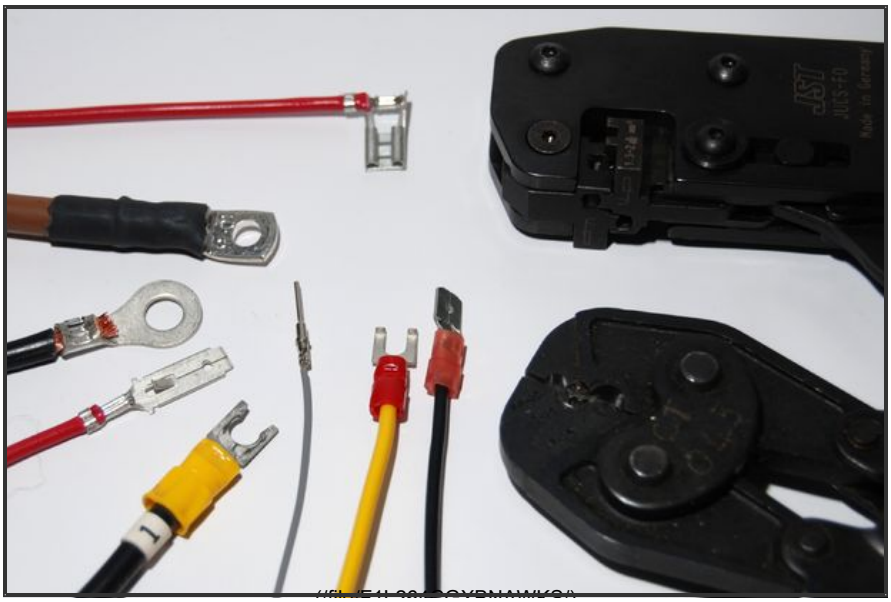

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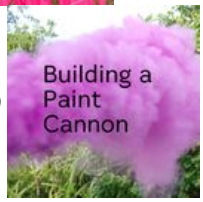

(/id/Paint-

Whilst understood well within professional harness makers, the correct application of crimps is something that doesn't seem to be as widely understood

in DIY circles with much information available ranging from not very thorough to out-rightly wrong; One of my friends was once given the advice by an employee in a car hi-fi shop to hold the crimp onto the cable with insulating tape and nothing else..... Crimping is a technique that can produce reliable, long lasting joint, efficiently and easily with very little training.

There are a vast range of crimps out there in the market- industrial users of crimps have good access to information from the crimp and tooling manufacturers so I won't go into depth on these applications. Instead, in this Instructable I hope to give some advice on using crimps that you are likely to encounter in installing accessories or making repairs to your car, boat or caravan or in projects at home.

Much of this Instructable will focus on materials and tools, so I will split this down into detail in three main areas and will keep the introduction materials simple:

Materials

Good quality crimp terminals to suit the application

Stranded wire of a known specification (not solid core)

Heatshrink

Tools

Good quality wire strippers

Crimp tool to suit the terminals

Step 1: Choosing the Wire

Cannon/)

(/id/Messtival-Very-Messy-Games/)

Tags: crimp (/tag/type-id/keyword-crimp/) crimping (/tag/type-id/keyword-crimping/) terminal (/tag/type-id/keyword-terminal/) wire (/tag/type-id/keyword-wire/) wiring (/tag/type-id/keyword-wiring/) conection (/tag/type-id/keyword-conection/) connector (/tag/type-id/keyword-connector/)

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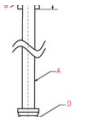


How to crimp a connector when connecting your cables (/id/How-to-crimp-a-connector-when-connecting-

Custom PWMs/Servo Wire (/id/Custom-PWMsServo-Wire/)
by FRC1477

Choosing the Wire

Depending on your application, you may or may not have a choice on the wire to use. Firstly do not use solid cored wire, and if you want a reliable job heavily avoid ‘conduit wire’ (a few largish strands intended for mains buried in conduit). Specific types of crimps are required to use this type of wire reliably. The best wire for general use will be one with many strands.

Next determine the wire size- This may be listed in a number of ways, the most common being AWG (American Wire Gauge)(e.g. 16AWG), Cross sectional area in square mm (e.g. 1sqmm) or strand and diameter count (e.g. 32/0.2). There are plenty of tables around to help you convert between common sizes.

