

# ELECTRICAL CONNECTIONS

Lesson 13 EET 150

## Electrical Connections Learning Objectives

- ▣ In this lesson you will:
- ▣ see different methods of making electrical connections.
- ▣ learn a procedure for making soldered connections.
- ▣ see commonly used mechanical splices for wires.
- ▣ see different types of crimp connectors and application tools
- ▣ learn how wire nuts are applied to make solderless connections.
- ▣ learn the steps used to make printed circuit boards.

## Electrical Connections

Components and wiring in electrical/electronic systems must be connected properly to operate correctly and safely.

### Connection Methods

Soldering

Mechanical Connectors

Splices

Crimp Connectors

Wire Nuts

Printed Circuits

## Electrical Connections-Soldering

Soldering – bonding metals with a dissimilar alloy of metals

### Solder:

provides strong electrical and mechanical connection.

is an alloy of tin (Sn) and lead (Pb) with given proportions  
Example: 60/40, 50/50 (tin/lead).

has a melting point of approximately 400 F.

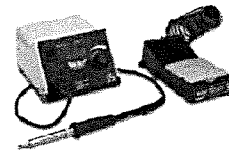
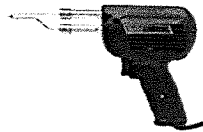
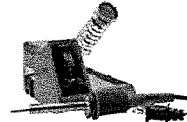
## Electrical Connections-Soldering

Good solder joints require sufficient heat to bring parts up to temperature

Heat sources for electronic/electrical connections

Soldering irons (20-250 Watts rating)

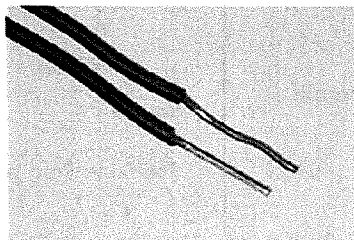
Soldering guns (100-250 Watts rating)



Available in ET Lab

## Electrical Connections-Soldering

### Preparing a solder joint



All parts should be clean  
free of corrosion, dirt, grease/oil  
copper should be cleaned until bright

Make good mechanical connection between parts  
twist wires together  
wrap wire around connector lugs

Use soldering flux to keep joint clear while heating  
flux prevents oxide formation  
use only rosin flux for electrical/electronic work

## Electrical Connections-Soldering

### Soldering Procedure

Apply iron/gun to joint

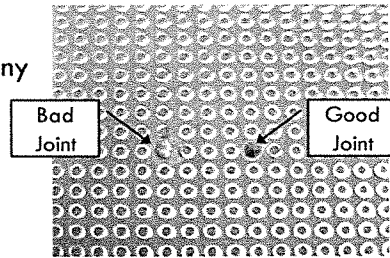
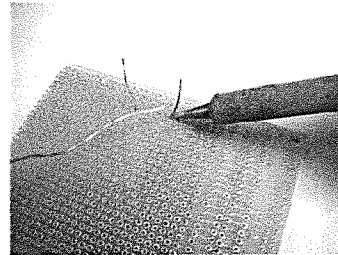
Allow joint to heat up

Apply solder to joint not tip of iron/gun

- Solder should flow
- Good joint will be smooth and shiny

Let joint cool before moving

- Let solder harden
- Don't touch! Still very hot



## Electrical Connections-Soldering

Melting and working temperatures of different alloy solders  
(All temperatures in degrees F)

Alloy	Tin ‰	Lead ‰	Solid to	Liquid at	Pasty Range
50/50	50	50	361°	421°	60°
60/40	60	40	361°	374°	13°
63/37	63	37	361°	361°	0°

50/50 has wide pasty range. 63/37 goes from solid to liquid very quickly

## Soldering Electronic Components

Transistors, diodes, and integrated circuits can be damaged by excessive heat while soldering.

### Use appropriately sized heat source. (Lower wattage)

- Use soldering station with temperature control if available

### Use heat sinks on component leads

- hold lead with needle nose pliers
- Use commercial heat sink clips

### Use component sockets

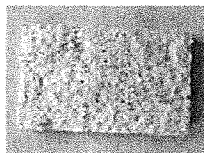
- Use caution sockets can also be damaged by excessive heat



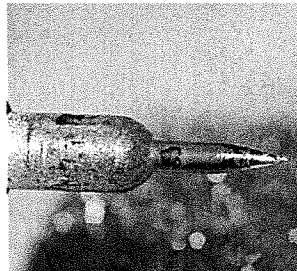
## Soldering Equipment Maintenance & Safety

### Maintenance

Keep iron/gun tip clean and tinned (coated with solder)



Wipe tip with damp sponge or cloth



Use flux or liquid tip cleaner



## Soldering Equipment Maintenance & Safety

### Safety

Iron/gun is very hot! Keep all flammable materials from soldering area

Always assume iron/gun is hot to avoid burns

Do not cool iron by dipping it in any liquid or water

Do not let iron/gun contact electrical cords

Solder contains lead – wash hands after handling

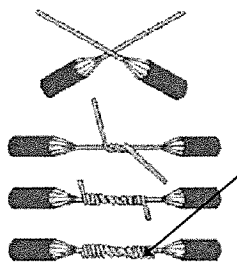
Fluxes can be toxic and/or corrosive – read all instructions and warnings before using

Hot rosins and fluxes give off fumes, solder in well ventilated area

## Wire Splices

Splice - Mechanical connections of two wires made by twisting the conductors tightly together

