• HAND SOLDERING TRAINING COURSE
• **Aim**
  - Review the whole soldering process to improve soldering quality.
  - Aim for high first time pass rates.

• **How to approach soldering**
  - Regardless of what product an electronic assembler makes, we can say they really only make solder joints. It’s the process that brings everything electrical together.
  - Every joint should be made with care. If not then you may be able to ‘weed’ out the poorest during inspection/test but some will pass and they will be the weakest bit of the product and will fail in service, especially in automotive products where temperature & vibration can be considerable.
  - In service failures are expensive to repair and always have other negative effects on the business.

• **All customers know the solder joint is potentially the weakest part of the product.**
Contents

1. What is soldering?
2. Cored Solder Wire
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1-1. What is soldering?

- Formation of a “metal to metal” joint using solder.
- The joint is made by alloy formation of base metal and solder.
- In soldering, there are three key elements: Heat, Solder, Flux, they are all important. Flux cored solder wire is used for hand soldering.
What is soldering?

1-2. Flux Function

What does it do?

- **Remove oxide**
  - Remove metal oxide to support wettability of solder.

- **Prevent from re-oxidation**
  - Coat metal surface to prevent from re-oxidation.

- **Reduce surface tension**
  - Reduce surface tension of solder to allow it to spread onto pad/lead.

- **Solder finish**
  - Make smooth surface finish of solder and prevent solder bridges.

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

1-3. Solder Wetting

Check the wetting angle

Not wetted  Wetted
No good    No good
Not soldered  soldered
(dry joint)

Good
What is soldering?

1-4. Melting and Diffusion

• Alloy is formed by melting and diffusion of metals
• Tin and copper alloy together

**Diffusion**

**Melting**

It takes a certain amount of time to create the perfect solder joint. Too slow a process can damage pcb/components and too fast will not create a ‘sound’ joint.
2-1. Cored Solder Wire

Solder type
Solder name
Diameter 0.5 $\phi$ ~ 1.6 $\phi$

Alloy Composition
Sn60, Sn50, Sn45
PbFree Alloy (Sn-Ag-Cu)

Always confirm before use. (Use of different solders and diameters depends on the products being soldered)
2-2. Construction of Cored Solder

Attention
Sn-Pb series
PbFree series

Solder metal

FLUX = Mix of resins, activators, wetting agents & corrosion inhibitors
2-3. Solder Wire Variables

• Solder Alloy
  • Most use Sn60/Pb40 or Sn62/Pb36/Ag2 or LEAD FREE

• Flux Type.
  • No-Clean RMA (ALMIT KR19 SH)
    • Flux residues are safe to leave on pcb. They will not cause corrosion or electrical breakdown of cct 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 job.

• Reel Size
  • Generally 500g
2-4. Handling method for cored solder wire

- Easy feeding for continuous process.
- Not suitable for continuous process.

Cored Solder Wire

50～100mm
2”～4”
3-1. Soldering Irons

**Soldering station**
Temperature setting differs depending on application.

Necessary to check the temperature before starting the process.

**Soldering Iron**

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.
3-2. Soldering Irons

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.
3-3. How to hold Soldering Iron

Pen-holder type
For normal operation

Grip type
For large component
3-4. How the tip is made

The most important part of the soldering iron is the TIP. The main part of the tip is made of copper. To extend the lifetime of the tip, it is iron coated. Before the iron is added the copper is nickel plated. The non-wettable part of the tip is chrome plated. The chrome stops the solder flowing up the tip. The tip is pre-tinned with lead free solder.

Nickel coating: ca. 10 - 20µm
Iron coating: ca. 150 - 300µm
Chrome Coating: ca. 3 - 6µm
3-5. How to clean Soldering Iron

- Cut sponge in V.
- Use the cut part to clean

- Use water or Tip Cleaning Fluid to clean.
- Do not use too much or too 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.
3-6. Temperature when cleaning

Temperature Loss

Temperature back to normal

Ideal range of operation
350°C ± 15°C

(Ex)

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

Too much water
Need longer time if temperature reduce too much.
3-7. Temperature Stability

Each time a solder joint is made, the heat in the soldering iron is depleted especially if joints are made ‘quickly’.

![Graph showing temperature stability for different wattages.](image-url)
This tip has soldered 1000 joints. The tinned area is still shiny and smooth. There is no charred flux adhering to it. Only use the tinned area to heat up joint area. It helps the heat to be transferred quickly/consistently. Using the none tinned area of the iron will cause soldering problems.

This tip has soldered 20000 joints. Still in perfect condition.
3-9. Solder Iron 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.
4-1. Soldering Workstation

- **Working table**: Always keep in clean condition.
  Take note of solder waste.

- **solder**: Check the Sn%, type, diameter.

- **Iron**
  - Fix the holder and check the iron tip.

- **Sponge**: Check the water or cleaning fluid qty.

