An Elma Electronic White Paper

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Every Millimeter Counts: Right-Sizing for Instrument Cases

Space is a premium in the markets for instrument cases. Whether it's a lab, hospital, industrial setting, or on a naval ship, instruments need to be smaller and smaller. In designing instrument cases, it's important to design to exact measurements to maximize density and performance. But, how can this be done without the high costs of tooling from scratch? How can costs be kept low for prototypes or low volumes?

Modularity

There are virtually limitless design possibilities for electronic enclosure design. For various types of instrument cases, it can be difficult to find the appropriate size and configuration for an application. Often, the engineer will have to incorporate a fully customized design or settle on a size that is not quite ideal. This can be expensive, time-consuming, and result in an inferior design solution. A "right-sized" modular design approach for enclosures can help solve these problems.

Extrusions help make modular enclosures possible. An extrusion-based design allows the frame of the chassis to be easily cut in different lengths for various size and configuration requirements. The piece parts are easy to incorporate in various sizes for an instrument case or system platform enclosure frame. If the enclosure has a card cage, injection molded card guides can then be popped in at regular intervals into the extrusion holes. As there is flexibility in where the card guides are placed, various card widths and types can be placed inside the enclosure.

When talking about modular design for a backplane-based system platform or a cabinet enclosure, the extrusions are typically cut in 1U measurements. The modular format allows various configurations of backplanes, drives, power supplies, shock isolators, etc, can be incorporated into the same base chassis. However, instrument cases need to have more precise sizes in many cases – saving every bit of space.

Finding the right enclosure for your application can be very challenging. Often, the designer is forced to develop a highly customized design. Not only are the costs much higher, particularly during prototyping, but the time to market can be lengthy. There is also inherently more risk, as you are relying on custom parts and potential problems with single sourcing, obsolescence, etc.

Right-sized Modular Design

A “right-sized” modular design can help alleviate these problems. For instrument cases, this process starts with the aluminum extrusion, which are cut to any specified length. In many Eurocard system platforms, the extrusion has a radius for sealing and gasketing purposes. In the instrument case solution in Diagram 1, the interlocking extrusions have a unique shape and design. See Diagram 2 The extrusion is designed to accept tapped strips, sealing cords for EMC, optional direct mounting of a panel or PCB, grounding terminals, or screws. This flexibility saves a few manufacturing processes, keeping costs low. Further, the extrusion shape allows the extrusion and panels to be directly mated together. This prevents drilling and tapping the extrusion, again saving costs. With a simple design and only a few pieces, the assembly can be quick and easy. These cost advantages far exceed the extra cost of a super-functional extrusion. The benefit to the designer is he can have an exact-sized case that is customized with a low cost – and in small volumes. Typically, this kind of customization would only be cost-effective in high volumes. Now, it can be done for prototypes and small volumes.

Diagram 1

A “right-sized” modular enclosure. The enclosure building blocks can be make to any length with the modular extrusions, allowing precise sizes and configurations with minimal customization efforts.

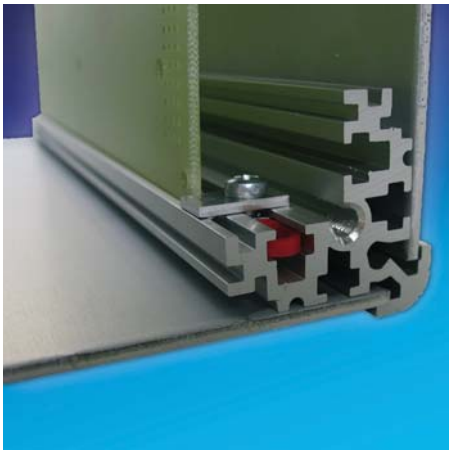


Diagram 2

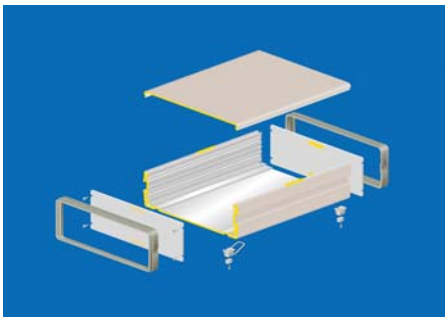
An extrusion can be designed to accept panels and covers, sealing cords, mounting panels, or various terminals. This allows a great deal of flexibility in the design and reduces assembly and customization costs.

