BLACK BOX
NETWORK SERVICES

Industrial Power Solutions

Understanding Power Needs for Industrial Control Devices

Because industrial environments are tough environments.

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Introduction

Industrial control is a designation for the devices that interface with machinery such as welders, mixers, generators, lathes, and packaging machines. Unlike most of the information technology (IT) arena, which focuses on machine-to-human interfaces, industrial control focuses on machine-to-machine interfaces of the type found in factories, building-control systems, mines, and other highly-mechanized environments. Typical of industrial-control machinery is the programmable logic controller (PLC), a computer used for the automation of a wide range of mechanical processes from the machinery on factory assembly lines, to HVAC systems, to theme-park rides.

Industrial environments are far more unregulated than typical offices and data centers and pose challenges of their own—challenges such as extreme temperatures, unusual power inputs, electromagnetic interference, dirt, moisture, and just plain wear and tear. Powering an average network device can be as simple as plugging it into the nearest wall socket; powering industrial control devices is more involved and requires that you match a power supply to both the device and to the environment it will operate in.

The challenge of industrial environments

Industrial controls face much harsher conditions than are found in typical office environments. Industrial environments not only often have extremes of temperatures, humidity, dirt, and corrosive materials, but may also contain devices such as motors and mechanical switches, which cause a large amount of electromagnetic interference (EMI).

Environmental extremes

Home and office electronics operate in nice climate-controlled environments, but industrial devices are often subject to temperature extremes. Many industrial devices are installed outdoors in unventilated sealed enclosures, which freeze in the winter and heat to extremely high temperatures in the summer—think of a car's interior after it's been sitting in the sun on a hot day.

Industrial devices are also often subject to dirt, dust, oil, salt spray, and chemicals when they're installed outdoors or indoors in an environment such as a factory floor.

Moisture in all forms is the enemy of electronic components, and industrial devices are often subject to water in all its forms from high humidity and condensation to drips and splashes.

Power problems

Domestic power in North America is, for the most part, stable, 120 V, single-phase, AC current, but industrial power isn't quite so predictable.

The power supplied to industrial sites can vary tremendously. AC power varies anywhere from 60 VAC to 960 VAC, and often only DC power is supplied, with 24 VDC or -48 VDC being common.

Industrial power may also be three-phase power. Most domestic power supplied to homes and offices is single-phase power in which the wire carries only one alternating current; three-phase power has three alternating currents on the same wire, each of which reaches the peak value of its cycle at different times. Three-phase power is used for power transmission across power grids and is favored for large motors and heavy loads at industrial sites.

Industrial power is also frequently "dirty" power, subject to noise, voltage fluctuation, and spikes. This inconsistent power is hard on the electronic components in industrial control devices and can cause equipment damage or data loss.

Industrial power supplies

Because conditions in industrial environments are so extreme, industrial devices are built to be far more robust than their domestic counterparts.

Power supplies for industrial controls, too, must adapt to these harsh environments and this tends to make powering industrial control devices more complex than powering network devices intended for home, office, and data center use.

Because of this variability, industrial control devices are either sold entirely separately from their power supply or are available with a choice of power supplies. Unlike ordinary networking devices, industrial controls require you to choose the correct power supply for both device and application.

Power variations

Industrial power supplies must be matched to both the type of power input they'll be receiving from the power grid and the power output they'll be expected to provide to the industrial control device.

Although power input is often ordinary 115 VAC North American domestic power, industrial power supplies may be expected to accept AC power that ranges anywhere from 60 VAC to 960 VAC and may be single-phase or three-phase. DC power may also be available. Typical supplied DC power inputs include 110 VDC, 220 VDC, 24 VDC, and 48 VDC.

Many industrial power supplies offer a universal input that will accept power across a wide range, typically 85–264 VAC and 120–370 VDC. This not only makes them adaptable to many different power sources, but provides them with the resilience to withstand large fluctuations in power input while still providing stable, reliable power output.

On the output side, industrial power generally supplies 12 VDC, 24 VDC, or 49 VDC power to the device side. Most industrial control devices in North America and Europe take 24 VDC power.

Industrial power supplies typically have screw or spring-clamp terminal blocks for power connections.

Standing up to the environment

Industrial power supplies are expected to perform over a wide temperature range. Typically they're rated so you can select one appropriate to your environment. Temperature tolerances from -25° to +60° C (-13° to 140° F) are standard and it's not uncommon to find power supplies rated for a temperature range as extreme as -40° to +85° C (-40° to +185° F).

