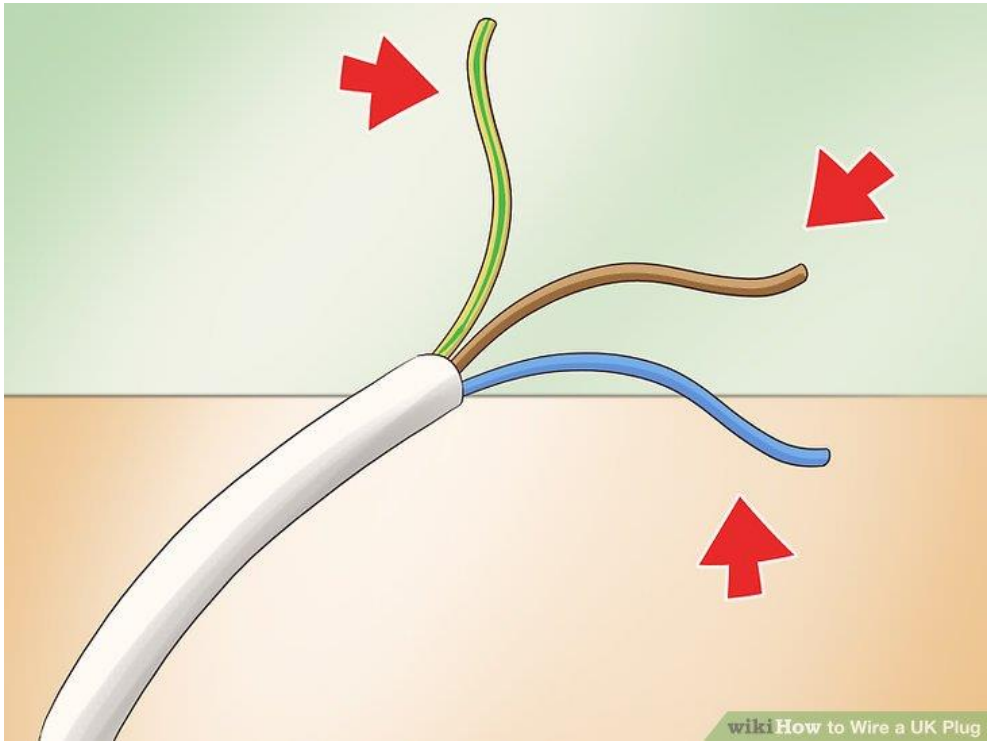


Undo the Philips screw in the center of the plug, on the side with the three pins poking out.

3

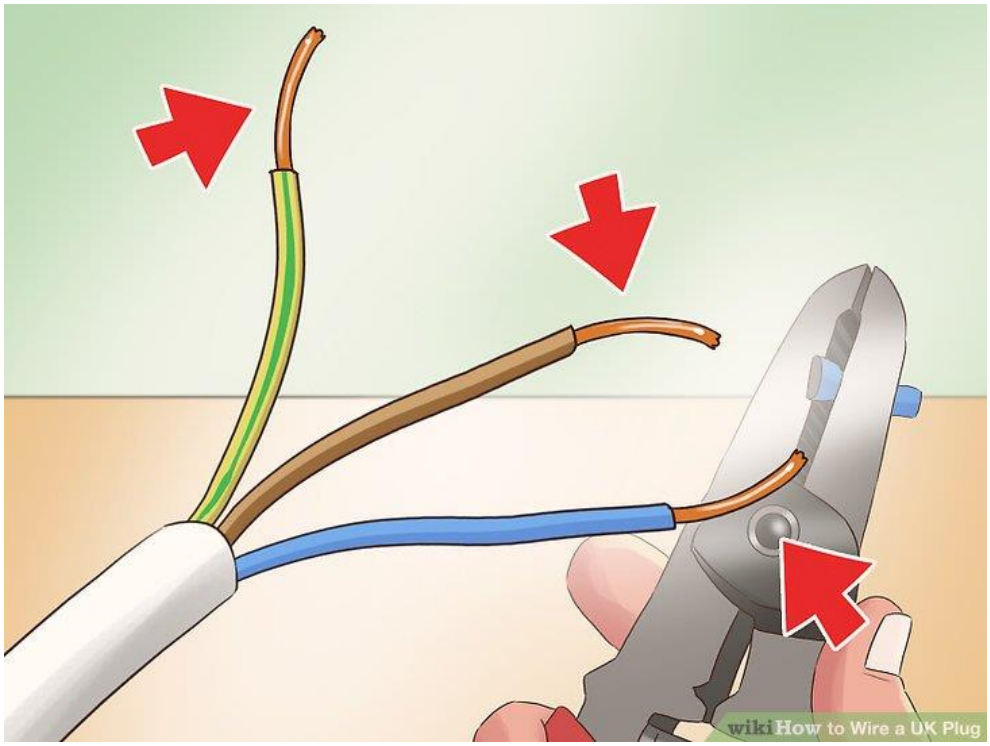
Take the back off of the plug (the part you loosened by undoing the screw).

4



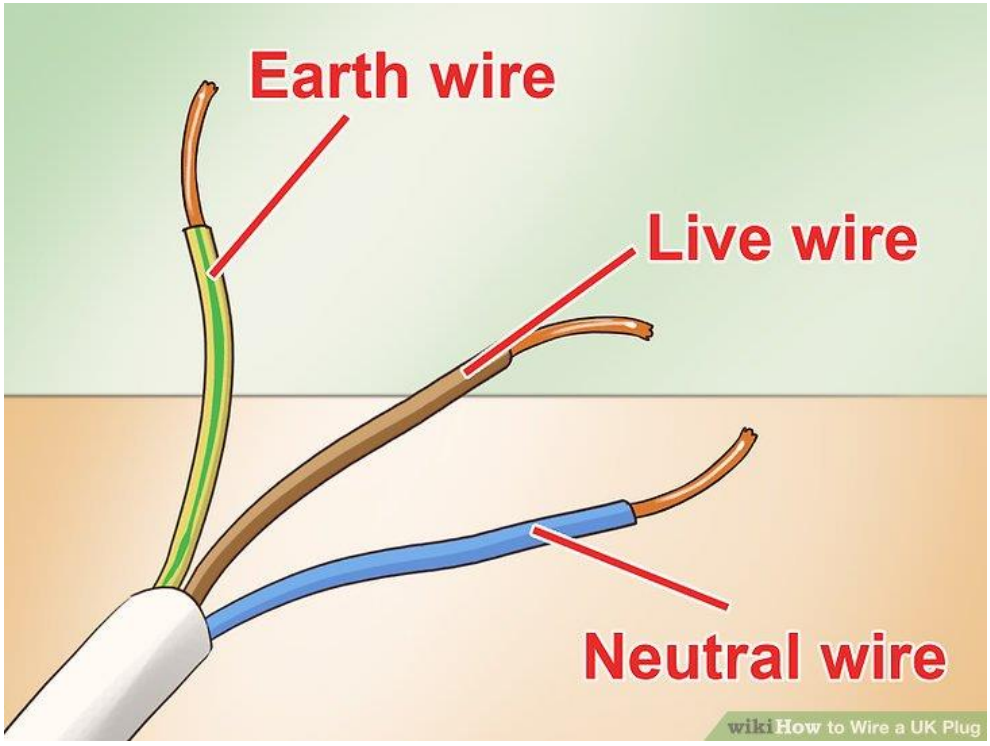
Leaving the plug on a desk/table/floor, take the stripped end of the thick white wire and separate the three wires inside it from each other, so each one is relatively maneuverable.

5



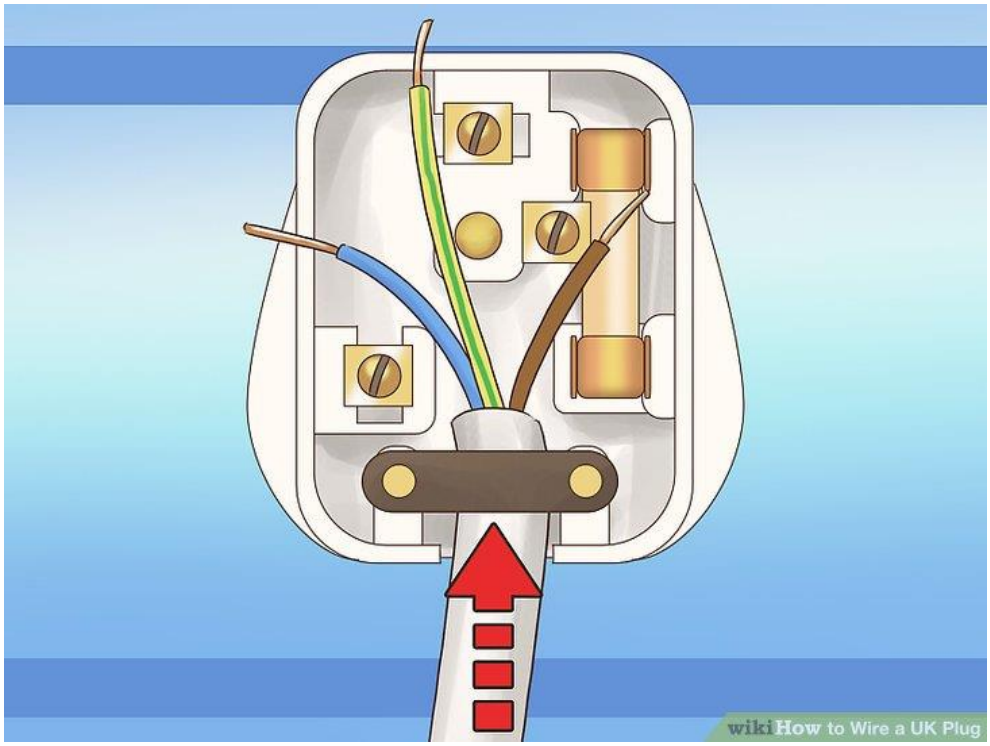
Strip roughly 0.5 to 1 centimeter (0.2 to 0.4 in) off of the end of the blue, brown and striped wires, so that the copper insides are clearly visible.

6



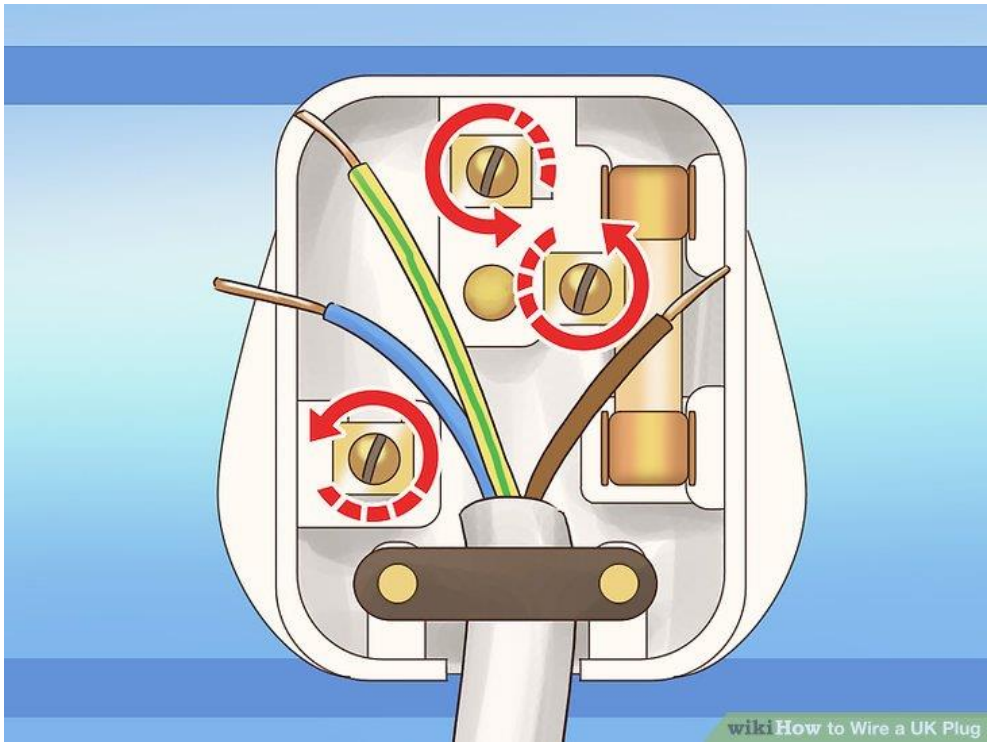
See the diagram below, in the External Links section for a clearer view.

7



Put all three wires through the cable grip, along with the thick white cable, until the cable grip can be securely tightened onto the thick white cable. The cable grip may have to be loosened with a Philips screwdriver in order to fit the cable underneath it.[2]

8



Undo the screws on top of the holes to allow the wires to go into the holes and get a good contact with the metal.

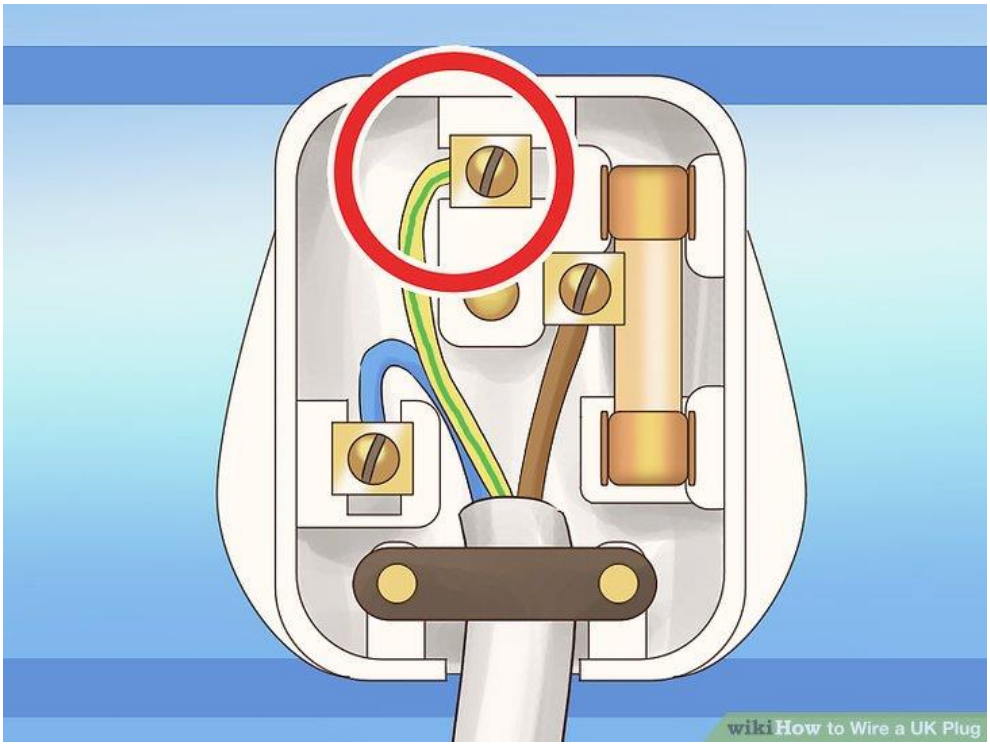
9

The Blue (Neutral) wire (bl = bottom left) goes into the hole in the bottom left (when the three pins of the front of the plug are facing away from you).[3]

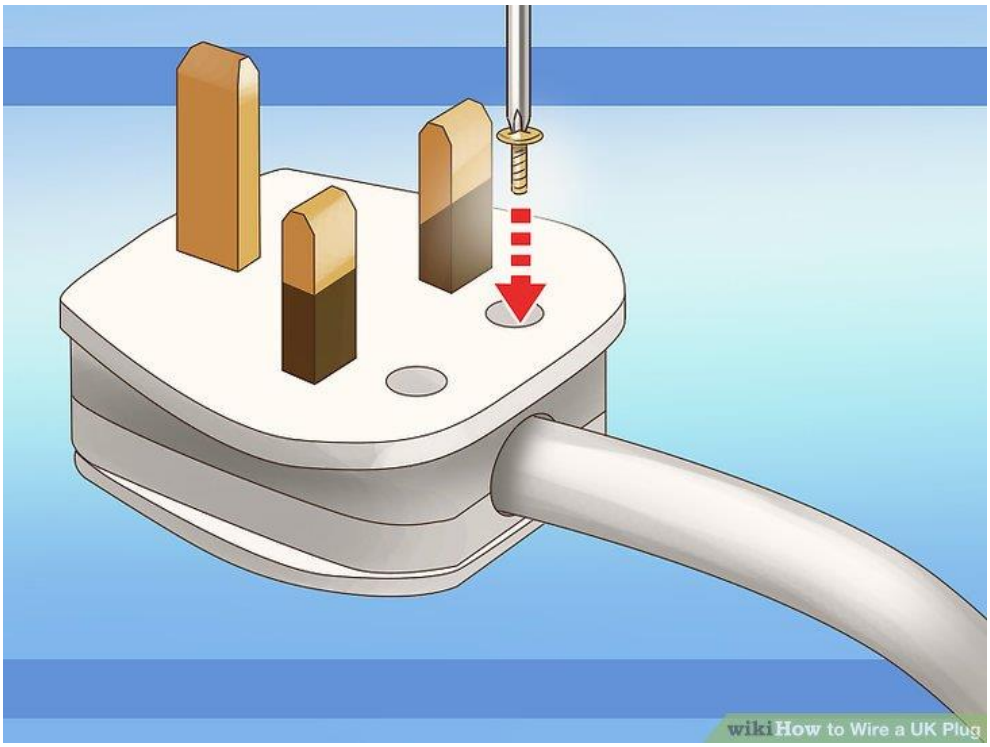
10

The Brown (Live) wire (br = bottom right) goes into the hole on the right, connected to the fuse (which should be clipped in).[4]

11



The green and yellow wire is the earth wire, and goes through the middle up to the hole in the top.



12

Put the back of the plug back on once all the wires are in and tight, and all the screws are securely done up.

Tips

- You will have to take out the fuse to put the wires in place inside the plug. Make sure you put it back in afterwards or the plug won't work as there will not be a complete circuit without the fuse.

Community Q&A

- **Question**

How would I wire a brown and blue cable?

Community Answer

Blue to the left and brown to the right, as shown above. It's a standard cable for a device which doesn't need an earth wire.

Not Helpful 22Helpful 32

- **Question**

If the wires are black and red, which is Live and which is Neutral?

Community Answer

Red will be Live and Black will be Neutral.

Not Helpful 16Helpful 24

- **Question**

The cable for my hob has four wires: green/yellow, blue, black and brown, whilst the plug only takes three. Can I use either the brown or black?

Community Answer

No! Usually a brown wire is live and black or blue wires are neutral, so they are NOT interchangeable. I haven't seen such a connection in my hobs, so I would recommend that you contact the supplier, manufacturer, or a professional electrician.

Not Helpful 11Helpful 20

See more answers

How to change a plug

Useful links

Changing a plug on your electronic device is a straightforward task anyone can do to increase the lifetime of electronic devices. If your electronic device isn't receiving power and the fuse has been replaced, you may need to replace the plug itself. The only tool you'll need is a Philips screwdriver. If the face plate doesn't have screws to release the plug head and cannot be removed, please do not attempt a replacement yourself. Instead, speak to a qualified electrician or the manufacturer of your electronic device.