The extrusions do more than just allow a modular enclosure frame to be put together. An extrusion solution can be designed symmetrically, so parts cannot be mounted incorrectly. The sidewalls, mounting panels, or even PCB can be mounted directly into the extrusions, greatly reducing labor. Even nuts/bolts, grounding terminals, etc can fit right into a carefully crafted extrusion design.

EMC Considerations

EMC is an important consideration in enclosure design. It is an important part of a packaging designer's responsibility to ensure that the system does not interfere with, and is not susceptible to interference from, other electronics equipment. Depending on the item's usage, electronics equipment must meet compliance standards like FCC and CE. The goal is to create ground continuity over the outer skin of the enclosure and to block given wavelengths from passing through any openings. In order to ensure compliance a wide range of issues must be considered. These include material type and thickness, conductive plating, vent hole size, seam length, gasketing, power filtering, access panels and AC cable routing. To provide a solid basis-point, the extrusions for the instrument case can be designed with 90-degree angles to cover any open seams. Further, the shape of the extrusion can allow the insertion of EMC sealing cords.

Take the instrument case examples in Diagram 3b. The top and bottom extrusions as well as the front panels have conductive connections (HF shield). This provides effective EMC protection. A further layer of protection can be added with seals. This allows protection against splash and dust. As seen in the illustration in Diagram 3a, the top (and bottom) covers are folded over in the sheet metal stamping process. This helps provide a tighter seal and boost the EMC protection of the unit. The typical attenuation in the electric and magnetic field are shown in Diagrams 4a and 4b.

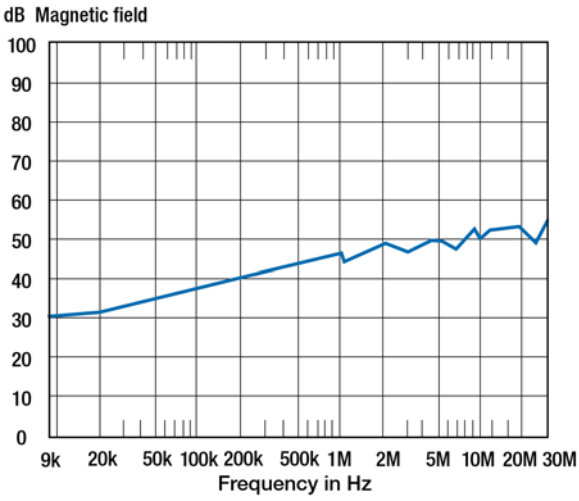


3a

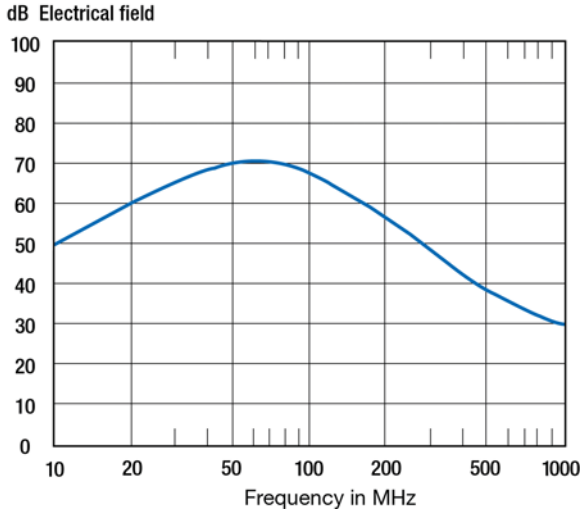
3b

Diagrams 3a and 3b

EMC considerations can be built into the modular design. 3a shows how the covers fold over the edges for EMC protection and 3b shows various configurations of assembled units.



4a



4b

Diagrmas 4a and 4b

An extrusion can be designed to accept panels and covers, sealing cords, mounting panels, or various terminals. This allows a great deal of flexibility in the design and reduces assembly and customization costs.

