



Rick Hance Engineering Note

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Project: DZERO Electronics Group
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Subject: Engineering Orientation for New Electronics Group Members

1. Documentation Control

It is important that all designs be documented so that they can be built and maintained. We do not specify what tools are used to create documentation. We are only concerned that up-to-date documentation be on file in the department files for all systems. Our requirements are very simple. They consist of getting a control number, preparing the document and filing it in the files. Whenever a document is updated, the changes should be added to the document in the files. There are three types of documents as described below:

1.1. Specifications and Engineering Notes

Anything that we design should have a document that describes it sufficiently that others can understand what has been done. This is done by preparing a DZERO Engineering note. The Engineering notes are kept in notebook binders on the north east corner, of the 5th floor of the assembly building. A photocopy machine is also available in that corner for making copies. An index binder is provided that contains a listing of all the engineering notes, and instructions on how to assign a number to a new note. The engineer chooses the next available number and writes a description in the index. The engineer should add the number to the cover of his Engineering Note, and file a copy of the note in its proper place in the binders. A secretary will occasionally retype the handwritten index pages to keep them orderly. The secretary will also maintain the tabulated binders for filing the completed notes.

Engineering notes should contain a description of the device and any information which will not be found on a schematic. This might include written programmable logic device (PLD) descriptions, parts lists and a list of all related drawing and software files.

1.2. Drawings

Anything that we design should also have a schematic diagram. Schematic diagrams may be hand drawn or drawn on a computer automated engineering (CAE) platform. Regardless of how they are drawn, an up-to-date hard copy must be kept in the DZERO files. The files are located in the north east corner of the 3rd floor of the assembly building. A photocopy machine is also available in that corner for making copies of any size drawing up to and including size E. Each schematic must have a drawing number. To get a drawing number, contact Rick Hance personally, by phone at X3898; or by EMAIL at HANCE@FNAL.GOV. Rick will maintain the drawing number data base until a new system becomes available.

The preferred way to do drawings is to use a hierarchical format. That is, a top level drawing is made which is a detailed block diagram of the design showing all sub-blocks and all connections between sub-blocks. Then individual drawings are made for each sub-block. Once the technique of hierarchical drawing is understood, drawings for systems of any size can be made clear and easy to understand. Contact Rick Hance for examples of hierarchical drawings. Below are a few suggestions for making clear drawings:

- Make all drawings on B size paper. B size can be folded once, punched and kept in a notebook with the rest of the documentation for a design. If B size is just too small - even for hierarchical drawings, then use D size. D size can be photographically reduced by 50% to B size and still remain readable.
- All INPUTS to sheets, and to medium and large scale integrated circuits, should be drawn on the left and/or top. All OUTPUTS should be drawn on the right and/or bottom. Small scale integrated circuits used as "glue logic" however, may oriented in any direction without confusing a drawing.
- Use ANSI standard or IEEE standard symbols.

1.3. Software

The term "software" includes programmable logic device (PLD) source files, Gerber photoplot files for printed circuit boards, computer test programs and etc. DZERO has no central facility for such files. For the present time, each engineer is responsible for his/her own files. The engineering note for a project or design should contain a list of all such files and where they can be found. When an engineer, who has a collection of such files, leaves DZERO, the files should be placed in the safe keeping of the Electronics Group Leader or his designee.

2. Engineering Reviews

Engineering reviews are a very useful tool in the design process. An engineer should welcome the opportunity to present his design for review by his peers. Reviews are conducted informally by the Group Leader and/or one or two other engineers in the group with related interests. The purpose of the review is not to criticize; but to foster a free exchange of ideas, techniques and procedures and give each engineer the benefit of the knowledge and experiences of the others.

To schedule a review, the engineer should merely inform the Group Leader that he is ready for a review. The Group Leader will help schedule a date and help decide who should participate. The engineer should prepare a documentation package for each participant and distribute them well before the review. Thus each participating engineer will have an opportunity to familiarize himself with the work.

At the review, the engineer will make a short presentation to whatever depth is necessary given the complexity of the design; and the participants will informally discuss the various design issues. After the review, the engineer and Group Leader should discuss the results of the review including the incorporation of any suggestions rendered by the participants. It is typical to hold two reviews which are as follows:

2.1. Conceptual Design

This review is performed before any detail design work begins. The engineer describes the problem and the plan he has for solving it. By reviewing at this point, the engineer will have a clear understanding of what he is expected to accomplish and can begin detailed engineering with a minimum of wasted effort.

2.2. Final Design

This review is performed once the design is completed or nearly completed. The engineer describes exactly how he has solved the problem. This review may be done before or after a prototype is built - depending on the situation. The Group Leader and the engineer can decide at what point this review should be done. This review is detailed. The engineer should be prepared to discuss circuitry - even to the level of PLD equations. This review may take more than one actual session. Production PC boards should not be made until this review is completed.

