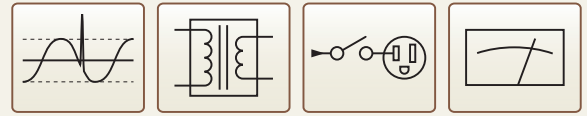## Pillars of Power Management
Conditioning • Conversion • Control • Monitoring

For over 30 years, Marway has specialized in purpose-built power distribution solutions for applications up to approximately 60 kVA. In addition to our core distribution features, we integrate power conditioning, conversion, control, and monitoring capabilities to optimize space and weight for today's electronics-intensive platforms. This has enabled Marway to deliver value-added solutions for our customer's unique military, defense, aerospace, and commercial applications.

Seeing is Believing

For many power distribution applications, the display and monitoring of power quality and status provides confidence that downstream equipment is getting what it needs. This could be a simple indicator lamp showing the PDU is powered on, or it may involve an array of digital meters to display specific parameters of multiple circuits.
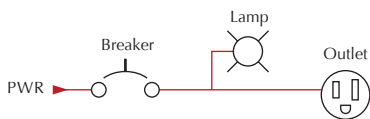
Power monitoring capabilities allow tracking of power quality, available capacity, and simple on/off status of circuits or outlets. Additionally, displays can be used for manual observation or integrated into an overall automated measurement and response system. With some equipment designs, the PDU is not visible to the user, so a method of remotely monitoring this information can be implemented. Since the PDU is a natural focal point of power management, it is the most logical place to integrate some kind of monitoring, and Marway can tailor design to utilize a variety of capabilities.

Common Measurements

The following measurements types tend to fulfill the majority of monitoring applications.
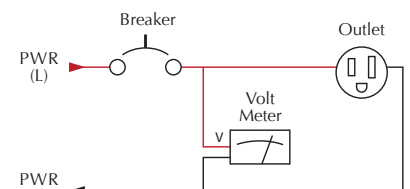
On/Off status can be used to monitor whether a power source is enabled, an outlet is powered or not, or the active choice status of an A/B switch selection. Typically there are only two values, though multiple choices are possible.

Time can be used to measure the cumulative time that the

On/Off status of a breaker, switch, or outlet is typically provided by a simple indicator lamp.

entire PDU or individual circuits have been powered. This is often used to coordinate maintenance scheduling of equipment connected to the PDU.
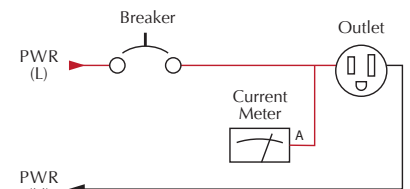
Voltage at a power outlet, or more commonly, the incoming power source can be measured to ensure facility power is meeting the requirement of downstream equipment.

Current can be measured at one or more points within the system to reveal the total load at the power input, on a branch circuit, or even at an individual outlet. Measuring capacity usage can be useful where downstream loads may vary, and drawing too much current will trip a circuit breaker.

Power is derived from a combination of voltage and current measurements from the same point at the same time. Calculated measurements can include watts, volt-amperes, power factor, and crest factor. *Energy* factors in time for values such as kilowatt-hours. All of these values are useful for analyzing consumption and efficiency.
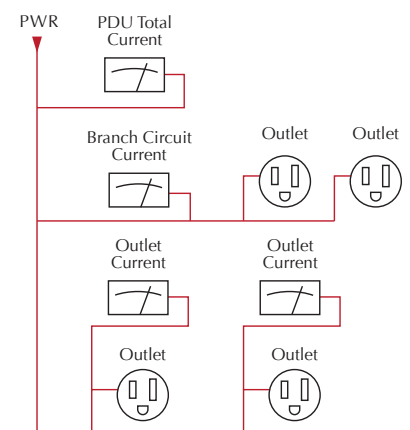

Voltage meters must be connected to two power lines such as the line and neutral of single phase power. Since voltage remains fairly constant anywhere in a circuit, the connection point isn't critical (though before or after a switch may be important).
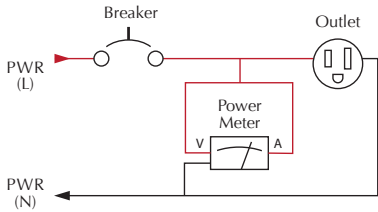

Current meters are connected to a single power line. The connection point is critical as it will reflect the total load downstream. Below, meter location shows how total PDU load, circuit load, or individual outlet loads can be measured.

Power meters require that the voltage and current measurement come from the same point. This allows calculations of watts and other useful values.

Power quality is a developing area of power measurement where some differences in formulas and calculations may still exist among device manufacturers. Generally speaking, power quality is represented by a number of measured and calculated parameters such as flicker, dips, swells, transients, and harmonics among others. These values can be used to define the quality of the power being provided by the facility power source. A power quality meter can be integrated into a PDU, but such equipment is typically a separate device which is temporarily installed for troubleshooting purposes.

Monitoring Methods

It is worth clarifying at this point that the term monitoring is used in many ways. It is often used to describe the combination of both measurement and display, but can also be used to mean just one or the other. For example, measuring voltage and sending the measurement signal into a device without displaying a value is "monitoring" the voltage. This document uses the term in all of its interpretations, and will attempt to be clear when the discussion is specific to measurement or display.

