

FRONT PANELS, PLUG-IN UNITS, AND FRAME-TYPE PLUG-IN UNITS REQUIREMENTS, SELECTION CRITERIA, AND OPTIONS FOR ADAPTATION



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1. INTRODUCTION: AREAS OF APPLICATION

Front panels and plug-in units are assembled into 19" subracks, cases, or systems (e.g., with CompactPCI or VME bus architecture) that are compliant with the 19" standard (IEC 60297-3-101 ff.) and provide the finishing touch to the front of the chassis both visually and functionally. Front panels are available in various versions, with or without a lateral groove, or as a U-profile, and are used to cover the area in a subrack, case, or system which is not equipped with printed circuit boards. This covering is necessary to guarantee continuous EMC protection for the entire system. In addition, it is an important element of the thermal management concept of a subrack or case. It helps to provide the ideal heat dissipation solution while preventing air short-circuits.

Plug-in units (PIUs) consist of a front panel, handle, assembly hardware kit, printed circuit board (PCBs are not always included in the delivery), and – for shielded versions – an EMC gasket. They provide the front or rear closure for euroboard-format printed circuit boards.

Frame-type plug-in units are compliant with the 19" standard (IEC 60297-3-101 ff.) and are designed to accommodate printed circuit boards and assemblies which can either be compliant with the 19" standard, or are non-standardized. The boards or assemblies housed in a frame-type plug-in unit become an electronic function unit that is self-contained and testable.

Front panels, plug-in units, and frame-type plug-in units

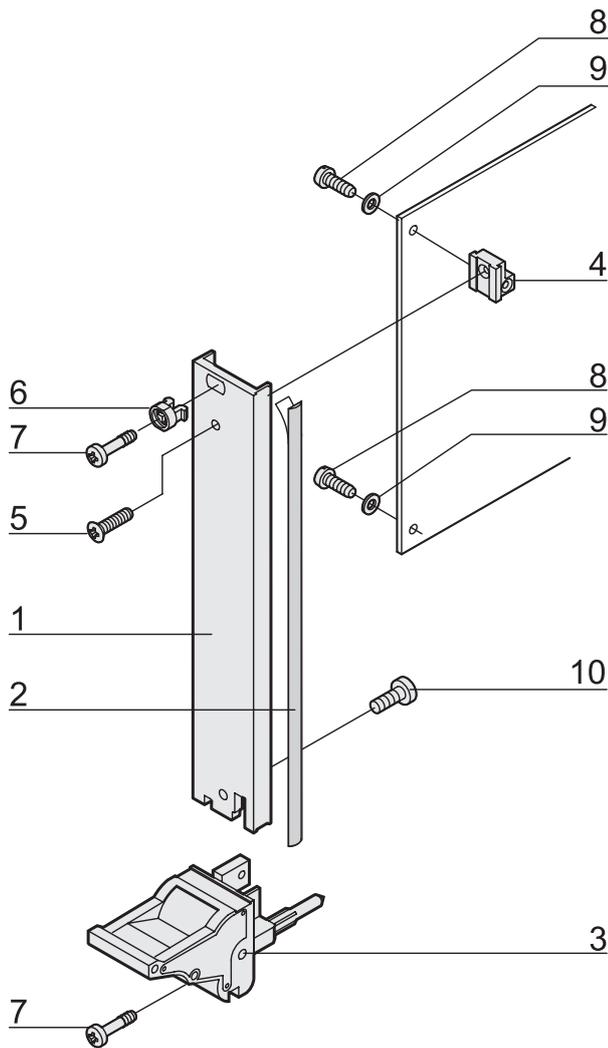


Fig. 1: Plug-in unit assembled from off-the-shelf components:
1 – front panel, 2 – EMC gasket, 3 – handle, 4 – board support,
5 – countersunk screw, 6 – sleeve, 7 – collar screw, 8 – panhead screw,
9 – washer, 10 – panhead screw

Safety requirements are often the reason for integrating printed circuit boards in frame-type plug-in units. In addition, in the event of maintenance, they allow the technician to replace the unit on-site easily.

