HAND SOLDERING TRAINING

By : ANANT PATIL

Contents

1 What is soldering?

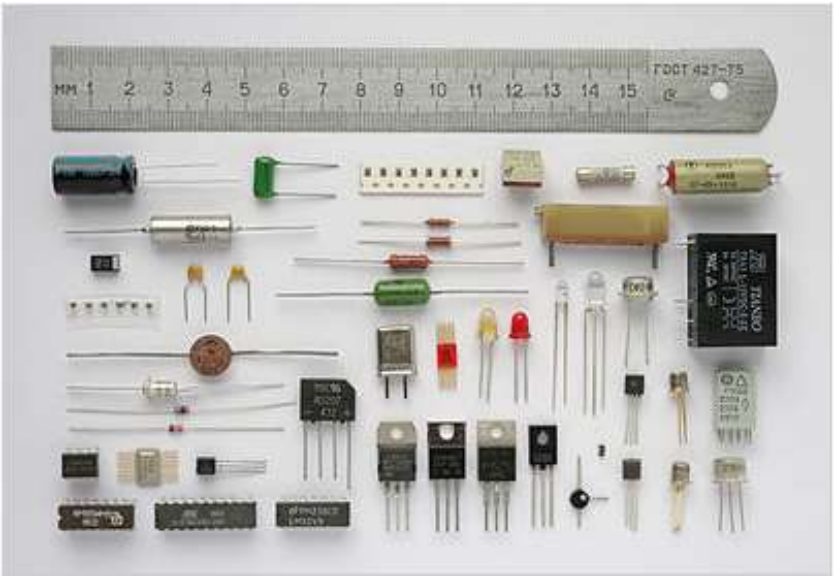
- Formation of “metal to metal” joint using solder.
- The joint is made by alloy formation of base metal and solder.
- In soldering, there are four key elements: Iron, Solder, Flux, And Component; they all are important.
- Flux cored solder wire is used for hand soldering

2.1 Electronic Component

Electronic components are basic electronic element or electronic parts usually packaged in a discrete form with two or more connecting leads or metallic pads.

There are main three types of Electronic components –

1. Active Component
2. Passive Component
3. Electromechanical



2.2 Classification of Parts

Active Component: Those devices or components which required external source to their operation is called Active Components.

For Example: Diode, Transistors, SCR etc…

Explanation and Example: As we know that Diode is an Active Components. So it is required an External Source to its operation. Because, If we connect a Diode in a Circuit and then connect this circuit to the Supply voltage., then Diode will not conduct the current Until the supply voltage reach to 0.3(In case of Germanium) or 0.7V(In case of Silicon)

2.2 Classification of Parts…

- **Passive Components:** Those devices or components which do not required external source to their operation is called Passive Components.

For Example: Resistor, Capacitor, Inductor etc…

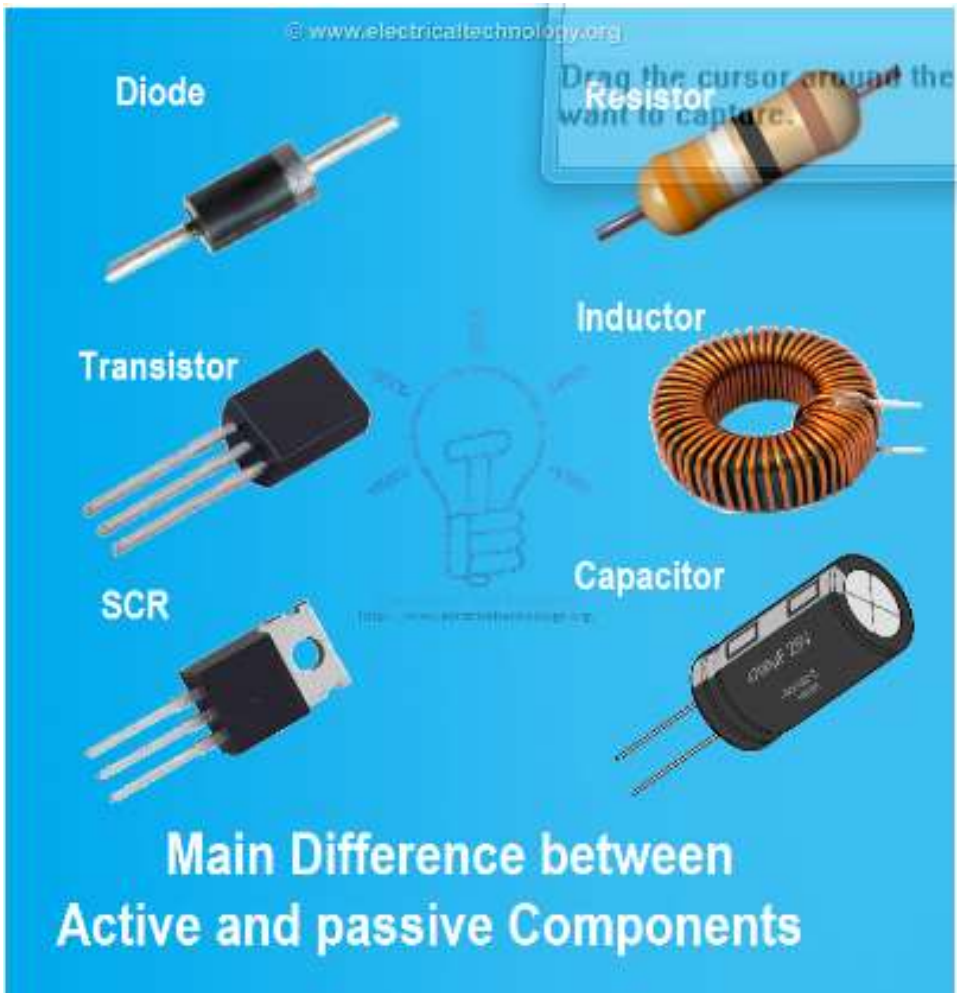
Explanation and Example: Passive Components do not require external source to their operation.
Like a Diode, Resistor does not require 0.3 0r 0.7 V. I.e., when we connect a resistor to the supply voltage, it starts work automatically without using a specific voltage.

2.3 Difference between Active and Passive Components

- **Active Components:**
  Those devices or components which produce energy in the form of Voltage or Current are called as Active Components
- **Passive Components:**
  Those devices or components which store or maintain Energy in the form of Voltage or Current are known as Passive Components

- ***In very Simple words;***
  Active Components: Energy Donor
  Passive Components: Energy Acceptor

2.3 Active and Passive Component



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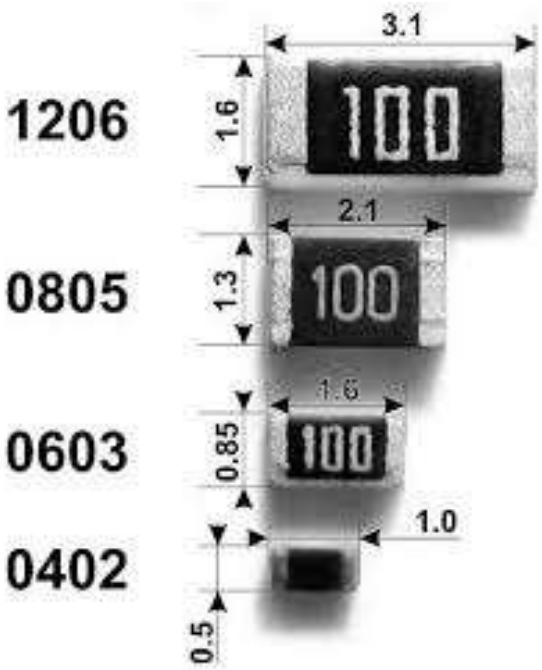
2.4 Type of Packages

There are many different type of Surface Mount Packages. Each time a new SM package is developed a new name is created. These names are usually abbreviated by their initials.

For Ex. The Quad Flat Pack is commonly known as the QFP.

The word “Package” is refer to the component’s physical shape or outline.

2.5 Component Identification & Size



Size Code		Approximate Size (LxW)	
Inch	Metric	Inch	Metric
0402	1005*	.04" x .02"	1.0 x 0.5mm
0504	1210*	.05" x .04"	1.2 x 1.0mm
0603	1508	.06" x .03"	1.5 x 0.8mm
0805	2012	.08" x .05"	2.0 x 1.2mm
1005*	2512	.10" x .05"	2.5 x 1.2mm
1206	3216	.12" x .06"	3.2 x 1.6mm
1210*	3225	.12" x .10"	3.2 x 2.5mm
1812	4532	.18" x .12"	4.5 x 3.2mm
2225	5664	.22" x .25"	5.6 x 6.4mm

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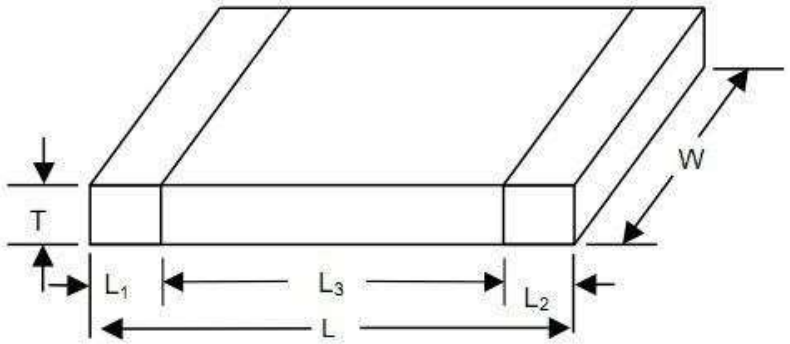
2.6 Parts Dimension



Style	L	W	T		L_1 : L_2		L_3
			MIN.	MAX.	MIN.	MAX.	Min.
CC0402	1.0±0.05	0.5±0.05	0.45	0.55	0.15	0.30	0.40
CC0603	1.6±0.10	0.8±0.10	0.70	0.90	0.20	0.60	0.40
CC0805	2.0±0.10	1.25±0.10	0.50	1.35	0.25	0.75	0.55
CC1206	3.2±0.15	1.6±0.15	0.50	1.35	0.25	0.75	1.40
CC1210	3.2±0.20	2.5±0.20	0.50	1.80	0.25	0.75	1.40
CC1812	4.5±0.20	3.2±0.20	0.50	1.80	0.25	0.75	2.20
CC2220	5.7±0.20	5.0±0.20	0.50	1.80	0.25	0.75	2.20

Unit: mm

Different Components with SMT Nomenclature

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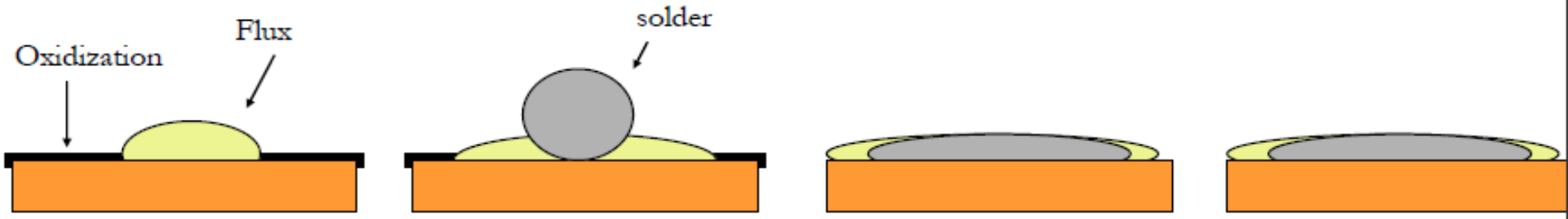
3 Flux Function

What does it do?



