Lesson 1402-3
Reliable Soldering Techniques

March 2002.

IMPORTANT NOTICE!

You are now starting with PRACTICAL EXPERIMENTS IN ELECTRONICS. Performing your work safely is of utmost importance! Please observe the following precautions.

ALWAYS WEAR SAFETY GLASSES. An accidental solder splash on the fingers may only burn momentarily, but if it hits your eye, you may loose part of your vision! Safety glasses will also protect you when cutting wire or component leads with your pliers. Experienced technicians will tell you that on more than one occasion a sliver of wire went sailing through the air while cutting wire. Protect your eyes.

The dangers of lead are under investigation. While its use is prohibited in home plumbing to minimize absorption by drinking water, it has not been banned in solder for electronic work. To be safe, avoid inhaling the fumes and try to work in a well-ventilated area.

The voltages you may be exposed to while experimenting are very low. If you ever need to repair your PTL however, be very careful. Hazardous 110 V line voltage exists inside your PTL, and line voltage should always be treated with the utmost respect!

A Chat with Your Instructor

You very likely know that soldering is the principal way of making secure electrical connections in electronics. Connections are soldered for two reasons: (1) the solder provides a reliable electrical path, and (2) soldering makes the connection mechanically secure. The success of space age electronic marvels depends upon the reliability of the soldered joints. Soldering must be well done. A poorly soldered joint will play havoc with the extremely feeble currents that often flow in electronic circuits. A single poorly soldered joint out of the thousands that may be used in a complex piece of equipment can cause equipment failure, and it probably will.

Soldering is easy to learn. Therefore it does not always receive the attention that good soldering must have. There is a tendency for people who have done a little soldering with some success to think they know how to solder. To illustrate the fallacy here, consider the fact that the major kit suppliers find poor soldering to be the most common cause of trouble with the construction of their kits. Poorly soldered joints can be hard to find after the equipment is built. You want to be sure of each solder joint as you build.

Good soldering requires some practice and also an understanding of the principles involved. This lesson will provide you with both. Good soldering is easy to learn, but not if you refuse to learn because you think you already know how.

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PRACTICAL SOLDERING INFORMATION

We know you are anxious to try your hand with the soldering iron, but first there are some important things you need to know about soldering. Your iron may be damaged if it is not tinned the first time it is plugged in. How to do this is explained in this section. Do not plug in your iron until you learn how to tin it.

1 SOLDERING TOOLS FOR ELECTRONICS... The first soldering requirement is some method of heating the parts to be joined hot enough to melt the solder. This is done by a torch in heavy work, such as for plumbing. The soldering gun and the soldering iron, shown respectively at the top and bottom of Figure 1, are used for lighter work, and they are the heating tools of interest to the electronic technician.

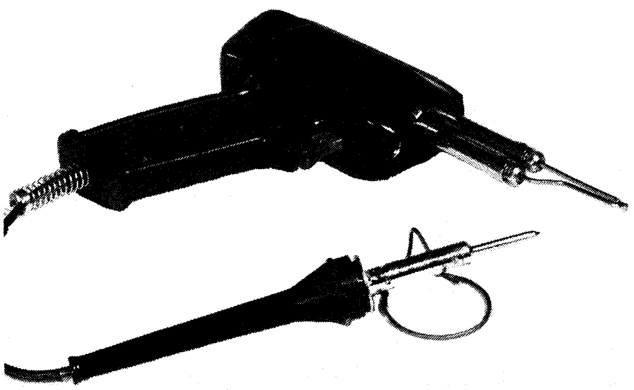


Fig. 1 Both the soldering gun (above) and the small soldering iron (below) are used by electronic technicians.

The soldering gun is widely used in electrical work and for general purpose soldering. Many family handymen own one. People unfamiliar with electronic equipment often suppose that the soldering iron is old-fashioned, having been replaced by the convenient-to-use soldering gun. The fact is that *the ordinary soldering gun is unsuitable for much of the soldering required in electronics.*

The soldering gun tip is too large to use for printed-circuit board soldering, where components are mounted close together. Secondly, the high heat level will damage both printed circuits and the solid state components mounted on the boards. A gun is also too heavy to handle easily for delicate work, and its several seconds' warm-up time is undesirable. A soldering gun is useful for heavier electronics soldering jobs.

You should assume that a small soldering iron, such as the one shown at the bottom of Figure 1, is *absolutely essential* for working in electronics, and for use in your CIE training. The soldering iron must be of low power. A 25 watt or 30 watt iron is excellent, a 50 watt iron is OK, but definitely no higher. These small irons are known as "pencil" irons. Old soldering irons, such as the one your grandfather may want to give you, are likely too big and high-powered for delicate work. A few special low-power, small-tip soldering guns are sold for small electronic work, but you will have much better luck with a suitable soldering iron. You can hold a small light-weight soldering iron like a pencil for good control and steadiness on delicate work.

A small soldering iron is suitable for all your work in your CIE course, and for 90 percent of your work as a professional electronic technician. For that remaining 10 percent, where more heat is needed, soldering guns are popular today, but your grandfather's big old soldering iron will work very well.

You must have a soldering stand to hold the hot tip of the iron up off of your workbench. One is easily bent up from a coat hanger to the shape shown in Figure 1, or to any shape that will support the hot end of the iron when it is not in use. You can even use a crumpled tin can as a stand. You will also need an old sponge or a rag for cleaning the iron, and a sheet of sandpaper for cleaning when the sponge won't do the job.

General purpose soldering iron tips are usually either chisel shaped or conical. Either will be suitable for your work, although many technicians prefer the chisel shape.