Adding Aesthetics

Aesthetics can be important in instrument case design. An attractive unit can set an OEM's medical device apart. There are several ways to enhance the appearance of a case including:

- bezels
- paint
- silkscreen
- swivel handle
- rounded corners
- aesthetic construction

The enclosures in Diagram 3b shows several units with various enhancements to their appearance. Actually, much of the aesthetics of this unit is inherent in the design. The rounded edges of the enclosure, molded handles, and aesthetic construction are all part of the base platform design. Aesthetic construction means design to minimize unsightly parts of the enclosure. For example, screws can be placed in hard-to-see locations, or the enclosure can be indented where the screws are placed to maintain a flat surface. Also, cover panels and bezels can hide these areas as well as add to the appearance of the chassis in their own right.

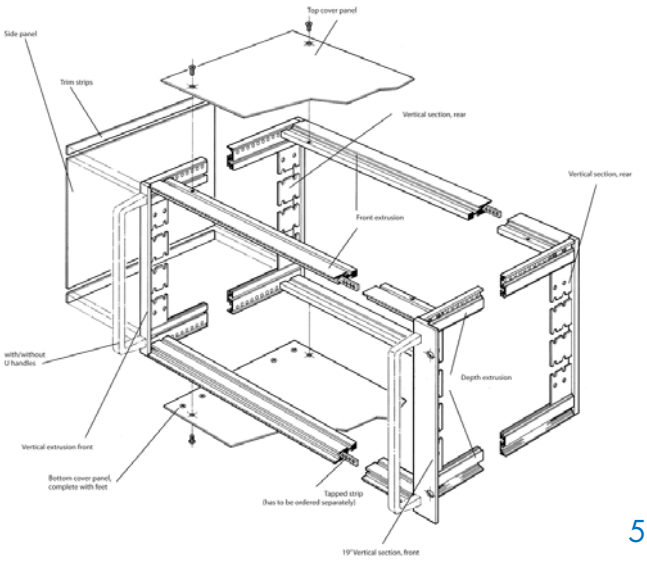
Universal Construction

There are other ways to achieve a high degree of modularity. Take the case in Diagram 5a. It has a universal construction with 4 front extrusions, 4 depth extrusions, and 4 vertical sections. This jigsaw approach to the base platform allows a high degree of flexibility in the configurations that can be assembled. Diagram 5b shows a finished unit. A construction like this is ideal for particularly prototyping for Eurocard applications.

5a

Diagrams 5a and 5b

Modularity takes many forms.This design is geared to provide a "universal construction" to maximize flexibility.The piece parts (5b) and assembled unit (5a) are shown.



5b

Assembly - Saving time

One very important area of packaging for instrument cases is the assembly time. Assembly is a variable cost – and not something that should be overlooked. There are many ways to save time. First, a mounting panel can be used to attach the PCB. This prevents the OEM from having to drill into the bottom of the enclosure. The mounting panel easily mounts into the bottom of the enclosure and sits up about ¼ inch off of the enclosure floor – allowing clearance for nuts, bolts, etc. For quick assembly time, the PCB can be mounted to the mounting panel outside of the enclosure. Assembled outside of the case, the solution provides easy access and less assembly time. Once complete, the case has sidewalls with grooves, so boards can slide directly into the enclosure, without further mounting or customization. Further, the PCB can be mounted to the front panel during assembly. This provides an extra secure mount and saves even more time.

Going a step further, the "right-sized" enclosure in Diagram 1 has T-shaped grooves in the extrusion to allow for very versatile mounting. This allows mounting panels to be loaded both horizontally and vertically in the enclosure case. Therefore, all types of components (fans, power supplies, tubes, etc) can be mounted without customization and with less assembly time. Further, the T-shaped grooves can allow grounding terminals to be placed. This provides a quick and convenient way to have a secure connection to ground.

Less Effort, Cost, and Risk

An extrusion-based solution will typically be a much more attractive enclosure. The finely machined parts and aesthetics of the design often have a cleaner, more professional look than simple stamped sheet metal.

Overall, these modular design techniques limit the effort, cost and risk of customization. In high volumes, many of these costs can be overcome. However, a modular design allows customization to be more cost-effective during prototyping and lower volumes.

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