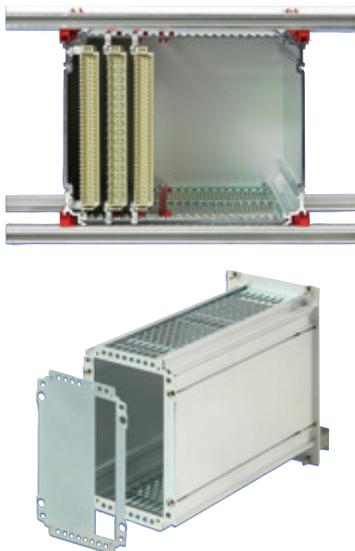


Fig. 2: Frame-type plug-in unit mounted in subrack (rear view)

2. WHAT DIMENSIONS ARE NORMAL?

The dimensions of the front panels, plug-in units, and frame-type plug-in units are determined by the size and type of the electronics assemblies installed. In general, off-the-shelf, standardized products should be used where possible because a wide range of solutions are available on the market. Off-the-shelf products save time and expense. Typical dimensions are 3 U and 6 U (height units: 1 U = 1¾ inches). In terms of width, front panels with 4 to 12 HP represent the majority of applications. A width of 4 HP corresponds to a “slot” – the amount of space required by an equipped euroboard in the subrack or case. Front panels with a width of 84 HP with 3 or 6 U height are also used, for example, to cover the entire front and/or rear side of a subrack or case. Hinged front panels are used for quick maintenance or replacement of installed components. Common off-the-shelf frame-type plug-in units available on the market are offered in widths of 10 to 42 HP. If the use of off-the-shelf products is not an option, many manufacturers also offer customized dimensions for front panels, plug-in units, and frame-type plug-in units.

3. DESIGN OF FRONT PANELS, PLUG-IN UNITS, AND FRAME-TYPE PLUG-IN UNITS

Front panels, plug-in units, and frame-type plug-in units are the actual “face” of an application. While the design of these elements is determined by technical specifications, they are also key elements of a system’s outward appearance due to their multicolored printing and inscriptions. In the last few years, customer demand for a high level of customization has grown, and product designs have reflected this trend.

Front panels are now available in steel, aluminum, or stainless steel. Individual front panels, front panels of plug-in units, and those used as the front closure for frame-type plug-in units are mostly made from aluminum and can be painted or printed as per customer requirements. Whether silkscreen printing or digital printing is used in this scenario depends on both the application and the local environmental conditions to which these front panels will be subjected.

Aluminum front panels are available with at least three different surface finishes as standard. The individually anodized finish is decorative and resistant to scratches, but compared with other surface finishes it is a rather expensive solution. This is because the front panels are only anodized after machining, meaning that there are no plain edges. A normal anodized surface, in which the whole aluminum sheet is anodized first before the individual front panels are cut from it, is also decorative and scratch-resistant. However, machining will result in plain, unprotected cut edges. These front panels are in the mid-range pricing segment. The third version comprises front panels with an anodized front side and a passivated – and therefore conductive – rear side. This also gives the front a decorative, scratch-resistant surface finish. Owing to the conductive coating of the rear side, these front panels are normally used in EMC-protected products.

The shape of the front panels can also vary. There are three versions on the market: flat board material, flat board material with lateral longitudinal grooves or as an aluminum U-profile. Flat front panels are mostly used in conjunction with unshielded systems. The same front panels, but with lateral longitudinal grooves, are also suitable for EMC applications. In this case, stainless-steel EMC gaskets are clipped into the grooves on the long sides.

Front panels, plug-in units, and frame-type plug-in units

Aluminum U-profile front panels are also suitable for EMC applications. A textile mesh EMC gasket is applied to one side, which is much quicker than clipping in stainless-steel gaskets. Textile gaskets are also cheaper. Because of their U-shape, these front panels are very robust, which is advantageous for 6 U-high covers. When connecting or removing a plug-in unit, the U-shape prevents the front panel from flexing and therefore reduces the risk of warping the printed circuit board. This also reduces the “stress” on the electronic components.

