

Electronic Circuit Prototyping Techniques

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BiPOM Electronics, Inc.

16301 Blue Ridge Road, Missouri City, Texas 77489
Telephone: 1-713-283-9970 Fax: 1-281-416-2806
E-mail: info@bipom.com
Web: www.bipom.com

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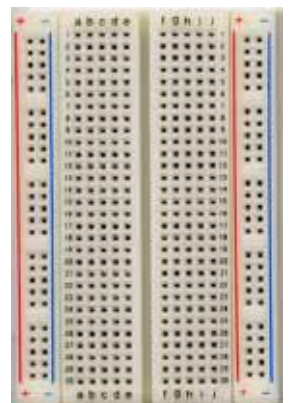
Prototype Design Methodology:

1. Specifications based on requirements
2. Research
3. Schematics
4. Simulation
5. Construction (PCB Layout or other wiring technique)
6. Parts Purchase
7. Assembly
8. Firmware Development (Assembly, C and/or BASIC)
9. Testing and debugging

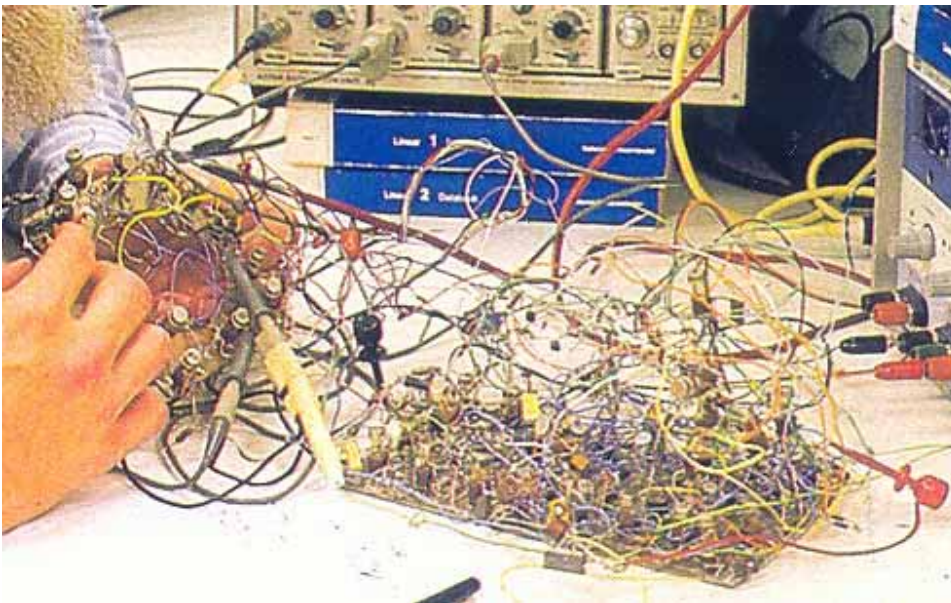
Construction

Breadboard: Quick way to set up a circuit. It can be used only with through-hole components although adapters for some surface mount devices exist. Not suitable for high frequencies, due to stray capacitance and inductance. Also, long connecting traces inside the breadboard act as antennas. Also, not suitable for high current and/or high voltage circuits.

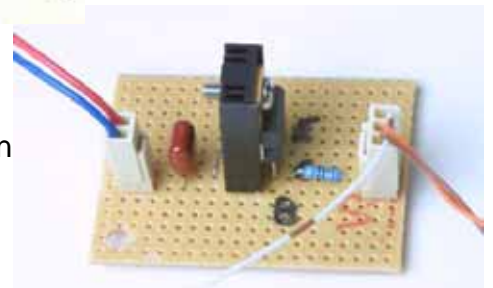
Breadboard cable for BiPOM boards: **EXPCABLE-BR1**



Video and Website © 2004 ClarkZapper.net



Point to point wiring: More permanent than breadboard. Components are soldered to a perforated board, typically known as Vero board. Radio Shack sells these.



