

Electronic System Design: From PCB Design to Product

- ① PCB Design Documentation
- ② PCB Manufacture
- ③ Soldering Techniques
- ④ Solution Deployment

Electronic Systems Deployment - Reflection

Electronic Systems Design will be used as an example.

Self-Reflection

What documentation do you currently produce to support your electronic system designs?

Could someone pick up one of your circuits and identify what it does without your help?

What systems do you currently use when procuring components for your projects?

What package footprints are you currently comfortable soldering by hand? (Eg. DIP, SOIC, TSSOP, QFN...)

Systems Design - Solution Deployment

① Documentation

- Circuit Manufacture Diagrams
- Interface Wiring Diagrams

② Manufacture

- Bill of Materials
- Sourcing Components from Vendors (Procurement)

③ Assembly Techniques

- Manual Assembly
- Pick and Place (Automated)
- Reflow Oven

④ Solution Deployment

PCB System Documentation

System architecture diagrams have already been discussed with reference to how the system is conceptualised. This documents "What does it do, and how is it connected?" but that is not enough.

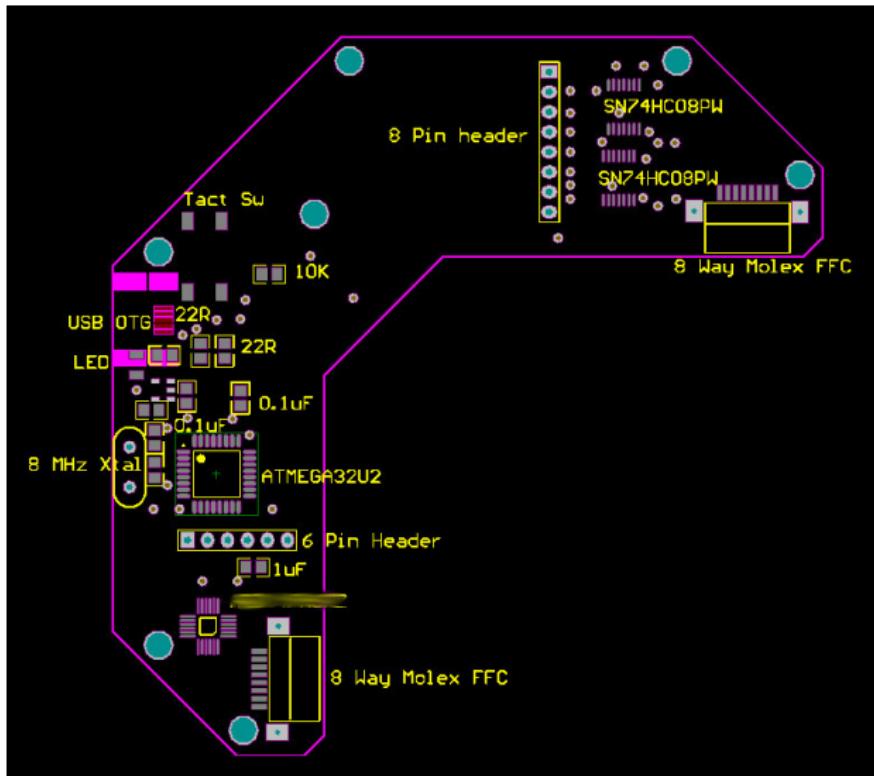
PCB System Documentation

In order for the PCB to be used what else might a user need to know?