Remove oxide	Prevent from re-oxidation	Reduce surface tension	Solder finish
Remove metal oxide to support wettability of solder.	Coat metal surface to prevent from re-oxidation.	Reduce surface tension of solder to allow it to spread onto pad/lead.	Make smooth surface finish of solder and prevent solder bridges.

During soldering chemical reaction takes place. The flux removes all the surface tarnish leaving clean metal underneath.

4.1 Solder Wire

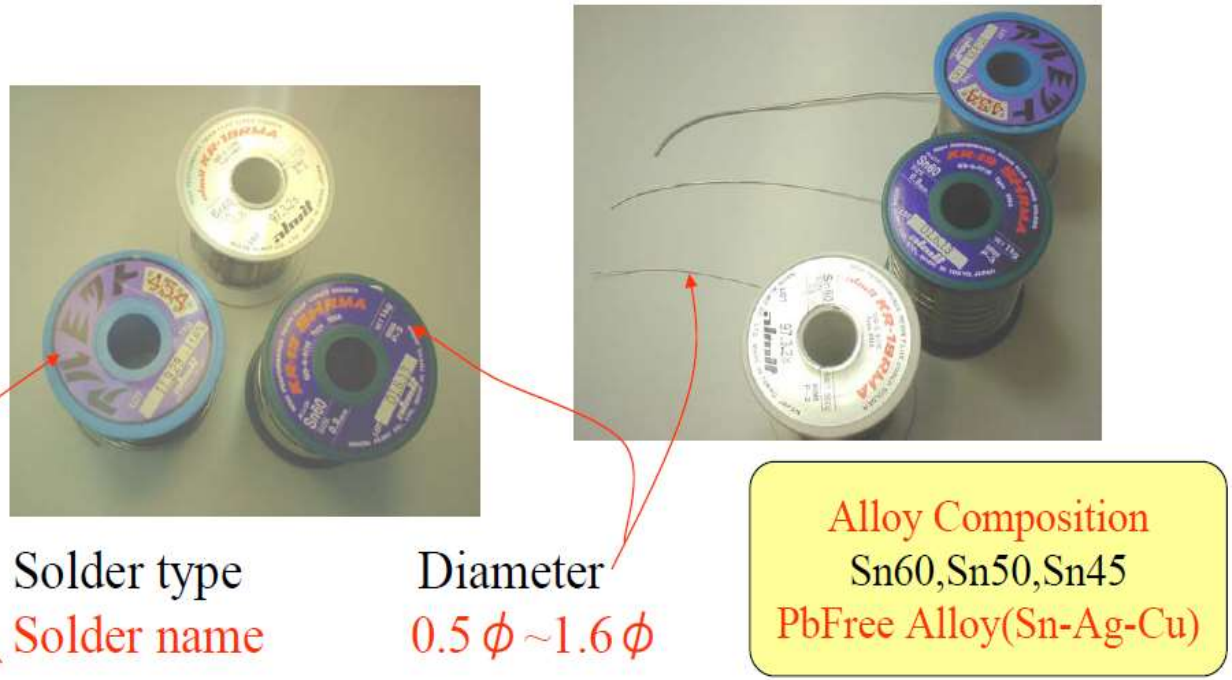
Solder is a fusible metal alloy used to create a permanent bond between metal and workpieces.

You should be aware of following while choosing solder wire –

Lead (Pb) Content

Flux Content

Wire Size



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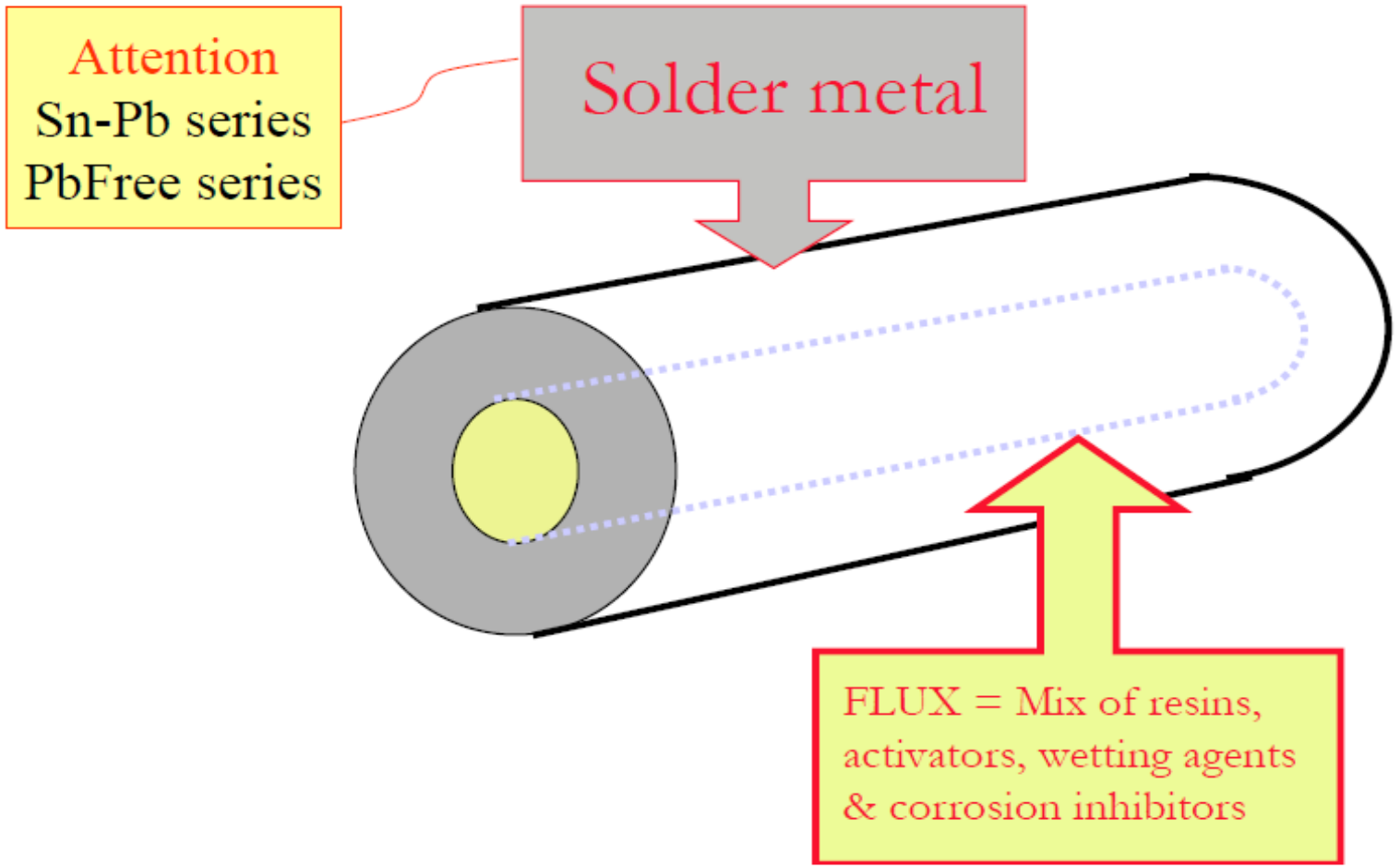
4.2 Construction of Cored Solder



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4.3 Variables in Cored Solder Wire

- Solder Alloy
  - Most use Sn60/Pb40 or Sn62/Pb36/Ag2 or LEAD FREE
- Flux Type
  - No-Clean RMA (Rosin Mildly Activated)
    - Flux residue are safe to leave on PCB. They will not cause corrosion or electrical breakdown of ckt during its lifetime.
- Flux %
  - 1, 2 or 3. Higher flux % makes soldering easier but can leave more flux residue which can make solder joint look cosmetically ‘dirty’
- Wire Diameter
  - Select the right one for the required job
- Reel Size
  - Generally 500gm.

4.4 Type of Solder wire

There are two main types of solder:

- Lead-based solder
- Lead-free solder

*The main practical difference between the two is the melting temp.

Lead-based solder: It was made of a mixture of tin and lead. Usually a 60/40 (tin/lead) mix, that melts at around 180-190 degree C.

Because lead has some damaging effects to our health. The industry is moving away from lead and towards lead-free solder.

Lead-free solder: It is solder without lead. Now it is recommended to use lead-free solder (RoHS) because of the health hazards of lead.

It has a higher melting point, so it is bit harder to work with, but usually not a problem.

4.5 Flux Content

Solder wires usually have a core inside the wire containing flux. Flux is designed to improve electrical contact and mechanical strength in solder joints.

There are mainly two types of flux cores –

- Acid core - Used for plumbing
- Rosin core - Used for electronics.

So use rosin core only, But there are four types of Rosin Flux –

- R – Rosin
- RMA – Rosin Mildly Activated (Preferably used)
- RA – Rosin Activated
- AC – Non-Rosin Activated

4.6 Wire Size

For basic electronics work, a solder wire between **0.711 mm to 1.63 mm** diameter is good enough. However, solder diameter is determined by the gauge number.

Gauge Number	16	18	20	21	22
Diameter (mm)	1.63	1.22	0.914	0.813	0.711
Diameter (inch)	0.064	0.048	0.036	0.032	0.028

- For restoring antique computers for the museum, and repairing vintage circuits that have huge solder tags, normally gauge 16 used.
- For PDIP and through-hole packages that have a standard pin spacing of 0.1-inch, gauges 18, 20, and 21 is preferred.
- For SMD components such as SOIC packages where the pin spacing is much closer, then a fine tipped soldering iron with a 22 gauge solder wire works well.

