Over the past two decades, industrial automation has benefitted from the convergence of IT (Information Technology) and OT (Operations Technology). As the static automation systems representative of Industry 3.0 were no longer sufficient, operations managers began demanding smarter, self-thinking and more interconnected solutions.

Enter the Industrial Internet of Things (IIoT), which initiated machine-to-machine (M2M) and machine-to-cloud (M2C) communications to enable solutions that leverage Big Data, Artificial Intelligence (AI), Machine Learning (ML) and much more. These advancements have empowered manufacturers to truly understand equipment usage and performance patterns and to accelerate overall equipment efficiency (OEE) along the path to attaining Operational Excellence. Enhanced data availability enables increased visibility of manufacturing processes and provides intelligence needed to optimize equipment uptime, implement effective preventative and predictive maintenance, and ultimately increase productivity and profitability.

The IIoT is composed of a connected ecosystem, including controllers, switches, edge nodes, actuators, sensors, and more. The lynchpin to the IIoT, however, is the sensor. Essential to attaining Operational Excellence, they serve as a factory's "eyes and ears" – the sources of essential data. Since one can't control what they don't measure, improvement starts with the information available from sensors mounted both on-machine and within the factory environment. Sensors monitor environmental conditions and machine conditions ranging from vibration and temperature to airflow and utilization. So called "smart sensors" make onboard calculations that can enhance autonomous and distributed control strategies, sometimes eliminating the need for human involvement.

In this whitepaper, we address the evolution of DC power supplies as IIOT-enabled devices that become active contributors to improved OEE and Operational Excellence. Specifically, we preview an innovative solution that combines the traditional functionality of a power supply with a new communication module. Serving as both power converter and IIoT-ready 'sensor', this power supply and communication module package continuously monitors power conditions on-machine, traps power issues, monitors its internal health, and adaptively predicts its lifespan. By adding intelligence to this solution, the need to visually check output voltages and indicator LEDs has been eliminated, thereby contributing to savings in maintenance, downtime, and labor.

Downtime Costs

It is easy to become complacent about DC power supplies. Because of their high mean time between failures (MTBF) and a service life that may span 10 to 15 years, it is not unusual for plant maintenance to have no record of when a power supply was last serviced, let alone installed.

Complacency is dangerous. When a DC power supply does fail it ceases to supply critical power to its connected loads, an event that oftentimes brings manufacturing to a standstill with an ensuing loss in productivity, and an increased risk of employee accidents and environmental incidents.

Unplanned work stoppages cost global industries billions of dollars in lost revenue annually. A recent study found that the average manufacturing outage lasted four hours and cost $2 million (USD). ① Additionally, outages can corrupt valuable data, put employees in harm's way by taking machine safeguarding offline, and lead to the long, costly, and arduous restarting of production. Aside from the financial ramifications, there are also intangible losses in customer trust, employee morale, and brand reputation.

According to the same study cited above, 70 percent of responding manufacturers were not aware of when their power equipment was due for maintenance, upgrading or replacement. Only 24 percent described their maintenance approach as "predictive." These findings place American industry in a dangerous predicament. Operations managers who lack the means to track key diagnostics in their plant are precisely those most likely to experience production outages, as well as to suffer the worst types of outcomes. Across all sectors, 82 percent of companies have experienced at least one unplanned downtime outage over the past three years, with the average number of outages being two.

Unscheduled downtime due to equipment failure, operator error, or nuisance trips is the nemesis of all manufacturers. ARC previously estimated the cost of unscheduled shutdowns is equivalent to about five percent of the total output of all the process industries. Other organizations, such as Deloitte, estimate that unplanned downtime costs of the U.S. manufacturing industry are $50 billion per year. ②

Power Supply Reliability Methods

As with other outages, when a DC power supply fails the maintenance team needs to first focus on the immediate restoration of operations. With so much at stake it is difficult to look past the money being lost while a line is down. However, savvy plant management must also keep longer-term strategic thinking in mind as they consider ways to prevent their next DC power supply failure, rather than simply reacting to it, and how they can build greater overall reliability into the plant's control systems.

The most frequently used approach to enhancing power supply reliability is redundancy. In industrial applications, a system that contains the minimum power supplies doesn't offer redundancy and won't have the ability to function if a failure occurs. Even the highest quality power supply can fail when subjected to long-term stresses like high internal and ambient temperatures, heavy loads and overvoltage stress.

A redundant system uses two or more of the same power supplies connected in parallel to the attached electrical load. If one fails, the other automatically takes over without human intervention. Terms often used when designing redundant

Emerson's Solution

Momentary loss of line voltage (voltage sag) is one of the most frequent power quality disturbances found in industrial facilities. Normally caused internally by large load start-ups or externally by utility switching, they prematurely wear machines and computer equipment. The result can be lost data, inexplicable resets, or a production shutdown. Most motors, lighting and indicators have some built-in resistance to sags. However, the AC/DC power supply used to power all DC control and logic circuits are often very vulnerable. SolaHD™ SDN-D Series Power Supplies by Emerson enable production facilities to safeguard almost any equipment application. They offer extreme reliability and efficiency, easy troubleshooting, and access to a wealth of information through optional network communication modules. Designed for use in harsh environments, extreme temperatures, and hazardous locations, these DIN rail mountable power supplies provide fast installations and reconfigurations.

power solutions are 1+1, N+1, and N+N redundancy, with 'N' referring to the minimum power modules required to meet the load requirement for a system to operate.