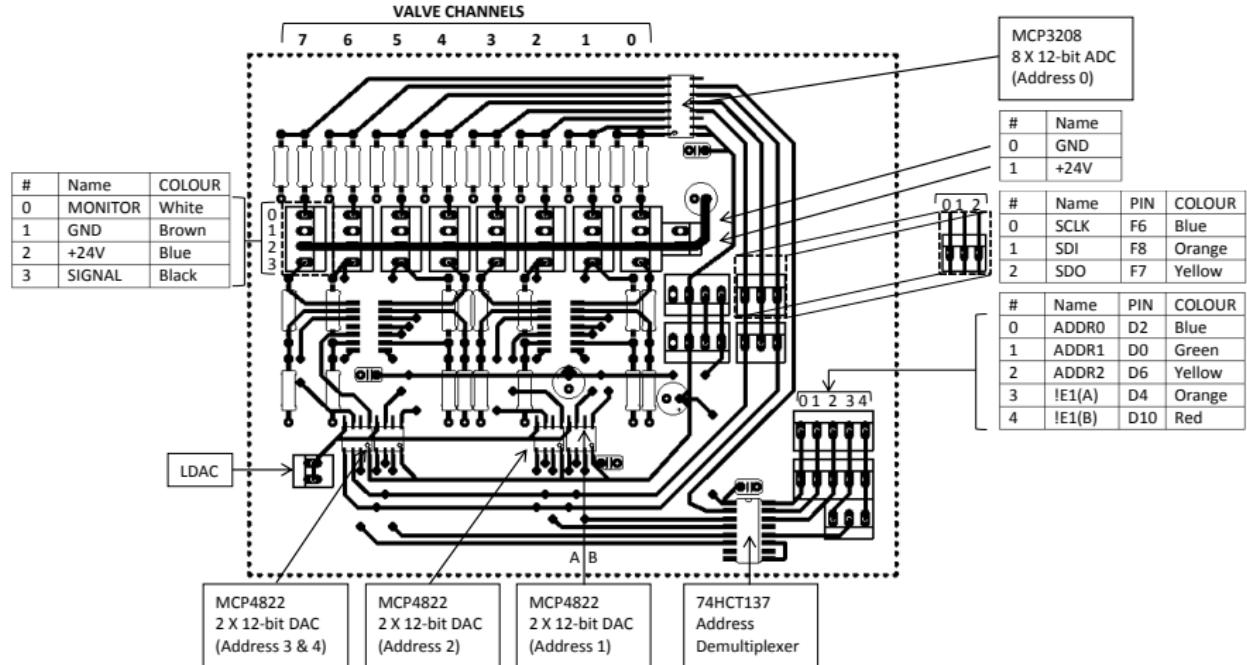
How are modular features configured?

What assumptions were made during design, and what are the subsequent system limitations?

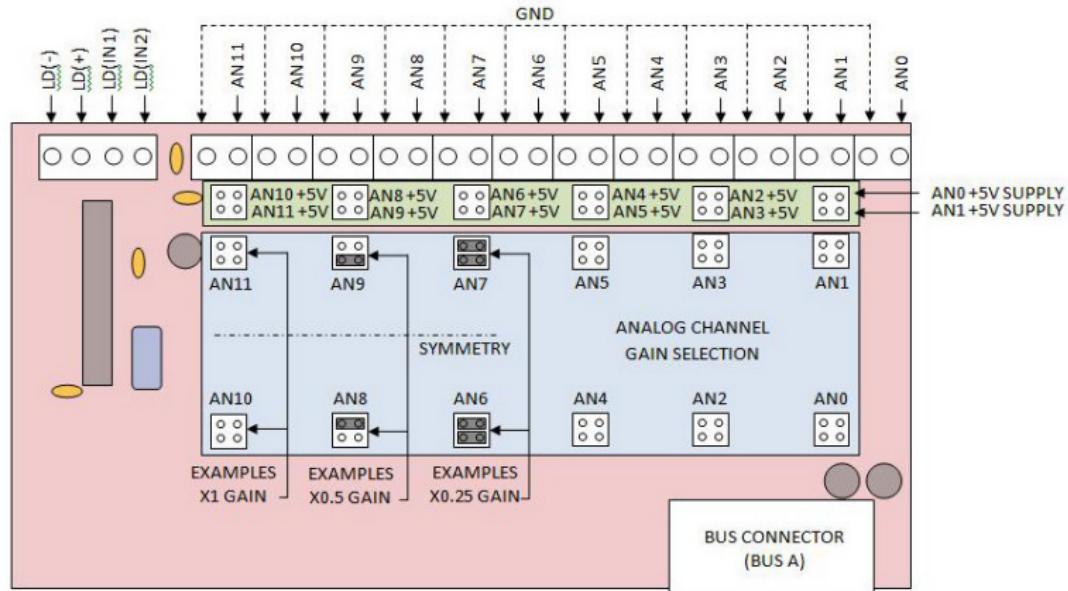
PCB System Documentation - Circuit Manufacture Diagrams