5.1 Soldering Iron

Soldering station

Temperature setting differs depending on application.

Necessary to check the temperature before starting the process.

Iron holder

Soldering Iron

Sponge for cleaning soldering iron tip.

The soldering iron is critical to good soldering. It must provide all the heat to heat up the joint which in turn must heat up the solder wire/flux

5.2 Variety in Soldering Iron

Differences in power capacity, size and ability.

Use one depending on the type of work . 80 W

Weller better for Pb Free or large joints

Iron tip

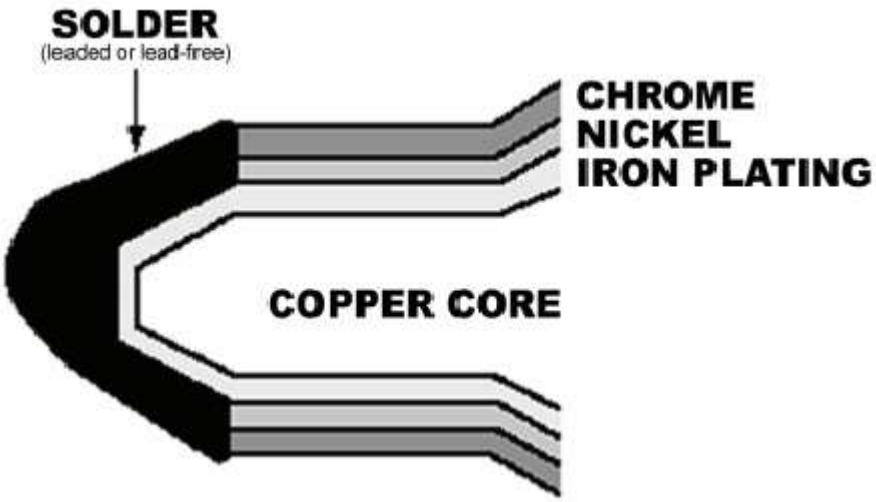
Iron tip shape is different for each process.
Choose correct iron tip for application.

Internal part of soldering iron

Ceramic heater

Weak to impact / shock.

5.3 Construction of Tip



A tip is mainly made up of Copper core, to ensure good heat transfer.

- Iron plating is done on copper core to make it thermally insulative (Heat should be transferred in proper way)
- Nickel layer is plated after iron to make non-wetting to keep solder wicking away from the tip.
- Chrome plating is done at last as a protective layer.

5.4 Types of Solder Iron Tip

Bevel Tip: It can be used for solder jobs that require pre-loading the iron with solder.

The large flat surface can hold more solder than most other tips, and it's helpful when soldering small-gauge wires together or dragging solder across surface-mount chips to solder multiple pins at once.

Chisel Tip: With its broad tip, the chisel tip helps to evenly deliver heat to component leads and pads.

This tip is great for soldering wires, through-hole components, large surface-mount components, and for desoldering as well.

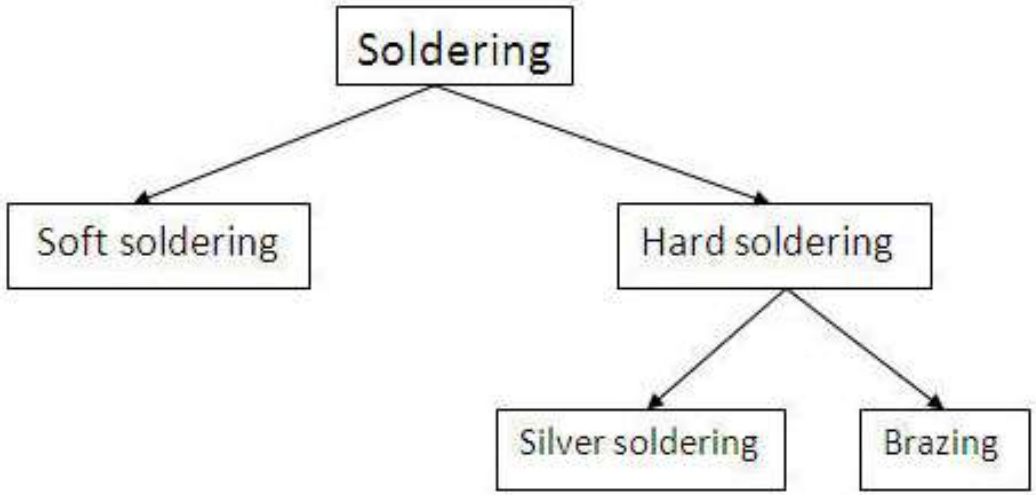
5.4 Types of Solder Iron Tip

Conical Tip:

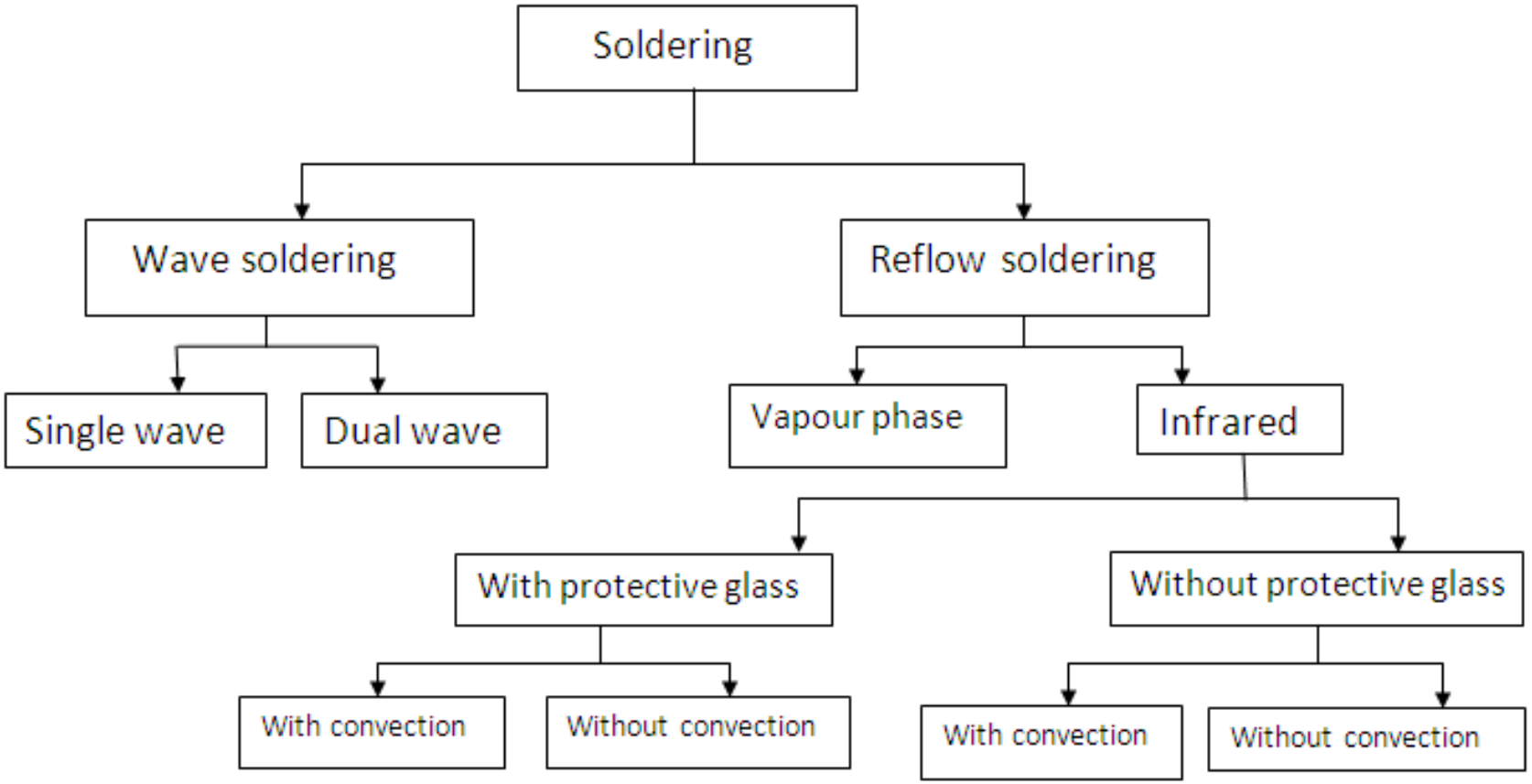
Conical tips are usually used for precision electronics work, though they're also often used for general soldering. The pointed tip helps deliver heat to small areas, such as tiny surface-mount components.

6.1 Type of Soldering

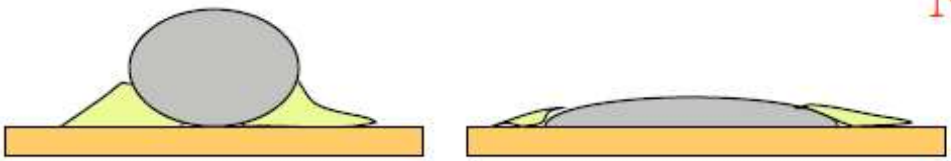
There are mainly two type of soldering :



6.2 Type of Soldering Processes



6.4 Solder Wetting



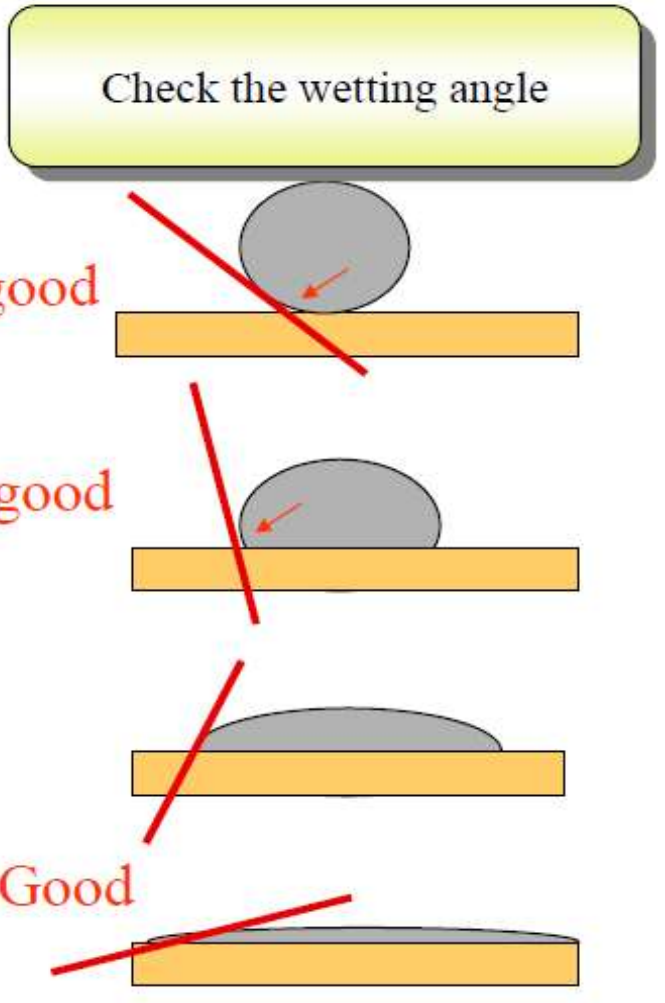
Not wetted

Not soldered

(dry joint)

