

Pragmatic Soldering

- ❑ **Material Science Review**
- ❑ Tools and Supplies
- ❑ Applying the Heat - Soldering
- ❑ How'd I do? - Inspection

The goals of this tutorial are to help you understand how soldering works, make you aware of good soldering practice, and show you how to inspect your work.

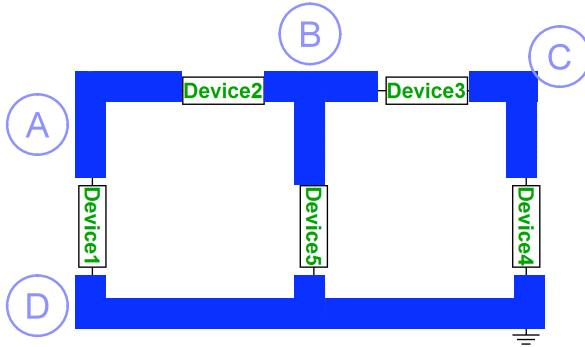
Review of Material Science

- **Alloy** - a substance composed of two or more metals
- **Eutectic** - the ability of an alloy to transition from solid to liquid without a paste phase
- **Diffusion** - the process whereby particles of liquids, gases, or solids intermingle as the result of their spontaneous movement caused by thermal agitation
- **Soldering** - method of making a permanent electrical and mechanical connection between metals^[1]

A eutectic alloy has just the right ratio of ingredients to minimize the melting point. If the mixture isn't eutectic, then the ingredients will melt at different temperatures, resulting in a partially melted or paste phase.

Resistance

Electrical Node is a connection between two or more elements in a circuit.

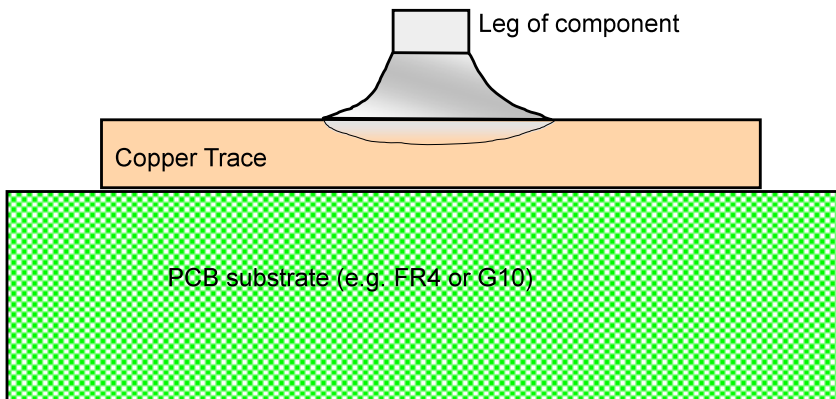


Resistance is the opposition to the flow of electrons.

The nodes in this circuit are assumed to be perfect conductors, with no resistance. It is necessary that the nodes exhibit low parasitic resistance (and capacitance and inductance) so that they do not add undesired elements to the circuit. This is the primary purpose of soldering, is to provide a reliable method of producing a low-resistance connection between elements.

Alloying

The process of alloying requires careful control of the mixture that results. The implication is that cleanliness (or lack of contamination) is paramount.



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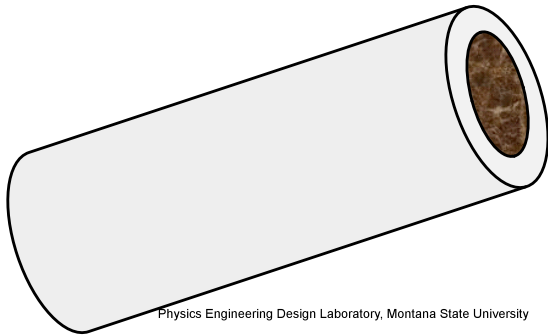
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Tools and Supplies

- Soldering iron
- Wet sponge
- Solder
- “Helping hand” (or scotch tape)
- Needle nose pliers
- Side cutters
- Flux remover
- Acid brush
- Burn Cream