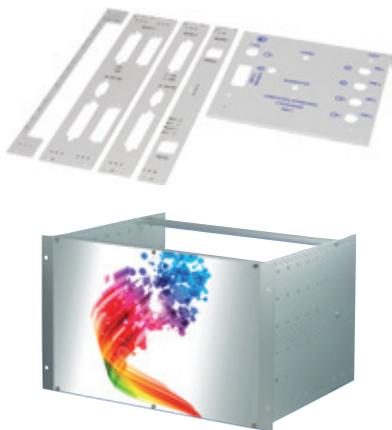


Fig. 3: Front panel design to customer specifications: Single or multiple colors

4. WHICH STANDARDS AND SPECIFICATIONS MUST BE OBSERVED?

International and market-specific standards and specifications define the requirements for particular areas of application. Current standards contain additional dimension specifications (IEC 60297-1, IEC 60297-2, IEC 60297-3-101, IEC 60297-3-102, IEC 60297-3-103, IEC 61969-2-1, IEC 61969-2-2) and – at a higher level – criteria for physical integration (IEC 61587-1), electromagnetic compatibility, as well as VG 95373, part 15, and thermal management (IEC 62194 Ed. 1). In addition to IEC standards, there are specifications for applications that are required for special market sectors. Examples are VME from VITA (VME International Trade Association) and CompactPCI, MicroTCA, and AdvancedTCA from PICMG (PCI International Computer Manufacturing Group).

There are specialized standards and guidelines for applications in rail or military technology, such as special welding certifications (EN 15085). Environmental tests (EN 50155) for rail technology and shock/vibration tests (MIL 901D) for the navy may also be relevant. Certain protection and safety standards stipulate that all conductive parts in a mechanical front panel, plug-in unit, or frame-type plug-in unit that can come into contact with dangerous voltages must be earthed and tested in accordance with IEC 61010-1. In addition, there should not be any sharp edges present in order to avoid injuries. User-accessible assemblies that generate heat and that, for example, are mounted into frame-type plug-in units, must be shielded. The design and materials used for front panels, plug-in units, and frame-type plug-in units must also be properly selected to avoid the risk of fire. Plastics should conform to the self-extinguishing class as per UL 94 V 0 to V 2, tested to IEC 60707. Owing to toxic additives that are found in materials of a higher self-extinguishing class, ISO 14000 must also be observed. Flammable material must not be allowed to seep into other

areas (IEC 60950). IEC 60529 specifies the IP protection classes to prevent the ingress of dust and water. It also stipulates protection for persons. The IP protection class designation contains two digits. The first of these specifies the protection level against foreign bodies (from contact by fingers to the ingress of dust) and the second indicates the protection against the ingress of water.

5. ARE THERE ANY PARTICULAR ENVIRONMENTAL CONDITIONS AT THE INSTALLATION SITE?

Because front panels, plug-in units, and frame-type plug-in units are normally installed into subracks, cases, or systems, which are in turn installed into corresponding electronics or electrical cabinets in some applications, they are usually protected from environmental conditions, such as dirt, dust, and water. Environmental conditions can have a more noticeable impact on portable applications. This is where the EMC shielding comes into play. For portable applications, the weight of the unit is of paramount importance. Front panels, plug-in units, and frame-type plug-in units made from aluminum help to reduce the weight for the end users. In addition, aluminum is resistant to many different environmental conditions. Users in the telecommunications field generally prefer stainless steel as the material of choice. Front panels made from stainless steel are therefore normally used for MicroTCA and AdvancedTCA systems.

6. WHAT EFFECT DO STATIC AND DYNAMIC LOADS HAVE?

A key consideration here is whether the systems in which the front panels, plug-in units, and frame-type plug-in units are used will be moved or subjected to displacement or are designed specifically for mobile use, as these components are subjected to varying dynamic loads. Owing to their sturdy construction, frame-type plug-in units are ideal for applications that require high resistance to shock and vibrations. These effects should also be taken into account for certain installation locations such as close to rotating machines, in railway or traffic installations, and on ships or aircraft. In these cases, additional fixtures and safety measures may be required. If the installation site is in an earthquake zone, the systems – including the front panels, plug-in units, and frame-type plug-in units – must undergo the appropriate seismic tests prior to installation.

