Whitepaper:

Power Distribution Units

Power Distribution Units (or “PDU’s”) serve as the interface between facility (or locally generated) power and end-user equipment. Any combination of input/output power may come into play with PDU’s – AC in / AC out; AC in / DC out; DC in / AC out, etc.

Typical Features found in power distribution units include the following.

FACILITY (OR INPUT) POWER CONNECTION

The PDU provides a central connection point for system input power. On higher power PDU’s (for example, over 10kW) this can require special consideration to accommodate required input conductor size, insulation to support applied voltages, safety, ergonomic, and cost considerations. Close cooperation is required between the system and PDU design engineers to assure input power connections meet these requirements.

SYSTEM SAFETY MANAGEMENT

A critical factor in PDU's is the ability to support personnel and facility safety. International safety standards such as those shown in Figure 1 are often employed to assure system safety.

Standard ID	Description
UL508	Industrial Control Equipment
CSA 22.2 No 14-13	Industrial Control Equipment
EN 12100	Safety of Machinery- General Principles for Design. Risk Assessment and Risk Reduction
EN 60204-1	Safety of Machinery, Electrical Equipment for Industrial Machines
EN 13849-1	Safety of Machinery - Safety Related Parts of Control Systems
EN 62061	Safety of Machinery. Functional Safety of Safety-Related Electrical, Electronic, and Programmable Electronic Control Systems
IEC/UL/EN 60601-1	Medical electrical equipment – Part 1: General requirements for basic safety and essential performance
IEC/UL/EN 62368-1	The standard for audio/video, information, and communication technology equipment - Part 1: Safety requirements
IEC/UL/EN 61010-1	Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements

Figure 1 – Typical Safety Standards

Safety standards will stipulate input over-current protection requirements. Many times, the PDU must include an appropriately rated circuit breaker. These generally must meet the requirements of UL489 or IEC60947 and typically require a Molded Case Circuit Breaker ("MCCB") versus a Miniature Circuit Breaker ("MCB") approved

to UL1077. Depending on overall system safety management strategies, a lock-out/tag-out ("LOTO") provision may be required on the PDU's main circuit breaker. Consultation with the end system equipment design authority is recommended to verify any such requirements.

SYSTEM INTERLOCK INTERFACE

The PDU can function as part of a system or safety interlock process, where power delivery to connected equipment is coordinated with various distributed system controls and switches so the system can only function when everything is properly connected and functional. Interlocks can be used to assure proper system performance, providing sequencing of applied power and/or assuring power is not applied before connected equipment is ready for it. Likewise, interlocks can be coordinated with a central system start button on the PDU.

A special deployment of interlock circuitry is Emergency Machine Off ("EMO") control. This is used to disconnect power quickly and safely from the machine and arrest any moving parts in the event of an emergency. Depending on the safety standard being employed, and depending on the safety level required, EMO circuits can require a hard disconnect mechanism (generally an electro-magnetic contactor) which is fault-tolerant (i.e., loss of control signal opens the contacts).

Systems with the highest level of safety management (such as IEC

13849-1 Safety Category 4) will also provide means of monitoring the state of safety disconnect and prevent system startup if compromised.

SYSTEM ELECTROMAGNETIC COMPATIBILITY

The PDU may be utilized to assure system conducted electromagnetic compatibility ("EMC") for both emissions and susceptibility. This generally includes the integration of EMI filters which are specifically tailored to suppress noise generated by connected equipment. Likewise, surge suppression devices may be integrated to protect connected equipment from input power surges, such as those specified by IEC-61000.

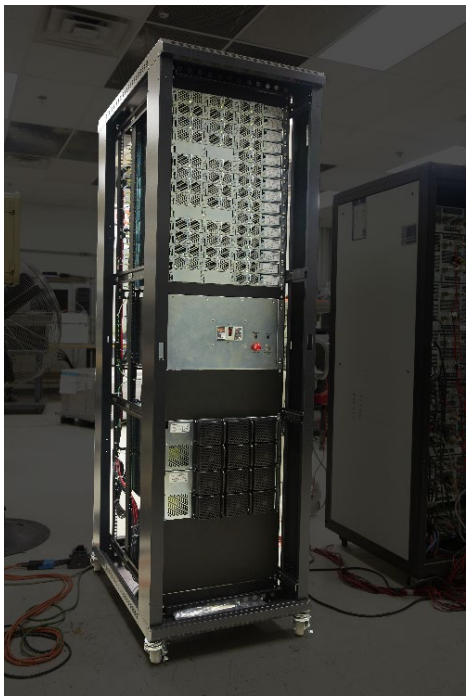
POWER DISTRIBUTION TO SYSTEM ELEMENTS

Fundamental to PDU functionality is distributing power to connected host system elements. The end system design authority generally sets these requirements, stipulating the number of connections, along with their power rating. Close collaboration between the PDU and end-system designers in thechoice of connectors for this equipment feeds must take into considerationmultiple factors, including component ratings, ergonomics, cost, etc.

BRANCH CIRCUIT OVERCURRENT PROTECTION

The ampacity of connected equipment must be properly protected. This is achieved either through circuit breakers, fuses, or electronic over-current protection devices. Depending on system architecture, LOTO provisions for certain outputs may be required. If the PDU's input circuit breaker meets the requirements of UL489 or IEC60947, downstream breakers may only need to meet UL1077 requirements,

where a miniature circuit breaker (MCB) is sufficient.



SYSTEM CONTROL BIAS

The PDU is often called for to provide DC bias voltage for connected system control functions. Usually, this voltage is 24VDC, although other voltages may be called for. Depending on host system design topology, a bias voltage may be made independent of system interlock and EMO functions.

SYSTEM MONITORING

PDU's are often called upon to provide monitoring of input and delivered power. The host system architecture will set these requirements, as well as the nature of the reporting signals (discrete, serial-digital, or visual). In addition to input power monitoring, delivered current and/or voltage of individual outputs may be required. Some applications require a rolling event history log to facilitate system maintenance and troubleshooting. Some common communication standards to follow include RS232/485, Ethernet, Ether CAT, Modbus, ProfNet, Can Bus, etc.

POWER CONVERSION ELEMENTS

The PDU may be required to provide power conversion elements, such as AC-DC, DC-DC, or DC-AC converters. They may also include AC-AC transformers forisolation, step-up, step-down, and/or power conditioning. Close consideration must be applied to the converter operating environment, as well as design for maintainability. Integration of these converters requires a high degree of collaboration between the converter and PDU designers. (The best case is where both these elements are produced by the same supplier.)

PDU QUALIFICATION ACTIVITIES

PDU's typically require certification to internationally recognized standards by a Nationally Recognized Test Lab ("NRTL"). Certification involves an exhaustive review of components and operating conditions. The PDU supplier must feature the required expertise to both design and qualify the product.

ISSUES WITH PDU DESIGN AND FULFILLMENT

Often the end equipment manufacture takes on the task of designing the PDU as part of the overall system design, and once the design is completed, the manufacture of the PDU is relegated to a 3rd party contract manufacturer. This process has shown itself to be prone to problems. The end equipment manufacturer may not have the required expertise to effectively design the PDU and get it through qualification.

More importantly, as previously mentioned PDU's often include power converters and other 3rd party equipment. If the PDU is manufactured by a contract

manufacturer and there are issues with these parts, assurance of ongoing product performance can be an issue. Identifying a single point of contact responsible for the resolution of performance, cost, or availability issues can be a challenge.

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