Solder

- Sn/Pb 60/40 Resin Core
- Sn/Pb 63/37 Resin Core (eutectic)
- Silver Solder



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7

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Alloy Temperature Chart

Alloy: TIN-LEAD	Melting Range °F	Melting Range °C	WIRE	BAR	SOLDERPASTE	PREFORMS
Sn63Pb37	361	183	X	X	X	X
Sn60Pb40	361 - 374	183 - 190	X	X		X
Sn55Pb45	361 - 397	183 - 203	X	X		X
Sn50Pb50	361 - 420	183 - 214	X	X		X
Sn45Pb55	361 - 440	183 - 225	X	X		X
Sn40Pb60	361 - 460	183 - 238	X	X		X
Sn35Pb65	361 - 477	183 - 247	X	X		X
Sn30Pb70	361 - 496	183 - 258	X	X		X
No. 123	366 - 503	186 - 262	X	X		
Sn25Pb75	361 - 514	183 - 268	X	X		X
Sn20Pb80	361 - 536	183 - 280	X	X		X
Sn10Pb90	514 - 576	268 - 302	X	X	X	X
Sn05Pb95	574 - 597	301 - 314				X
LEAD-FREE						
Sn96.5Ag3.5	430	221	X	X	X	X
Sn98Ag04	430 - 444	221 - 229	X	X		X
Sn95Ag05	430 - 473	221 - 245	X	X		X
100%Sn	450	232	X	X		X
Sn95Sb05	450 - 464	232 - 240	X	X	X	X
SAF-A-LLOY	426 - 454	210 - 235	X	X		X
OTHER ALLOYS						
Sn62Pb36Ag02	354 - 372	179 - 189	X	X	X	X
Sn60Pb36Ag04	354 - 475	179 - 246	X	X		X
Sn10Pb88Ag02	514 - 570	268 - 299	X	X	X	X
Sn05Pb93.5Ag1.5	565 - 574	296 - 301	X			X
Sn05Pb92.5Ag2.5	536	280	X	X		X
Sn43Pb43Bi14	291 - 325	144 - 163	X	X	X	X

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Note that the eutectic solder has a single, well-defined melting point rather than a range.

I do not recommend lead-free solders for electrical work. Many of them will spontaneously form metallic whiskers as they age, causing short circuits and erratic performance.

(Preforms are bits of solder in special shapes that conveniently fit particular applications.)

Flux

Flux provides several benefits:

- Cleans the base metal (copper trace)
- Protects the solder and base metal from oxidizing during the soldering process.
- Promotes wetting action of the melted solder

But using flux represents some trade offs:

- Can become entrained in the joint
- Is corrosive and so must be removed

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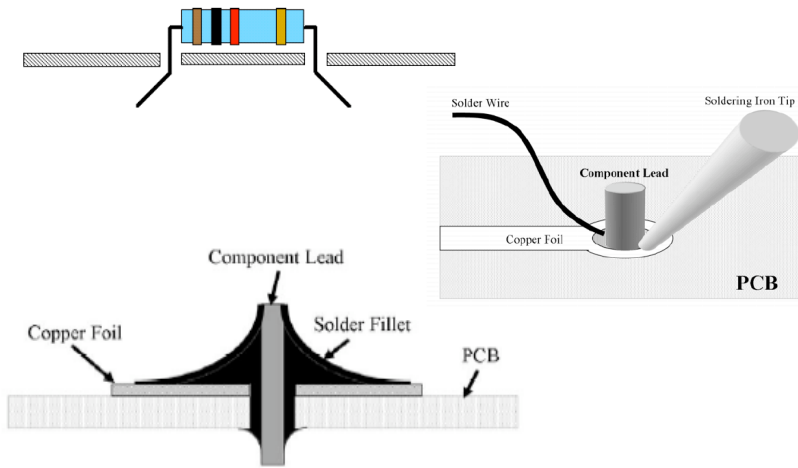
Soldering Methods

- Wave soldering
- Solder pot
- Reflow
- Hand soldering

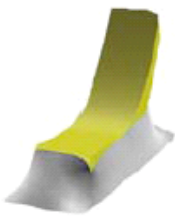
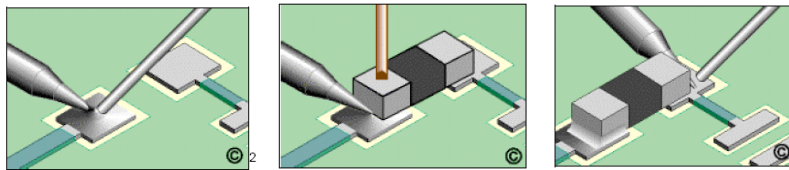
Soldering Recipe

- Prepare joint
 - Tin wires and connectors when needed
 - Make a good mechanical connection
 - Install heat sinks if required
 - Apply flux if required
 - Clean soldering iron tip
- Solder
 - Apply heat to both parts to be bonded
 - Apply solder sufficient to coat joint
- Clean joint (remove flux)
- Inspect

THT (Through Hole Technology)



SMT (Surface Mount Technology)