Wetted

soldered



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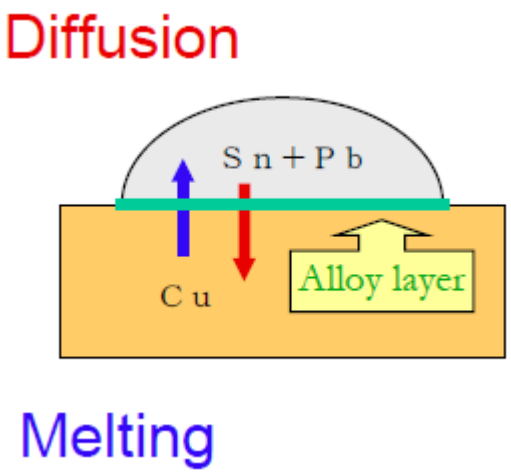
6.5 Melting and Diffusion

- Alloy is formed by melting and diffusion of metals
- Tin and Copper together makes alloy formation

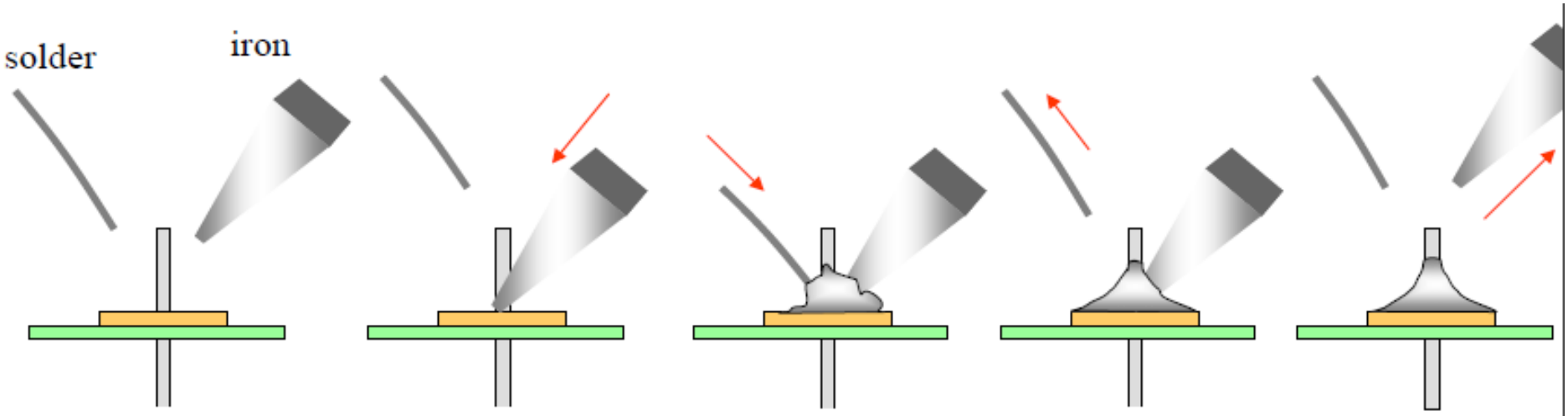


It takes certain amount of time to create the perfect solder joint. Too slow process can damage PCB/Component and too fast will not create a 'sound' joint

Alloy layer in good condition

Thin and even thickness of alloy layer

6.6 Hand Soldering Process

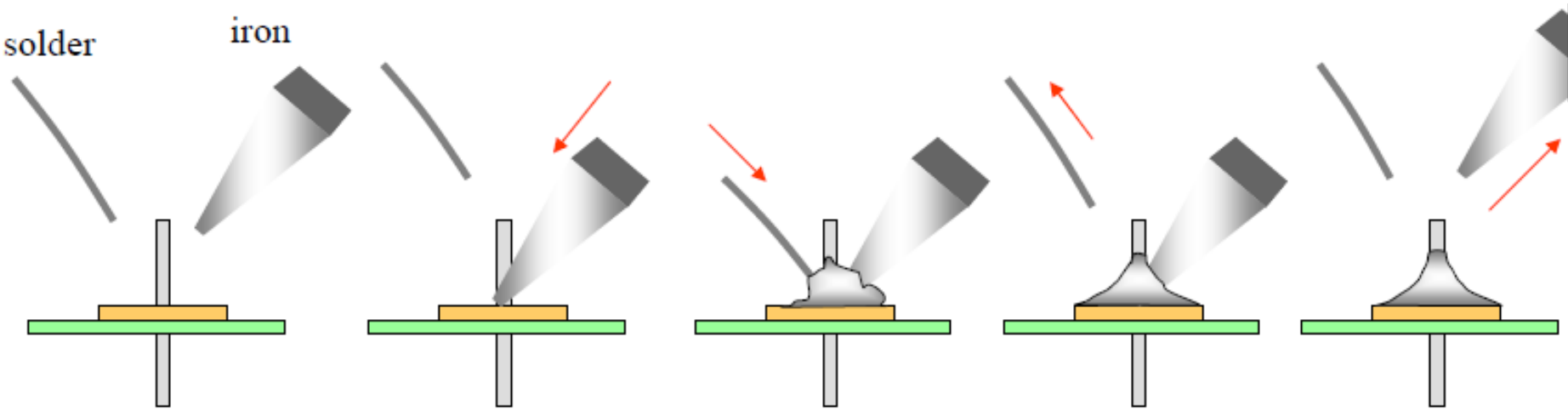


NOTE:

Solder will not alloy if the parts and solder are not fully heated.

The soldering iron is not just to heat and melt the solder, but to heat the part being soldered.

6.6 Hand Soldering process



preparation

Heat up to @ over 100°C.

May take @ 2 secs

Insert solder to hot joint area. Flux melts and covers joint. Flux helps melt solder and it flows over clean pad/lead. Solder area @ 230-240°C.

Pull out solder

Pull out iron tip

6.7 Surface Mount Soldering

There is no change in process of ‘Through-hole soldering’ and ‘Surface Mount Soldering’.

Difference between Through-hole And Surface Mount Soldering

PLAY

PLAY

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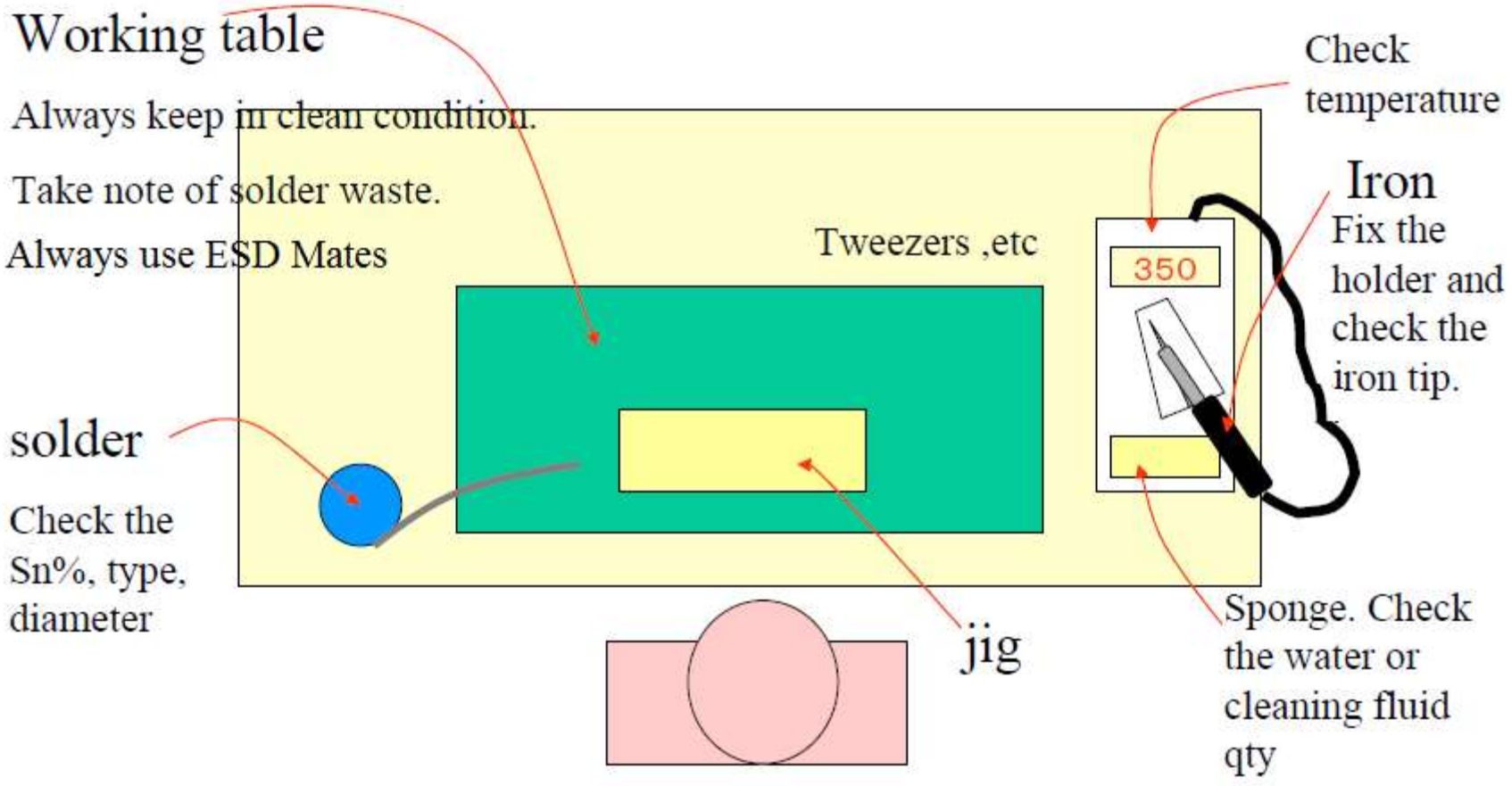
7.1 Precautions: Soldering Station