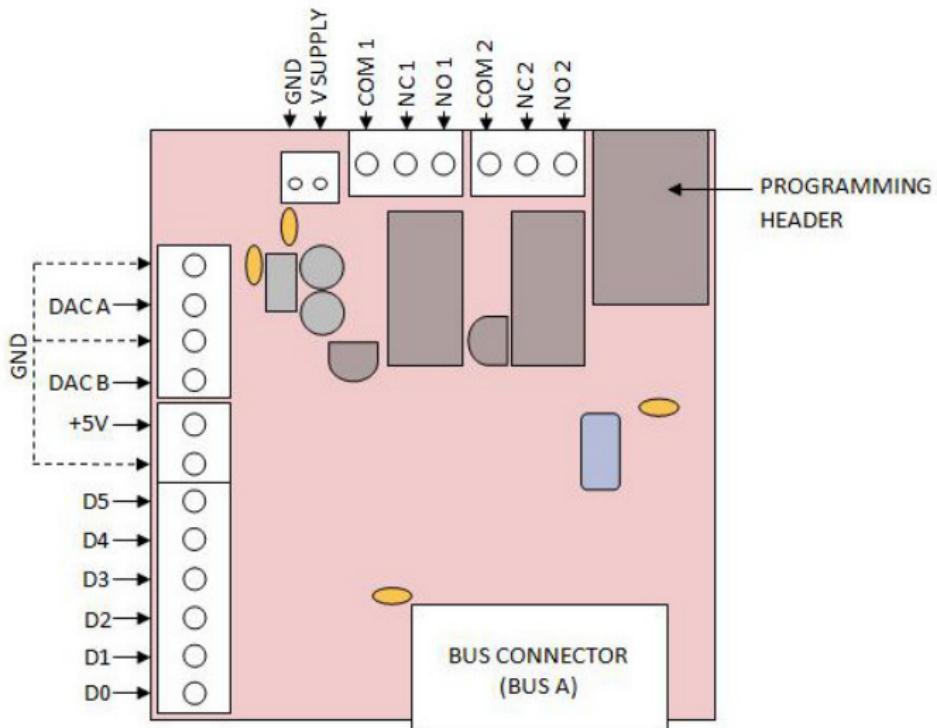
PCB System Documentation - Interface Wiring Diagrams



PCB System Documentation - Interface Wiring Diagrams



PCB System Documentation - Interface Wiring Diagrams



PCB System Manufacture - Bill of Materials

A bill of materials can be a very useful technique to ensure that all parts are accounted for, and can be ordered simultaneously.

Consider price breaks (Eg. Buying in bulk is cheaper)

Part	Qty	Element14 Price	Element14 #	RS Price	RS #
ATMEGA32U2	1	\$8.36	1748524	\$7.1	715-3801
Molex FFC/FPC SMT 1P8	2	\$1.85	1757089	\$1.242	670-6814
MOLEX MINI USB OTG	1	\$4.23	9786473	\$2.782	515-1995
NCP512SQ33T2G	3	\$3.2	2464341	\$0.86	748-5253
SN74HC08PW	2	\$0.108	9591001	\$0.603	663-1887

** For simplicity, only prices for minimum order quantity are shown in the table

PCB System Manufacture - Procurement

Consider procurement from multiple vendors.

Procurement Considerations

Which vendors have the required components?

What quantities do different vendors set for price breaks?

Are the parts in stock, or on back order? What is the current lead time?

Where are the parts shipped from?

Are all vendors created equal?

