The packaging design equation

When it comes to sophisticated instrument and control systems, the packaging can be as critical as the electronics.

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This article, which launches a three-part series on electronic control system packaging and hardware, covers factors affecting packaging including human and environmental elements and the DIN standard. The second installment, appearing in August, will examine the latest developments in racks, cabinets, and enclosures. The final part, scheduled for October, will cover fans and blowers.

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The packaging of electronic instrument and control systems, such as microcomputers, controls, data acquisition equipment, and so on, is as important as the systems themselves. Bad packaging can lead to early failure, burnout, environmental damage, erroneous, ineffective, or bad signals, and a host of other reliability problems. Good packaging helps you avoid these problems and, in addition, makes the product easier to use and to troubleshoot. An added plus for control system OEMs is that good packaging can have a dramatic effect on sales.

Which brings us to the first important packaging consideration: Will the product being developed be used for internal purposes only or manufactured in large quantity for later sale? The answer to this question will help you make some cost decisions in the area of parts and tooling.

While the rules aren't rigid, quantity bench marks to keep in mind are:

• Less than 500 units – buy off-the-shelf packaging;
• Between 500 and 5000 – develop a custom design and, if the quantity is at the high end, spend some money on special tooling;
• More than 5000 – you can probably afford the tooling needed for the design.

An important exception to the above is that, if you don't have the design skills in house and/or the time to create a custom packaging design, you may want to stay with off-the-shelf parts – even if you plan to manufacture your product in quantity.

Your assembly capabilities must also be taken into account. If you don't have the people and facilities for a long production run, it may pay you to spend more money on the design and tooling if it will shorten the assembly time.

How important is appearance? If the equipment will never leave the plant, appearance can take a back seat to

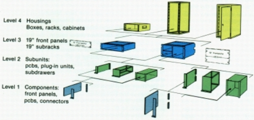


Fig. 1: Under the DIN system, various packaging elements are divided into four levels.

other, more pressing factors. However, if you're working on a commercial product, design and appearance become extremely important.

System size is always an important consideration. Whether the packaging required is a simple box or a large floor mounted enclosure, be sure to make allowances both in the number of card racks and the number of slots per card.

Human factors

There are a number of human factors that should be tossed into the packaging design equation. These include safety, ease-of-use, and ease or difficulty of maintenance. For example, displays and indicators should be easy to see, easy to understand, and easy to reach. The packaging should never pose a fire or shock hazard, and test points should be readily accessible and boards easy to change.

The operating environment of the instrumentation is a leading contender for being the top packaging consideration. Obviously, air-conditioned control rooms are the ideal location. They are clean and often provide filtered air. However, instrumentation is often required to survive less than ideal, or even hostile, environments. Various types of explosion proof, weatherproof and/or corrosion resistant enclosures are available from a variety of manufacturers. *(Editor's Note: As mentioned earlier, these will be covered in some detail in Part 2 of this series.)*

Standardized packaging

The growth of the packaging industry, coupled with a high demand for interchangeable products, are the key factors behind the current push for more packaging standards.

The big swing towards standardization came when Motorola adopted a mechanical packaging system for its board type products based on the DIN 41494 spec for electronic equipment. At the same time, Intel adopted the DIN standard for its Multibus II products. This standard provides a packaging technique compatible with both the U.S. and European metric measurement systems.

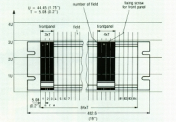
Manufacturers selling to the U.S. military systems market have just recently begun the transition to the DIN standard. Increasing pressure from the Military Equipment Procurement Agencies for cost reductions brought on by Graham-Rudman and other congressional and DOD forces, as well as considerations of compatibility with NATO forces, has motivated DOD contractors to adopt the DIN (VME and Multibus II) standard for U.S. systems.

Defense contractors, long used to redesigning the wheel for each new contract, are finding the wide variety of off-the-shelf DIN subracks, panels, card guides, and other options sufficient to cover most of their nonairborne electronic system packaging requirements.

Vibration proof subracks with electrically conductive yellow chromate finishes have been in use for some years by NATO forces for shipboard and land vehicle applications. These ruggedized subracks are designed to withstand shock and vibration up to 5 g's in a frequency range of 50-500 Hz.

With all of this interest and activity in DIN type packaging, it's worth our while to look at DIN 41494 in some detail.

