Plastic Electrical Enclosures – Solutions for Extreme Customization

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EQUIPMENT PROTECTION

Standard enclosures do not remain standard for long. In no time, engineers put holes, cutouts, and recesses into pristine boxes. This process is necessary to make the enclosures functional. There are switches to mount, readouts to view and connections to be made.

Every application is unique and every solution is different, and all applications seem to require customizing the enclosure. Rather than create a custom package, OEMs often choose to modify, or customize, a standard enclosure.

Reasons may be to lower development cost, reduce product cost or achieve a faster time to market. Seeking to achieve a more custom solution, OEMs request enclosure manufacturers to cut holes, slots, recesses and all manner of shapes into their standard enclosures.

The trend toward packaging multiple functions into a single enclosure to achieve a compact, integrated package has greatly increased the complexity of these modifications. While it may appear this trend is driving designs toward custom solutions, and limits the use of standard enclosures, in reality, advances in customization methods continue to increase the use of modified standard enclosures. This is especially true for plastic enclosures.

Electronic packaging will continue to increase in density. The man-machine interface will continue to become more sophisticated with multiple inputs and outputs. Applications will be subjected to harsher and more demanding environments. Future packaging complexity will require either extensively customized standard enclosures, or force designs requiring custom molded enclosures. Can a standard enclosure still be viable?
How does an OEM tackle the possibility of extreme customization? What solutions exist for high precision patterns, for creating holes with complex irregular shapes, for modifying most or all of the sides of the enclosure? Let's examine 3 designs that resulted in extreme customization. We'll take them in order of increasing complexity.

Application #1 -
Customized Fibox CAB enclosure for Liquid Process Control

This application was customized for an OEM that develops and manufactures liquid automation machinery, consisting of concentration control and pumping systems for chemical feed applications, based upon innovative chemical metering.

A newly designed control and pump system required a compact enclosure that could be configured in multiple ways for different end users. The unit contained an operator interface for programming as well as power supply, pump control modules, solenoid valves and optional, externally mounted peristaltic pumps.

Figure 1 shows the modified front cover of a Fibox CAB Series enclosure hinged for landscape mounting, i.e. hinges on the short side. The precision hole pattern on the upper left quadrant is used for mounting the operator interface module. The rectangular cutout is for the LCD readout, the round holes below are for tactile-feedback pushbuttons used for programming. The two holes above the cutout are for LED status indicators.

The relative positioning of all the holes is critical as they mate to components mounted on a PCB assembly, which is mounted using the 4 counter sunk holes. Also on the cover, are 2 groups of precision hole patterns used to mount optional peristaltic pumps.

The pump motors are housed inside the enclosure, with the motor shaft passing through the center large hole. The surrounding 4-hole pattern mounts the external rotor housing to the interior pump motor.

An overlay is applied to the surface of the cover, which creates a clear window for the display and LED indicators. The overlay creates the touch pads for the tactile pushbuttons, and seals all the hole patterns and conceals any holes unused for that particular instrument configuration.

The overlay may be modified to permit 1 or 2 pumps, or used without holes when optional pumps are not required. For this application, the overlay was designed to seal the enclosure and restore the original ingress rating.

Figure 1 also shows the bottom side of the enclosure base, which also has extensive customization. Three of the holes have counter bores and are used for mounting precision solenoid control valves. Two simple round holes are used for cable glands or conduit entry of wiring. The sealed power switch mounts into the smallest hole. While not visible, all 4 sides of the base are modified.

The modifications for this OEM consisted of precision hole patterns requiring tight tolerances on multiple sides of the enclosure. The next application goes beyond.

Application #2 –
Customized Fibox MNX enclosure for Water Level Detection

This application was customized for an OEM that designs, develops and manufactures real-time data collection systems and control products for Hydrologic, Meteorological and Oceanic applications.

Under development was a new, precision indirect water level measuring instrument. Based upon innovative radar technology, the unit would be fully integrated with internal radar antenna and full data logging capability.

