



The *Only* Soldering Course That Meets
Modern Component Reliability Requirements



SIERRA CIRCUITS CURRICULUM

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Perfect soldering should be easy. So why are touchup and rework such common activities? Because the electronics assembly industry has failed to provide the knowledge that operators, technicians and engineers require to do their jobs effectively. Quite simply, traditional training doesn't work. *Science of Soldering* from Electronics Manufacturing Sciences is the only soldering course specifically designed to prevent defects.

Science of Soldering is the only soldering course that teaches the electronics soldering *process*. Other courses focus on memorization of pictures, rules and finding defects without explaining how to eliminate the touchup and rework that disguise defects, *Science of Soldering* teaches an easy “recipe” that delivers perfect soldering without touchup or rework. The results are efficiency and reliability beyond anything previously possible.

Reliable soldering of modern components requires solid knowledge of process science, not just familiarity with industry workmanship requirements. *Science of Soldering* provides that knowledge through demonstrations, experiments and troubleshooting of a unique soldering process problem that everyone understands regardless of formal education background.

Science of Soldering teaches that defects result from defective process, not operator error. If a defect occurs, it will occur over and over until the process is corrected. Rather than reworking the solder connection to make it cosmetically acceptable, the operator must address the process issue (which often involves bringing materials issues to the attention of managers). Our soldering “recipe” simplifies troubleshooting the process and taking effective corrective action.

Science of Soldering also teaches our simple technique that prevents all heat damage during hand soldering. U.S. Navy laboratory analysis shows our simple technique matches the results of their costly “high reliability” procedures. However, our technique takes much less time and does not require any special tools or equipment. With this technique, the component will never be heated beyond 450°F even if the soldering iron is at 800°. (When the temperature of an I.C. goes beyond 450°F, growth of the intermetallic between the gold ball bonds and the pads to which the leads are bonded causes Kirkendall voiding failures. Most component failures today are the result of this invisible heat damage inside the components.)

Part 1: Education — *The Science of Soldering*

1. The Core Science

- Wetting forces
- Chemical reactions
- Intermetallic bonds

2. Clean Surfaces

- Definition and importance
- Contamination
- Oxides

3. Flux

- Defined
- Types and attributes
- Acidity, ionic contamination and effects on reliability
- The real definition of no-clean flux
- Selecting fluxes suitable for high reliability applications

4. Solderability

- Definition and importance
- Solderability of different component and PCB surfaces
- Implications of lead-free component finishes
- Scientific solderability management

5. Solder

- Defined
- Alloys (leaded and lead-free)
- Mechanical properties (ductility and tensility)
- Lead-free solder differences and techniques

6. Heat

- Why heat is needed
- How much heat is needed
- Failure modes from overheating
- Scientific heat control and elimination of damage during hand soldering

7. Why Electronics “Soldering” has Actually Been *Welding*

- The difference between surfaces that melt (welding) and surfaces that do not melt (soldering)
- Most standard electronics industry practices were developed for surfaces such as tin or tin/lead that melt during application of the solder
- Standard electronics industry practices do not work unless surfaces melt

- Many modern components have surfaces that do not melt
- Process modifications required for the new component surfaces

8. Prevention of Heat Damage in Hand Soldering — The Electronics Manufacturing Sciences Solution

9. Troubleshooting Using the EMS *Science of Soldering* Recipe

10. Analysis of Client's Existing Processes to Identify Opportunities for Enhanced Reliability and Efficiency

Part 2: Skills Development — Using the EMS Soldering Recipe to Achieve Perfect Soldering

1. Wiring methodologies and multi-terminal exercises: turret terminals, bifurcated terminals, eyelet terminals, cup terminals
2. Through-hole soldering: IC's, transistors, capacitors, resistors; includes heat sink and solderability problem
3. Surface mount soldering: resistors, transistors, MELFs, PLCCs, SOICs including fine pitch and J-leads, quad packs
4. Repair techniques (through-hole and surface mount)

Part 3: Industry Workmanship Requirements

Most requirements are explained in Parts 1 and 2 when the relevant technologies are being soldered. Part 3 explains any requirements not covered in the other sections. The emphasis is always on how to exceed the requirements by doing the job right the first time without touchup or rework.

Part 4: Machine Soldering and Quality Systems Applications