DIN 41494 segments elements of the packaging systems into four integrated levels; these comprise all the components of the technique, from small filler panels to large floor standing vertical racks (Fig. 1). In this standard:



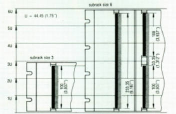


Fig. 2 (top): Standard front panel has 85 steps of 0.2 in. each, resulting in a 21 slot capacity.

Fig. 3 (bottom): Spacer strip in the double card height raises the total height to 233.35 mm.

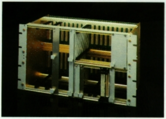
- Level one includes all accessory products such as front panels, programmable control boards, connectors, card guides, and mounting hardware.
- Level two consists of subdrawers, plug-in cassettes, disk drive carriers, and other subassemblies.
- Level three treats 19-in. subracks and 19-in. front panels.
- Level four incorporates table top housings and 10-in. vertical rack enclosures.

Four basic dimensions have been adopted in the level three subrack system to reduce international conversion problems and the associated costs. These are the 19-in. front panel width, the front panel height, the front panel mounting increment, and the subrack depth.

The front panel increment or horizontal pitch (HP) has been set at 0.2 in., resulting in 85 HP (steps) across the open front panel space of 17.0 in. Card guides normally take up 0.8 in. (4 HP), providing a maximum of 21 slots in a standard 85 HP subrack (Fig. 2).

The front panel is in the familiar U.S. standard of 1.75 in., which in the DIN system is given a new designation of 1 unit (1U). Both VME and Multibus II occupy 10.5 in. of panel height or 6U (6 × 1.75).

The subrack front mounting width is 19 in., which is the same as the 50-year old U.S. RETMA standard. One basic



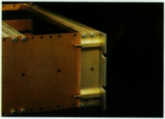


Fig. 4 (top): DIN 41494 subrack with divider kit is 6U high.

Fig. 5 (bottom): Double bolted subrack for applications where shock and vibration resistance is required.

dimension that incorporates a metric measurement is that of the subrack depth. Increments begin at 100 mm and continue in 60 mm steps. Standard with most manufacturers are 160, 220, 280, 340, and 400 mm.

A number of problems had to be overcome when incorporating inch and metric dimensions in one unified system to ensure a universal design for the DIN system. While the combination of inch and metric presented no problem for the width and depth components, panel height was another story. A Eurocard (100 mm) fit very well with the 3U front panel height of 133.35 mm (5.25 in.), but problems arose when the double height card was required for the design demands of larger systems. Doubling the height of the card to 200 mm did not leave enough room for card guides in a 5U (222.25 mm) configuration, and left too much space in a 6U (266.70 mm). The pragmatic solution was to add a 33.35 mm spacer strip to the 200 mm double card for a total card height of 233.35 mm (Fig. 3).

VME and Multibus II subracks are mechanically identical, with the exception of the depth component, which is 160 mm for VME and 220 mm for Multibus II.

The basic 6U high subrack is made up of two sideplates with mounting flanges and aluminum cross pieces called profiles. Front and rear profiles are available in a variety of cross-sections, depending on the types of front panels, doors, or connectors required by the application (Fig. 4).

Benefits of the DIN system to VME, and ultimately Multibus II, users are flexibility and simplicity in application, universality in availability of parts, and low cost of design and procurement.

U.S. designers have begun adopting the DIN and VME standards to the general American philosophy of bigger is better by expanding the board size from 6U to 9U and the depth from 220 to 400 mm. A good example of this expansion can be seen in Sun Microsystems Inc. MC 68020 based workstation products.

The jump from 3U and 6U board sizes imposes greater stress upon the interconnection of the side points and profiles (cross rails). These stress points should be bolstered by double bolting (Fig. 5), in the case of the side plates/profile interface, and greater stiffness in the profile cross section. These points may seem obvious, but are often neglected in the rush to market a new CPU card or I/O interface product. Attention to these points leads to the binding of boards in card guides and the mis-mating of card and backplane connectors. This ultimately leads to system unreliability and customer dissatisfaction.

From its start in the U.S. three years ago, the DIN electronic enclosure system embodied by VME and Multibus II has become the leader in providing an enormously flexible and cost effective standard for commercial, industrial, and military system packaging design.■

Bibliography

Kolodziejczak, Jeff, *Packaging the system*, I&CS, September, 1983.

West, Bryan, *VME packaging: A critical system concern*, I&CS, June, 1986.

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