White Paper

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Intelligent Power Strips in IT

Applications with power strips equipped with sensors and switching elements in data centers and other IT infrastructures

PANDUIT™

Content

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Introduction

Anyone who plans the technical infrastructure of data centers, server rooms or IT floor distributors today will quickly come across different points of view regarding the energy supply of the active components.

While the management of building technology relies on tried and tested concepts for the distribution and control of energy supply, those responsible for the areas of data network technology, servers, storage and IT operations often want to collect a lot of detailed information about the individual components. Business goals are often the driving force here, such as increased efficiency, redundancy concepts, operational security or even predictive maintenance of components and the associated failure minimization.

For most companies, IT has long since emerged from being a cost center and represents a fundamentally important area of business that, in addition to its original function, can also help to manage buildings more intelligently, save costs and reduce business risks. Without functioning IT, no internal or external communication, no accounting, no logistics is possible today.

Controls and security technology can be set up much more efficiently and scalable using modern IP-based systems. Where conservative, decades-old and unmatched safety regulations unfortunately often make innovation difficult today, the possibilities of modern systems with regard to accuracy and avoidance of false alarms are almost unlimited.

When systems that will even be equipped with artificial intelligence soon, meet established industry standards from the “pre-internet era”, difficulties in implementing modern infrastructure designs are inevitable.

In this context, this white paper refers to intelligent power strips / PDUs (Power Distribution Units) that are equipped with sensors, displays, switching elements and / or network access and that provide the power connections for the most diverse components in the data network cabinets.

The additional functions provide users with a lot of data and – depending on the equipment – allow to monitor and control the energy supply of individual components or provide access to the racks.

The advantages of such intelligent PDUs in operation compared to the basic models are explained in detail below. The order of the names does not represent the significance of the respective function.

Types of intelligent PDUs

There are various categories of intelligent PDUs on the market, ranging from simple bars with only local display of consumption values and without a network connection to modular systems with various pluggable control and connection modules.

Based on many years of global experience and a wide variety of its own PDU systems in the past, Panduit has decided against the two extremes mentioned above for the fifth generation of PDUs (hence the product name "G5").

Panduit offers all intelligent PDUs – whether standard products or customized power strips – as fixed models with the same control module regardless of the respective function.

As an example, for most systems on the market, the G5 series also distinguishes the following 4 types of intelligent power strips:

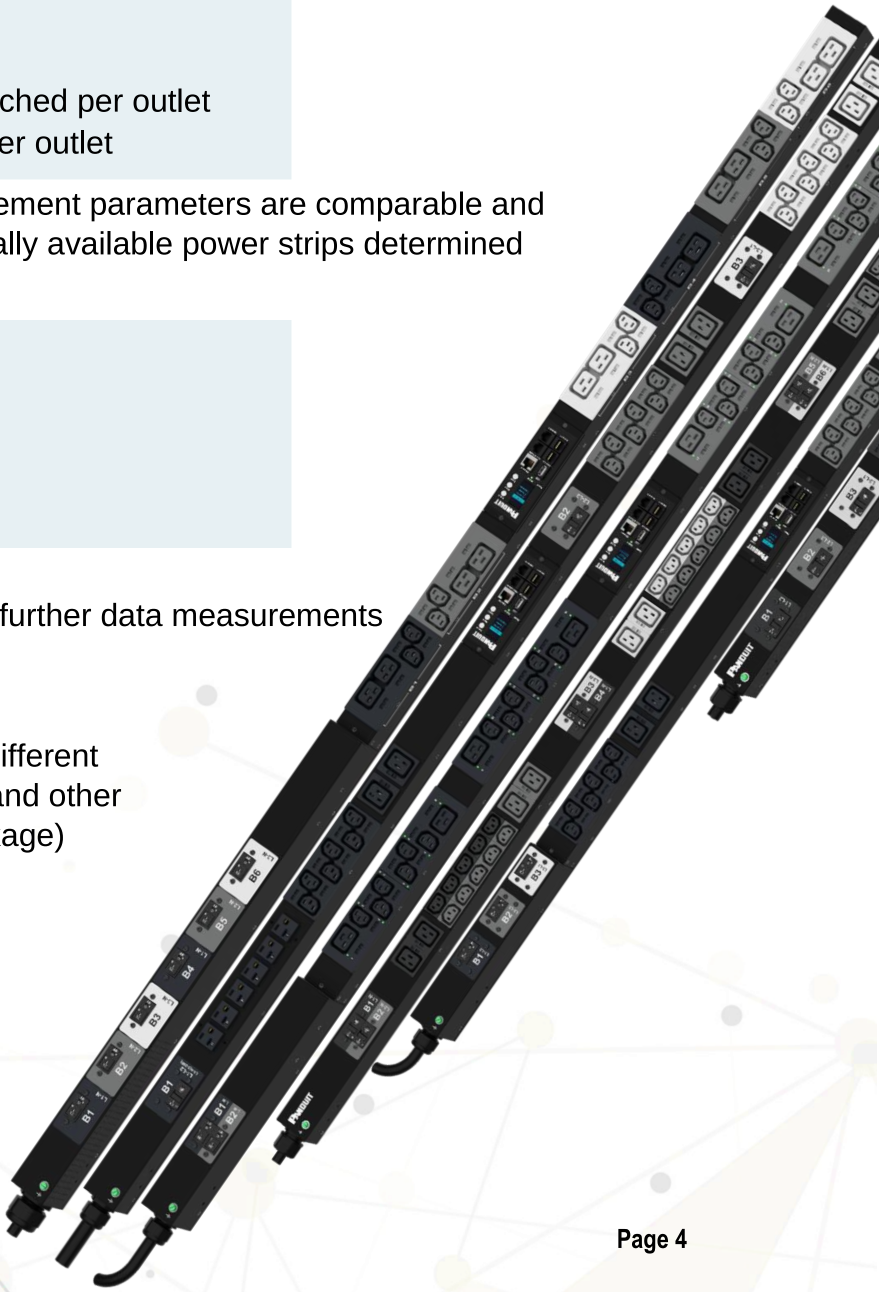
- Measurement per phase
- Measurement per outlet
- Measurement per phase, switched per outlet
- Measurement and switched per outlet