2 THE SOLDERING IRON TIP. . .The tip of the soldering iron (see Figure 2) is the working part of the iron, and therefore deserves special discussion. The simplest tip is made of solid copper. The cores of practically all tips are of copper (the term soldering "iron" is quite misleading). Copper is an excellent conductor of heat — one of the very best. This is important because, as you can see from Figure 2, the heat from the electric heating coil must flow down to the tip end (which does the soldering) and out into the joint to be heated.

The trouble with a plain copper tip is that the tin in the melted solder in contact with the tip slowly dissolves the copper, eating away the tip. Moreover, the hot copper tarnishes (oxidizes) badly if in direct contact with the atmosphere. The latter can be avoided by keeping the tip covered ("tinned") with a coating of solder. It is important to keep your soldering iron well tinned. You will learn later in this lesson how to do it.

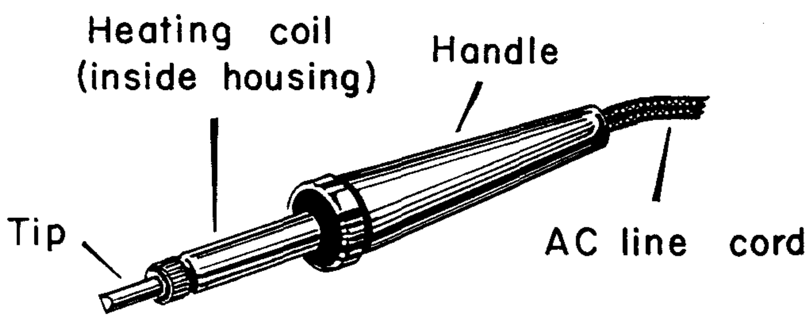


Fig. 2 The parts of a small soldering iron.

After a plain copper tip has been used for a while, enough of it will be eaten away by the solder that it becomes necessary to file the tip to smooth the surface and return the tip to its original shape. The day comes, of course, (quicker than you might suppose) when there is not enough tip left to reshape it once more.

Many of the best irons have removable tips, which simply screw into the body of the iron, or are held in with a set screw. This feature allows the use of different shaped tips, as well as making it possible to replace worn out tips. Removable tips must be removed regularly, every day when in continual use, and the oxide accumulated in the threads and elsewhere tapped out. If this is not done, the tip will "freeze" in the body so that removal becomes impossible.

Soldering irons today very commonly have the copper tip plated with iron or nickel to keep the solder from making contact with the copper and dissolving it away. This eliminates the need for filing the tip. In fact, you must not use a file on a plated tip; filing would remove the plating.

Plated soldering tips must be kept well tinned with solder, so that the iron coating does not make contact with the atmosphere. Otherwise, the hot iron would oxidize badly, so badly that later tinning may not be practical. The manufacturer usually pretins plated tips, but it is up to you to keep your soldering iron tinned.

Plated soldering tips are very popular for the reasons given. Nevertheless, a plain copper tip, in good shape, works well.

When removing a corroded tip on a soldering iron, it is best to use a pair of pliers to hold the tip and another pair of pliers to hold the heating coil into which the tip is screwed. If you hold the iron by the handle while unscrewing an old tip, you place a strain on the insulators which hold the heating coil and the handle together. This can permanently damage the iron.

It is good practice never to assume that an iron which has been lying around has been unplugged. To test the iron to see if it is hot, touch a moistened sponge to the tip. If the iron is hot the moisture will sizzle.

You will also find that while you are in the middle of a troubleshooting job, you may be concentrating on the circuit on which you are working, a meter, or a schematic diagram. Develop the habit of taking your eyes off *everything but the iron* before you reach to pick the iron up.

3 HOW TO TIN YOUR SOLDERING IRON. . . Even though your iron is brand new, just out of the box, it should be tinned when first plugged in and before it is ever used. This is true even when the iron has been pretinned by the manufacturer. A good coating of solder not only protects the tip from oxidation, but also aids in transferring the heat from the iron to the joint being soldered. It is difficult or impossible to solder with a poorly tinned iron.

Tinning is simple enough. Assuming your soldering iron is new with a clean and shiny tip, plug it in and let it heat. Check the temperature by touching the tip with the solder wire every minute or so. When the iron is hot enough to melt solder easily, touch the solder to several points on the tip, melting enough solder so that it will flow out and completely cover the tip. See Figure 3. It is only the conical or chisel point of the tip that needs covering, as that is the part of the tip that is used for soldering. Make sure this point is well covered. More than enough will do no harm.

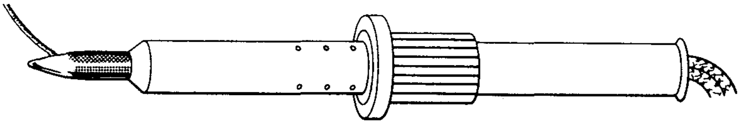


Fig. 3 To tin an iron, the iron must be clean and hot enough to melt the solder, but not too hot.

As soon as the point of the iron is well covered with plenty of solder to your satisfaction, unplug the iron until you are ready to use it. If you leave the iron plugged in without using it, it will overheat. Overheating the iron will destroy your nice tinning job, blacken the iron so that it must be cleaned, and perhaps damage the iron. Irons in frequent use do not overheat because the excess heat is drawn away in heating the materials being soldered.

If your soldering iron is one that has been used, inspect the tip before tinning. If it looks clean with plenty of solder on it, no tinning is needed. If the iron is dirty, perhaps with black or dark spots, heat the iron hot enough to melt solder and then clean by wiping on a rag or damp sponge. Don't expect solder to stick to a dirty iron, or to anything else that is dirty. After the iron has been cleaned, tin as explained for a new iron.

