

Top Ten Tips when specifying small metal and plastic enclosures Hammond Electronics

Your new industrial electronic product has been designed and the board components specified. It has been prototyped, either on a development board to check functionality and performance or laid out on a final PCB design. It has been debugged, tested, tweaked, tested again and finally signed off for production. So far, so good. Now all that has to be done is to decide on the choice of enclosure for it. In the ideal world, the enclosure would have been selected far earlier in the process, so that, in particular, the size constraints of the PCB would be known. In the real world, the first question is normally, “what size box do I need”.

We list below, based on our extensive experience as an enclosure manufacturer, the criteria that need to be considered when the enclosure is specified. These relate to standard or modified standard enclosures, which are normally the best choice for low/medium volume applications. For consumer-facing products, where volumes are expected to be far higher, a fully custom enclosure is normally the best approach.

1. Size

The most fundamental series of questions. How big is the PCB? Is it to be mounted horizontally or vertically? Many plastic enclosures have slots moulded in to the sides of the enclosure for direct vertical mounting and PCB mounting bosses moulded in to the top and base for horizontal mounting. Extruded aluminium enclosure will typically have full length slots in the sides for horizontal PCB mounting. How much space, if any, does there need to be on the external surfaces for any indicators, switches, connectors, cable entries and similar components that are required? What height is required for board-mounted components or multiple horizontal boards?

2. Installed environment

Where will the product be used? Inside, outside or possibly either? For outside installation, UV stability is a potential issue for plastic enclosures. For mobile applications such as road and rail, is shock and vibration likely to be a concern? Will the ingress of dust and water be something to be considered – see Point 4 below. Are there likely to be contaminants present – oils, chemicals and so on. Is resistance to impact damage a possible problem? If so, metal enclosures typically offer better resistance than plastic ones. Are particularly high or low temperature expected?

3. Material

For small enclosures, the choice is typically between plastic, aluminium and GRP. The most widely used plastic materials are ABS and polycarbonate. Fire resistance is a consideration; the relevant standard is UL94, which specifies a vertical or horizontal burn. The more stringent test is the vertical burn test; material will be classified as V0, V1 or V2 where V0 is the highest performance. Polycarbonate or GRP would normally be specified for outdoor use because of its better resistance to UV embrittlement and colour fading than ABS.

Aluminium enclosures are either die-cast or extruded. Both are robust and give good impact resistance and are intrinsically electrically conductive, although painted or anodised finishes must not cover mating areas to preserve continuity throughout the enclosure. Some designs of extruded enclosures offer features such as multiple fins to significantly increase the surface area to improve heat dissipation. Die-cast aluminium housings are strong and robust; they do not corrode, are electrically conductive, have an intrinsically high level of electro-magnetic attenuation and are easily machined. With a suitable gasket fitted between the lid and the base, environmental sealing to IP68

can be easily achieved, and by adding inserts during the casting process, repeated openings and closures are facilitated. Such enclosures can be cast with relatively thin walls, although they will always be far heavier than the equivalent sized plastic moulded one. For applications where protection against shock damage is important, where EMC is likely to be an issue or where high temperatures, dust or water are expected to be present, the die-cast enclosure is the ideal low-cost choice.

4. Environmental sealing

Sealing typically relies on a tongue and groove construction between the mating halves; for higher levels of sealing, a compressible gasket will also be used at the interface. The relevant international standard is IEC 60529. Typically, enclosures rated at IP54 are suitable for general purpose use; for installation in environments where dust and water are likely to be present, IP66, 67 or 68 would normally be specified. The highest rating is IP69K, which gives protection against steam cleaning at high pressure. In North America, enclosures’ environmental sealing is normally defined as a NEMA (National Electrical manufacturers Association) number. NEMA ratings also require additional product features and tests (such as functionality under icing conditions, enclosures for hazardous areas, knock-outs for cable connections and others) not addressed by IP ratings.

IP Rating	NEMA number
IP20	1
IP22	2
IP24	3R, 3RX
IP53	5
IP54	12, 12K, 13
IP55	3, 3X, 3S, 3SX
IP66	4, 4X
IP67	6
IP68	6P

5. Appearance/styling

The most subjective of criteria. Plastic enclosures offer a choice of opaque and translucent material in a variety of colours, they can also be moulded in a transparent material; styled lids with recesses for membrane keypads and displays are available. Die-cast aluminium enclosures can be painted in a variety of different finishes and colours; extruded ones can have a clear or coloured anodising finish.

6. EMC

In many applications EMC capability is of no interest, but in others it can be a design consideration. Plastic enclosures have one specific weakness: by virtue of the intrinsic properties of the material itself, plastic, unlike metal, offers no intrinsic attenuation. If EM radiation emitted by the housed electronics or their susceptibility to external fields is a potential problem, the lack of screening could be an issue. Internal coatings in a variety of materials can be applied to the inner surfaces of a plastic enclosure to give different degrees of attenuation dependent on the project requirements. By offering different materials in a range of thicknesses, the most cost-effective and technically competent solution can be provided.

Metal enclosures, providing they are designed in such a way that electrical continuity is present between the top, base and removable panels and that any painted or anodised finish is purely for external decorative purposes, will provide a level of EMC likely to be more than sufficient for the

majority of applications. A conductive gasket will be used to electrically link the two halves of the enclosure.

7. Fixings – captive screws/material/tapped bushes v direct into plastic

Enclosure panels and covers obviously have to be secured to their mating half. There are two main methods for plastic and die-cast enclosures. In the first, a self-tapping screw is secured directly into the material of the base; in the second, a machine screw mates with a threaded bush moulded into the base. A machine screw is preferable if repeated openings and closures are anticipated during the life of the equipment, a self-tapping screw is fine for 'close-and-forget' uses. A further refinement, normally only appropriate for machine screw closures is the use of captive screws, which do away with the possibility of one of the screws being lost during opening.

8. Downloadable drawings and support materials

Any reputable enclosure manufacturer will provide a comprehensive library of technical information on its web site. Typical downloadable resources should include dimensioned drawings to assist with the design and modification requirements, technical details and key product attributes.

9. Manufacturer modification capability

In order to make a standard enclosure suitable for a specific application, it will need to be modified. The best option is for the original manufacturer to provide a modified enclosure configured to the specific requirements of the project, so there is no need to over-order to allow for set-up and wastage quantities. Enclosure manufacturers will typically be able to provide milling, drilling, punching, engraving, screen printing, painting and EMC coatings for their range of standard products. Manufacturers of moulded enclosures can normally also offer enclosures moulded in custom colours to meet any applicable identifying requirements or corporate branding needs.

10. Manufacturer and distributor technical support/ standard product availability

Standard enclosures for the electronics and electrical industries are produced in a huge variety of sizes, styles and types by many specialist manufacturers. A moulded, extruded or die-cast enclosure may appear to be just a simple box, but in fact it is the result of extensive design expertise that has resulted in a feature-rich housing, suitable for a use in a wide variety of applications and environments. However, a standard enclosure will inevitably need to be modified to make it fit for purpose. Most manufacturers and distributors keep stocks of standard enclosures on the shelf and the modern trend is that distributors are now joining manufacturers in providing technical support to their customers, working with them at the design stage to help choose the most appropriate enclosure for the application.

Conclusions

A superficial glance at a moulded or die-cast enclosure may give the impression that it is a simple box, but in reality, it is the end result of a great deal of design effort and expertise that has been expended to create the most useful and feature-rich housing, suitable for a use in a wide variety of applications and environments. Work with the enclosure manufacturer from an early stage in the project design cycle to tap the wealth of experience behind a standard enclosure.