Like the types, the standard measurement parameters are comparable and are available in almost all commercially available power strips determined per phase or per outlet:

- Voltage (V)
- Current (A)
- Power Factor (λ or cosρ)
- Power (VA or W)
- Energy Consumption (kWh)

In addition, different models provide further data measurements and outputs.

Usually, sensors for environmental (for the G5 series these are mainly different temperature and humidity sensors) and other conditions (e.g. door opening or leakage) can be connected.



More efficient cooling and hotspot avoidance

In many server rooms and data centers, room air conditioning is controlled exclusively via sensors in the supply and exhaust air areas of the air conditioning units. Even advanced systems measure for the control either only at a few points within an enclosure or traditionally with individual sensors in the cold aisle at a height of 1.50m in the middle of the cold aisle (according to Telcordia NEBS GR-63-CORE).

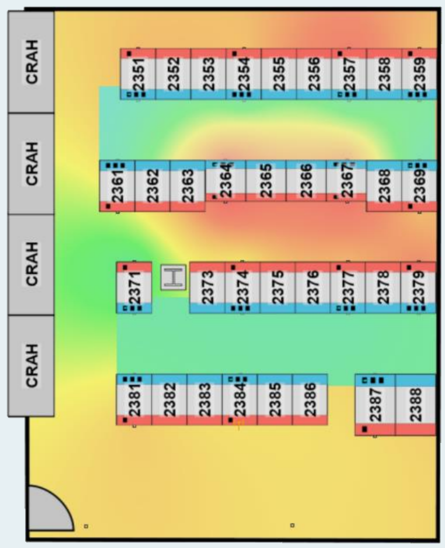
Today's high energy densities in cabinets are difficult to control and can lead to unexpected effects in the entire server room. Modern blade server systems already achieve double-digit kilowatt consumption. Some users fill the cabinets almost completely with 1U and 2U server systems due to space constraints and thus also receive very high selective energy densities, which should be closely monitored in order to be able to react in time to emerging problems

If uniform systems from one provider are used, the measurements from the respective components can be integrated and monitored relatively easily into higher-level management systems. In heterogeneous environments or model changes, however, this information quickly becomes inaccurate or is completely missing after software updates and changed access. Temperature sensors in active components rarely require high accuracy.

Here, the sensors that can be optionally used with intelligent PDUs offer a good alternative, which also meets the requirements of ASHRAE[1] for the positioning of measuring points and thereby more precisely maps the operating conditions.

The lifecycle of a power strip guarantees (with the usual rotation of active components within 3-5 years) with the usual 15-20 years of service life after the first installation, long-term reliable temperature and humidity monitoring in almost any granularity and with a high degree of accuracy
(+/- 1% deviation for Panduit G5).