Aside from the basic redundant system approach of connecting two identical power supplies in parallel, "redundancy modules" and "buffer modules" can be installed with the power supplies. A redundancy module will decouple the two power supplies to prevent concurrent delivery of power. It will also detect faults and immediately bypass the malfunctioning unit while shifting to the other power supply or supplies for power delivery.

Buffer modules are supplementary electrical devices that address a brief (milliseconds) power failure by injecting bridge DC power. The buffer module directly connects to the power supply and stores standby energy in its electrolytic capacitors. Given that 80 percent of mains power failures last less than 200ms, a buffer module can be a valuable addition. To ride out longer power interruptions and to perform an orderly shutdown, a DC uninterruptible power supply (UPS) can also be added to the power supply redundancy infrastructure.

It is important to note here that even a well-designed redundant infrastructure can suffer outages. The design needs to ensure that a single power supply can handle the load. Often times additional loads are added over time that can jeopardize redundancy. In this case, the failure of one power supply can place an additional load on the output of the second unit, causing it to overload and shutdown. A failure could even be as simple as overheated units. This can happen when the power supply's internal temperature reaches critical temperature due to inadequate airflow outside or inside the control cabinet. Of course, the consequences of a power supply redundancy failure increase significantly in continuous and irreversible processes, or in any process requiring an extended restart time.

In the IIoT age, the chief drawback of power supply redundancy is that it provides little visibility into power supply health, nor does it have the capacity to transmit predictive maintenance data to the control system. Instead, a power supply's diagnostics must be manually monitored via multicolored LEDs (i.e., AC Power Loss, AC Input Low, No DC, High Load, Overload, et cetera). This means a lengthy visit by your maintenance team to the field site, where they can potentially be subjected to danger due to the need to open the control cabinet to visually inspect the power supply's diagnostics.

In today's competitive global economy, yesterday's solutions fall short. Mission-critical, high-reliability power applications require immediate attention. Managers must be alerted to any abnormal operation without delay. The fact is, when it comes to power supplies, most operations managers are working in the dark. Only an IIoT-ready power supply can deliver status updates and alarms with the urgency needed to prevent shutdowns.

Emerson's Solution

The SolaHD SDN-D Series Power Supplies support redundant power supply operation using optional SolaHD Power Supply Redundancy (RED) Modules. This combination allows operators to continually monitor the condition of both power supplies connected to a single load. They are certified internationally, for harsh industrial environments and hazardous locations. They offer higher efficiency which equates to less heat being generated, potentially extending the life of all components in the enclosure.

The Value of Predictive Maintenance

According to a study conducted by Jones Lang LaSalle Incorporated, preventive maintenance over a 25 year period in commercial buildings delivers an astounding ROI at 545 percent. ② In an industrial setting, where the IIoT is fully utilized, the potential ROI is much higher, thanks to the real-time data supplied by smart sensors that help operation managers predict and fix problems before they occur.

This practice is widely known in the industry as "predictive" maintenance. A prime example of predictive maintenance would be using sensor data to detect when a part is expected to wear out and replacing it beforehand, rather than waiting for scheduled maintenance or until the entire machine breaks down and production is halted. One study found that a manufacturer can save between 12 to 18 percent using preventive maintenance over reactive maintenance. ③ IIoT-ready power supplies can help make those savings a reality.

Predictive maintenance can significantly improve OEE when using the metrics to review the level of productivity of a piece of equipment. By implementing IIoT technology, machinery data needed to calculate OEE — availability, performance, and quality — is accessed in real time, enabling a plant manager to build an OEE model for each key piece of machinery. If OEE is deteriorating, this can be a signal that a machine requires maintenance otherwise a significant breakdown is imminent. An IIoT-ready power supply would make it possible for managers to apply similar OEE calculations for each unit installed.

Power Supplies as Sensors

Sensors respond to specific types of conditions in the physical world, and then generate a signal, typically electrical, that represents the magnitude of the condition being monitored. Those conditions may be vibration, heat, sound, light, pressure, or the presence or absence of a liquid.

The same sensor technologies and protocols that connect compressors, pumps and motors to an IIoT gateway also connect DC power supplies. Tapping into data from DC power supplies and connected loads via the communication module would help manufacturers improve their preventive maintenance program by:

- Monitoring the system for key power parameters
- Measuring control cabinet temperature
- Detecting unbalanced loads and abnormal conditions that may indicate a potential equipment problem
- Ensuring redundancy is maintained
- Tracking current operations versus historical trends
- Calculating power supply end-of-life in energized hours
- Determining load changes that may indicate equipment issues
- Eliminating visual inspections of power supplies and connected loads
- Responding quickly to alarms signified by event codes for short circuits, overvoltages, Power Boost, and over-temperature.