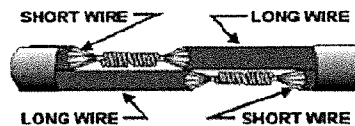
Give good mechanical strength and electrical conductivity



Western Union Splice

Works best with solid wire

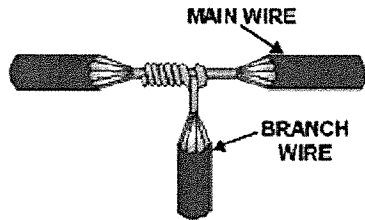
Make 5 to 10  
tight turns on  
each side



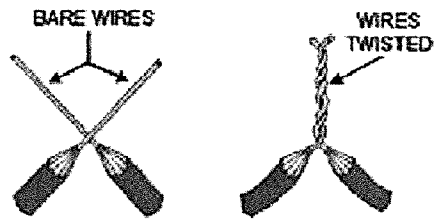
Splicing multi-conductor cables  
using offset Western Union splices

# Wire Splices

Tap Splice



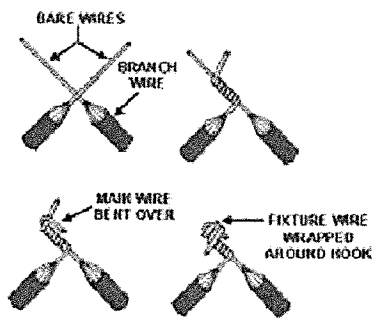
Rat Tail Splice



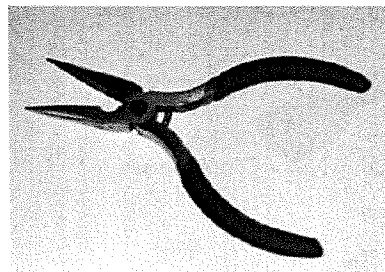
All splices can be soldered to add strength and conductivity

# Wire Splices

Fixture Splice



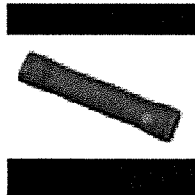
Use needle-nose pliers to make tight bends and joints



Provides extra strength for hanging light fixtures

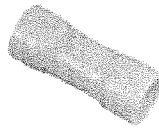
## Crimp Connectors

Used to join wires or add terminal lugs to ends of wires

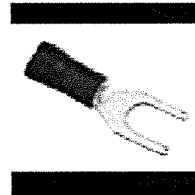


Insulated  
butt splice

Join two wire ends



Insulated  
parallel splice



Insulated  
spade lug

fit under terminal screw

## More Crimp Connectors



Ring Lug  
(Insulated)

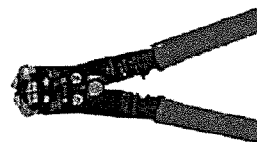


Female  
disconnect  
lug  
(Insulated)



Male  
disconnect  
lug  
(Insulated)

Crimp connectors require  
proper crimping tool

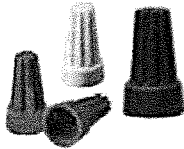
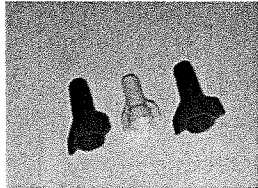


Typical combination wire  
stripping and crimping tool



## Wire Nuts

Solderless connection using a conical threaded connector



AWG – American Wire  
Gage

Different color denotes number and size of conductors that can be terminated using the wire nut

Yellow: up to 2 number 12 AWG or 3 number 14 AWG wires

Tan: up to 3 number 12 AWG or 4 number 14 AWG wires

Red: up to 5 number 12 AWG or 3 number 10 AWG wires

Grey: up to 4 number 10 AWG, 3 number 10 AWG or 2 number 8 AWG wires

Blue: (big ones) up to 3 number 8 AWG or 2 number 6 AWG wires

## Printed Circuit Boards

Modern electronic circuit designs use printed circuit boards (PCBs) to interconnect components.

### PCB Design Process

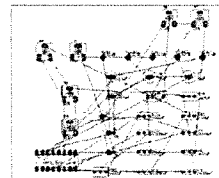
Draw schematic in Computer-aided Design (CAD) package

Use routing software to convert schematic to physical layout.

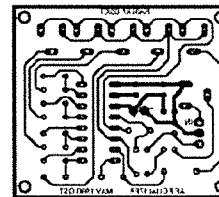
Print routed design to resist paper

Transfer design to copper-clad blank PCB

- Areas coated with resist will remain



Initial Component Placement



Routed Design

## Printed Circuit Boards

### PCB Design Process

Immerse blank board into chemical bath

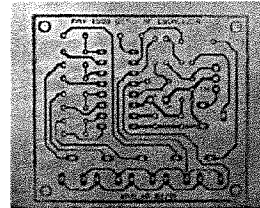
- Unwanted material removed by chemicals

Drill holes for components

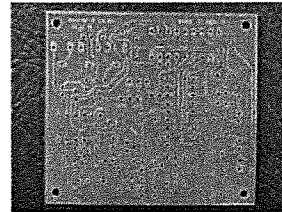
- Use small drill press and very small bits

Clean board surface and prepare for soldering

Solder Components onto PCB.



Design ready for chemical bath



Completed PCB

## Electrical Connections

End Lesson 13 EET 150

Coming Next: Theory of Operation: Soldering  
Kit Circuit