Method

1

First, turn off the power and unplug the device from the power outlet.

2

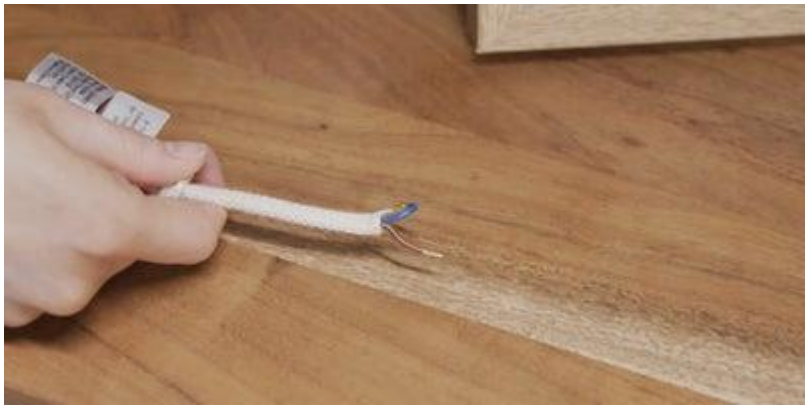
Now use a Philips screwdriver to remove the screws from the face plate to release the back plate.

3

Top tip: We suggest taking a picture on your phone of the inside of your plug to show where the wires lead to. This'll ensure you're re-fitting them correctly.

4

You can now lightly unscrew all the screws inside the plug to free the live, neutral and earth wires from the plug, ready for the replacement plug. Some electronic devices won't have an earth wire, so in this instance, disconnect the neutral and live wires from the plug.



5

Now fit the neutral wire (blue) into the gold contact and keep it in place by screwing it in with your Philips screwdriver.

6

Now fit the neutral wire (blue) into the gold contact and keep it in place by screwing it in with your Philips screwdriver.

7

If your device has an earth wire, fit the earth wire (yellow and green) into the gold contact and keep it in place by screwing it in with your Philips screwdriver.

8

Finally, reassemble your plug by feeding the screws through the front plate to lock the back plate and wire into place.

9

Fit the back plate on to the front plate and make sure all the screws are tightly turned before use.

10

To check its working, plug your electronic device back into a power outlet and turn on the power.

How to change a socket

Useful links

Planning & preparation

- Here we will show you how to replace an old socket with a surface-mounted double electrical socket with USB ports. Bear in mind that different socket designs may have different fitting requirements, so be sure to always check the manufacturer's instructions
- Sockets are available in a range of sizes, colours and finishes, with some more modern designs also featuring USB ports and Wi-Fi extenders
- Electrical installations and alterations are subject to local building and electrical regulations that you must comply with. For information on the regulations in your area, visit: https://www.electricalsafetyfirst.org.uk/ or your Local Authority website
- Wiring should always comply with IEE Wiring Regulations
- If you have any doubts or queries, then it's best to contact a registered electrician

Do it right

- When replacing an existing socket, it is essential that the cable connections wire up to the new product in the same way as the old one. The colours of your wires will depend on how old the wiring is:
    - Brown (or Red if you have old wiring) – indicated by 'L' on your socket (Live)
    - Blue (or Black if you have old wiring) – indicated by 'N' on your socket (Neutral)
    - Yellow & Green striped – indicated by 'E' or three vertical lines on your socket (Earth)
- Before using a voltage or socket tester, use it on the old socket before the power is turned off; that way you can be sure that the tester is working
- If there is any sign of heat damage or fraying on the wiring, use side cutters and electrical wire strippers to trim back the damaged wire

Staying safe

- Electrical work can be dangerous, so be sure to always follow instructions and to never work on your electrics unless you are sure they have been turned off and isolated at the consumer unit (fuse box)
- Purchasing a voltage or socket tester is the safest way to ensure there is no electrical current to the socket. Test the voltage tester on the old socket before the power is turned off; that way you can be sure it is working
- We would recommend that all homes are fitted with a fixed RCD (Residual Current Device) as they offer the highest level of protection

Aftercare

- Take care not to overload your socket as this can cause damage and overheating
- Wipe with a soft dry cloth from time to time

Step by step

Step 1

Locate your consumer unit (fuse box) and identify the circuit you'll be working on. Isolate the circuit by flicking the micro-circuit breakers (MCB) to the OFF position or by removing the fuse, keeping it safely in your pocket until the job is completed.

Step 2

Use a voltage or socket tester to check that the socket is no longer live. You could also double-check by plugging in a lamp before isolating the circuit, then checking the light has gone off.

Step 3

Use a screwdriver to remove the retaining screws and gently manoeuvre the front of the socket to reveal the wiring. There should be enough slack in the wire that you can easily access the back section.

Step 4

You may have single, double or triple wiring, and it’s vital that you replace the wires like-for-like.

Step 5

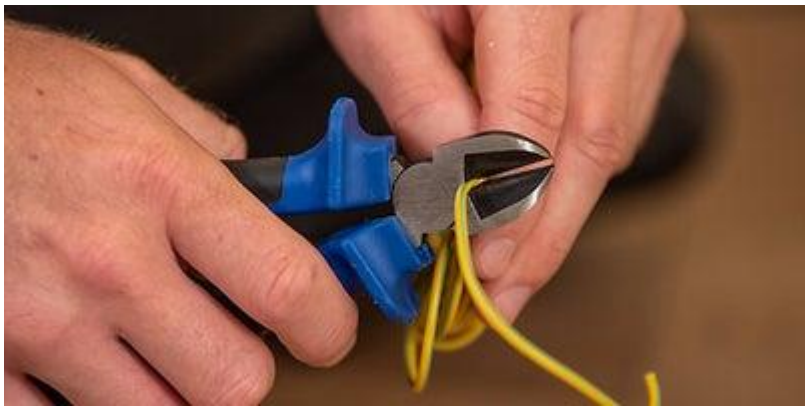
Loosen the terminal screws, gently free the wires and put the old socket to one side.

Step 6

If any of the wires are frayed, use side cutters and electrical wire strippers to leave 5mm of wire clear.

Step 7

Cover any bare earth wires with appropriate green or yellow sleeving.



Step 8

Note that the order and positioning of the Live (L), Neutral (N) and Earth (E) terminals on the new socket may be different from the old socket. Be sure to check the terminal labels on the new socket carefully.

Step 9

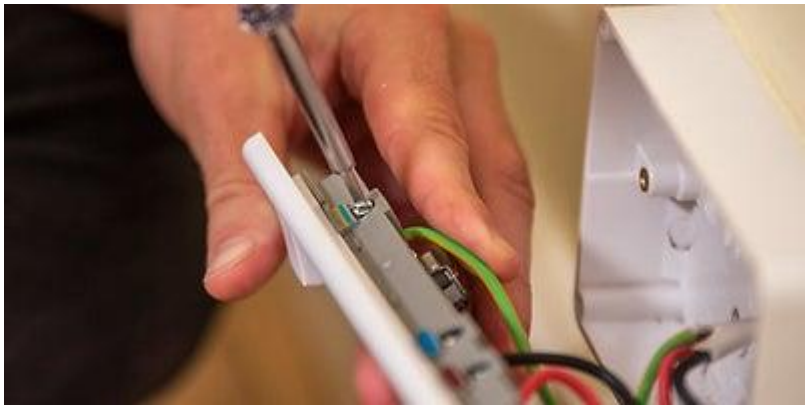
Ensure that the terminal screws on the new socket are open. Then, depending on the age of your wiring, connect the brown (or red) wiring to the Live (L) terminal, making sure no bare wire is visible, and that the connection is secure.

Step 10

Repeat this process connecting the blue (or black) wiring to the Neutral (N) terminal and the green & yellow wiring to the Earth (E) terminal.

Step 11

Re-tighten the terminal screws so that they are firmly fixed but not over-tightened.



Step 12

Carefully manoeuvre the faceplate back into position, making the sure that wiring is not caught or trapped.

Step 13

Reattach the faceplate with the retaining screws, checking it is level with a spirit level and being sure not to over-tighten.

Step 14

Replace the fuse and restore the power at the consumer unit.

Step 15

Use the socket tester to make sure the unit is correctly wired and functioning.

How to Install a Circuit Breaker

Download Article

Article Summary

Co-authored by Jesse Kuhlman

Last Updated: May 26, 2023 Approved

Installing a circuit breaker is sometimes considered the most intimidating part of home electrical work. In fact, most people choose not to do it themselves out of fear of being shocked. However, installing circuit breakers into most residential electrical panels doesn't have to be dangerous or overly complicated. By understanding the layout of your electrical panel and taking adequate precautions during the installation process, you can safely install a circuit breaker in your home.

Part 1

Determining Where to Install the Circuit Breaker

Download Article

1

Turn off the power supply to the electrical panel. Locate the *Service Disconnect* or *Main* circuit breaker in the panel and set it to the "Off" position. This circuit breaker is likely to have the largest amp value and will be located either at the top or bottom of the panel.

- If you don’t see a circuit breaker labeled “Service Disconnect” or “Main” in the panel, it is likely in another panel in the building or in the meter socket enclosure (a separate, usually gray box that houses the utilities meter for many houses and mobile homes and that is connected to various circuit breakers throughout one section of a building). Look for other panel(s) as needed until you find this main circuit breaker.
- Turn off all computers in your home before switching off the power, as they may be damaged by suddenly losing power.

2

Inspect the circuit breaker arrangement for unused locations. Look for a blank area on the electrical panel that could accommodate a circuit breaker, paying particular attention to unused spaces at the top and bottom of the cover. Some manufacturers of electrical panels have removable

knockouts or plates at these locations, but the panel itself lacks provisions to mount a circuit breaker.[1]

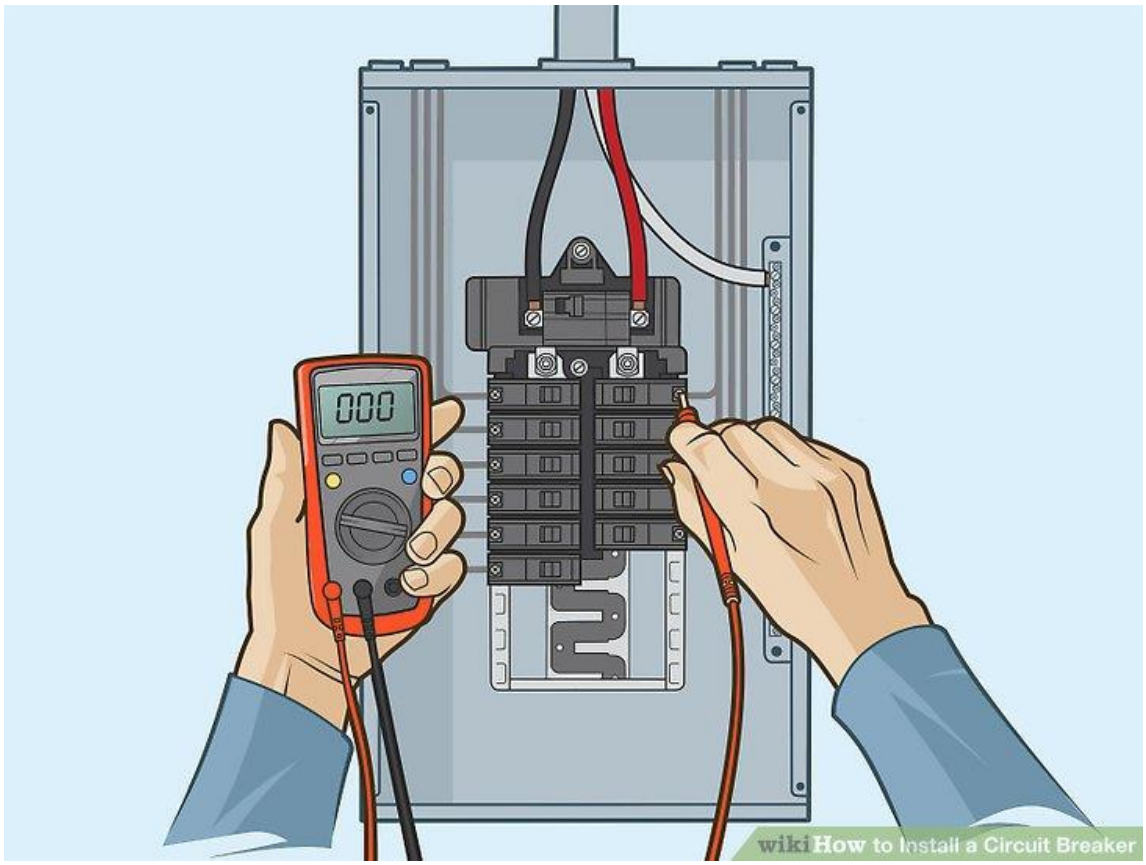
- If the unused location has a knockout plate over it, you'll have to eventually remove it before completing the installation process. For now, you simply need to identify a space where you can install the circuit breaker.

3

Remove the electrical panel cover. Use a screwdriver to remove 3 of the screws supporting the cover. Then, use 1 arm to hold the panel cover in place as you unscrew the last screw. Finally, pull the cover away from the panel.[2]

- Be sure to hold the panel cover tightly in place as you remove the screws; if the cover slips and falls, it could damage the breaker handles.
- If you're unable to hold the panel cover in place with 1 hand, ask a friend to help you.

4



Test the panel to make sure the power is off. Use a test light or meter set to check for the presence of power. Touch 1 probe to ground (the bar that has bare or green and white wires connected) or neutral (the bar that has just white or just bare or green wires connected) and touch the other probe to the screw terminal of a circuit breaker that has a black, red, or blue insulated wire connected. If 120 (or more) volts is indicated, the panel is still being powered and will need to be turned off before proceeding.[3]

- Make sure your test light is set to the highest AC voltage range available (and is set at minimum to 120 volts).
- If the Service Disconnect or Main circuit breaker is in this panel, it will always indicate power on the terminals that have cables connected. The output of the Main or Service Disconnect when located in the panel, connects to the bus bar. The bus bar should have no power present when this breaker is OFF. Testing at the Service Disconnect or Main circuit breaker is not recommended due to this "seemingly conflicting" information.
- It is not safe to install a circuit breaker in an electrical panel that still has power flowing to it. *Do not continue if power is present on a circuit breaker other than Service Disconnect or Main circuit breaker, until the power source has been shut off.*

5

Find an unused space next to or between existing circuit breakers. The new circuit breaker you install will need to be placed next to a circuit breaker already in place. Carefully compare this location to the cover that was removed earlier to make sure it aligns with an unused location on the cover.[4]

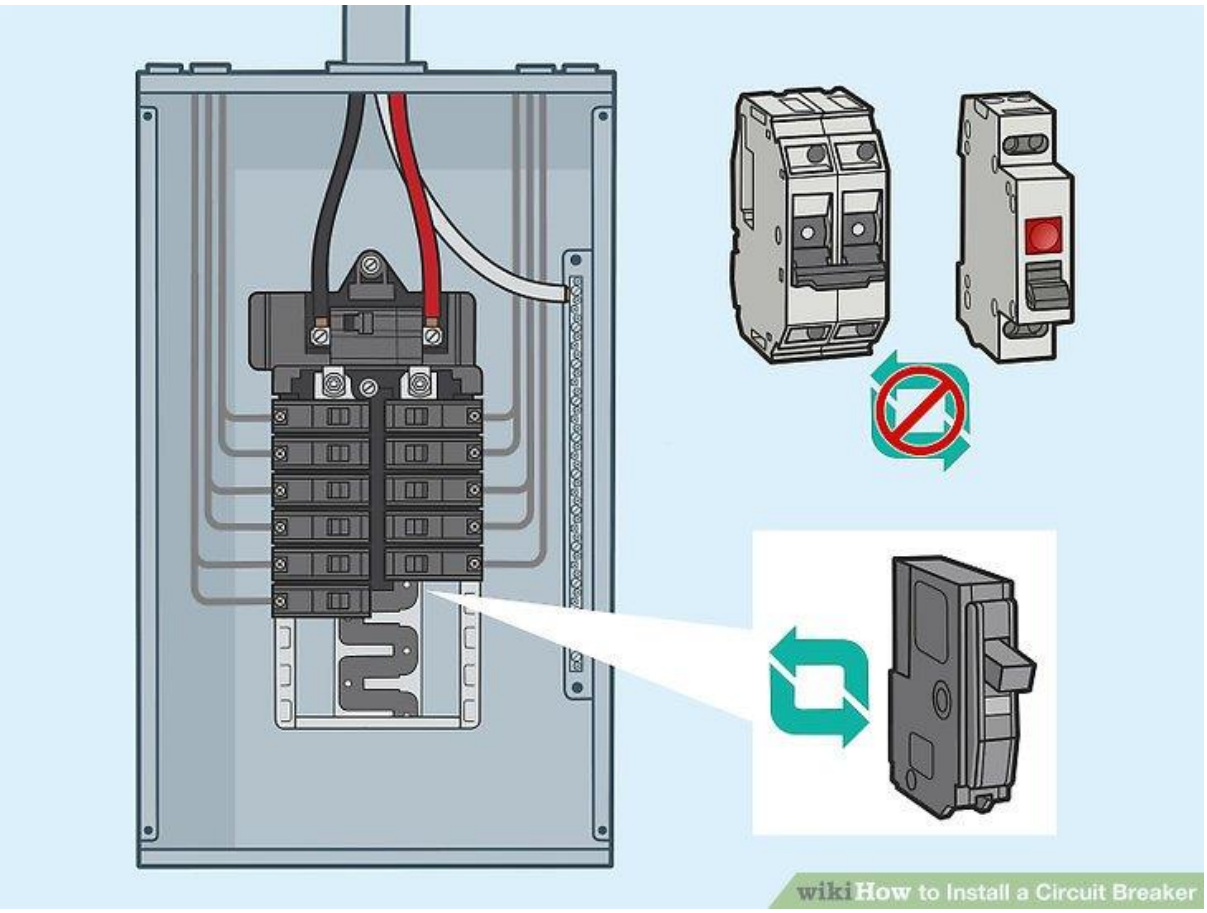
- It’s very important that the cover has provisions for exposing the new circuit breaker by removal of the knockout plate. If there’s no plate to be removed, the circuit breaker will have to be located in a different place on the panel.