WHAT HAVE YOU LEARNED?

1. Most soldering in electronics can best be done with a (*soldering gun*) (*soldering iron*).

2. In working on printed circuit boards, you should not use an iron rated at more than __________ watts.

3. Although a soldering iron tip is often plated with other metal, its body is always made of _________.

4. Unless the chisel or conical point of the soldering tip is well covered with solder, it will (*not heat to the right temperature*) (*suffer from oxidation when hot*) and so will not solder properly.

5. A soldering iron is apt to overheat if (*used too long at a time*) (*allowed to stand plugged in without being used*).

ANSWERS

1. Soldering iron.

2. 50. . . Smaller is better, between 25 and 40 watts.

3. Copper. . . Copper holds a lot of heat, and conducts it quickly to the part being heated.

4. Suffer from oxidation when hot. . . In plain English, the uncoated iron rusts when hot, turning brown or dark. Clean the iron, using sandpaper if necessary, and then tin properly.

5. Allowed to stand plugged in without being used. If the tip of the iron rests on a block of metal when not in use, overheating will not occur. The block of metal draws away the extra heat. Overheating spoils the tinning, the tip turning a dull color with black spots. Clean and re-tin.

EXPERIMENT 1

THE SOLDER MUST WET THE SURFACE

Any liquid (including melted solder) is said to "wet" a surface if the liquid spreads freely and smoothly over it. This shows that it is adhering to the surface. A surface is not wetted unless the liquid adheres to the surface. Wetting is of the utmost importance. A soldered joint will likely cause trouble if the solder has not wet the surface. A simple experiment will demonstrate what we mean by a liquid wetting the surface.

1. Take a flat piece of clean smooth metal (a table knife or a pocket knife will do fine) and spread a thin layer of oil or grease over the surface. Anything greasy can be used, such as cooking oil or a tiny piece of raw bacon rubbed over the surface. The oil layer can be so thin as to be invisible.

2. Wet your finger and let a drop of water fall on the oily surface. The water will ball up as in Figure 4 (a). The water is not sticking to the surface, but rather it is lying on the surface. Tilt the metal on edge and the water will roll off, leaving the surface dry. The water did not wet the surface.

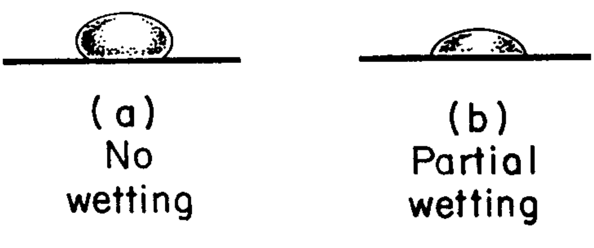


Fig. 4 How to tell if solder is wetting the surface.

3. Let another drop of water fall on the oily surface. Examine it with care, comparing with Figure 4 (a). Solder that does not wet the surface will be humped up like this drop of water.

4. Wash the metal you are using with soap and water, getting it really clean, and then dry. Then further clean the surface by scrubbing with cleaning fluid (spot remover), lighter fluid, nail polish remover (acetone), or any of the various substitutes for carbon tetrachloride. You can skip this last scrubbing if you have none of these substances available. Keep your fingers off of the clean surface; they would make the surface oily again.

5. Let a drop of water fall on the very clean surface. The drop of water now spreads out as in Figure 4 (c). The cleaner the surface, the more the drop will spread out; and the thinner it will be near the edge of the drop.

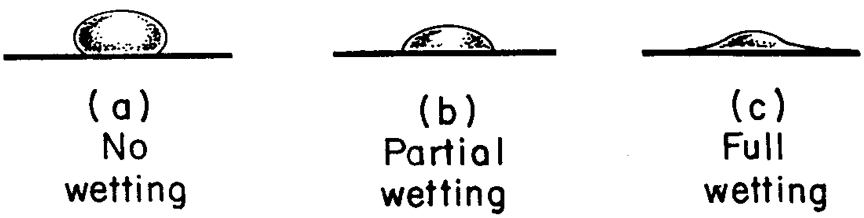


Fig. 4 How to tell if solder is wetting the surface.

6. Tip the piece of metal on edge. The excess water will run off, but a thin layer of water stays on the metal. The water has wet the metal. In other words the water is sticking to the metal. Your soldering is faulty unless the hot solder wets and adheres to the metal like a drop of water does on a clean surface. When you tinned your soldering iron, the solder wetted the surface. You can be sure of that because the solder spread out smoothly over the surface without difficulty. If you tried to tin a dirty iron, the solder would not spread out, but would gather into blobs.

7. Compare Figure 4 (a) with (c). The way to tell if solder is going on well is by its appearance. The hot solder must flow out to thin edges as in (c). If it does, you can be sure that the solder is wetting the surface. The solder must not hump up as in (a) or as in (b). The partial wetting of the surface shown in (b) is not acceptable.

4 SOLDER FLUX AND SOLDERABILITY. . . The last topic should have made it clear that you can't expect solder to wet and properly adhere to metal unless the metal is clean — really clean. Clean enough to eat off is hardly clean Flux is always used when soldering to help in cleaning. If you start with surfaces to be soldered that are reasonably clean and bright, the heated soldering flux will do the rest of the cleaning.

Take a piece of metal that looks clean (a copper penny will do) and scrape it a little with a pocket knife or anything sharp. You notice that the metal is brighter where it was scraped. Metals react with the atmosphere so that a tarnish film (oxides) forms on their surface, dulling the surface. The solder will not wet the surface unless the heated flux is powerful enough to remove the tarnish film. Even if you first scrape the tarnish off of the surfaces to be soldered, more will form quickly at soldering temperatures, so that flux is still needed. Mild fluxes used in electronics soldering do not go to work until the soldering iron has heated the joint to soldering temperature. Mild fluxes are inactive at room temperatures.

