ELECTRICAL CONNECTIONS

ET 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 (Sb) 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

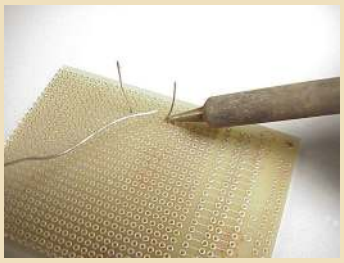
Soldering Procedure

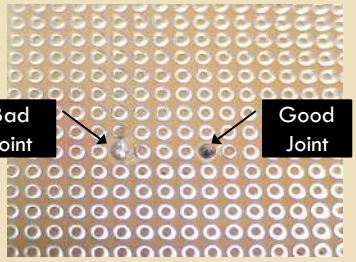
Apply iron/gun to joint

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

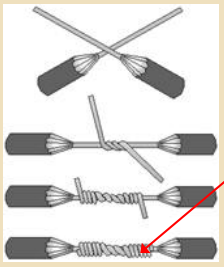
Fluxes can be toxic and/or corrosive – read all instructions and warnings before using

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

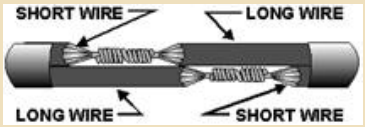
Give good mechanical strength and electrical conductivity



Make 5 to 10 tight turns on each side

Western Union Splice

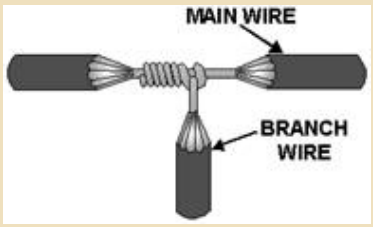
Works best with solid wire



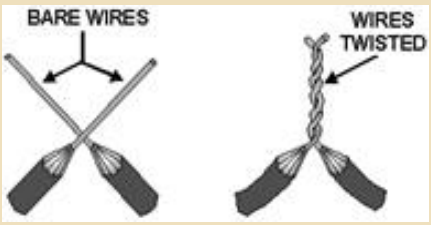
Splicing multi-conductor cables using offset Western Union splices

Wire Splices

Tap Splice



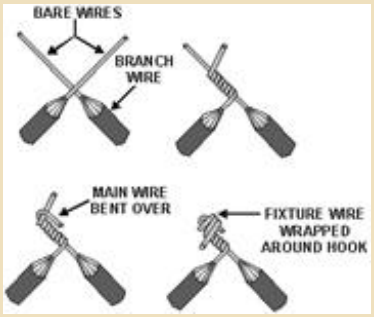
Rat Tail Splice



All splices can be soldered to add strength and conductivity

Wire Splices

Fixture Splice



Provides extra strength for hanging light fixtures

Use needle-nose pliers to make tight bends and joints

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
striping 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 number10 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.

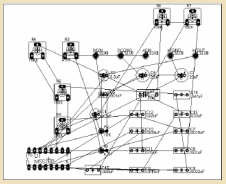
PCB Design Process

Draw schematic in Computer-aided Design (CAD) package

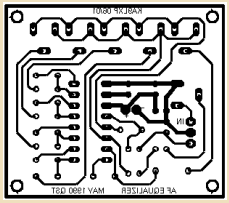
Use routing software to convert schematic to physical layout.

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

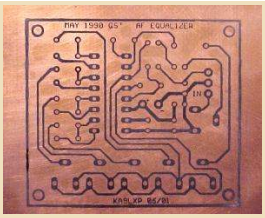
PCB Design Process

Immerse blank board into chemical bath
• Unwanted material removed by chemicals

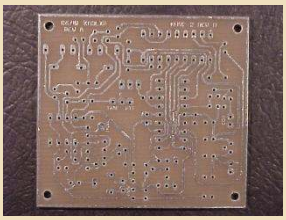
Drill holes for components
• Use small drill press and very small bits

Clean board surface and prepare for soldering

Solder Components onto PCB.



Design ready for chemical bath



Completed PCB

Electrical Connections

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Coming Next: Theory of Operation: Soldering Kit Circuit