Based on more precise measurements, critical areas for new installations can be avoided during planning or even these critical areas can be resolved as part of conversions.

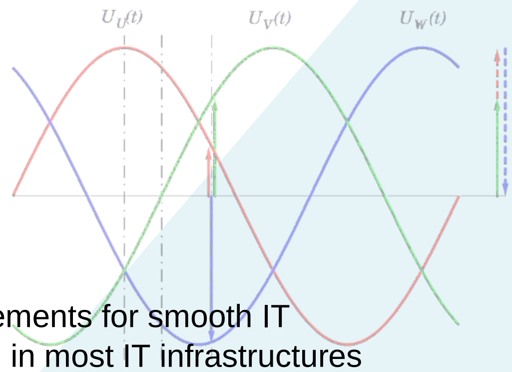


Example of a granular temperature measurement with clear recognizable temperature problems inside and outside the cold aisle containment due to missing seals, incorrect installations and narrow aisle widths.

[1] ASHRAE The American Society of Heating, Refrigerating and Air-Conditioning Engineers is the professional association of heating, cooling, ventilation, and air conditioning engineering professionals in the United States.

The integration of this permanently available measurement data in a higher-level management can - with a suitable design and in close coordination with the air conditioning technology - even enable a more efficient and precise control of the air conditioning technology by adjusting fan speeds and temperature setpoints.

Some providers of air conditioning technology in the IT sector already offer such sensor integrations and enable significant energy savings through this intelligent cold air distribution.



Flexible installation of devices with balanced phase loading

A high quality of the power grid is one of the basic requirements for smooth IT operation. Uninterruptible power supplies (UPS) are used in most IT infrastructures to compensate and filter external network disturbances. These UPS serve among other things also to compensate for voltage fluctuations and should ensure a stable energy supply for the active components.

Usually a 3-phase power grid is installed in buildings, ideally the individual phases should be equally loaded. This means the currents on the respective phases are balanced or have approximately the same amperage value

If this is not the case, voltage shifts occur in the system and compensating current flows on the neutral conductor, which in worse case can exceed the current on the actual main conductors due to the summation.

A maximum load variance of the phases of 15% is permitted.

In best case, deviations beyond this will lead to inefficient operation of the UPS. But they may even cause devices to be switched off or damaged.

In order to obtain a balanced phase load in normal operation, there are various strategies, which ultimately all depend on the installation of the devices depending on their electrical power and an even distribution over the individual phases.

When using single-phase strips (most common 2 strips per cabinet are then installed on different phases), in addition to the low power density per cabinet, there is also the challenge of balancing the load conditions across several cabinets with different configurations.

If technically feasible (and usually the preferred option due to the higher power density), the easiest way to adjust the phase load is to use 3-phase power strips directly in the data cabinet.

Since in this case an adjustment can be made per cabinet, the corresponding control of the overall system is much easier.

In any case, you need sensors that measure the current flow per phase. You cannot rely on the nameplate information and a purely theoretical calculation here - see also the corresponding section in this white paper.

As a minimum solution, a display of the phase load should therefore be integrated in a 3-phase PDU.

However, a local display of the current load is also recommended for the single-phase variant mentioned above.

In this way, possible errors in planning can be corrected before switching on a component.

Subsequent changes, with corresponding maintenance windows and failures, require significantly more planning effort or are sometimes associated with considerable business risks.

Remote transmission of the data and their integration into the central monitoring of the power supply will be also best practice.

Nameplate consumption vs. real power consumption

Planning the energy requirements of an IT infrastructure without knowledge of real consumption data is often associated with assumptions and high security factors, which are then clearly reflected in the investment costs. Even information from manufacturers about typical consumption, still contains high safety factors that want to take all eventualities into account.

In 2012, the German ECO Association published a white paper "Orientation aid for power density and load determination of servers, data cabinets and data centers", in which the deviations between the individual information and the reality across different manufacturers were listed in detail. The real consumption data were determined in real operation and taking temporary fluctuations into account.

As a result, it became clear that many power supplies were planned to be significantly oversized, if one relied on officially available information from the manufacturers.

Such detailed consumption data can only be efficiently determined with a per-outlet measurement on the corresponding PDUs. This means that - regardless of the size or other technical equipment of the data center - the reserves for additional installations down to the cabinet can be precisely determined and used.

This can save a considerable amount of investment in extensions or new buildings and also increases operational reliability.