As you perhaps know, some metals are much more difficult to solder than others. This is mostly a matter of how difficult it is to remove the surface oxides so that the solder can wet the metal. Aluminum is very difficult to solder because oxides form so fast at soldering temperatures. Aluminum is not used in electronics for parts that require soldering. You can best think of aluminum as being impractical to solder, although it can be done.

Most circuit soldering in electronics is to copper, one of the easiest of all metals to solder. Only a very mild flux is needed. Gold, silver, tin, lead and brass are also easy to solder using a mild flux. Iron or steel and nickel solder easily with a stronger flux. Stainless steel, nichrome, and germanium will solder well if a very strong flux is used, such as hydrochloric acid.

The mildest flux is rosin, which comes from pine trees. Rosin is the only flux suitable for soldering delicate electronic circuits. Rosin is non-corrosive and non-conductive. Properly soldered electrical connections using rosin as the flux will have minimum resistance when made, and will stay at minimum resistance. The excess rosin which runs down into the insulation will not form current leakage paths because rosin is non-conductive.

The paste flux widely available from hardware stores is often marked "non-corrosive." Nevertheless, this flux is not suitable for delicate electronics soldering. It is often useful to have it about for less demanding jobs, and where a stronger flux than rosin is needed. Hydrochloric and other acid fluxes are highly corrosive. Use them where a milder flux will not cut the oxides (never on electronics wiring). Wash the soldered parts well to remove as much of the acid flux as possible.

Solder intended for electronics use is available hollow, the hollow core being filled with rosin. Thus the work is automatically fluxed as you solder. This is a convenient arrangement and works very well. For ordinary repair and wiring of electronics circuits, rosin core solder is nearly always used. It is all you need for your CIE course.

We must emphasize that fluxes, and mild fluxes such as rosin in particular, are intended only for removing surface oxides. The surfaces to be soldered must be free of dirt and grease. Scrape or use sandpaper to clean dirty surfaces before attempting to solder. Manufacturers usually pretin component leads and terminals, and also hookup wire. If that has not been done, we suggest scraping or sand-papering for clean bright surfaces before soldering with rosin flux.

Technicians often need to solder joints that carry no electrical current, or ones which carry substantial voltage and current, such as on line cords that power electronic equipment. The use of paste flux is permissible here. The extra kick in paste flux will make good soldering easier where it is difficult to get the parts as clean as you would like.

Acid-core solder is widely sold and used. Electronic components wired with this solder will be ruined, often beyond repair. You must use rosin core solder specifically sold for electronics work, which is so marked on the package. Such solder is often sold as "radio" solder. If you are not certain of the suitability of the solder you are using, don't use it.

WHAT HAVE YOU LEARNED?

1. In order to form good solder joints, the solder must be allowed to ___________ the surfaces of the metals to be joined.

2. Soldering temperatures increase the speed at which ___________ form on metals, which make it difficult or impossible for the solder alone to wet the surface of the metals.

3. The purpose of soldering fluxes is to (*make the solder "wetter"*) (*dissolve oxides on the surfaces of the metals to be joined*).

4. If solder is properly wetting a surface, the solder will *(hump up into a bead*) (*spread evenly*) on the metals.

5. Group the following metals into three categories: mild flux required, paste or strong flux required, acid or very strong flux required: nickel, copper, gold, iron or steel, stainless steel, brass, nichrome, tin, silver.

6. Strong fluxes may not be used where currents or voltages are (*strong*) (*feeble*) (*nonexistent*).

7. A box marked "acid core solder" lists electronics and radio as uses for the solder. Such solder (*is*) (*is not*) safe for use on electronic circuit boards, tube sockets, and terminal strips.

8. When using magnet wire, or other kinds of wire with tough insulation, it is better to (*scrape*) (*burn*) the insulation off the wire.

ANSWERS

1. Wet.

2. Oxides. . . Oxidation is a chemical reaction between the metal oxygen in the air. Heat increases the rate at which the reaction takes place.

3. Dissolve oxides on the surfaces of the metals to be joined.

4. Spread evenly.

5. Mild flux: copper, gold, brass, tin, silver. Stronger flux: iron or steel, nickel. Acid or stronger fluxes: stainless steel, nichrome.

6. Feeble. . . a simple way to remember this rule is that strong fluxes and feeble currents do not go together.

7. Is not. . . Rosin flux is the only safe kind to use on electronics work.

8. Scrape. . . Burning the insulation off a wire leaves ash and oxides on the wire. Solder will not properly wet the wire unless these materials are scraped off. It is generally considered good practice to use sandpaper or a pocket knife to remove insulation.

5 SOLDERING PROPERTIES OF SOLDER. . . Ordinary solder is a combination (alloy) of tin and lead. Different proportions are in common use. Solder is described by giving the percentage of tin in the alloy, followed by the percentage of lead. Thus 40/60 solder is 40 percent tin and 60 percent lead. The most popular solder for electronics is 60/40, which is 60 percent tin and 40 percent lead.

The melting temperature of solder depends upon the proportions of tin and lead. A low melting point solder is important in electronics. If too much heat is needed to melt the solder, printed circuit boards and heat sensitive components will be damaged. Before going further into this, let us comment on what is meant by melting point.