PCB System Manufacture - Procurement

Shop around - especially when making bulk orders.

Think about the tradeoff of diversifying vendors - using multiple vendors may increase administration burden.

Have a system to mark deliveries off against the bill of materials.

For prototyping and small runs with few components it is possible to keep track of component inventory. As scale increases rigorous tools are required to keep track of this.

Assembly Techniques - Manual Assembly

PCB Assembly - By Hand

Which techniques are available?

Which chip packages are suitable for these techniques?

How can PCBs be designed for hand assembly?

What tools are required for hand-assembly techniques?

Assembly Techniques - Manual Assembly



Also need liquid flux, tape and magnifying glass $\approx 20\times$

Assembly Techniques - Manual Assembly

There are two basic techniques:

① Hand Soldering

- Place part on pads (Sometimes clear tape can be used to stabilise)
- Apply a small amount of solder on a fine tip, Solder two diagonally opposite pads of IC, then carefully wipe the rest with solder in an outward motion from the package. (Alternatively use solder paste)
- Apply liberal liquid flux and tidy up solder connections

② Manual Placement for Reflow Soldering

- Apply solder paste to pads
- Place components with a set of tweezers
- Place PCB in reflow oven to solder
- Hot Air SMD with Solder Paste

Assembly Techniques - Manual Assembly

A Structured Manual Assembly Approach

A structured approach will keep the smoke inside your ICs

- When assembling manually, start with features such as the power supply.
- After each module is completed check that there is a high enough resistance between power rails.
- Frequently perform continuity tests to ensure correct connectivity.
- Do these steps as you go - it is much easier to troubleshoot errors when there are fewer components.
- Check for shorts between signal lines and power / ground rails

Assembly Techniques - Manual Assembly



[https:](https://)

//upload.wikimedia.org/wikipedia/commons/5/57/Electronics_factory_in_Shenzhen.jpg

Assembly Techniques - Pick and Place (Automated)

Large assembly houses will generally assemble at least part of a PCB automatically.

Eg. [A High Speed Pick and Place SMD Machine](#)

Some of these machines may require reflow soldering; others may solder directly

Reflow ovens are used particularly for chips that have pads underneath themselves Eg. Ball Grid Array (BGA) package chips.