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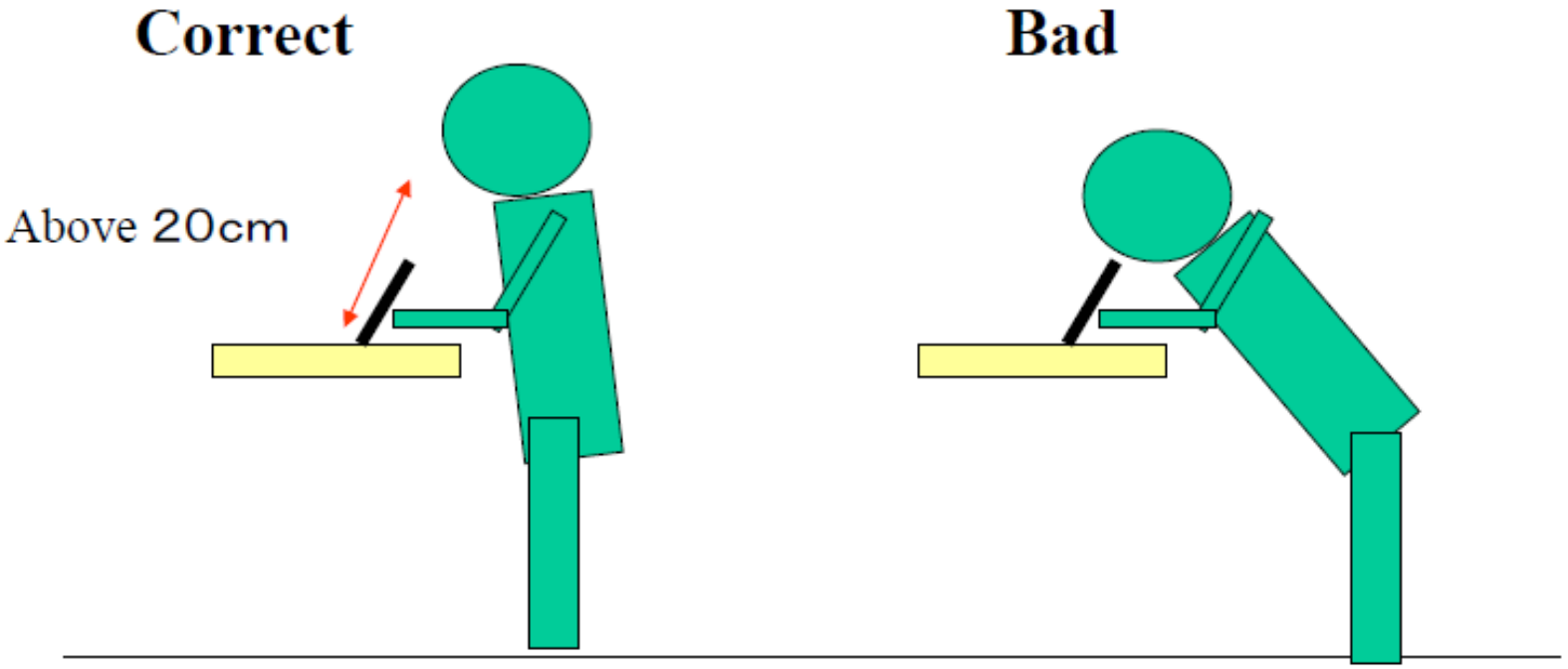
7.2 Correct Posture when soldering



Must have clear view of work. Feeding in wire and iron movement must be smooth and easy.

Not suitable. Poor position for 'back pain'. Flux fumes could be inhaled.

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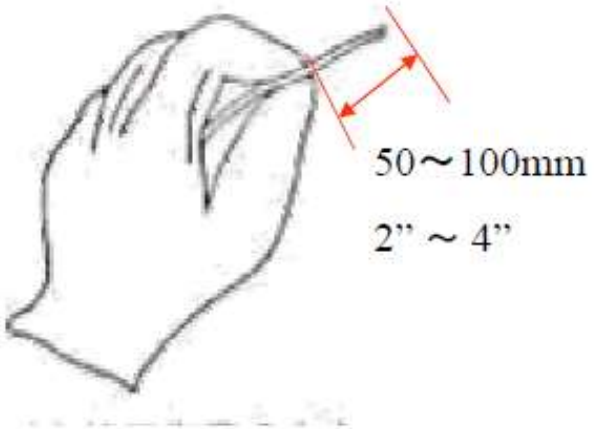
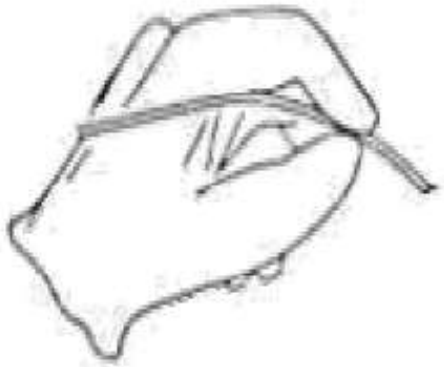
7.3 Handling method for cored solder wire during soldering





Easy feeding for continuous process.

Not suitable for continuous process.

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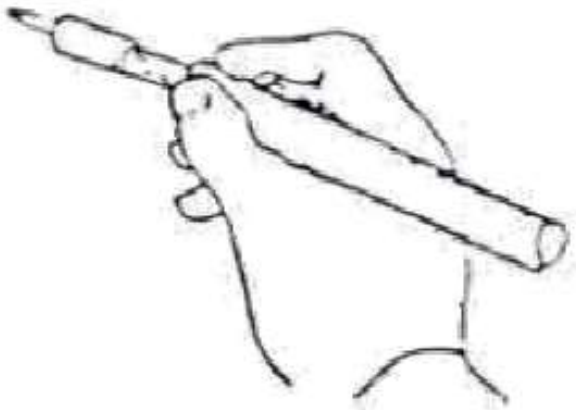
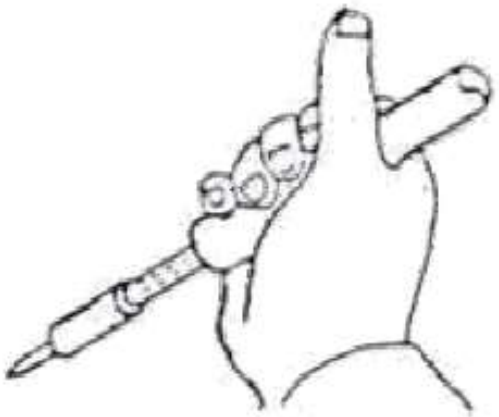
7.4 How to hold Soldering Iron

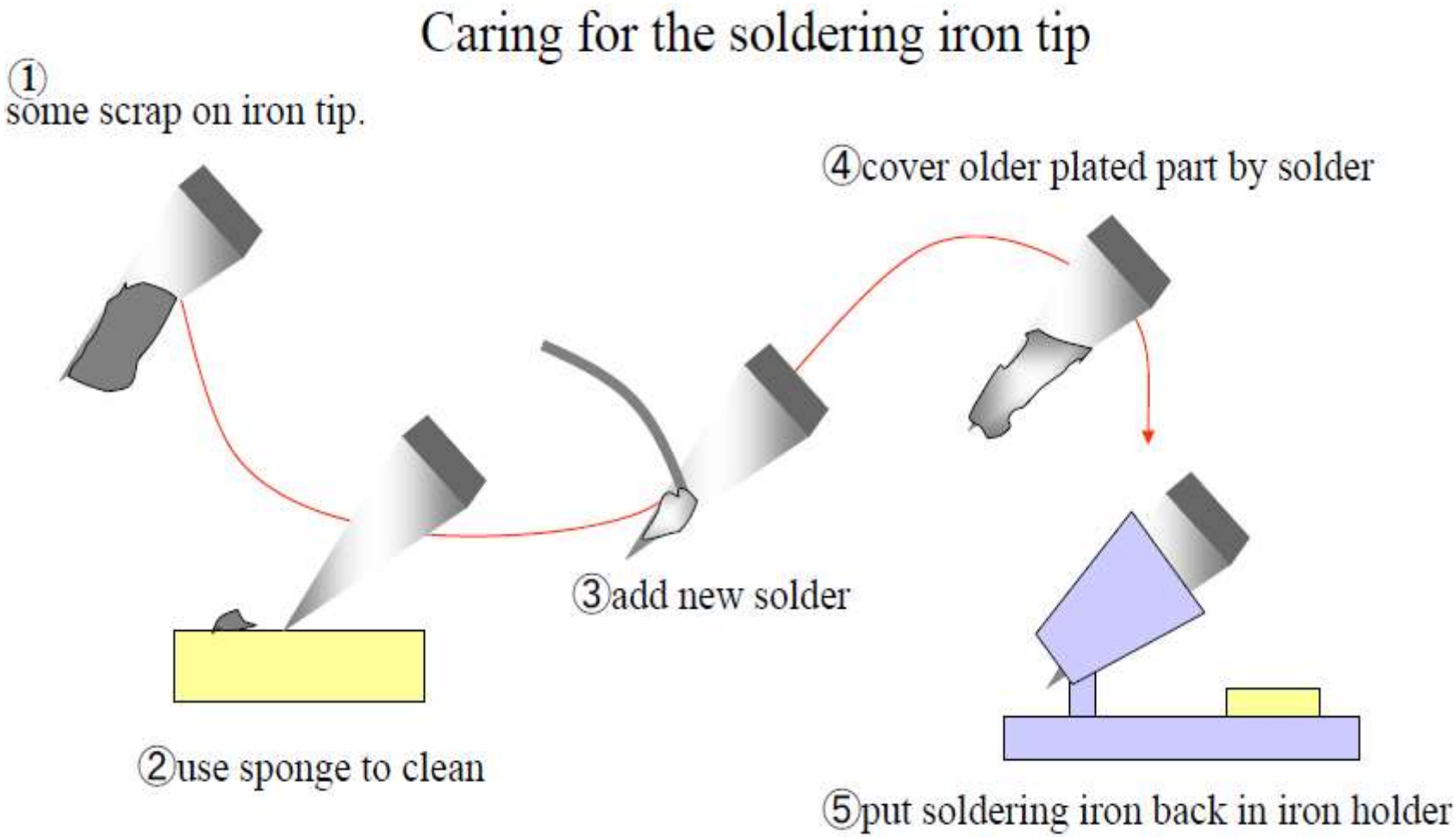


Pen-holder type
For normal operation



Grip type
For large component

7.5 Solder tip caring



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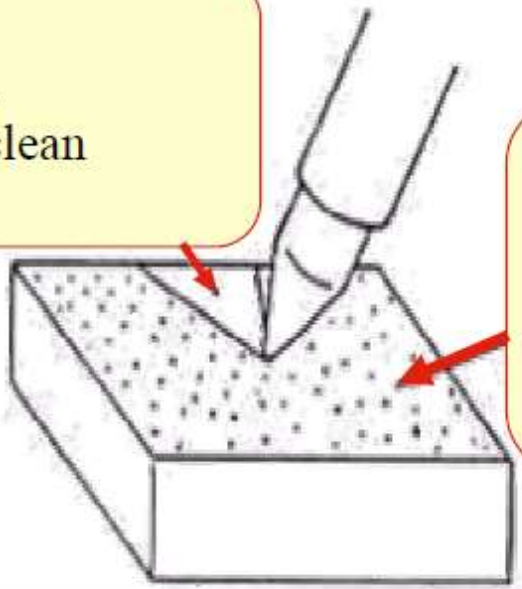
7.6 How to clean the soldering iron