Wirewrapping: It used to be popular in the 70's and 80's. Similar to point to point wiring except that a special tool/gun and special sockets are used. Wire is connected to endpoints by wrapping onto a rectangular pin, instead of soldering.

Printed Circuit Board (PCB): Most reliable method. It used to be the costliest method of prototyping but with recent advances in automated manufacturing of printed circuit boards, prices have decreased significantly.

Some Web-based quick-turn PCB manufacturing houses:

- Advanced Circuits: \$33 special, 3 piece minimum, 1 week turnaround: www.4pcb.com
- Accutrace: \$10 or \$15 special, 5 piece minimum, 10 day turnaround: www.pcb4u.com
- Alberta Printed Circuits (APC): Typically under \$100 for 2-3 PCB's. No solder mask, no silk mask but fastest (1 day turnaround): www.apcircuits.com
- PCB Express: Fast-turnaround specials on multi-layer boards: www.pcbexpress.com

Some board manufacturers offer free CAD program that will allow you to layout a board for your design and submit to the manufacturer.

Eagle CAD is a professional package that has a free download version with limited board size. Suitable for student/small projects: www.cadsoftusa.com

Parts Purchasing

Local: Electronic Parts Outlet (EPO)

Catalog Suppliers: Digikey, Mouser, Newark, Allied Electronics

Distributors: Arrow, Future, Avnet, TTI, Nu-Horizons
Sometimes, distributors offer free samples.

Assembly

Hand assembly: Suitable for prototypes

Pick and Place Machines: Suitable for mass production. It takes time to set up. There is a set up fee. Some parts need to be purchased in reels.



Model L60

Testing and Troubleshooting

Design your boards with ease of testing/troubleshooting in mind:

Simulate your design, if possible, before building it.
Go over your design many times by eye and pencil.
Have somebody else review your design.

Use through hole components.
Use connectors.
Put IC's on sockets.
Add test points. Especially ground and power lines should be easy to reach.

Have your schematics and board layout printed and in front of you when troubleshooting a circuit.
Mark your schematics and/or board layout as you find mistakes.

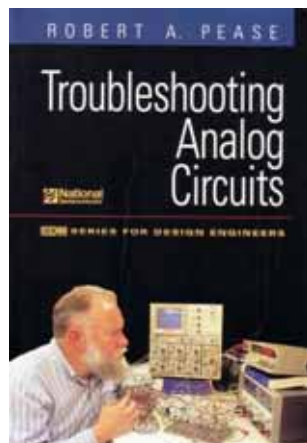
If you use a printed circuit board, make corrections by cutting traces and making connections using jumper wires.

Bugs to expect:

- Design Error
- Design is OK but you have a schematics error
- Schematics is OK but you made a mistake in board layout
 - o Examples: Wrong package for the part
 - o Mirror package for the part
 - o Wrong hole size
 - o Too thin a trace to carry the current
 - o Supply and/or ground does not reach all components
 - o Missing traces
 - o Packages conflict with each other
- Board manufacturing flaws: Usually short circuits or open circuits. This is rare when the board is coming from a professional board house but it may happen.
- Assembly errors: Wrong component was installed. For example, you meant 10K resistor and a 10-Ohm resistor was installed.
- Correct component was installed but it was installed backwards. Typically happens with 2-pin components that have a polarity such as diodes.
- Component damaged during assembly. Some resistors may crack/break during soldering due to high heat. Some IC's cannot tolerate soldering iron's heat longer than 10 seconds. Cool the IC package during soldering if necessary.
- Printed Circuit Board Traces can be lifted during soldering if you keep the soldering iron on the board too long.

Recommended Reading:

The Art of Electronics by Paul Horowitz and Winfield Hill (Cambridge University Press)



Troubleshooting Analog Circuits by Robert A. Pease (Butterworth-Heinemann)