The OEM sought a compact package, for moderately hostile environments. To meet cost targets, a standard enclosure would be ideal if it could accommodate an easily used HMI (Human-Machine Interface) system for programming system operation consisting of 6 tactile feedback pushbuttons for programming, a 2-Line LCD display and 2 status lights. An overlay would seal the front of the unit, create the viewing area for the display and status indicators, plus form the raised surfaces required for the tactile buttons mounted below.

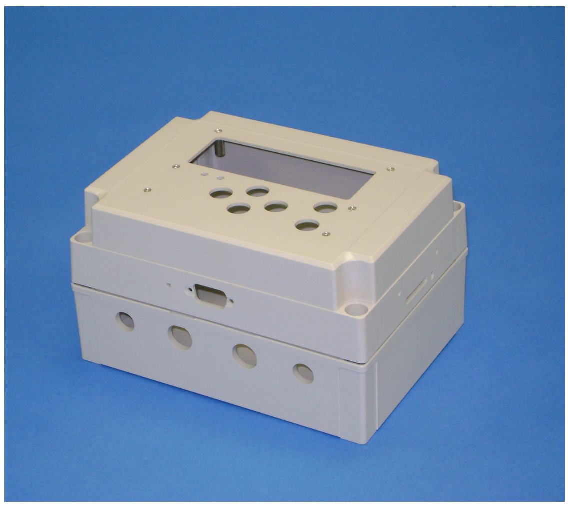

Figure 2 shows a Fibox MNX enclosure with extensive modifications. As in the first application, the cover has a large rectangular cutout provided for viewing an LCD display. Immediately below are round holes for 6 tactile-feedback push buttons which protrude slightly through the cover. This customization is more complex then the previous example because threaded metal standoffs are used to mount the operator interface electronics assembly.
A precision set of 6 holes is drilled within the perimeter outline of the cover. Hole to hole spacing is maintained at a tight tolerance to match the tolerances of the PC board. A secondary manufacturing step is performed to press fit the 6 threaded metal standoffs which are specifically designed for plastic materials.

One of the metal standoffs is visible through the cutout for the readout in Figure 2. Figure 2 also shows additional modifications to the cover and the base. For data connection, there is a “DB-9” subminiature connector cutout complete with recessed holes for the connector’s mounting ears. On the side of the cover, there is an additional milled slot and holes for mounting an SD (Secure Digital) memory card reader. The base is also modified with 3 round holes and one “D” hole.

While not visible, both the cover and base are each modified with 4 mounting holes for the hinges which secure the cover to the base.
The modifications for this OEM required precision holes and cutout patterns on 4 sides of the cover and 2 sides of the base. Additionally, using a secondary operation, threaded standoffs were press fit into the cover interior for mounting electronic PCBs. Our third application moves the bar a bit farther.

Application #3 –
Customized Fibox CAB enclosure for Gas Process Control

This application was customized for an OEM serving the oil, gas, water, and wastewater treatment industries as well as many other industries that require remote process control, automation, or measurement solutions.
The CAB Series enclosure was chosen because it created the instrument appearance marketing wanted, while being a standard enclosure which reduced both design and manufacturing cost. Since this effort was repackaging an existing design, customization of the enclosure was required to comply with a number of predetermined constraints. For example, sensor mounting was fixed and unchangeable.

The complex and very tight tolerance hole pattern shown in the base was required to match with the existing sensor mounting configuration and also mate to an interior mounted chassis. This complex hole pattern is milled using specialized high spindle speed, CNC machinery. However, should production volumes increase, the option exists to modify the injection mold to create a “molded-in” hole pattern and eliminate the machining process, resulting in a significant piece part cost savings. Also visible in the photo, the enclosure front contains a hole pattern for mounting the operator interface and readout display, plus a data connector on the side.

As in the other applications, a custom overlay completes the unit and restores the original ingress ratings. The customization for this application grew even more complex as one side of the base mold was altered to provide a smooth flat surface for optional mounting of a solar cell power array.