If buying new wire, the size will be listed on the reel or packet. If modifying an existing installation it may be more difficult to determine. Many wires are now either printed or moulded into the insulation with this information repeated along the length so it will be work a look to see if you can find it.

If you can’t find this information you will have to fall back to measurement and a bit of calculation. Strip back a length of the insulation and then count the number of individual wire strands and measure the diameter of one with a micrometer or vernier calliper. You can then cross refer to a table or calculate the cross sectional area by multiplying the number of strands by the area of one strand calculated by πr2.

Insulation diameter is important for the most reliable crimps as it affects how the rear of the crimp grips the wire, however as long as you use standard wires, then this should not give you a significant issue. It is however important to consider this is you are using a crimp in a professional application.

Step 2: Choosing the Crimp Terminal

Show All Items

Choosing the Crimp Terminal

Now you know what wire size you have, you will also need to work out what you need to connect to. There are many, many variations of crimp, but there are a handful of very common ones, most shown in the image. Crimps designed to fit to threaded fasteners can be simply specified by the bolt size (e.g M4/ ¼”). Others may have different names dependent on the industry and manufacturer (eg lucar, faston, ¼” blade). Critical to getting a good joint will be the quality of the crimp- it is difficult to get a good, long lasting joint with a poor quality crimp terminal.

Plating

Terminals are available with a number of different plating options to give corrosion protection and for other technical reasons (such as low contact resistance). I would avoid any crimp (if at all possible) that doesn’t have a plating so that you don’t have to re-visit it in the future to clean it of corrosion. This will be especially important in the more corrosive atmosphere like those found on a boat. The most common available plating is tin, and this will be suitable for most needs. Silver and gold are also common in certain applications, but are usually used in low current/ signal applications where a minimum resistance across the joint is needed.

Pre Insulated Crimps

If using pre-insulated terminals the better quality connectors have a metal sleeve to grip the wire insulation, the lower quality parts don’t have this. The image of the sectioned crimps shown make this obvious, but to determine this when not

sectioned, look down the barrel of the crimp from the wire entry end. You will see metal to almost the end of the crimp in a quality part, but it will stop short in cheaper parts.

All terminals will be sold with a defined wire size range- this should be listed on the packet, but if not and you are using pre-insulated parts you can tell by the colour of the sleeve. The generally adopted standard is:

Red Insulation 0.5-1.5mm2 / 22-16 AWG

Blue Insulation 1.5-2.5mm2 / 16-14 AWG

Yellow Insulation 4.0-6.0mm2 / 12-10 AWG

There are other colours around, but you are unlikely to come across these unless you are doing industrial, aerospace or military work.

Closed Barrel Un-insulated Crimps
These parts are made in one of two ways- sheet formed or tube terminals. The sheet formed ones are manufactured by cutting the material out of flat sheet and then shaping to make a tube on one end. Better quality ones of this type will have thicker material and the seam brazed. Tube terminals are manufactured by cutting a piece tube to length, flattening one end and punching a hole. The tube type tend to be heavier duty and therefore are more common in the larger sizes- for example you might encounter these on a starter motor feed.

Open Barrel Un-insulated Crimps
This type of crimp has by far the biggest amount of variation tending to be the type used in connector housings. Of the many thousands available, by far the most common that you are likely to come across are of the blade type of these, the ¼" blade are the most common with 1/8" (3.2mm) and 3/16" (4.8mm) also frequently encountered. You will find these connectors widely used in cars, domestic appliances, Hi-Fi equipment etc.

You may well find different types on your car for other applications- if you need to replace these good auto-electrical suppliers can often provide you with a kit of parts. These types will often need a very specific tool to crimp correctly.

Turned Pin
These are most commonly encountered in military-spec connectors, but may also be encountered in industrial connectors, RF connectors and high quality D-Types. They are manufactured by turning parts from rod and hence are almost invariably round.

Other Types
There are many other types of crimp around, most of which have specific applications and you are therefore unlikely to encounter in day to day life.

Packaging
A large proportion of crimps are available in a form that enables automatic crimping on a specialist machines- normally a strip or carrier supplied on a reel. These can be crimped with hand tools, but will need to be removed or cut from a carrier strip. Other terminals are supplied as 'loose piece'- individual parts supplied usually in bags or boxes.