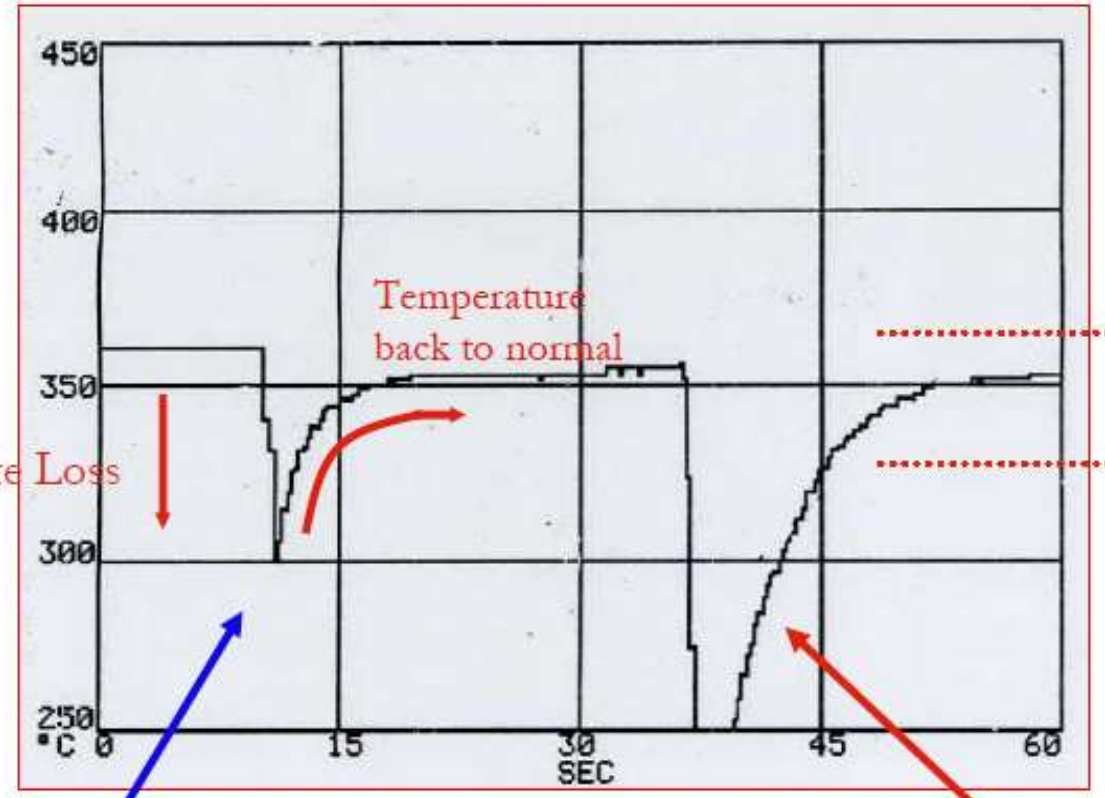
Cut sponge in V.
Use the cut part to clean



Use water or Tip Cleaning Fluid to clean.
Do not use to much or to little. Keep tip tinned with Tip Cleaning Tin.

If tip not properly cleaned this can cause flux splatter, solder waste and poor heat conduction to joint area which can cause defects.
May need to increase the number of cleaning times when using Pb Free solder.

7.7 Temperature when cleaning



(Ex)

Ideal range of operation

350°C±15°C

Good condition

To start operation after temperature back to normal and consistent..

Too much water

Need longer time if temperature reduce too much.

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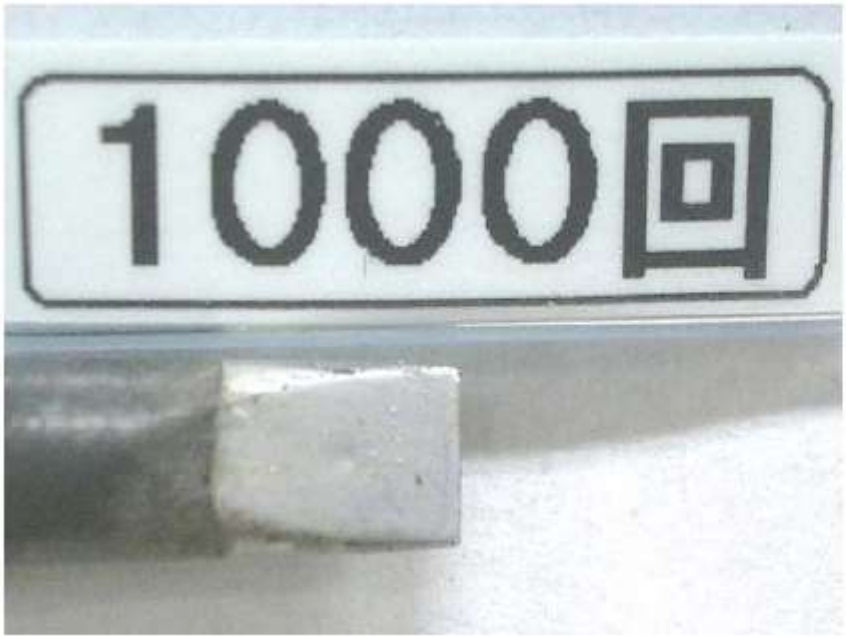
7.8 Solder tip condition-1



This tip has soldered 20000 joints. Still in perfect condition

This tip has soldered 1000 joints. The tinned area is still shiny and smooth. There is no charged flux adhering to it. Only use the tinned area to heat up Joint area. It helps the heat to be transferred quick/consistently. Using the none Tinned area of the iron will cause soldering problems.

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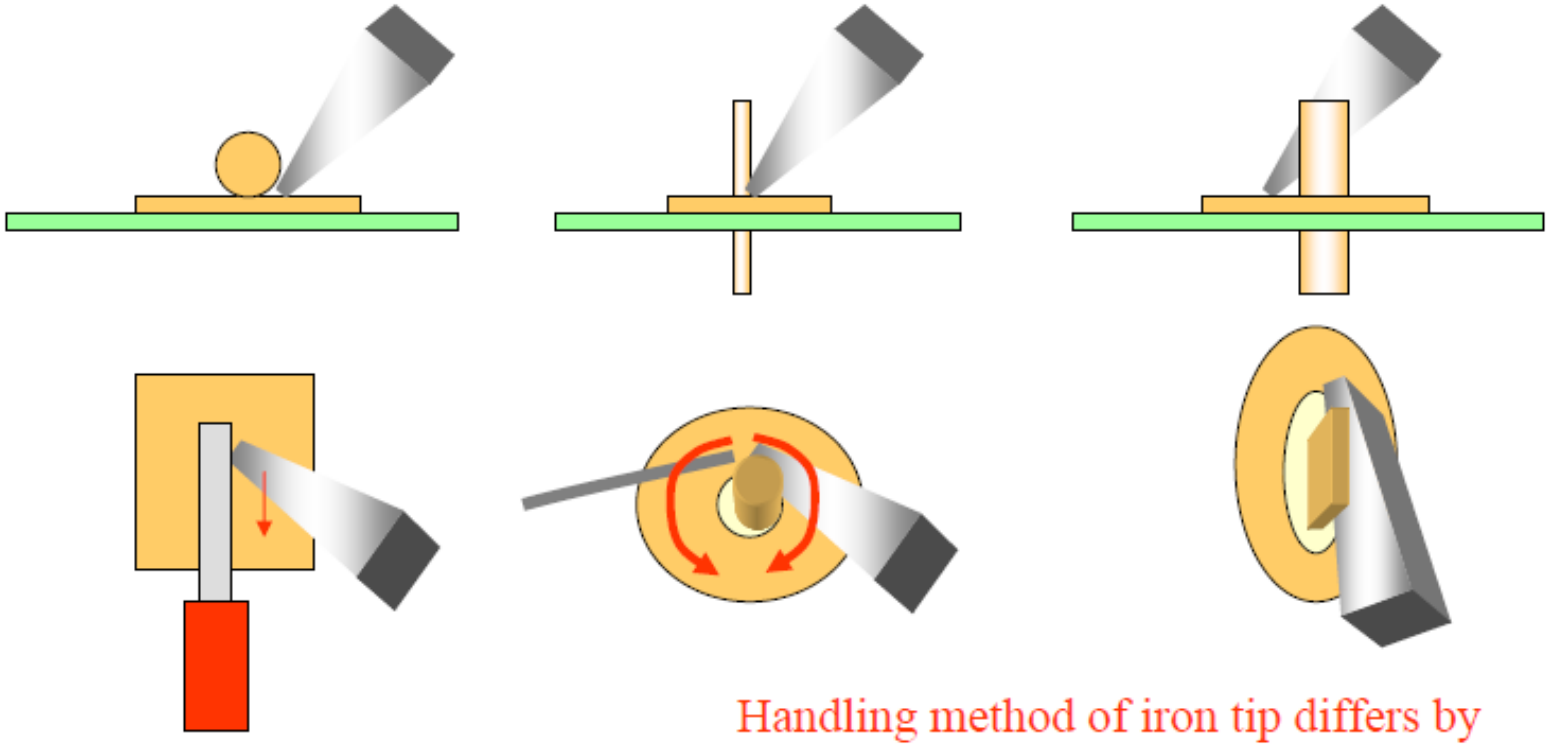
7.8 Solder tip condition-2

The tinned area is dull and inconsistent and there is lots of charred flux adhering to it. The ability of this tip to transfer heat to the solder joint is significantly impaired by its poor condition.