Evaluation of historical data and predictive maintenance

Of course, you can see the current consumption - e.g. of a server - also traditionally with a clamp measurement around the power cable. However, there is often the difficulty that many devices are equipped with several power supplies and some distribute the load differently between the power supplies. You would then have to measure and add the power consumption in parallel with several clamps.

The decisive problem, however, is the energy consumption of the components, which varies over the operating period. Of course, clamp measurements can only deliver an instantaneous value.

Due to different business processes and the high level of virtualization of many systems, the energy consumption of individual components can fluctuate considerably - be it due to load balancing effects, invoice runs or other causes that occur during normal operation for a limited time.

The data provided by intelligent power strips is stored locally and / or centrally and can be used at any time for planning or research into the causes of failures. This results in optimization potential - especially in the area of predictive maintenance.

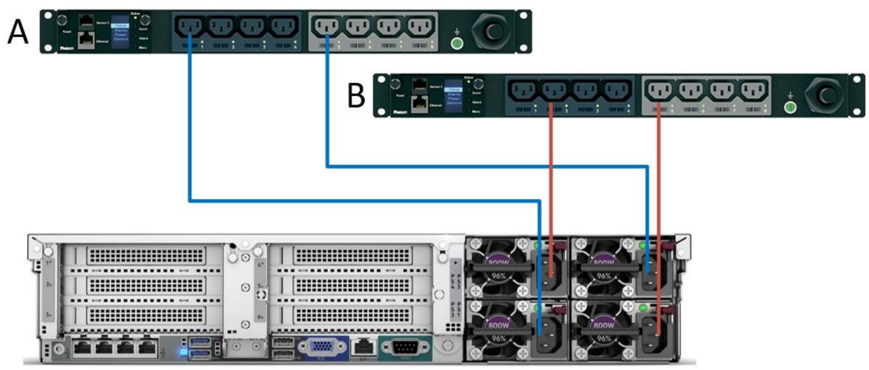
Possible risks are easier to identify and avoid with detailed analytics.

Even unusual behavior, for example excessive power consumption outside a known time window, can be detected and appropriate measures (e.g. replacing a fan) can be carried out proactively and before damage occurs (failure, fire, etc.).

Depending on the importance of the IT infrastructure and the amount of data generated, artificial intelligence will also help in the near future to analyze the existing information, create patterns for the individual components, compare them with current values and warn the operators or at least give recommendations for necessary adjustments or interventions.

Ensuring system redundancy

Working redundancy concepts are one of the most important and at the same time the most demanding plans for IT infrastructures. A phase or circuit failure should not result in a failure of the connected components. Components such as emergency power systems, battery buffers and the like must be designed so that failures are avoided or at least reduced in time. Seen top down, the power strips installed in the cabinets are an important part of such concepts, since even small locally restricted failures can cause cascade failures due to incorrect connections.



Professionally planned environments therefore rely on components with an N+1 power supply[2]. The devices are connected to different phases and power strips, which in turn are connected to different circuits.

In addition, it must then be constantly monitored that none of the PDUs is connected to more than 50% of the total load in order to be able to continue working with a maximum of 100% load in the event of a fault. Due to the temporarily fluctuating consumption, an overload situation can easily arise here, which in the event of a fault leads to a complete failure of the system.

Intelligent PDUs help to identify the current load situation and issue corresponding warnings or alarms when adjustable threshold values are reached, so that action can be taken in good time before a possible failure and the redundancy can be restored.

At the same time, the optical display on the PDU itself helps to identify excessive loads on a single power strip and to initiate appropriate remedial activities.

A measurement of the individual connected consumers is - compared to an overall measurement - more helpful, since the main cause of a redundancy violation is

[2] In this case, "N" defines the number of power supplies for the required nominal power of a component, N + 1 indicates that this nominal power is secured with at least one additional power supply and the failure of one power supply does not cause any malfunction or interruption.

specifically identified, and rescheduling can take place based on facts instead of assumptions.

Cold start of components in the "lights off" data center

Most configurations of active components can be changed, tested and finally brought into the operating state remotely. This is one of the reasons why companies with multiple IT locations generally do not have trained staff at each of these locations. This saves the company personnel, training and travel costs.

If necessary, additionally installed automated infrastructure management systems (AIM) can ensure that even connections to new or dismantled workplaces can be carried out by almost every employee on site, without the risk of incorrect operation.

However, when it comes to switching systems off and on again, experts are happy to rely on staff who can evaluate all the consequences of such a “cold start” and assess the risks for the business.