Part 2

Placing the Circuit Breaker in the Panel

Download Article

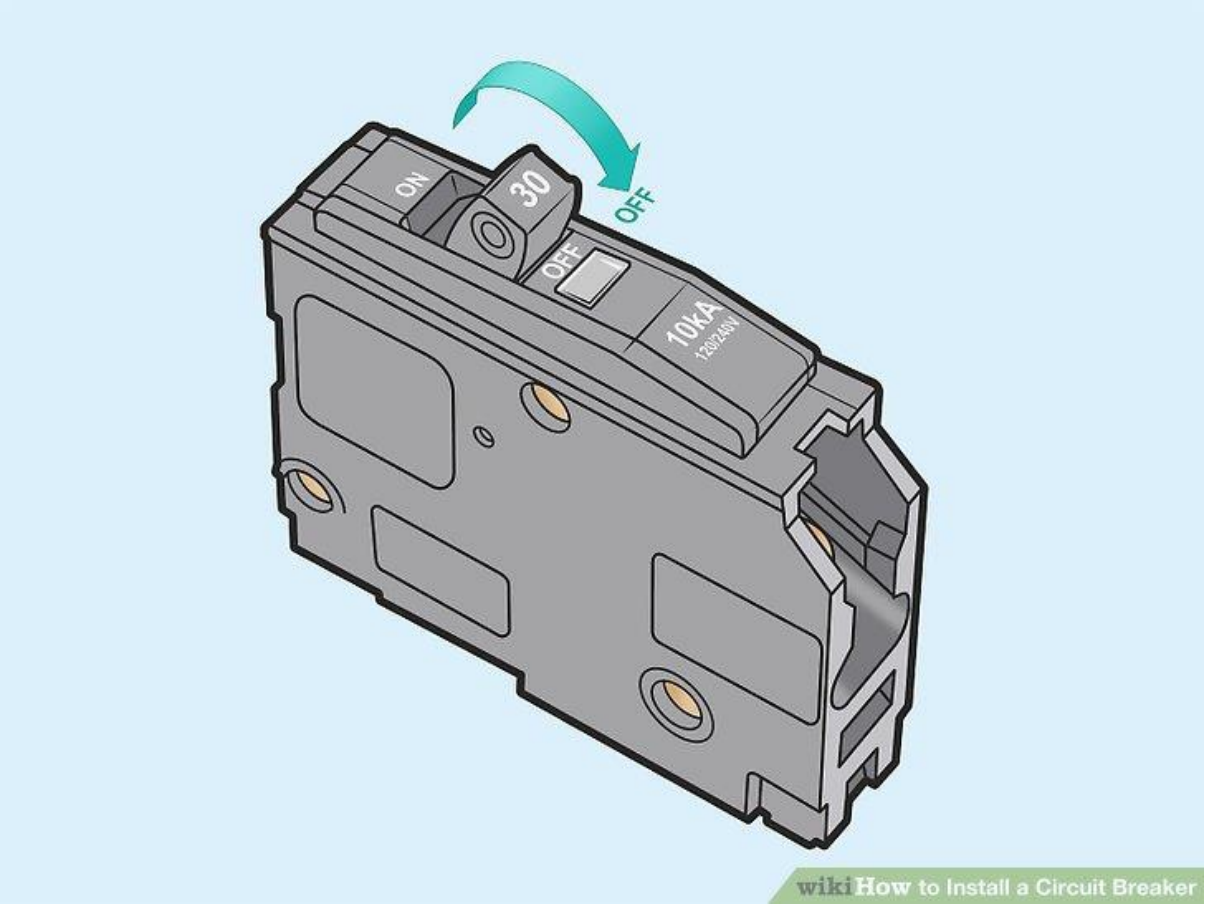
1



Make sure you have the correct circuit breaker. The panel label will list all the approved types of circuit breakers that can be installed in the panel. Deviating from the list is a code violation and voids any UL, FM or other listing services' approval. For maximum safety, use only those circuit breakers that are allowed to be installed in the panel.[5]

- Typically, the only breakers allowed to be installed are from the same manufacturer of the panel - even if other brand breakers are labeled as "fits (brand name here) panels".
- The breaker should be of an ampacity that does not exceed the circuit conductor's rating. This is typically 15 amps for #14 copper, 20 amps for #12 copper and 30 amps for #10 copper conductors or wires. Consult the code book to determine sizes for other circuits.
- The terminal size should be large enough for the wire to fit. The need to remove strands of wire to fit the terminal is an indication of an error somewhere along the line.

2



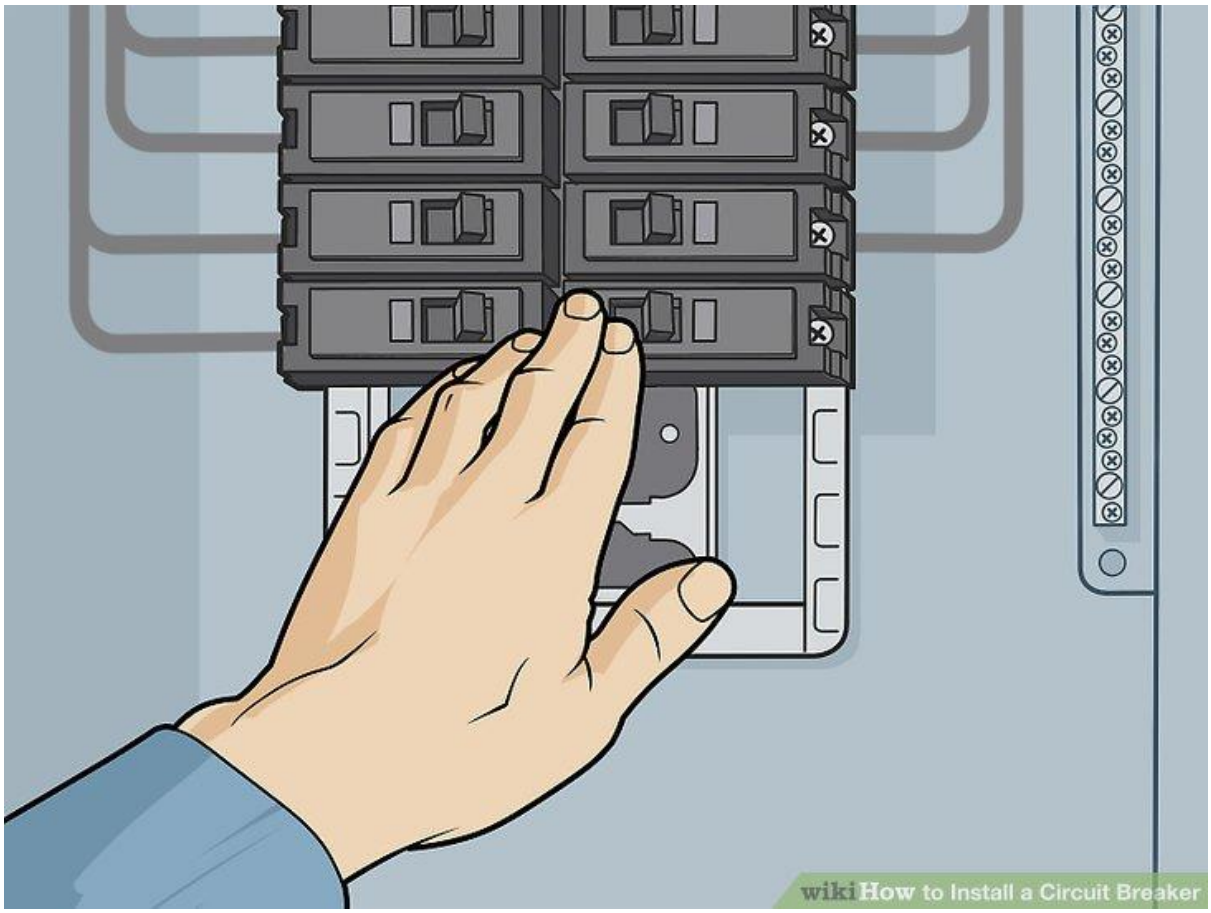
Set the circuit breaker handle to the OFF position. The circuit breaker has 3 possible positions: ON and OFF and a mid position when TRIPPED. Push the handle towards the OFF position before installing the breaker to ensure your own safety during the installation process.[6]

3

Align the circuit breaker with the bars in the panel. Tilt the circuit breaker so that the hold-on clip on the bottom of the breaker is attached to the plastic “grab” bar in the panel. Once attached, pivot the circuit breaker on the mechanical contact and roll towards the center of the panel - making sure the bus bar of the panel is still aligned with the slot or opening on the circuit breaker case.

- You may have to apply pressure to the breaker for it to become attached to the plastic bar.

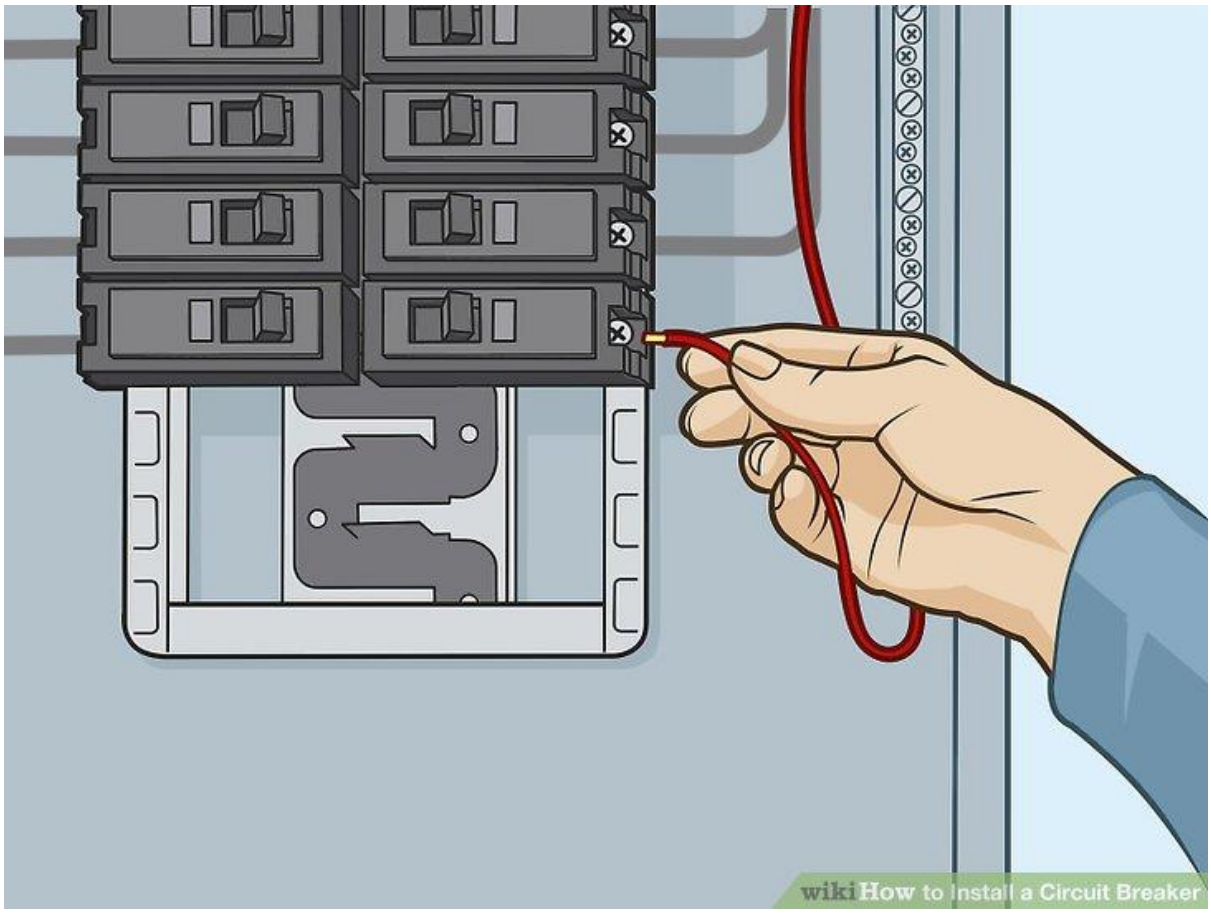
4



Firmly press on the circuit breaker to seat it onto the bus bar. Use your thumb to press firmly but gently on the circuit breaker until it snaps into place on the bus bar. You don’t have to screw the breaker into place; it’s held in place by spring clips and the panel cover.[7]

- While it will require firm even pressure to be seated, it should not have to be forced.

5



Connect the circuit wiring to the electrical panel. After making sure the circuit breaker is still in the OFF position, connect the white neutral wire and the black hot wire to the breaker. Loosen the screw over the breaker's connection terminal, insert the wires into the appropriate terminal locations, then tighten the screw until snug.[8]

- Your circuit breaker should have a label that indicates where to insert the neutral and hot wires.
- If you're installing a double pole breaker, you'll connect it to both the black and red hot wires. Just make sure you're using a switch that's designed to be used as a double breaker.[9]
- Note that there's no need to bend the end of the wire into a hook; it just needs to be straightly inserted into the connection terminal.

Part 3

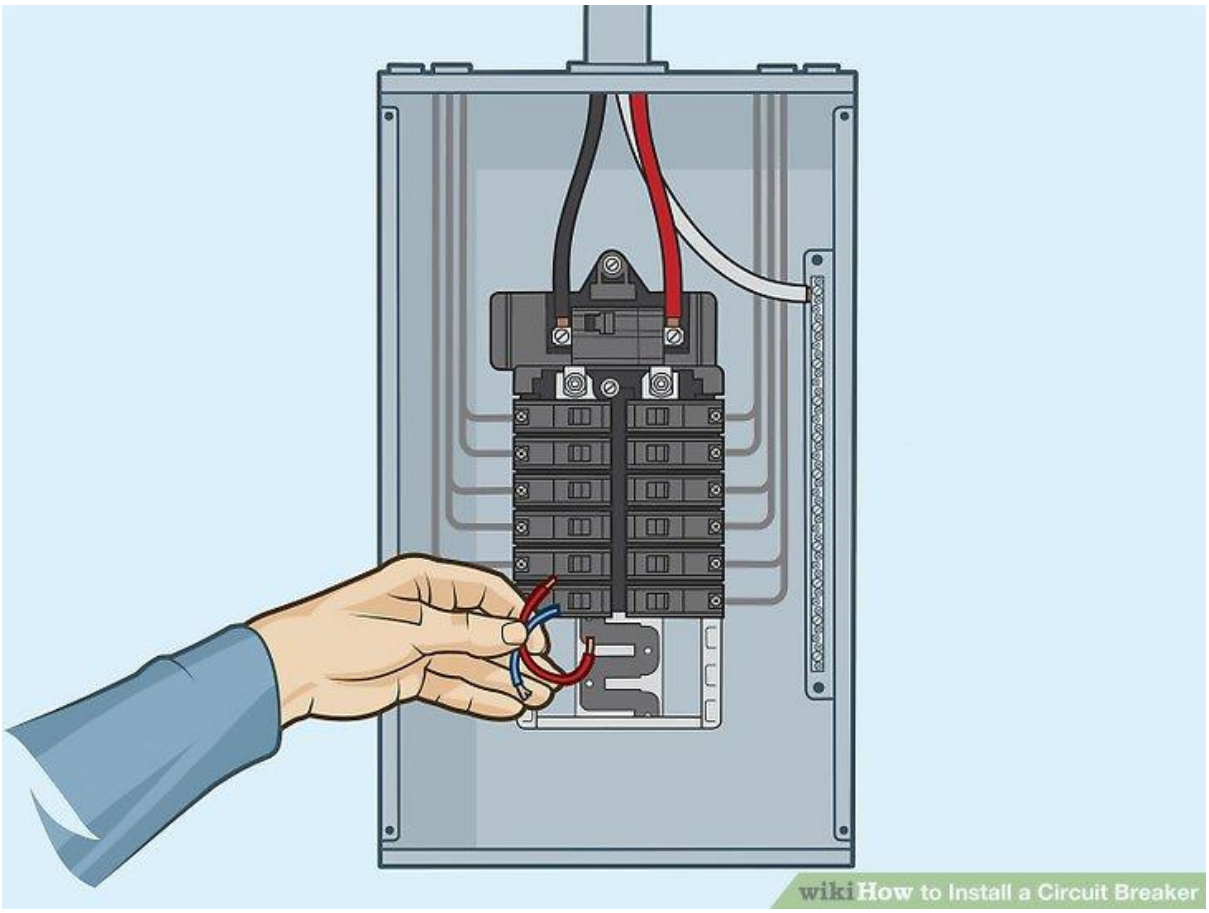
Finishing and Testing the Installation

1

Remove knockout plates from your cover as needed. Bring the cover up to the panel to compare the new circuit breaker location to the cover openings. Use a pair of pliers to remove any knockout plates on the cover location where the circuit breaker will be located.

- To remove the knockout plate, simply grip with the pliers and move the metal back and forth until it comes away.

2



Clean all foreign objects out of the panel and reinstall the cover. Remove any tools, wire scraps, or other foreign objects that could cause a short circuit from the interior of the panel. Then, place the cover on the panel to check that the circuit breaker has fully been seated at both contact points and fits through the cover. Finally, rescrew the cover onto the panel.[10]

3

Turn on the main breaker and test your new circuit breaker. Standing to the side of the panel, restore power to the panel by setting the Service Disconnect or Main to "On" and then set the new circuit breaker to "On". Check for correct operation of the new circuit (light, outlet, etc.) with a test light or meter.[11]

- Clear any short circuit before attempting a reset if circuit breaker instantly trips.

4

Label the circuit breaker. Locate the panel's *circuit directory* on the inside of the panel door. Determine the circuit breaker location (or "circuit number") and write a description of the circuit (load type such as "refrigerator" or a location such as "living room") in the space provided. Be sure to edit the directory if any circuits were moved to install the new circuit.[12]

Warnings

- Voltage levels as little as 50 volts can be lethal under the right conditions. Most residential electrical systems are 2 to 5 times this value. Shut off power whenever working on circuits and never proceed if unsure or uncomfortable performing the steps above.
- Always stand to the side of an electrical panel when turning circuit breakers "on". The amount of energy being transferred is directly proportional to the amperage value rating on the circuit breaker. While a single pole 15 or 20 amp short circuit would probably not cause catastrophic damage, a double pole 100 or 200 amp short circuit certainly could. Standing off to the side takes a person largely (though not completely) "out of harms way".

- Never install a circuit breaker into a panel for which it was not designed. Many circuit breakers will physically fit into different panels, however only those identified on the panel's label are approved for use. Using improper circuit breaker causes forfeiture of UL, Factory Mutual and all other "listings". Use of unlisted devices is a code violation and in extreme cases, may result in denial of a claim to the insurance company in the event of a loss.
- Prior to using any tester or meter, be sure it works by first checking on a known live circuit. If the device fails to indicate properly, do not use until repaired or replaced.
- In the US, 120/240 systems (the type most often found in a residence or dwelling) use a color code for wiring; Black, Red, Blue "hot wires" and White neutral wires. In addition to 120/240 volt systems that appear in residences, many commercial and industrial settings also have 277/480 systems. These higher voltage systems use a different color scheme to immediately alert the electrician of the higher voltage panel. The color scheme used for these systems is Brown, Orange, Yellow (think "BOY") "hot wires" and Gray neutral wires. Be sure new wiring is installed in the correct panel.

Things You'll Need

- Screwdriver
- Voltage Tester or Meter
- Pliers

Tips

- Installing an extra circuit breaker can help if one of your circuits is overloaded and trips frequently.[13]
- If you have a circuit breaker that's been overloaded for a long time, and it's been tripped repeatedly, it may need to be replaced entirely.[14]

Expert Q&A

- **Question**

Should I install an additional circuit breaker in my home?

Jesse Kuhlman

Master Electrician, Kuhlman Electric

Expert Answer

The only reason you'd really need an additional circuit breakers is if one of your circuits is overloaded. For instance, if you have an AC in your bedroom window and you put one in another bedroom and those rooms are tied on the same circuit, that breaker will likely be overloaded and trip.