Proper joints

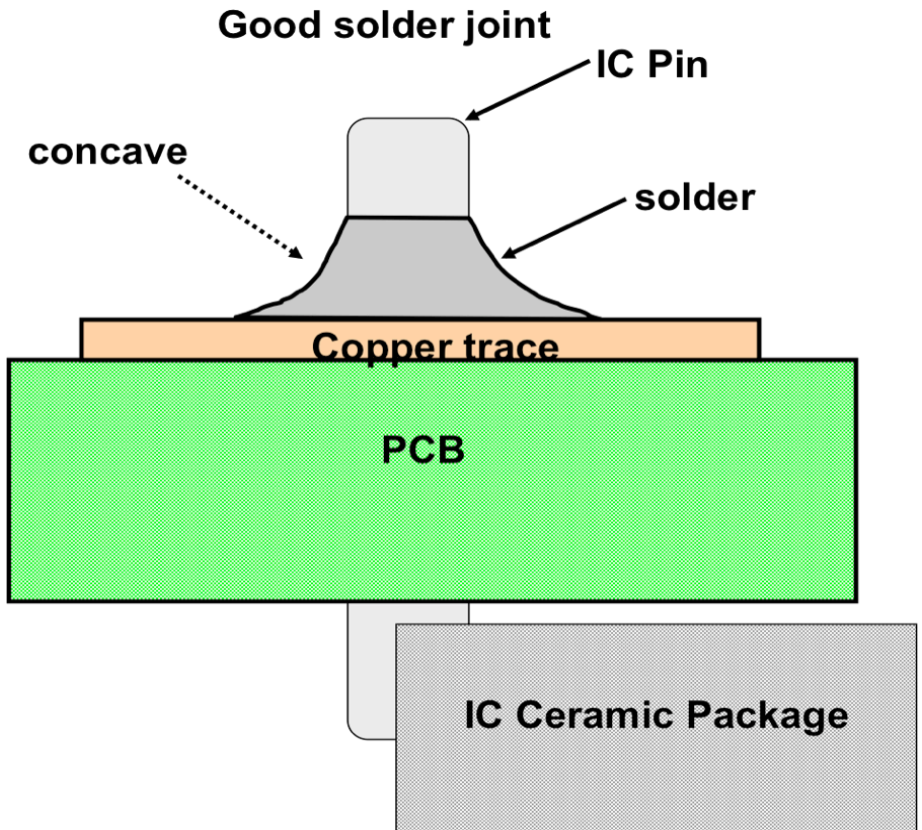
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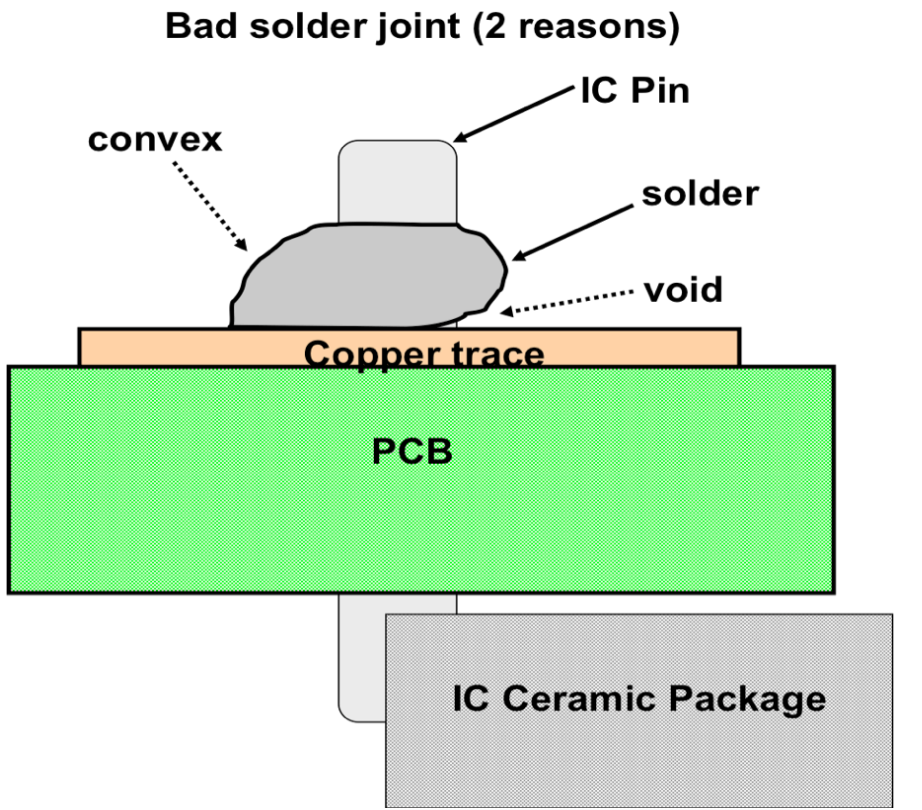
The Good, the Bad and the Ugly



Vincent Sieben, "Soldering Tutorial", September 2003 - Revision 1.0, <http://feynman.ee.ualberta.ca/~vjsieben/tut/solder.pdf>, accessed 11/19/2003



Right amount of solder, and the copper is thoroughly wetted indicating a good connection.



Too much solder, yet the connection looks doubtful.

SMT Disasters



Poor joints

The solder hasn't wetted the copper beneath this surface mount component. It'll probably fall off.

Desoldering and Repair

- Powered Desoldering tool
- Manual solder pump
- Solder wick



Nobody gets it right all the time. Fortunately, we have tools to remove solder.

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References

1. Mark J. Hoban, Mark J. Hoban, Brigham Young University, "Soldering", <http://et.nmsu.edu/~etti/spring97/electronics/solder/solder.html>, accessed 11/19/2003
2. <http://www.webster.com/cgi-bin/dictionary>, accessed 11/19/2003
3. Vincent Sieben, "Soldering Tutorial", September 2003 - Revision 1.0, <http://feynman.ee.ualberta.ca/~vjsieben/tut/solder.pdf>, accessed 11/19/2003
4. <http://xanadu.ece.ucsb.edu/~long/ece145a/SMSoldering.pdf>, accessed 11/19/2003