Assembly Techniques - Reflow Oven



https://en.wikipedia.org/wiki/Thermal_profiling#/media/File:Reflow_oven.jpg

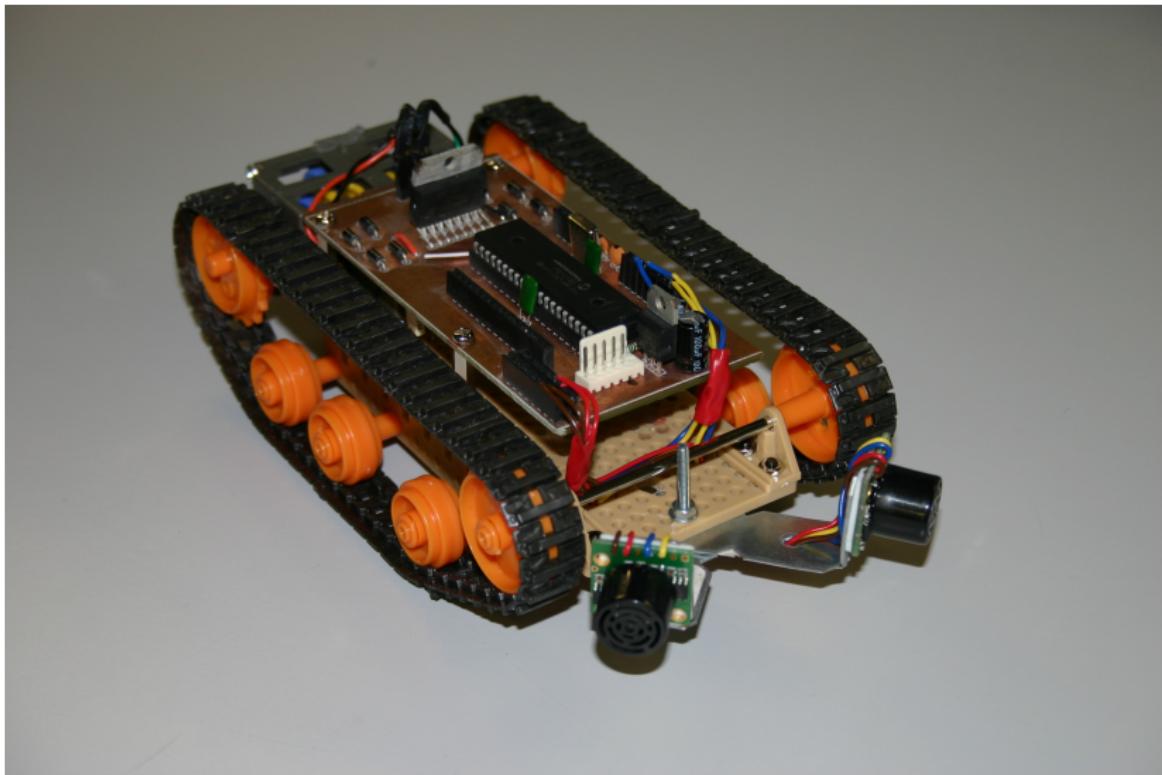
Solution Deployment

Recall, we are only using electronics / PCB design as an example of system design. This might be for a component of a larger system, so how should it interface with the next level up? Eg. a product?

The PCB needs to be mounted in a logical manner and have its inputs and outputs mapped to its neighbouring components.

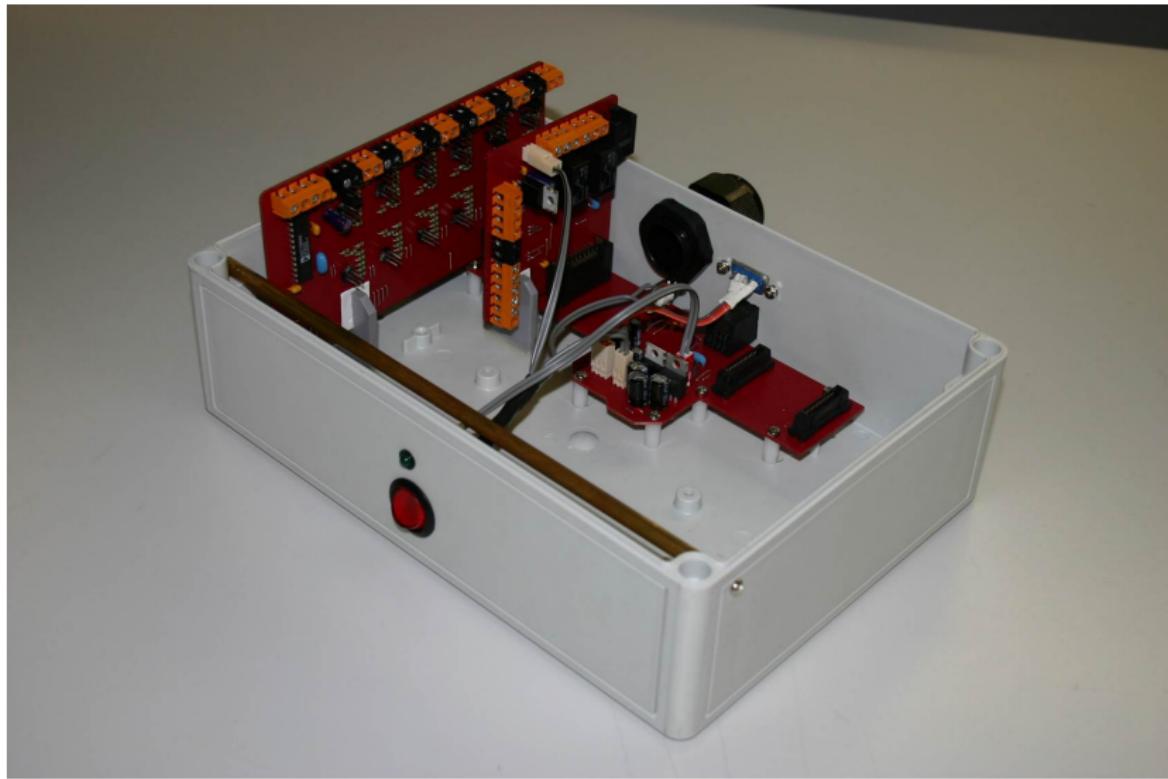
This needs to be considered at the design stage. However, the interfaces should connect harmoniously Eg. Packaged with tidy wiring and suitable mounts etc.