How to Wire an Electrical Socket

Download Article

PARTS

Co-authored by Ricardo Mitchell

Last Updated: May 29, 2023 References

Has your electrical socket cracked its casing or mysteriously stopped functioning? As long as it's a standard home outlet, the repair is pretty achievable even if you're not a DIY expert. Of course, any work on electrical systems can be dangerous. Work slowly and steadily, and contact an electrician if you see anything unusual such as burn marks or a wiring setup that this guide doesn't cover.

Part 1

Preparing for a Safe Installation

Download Article

1

Check regulations for kitchens and bathrooms. Due to the high chance of water spill, these installations require extra safety precautions. These guidelines are also recommended for unfinished spaces, outdoor areas and sheds, laundry rooms, and anywhere else near sinks, hot tubs, and other water sources.[1]

- At minimum, you'll need an outlet that includes a GFCI (ground fault circuit interrupter), also called a RCD (residual-current device). This will shut off the power if it gets wet.
- Installing brand new sockets in these locations is best done by qualified electricians. Replacing a damaged socket here may be doable by yourself.[2]

2

Protect yourself from shocks. Prevent electrical shocks by taking safety precautions:[3]

- Use tools with rubber handles.
- Wear rubber-soled shoes.
- Don't touch your bare skin to any metal or other conductive surfaces, including multimeter probes.

3

Switch off the power. Flip the circuit breaker or remove the fuse that powers the outlet you will be working on. If you're not 100% sure which power source to cut, turn off the power to your whole home and work with a flashlight.

4

Test the voltage. Never assume that the wires are dead without testing. Test a live circuit first to confirm the tool is working, then test the circuit you're working on. If you get a voltage reading, the outlet is still live and cannot be worked on.

- A **non-contact voltage tester** is easy to use, but less reliable. While you are grounded, place the tool against each hole in the outlet. If it lights up, or if its display reads anything other than zero, the outlet is live.[4]
- A **multimeter** is more reliable and gives a more accurate result. To test voltage with a multimeter, set the tool to its AC voltage setting in the 100V range (230V or higher for most European countries). Test by placing the red probe to the live socket (the small vertical hole in a US socket), then keep it there while you put the black probe first into the neutral socket (the taller vertical hole), then the ground (rounder hole).[5][6]
- **Warning:** In the UK and some former UK colonies, some houses are wired in a ring circuit. These DIY tests are not sufficient in these cases. **Never** work on a circuit in these areas until an electrician has identified the type.[7] This article does not cover safety information for ring circuits.

5

Remove the old socket. Once you are certain the power is off, unscrew the faceplate of the old socket and pull it out from the wall box. To detach the wires from the socket, unscrew the terminals just enough that you can slip the wire loop off of them.[8]

Part 2

Wiring the New Socket

Download Article

1

Identify the live, neutral, and ground terminals of the socket. A standard modern outlet for household use should have three terminals for connecting the appropriate wires.

- **US sockets:**[9]
  Brass terminals are live (hot)
  Silver terminals are neutral
  Green terminals are ground
  UK sockets:[10]
  "L" indicates live
  "N" indicates neutral
  "E" or three parallel lines indicates earth (ground)

2

Adjust your plan if there are more terminals. If you see more terminals than described above, you are probably in one of these situations:

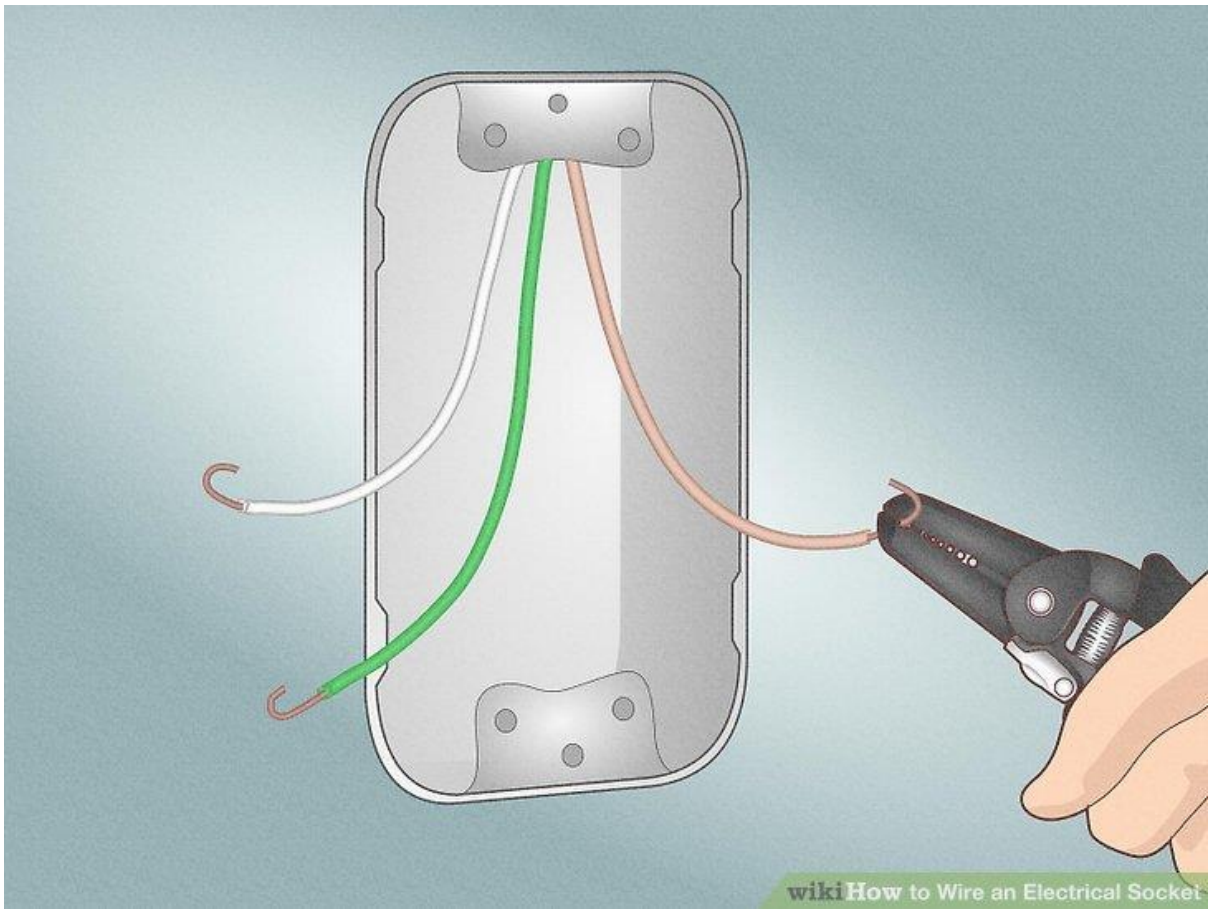
- When replacing an existing socket in the UK, you'll often have to fit two wires of each type to matching terminals. Installing a new socket only requires one set of wires.[11]
- A US two-socket outlet generally has a metal tab connecting the two live terminals, and another for the two neutrals. If there is only one wire of a given type in your wall, you can attach it to either terminal to power both sockets.
- A GFCI (RSD) outlet has two sets of terminals. Use the line terminals for these instructions. The load terminals (usually marked with yellow tape) are used to connect other devices to GFCI protection.[12]

3

Strip the ends of your wires. If the wires are frayed or nicked, cut the damage off, then strip off roughly ¾" (2cm) of insulation. You can do this using a wire stripper or a utility knife. Take care to avoid nicking the metal of the wire, which can cause electrical faults later.[13] Err on the side of under-stripping so you can correct later.

- Some outlets have a built-in guide: place the wire in the short groove on the back and mark the end of the groove as your strip point.[14] Note that this guide may be for the "push-in" connector instead of the recommended wrapping method.
- If the three wires are enclosed in one PVC jacket, find the end of the bare copper ground wire. Grab this with needle-nose pliers and tug down to split open the seam of the jacket to access the other wires.[15]

4



Bend the wire ends into the shape of an umbrella handle. The best way to secure your wires is to wrap them around the screw terminals. To prep for this, bend the stripped end into a U shape, so it will fit snugly around the whole screw.[16]

- Wire strippers have holes in them for this purpose. Slip the end of the wire in and twist. If you don't have a wire stripper, use needle-nose pliers.
- Many outlets have push-in connectors, or small holes below the terminal that hold the wire in with a spring clamp. If you use this, all you need to do is push the wires into the holes. However, these clamps can lose tension and eventually weaken the connection.[17]

5

Wrap the wires around the screws clockwise. Each wire should rest snugly around its terminal, with all three sides of the U-bend in close contact. Wrap them in the direction the screw tightens (usually clockwise) for maximum contact with the screw threads.[18] Before you do this, be about 700% sure you are using the correct wire:

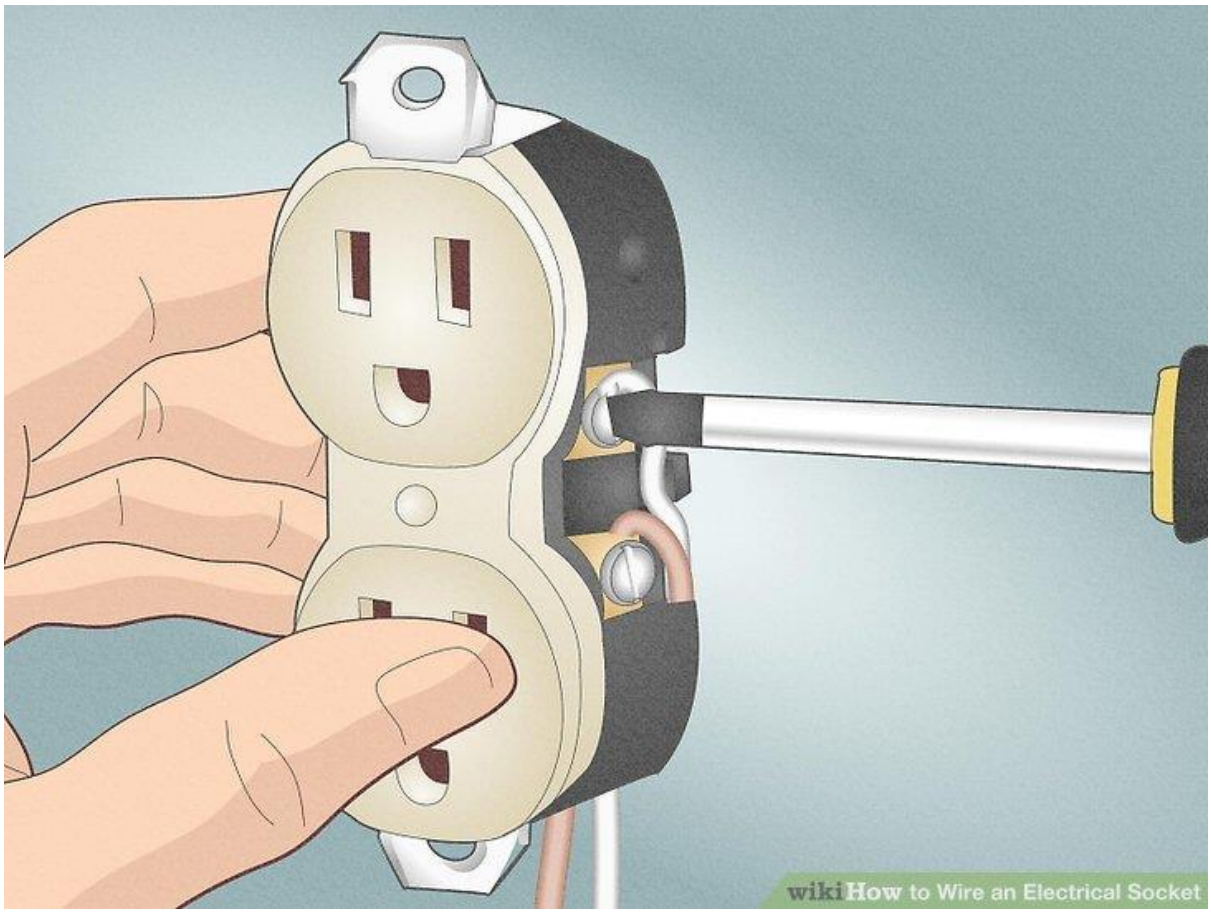
- **USA:**[19]
  Live cable is black (if there are two live cables, the second one is red)
  Neutral cable is white or grey
  Ground cable is uninsulated, green, or green & yellow
  EU & UK:[20]
  Live cable is brown (red for pre-2004 UK)
  Neutral cable is blue (black for pre-2004 UK)
  Earth (ground) cable is green & yellow

6

Tuck the wire under the plastic retainer. Most outlets have small plastic ledges for you to tuck the wires under to secure them in place. If this isn't working well, double-check the wire stripping:[21]

- The wire in contact with the terminal should be completely bare. If insulation is touching the terminal, strip it off.
- The portion tucked under the retainer should be insulated. If it is bare, snip off the end of the wire.

7



Tighten the terminal screws. Use a screwdriver to tighten each screw until it presses down against the wire. Tighten enough for a firm connection, so the wire cannot get jostled out of place, but don't tighten with maximum force.

8

Wrap the outlet in electrical tape. For extra safety, wrap the sides of the outlet in electrical tape to reduce the chance of contact with a wire if it ever gets loose.[22] Your outlet is now ready to be inserted back into the wall.

- If you have just installed a GFCI outlet, use the test button to confirm that the safety feature is working. When the test has been activated, a multimeter should read zero voltage from the outlet.

Tips

- If you have a US two-socket outlet and want one of them to be controlled by the light switch, use needle-nose pliers to remove the small brass tab connecting the hot terminals of the two sockets. Now you can attach the two live cables (black and red) to the two terminals and control them independently. One will always be live, while the other will be controlled by the light switch.[23]
- You can use a socket tester after you've finished to check your work. These plug into your socket and check for common wiring errors.

Warnings

- It is not recommended to use the push-in connectors (small holes that can hold wires) found in some outlets. This is more likely to cause electrical failures, and is against code in some areas.[24]
- If installing new wire, always make sure to use the gauges and color codes standard for your country.

Community Q&A

- **Question**

Where is the green (ground) cable attached?

L.B

Community Answer

The ground wire is looped around the green screw (terminal), usually located on the bottom of the wiring device.

Not Helpful 2Helpful 0

- **Question**

How do I connect a very short wire to an electrical outlet?

L.B

Community Answer

If the wire has been cut back too far to make wiring feasible, you will have to extend it by using a pigtail. To do this, you will need an extra piece of 12 AWG copper wire (6" should be enough) and a yellow wing wire nut. Strip back the wire half an inch on both sides. Twist together one side of the new wire with the existing wire using the wire nut (the copper ends must make contact inside of the wire nut). Connect the other end of your new wire to your wiring device as normal. For added safety, use electrical tape to secure the wiring nut and the wires together so they don't come loose.

Not Helpful 1Helpful 0

- **Question**

How to connect earthing to ground?

Yannick Slock

Community Answer

In a modern network there should be a L,N,E network. The E should be green/yellow covered. In your technical/electrical locker all Earth wires are combined. This is usually done on a copper strip or a connection bar (usually green). From there the earth wires go to 'the earth'. This is or directly to the city's network but will mostly be a leaden loop laying below the foundations of your house. If it is an old house and there is no option to connect with the loop, what can be done is to hammer copper coated pins in the soil near the electrical locker. These pins should make a low resistance connection with the earth. This can be measured with a specific tool measurement tool.

How to Wire a 3 Way Switch

Download Article

METHODS

Co-authored by Ralph Childers

Last Updated: May 28, 2023

A 3-way switch allows you to turn a light on or off from two different switches. 3-way switches are useful for large rooms with multiple entrances but require a bit more wiring than a standard, single-pole switch. The wiring method will depend on whether your power goes to the switch first or the light first.

Method 1

Taking Safety Precautions

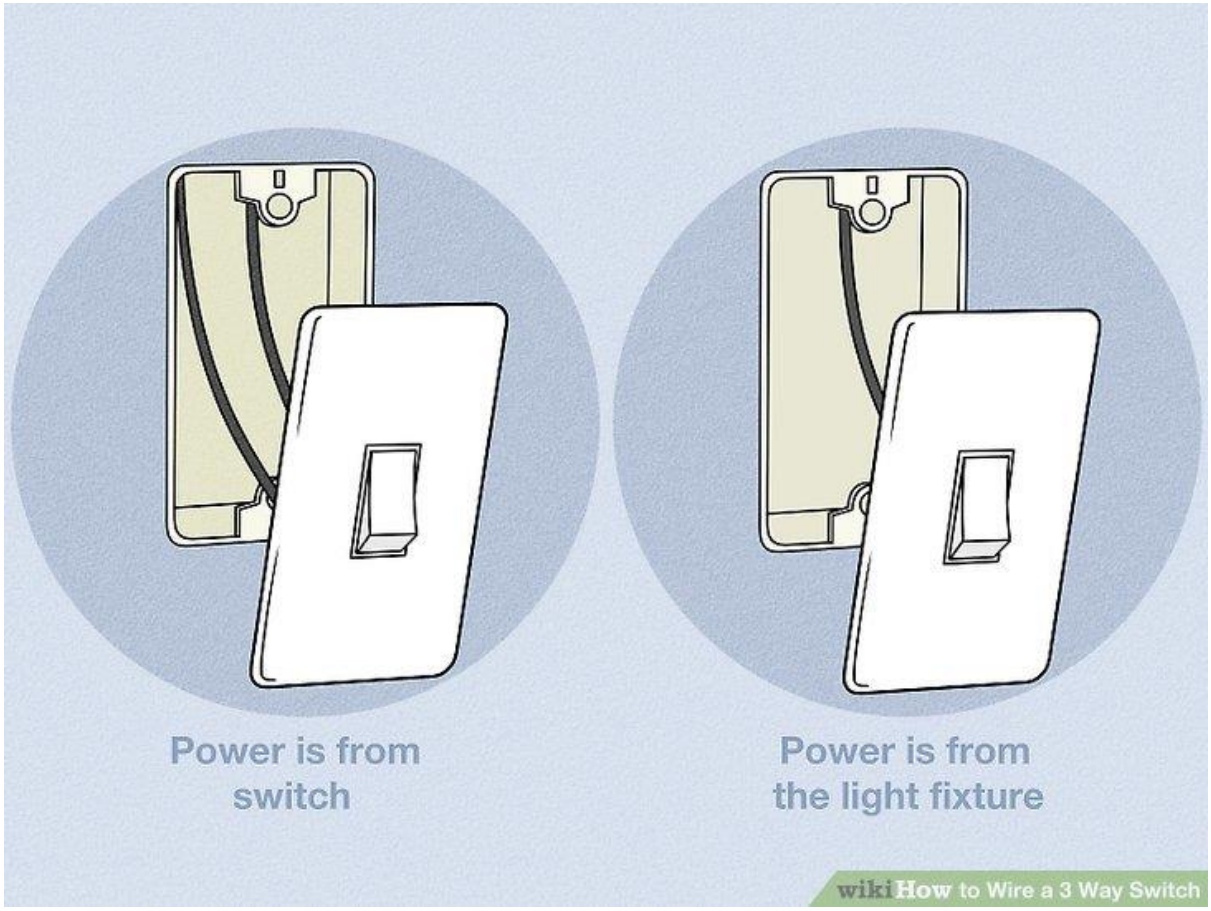
Download Article

1

Switch off the circuit. Ensure that the circuit for the room you are working in has been flipped off. This will prevent accidental electrocution and reduce the risk of fire.[1]