Step 3: Choosing a Tool

Choosing a tool

As with any other tool, there are a wide variety of options available, covering a huge range of price and quality. A cheap generic tool may start at £2 with good quality, calibrated hand tools often exceeding £400 and automated equipment running into tens of thousands of pounds or more.

As a general rule, I would try and avoid any tool that doesn't have a ratchet feature- although sometimes this is just not possible, it is best to make the choice knowing why.

Pliers type tools rarely have any method of ensuring that a crimp is correctly consolidated- a ratchet tool will have. You can therefore guarantee that a crimp has been correctly formed (if you have selected the correct crimp and wire for the die). Similarly hammer type tools have the same issue. More about this later.

To get the best results the tool should be selected to suit the terminal- the best way to do this would be to buy the manufacturer's recommended tool for every crimp you use, however this isn't likely to be practical for the DIYer for obvious reasons. Manufacturer's datasheets will generally list the part number of the correct tool. For the most common crimps, there are generic tools available at reasonable prices which will work suitably well. In reality there are a very limited number of manufacturers of these tools in the world, so if you buy a cheap, basic tool the chances are it will be the same part. The main manufacturer of these is a company called OPT in Taiwan- http://www.opttools.com/ . From personal experience these are good functional tools for the insulated terminals, blade terminals and un-insulated closed barrel terminals, and are available at reasonable prices.

The other main manufacturers of hand tools for the big crimp suppliers I am aware of are:
http://www.wezag.de/index.php?lang=en_US
http://www.pressmaster.com/
http://www.rostratool.com/
http://www.dmctools.com/
http://www.astrotool.com/

These do all sell under their own name as well as ‘badge engineering’ for others. You will however have to go to a dealer/ distributor to purchase their parts as they all only sell to the trade.

Step 4: Making the Crimp

(/file/FECYWKTGX8SHL1E/)

(/file/F9R9UM7GXBJUZJ9/)

Making the crimp

If you are using an un-insulated crimp and need to sleeve it, put a suitable piece of sleeving onto the wire. Typically 3:1 shrink ratio, adhesive lined heat shrink would ensure that good support of both the wire and crimp is made. A length at least 2 times the crimp barrel will usually give a good grip. Other sleeving can be used- in particular neoprene sleeves (Hellermann Sleeves) also work well.

Before carrying out a lot of crimps, it is probably worth doing a test crimp on representative wire and terminals to ensure you have settings correct.