Solution Deployment



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Solution Deployment



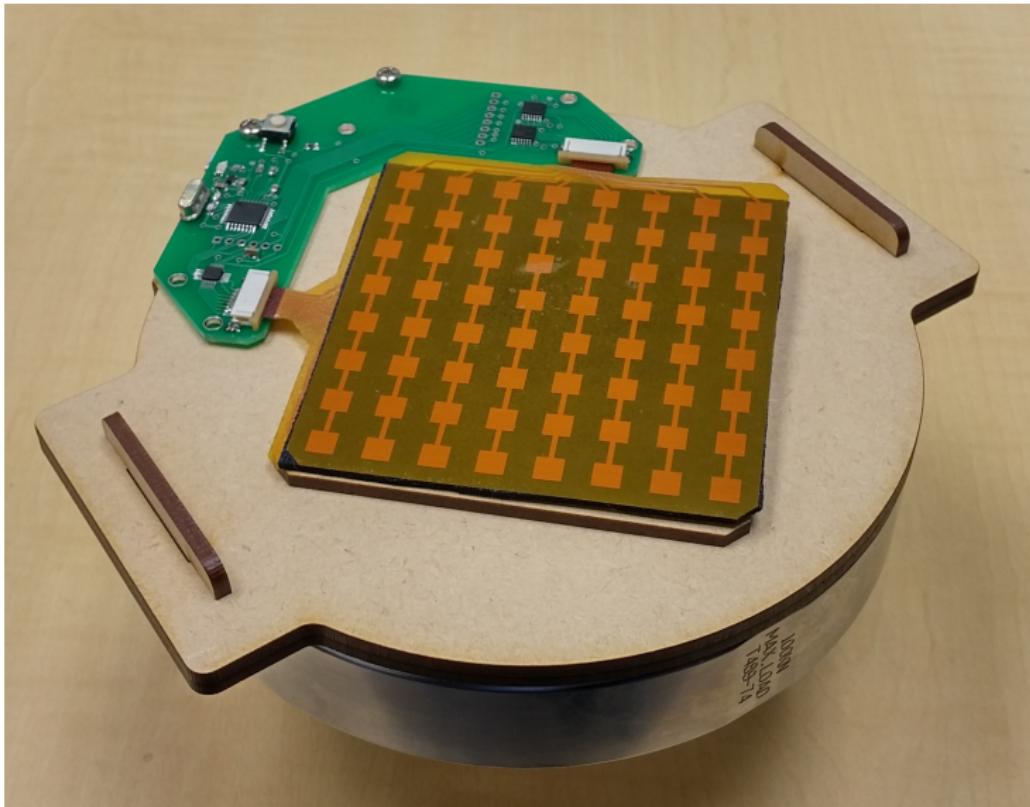
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Solution Deployment



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What to Take Away From This Lecture

The Main Points

- A system, whether it be a PCB (electronic), or mechanical / software in nature is only as useful as its supporting documentation. We reviewed PCB manufacture diagrams. For mechanical systems this would consist of drawings, for software a flowchart.
- Employ a structured procurement process
- There are multiple methods of assembly (Eg. PCB fabrication and assembly techniques). Determine which is the most suitable.
- Have pride in deploying your solution in a professional manner.