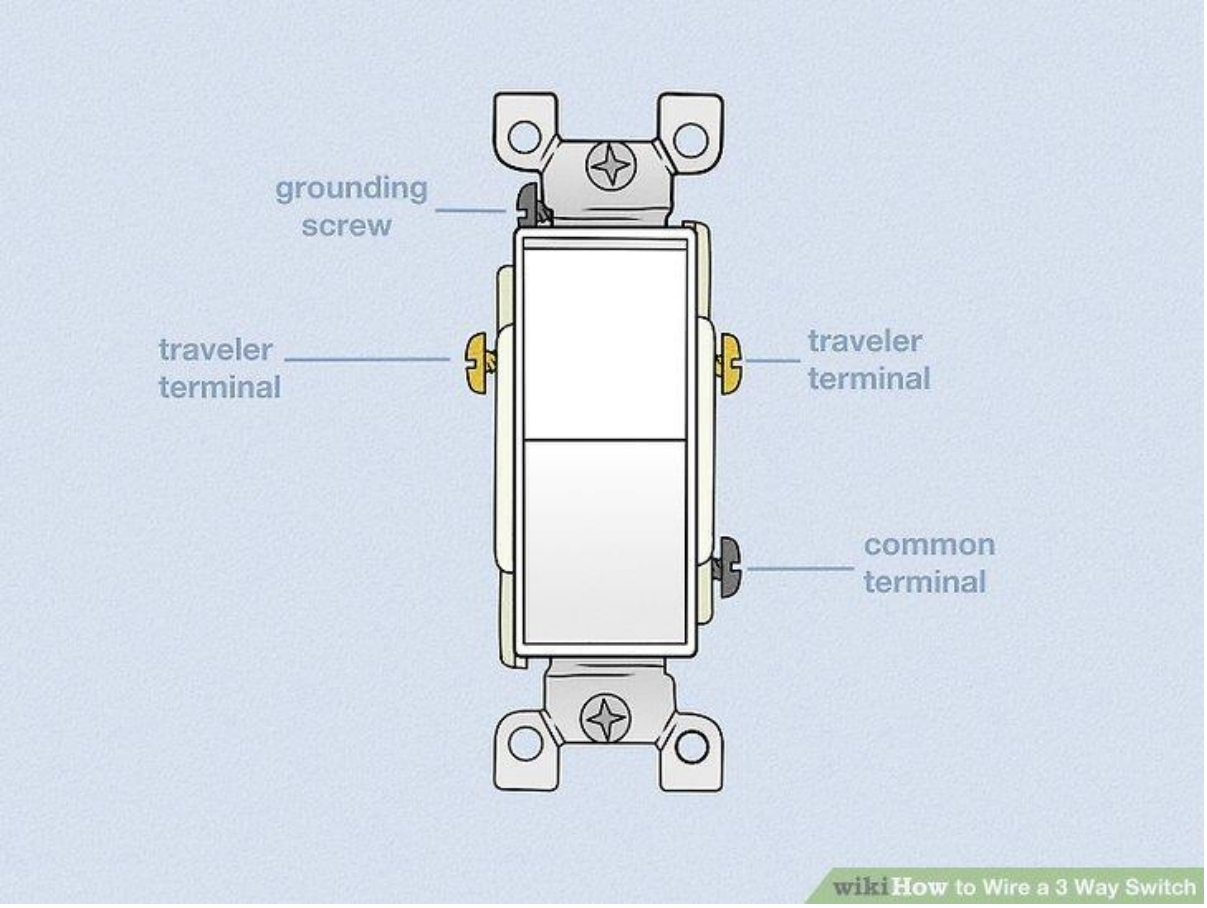
- Most circuit breakers are located in the garage or basement, but placement will vary from home to home.
- When you find the breaker box, locate the breaker that controls the lights for the room you are working on. Flip it to the off position to keep power from traveling down those wires. Most electrical panels label switches for the different rooms in your home.
- Use a voltage tester to check that power is no longer flowing to that room.

2



Determine if the power goes to the light or the light switch. This will affect the way that you perform the installation. You can tell if the power is coming into the switch by removing the light switch panel. If two black wires are coming into the switch box, then the power is coming into the switch first. If there is only one black wire, then the power is coming into the switch from the light fixture. You can usually use an electrical tester to be sure.

3



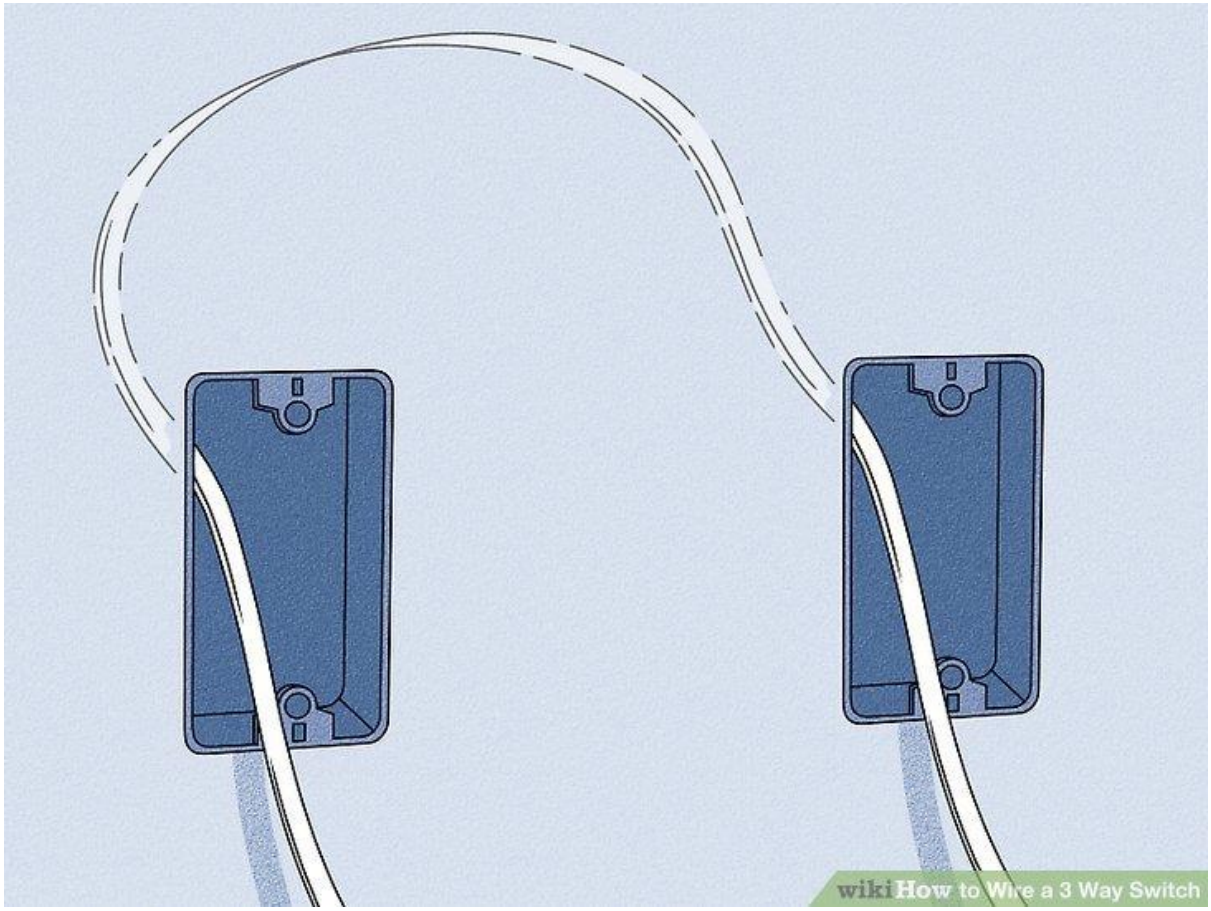
Replace any regular switches with the 3-way switches. A 3-way switch will not have the words on or off written on it. Before you start installing, take a look at your new 3-way switch to identify all of the terminals that you will be connecting wires to.[2]

- Traveler wire terminals - These are located on each side of the switch towards the top of the switch.[3]
- Ground wire terminal - Older switches may not have this, but all new switches must. This is usually a green screw located on the top or bottom of the switch, mounted to the frame. [4]
- Common wire screw - This is located on the left side of the switch, and is a different color than the two traveler terminals.

4

Install larger electrical boxes. You will likely need larger boxes than you already have if you are replacing a regular single-pole switch. 3-way switches involve more cables, so you will need a little more room to work.

5



Run 2 2-wire conductors between the two boxes. Choose 14-2 or 12-2 NM cable, depending on the breaker.[5] 14 gauge wire needs a 15 amp breaker, while a 12 gauge wire requires a 20 amp breaker. You'll be using the top conductor to run your hot wires and your neutrals while the bottom conductor will be used for your traveler wires.

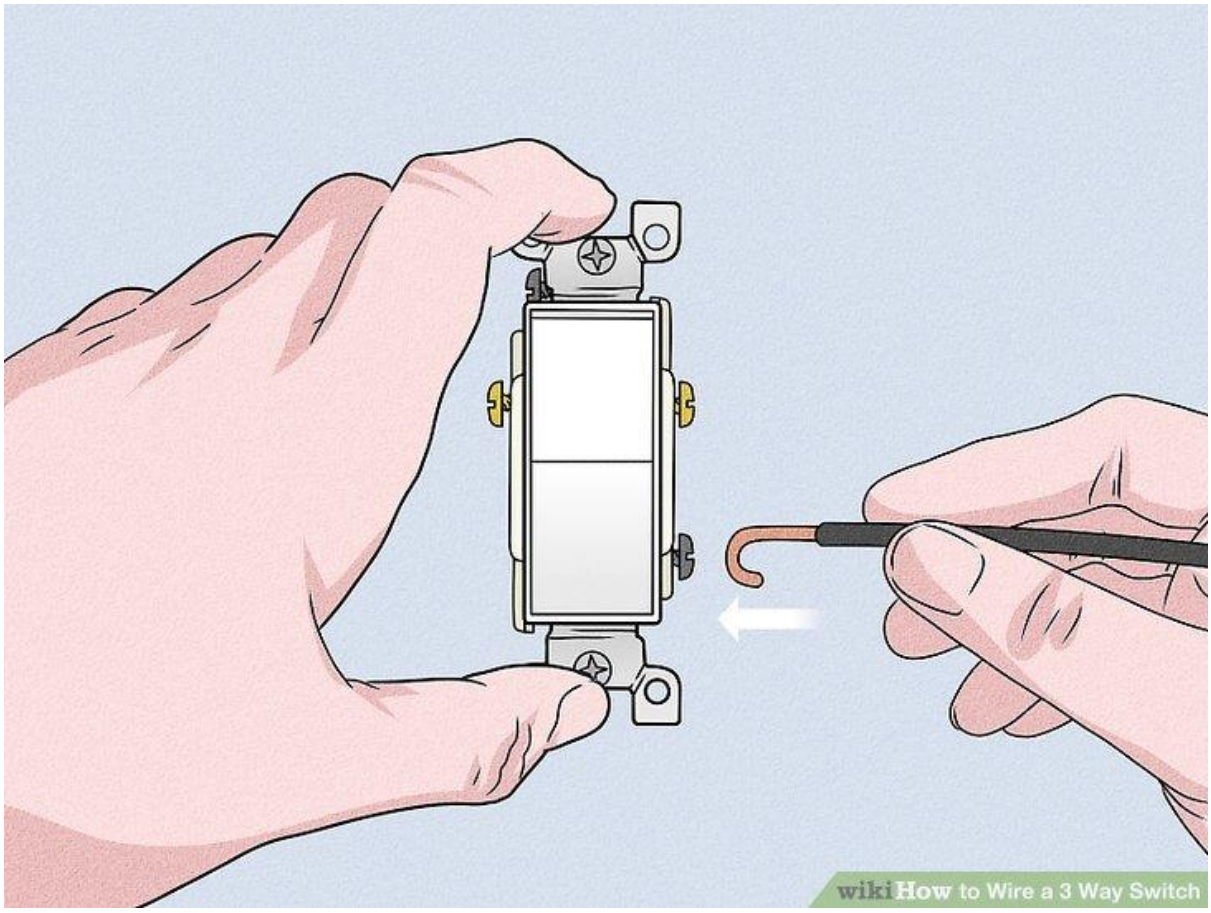
- See this guide for details on running wire through your wall.
- The first number specifies the gauge and the second number is the number of wires carrying current.
- You may also use a single 14/3 or 12/3 cable, which contains 1 bare ground wire, 1 white wire, 1 black wire, and 1 red wire.
- If the power comes from the light's location, run the 2-wire conductors up from each switch to the light fixture. Many of the conductor connections will be made in the light's device box, so make sure you have enough room for all the wires.

Method 2

Converting a Single-Pole Switch to a 3-Way

Download Article

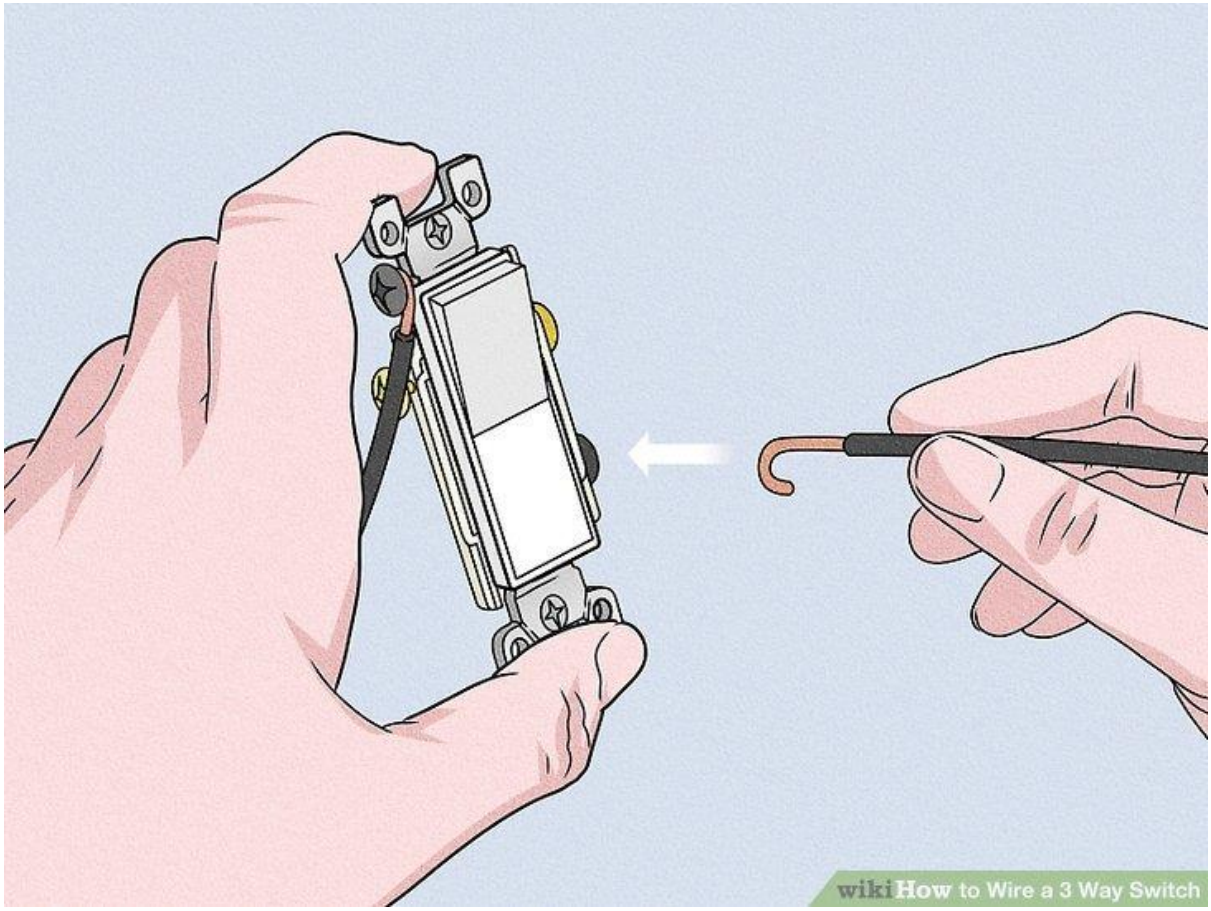
1



Run a black wire from the new switch to the power source. Use the black wire in the top 2-wire conductor to attach the switch to the source. Make a J-hook in the wire with a pair of pliers and wrap it around the black common screw on the light switch. Tighten the screw to secure it in place. Cap the wires connecting the source and the switch.

- The screw is typically on the bottom of the switch.
- Don’t attach the traveler wires to the common screw since they’re only used to connect the switches together.

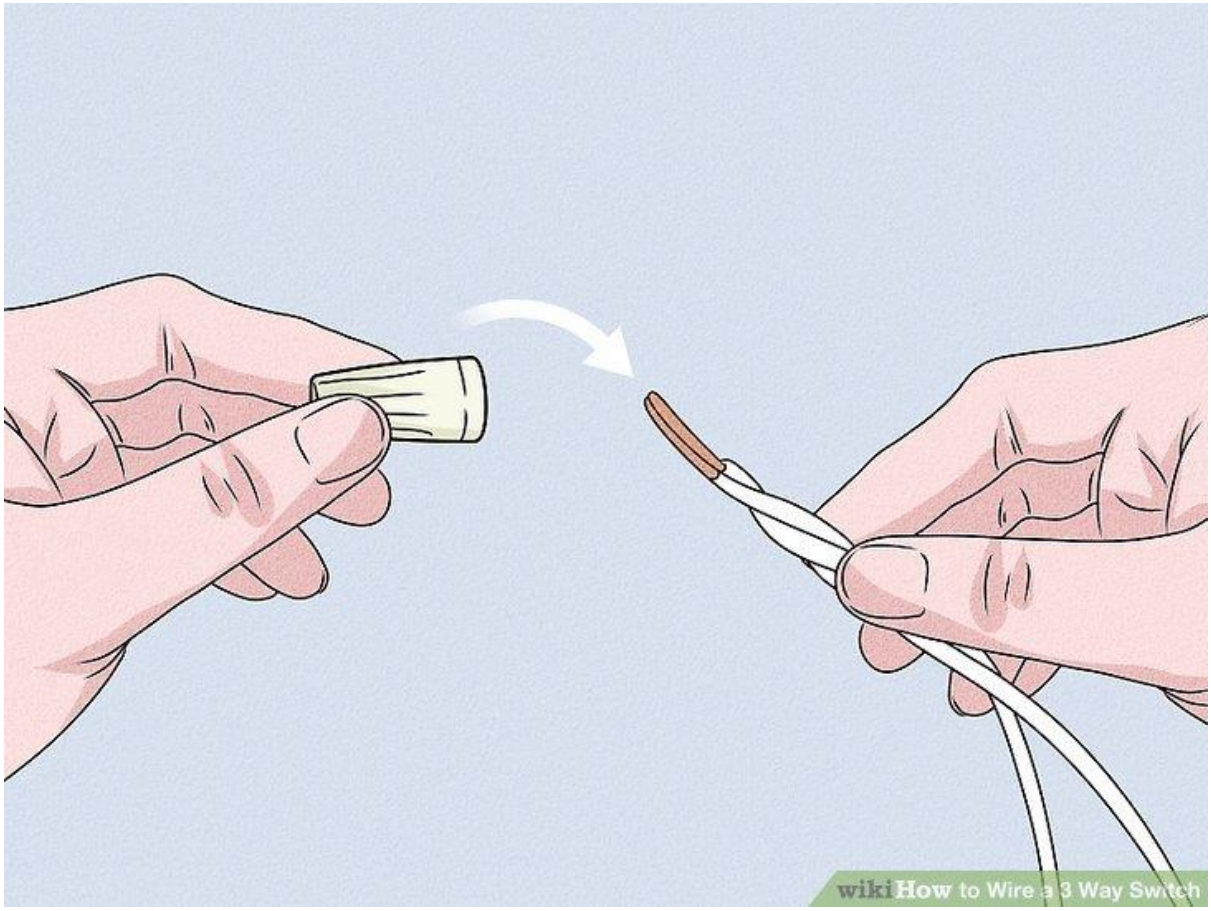
2



Connect another black wire from the light to the original switch location. Use the existing 2-wire conductor leading from the light to the switch. Attach the wire to the black common screw on the switch.