As everyone knows, when ice melts it changes from a hard solid directly into fully liquid water. Conversely, water freezes by going directly from water to ice. Water freezes and melts at the same temperature, 32˚F. Not all substances pass directly between solid and liquid when freezing or melting. Many substances pass through a mushy or plastic state while going from solid to liquid, or from liquid to solid. For example, when 30/70 solder is heated it turns soft or plastic at 361°F, but must be heated on up to 496 °F before it becomes liquid. As the liquid solder cools, it turns plastic at 496 °F, but must cool on down to 361°F before it freezes (solidifies).

The borderline temperature between the plastic and liquid state is the melting point (technically, it is called the liquidus) , and is 496 °F for 30/70 solder. The borderline temperature between the solid and plastic state is called the freezing point (technically, the solidus), and is 361 °F. While the freezing and melting point are the same for water, this is not true for many substances.

The melting and freezing temperatures of solder are of great importance. Soldering must be carried on with the materials to be soldered and the solder above the melting point of the solder, so that the solder is fully liquid. Otherwise, the solder will not wet the surfaces to be soldered. It has already been mentioned that components can be damaged if the soldering temperature is too high. After a joint has been soldered and is cooling, it is not mechanically secure until the temperature has dropped to freezing and the solder has solidified. If either part of the joint is moved in relation to the other while the solder is plastic, the solder will become coarse grained, and the resulting connection will be physically weak and unreliable. Such a joint is called a fractured joint. It will have a frosty appearance. Fractured joints should be resoldered.

6 EUTECTIC SOLDER. . . Fractured joints can be largely avoided by using a solder with the same or nearly the same melting and freezing points. Then the solder will be plastic for only a very short time during the cooling period, so that there is less danger of fracturing. Figure 5 shows the plastic temperature range for different tin-lead proportions. The graph shows that the freezing temperature of solder stays at a constant 360 °F over the entire range of tin-lead proportions in normal use, from 20/80 to 90/10. This is by no means true of the melting point. You will see by the graph that the melting temperature (the line between plastic and liquid) drops rapidly as the proportion of tin in the alloy is increased until a melting point low is reached at 360 °F for 63/37 solder.

Solder proportioned 63/37 is called eutectic solder. Its melting and freezing points are the same, 361 °F. Like water, eutectic solder has no plastic state. Eutectic solder is excellent for delicate circuit work because it has the lowest melting point and because it has no plastic state.

Solder proportioned 60/40 has only a narrow plastic range and its melting point, 370 °F, is only a little above that of Eutectic solder. This is a fully satisfactory solder for general electronics circuit work. It is readily available and widely used by electronic technicians. Solder proportions other than 60/40 and 63/37 are definitely inferior for electronic circuit work, and are not recommended.

Solder varies in quality because of impurities in the alloy. You should buy solder that is intended for electronics work. Ask for 60/40 rosin core wire solder. It comes in various diameters. You need a small diameter solder for small delicate work where space is at a minimum, such as for working on printed circuit boards.

Gauge 21 is good, which is 1/32 inch (0.031") in diameter. This is the only solder you will need in your CIE training. A larger diameter solder, such as gauge 16, 1/16 inch (0.062 "), is useful to have for less demanding electronics work. Use the coarser solder too for occasional heavier work, such as electrical wiring and general light soldering. For these jobs you may need to use a little paste flux on the joint to help cut the oxides. Never use paste flux for electronics circuit wiring, even though the paste flux is sold as non-corrosive.