Connecting DC power supplies to the IIoT also makes it possible to modify configurations remotely to match fast changing operational requirements related to a connected load, such as adjusting the system to switch “off” if repeated overloads occur. An alert email would be automatically sent to an operations manager, making them aware of an abnormal occurrence. In turn, the manager simply opens a portal on their laptop’s browser, punches in the change, and the problem is solved, anytime and from anywhere.

Communication Protocols

The flexibility of applying either the Wired HART™ or EtherNet/IP™ protocols to communicate key power supply diagnostic information to the automation system is essential. A simple graphical user interface (GUI) allows users to commission the devices quickly.

Wired HART field communications protocol has evolved from a 4 to 20 mA based signal to the current wired and wireless-based technology with extensive features supporting security, unsolicited data transfers, event notifications, block mode transfers, and
advanced diagnostics.

EtherNet/IP is a widely used Ethernet-based fieldbus for implementing standard Ethernet technology in industrial automation. Industrial systems are increasingly adopting Ethernet connectivity to solve manufacturers’ key Industry 4.0 and smart factory communication challenges. These challenges include data integration, synchronization, edge connectivity, and system interoperability.

Emerson’s Solution

The SolaHD Communication Module (SCM) by Emerson can provide network connectivity support to one or two SolaHD SDN-D Series Power Supplies. This allows key diagnostic data, alarms, and operating parameters to be communicated to supervisory systems for increased efficiency and predictive maintenance. Being able to monitor the health and performance of devices ensures greater reliability and reduced unscheduled downtime.

The Time is Right to Upgrade Your Power Supplies

One of the insights gleaned from a recent automation survey by ARC Advisory Group (ARC) is that the installed base of "aged out" automation and controlled equipment has grown over the past decade from $65 to $70 billion. ④ Add to that the findings of an Emerson study showing 21 percent of purchase decisions for power supplies require network communications, making it is clear that now is the time to integrate a power supply and communication module solution. ⑤ This 'drop-in' upgrade is compatible with any current infrastructure, regardless of age or level of control sophistication. There is no 'rip and replace' with the current infrastructure. Power supplies paired with communication modules start diagnosing performance and monitoring key performance metrics the moment they are installed, so you can keep a check of what is happening in real-time, anywhere, and on any device.

Conclusion

While they may not get the attention that PLCs, HMIs or sensors receive, DC power supplies are just as vital to control systems. In fact, one major system integrator has gone as far as to claim that 80 percent of control problems could be traced back to a power supply or grounding.

Despite the importance of DC power supplies to control systems, most have no means of communicating real-time operational status or warning of an imminent failure. Operations managers have resolved that deploying a redundant power supply or sourcing from a UPS overcomes the need to monitor at the field level. But without monitoring, there is no way to expose critical power supply diagnostics for the predictive maintenance programs that improve OEE and prevent costly downtime. If you are to realize the full potential of the IIoT, it can't be done without including power supplies and communication modules.

For more information, visit www.solahd.com.

Emerson's Solution

Outdated power supplies can cause frustration and delays. They often lead to increased maintenance requirements, and additional safety issues. That's why the SolaHD SDN-D DIN Rail Series Power Supplies by Emerson are the ideal choice for those who need stable power and higher efficiencies.

A high-end DIN rail power supply that boasts one of the highest efficiencies available in the market today, this solution is designed for use in harsh environments, extreme temperatures, and hazardous locations with no derating. Available in 10 and 20 Amp versions with 24 Vdc output, it offers a wide ambient temperature range, a redundancy option, drop-in compatibility with existing power supplies, and a five year warranty.

By generating less heat, the SolaHD SDN-D consumes less energy, and increases the life of ALL temperature sensitive components in the enclosure. This solution has extensive capabilities in a compact design, requiring less DIN rail space.

Extensive diagnostic monitoring capabilities are possible with the optional SCM network communication module, which utilizes popular industrial network protocols to provide critical power supply data to computers, PLCs, DCSs, HMIs, and other devices. For applications requiring even higher reliability, combine the SDN-D with SDN redundancy modules. The SolaHD SDN-D DIN Rail Series Power Supplies by Emerson is the ideal solution to help customers improve their operations regardless of where it's put to use.

Footnotes

① ServiceMax (conducted by Vanson Bourne of GE Digital), October 2017, "After The Fall: Cost, Causes and Consequences of Unplanned Downtime," www.vansonbourne.com/work/19061701tc

② Jones Lang LaSalle IP, Inc., "Deferred maintenance is not cost saving," www.joneslanglasalle.com.cn/en/views/deferred-maintenance-in-challenging-times-the-case-for-preventive-maintenance

③ Plant Engineering, "2018 Maintenance Survey: Playing offense and defensem" sponsored by ATS, www.plantengineering.com/articles/2018-maintenance-survey-playing-offense-and-defense/

④ ARC, Larry O'Brian, 2019 "Key performance metrics and indicators survey highlights industry issues," www.isa.org/intech-home/2019/march-april/features/key-performance-metrics-and-indicators-survey-high

⑤ Hanover Research, 2019 "Market Survey" sponsored by Emerson, www.hanoverresearch.com/reports-and-briefs/2019-trends-in-market-analysis/

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