- Make sure you don’t attach the traveler wires to the common screw, or else the switches won’t work properly.

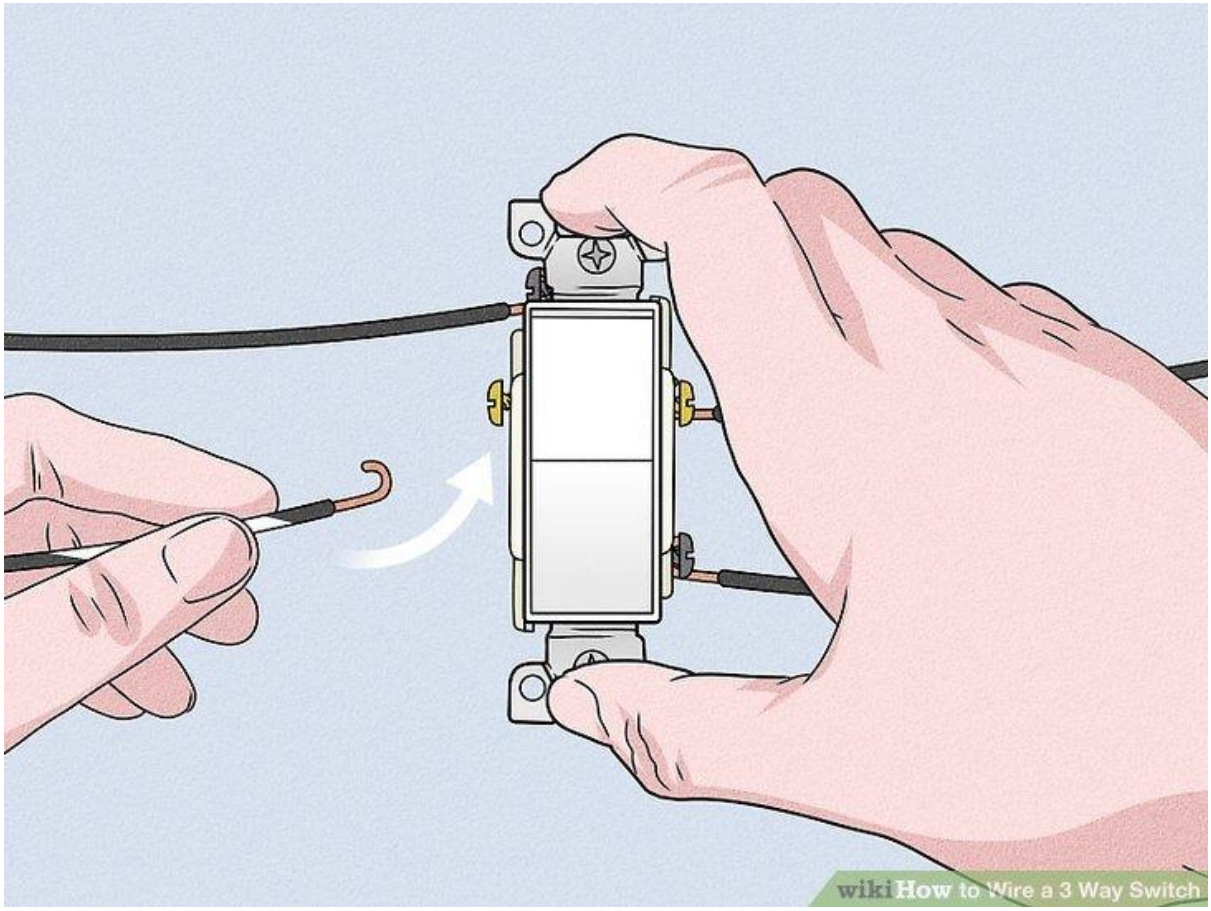
3



Cap the white neutral wires to each switch box. Place a plastic cap on the end of the white wire from the top conductor in the new switch location. Take the neutrals from the other end of the top conductor, the power source, and the light and cap them in the original switch location.

- Neutrals need to be in place at every switch box according to the NEC 2017 electrical code. Older homes may not have neutrals in the switch boxes. It is okay to replace switches in this instance.
- If you install smart switches, the neutral will attach to them and make it work. If there isn't a neutral wire in the switch box, you have to run one from another location before installing the smart switch.

4



Connect the traveler wires using the bottom conductor. Use the black and white cables from the bottom conductor to attach the traveler terminals on each switch. It doesn't matter which terminals they are attached to on each switch. Use a pair of pliers to bend the exposed ends of the wire around each screw.

- Mark the white traveler cable with a black piece of electric tape so you know that the wire is hot.
- If you're using a 12/3 or 14/3 cable, use the black and red wires as your travelers.

5

Cap the equipment grounding conductors together at each switch and the light. Find the grounding screw on the top or bottom of each of the switches. Wrap the wires tightly around the screw and use a screwdriver to tighten the screws. Cap the grounding conductors at each switch box. Push the wires into the back of your box.

- Make sure you ground both switches, or else they may not be safe.
- If your switch boxes are made of metal, the grounding conductor needs to bond to them as well.

6

Replace the switch box covers. Screw the switches into the electrical box and secure the wall plate over the opening. Flip the breakers back on and test the switches.

Warnings

- Always make sure the power to the area where you are working is off to avoid electrocution.
- Call a licensed electrician if the wiring in your house is aluminum. The inside of the coating will be light gray instead of copper. You should not work on it yourself.

Things You'll Need

- 14-2 or 12-2 wire cable
- 3-way switches
- Voltage tester (non-contact)
- Screwdriver
- Needle-nose pliers
- Wire stripper

- Black electrical tape
- Utility knife

Tips

- According to the 2017 National Electric Code (NEC), a neutral is required at each 3-way switch location to complete the circuit.

House Wiring for Beginners

Jump to navigationJump to search

House Wiring for Beginners gives an overview of a typical basic domestic 240V mains wiring system as used in the UK, then discusses or links to the common options and extras.

Further information on options is available in the Rewiring Tips article.

Contents

Safety

- This article cannot practically cover everything.
- The writing of this article may be incomplete when you read it.
- Laws and regulations change over time.
- Interpretation of regulations and law may change over time
- The article may assume knowledge that some readers might not possess
- Unexpected situations may change the specific requirements for some circuits.

For these reasons and more, one should not carry out safety critical work based solely on wiki content. Information and plans should be independently checked and verified before action.

Anyone installing wiring should also understand some basic safety issues not discussed here. This article is an introductory overview rather than a complete A to Z on rewiring, and assumes some basic electrical knowledge.

Regulations

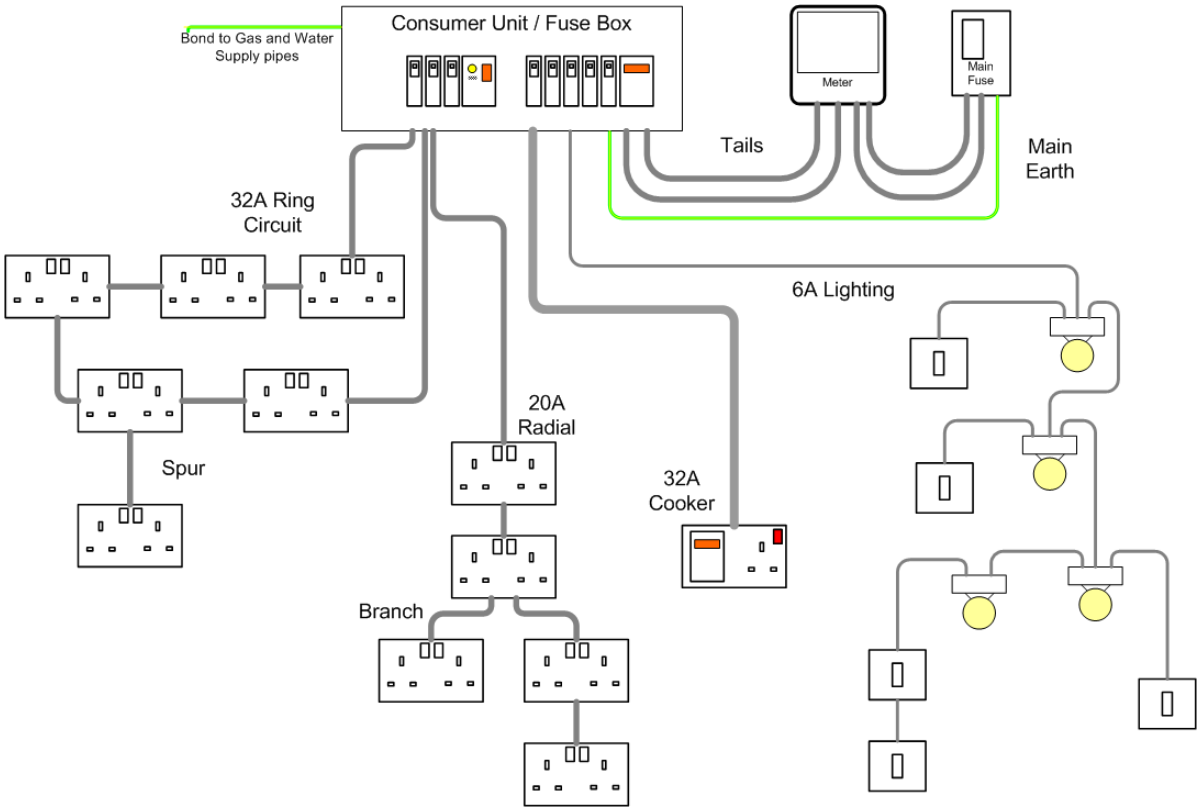
Some regulatory requirements are mentioned in this article. These apply to new wiring, and in many cases are not requirements for existing wiring.

Word Meanings

The Electrical Glossary may be useful.

Overview

Typical house wiring diagram illustrates each type of circuit:



In a typical new town house wiring system, we have:

- Live & Neutral tails from the electricity meter to the CU
- A split load CU
- Ring circuits from 32A MCBs in the CU supplying mains sockets. 2 such rings is typical for a 2 up 2 down, larger houses have more.
- Radial lighting circuits from 6A CU MCBs. 2 or more circuits typical.
- Earth connection from incomer to CU.
- 10mm² Main equipotential bond to other incoming metal services (gas, water, oil)

Systems often have some of the following as well:

- Dedicated circuit MCB & cable supplying cooker
- Dedicated high current circuit MCB & cable supplying shower
- 2 way lighting switching for stairs, large rooms & walk through rooms
- Outdoor lighting supplied by a 6A MCB, often via a PIR motion detector switch.
- 16A MCB and cable supplying hot water immersion heater.
-

AEI Storage heater switch with separate supplies for (unfused) off-peak supply on dedicated radial circuit and (fused) boost/fan supply on the socket circuit.

A high current MCB supplying storage heaters. Sometimes these are run from the main CU, but often from a timeswitch controlled dedicated CU (with either a separate "off peak" electricity meter, or a dual tariff meter).

The radial lighting circuit has 3 common wiring options, which may be mixed at will:

- "Loop-in" (as per diagram above). The circuit is fed to each lamp fitting in turn, and a separate cable connects from the fitting to the switch. (this is the most common method)
- Switch loop through (the circuit connects to each switch in turn, and a separate cable goes from the switch to each lamp)
- Junction box loop in, where the termination and feed connection are done at junction boxes, and cables run to switches and lamps from there.

The diagram is shown with 6A lighting fuse and 32A ring circuit MCB. Other options are also possible:

- 20A radial socket circuits
- 10A lighting circuits are occasionally used

Consumer Unit (CU)

The Consumer Unit, previously called a fusebox, contains these things:

- A main isolating switch. This switches off everything.
- In most cases at least one RCD
- A fuse or MCB for each circuit. This cuts the power to the circuit in the event of high fault current.
- An earth connection block which connects earth to the earth wires of the various circuits
- 1 or 2 neutral connection blocks which supply the neutral connection to the Neutral wires of the various circuits

Each fuse or MCB supplies one circuit only. One circuit may supply anything from 1 to a large number of loads.

Split Load CU

Split load CUs have become popular in recent years, and ubiquitous since 2008 with the introduction of the 17th edition of the wiring regs. They usually offer significant advantages over the traditional unsplit CU type. See 17th Edition Consumer Units for more details.

A split load CU divides the MCBs into 2 or more separate banks. Each bank usually having its own RCD. There should also be a master switch that will switch the whole CU.

The split load CU has the following advantages:

- Some wiring work can be carried out with just a section of a CU turned off, perhaps retaining access to light and power while working.
- Almost all faults can only take out the power to part of the system
- The split load arrangement means both RCDed and non RCDed loads can be supplied from the one CU.

Split load CUs are recommended, and this article will assume the use of a split load CU.

Earthing

Earthing is a fundamental safety system used in electrical installations. It works in co-ordination with circuit breakers MCBs, Fuses, and RCDs to ensure that an

electrical supply can be disconnected quickly in the event of a fault. This greatly reduces shock risk.

Most houses have an earth connection supplied by the electricity supplier. Those that don't (generally country houses several miles from the nearest town), use a local earth rod instead.

The supplier's earthing terminal or your own earth rod is connected to the CU earth block. Each electrical circuit in the house takes its earth connection from the CU earthing block.

Residual Current Devices (RCD)

The 17th and later editions of the wiring regulations impose more frequent requirements to install RCD (or RCBO) protection than the previous 16th Edition. In general, ANY cable which is buried less than 50mm below a wall's surface AND is NOT mechanically protected, or wired in one of a number of specialised cable types that incorporate an earthed screen must have 30mA trip RCD protection. Such circuit protection may be derived from either an RCD protecting several circuits, or individual RCD/RCBOs on each circuit.

New installations will have two or more RCDs. Older ones may only have one or none. (currently half the properties in the UK have none according to research)

RCDs reduce the risks of injury from electric shock (they don't eliminate it completely), however they can also introduce reliability and issues of their own if not used in an appropriate way. Historically RCDs were usually only used on some circuits rather than all.

With a supplier provided earth connection, the most common historical arrangement was a split CU with a RCD on one side, and no RCD on the other. Generally the RCD side is used to supply sockets and shower, with most other items on the non-RCD side.

With a local earth rod, the situation is different in that all circuits must be RCD protected, since a local earth rod is not usually a sufficiently good earth on its own to clear all earth faults. So RCDs are used on all circuits even in older installations. A common option is to have the supply fed through a 100mA time delayed RCD, the output of which goes to a split CU with RCD on one side. This is not an ideal arrangement, as a large earth leakage fault on the non-RCD side will cause complete power failure, and sometimes inability to reset the power.

RCBOs

An RCBO is a combined RCD and MCB in one module, and is fitted in place of an MCB. RCBOs allow individual circuits to be protected by their own RCD without any risk that a fault in an unrelated circuit could cause it to trip. However protecting all circuits like this is more expensive.

Where RCBOs are used, they are fitted in the non-RCD side of the CU, and supply circuits needing RCD protection. See 17th Edition Consumer Units for details.

Neutral Connections & RCDs

Neutrals for circuits protected by different RCDs (or those from an RCD and non RCD protected circuit) must not be mixed. If any neutral wire is connected to the wrong side, the RCD will trip.

The same principle is true for RCBOs, each RCBOed circuit needs to have its neutral connected to the RCBO neutral and not elsewhere.

RCD or non-RCD side

Historically, installations using a supplier earth connection will run some circuits directly off the non RCD side of a CU. These include:

- Lighting circuits
- Immersion heater circuits
- Circuits
- Circuits where disconnection is undesirable (i.e. freezers, fire alarms, boilers, etc)

All socket circuits, should have RCD protection since Plug-in are the source of almost all electrocutions.

Modern installations will typically provide additional RCDs so that vulnerable circuits (i.e. lighting) are unlikely to be affected by a nuisance trip, and so that circuit types prone to high earth leakage (e.g. things with heater elements and water in close proximity) are separately protected from others.

Sockets

Sockets may be wired on ring circuits or radial circuits. Mostly rings are used, as they use less copper for most circuit layouts, they have safety advantages over radial circuits (sometimes debated), can provide more power, and cover more floor area per circuit.

Ring

Sockets are on 32A ring circuits in most house installations. These use a ring of cable (ie a loop), so that at the CU 2 cables are connected to the MCB instead of 1. An unlimited number of sockets may be connected on each ring.

One ring circuit per floor is a fairly common arrangement, but by no means the only option. Larger houses generally have more rings. Its also common to have a ring dedicated just for sockets in the kitchen since that is where you will find many of the highest power consuming appliances in a modern house.

2.5mm² cable is usually used for ring circuits. 4mm² is used when cable will be under insulation or bunched with other cables.

Spurs

Spurs are permitted, but sockets should be included in the ring rather than spurred wherever practical. Spurring is best only used for later additions to circuits.

Rules apply to the loading and number of sockets allowed on the end of a spur.

Spurring sockets prevents the easy later addition of more sockets in some positions, as a spur may not be spurred off a spur. Spurs also prevent the addition of more sockets at existing spurred positions, whereas a practically unlimited number of sockets can be added where a socket is in the ring. Bear in mind the number of sockets wanted has risen greatly over the years, and can only be expected to rise further.

Radial

Radial socket circuits are used less often. These use a single cable from CU to socket, then a single cable to the next socket along the line etc. Radials use more copper on most circuits, though less cable on physically long narrow shaped circuits. Connection faults have greater consequences than with ring circuits. (Confusion over the relative safety of ring & radial circuits is widespread.)

- 20A radials use 2.5mm² or 4mm² cable.
- 32A radials use 4mm² cable

Number of Sockets

Minimum and desirable numbers of sockets recommended per room are given. Recommended numbers are inevitably a matter of opinion, and are only recommended as a starting point for consideration.