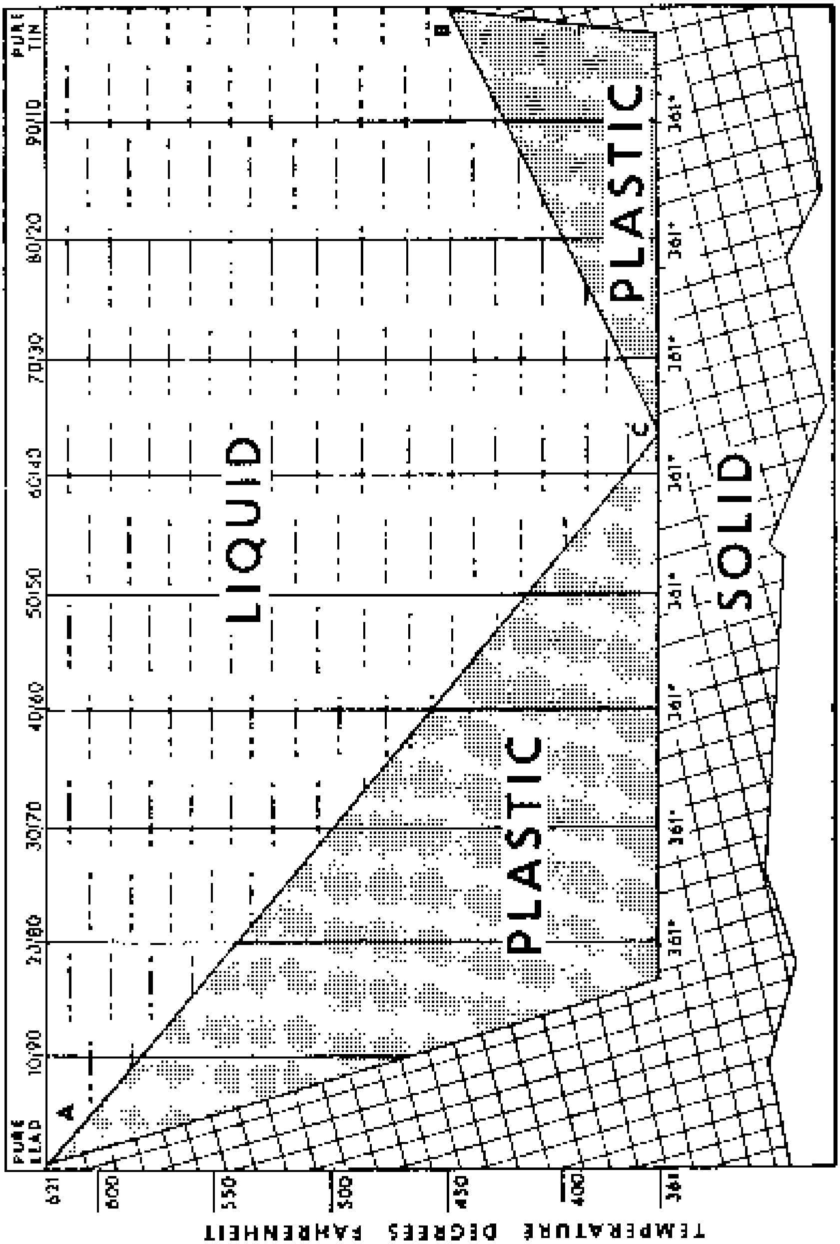


Fig. 5 Solder characteristics.

Use View -> Rotate Clockwise
To turn plot

WHAT HAVE YOU LEARNED?

1. The two metals used to make solder are _________ and _________.

2. The proportions in which the tin and lead are mixed to make solder determines the (*solidus*) (*liquidus*) of the solder, although the (*solidus*) (*liquidus*) is always __________ degrees Fahrenheit.

3. Ordinary 60/40 solder is 60 percent _________ and 40 percent

4. The only solder which has the same solidus and liquidus is called (a) __________ solder. It is (b) ________ percent tin and (c) ________ per cent lead.

5. To ensure proper wetting of a solder joint you must first heat the (*solder*) (*metals to be joined*).

6. With 60/40 solder, the joint must not be disturbed until the temperature has fallen below the (*melting*) (*freezing*) point of the solder. Otherwise a (*plastic*) (*fractured*) joint will result.

ANSWERS

1. Tin; lead.

2. *Liquidus*; *solidus*; 361.

3. Tin; lead.

4. (a) Eutectic (b) 63 (c) 37.

5. Metals to be joined. . . The metal to be joined must be heated above the *solidus* and *liquidus* of the solder before the solder is applied and while the solder is flowing onto the joint. Otherwise inadequate wetting can result.

6. Freezing; fractured. . . A fractured joint will often have a frosty appearance.

7 TOOLS FOR ELECTRONIC TECHNICIANS... You should have a pair of diagonal cutting pliers ("dykes") for cutting hookup wire and component leads to proper length (see Figure 6, right). Five-inch dykes are a good length for general electronics work. Four-inch ones are convenient for small work where parts are close together.

For bending wires and component leads you should have a pair of long nose or needle nose pliers, such as shown in Figure 6, left. Needle nose, which have longer, narrower tips than do long nose, are convenient for holding small parts and for use as a temporary heat sink while soldering.

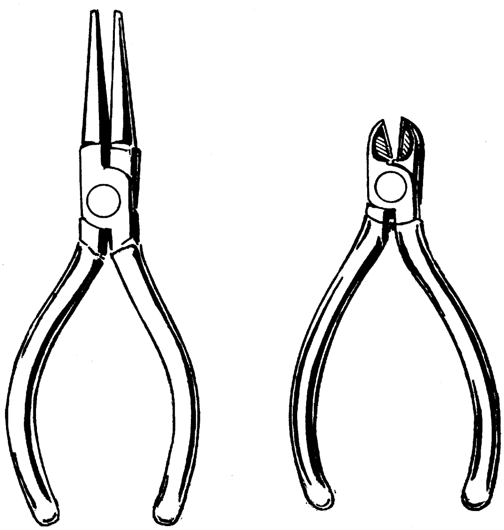


Fig. 6 Essential tools for electronics work, long nose pliers (left) and diagonal cutting pliers (right).

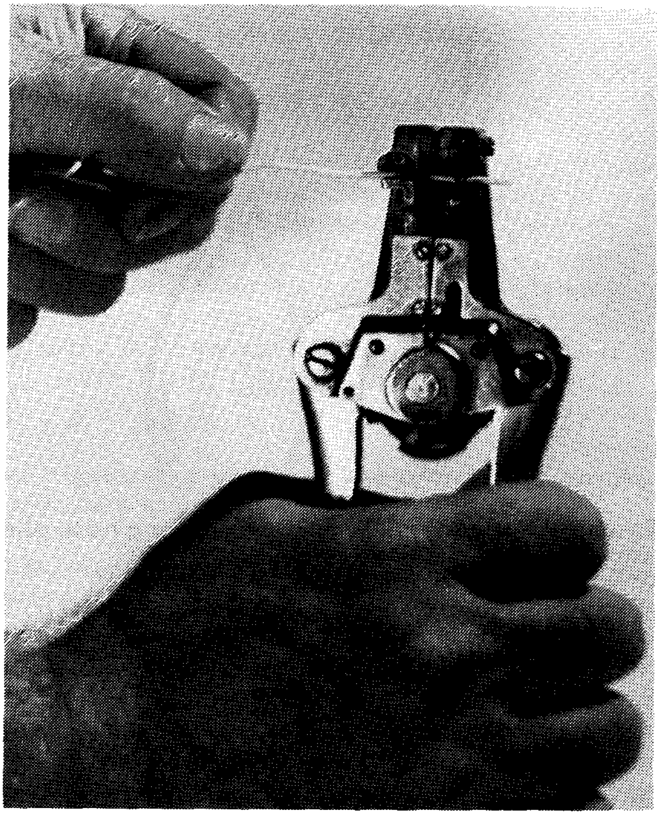
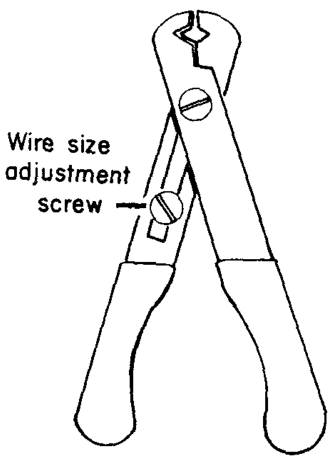


Fig. 7 Commercial
type wire strippers.