Because industrial power supplies are sealed against contaminants and also because they're often installed inside enclosures, they rely on air convection rather than fans for cooling.

Industrial power supplies installed in extremely damp or dirty environments should have a conformal coating—a protective coating that protects circuitry from humidity, moisture, dust, and corrosion. Conformal coatings extend the working life of electronics and improve reliability. This coating can be acrylic, silicone, lacquer, plastic polymer, or another material. Some manufacturers offer conformal coating specially designed for extreme environments such as salt spray or corrosive chemicals.

Another way to protect industrial devices from their environment is with a protective enclosure designed to protect against contaminants such as dust and moisture. These enclosures are usually NEMA rated to describe the amount of protection they provide.

There are many numerical NEMA designations, but the most relevant ones are NEMA 3, NEMA 3R, NEMA 4, NEMA 4X, and NEMA 12.

NEMA 3 enclosures, designed for both indoor and outdoor use, provide protection against falling dirt, windblown dust, rain, sleet, and snow, as well as ice formation.

The NEMA 3R rating is identical to NEMA 3 except that it doesn't specify protection against windblown dust.

An example of a protective enclosure: Black Box NEMA 4X Equipment Cabinet (RM900A).

NEMA 4 and 4X enclosures, also designed for indoor and outdoor use, protect against windblown dust and rain, splashing and hose-directed water, and ice formation. NEMA 4X goes further than NEMA 4, specifying that the enclosure will also protect against corrosion caused by the elements.

NEMA 12 enclosures are constructed for indoor use only and are designed to provide protection against falling dirt, circulating dust, lint, and fibers, and dripping or splashing noncorrosive liquids. Protection against oil and coolant seepage is also a prerequisite for NEMA 12 designation.

Mounting

Industrial power supplies are generally mounted for stability. There are two primary ways that power supplies are mounted in industrial applications: panel mount and DIN-rail mount.

Panel mount simply means the power supply is bolted to a flat surface—often on a panel at the back of an enclosed cabinet. This method is still widely used, but is best for permanent installations, because it takes time and tools to change.

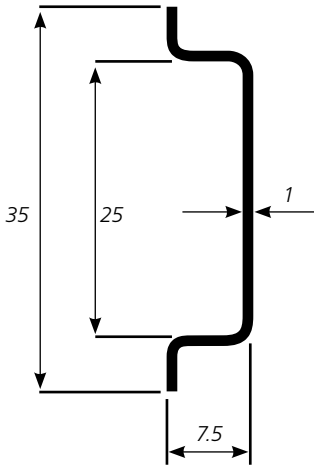
An example of a panel-mount industrial device with its power supply: Black Box Hardened Ethernet Switch (LB9901A).

The standardization and ease-of-use provided by DIN rail has led to the widespread use of the DIN-rail mount power supply. This is by far the most common power supply you'll encounter in an industrial setting.

An example of a DIN-rail mount power supply: Black Box 24-VDC DIN Mount Power Supply (PSD012).

A metal rail called DIN rail is a standard mounting method for many industrial devices including switches, serial servers, power supplies, terminal blocks, and circuit breakers. DIN is an acronym for Deutsches Institut für Normung, a German member of the International Standards Organization (ISO). Other common standards developed by this organization are the DIN connector and mini-DIN connector.

DIN rail is sometimes also known as a "top hat" rail because it has a vaguely hat-shaped cross section. Most DIN rail is 35-mm wide, but 15-mm and 7.5-mm rail, and G-type rail also exists. When DIN rail is referred to, the 35-mm size is generally assumed unless another size is specified.



DIN rail cross section.

DIN-rail mount power supplies have an advantage in that they can be easily detached for servicing or replacement. They snap right onto the rails, sometimes requiring a set screw, and are then ready to be wired and put into service.

Black Box Industrial Multipower Media Converters (LIC023) shown mounted on DIN rail.

DIN rails are widely used for industrial applications, but are also readily adaptable to other applications. DIN rail can be used in a standard rack, on a wall, on a control panel, or anywhere a stable mounting platform is needed.