- Bedroom
  - Minimum: 1 double socket at each of 2 locations
  - Recommended: 2x double sockets at each of 4 locations (in or near corners) + a double socket at side of single bed, or a double socket at each side of double bed. 2 way lighting switches controllable at door & bedside.
- Corridor
  - Minimum: none
  - Recommended: 1 double socket for a short corridor, 2 or possibly more in a long one. Put one where a hall table might go.
- Kitchen
  - Minimum:
  - Recommended: Under worktop: 4 or 5 double sockets. Over worktop: 1 double socket per 2 metres. All sockets on ring circuit, no spurs. 2A or 5A sockets on lighting circuit: one above each set of cupboards, one below each set of cupboards, one away from cupboards & worktop.
- Lounge:
  - Minimum: 1 double socket at each of 2 locations
  - Recommended: 2x double sockets at each of 4 locations (in or near corners) + 1-3 double sockets where PC or AV equipment is to be used. If the room has 2 or more doors, 2 way lighting switches controllable at each door. 4-6x 2A or 5A sockets on lighting circuit.
- Utility room:
  - Minimum: 1 double socket
  - Recommended: 2 or 3 double sockets, all on ring circuit
- Bathroom:
  - Minimum: no sockets
  - Recommended: none. 1 socket somewhere out of easy reach in zone 3 if you wish to use an appliance in the bathroom (eg washing machine or dehumidifier). A shaver

socket at the sink is an option, but plugging items in outside the room is probably better practice.

- Home Office:
  - Minimum: a double socket at 2 locations
  - Recommended: 2x double sockets at each of 4 locations (generally near corners), plus anything from 2 to 6 double sockets where computer or other business appliances will go.
- Small shed:
  - Minimum: no electricity supply
  - Recommended: if far from the house, a double socket can be useful. If you'll spend time in it, a light too.
- Large shed:
  - Minimum: no electricity supply
  - Recommended: plenty of lighting & sockets according to size & proposed use. Given the tendency for electricity use to rise over the years, an overrated feed cable may prove useful in time.
- Greenhouse:
  - Minimum: no electricity supply
  - Recommended: A splashproof double socket above head height can be handy. For a dedicated horticulturalist, fluorescent lighting, a couple of splashproof double sockets positioned at head height or above, and a 13A socket for discharge lighting can all come in useful.

Lighting

Radial circuits are used for lighting. There is one lighting circuit on each lighting MCB. Lighting circuits are usually on a 6A MCB or 5A fuse, though 10A can be used (with some extra restrictions (now removed in the 17th edition of the wiring regs)) for large circuits. However if the area served is large, more 5A or 6A circuits would in most cases be preferable.

lighting circuits are typically wired in 1mm² or 1.5mm² T&E cable (1.5mm² allows a longer cable run, before suffering too much voltage drop).

Fuse or MCB

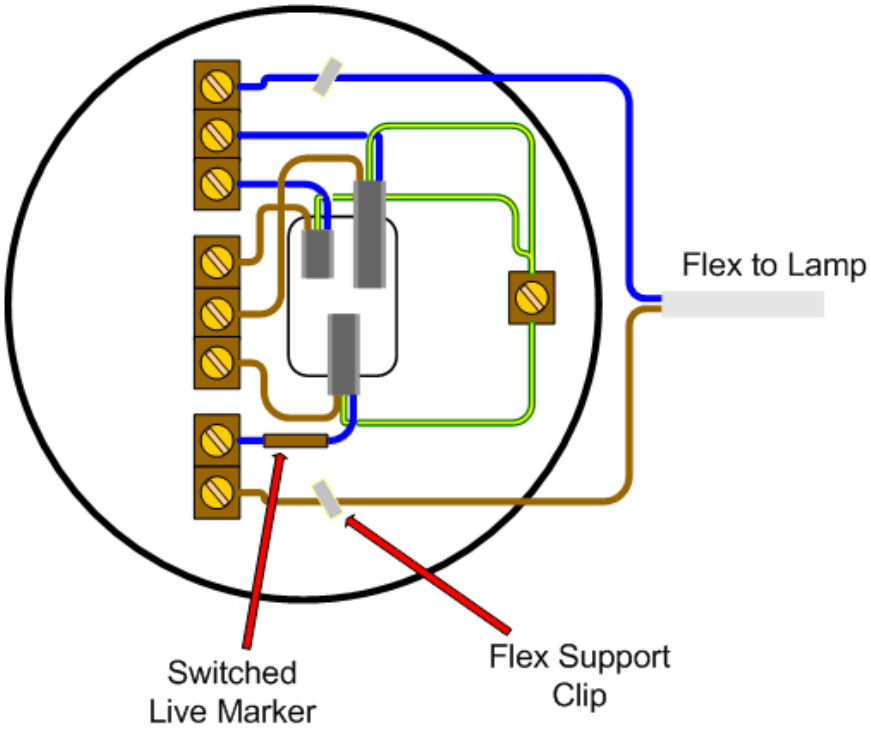
Filament lamp failures can trip MCBs, so fuses have an advantage over MCBs for lighting circuits, as they rarely nuisance trip on bulb failure. (Less sensitive type C and D MCBs can often be used to help reduce this problem.)

Loop-in Wiring

The power feed cable may go to either the switch or the bulbholder. If it goes to the bulbholder, this is called loop-in wiring, and the ceiling rose (a junction box with a downward facing cable outlet) then uses four sets of connections instead of 3, the extra one being a switched live.

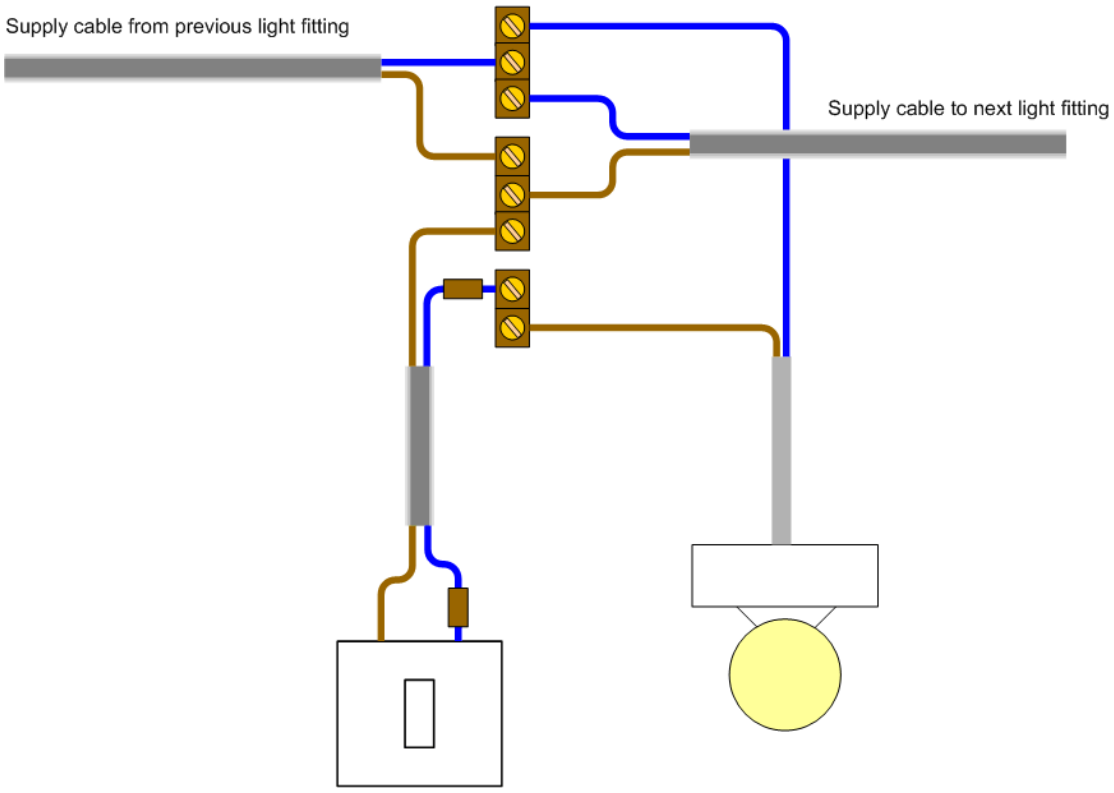
With loop-in wiring, the cable from the ceiling rose to the switch has 3 conductors, namely earth, unswitched live and switched live. Regs conformance requires that brown sleeving be fitted over the neutral coloured conductor at each end of the switch cable since it is being used as a live.

A typical view inside a ceiling rose:



Which is a little easier to understand in schematic form:

Simplified “Loop In” wiring (earth omitted for clarity)



All cable colours are as expected **except** for the switched live. Light switches are usually wired with standard T&E, which means the switched live wire will be black (existing installs) or blue (new installs) - this **should** be marked with live coloured tape or sleeving (though alas this is often missing).

So beware, if you take down a rose without paying attention to which wire is which, and you re-connect all the blacks or blues together, your fuse or MCB will trip.

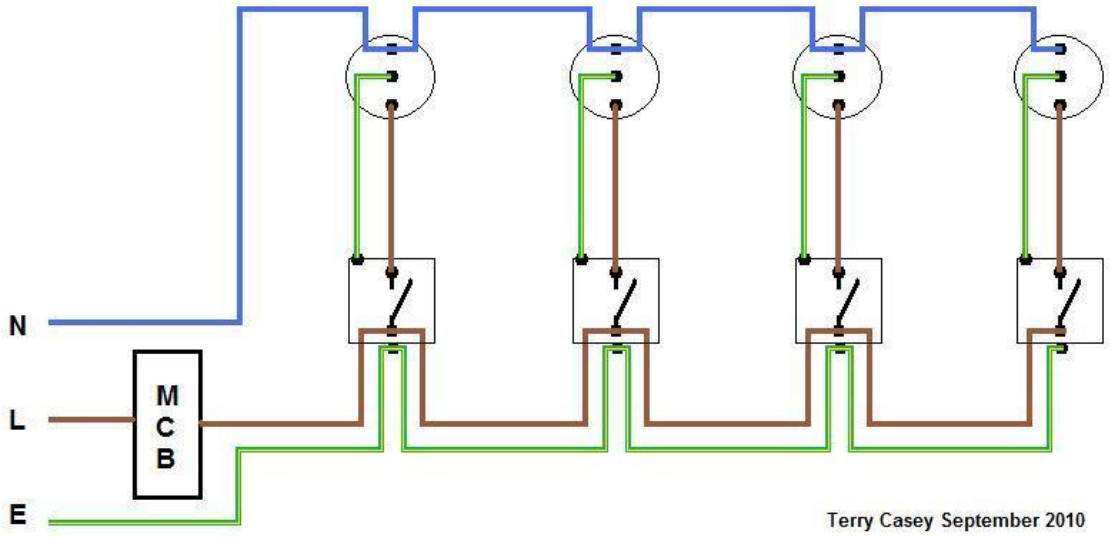
Single & Earth

A less commonly met system of wiring lighting circuits.

The permanent lives and switched lives of the circuit use the single core and earth cable (type 6241Y).

This run starts from the MCB and loops between the lightswitches to provide a permanent live and earth to the lightswitches. Another length of 6241Y is then used from the lightswitch to the light fitting to provide a switched live and earth at the light fitting.

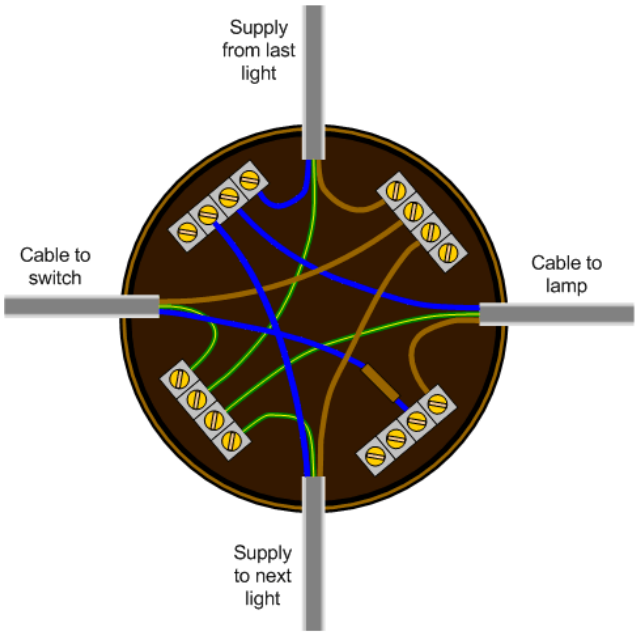
The neutral cable is a double sheathed cable (6181Y with a blue inner sheath) that runs from the CU neutral busbar and from light fitting to light fitting (there will only be one neutral at the end of the circuit).



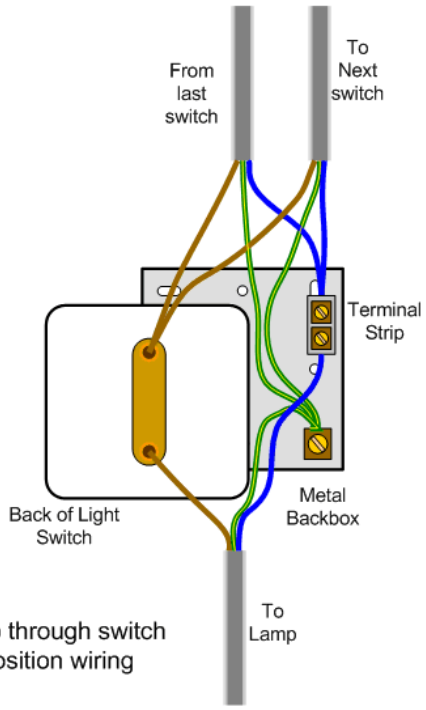
It makes it easier to put light fittings up as there are less cables to mess with at the fitting.

Other Wiring Options

In addition to the common Loop In scheme shown above, other systems are also often used. These are Switch loop through which makes all the connections at a switch. There is also junction box wiring which is basically the same as the ceiling rose system except there is no local connection to a lamp - so its better suited to remote lamps like wall lights. All combinations of these can exist on the same circuit if necessary :



Junction box light position wiring



Loop through switch position wiring

Two Way Switching

Two way switching means having two or more switches in different locations to control one lamp. They are wired so that operation of either switch will control the light(s).

Light circuit earthing

In some older properties (typically wired in or before the mid 1960s), its not uncommon to find lighting circuits without an earth wire. Care should be taken if you have such a circuit to ensure that only appropriate light fittings and switches are used. Most metal light fittings and switches will require earthing, but those marked with the double insulated symbol ⧈ do not need an earth connection. Most plastic switches and light fittings are also safe for use on circuits with no earth.

Note the earth wire in the T&E must be run to all switches, junction boxes & light fittings, including those that are currently plastic. It is not permitted to borrow an earth from another circuit. Ideally the non-earthed circuit ought to be re-wired, or at least have a RCD installed to protect it.

For more information about unearthed lighting circuits see Lighting Circuits Without an Earth

Outdoor Lighting

Outdoor lighting is usually run on its own radial circuit off its own MCB in the CU. Usually this is a 6A MCB, but lighting is less likely to cause problems if run on a 5A fuse. Exterior cabling must be appropriate for use outside (many cable types degrade under prolonged exposure to sunlight for example).

Bathroom Electrics

Bathrooms (or rooms with showers) are "special locations" in the language of the wiring regulations. This is because they are places where people are particularly vulnerable to serious injury from electric shock (due to being wet and barefoot). In modern designs **all** bathroom electrics are supplied by RCD protected circuits.

Zones

Bathrooms are divided into 3 zones, with different rules for each zone.

- Electrical fittings in the bathroom in zone 0 must conform to IPX7 or better, and must be of an extra low voltage type.
- Electrical fittings in the bathroom in zones 1 & 2 must conform to IPX4 or better.
- Electrical fittings in the bathroom outside of the zones do not need to confirm to any specific IP rating, but must be appropriate for the circumstance in which they are used.

There are also limitations to the type of electrical equipment permitted in each zone. See the Bathroom electrics article for more details.

Equipotential Bonding

All metal items that enter a bathroom from outside of the room (e.g. copper pipes, electric circuit cables) are connected together using 4mm² green/yellow insulated wire. Connection is also made to each of the protective earth wires in each circuit that feeds an appliance in the bathroom (e.g. lamps, heaters, towel rails etc). This is called equipotential bonding and is designed to minimise exposure to dangerous voltages that may be present during electrical fault conditions. The wire is connected to metal pipes using BS 951 earth clamps. The wire is connected to radiators using connectors. It is permitted to place equipotential bonding connections immediately outside the bathroom if necessary. Note equipotential bonding can be omitted if all the circuits that enter the bathroom are protected by RCD(s) with trip thresholds of 30mA or less.

Sockets

Until the introduction of the 17th edition of the wiring regulation, sockets were not permitted in a bathroom at all, unless they were either a transformer isolated shaver socket, or sockets to power extra low voltage devices, both of which are permitted in Zone 2 or outside. For more information on bathroom electrics, see Bathroom electrics.

Showers

An electric shower will be fed on its own high current cable, fed from its own MCB on the RCD protected side of the CU. For more information on electric showers, see Installing an electric shower

Kitchens

Modern kitchens often have a high concentration of electric appliances, many of them high power consumption devices. Hence they are worthy of special mention.

Cookers

All in one electric cookers (oven, hob & grill in one unit) are fed by a high current cable from the CU, typically on a 32A MCB. Single cavity ovens with no hob are more often put on a 13A plug. Most hobs require their own high current feed, but some are available that incorporate load limiting switching, and are designed to be run on a 13A plug. Combi cookers (microwave & fan oven, with or without grill) are always on a 13A plug.

Equipotential Bonding

Contrary to popular belief kitchens do not need equipotential bonding.

Number of Rings

Most kitchens are supplied by one ring circuit. However this may be insufficient for large or all-electric kitchens.

Misc Information

Part P

Complete rewires and a number of other electrical jobs are now covered by Part P of the building regulations. For more information on Part P, see Part P

Cable Colour changes

Although the UK has used the European standard of Blue / Brown colouring for flexes for a long time, the same colour standard has also now been adopted for fixed wiring as well. Hence you need to be aware of the changes:

Old colours:

- Red = Live
- Black = Neutral
- Bare or green/yellow = Earth

New Colours:

- Brown = Live
- Blue = Neutral
- Bare or green/yellow = Earth

For more information on cable colours, see Wiring colour codes

See Also

For more info on house wiring see

- Rewiring Tips
- Electrical Glossary
- Bathroom electrics
- Taking electricity outside
- and Category:Electrical

For more information on lighting see

- Category:Lighting
- Dimmers & Switchbanks

For more information on outdoor lighting, see

- Category:Lighting
- Rewiring Tips#Outdoor Security Lighting
- Dimmed PIR Lights
- Taking electricity outside

For more information on RCDs & RCBOs, see

- RCD
- Rewiring Tips

- To suggest article improvements, click the 'discussion' tab at top of page
- Wiki Contents
- Wiki Subject Categories

Home wiring guide

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- Overview

Safety

Consumer Unit

Cable

Radial Circuit

Ring Main

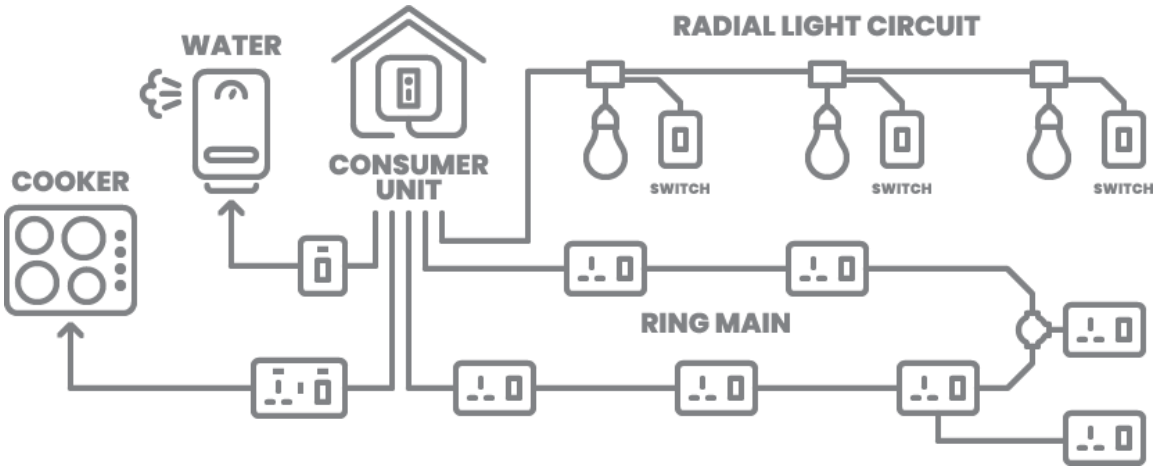
Spurs

Appliance Circuit

Earthing & Bonding

Electrical Device

Overview



This is an overview of a typical UK home wiring. All circuits begin from the consumer unit.