The insulation must be removed from the ends of hookup wire before making a connection and soldering. There are several devices available for doing this job. Commercial-type wire strippers (Figure 7) are fast, easy to use, and do an excellent job. They are relatively expensive, however, and you will probably want to use a less expensive tool unless you're going to strip a lot of wire. Such wire strippers are used mostly by equipment manufacturers, where many wires must be stripped every day.



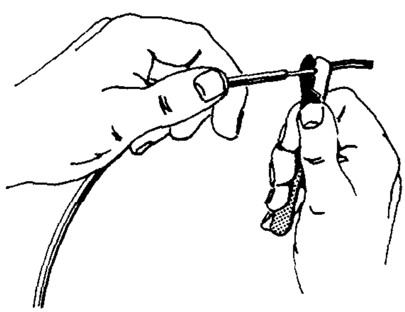


Fig. 8 Inexpensive wire strippers and how to use them.

Inexpensive wire strippers are available. See Figure 8. Like the commercial type strippers, they can strip many sizes of wire and with care will do almost as good a job. To use, close the notches over the wire at the point you wish to cut the insulation. Then slide the unwanted insulation off the end by pulling the tool along the wire. It is necessary to lock the adjustment screw in the correct position for the wire size being stripped so that the insulation can be easily cut without nicking the wire.

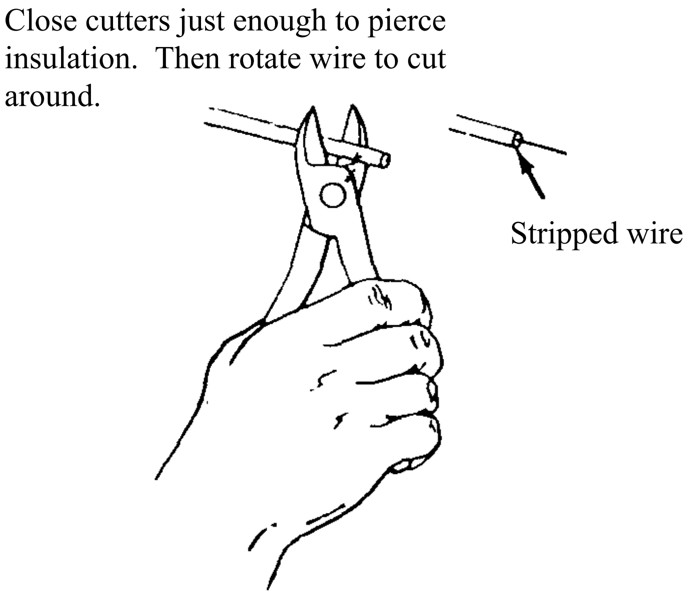


Fig. 9 Diagonal cutting pliers can be used to strip wire if car e is used.

If you don't have wire strippers, you can use diagonal cutting pliers to strip wire, as in Figure 9. It takes practice to do this job well, though, since you must close the cutters just enough to pierce the insulation but not enough to nick the wire. To avoid nicking the wire, you may use the pliers to cut the insulation only partly through. The insulation will tear a little when you pull it off, but this is better than damaging the wire itself.

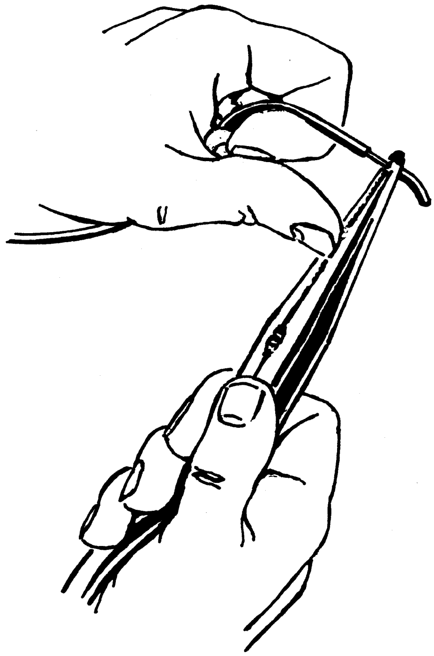


Fig. 10 To remove insulation using longnose pliers, squeeze tight and pull hard.

You can reduce the chances of nicking the wire even more by using long or needle nose pliers to strip wire. Simply grasp the wire tightly with the pliers and pull, tearing the unwanted insulation away. The insulation left on the wire will probably have a ragged edge, but you can trim it if you want with a razor blade. This method is shown in Figure 10.