7.9 Heating Large Joints

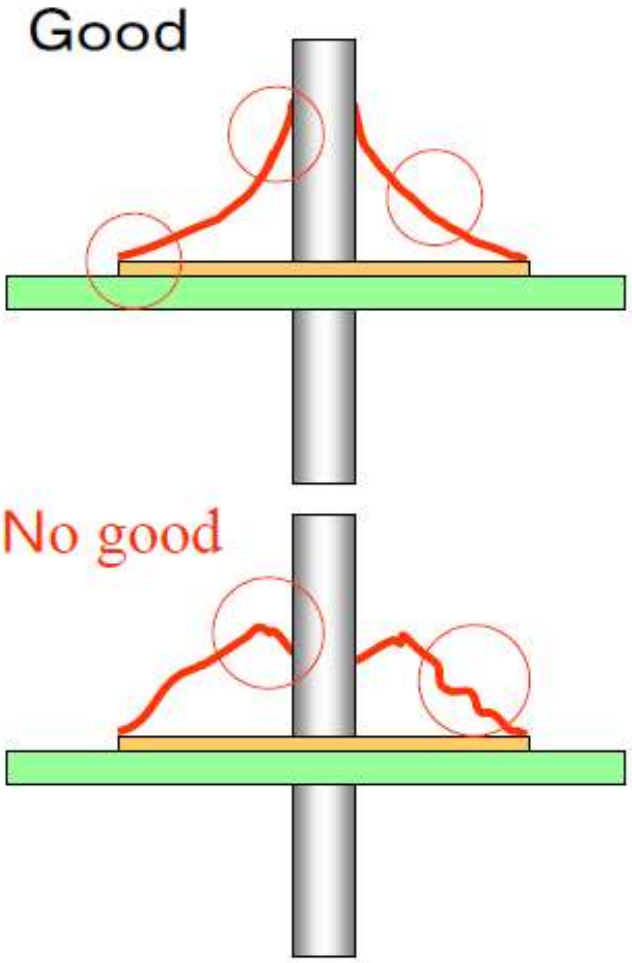
Use iron tip body to heat up the joint, but the area in contact with the joint must be tinned and clean.

Solder large terminal/area by moving iron tip



Handling method of iron tip differs by shape of terminal.

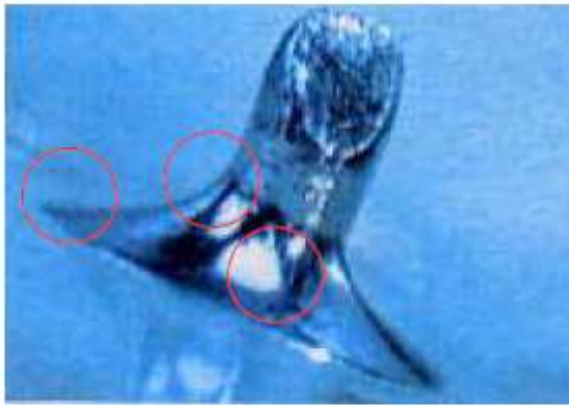
7.10 Solder Wetting



Solder wets to lead and land.

Smooth and shiny surface.

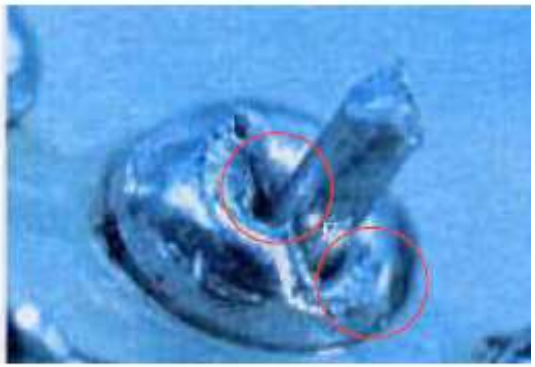
No holes, no spikes.



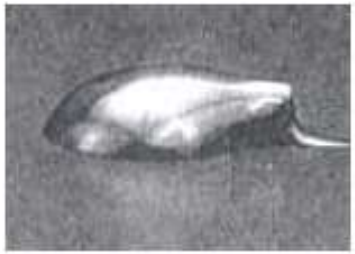
Poor wetting to lead.

Rough surface.

Holes.



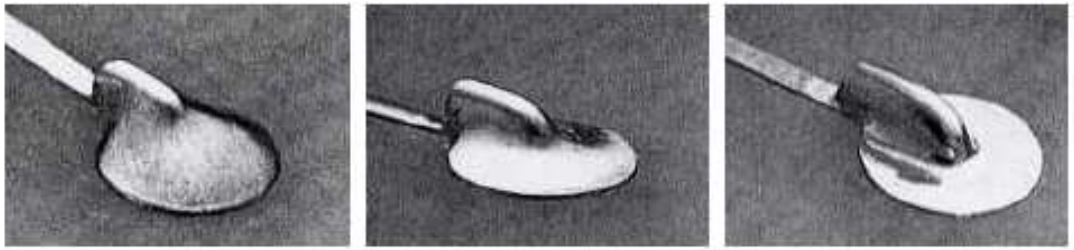
7.11 Solder Quantity



No good

Excess amount

Unable to confirm whether solder is wetted.



OK

Apply correct solder amount.

No good if too much or too little.

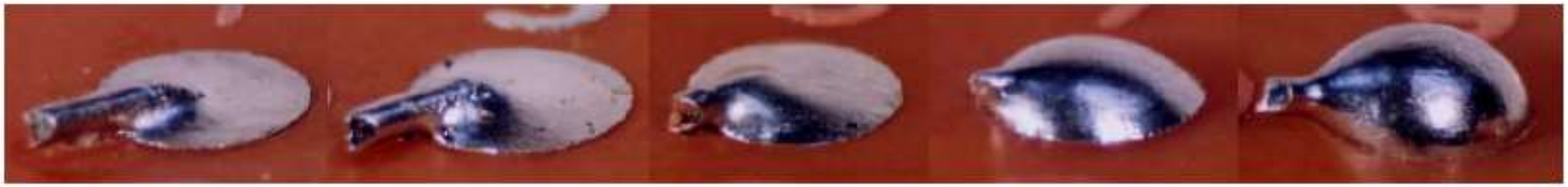
No good

Lack of solder

Solder joint is weak, and leads to crack.

7.12 Solder Quantity & Surface Condition-1

Sn60



Pb Free

GOOD

Small amount

Large amount

7.12 Solder Quantity & Surface Condition-2

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7.13 Key points for heating

What is the appropriate temperature for soldering???

Joint area temperature = The M.P. of Solder Alloy + 40~50DegreeC

For Sn60% solder

Joint area temperature = 190DegreeC+40~50DegreeC
= 230~240DegreeC

However the iron will be set much hotter at 350-450DegreeC

Note: The hotter the iron faster the joint can be made providing the heat transfer from it is good.

Must try to heat up both/all parts to be soldered **at the same time**

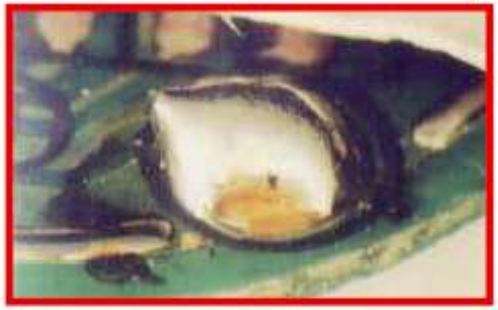
If it is difficult to do this then evaluate special solder iron tips

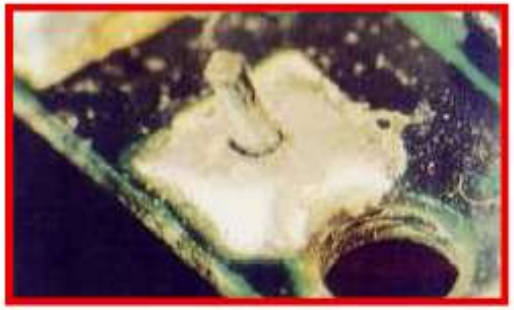
Heating up more than needed, will cause **overheating defects**

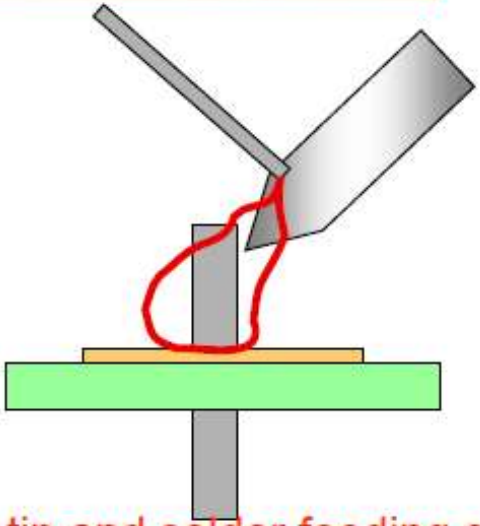
Note: Using a very hot iron will increase the risk of soldering defects and component damage. Soldering is a balance of time and temperature.

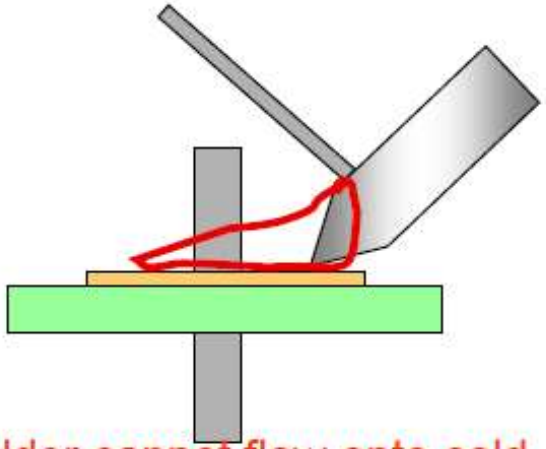
7.14 Incorrect Heating

No wetting









Locate iron tip and solder feeding spot carefully. Solder cannot flow onto cold areas or areas not cleaned by flux. Here flux has been used up on iron.