- **Ventilation duct**

- **Tweezers, etc.**

- **jig**
4-2. Correct posture when soldering

**Correct**

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

**Bad**

- Not suitable. Poor position for ‘back pain’. Flux fumes could be inhaled.
4-3. Considerations to create best workstation

- **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
4-4. Summary so far..

- Check the solder type
- Check the solder iron
- Check the cleaning sponge
- Soldering posture
5-1. Soldering

5 step method

preparation

heat

Insert solder

Pull out solder

Pull out iron tip

Use iron tip to heat the soldering part.

Melt properly

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.
Soldering

5-2. Soldering

5 step method

preparation

Heat up to @ over 100ºC.
May take @ 2 secs

solder

iron

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

Pull out solder

Pull out iron tip
5-3. Heating Large Joint

Solder large terminal/area by moving iron tip.

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

Handling method of iron tip differs by shape of terminal.
5-4. Solder Wetting

Good
Solder wets to lead and land.
Smooth and shiny surface.
No holes, no spikes.

No good
Poor wetting to lead.
Rough surface.
Holes.
5-5. Solder Quantity

Solder joint is weak, and leads to crack.

Apply correct solder amount.

No good if too much or too little.
5-6. Solder Quantity and Surface Condition 1

Sn60

Pb Free

Small amount Large amount
5-7. Solder Quantity and Surface Condition 2

Sn60

Pb Free

NG

NG

NG
What is the appropriate temperature for soldering?

Joint area temperature = The M.P of solder alloy + 40~50 Degree C

- Sn60% Solder (190 Degree C) + 40~50 Degree C = 230~240 Degree C
- However the iron will be set much hotter @ 350-450 °C
  - The hotter the iron the 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.
  - Using a very hot iron will increase the risk of soldering defects and component damage. Soldering is a balance of time/temperature.
5-9. 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.
5-10. Movement before solder solidifies

- Crack occurs when soldering point moves.

Do not move parts until solder has solidified. Liquid solder has no strength. Large parts may take a few seconds to cool.
5-11. How to release the 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
5-12. Process Completion

Caring for the soldering iron tip

① Some scrap on iron tip.

② Use sponge to clean

③ Add new solder

④ Cover older plated part by solder

⑤ Put soldering iron back in iron holder.
5-13. 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.
6-1. Inspection + 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)
6-2. TRB Product

Inspection of this part; Solder has wet well to pcb pad and to pin. This shows the flux has cleaned the pad/lead well. The wetting angle is good. The solder surface is smooth/shiny. There is no charred flux or noticeable flux residue. The solderability of pcb and component seems good.
6-3. TRB Solder Defect

Pin 5 from right has solder slither on. Solder ball on pcb resist.
6-4. TRB Solder Defect

Solder process starts on right. First 2 pins are thick and soldering iron is at its Peak temp. As iron is moved onto pins 3,4,5, which are thinner pins, the iron temperature falls but is still hot enough to heat joint and solder. As it reaches pin 6, which is a thicker pin, the iron is quite a bit cooler than its’ ideal temp. and does not heat up the joint area before the solder is fed onto joint. The ‘warmed’ solder wire is squeezed through pcb hole and onto pin shoulder.
6-5. Solder Ball

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.

Solder ball and flux spattering

Large solder ball

Solder ball in flux
6-6. Other Defects that require attention

- Non-wetting
- Non-wetting
- Solder ball
- Solder scrap
- Bridge
- Projection
- Crack
- Poor wetting
- tunnel
- Forget to solder
- Land peeled off
- Over heat
6-7. Reminder ①

Handling PWB

Good

No good

Do not touch the solder pad side of the PCB before it is soldered.
6-8. Reminder ②
Handling PWB

The crack occurs at the solder interface even with small impacts.

Do not pile up PWB
6-9. Cleanliness
Parts to be soldered must not be contaminated.

Contaminated lead
Didn’t wet on the pollution.

Dirty substrate
The pad on substrate was polluted by touching it with bare hands.

Poor cleaning of iron tip
Working with poorly cleaned iron tip causes soldering defects.
7. Practical training

Training 1

Soldering copper wire to pad

Inspection
7-1. Operation procedure

- **Copper wire**
  - Remove outer layer
  - Twist
  - Pre-solder
  - Decide position
  - Heat solder iron (soldering)
  - Cleaning?
  - Inspection

- **PCB**
  - Pre-solder
  - Wicking
  - Pre-solder

7-2. Practical Training

- Wire position
- Pad centre
- Tinned pad?

① Solder qty, must be able to see wire outline/shape
② Fillet curve in shape of a bow
③ Smooth and shiny solder surface without holes and spikes etc

① Correct position
② Correct shape
7-3. Surface of copper soldering

Good sample of Sn60

Condition of Pb Free

Poor wetted parts occur because spreadability of lead free is poor.
7-4. Soldering Wire to Metal Pad

Poor example of Sn60 solder

Poor wetting occurs because insufficient heat on pad
Thank you