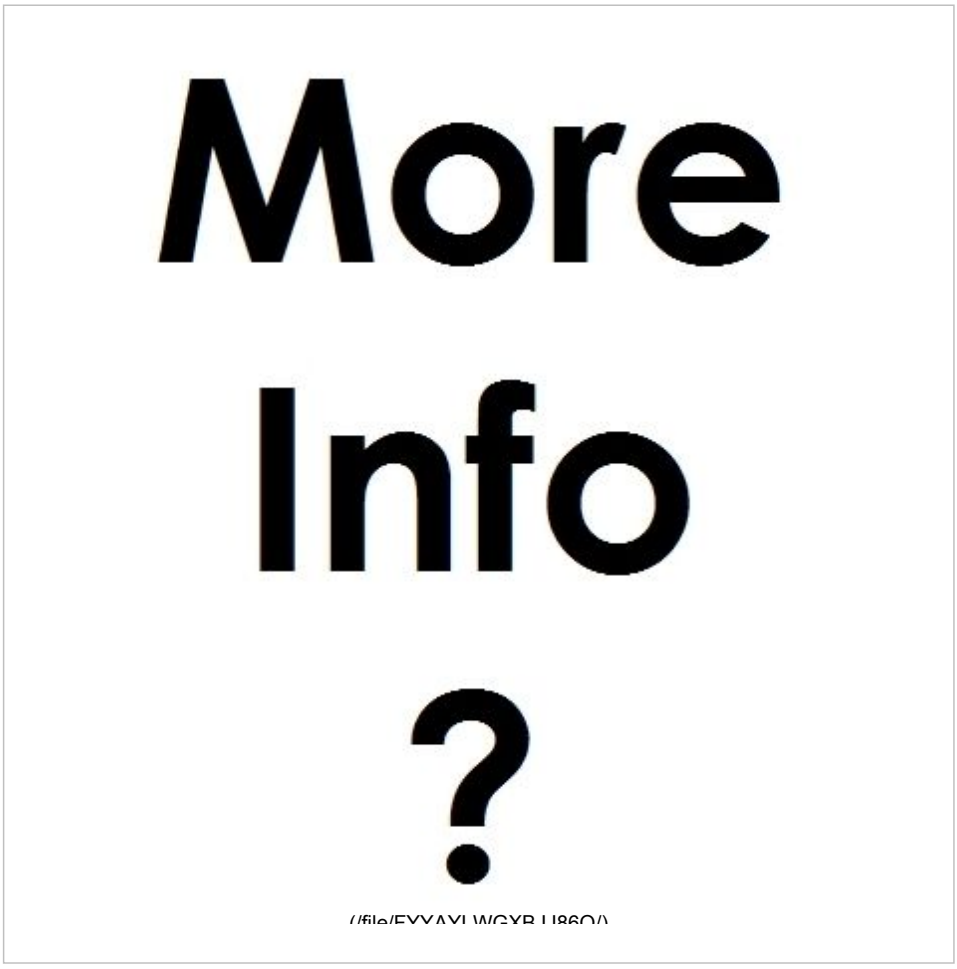
Once you have determined the length of the wire is to strip the end, being careful not to damage the conductors. The length to strip may be stated on the packaging of the crimp, but if not should be so that when the wire is inserted in the crimp, 1-2mm extends out from it. Insert the wire into the crimp, making sure all strands are in, and none are left straying. It is not recommended to twist the strands together.

Carefully place the crimp in the wire in to the tool (you may find it easier to put the crimp into the tool prior to the wire with some crimps), and ensure the wire is seated home. Cycle the tool- if a ratchet tool, until the tool releases. Remove and inspect the crimp- ensure that the wire is in the correct position, and the insulation is gripped successfully. Give a small tug to ensure fully crimped.

If you are using some of the cheaper/ non-ratchet tools, you may have to crimp each terminal twice, possibly with two settings on the tool. If you need to do this, crimp the conductor end of the crimp first, followed by the insulation.

If using heatshrink, or other sleeving. Fit the sleeve and if necessary heat to shrink down. Use a suitable heat source- ideally a hot air gun, but items such as soldering irons can be used with a lot of care. Before shrinking, make sure the sleeving is in the correct place, not obstructing the terminal end of the crimp.

Step 5: Further Information



Further Information
Some Science & quality Control

It is both possible to over and under crimp a terminal;

Crimp systems are designed to compact the wire strands together to a set level so that no interstitial spaces (gaps) are left between the strands. This stops both moisture and oxygen entering the crimp and therefore prevents corrosion from occurring. If this is correctly carried out, soldering the rear of a crimp (as some people will recommend) will have no effect on the corrosion resistance of the joint as there will be no space for the solder to enter. Ultimately the crimp process aims to deform the wire and crimp to a preset level, to eliminate the spaces as well as cold work the wire to a pre-determined level.

Under-crimping which can be achieved by using the wrong tool or die for the crimp, not cycling the tool to fully closed, using pliers type tools or by incorrect selection of crimp and wire, will leave these interstitial spaces open, allowing moisture and oxygen to enter, ultimately allowing corrosion and hence a high resistance joint, or mechanical failure. If under-crimped, the joint will also have

reduced mechanical strength, and at an extreme level will pull out with very low force. Whilst the pull strength of the joint isn't an ideal test (due to over-crimping issues described next), it is a common test that is quick to apply in a factory environment and is hence commonly used as a quality control check.