3. Obtaining Resources

We have to share resources. There are financial and space limitations that prevent each engineer from having a fully equipped laboratory of his own. Each engineer usually has his own workbench, hand tools, soldering equipment and computer; but sophisticated equipment such as logic analyzers, PLD programmers and high end digital oscilloscopes are shared amongst the engineers in the group. The Group Leader will arrange for work space for each engineer and advise or assist in getting tools and supplies as needed. The main issues of tools, instruments, vendor literature and supplies are discussed below:

3.1. Tools

Most of the tools an engineer needs can be gathered locally from tools and tool boxes left behind by past employees and guest engineers. The Group Leader will help with this or assign someone to help. Those tools which cannot be gathered locally can be purchased from the stock room or from outside vendors. See "Obtaining Supplies" below.

3.2. Instruments

The Electronics Group has a good assortment of oscilloscopes, logic analyzers, bus analyzers, signal generators, bench power supplies and etc. The Group Leader or his designee can assist the engineer in locating this equipment for use in his work area.

3.3. Vendor Literature

Vendor literature is easy to get. Fermilab has a good rapport with the vendors in the Chicago area; and all major manufactures are well represented. To get vendor literature, such as data books and catalogs, the engineer has but to call the nearest vendor with his request. Data books and literature are usually supplied by vendors free of charge. The Group Leader or any of the other engineers can supply the phone number of the proper vendor from which to request information. Most data books and catalogs can be obtained within a

matter of days. Specific information can often be received by FAX within hours. Many of the group's engineers maintain their own libraries of data book and can be consulted for specific data sheets or other information. Additionally, the internet is a very good source for information. Most manufacturers and vendors maintain sophisticated web sites which contain product information such as data sheets and application notes.

4. Obtaining Supplies & Services

Eventually, the engineer requires supplies and services that he cannot get from within the resources of the group. Then he/she will have to purchase them either from the stockroom or by requisition from outside the lab.

4.1. Budget Codes

Supplies and services are paid for from various DZERO "budget codes". There is a budget code for each major project - such as Muon Readout Electronics Upgrade. The Group Leader has a list of all the budget codes which includes the name of the person who is authorized to sign for purchases.

4.2. Stockroom

The Fermilab stockroom has a good selection of tools and supplies including many common electronic components. Stockroom catalogs are available on the internet (within Fermilab); and in hard copy. To get things from the stockroom, the engineer should fill out a stock request form which is available from the secretary's "forms" cabinet. On that form, he should put the stock number which he has found in the Fermilab stock catalog, and the budget code which he has received from the Group Leader or designee. Then he should take the form to the stockroom to request the item. He will need his Fermilab ID card to make the withdrawal. Large orders can be left at the stockroom to be filled at their convenience.

4.3. Requisitions

If the stockroom does not have the required items, they can be ordered from outside vendors. To do this, the engineer must fill out a "requisition form" which is available on the internet at <http://d0server3.fnal.gov/po/index.cfm>. On that form, the engineer will enter the suggested vendor, a description of the item from the vendor's catalog, and a budget code which he has received from the Group Leader or designee. The completed form will be routed automatically to the secretary for processing. Most items will be received in less than two weeks if the vendor had them in stock. If faster service is required, the secretary can rush the order on request.

4.4. Printed Circuit Boards

Circuit boards are procured from outside vendors. The engineer may actually design the circuit board using printed circuit design tools and have a vendor manufacture the board; or, he may only design the schematic, have an outside printed circuit design service do the board design; and have a separate vendor manufacture the board.

In the case of the design service designing the board, the engineer typically draws a schematic and produces a netlist, bill of materials, component placement layout and a list of any special requirements for the board. Special requirements would include such things as definition of power and ground layers, minimum trace widths, critical signal paths etc.. He may confer with his preferred vendor regarding netlist formats, documentation media etc. the vendor may be able to give an approximate price. Then he fills out a requisition form as described above. A specialist from the purchasing department will contact the engineer for the documentation required to issue the contract. Once the board is designed, the engineer might go to another vendor to get the board manufactured.

In the case of the engineer designing the PC board and a vendor manufacturing it, the engineer will supply computer disks containing photoplot files of the board and a complete description of the board and special instructions along with a requisition. The engineer may confer with a preferred vendor to get an approximation of the cost for the purpose of filling out the requisition; but the purchasing specialist will choose a vendor to make the board.

4.5. Computer Accounts

Each engineer will require an account on one or more Fermilab computers. These accounts will give him/her access to electronic mail (EMAIL) and possibly to many computer applications as needed. To get an account, the engineer should review the information found at the Computer Division's web information page at "<http://www.fnal.gov/cd/main/accounts.html>". The Electronics Group Leader can assist in arranging for accounts. Usually, a computer terminal will be available in the engineer's office and work area. If not, the Group Leader or designee can assist the engineer in getting a terminal and getting it connected to the network.