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28 May, 2005

## Guidelines for PCB Layouts.

### Overview - Prototyping.

Due to the wide range of electronic design and engineering fields, the huge variety of components, design principles, even mechanical constraints, it is inevitable that any electronic design will need to go through some form of prototype / pre-production development stage.

Experience has shown that ALL designs should have at least one prototype stage, followed by a low volume production run - the end user is usually the best test site. Experience has shown that the cost of a solder mask for a prototype is a good investment, when compared the hours of fault finding for solder bridges. Major changes from an initial prototype should usually go through another prototype stage.

Problems in the PCB design stage can arise from many sources. These can include:






- Mis-interpretation of mechanical drawings - eg. Is a transformer's pin-out drawn looking at the board, or from the bottom of the component? Do mechanical drawings of connectors show the front or rear of a connector?
- Different component footprints used - eg a 1000 $\mu$ F electrolytic capacitor comes in dozens of different shapes and sizes.
- PCB manufacturing and production problems. Every PCB manufacturer Circuit Designs has been involved with has, at some stage, had problems PCB manufacturing. Eg routing in wrong places, inaccurate guillotining, tinning problems, etc.
- Errors in the standard component libraries in software.
- Physical and mechanical constraints.
- Errors in the interpretation or re-drawing of artwork.
- PCB design software bugs.
- PCB layout effecting circuit performance.
- Changes in component specifications.

Every effort is made to ensure no PCB design problems occur. All new designs, and PCB changes are followed up with either a fax or email showing the revisions, for final approval by the customer.

However, experience has shown that problems do occur. For this reason Circuit Designs' liability for problems / errors in an initial PCB prototype layout is limited to amendments of PCB artwork files alone, at no cost to the customer. The liability for problems / errors in any subsequent PCB layouts will depend upon the nature and complexity of revisions from previous designs. At a minimum it will cover amendments of PCB artwork files alone, at no cost to the customer. Under certain circumstances liability maybe extended, to be discussed between the parties, and at the discretion of Circuit Designs. Circuit Designs is always happy to help to resolve any PCB problems, regardless of where the cause may lie.

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## General Guidelines.

Every application and customer has different requirements in PCB design. Eg:

- Single sided PCBs require larger holes;
- Different PCB manufacturers manufacture to different tolerances;
- Automated soldering has different requirements to hand soldering;
- Customers may have particular requirements for component placement.
- Compliance to different standards.

Unless otherwise specified, we will use the following as standard guidelines.


- Standard components will be used. Eg:
  - i 1/4W resistors at 0.4" pin spacing.
  - ii DIP through hole IC packages.
  - iii Small caps at 0.1" spacing.
  - iv Small electrolytic 0.1" spacing, 0.2" package.
  - v For large caps, common sizes will be selected from data books.
- Creepage and tracking distances compliant to IEC950 Low Voltage Safety Standard, and/or IPC-D-275, which ever is applicable.
- PCBs will be designed doubled sided, plated holes, with free board as powers planes, unless otherwise specified. Experience has shown that double sided, non plated PCBs can be more trouble than is worth in the small manufacturing saving.
- Where applicable component mounted vertically to minimise PCB space. Eg:
  - i Transistor type packages will be mounted vertically.
  - ii Electrolytic caps, etc, use vertical, radial packages.
- PCB design. (These can differ considerably.)
  - i Component holes generally 0.2~0.4mm larger than component legs.
  - ii Pad outer diameter approximately twice hole size.
  - iii Generally 8~12 thou tracks for small signal tracks.
  - iv Generally 30~50 thou tracks for power supplies.
- Mechanical / aesthetics.
  - i Where ever possible, component values inside component footprint, designators outside footprint, near pin 1.
  - ii Pin 1 will be identified. Usually a square pad, otherwise a dot.
  - iii Mounting holes to fit 3mm screws, isolated from circuit.
  - iv Customer name and board name on bottom copper and top overlay.
  - v Circuit Design logo and date will be added, for traceability.

These guidelines are arrived at by a culmination of PCB and hardware design experience; knowledge of manufacturers capabilities; component availabilities; study of technical literature; including International Standards; and general feedback persons in the field. Further input is always welcome.

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## Minimising the chance PCB errors.

Basically the more information supplied, the lower the chance of any problems. Here are some items listed in order of preference, that will greatly reduce the chance of problems / errors occurring from the PCB layout side of the design:

- Specialised components. Eg Connectors, switches, transformers,
  - i If possible, supply components.
  - ii Detailed mechanical drawings, with pin outs.
  - iii Exact part numbers, suppliers, etc, so all necessary details can be found.
- Semiconductors. Eg, IC package, Pin-outs.
  - i If possible, supply unusual components.
  - ii Complete part number. Eg LM234AM
  - iii Generic part number and package. Eg LM324, 14 pin DIP.
- Passive components. Eg Caps, resistors etc,
  - i If possible, supply components.
  - ii Mechanical dimensions. Eg pin spacing and body sizes.
  - iii Complete part number and manufacturer.
  - iv Generic part number and ratings.
- Circuit specifications:
  - i Current and voltage ratings. Determines track width and spacings.
  - ii Sensitive circuitry. Determines guarding and screening.
  - iii High frequency circuitry, Determines tracking specifications.
  - iv Isolation paths through circuit.
  - v Any standards the design must comply with.
- Mechanical specifications:
  - i If possible, supply the enclosure the product is to fit into.
  - ii Physical dimension, including height restrictions.
  - iii Mounting holes.
  - iv No go areas on the PCB.
  - v Any special requirements. Eg Internal routing, V-grooving. etc.

In many cases the actual physical components are not finalised at the prototype stage. Eg a DPDT switch may be required, but the make and model of switch is not specified or known. As mentioned this is often the case. Circuit Designs is happy to make recommendations, source samples, or help out in any way to finalise components. We see this as all part of a PCB Design Service.

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The purpose of this helpful letter is **NOT** to remove any responsibility or place any blame for any potential problems that may occur with PCB layouts. The purpose is to minimise as many possible sources for such problems. PCB design can be an expensive and time-consuming process. The tips in this letter will help increase everyone's confidence in the end product.

Generally the customer is far more familiar with the circuit and components used in a design. For this reason we will always send copies of artwork to customer prior to finalising any design. This is not to verify the connectivity of a PCB, but usually to confirm the mechanics of the design. Eg.

- Are there mechanical constraints overlooked;
- Are specialised parts / connectors correct. Is the pin-out correct.
- Are there changes to the layout the customer may prefer.

As we become more familiar with individual customer's requirements, components, and practices, much of this information will become redundant.

We are always happy to discuss any requirements you may have. We are happy to give advice, and make recommendations we think may be of assistance.

Finally, the small print:

Circuit Designs retains ownership of all goods and copyrights until the account is paid IN FULL. Any repossession, debt collection or legal costs incurred to recoup overdue debt may be passed on. Interest may be charged on any overdue amount. Any claim invoices must be made within 7 days.

Thank you for your time.

Yours Sincerely,

A handwritten signature in black ink, appearing to read 'M. W. Richardson'.

M. W. Richardson. (Mike)