Another important aspect is the necessary insertion and withdrawal forces that have an impact on the front panels, plug-in units, and frame-type plug-in units. Appropriate connectors, which require different insertion and withdrawal forces, are used according to the bus system in use. The insertion and withdrawal of the assemblies are supported by various forms of handle, which can help to reduce the force required using the principle of leverage.

7. ELECTROMAGNETIC SHIELDING

Requirements concerning EMC shielding vary for different electronic devices depending on the field of application and the installation environment. Shielding is designed to cover electrostatic discharge issues and include low-frequency capacitive or inductive couplings and cable-related faults, as well as high-frequency electromagnetic interference. This is due to the increasing prevalence of microprocessors featuring high clock frequencies. The option to retrofit EMC protection is therefore always a good idea.

Front panels, plug-in units, and frame-type plug-in units

Busstandard	"Typ of the Connector"	Number of Pins	Strength	Picture of the Handle	Suggested Handle (PIU with Handle Typ)
VME	DIN connector conform to IEC 60603-2 (DIN 41612)	192	~ 180N		Static Handle or Handle Typ 2 (old or new Version)
VME64x	DIN connector conform to IEC 60603-2 (DIN 41612)	415	~ 420N		Typ IEL / IET
CompactPCI	Connector conform to IEC 61076-4-101 (Hard metric)	535	~ 610N		Typ IEL / IET
CompactPCI Serial (CPCI-S.0)	Connector conform to CPCI-S.0 (Airmax VS)	1,128	~ 550N		Typ IEL / IET
VXS	Connector conform to VITA 41 (Tyco MultiGig RT)	1,664	~ 1.250N		Typ IEL / IET or XL
VPX	Connector conform to VITA 46 (Tyco MultiGig RT)	1,664	~ 1.250N		Typ IEL / IET or XL

Fig 4: Selection criteria for suitable handle versions

To this end, front panels, plug-in units, and frame-type plug-in units are finished with a conductive surface (e.g., passivated) and linked conductively with one another by means of contact materials such as stainless-steel EMC spring or EMC textile gaskets (-40 to +85°C). Standardized EMC tests (VG95373 part 15) are used to establish whether the EMC shielding measures satisfy the requirements of a given application and to assure the reproducibility of this performance level.

The IEC 61587 environmental standard also defines tests for EMC behavior. Section 3 of IEC 61587 defines the test conditions for components with respect to their EMC shielding properties in the frequency range from 30 MHz to 2 GHz and the attenuation values required. In this respect, the standard is based primarily on IEC 60297 and IEC 60917.

The standard applies solely to the mechanical structure for the electronic devices and not to the electronic devices themselves. Other standards apply to the end products. In most cases, the required test procedures for these differ significantly from those described in the standards mentioned above. Such tests are normally performed by the manufacturer of the finished system or are contracted to independent outside testing agencies.



Fig 5: Aluminum U-profile front panel shielded with EMC textile gasket

Front panels, plug-in units, and frame-type plug-in units

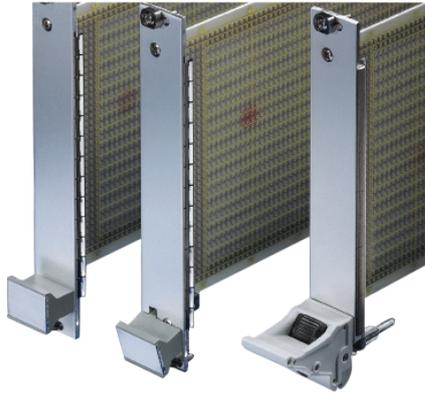


Fig 6: Plug-in unit shielded with EMC spring gasket

8. SUPPORT DURING PRODUCT SELECTION

In order to keep product selection or modification of an off-the-shelf product as easy as possible for designers and hardware developers, support services such as test reports, CAD drawings in various CAD formats (e.g., from www.traceparts.com), and digital user manuals should be provided free of charge by the manufacturer.