With strips that can be switched per port, such electrical switching operations can also be carried out remotely and without travel.

In order to prevent possible external influences in the age of growing cybercrime, one relies on an encrypted transmission of control traffic (e.g. https and SNMP V3) and on the security of the individual components with complex passwords, which must be set up when the PDU is started for the first time in order to replace the standard password of the manufacturer.

LDAP integration, Active Directory Support, TLS and implementable security certificates round off the protected access options to this sensitive area of the power strip

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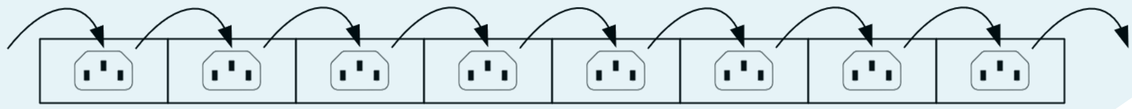
Controlled restart after a power failure

If there is a power failure despite all the precautions, switchable power strips per port offer further advantages. To avoid renewed failures due to high starting currents and the associated triggering of the circuit breakers, the individual ports can be switched on again sequentially.



The sequence duration can be configured for the switched Panduit G5 PDUs per port.

Likewise, it can be decided here for each port which state each individual socket assumes after a power failure. The default setting is the same state as before the failure, but it is also possible to switch on individual connections directly or after a delay or to keep them switched off.

Residual current monitoring

Statutory operating regulations require regular checking of the electrical protective devices of portable devices. Power strips with an IEC connector that are not permanently connected are covered by this regulation.

However, since a check of the protective conductor and insulation resistance of a socket, as well as the proof of the safe separation of live parts from touchable parts, cannot be carried out during operation, regular decommissioning of the power strip would be necessary - a condition that IT is happy to avoid.

However, the necessary personal safety can be ensured in accordance with the regulations with continuous residual currents monitoring (RCM) and clear processes to identify, isolate and repair a faulty device.

What is important here is an AC / DC sensitive monitoring system, which not only detects the AC current with different frequencies, but also any DC components. Modern RCM type B sensors are used for this.

Whether this monitoring is carried out on the power strip itself, centrally in the power panel or on the power bus bar in relation to the individual supply line to the PDU, it does not make any functional difference. When reaching previously set thresholds, an alarm must be issued, which then triggers precisely defined customer-specific processes to identify the corresponding cabinet, isolate and eliminate the error.

The level of the limit value must be adapted to the installed devices. Electronic switching power supplies, such as those installed in servers and other IT components, usually generate a low fault current. If these fault currents add up e.g. in fully equipped cabinets, a false alarm would be triggered permanently without adaptation, since the total current is above the limit value dangerous for humans.

This adjustment must be carried out in the protective device. If the RCM sensor is installed in the PDU, the limit values must be adjusted accordingly. This can usually be done more easily with central monitoring. But it depends essentially on the overall concept of the user.

Billing consumption data

The measuring sensors of intelligent power strips are usually not officially calibrated and are therefore not approved for legally binding bills in many countries.

However, due to its low measurement tolerance, the device-related consumption determination associated with port-by-port measurement offers users an inexpensive way of fairly allocating the costs of the IT infrastructure to the various departments and cost centers in the company.

Access control and security aspects

The server rooms are usually located in the inner protection zone of a data center and can only be entered after a controlled passage through the outer zones. Unauthorized access is not possible with standard-compliant perimeter structures.

Nevertheless, there is a requirement in areas with particularly sensitive data to additionally restrict and control access to individual cabinets or rows of cabinets.

But also, in floor TK distribution rooms, additional access control to the rack itself offers good protection against accidental or intentionally unauthorized access to the IT components.

In addition to their actual function, intelligent power strips can also offer additional functions such as the integration of electronic locks, card readers, pin pads and even biometric authentication processes.

For some time now, many companies have been subject to strict official regulations regarding the complete logging of all activities on the IT systems.

Here, the integration of messages from magnetic or electromechanical door sensors about the exact time when doors or side walls of a data cabinet are opened offers a good opportunity for documentation.

At the same time, local access rights can only be granted to dedicated employees in connection with work orders or cabinets can be opened remotely from the security center.

Since control of the switched power supply of lighting is usually carried out via the door opening, this is an additional benefit for simplified work in the cabinet.

Conclusion

Intelligent PDUs simplify work processes compared to traditionally only centrally monitored power supplies, significantly increase operational safety and efficiency and offer users in building technology and IT a valuable additional benefit with relatively little effort.

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