Over crimping of the joint can have equally disastrous results- at an extreme level, the imposed stress on the wires can lead to complete failure, which is likely to be obvious. A less obvious issue is a greater sensitivity to fatigue, which will occur in places with vibration where the failure may not become apparent for some time. This type of failure is analogous to what happens when you keep flexing a paperclip- the material work hardens and then eventually fails. Over crimping is more difficult to detect as a simple pull test won't necessarily pick up the issue, due to this other quality control techniques tend to be used, although none of these are practical for the DIYer;

Microsectioning- this is a destructive test that is the only completely definitive method of determining the quality of a crimp- It is therefore often used in industry to ensure the design/ calibration and set up of crimp machinery is correct, where samples can be taken and analysed. The process consists of cutting a crimped joint through the crimped area, mounting and polishing the section and inspection and measurement with a microscope. The criteria for a good joint are mostly to determine if correct consolidation has occurred- i.e no void spaces, no inclusions of foreign matter or oxides and approximately hexagonal sections of the crimped wire strands.

Pull tests- by hand this can be a gentle tug on a joint, but in a production environment a calibrated tester is usually used to apply a force until the joint fails, noting the yield force achieved. This can be a quick in-process check which will detect under-crimping, but not necessarily over-crimping.

Crimp height- measurement of the height of the terminated wire in the crimp area is a good method for quality control as it is non-destructive, and can pick up both over and under crimping simply.

Crimp force- many automated crimp tools measure the force applied during the crimping process. This is another reliable method of getting an indication of crimp quality, and has the advantage that it is an in process check- no need to stop machines or remove samples.

Soldering- you may see recommendations to solder crimps elsewhere. There is absolutely no need to solder any crimp. In fact you may reduce the reliability of the crimp by doing so. Crimps are designed to control the flexure of cable at the entry point. Soldering can stiffen the joint and result in premature failure.

Esoteric tools- Due to the dangers of over-crimping described above, and the difficulty of detecting it, I would strongly advise against using a hammer type tool, or anything else that is not specifically designed for the type of crimp. This includes squeezing in a vice, squeezing with a vice with a nail to indent, using ground pliers, whacking it with a hammer or any other brutal method that might come to mind. You might get a reasonable result, but there is a very high risk you won't and the joint will fail prematurely.

Further Reading
Unfortunately there is very little widely available information on crimp technology, and by far the best book is currently out of print;

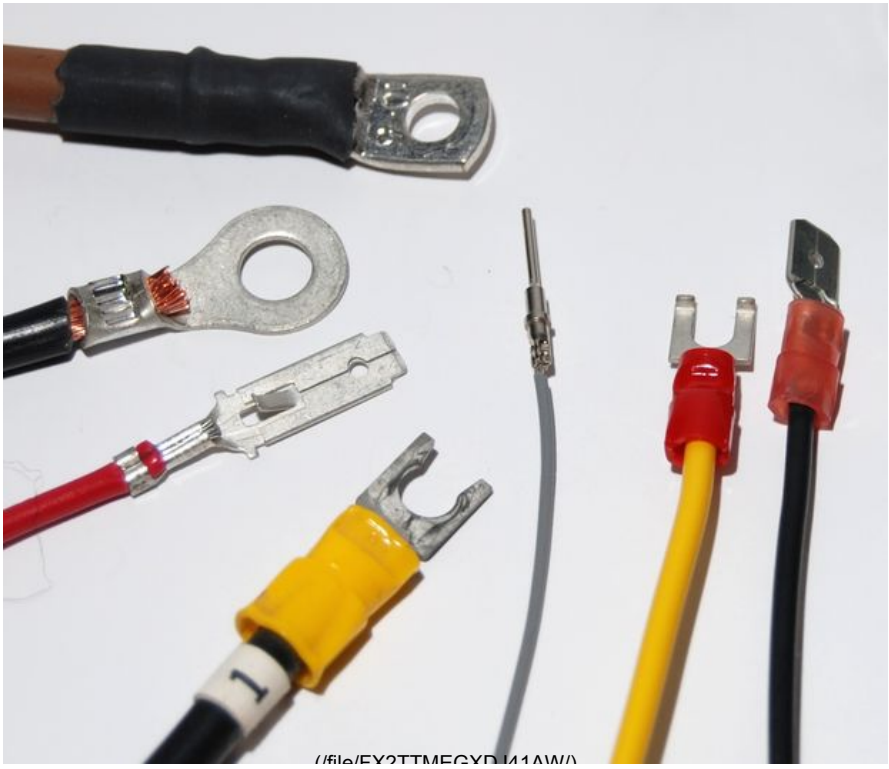
Electric Connector Handbook: Technology and Applications (Electronic Packaging and Interconnection Series), Robert S Mroczkowski, ISBN 978-0070414013

