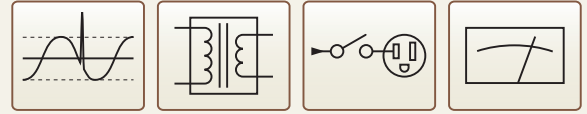


Pillars of Power Management

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.

Electronics Need Clean Power

Modern electronic equipment such as computers, communications hardware, security systems, data acquisition systems, and others require clean, stable power free of noise in order to perform their functions optimally and reliably.

A clean ac signal has a perfectly smooth sine wave when viewed on an oscilloscope. Any imperfections in this signal can adversely affect electrical equipment causing poor performance, incorrect functionality, or even damage. Most electronic equipment will have some minor power conditioning capabilities built in, but there's a basic assumption that incoming power is pretty close to a perfectly clean signal.

However, mobile power sources, and power utilities in some developing nations, will not deliver clean signals. Even the clean power supplied by a developed nation power utility will become degraded within a facility. This degradation is caused by the very devices using the power such as:

- air conditioners and compressors,
- electric heating equipment,
- motor-driven industrial machinery,
- elevators, conveyors,
- computers, printers, copy machines, and
- ballasts for fluorescent lights.

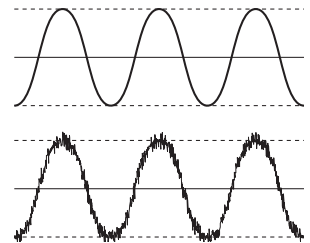
Since signal problems are introduced to power lines throughout a facility's wiring, it is beneficial to add power conditioning at points throughout the facility. An effective place to do this is at power distribution points near the end use equipment with Marway's power distribution units (PDUs).

Signal Conditioning Challenges

There are several problems which can affect a voltage signal. The most severe is a complete loss of power for short- or long-term durations. Similarly, significant periods of excessively low

or high voltage is also a problem. Solutions to these problems are generally too large or specialized to integrate within a near-point-of-use PDU, and are best applied as external complements.

Most other conditioning problems involve various forms of high voltage surges (a.k.a. "spikes") and electromagnetic interference (EMI), also known as electrical noise, or just "noise." The solutions to minimizing these signal problems are well suited to integration within a Marway PDU, and are the focus of the rest of this document.

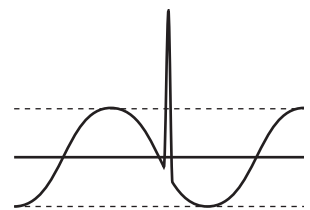


Signal conditioning of ac power seeks to ensure as close to a perfect sine wave in the voltage signal as possible. The upper waveform has no noise, where the lower one is quite noisy.

Voltage Spikes

Spikes are very short increases in voltage, and commonly come from power switching equipment like circuit breakers, contactors, and other causes. Less common sources include short circuits, static electricity, lightning, and even large electromagnetic fields. While spikes are short, the increased voltage for even that short time may be enough to damage microelectronic components or cause malfunctions.

Counteracting voltage spikes is done with surge protection devices ("SPDs," a.k.a. surge suppressors). These devices typically divert excess voltage from the power line being protected straight to ground, though there are other techniques. There are a variety of technologies to choose from, each with advantages for particular power environments.



A voltage spike may have a very high voltage value, up to several thousand volts, but the duration is on the order of microseconds.

Pillars of Power Management: Conditioning

Electromagnetic Interference (EMI)

EMI is a broad term covering multiple causes where the net effect is that electromagnetic waves of a wide spectrum of frequencies cause interference with the power signal. This interference, or noise, on an ac power line is any deviation in the signal from the desired perfect sine wave form.

Types of EMI Noise

EMI can be classified in several ways. One way is to identify how interference gets into the power lines which includes conduction, capacitive coupling, and induction.

Another way is to address the frequencies being added to the signal. RFI, or radio frequency interference, is a name to identify a subset of frequencies common to communications and other equipment.

A third distinction is identifying common mode and differential mode noise. Common mode noise manifests identically on multiple power conductors where the noise signal flows in the same direction, in phase, and typical returns through ground. Differential mode noise occurs when the noise on each power line is not identical. Here, the noise signal flows through one power line and returns through another.

The primary defense for reducing induced noise is shielding. This is commonly, but not exclusively, done to mitigate RFI. Cables and components are encased in metal, and may require additional RFI gaskets with significant design detail to eliminate all air gaps.

The remaining noise types can be reduced through EMI filters and isolation transformers. Filters use a combination of capacitors and inductors to block or

divert frequencies outside the 50 or 60 Hz of the power signal. Isolation transformers provide good reduction of common mode noise, and allow an isolated ground which can offer significant benefits in noise reduction on downstream power lines connected to the PDU.

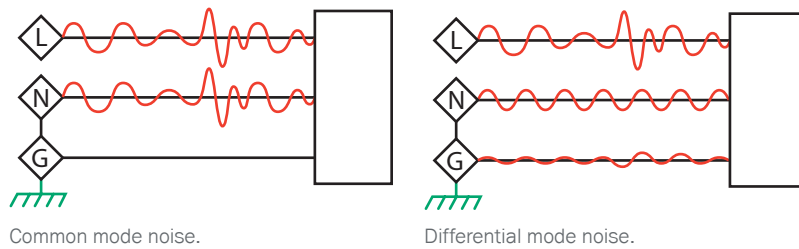
Power Conditioning integration in Marway PDUs

Surge protection devices, EMI filters, isolation transformers, and shielding are power conditioning strategies well suited to integration within Marway's PDUs. Adding these capabilities helps isolate sensitive equipment connected downstream of the PDU from the noise created by upstream power consumers.

When creating an integrated solution, Marway can address the unique needs of an application. We can identify appropriately sized surge suppression devices. We can select EMI filters to address application-specific or general purpose frequency bands of common mode and differential mode noise. We can specify unique details to control the performance of isolation transformers. Finally, we can optimize the selection of these elements 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 power performance 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.



Noise Problem	Countermeasure	Marway Capabilities	Optional Standards
voltage spikes	surge protection device	metal oxide varistor, gas discharge tube	UL 1449
radiated EMI	shielding	shielded cabling, shielded chassis, internal shielding between input and output circuits	MIL STD 461 and 464, EN 61000
conducted EMI	EMI filter(s)	common, differential, and mixed-mode filters, standard and specialty frequency coverage	MIL STD 461, EN 61000
poor grounding, poor load regulation, some conducted EMI	transformer	basic or shielded, optional separately derived ground, optional custom taps for non-standard voltages, options to improve load regulation	UL 1012, UL 60950-1