Remote Monitoring Signals

In addition to the panel displays which can be mounted on local or remote panels, it is possible to convey measurements to separately housed monitoring equipment with a variety of remote signals. These are very similar to the signals described in the *Power Control* document. The difference is the intent. Where a control signal is used to send a command, a monitoring signal is used to indicate a data value. The signal itself may technically be identical in both cases.

A *dry contact* is the simplest form of remote monitoring interface. A contact closure on a switch or relay is used to signal an on/off or other A/B selection condition. This signal would typically be used with an external control system.

A *discrete signal* involves sending a fixed voltage or current signal which has only two states, such as 0 Vdc vs. 5 Vdc or 0 mA vs. 20 mA, from the remote panel to the PDU. The signal is received by a digital control circuit or the coil of a relay of an external control system. The design requirements of the sender and receiver must be understood to ensure the signal is compatible with both.

An *analog signal* is a variable voltage or current, typically 0–10 Vdc or 4–20 mA, used to represent a data value such as

line voltage, main input current, or chassis temperature. The signal is wired directly to a panel meter for display, or several of them may be wired to a digital controller to display multiple measurements on a single display.

A *communications interface* provides a means to transmit multiple measurements using digital controllers. Multiple sensors will be wired into a local controller in the PDU. One or more remote stations will house their own controller. Measurements at the PDU are converted into pre-defined "messages" and sent to remote controllers following a standardized protocol such as RS-232, Modbus, HTTP, SNMP, or others. This form of remote communications offers the richest flexibility of monitoring, but may require the most engineering resources to implement.

Panel Display Options

Panel displays are any indicating device mounted to a PDU's chassis, or to a separate remote panel. The images on the right correspond to the following descriptions.

Indicator lamps are the simplest form of display (unless you count visually noticing the position of a toggle switch). They can be used to indicate the presence of power, the selection status of a switch, or the open/closed status of an interlock.

A *digital meter* provides an alpha-numeric display of a single measured value, though usually only numeric for PDU applications. The sensor is connected directly to the meter for a real-time display of the measurement.

An *analog meter* uses a movable needle in front of a printed numeric scale to indicate the measured value. Like a digital meter, the sensor is wired directly to the meter.

A *digital interface* or *multifunction meter* provides for the display of multiple values in one device. Buttons allow the user to choose which value to display. Multiple general purpose devices might be used to cover all possible values, or a single custom device might be used. In either case, these displays are used where there is insufficient panel space for individual displays.
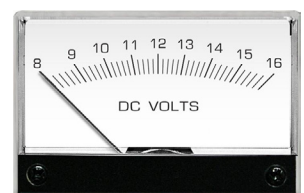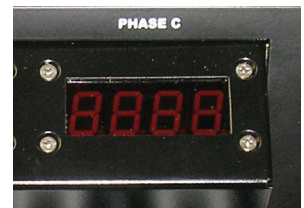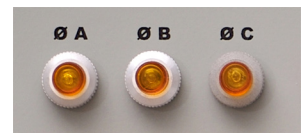

From top to bottom: indicator lamps, a digital meter, an analog meter, and a multifunction meter.

Setpoints and Alerts

Additional important capabilities in monitoring include setpoints and alerts. These features expand on the mere display of data measurements by providing automated responses when conditions are outside desired parameters.

A setpoint is an adjustable value which when exceeded will change the state of an alarm signal. For example, if a maximum main input current is rated for 30 A, a setpoint may be set for 27 A. A panel meter might contain a dry contact which would normally be open (no contact) when the measured current is below 27 A. If the measured value exceeds 27 A, the dry-contact is closed, and the PDU could route a signal through that contact to power either an indicator lamp, or even trigger an alarm speaker to alert a nearby operator. In

High Critical
High Warning
Measured Value
Low Warning
Low Critical
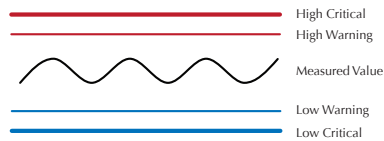
Some meters and controllers will provide up to four values to allow for warnings before critical conditions are detected.

equipment with advanced digital controllers, setpoints can even be configured to send SMS or email messages as alerts. Setpoints are often used to monitor the high and low limits of an operating range of volts and amperes, though other parameters are also possible.

Advantages to Power Monitoring Integration in Marway PDUs

Ultimately, a reduction in packaging complexity and component redundancy is the root of the following advantages found in the integration of power monitoring features into a PDU:

- reduced space,
- reduced weight,
- reduced cost,
- improved cable management, and
- added convenience.

When creating an integrated solution, Marway can address the unique needs of an application, and optimize the selection of components for power capacity and packaging efficiency.

Marway has specialized in the single-chassis integration of these capabilities to reduce space, weight, and costs, and to improve monitoring capabilities compared to separately housed third-party components. We believe that ultimately it's the combination of power performance, packaging efficiency, and product quality which keeps our customers coming to Marway to meet their power distribution needs.

Measurement	Marway Local Capabilities	Marway Remote Capabilities
power on/off	Indicator lamp	dry contact
selector switch position	• power on/off	discrete signal
volts	• switch positions	analog signal
amperes	analog meter	communications interface
watts	• volts, amperes, time, temperature	
power factor	digital meter	
crest factor	• volts, amperes, time, temperature	
time	multi-function meter	
temperature	• volts, amperes	
	• hertz, watts,	
	• voltamperes, power factor	