7.15 Movement before solder solidifies

- Crack occurs when soldering point moves.

Crack due to vibration before solidification.

Crack due to movement before solidification.

Do not move parts until solder has solidified. Liquid solder has no strength. Large parts may take a few seconds to cool.

7.16 Considerations for good soldering

- ESD Bench
  - Must be ESD safe to eliminate static
  - Keep it clean/tidy
- Lighting
  - Keep it as natural as possible.
- Fume Extraction
  - Keep the filters clean
- Iron/wire Position
  - Must be positioned to allow smooth access to solder joint area.
- Work Jig
  - Must be free from flux residues etc

7.17 Soldering Summary

- No success in soldering with poor heating,
- Heat all parts at once.
- Apply correct amount of solder
- Don't move part until solder has solidified.
- Pay attention when releasing iron.
- Visual check to confirm soldering quality.

8.1 Inspection and Handling

Has soldering process been done well?
Take responsibility and do your own inspection.
Be able to make the correct judgment.

Inspection point

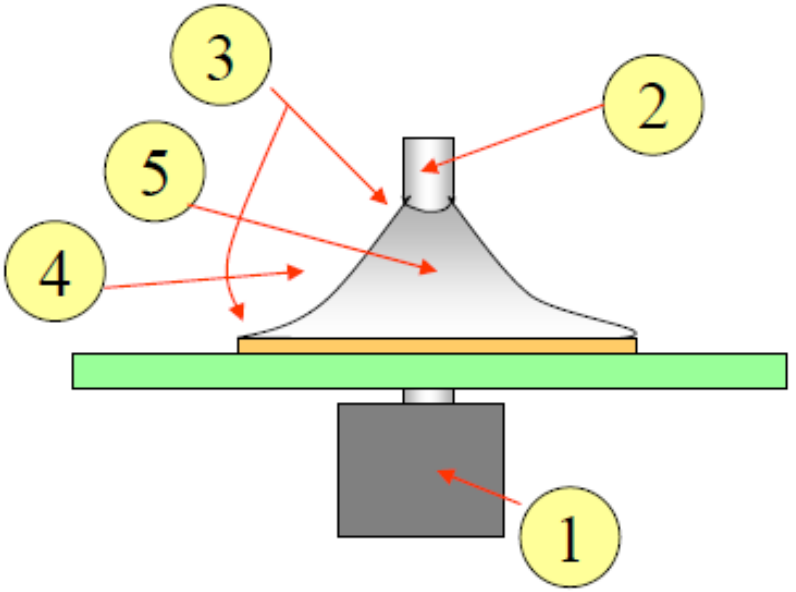
(1) Correct position (part, lead etc)

(2) Correct shape (part,lead etc)

(3) Wetting (lead, land)

(4) Solder amount (qty)

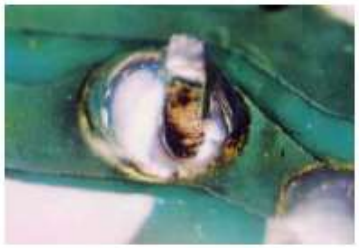
(5) Solder surface (smooth,shiny,no-hole,etc)



CORE RESEARCH

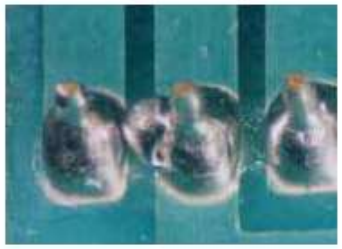
8.2 Different Types of Defects

Non-wetting

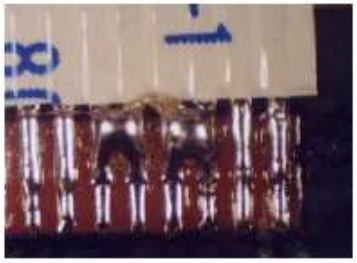


Non-wetting

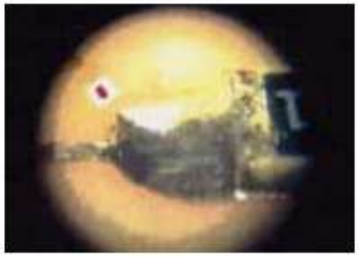
Solder ball



Solder scrap



Bridge

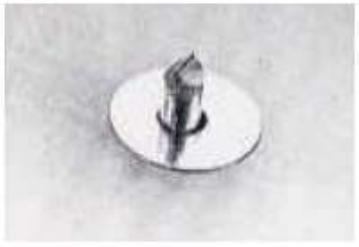


Projection

Crack

Poor wetting

tunnel



Forget to solder

Land peeled off

Over heat

8.3 Defects due iron tip

- Common defects caused by iron tip releasing

Projection/solder spike

Too slow release speed of iron tip

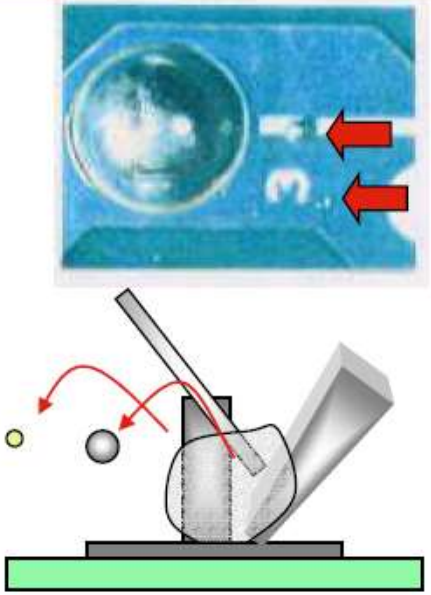
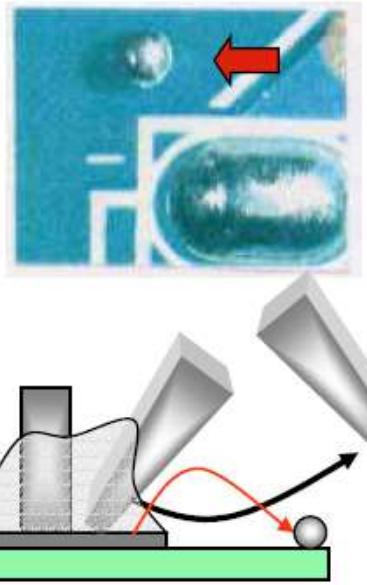
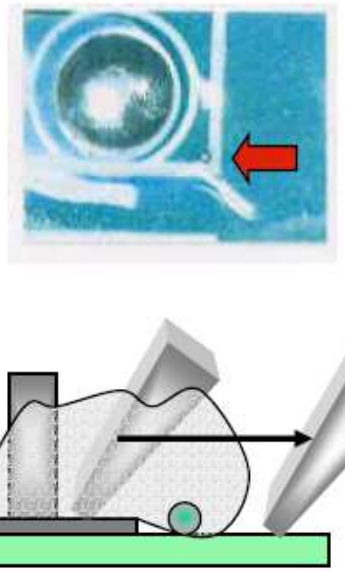
Solderball

Wrist twisting

Adhesion of scrap/flux residue

Bad direction when releasing iron tip

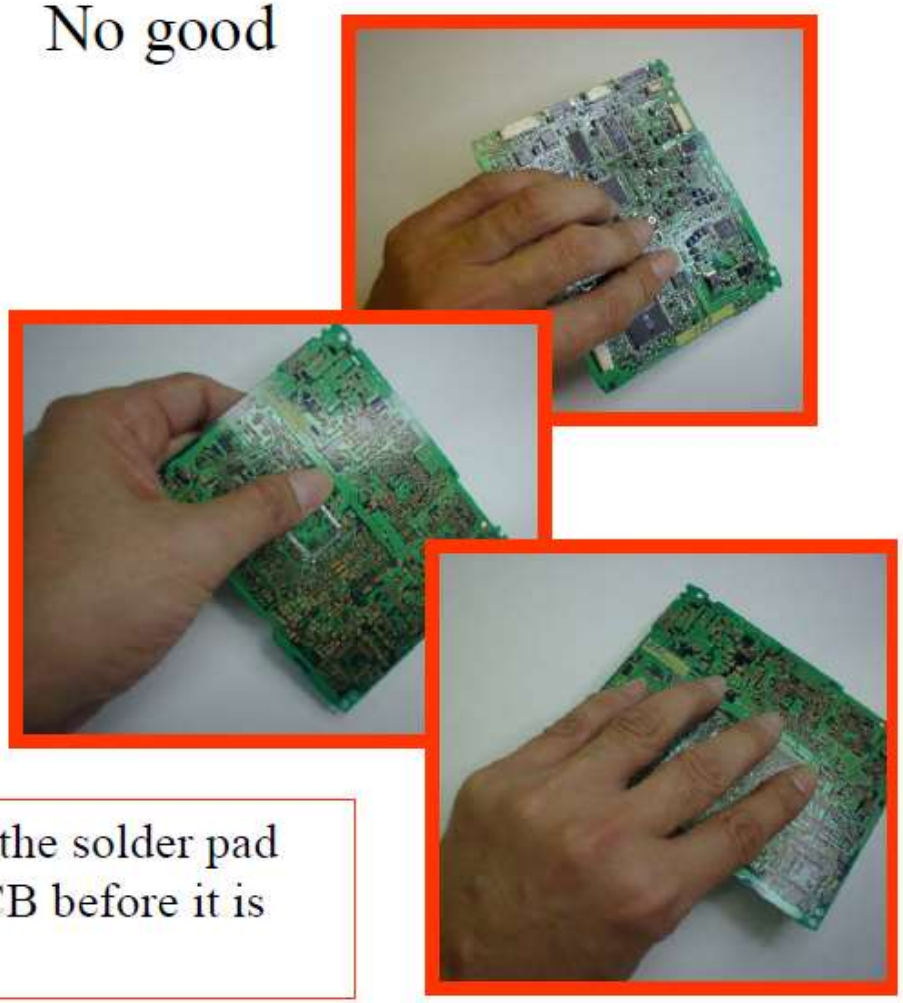
8.4 Solder balls

Solder ball and flux spattering	Large solder ball	Solder ball in flux
		
Apply solder material forcibly while the base metal is heated insufficiency.	Speed of withdrawing solder-iron too fast.. Withdraw solder-iron with smooth sweeping movement.	When iron-tip "slip" on to PCB

8.5 Handling of PWBs

Good

No good



Do not touch the solder pad side of the PCB before it is soldered.

THANK YOU!