Most of the major crimp manufacturers do however produce some sort of guide, the following are good examples. Others are available;

http://tooling.te.com/pdf/US_crimpposter.pdf
http://tooling.te.com/europe/pdf/crimp-connections-english-german-3-1773444-1.pdf
http://www.molex.com/pdm_docs/ats/TM-638000029.pdf

http://www.molex.com/pdm_docs/ats/TM-640160065.pdf

Step 6: Top Tips



Top Tips

Finally, my top tips for a sound, reliable crimped joint are;

Buy good quality crimp terminals
Match the right crimp to the right wire size
Take care when stripping wire not to damage it
Use a good quality ratchet crimping tool
Don't solder the crimp
Use heat shrink tubing to provide any strain relief or insulation if needed

AlanS14 (/member/AlanS14) 7 months ago Reply

Good for one particular audience - beginners . Too lightweight by far-for almost everyone else, it's a very basic primer at best.

superpants (/member/superpants) (author) ▸ AlanS14 (/member/AlanS14)

Perhaps you'd like to write a detailed Instructable?

7 months ago Reply

AlanS14 (/member/AlanS14) ▸ superpants (/member/superpants)

It's a subject that can easily fill a book, and has. The best book imho is the out of print one you mention. Why don't you write one?

Reply 7 months ago

argos090 (/member/argos090)

Can I ask why not just solder wire with a $10(or less) butane torch?

4 years ago Reply

AlanS14 (/member/AlanS14) ▸ argos090 (/member/argos090)

Crimps are superior in several ways for many applications not least of which is lower resistance than soldered joints.

Reply 7 months ago

superpants (/member/superpants) (author) ▸ argos090 (/member/argos090)

There are many reasons why a crimped joint may be used, and indeed may be preferable to a soldered (or indeed screwed joint). The common advantages are:

Higher reliability of joint in many cases, especially in vibration or high temperature applications.
No heat involved so safer to use in many cases- especially in confined spaces, or near flammable materials
Equipment highly portable- especially compared to soldering equipment for larger cables
No heat damage of insulation possible, or solder wicking up conductor
A mating half to an existing connector may only be available in crimp style
Lower level of skills training required for a user to achieve consistent results
For production users, ease of automation & integration of process controls for quality
It is easy to correct wiring errors by removal and re-insertion of contacts in a housing

There will of course be many applications where a soldered joint is preferable, but I hope that this Instructable helps people make an appropriate choice.

4 years ago Reply

superpants (/member/superpants) (author)

Muzk- thanks for the kind comment!

a year ago Reply

superpants (/member/superpants) (author)

Jim- You are right, thanks for noticing! I have updated the page.

a year ago Reply

MuzK (/member/MuzK)

Dear thanks for providing such a nice guide on wires crimping, it helps me lot.

a year ago Reply

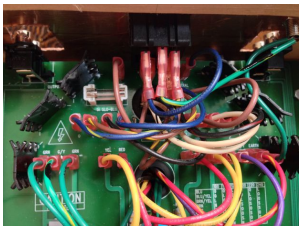
jim.lastella (/member/jim.lastella) a year ago Reply

For 10-12 AWG terminals I think you meant the insulation will be yellow, not red.

mucool (/member/mucool) 2 years ago Reply

Hi! Thank you so much for the detailed guide on crimp terminals. No where else I could find so much info. I recently built a circuit and now I want to upgrade a few capacitors. I am not able to pull the crimp terminals from the connectors (these are soldered on to the PCB http://www.digikey.com/product-detail/en/1285/1285... (http://www.digikey.com/product-detail/en/1285/1285K-ND/151539))

If i try too hard, the crimp insulation cover comes out (pink plastic). Is there a trick you have up your sleeve or any tools you'd recommend. The wires coming out of the transformer are short, and cutting them every time is not an option. Thanks!