Threaded brass inserts were installed to comply with vibration requirements, and a custom silicone gasket replaced the usual PUR (Polyurethane) gasket. Finally, the cover mold and the latch handle molds were customized to add the OEM's name.

The customization for this OEM demanded precision hole patterns and secondary operations similar to those required for the first two applications. But well beyond that, a number of alterations of the injection molds were necessary to meet this OEM's need for extreme customization.

A Roadmap for Customization Success

What lessons can we learn from these three examples of extreme customization? Can we generate a "road map" for successful extreme customization? The answer is yes, as there are commonalities in these success stories. Here are some key steps.

1. Early contact with the enclosure manufacturer.

The engineer should look for a manufacturer with a wide selection of standard enclosures that are suitable for his proposed environment. This is critical when dealing with factors such as the ingress rating of water and dust. The basic enclosure must be up to the task. It is usually impossible to increase the inherent NEMA/IP rating of an enclosure by customization. Another critical check is assuring chemical compatibility with the proposed environment. The enclosure manufacturer's technical staff can help guide the engineer to select the proper enclosure for the application.

2. Verify the manufacturer's level of customization expertise.

The engineer must determine the customization abilities of the supplier. Most enclosure manufacturers offer some level of customization. Some provide simple holes and cut outs, while others specialize in a certain type of enclosure, e.g. aluminum. But achieving extreme customization in high ingress rated plastic enclosures requires equipment specifically designed for the task. These machines are state of the art computer controlled milling machines that operate at extremely high spindle speeds exceeding 40,000 RPM. Preferred machines will have automatic tool changers and a wide assortment of specialized high speed cutting tools specifically designed for plastic milling. This feature allows flexibility in machining complex shapes. And if anticipated unit volumes are very large, the engineer should look for automatic loading and unloading of customized parts.

The engineer should ask to see examples of previous "extreme" customization. He should review production of units with similar modifications to his own, verifying that held tolerances are sufficient for his design. Ideally, typical past production volumes should approximate his volume requirements.

3. Understand the factors impacting cost.
Many items affect cost. There are charges to program the computer numerical control (CNC) machinery. There are recurring set-up costs with each machining run of enclosures. Of course, the actual modifications affect cost. A large cutout for a DIN meter is more expensive than a small round hole and a milled recess more expensive than an open slot. The total time to machine the modification determines the cost. One of the most significant cost drivers is the number of enclosure sides being modified because each side requires it own program (a one time cost) and each side requires a set-up (a recurring cost). Also remember that the cover or door is a separate part from the base. Each requires a separate set-up and program. Understanding what is possible, and what it costs, ensures that selecting extreme customization over a custom enclosure is the correct choice.

4. While not inexpensive, extreme customization can still be made cost effective.
The engineer can design to reduce customization cost. He should know that buying customization is buying time. He should understand that different machine operations can require different tools. Tool changes, even when automatically done, require time. Simple design changes can minimize tool changes. The enclosure manufacturer will usually offer suggestions, but it never hurts to ask if any design changes might lower total cost. Maintaining tight tolerances can be easily achieved, but specifying excessively tight tolerances increases cost. Again, seek the assistance of the manufacturer's engineering staff. Extreme customization is usually not inexpensive, but it can be made cost effective.

5. Design with the manufacturer's documentation and CAD files.
Most plastic enclosure manufacturers supply CAD files of their enclosures. Using the manufacturer's files as the starting point ensures dimensional accuracy, simplifies drawing interpretation, and eliminates errors. Using these files will be crucial if the customization requires a mold modification or insert change. Success in extreme customization requires clear communication between all the parties. Using the manufacturer's CAD files establishes a common language.

Conclusion
Now, more than ever, standard, off-the-shelf, plastic enclosures offer cost-effective value for customized electronics packaging. Despite the trend toward increasing density of packaging multiple functions into a single enclosure, despite the increasing complexity and precision of modifications, despite harsher and more demanding environments, customized standard enclosures continue to maintain their cost advantage because many enclosure manufacturers have risen to the challenge of extreme customization.

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