The PoE option

Ethernet technology is coming to the factory floor. Once limited to office environments, Ethernet has proven to be a robust alternative to the RS-232 interface traditionally used with industrial devices such as programmable logic controllers. Ethernet brings speed, versatility, and cost savings to industrial environments. Industrial Ethernet adapts ordinary, off-the-shelf IEEE 802.3 Ethernet communication chips and physical media to industrial applications—it's the same as any other Ethernet except it communicates with industrial devices and uses robust equipment and cabling that can stand up to industrial environments.

One Ethernet standard in particular, Power over Ethernet (PoE), is particularly well suited to industrial environments because it eliminates the need for separate power supplies for industrial control devices by transmitting data and power to low-wattage Ethernet devices over standard UTP cable.

Power over Ethernet (PoE) was ratified by the Institute of Electrical and Electronic Engineers (IEEE) in June 2000 as the 802.3af-2003 standard. It defines the specifications for low-level power delivery—roughly 13 watts at 48 VDC—over twisted-pair Ethernet cable to PoE-enabled devices.

The way PoE works is simple. Ethernet cable that meets CAT5 (or better) standards consists of four twisted pairs of cable, and PoE sends power over these pairs to PoE-enabled devices. In one method, two wire pairs are used to transmit data, and the remaining two pairs are used for power. In the other method, power and data are sent over the same pair.

Example of a PoE device: Black Box 4-Port Power over Ethernet Switch (LP004A).

When the same pair is used for both power and data, the power and data transmissions don't interfere with each other. Because electricity and data function at opposite ends of the frequency spectrum, they can travel over the same cable. Electricity has a low frequency of 60 Hz or less, and data transmissions have frequencies that can range from 10 million to 100 million Hz.

There are two types of devices involved in PoE configurations: Power Sourcing Equipment (PSE) and Powered Devices (PD).

PSEs, which include end-span and mid-span devices, provide power to PDs over the Ethernet cable. An end-span device is often a PoE-enabled network switch that's designed to supply power directly to the cable from each port. The setup would look something like this:

End-span device → Ethernet with power

A mid-span device is inserted between a non-PoE device and the network, and it supplies power from that juncture. Here is a rough schematic of that setup:

Non-PoE switch → Ethernet without PoE → Mid-span device → Ethernet with power

Power injectors, a third type of PSE, supply power to a specific point on the network while the other network segments remain without power.

PDs are pieces of equipment like surveillance cameras, sensors, wireless access points, and any other devices that operate on PoE.

PoE can save money by eliminating the need to run electrical wiring. It also has the advantage of needing fewer components within the industrial area—for instance, instead of needing to mount a switch and a separate power supply, PoE enables you to have only the switch.

Summary

When selecting a power supply for an industrial control device, take into account the following factors:

- The kind of power supplied to the industrial site: Is it AC or DC? What is the voltage.
- Power required by the industrial control device: What kind of power does the device need from its power supply? 24 VDC is becoming standard, but 12 VDC is still very common, and you may run into other variants such as 5 VDC.
- Ambient temperature range at the industrial site: Take into consideration that enclosed NEMA cabinets installed outdoors can get extremely hot. Choose a power supply rated for the most extreme temperature its likely to encounter.
- Presence of high humidity, liquid water, dirt, and corrosive materials: look for sealed power supplies with conformal coating. Install within a NEMA rated cabinet if possible.
- Desired mounting method: panel mount or DIN rail mount. Look to make sure that the power supply you select is configured for your preferred mounting method.
- If you're using industrial Ethernet, you may want to choose PoE devices rather than have a separate power supply for each device.

Supplying power to an industrial control device is a bit more involved than powering average office equipment, but by paying attention to a few simple factors, you can supply appropriate power from a power supply that can withstand its environment.

About Black Box

Black Box Network Services is a leading industrial and networking solutions provider, serving 175,000 clients in 141 countries with 192 offices throughout the world. The Black Box catalog and Web site offer more than 118,000 products including industrial switches, media converters, and cabling systems for extending your network into difficult industrial environments. Heavy-Duty Edge Switches are tough, made-in-America switches that come in versions that range from standard switches for offices to extreme switches for outdoor installation. More information is available at http://www.blackbox.com/go/industrial.

Black Box also offers KVM switches, splitters, and extenders, as well as cabinets, racks, cables, connectors, and other video, audio, and data infrastructure products. To view Black Box's comprehensive industrial offering, see blackbox.com.

Black Box is also known as the world's largest technical services company dedicated to designing, building, and maintaining today's complicated data and voice infrastructure systems.