Quick and cost-effective modification and inscription services are particularly useful for front panels which are often modified during the final stage of product development. Standard blank panels are available in various sizes and versions as catalog items from a range of manufacturers. But few users today have the facilities necessary to efficiently carry out the machining and printing these panels require. Even for some front panel manufacturers, it can take weeks until the required measures are implemented at the production stage and the product arrives at the customer's facility. This may be acceptable for large production runs, which can be planned over a longer term. For prototypes, pre-production, or small production runs, however, it is often essential to carry out the machining in just a few days so that any corrections or modifications can be made quickly.

When selecting a product, it is worth finding out what services the supplier can offer to ensure that the front panels are machined and printed quickly to meet the end customer's specific needs. Some manufacturers offer a "front panel express" service, whereby these customized products can be ordered, even as a single piece, and can be delivered at a pre-arranged date.

9. INTEGRATING CABLING, CONNECTORS, PRINTED CIRCUIT BOARDS, AIR BAFFLES, AND SOLDER-SIDE COVERS

Customers are asking more frequently for front panels, plug-in units, and frame-type plug-in units that are integrated with additional components. This includes, for example, the combination of electro-mechanical and electronic components, such as the entire assembly of a plug-in unit. This means that front panels, which are often machined and printed to particular customer specifications, are immediately given the corresponding handles. Alternatively, microswitches – such as those used with CompactPCI boards – can be included with the handles. Board brackets are pre-assembled and a printed circuit board from the customer may also be installed. In order to provide better protection for the solder side of the printed circuit boards, elements such as printed board covers are used.

Stainless-steel or textile EMC gaskets can also be applied as per the customer's request. Frame-type plug-in units are also delivered pre-configured with various accessories or additional components, such as small, even non-standardized backplanes or cabling, if requested by the customer.

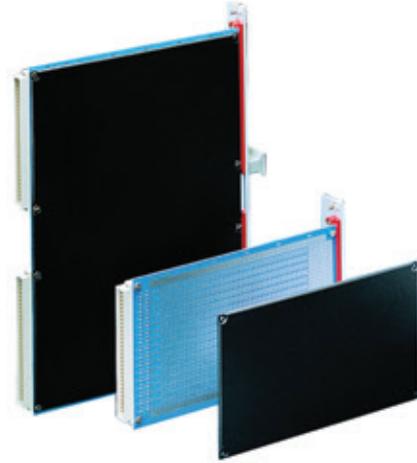


Fig 7: Printed board cover for mechanical solder side protection

In order to support and improve the system's heat dissipation capabilities, front panels or plug-in units can be pre-fitted with components called air baffles. These components serve to optimize air distribution in the subrack, case, or system. Air baffles are used to prevent so-called "air short-circuits". If this airflow is lacking, the air may flow through the areas in the board cage not equipped with components, rather than through the installed active boards. Air baffles seal these areas and ensure that the air flows through the active boards and cools them effectively.

10. EASE OF CONSTRUCTION



Fig 8: Plug-in unit/front panel with assembled air baffle

Ease of construction and assembly is also an important consideration when selecting front panels, plug-in units, or frame-type plug-in units. Normally these products can be supplied either in kits, i.e., as a parts kit, or fully assembled. When supplied as individual parts, the final product must be simple to assemble, without the need for costly special tools or large time investments because of instructions that are unclear or difficult to understand. It is desirable that the assembly of the entire mechanical structure of the front panel, plug-in unit, or frame-type plug-in unit be carried out using a basic single tool.

Front panels, plug-in units, and frame-type plug-in units

11. SUMMARY

There are many factors to take into consideration when selecting front panels, plug-in units, and frame-type plug-in units for a given application. The selection is made easier if you can draw from a broad product portfolio that can be modified to suit the requirements of the customer, the application, and the environmental conditions at the installation site. Additional services are just as important here as a flexible, off-the-shelf product. Even when it comes to supposedly "less important" components like front panels, the user should be aware that choosing sub-standard or incorrect components can cause the entire system to fail, or at least impair its functionality.

12. COMPANY PORTRAIT AND AUTHOR INFORMATION

ABOUT nVent

At nVent, we believe that safer systems ensure a more secure world. We connect and protect our customers with inventive electrical solutions. nVent is a \$2.1 billion global company that provides enclosures, electric heat tracing solutions, complete heat management systems, and electrical and fastening solutions. nVent employs 9,000 people worldwide.

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AUTHOR

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