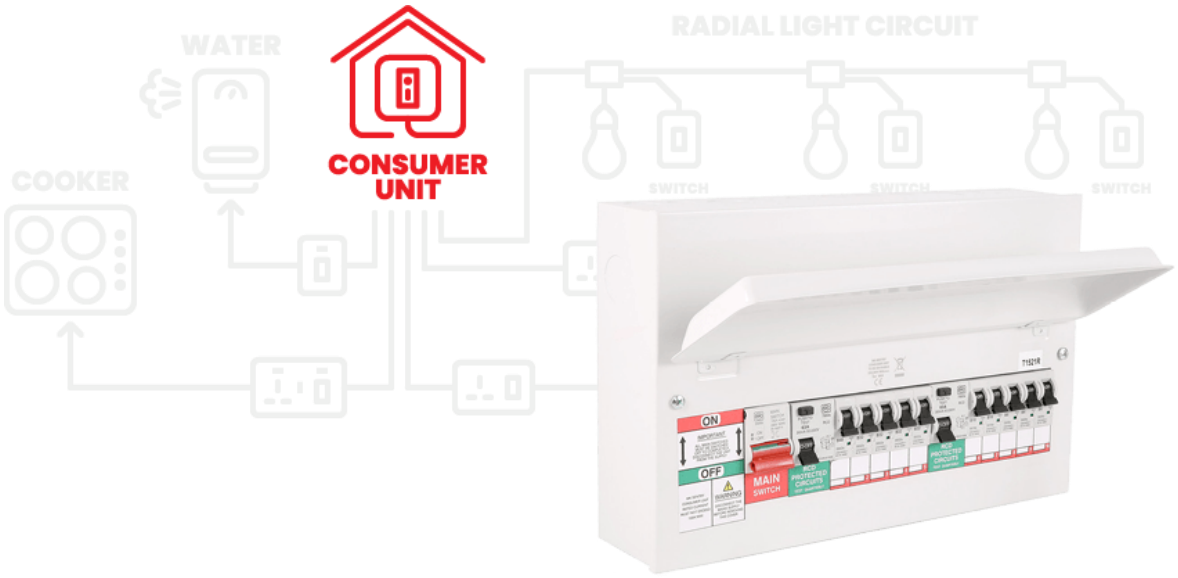
There are 3 main kinds of circuits:

- Ring main
- Radial circuit
- Hard wired appliance circuit

Safety

- Product must be installed by a competent person (e.g. a qualified electrician) in accordance with the relevant clauses of the current edition of the IEE Wiring Regulations (BS 7671: Requirements for Electrical Installations) and appropriate statutory regulations.
- Switch off main power at the consumer unit.
- Remove the circuit fuse to isolate the circuit you are working on and keep the fuse in a secure location to avoid accidental replacement.
- Turn off the circuit breaker of the circuit you are working on and lock it if possible.
- Place a note in a visible location to advise that you are working on the circuit.
- Make sure the circuit is not live by checking it with a socket tester or voltage tester.

Consumer Unit



The consumer unit or commonly known as fuse box is the heart of a home wiring installation. It is usually mounted near the energy meter. A modern consumer unit as pictured above houses modular electrical devices called circuit breakers. There are 4 main kinds of circuit breakers in a common household: Main switch, MCB and RCD.

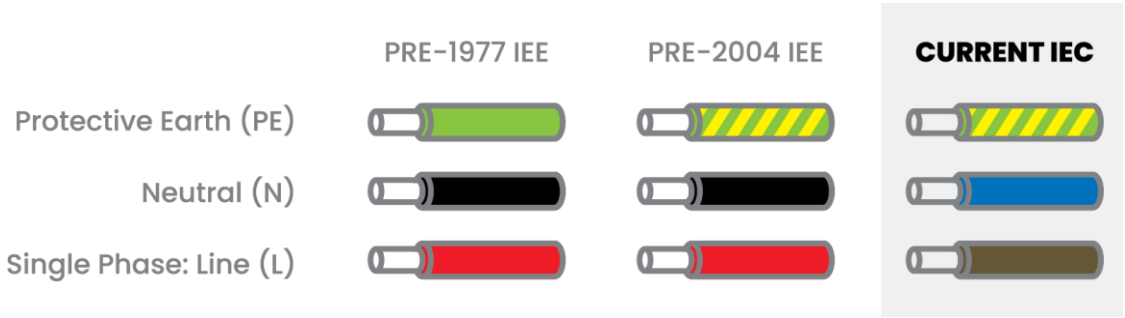
The main switch functions like a master switch that is able to isolate the incoming electrical power supply to the house.

After the main switch the incoming power supply is split to several circuits such as power, light and appliance.
Each circuit is protected & controlled by a miniature circuit breaker MCB. When the circuit draws current above the MCB rated current, the MCB trips and turns off the power to protect the devices on that circuit.

In modern homes, consumer units are also equipped with a residual current device RCD. RCD is a sensitive safety device that switches off electricity when it detects a fault. It is designed to prevent electrical shocks & fire caused by earth faults. Circuits that powers outdoor devices must be installed with RCD protection.

Every circuit breaker is then labelled carefully so that the circuits can be identified and isolated when work needs to be done on them.

Cable



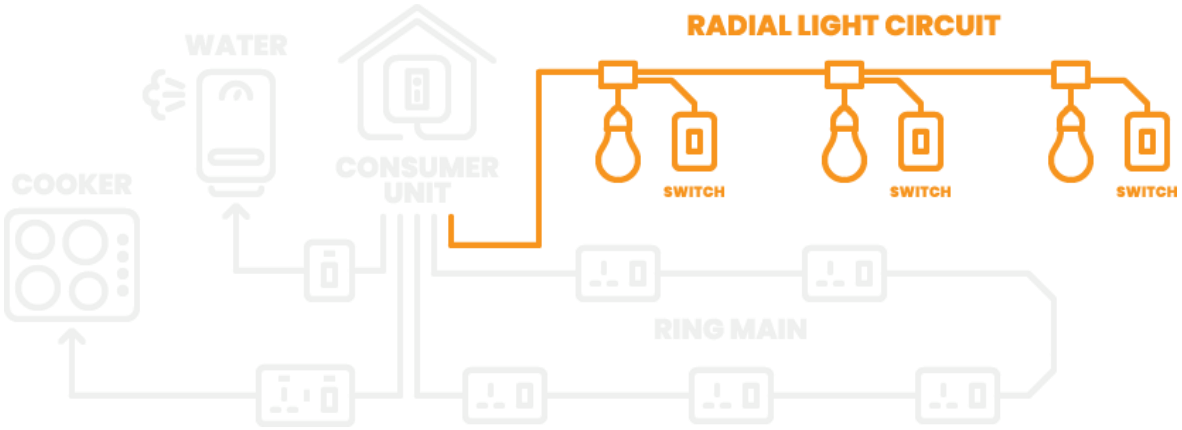
Cables that are used in home wiring are separated into three copper wires, live, neutral and earth.

Electrical current flows to electrical devices along the live wire and flows back along the neutral wire. The earth wire which is located between the live and neutral wire provides a safe escape route for leakage current from a circuit as a result of electrical fault or poor connection.

With the progression of wiring standards over the years, there are several electrical wiring colour coding used in homes around UK. The colour coding for current wiring standard is highlighted above. Brown for Live, Blue for Neutral and Green/Yellow for Earth. This colour coding is implemented in 2006 Amendment 2 of 17th Edition BS7671 to harmonise the UK & Europe wiring colours to maintain consistency & avoid confusion.
It is important that the wiring is done in accordance with BS7671 Wiring Regulations. To ensure safety, it is important to make sure the wiring is in good condition. The average lifespan for wiring is around 30-40 years and the condition deteriorates over time.

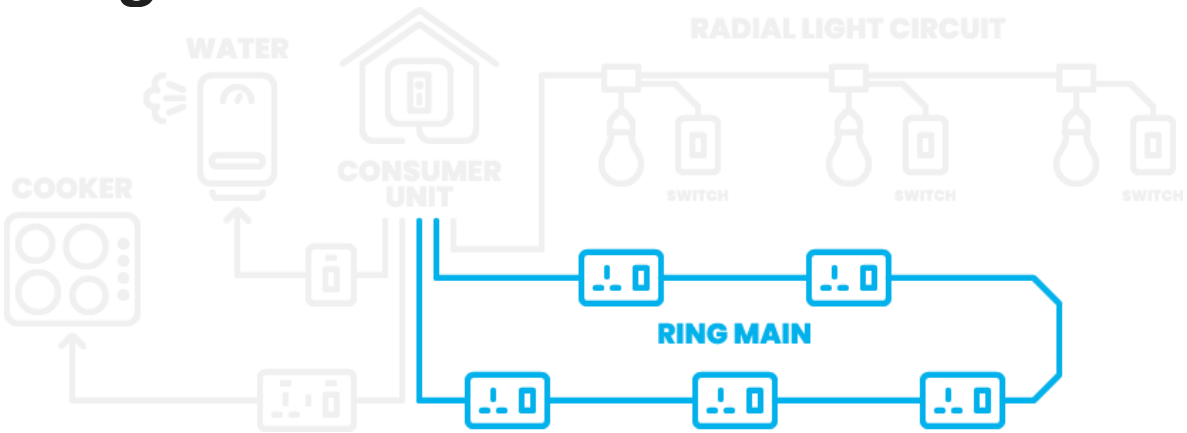
Some properties in UK are currently still using wiring with old colour coding. This is a sign that the wiring is quite old and it needs to be tested or updated.

Radial Circuit



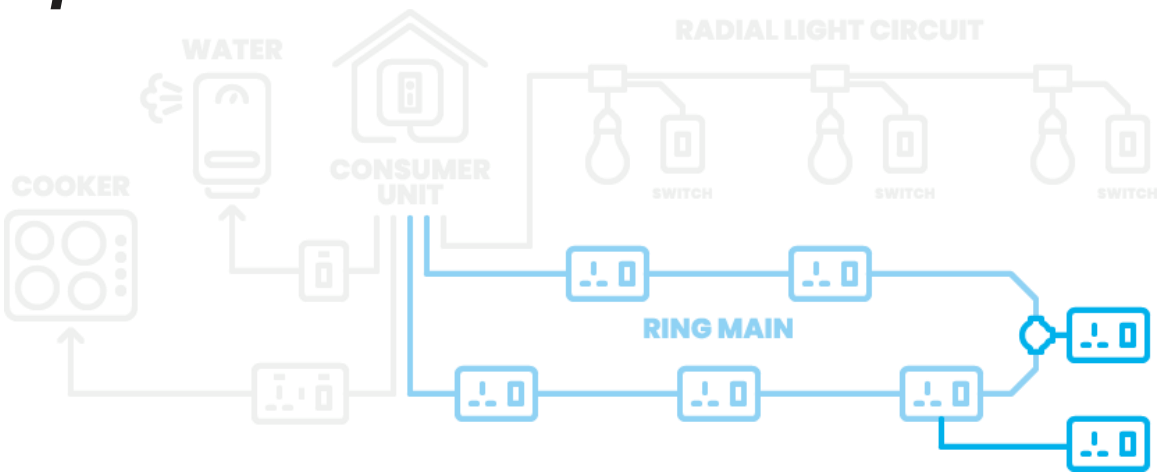
Radial circuit is a single cable run from a consumer unit circuit breaker to a number of electrical devices and terminates at the last device.
The current rating of a radial circuit limits the area the circuit can supply. For example, a 20A radial circuit can supply up to 50 square metres and 32A radial circuit can supply up to 100 square metres.

Ring Main



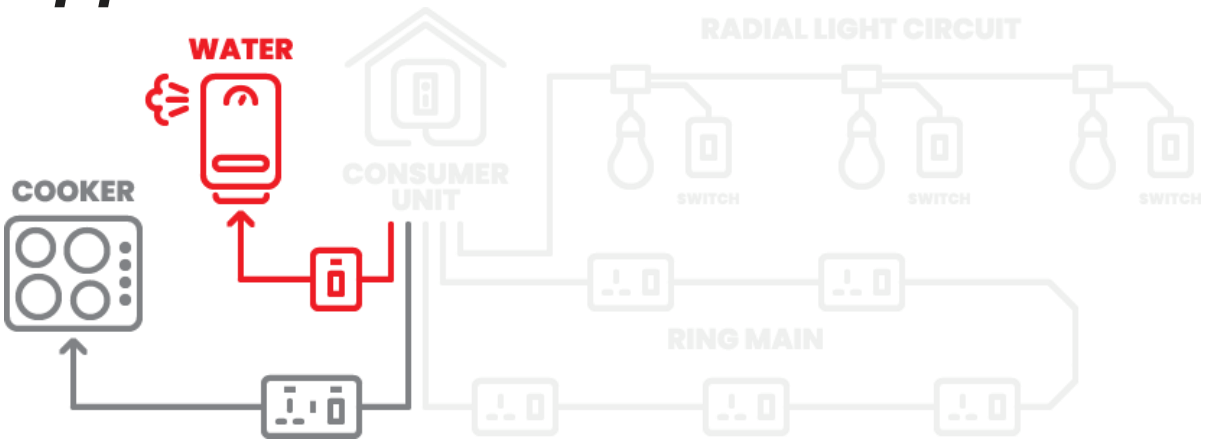
Ring main circuit starts from the consumer unit, connects to a number of electrical devices (typically sockets) and then returns to the consumer unit. Electrical current can flow from either end of the ring.
This increases the current carrying capacity without increasing the wiring size. The ring main is typically 32A in rating which allows it to power an area of 100 square metres.

Spurs



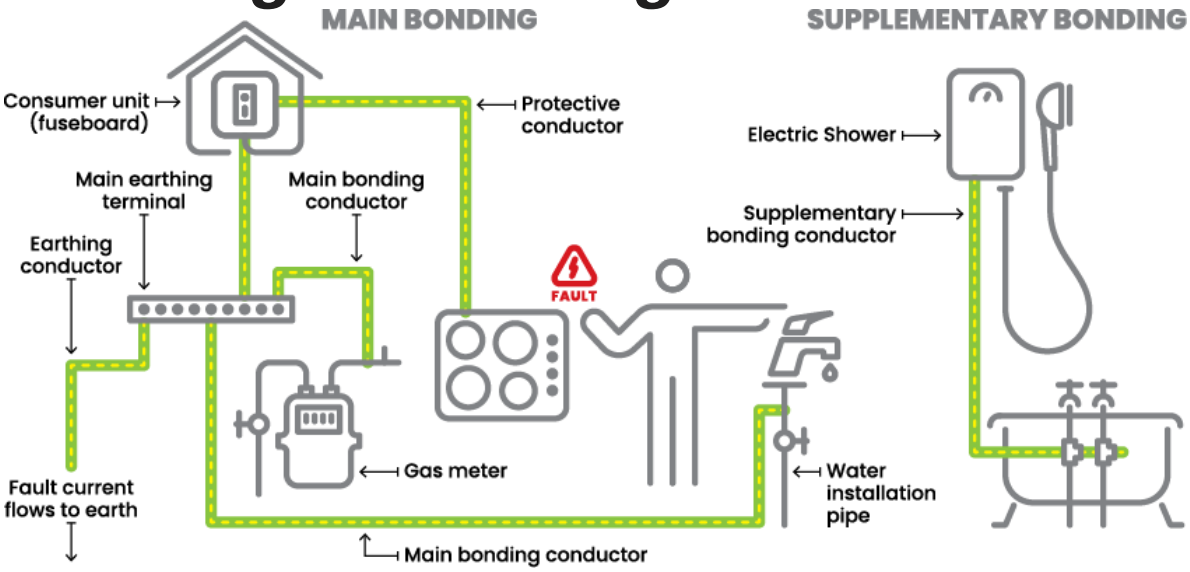
Spur is a short branch of cable from existing ring main circuit. The branch can stem from an existing electrical device or from a junction box as pictured above.
Every unfused spur can only supply one socket or connection unit. The total number of spurs cannot exceed the number of devices on a ring main circuit.

Appliance Circuit



High current hard wired appliance such as cooker, hot water unit and electric shower require dedicated circuits from the consumer unit. These circuits have higher gauge wiring and protected by high rating circuit breakers.
Cookers are typically controlled by a cooker control unit and other hard wired appliances controlled by connection units. The switches for the connection unit are typically double pole, meaning it switches both live and neutral at the same time.

Earthing & Bonding



Earthing and bonding must be implemented in accordance with BS7671 to ensure the safety of the wiring installation. Both earthing and bonding uses the yellow and green wire colour coding.

Earthing is required in every home wiring installation to protect you against electrical shocks. Electrical current always uses the shortest path to flow from the electrical fault to the ground. If a circuit does not have earthing & a fault happens, the metal body of the faulty appliance can become live. If the human body comes in contact, it can become the shortest path to ground and lead to potentially fatal incident. If a fault happens on a properly earthed circuit, the electric current will flow through earth wire to ground and this will trigger the circuit breaker in consumer unit to cut off the power supply instantaneously.
Bonding is a connection of all metal components to the earth circuit. Taking the image above as an example, if you were to touch the faulty cooker and then touch a metal tap in your kitchen, you would be the earth path and could receive a potentially life threatening electric shock. The lack of bonding could create a chain effect that makes all metal parts, including metal water pipes, in a home to carry live electrical current.

Electrical Wiring Devices

Switch

Light Switch

Dimmer Switch

Appliance Switch

Pull Switch

Appliance Pull Switch

Socket

Unswitched Socket

Switched Socket

Switched Socket with USB Charger

Connection Unit

Unfused Connection Unit

Fused Connection Unit

Cooker Control Unit

Mounting Accessory

Metal Back Box

Surface Pattress Box

Dry Lining Box

Lighting Accessory

Pendant Set

Lamp Holder