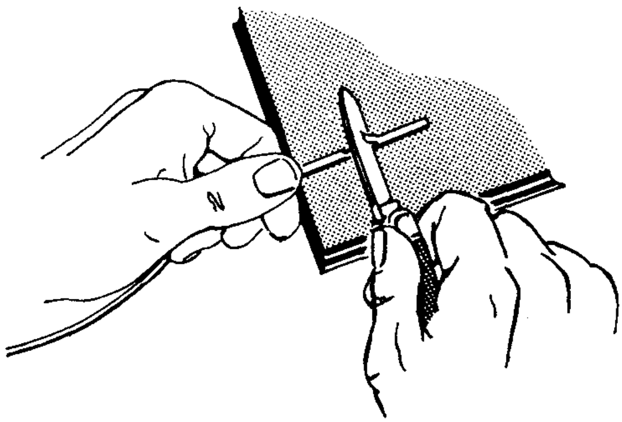


Fig. 11 To strip insulation with a knife, shave at an angle, like sharpening a pencil.

The last method of stripping wire is shown in Figure 11. This method uses the old standby, the pocket knife. This method works well if the knife blade is really sharp. Most pocket knives aren't, even when new. To reduce the chances of cutting yourself, lay the wire on the workbench. Shave the insulation off as if you were sharpening a pencil. If you cut vertically into the insulation you are apt to damage the wire.

We have continually stressed that the wire must not be nicked while being stripped. You may not think a tiny nick is very important, but nicks are a serious matter. If the wire is bent near the nick, and it probably will be. the nick will enlarge. After a few more bends, the wire will break in two. This may be only a minor inconvenience when it happens on an experimental circuit but can be quite expensive if it happens on equipment in the field. For this reason you should learn to strip wire without damaging it.

WHAT HAVE YOU LEARNED?

1. A wire cutter about ___________ inches long is a good size for use in this course, and will be the most useful for general work in electronics.

2. For grasping, bending, or stripping wire a __________ or __________ nose pliers is generally the most useful.

3. With any kind of tool, the most important consideration in stripping wire is that you not ___________ the wire.

4. Stresses caused by shock, vibration, bending, or temperature changes can cause a nicked wire to __________ at any time.

5. Assume that you are using a pocket knife to strip insulation off the end of a wire. The edge of the blade should be (*angled toward*) (*at a right angle to*) (*angled away from*) the end of the wire. This means that the wire must never be pointed (*toward*) (*at a right angle to*) (*away from*) you.

6. Most small wire strippers have an ___________ __________ which must be locked in place to avoid scraping the wire.

7. If you do not have a wire stripper, a (*needle nose plier*) (*wire cutter*) will have the least chance of nicking a wire.

ANSWERS

1. 5. . . Larger cutters are awkward to use on small electronic components, and are meant for heavier work. Smaller types may not provide enough leverage to cut some kinds of wire you may encounter.

2. Needle; long. . . Here again the main consideration is that the pliers allow you enough freedom of movement, yet are strong enough to do the job.

3. Nick.

4. Break.

5. Angled toward; toward. . . You should hold the knife and wire as you would do if you were whittling the end of a pencil to sharpen it. The most important idea here is that you should have the blade away from yourself as it cuts.

6. Adjusting screw.

7. Needle nose plier.

LESSON 1402-3
RELIABLE SOLDERING TECHNIQUES

EXAMINATION

Circle the number of the correct answer for each question. After you have finished taking the Exam you may send in your results using one of the following methods:

1) To send in your exam using EGrade
click here EGrade System.

2) To send in your exam by mail or fax(216-781-0331)
click here Answer Sheet.

3) If you received scan cards and wish to mail them then
click here Mail Address.

1. The numbers used to describe solder of the type ordinarily used (for example, "60/40" solder) lists the __________ content FIRST.

(1) Copper
(2) Lead
(3) Tin
(4) Zinc
(5) Silver

2. The freezing point of solder for all tin/lead proportions in normal use is

(1) 163 degrees Fahrenheit.
(2) 361 degrees Fahrenheit.
(3) 631 degrees Fahrenheit.
(4) Different for every different tin/lead proportion.

3. A joint which is referred to as fractured

(1) Results from overheating the joint.
(2) Results when solder is applied without parts touching.
(3) Was mechanically disturbed while the solder was in its plastic state.
(4) Was not heated sufficiently to evaporate the rosin.

4. One kind of solder recommended for use in radio and electronics servicing is

(1) 40/60 rosin core.
(2) 50/50 rosin core.
(3) 60/40 rosin core.

5.Soldering irons for printed circuit board work should have a rating of

(1) 2 to 3.5 watts, 5 watts at the most.
(2) 20 to 35 watts, 50 watts at the most.
(3) 100 to 250 watts, 500 watts at the most.
(4) 20 to 30 amps, 50 amps at the most.

6. Paste or acid flux

(1) Should always be used.
(2) Should not normally be used.

7. Besides safety, the most important consideration when stripping wires is

(1) Making a clean cut with no frayed pieces.
(2) Not to let the remaining insulation slide down the wire.
(3) Stripping off the exact length of insulation.
(4) To avoid nicking the wire.

8. To keep the tip of a soldering iron from oxidizing rapidly, the tip should be well

(1) Tinned.
(2) Tightened.
(3) Cooled.
(4) Sharpened.

9. The tips of soldering irons are generally made of plated or unplated

(1) Brass.
(2) Zinc.
(3) Copper.
(4) Iron.

10. In soldering, the most common way of removing oxides from the surfaces of the metals to be joined is to use

(1) Lighter fluid or carbon tetrachloride.
(2) Flux.
(3) A small torch, cigarette lighter, or a match.
(4) Grease or oil.

11. What kind of solder has the same melting and freezing temperatures?

(1) 37/63.
(2) 60/40.
(3) 63/37.
(4) 67/33.

12. Solder which has the same melting and freezing temperatures is called __________ solder.

(1) Solidus.
(2) Liquidus.
(3) Eutectic.
(4) Plastic.

END OF EXAM

Index for Lesson 1402-3