(http://cdn.instructables.com/FP4/KBW4/HWLCX3NM/FP4KBW4HWLCX3NM.LARGE.jpg)

RangerJ (/member/RangerJ) 3 years ago Reply

Very good Instructable. I appreciate that you provided sufficient detail to make it understandable.

superpants (/member/superpants) (author) ▸ RangerJ (/member/RangerJ)

Thanks! Always good to get feedback. 3 years ago Reply

Technosteve (/member/Technosteve) 4 years ago Reply

twisting the wire will cause crimp faliure and can do so by nearly 60% in some tests during calibration testing using hellerman crimps and tools.

The correct colour crimp tool is thefore paramount to a good crimped connection.
The manual crimp tool that indents the crimp and is usually found as a kit in car parts places those without a ratchet will quicly fail as the insulation will return to its former shape and can slide off the crimp, they can also deform the crimp badly leading to cable faliure usually as a result of over crimping.

I would recommend always using the ratchet type as shown in the pictures.

When looking at the closed crimpers you will see one side is slightly larger then the other this is the insulation side of the cimper and the smaller deforms the metal part of the crimp with this type the insulation does not relax as much over time.

a good instructable none the less.

dchall8 (/member/dchall8)

4 years ago Reply

It seems I could follow your Instructable and still do it wrong. You go into mind numbing detail all the way up until you finally stick the crimp fitting into the tool. It seems to me that the only thing that matters, assuming you are somewhat close in mating the wire to the fitting, is the part you were vague about. Which way do you put it in? Is there a right way and a wrong way? Does it matter if the fitting is sideways or upside down?

It looks like there are many ways to make a crimp, at least by looking at the last picture. Is the same tool used for all of them?

superpants (/member/superpants) (author) ▸ dchall8 (/member/dchall8) Reply

4 years ago

Thanks for taking the time to comment. One of my aims in writing this Instructable was to make it clear that there is far more to making a reliable crimp than often thought- I'm therefore disappointed that this is seen as 'mind numbing detail'. On re-reading that section, I can see that I do need to expand it a little to ensure orientation & cavity size is properly covered and will do so.

I have earlier in the Instructable indicated that the correct tool for the crimp needs to be selected to suit the crimp- so no, the same tool cannot be used for all of them.

pcooper2 (/member/pcooper2) 4 years ago Reply

A properly executed crimp joint will be mechanically and electrically more reliable than a soldered joint. The key to an acceptable crimp joint is that it must be "gas tight" -- the metal of the wire and the crimp lug are pressed so intimately together that if it were the lid of food can, it would be an hermetic seal. To get the best joint, the crimp lug should be matched closely to the wire gauge: The stripped wire should just slip into the lug with minimal side-to-side play. The crimping tool is important as well, as the most inexpensive tools found in automotive supply stores tend to crush the crimp lug and not properly compress it around the wire. Unfortunately, industrial crimping tools can be quite expensive, costing hundreds of dollars apiece, and one may need several different tools for different sizes and styles of lugs and terminals.

Avoid cheap knock-off crimp lugs from China and other moderately disreputable places, especially if they are to be used in automotive or aviation applications. The brand-name lugs and terminals from western European and North American suppliers will cost more, but are worth it in the long run by avoiding joint failures later.

pecker (/member/pecker) 4 years ago Reply

Excellent instructable.
I'd agree! Buy a ratchet crimper.The cheap "squeeze and pray" type of crimper will either chew your terminal, leave bare wire exposed or not grip properly.

superpants (/member/superpants) (author) ▸ pecker (/member/pecker) Reply

Thanks a lot for the kind comment facklere, senorbutt & pecker! 4 years ago

magickaldan (/member/magickaldan) 4 years ago Reply

Your suppose to put the dimple of your crimp tool on the opposite side of the seam on a crimp connector. Unless the

seam is brazed then it doesn't matter what orientation you put the crimp tool on.

superpants (/member/superpants) (author) ▸ magickaldan (/member/magickaldan)

Absolutely right- In the example in the photo this is a brazed seam crimp, wher I wanted to show the indent. 4 years ago Reply

facklere (/member/facklere) 4 years ago Reply

Excellently written and illustrated. This topic was always a bit foggy to me, but now I feel like I have a good beginner's knowledge. Thanks!

senorbutt (/member/senorbutt) 4 years ago Reply

Very well written and informative, thanks!

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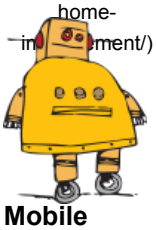

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