The Next Revolution
How Rittal Plans to Change Industrial Automation As We Know It

Interview with Rittal’s Gregg Holst

Tesla’s New Powerwall Home Battery

Protecting Your Product from Copying
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EDITORIAL STAFF
Content Editor
Alex Maddalena
amaddalena@aspencore.com

Digital Content Manager
Heather Hamilton
hhamilton@aspencore.com
Tel | 208-639-6485

Global Creative Director
Nicolas Perner
nperner@aspencore.com

Graphic Designer
Carol Smiley
csmiley@aspencore.com

Audience Development
Claire Hellar
chellar@aspencore.com

Register of EEWeb
http://www.eeweb.com/register/

Published by
AspenCore
950 West Bannock
Suite 450
Boise, Idaho 83702
Tel | 208-639-6464

Victor Alejandro Gao
General Manager

Cody Miller
Global Media Director
Group Publisher

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DC/DC Converter Protection

RECOM’s DC/DC Book of Knowledge is a detailed introduction to the various DC/DC converter topologies, feedback loops (analogue and digital), test and measurement, protection, filtering, safety, reliability, constant current drivers and DC/DC applications. The level is necessarily technical, but readable for engineers, designers and students.
As mentioned in the Preface, one of the functions of a DC/DC converter is to protect the application. At the most simple level, this protection consists of matching the load to the primary power supply and stabilizing the output voltage against input overvoltages and undervoltages, but a DC/DC converter is also a significant element ensuring system fault protection. For example, output overload limiting and short-circuit protection not only stops the converter from being damaged if the load fails, but also can protect the load from further damage by limiting the output power during a fault condition. In an application with several identical circuits or channels each separately powered by individual DC/DC converters, a fault in one output channel will not affect the other outputs, thus making the system single fault tolerant. Other converter protection features, such as over-temperature shut-down, are primarily designed to safeguard the converter from permanent damage caused by internal component overheating, but a side-effect is also to shut down the application if the ambient temperature gets too high, thus also protecting the components in the application from over-temperature failure.

Adding isolation between input and output breaks ground loops, eliminates source of interference and increases system reliability by protecting the application against transient damage. The elimination of power supply feedback effects is an important facet of DC/DC converter protection. For example, consider a heavy duty DC motor speed controller. The speed controller circuit needs a stable, noise-free supply to smoothly regulate the motor speed, but the high DC currents drawn by the motor can create significant voltage transients that could feed back into the speed controller regulation circuit to cause jitter or instability. An isolated DC/DC converter not only delivers a stable low-noise supply to the speed controller circuit, but by breaking the noise feedback loop also protects the motor from unwanted and erratic control signals that could damage the motor and associated drive chain.

However, a DC/DC converter is also constructed from electronic components that are just susceptible to failure if used outside their voltage, current and temperature limits as any other electronic circuit. This chapter investigates protection measures that may be needed to safeguard the converter itself from damage.

**Reverse Polarity Protection**

DC / DC converter are not protected against reverse polarity connection. Swapping V_{in} and V_{out} terminals will almost certainly cause immediate failure, so care must be taken to ensure that any input connectors or battery connections are polarized. If the primary supply is transformer, then a rectification diode failure could cause a negative-going output that would then also cause the DC/DC converters to fail.

The main reason why DC/DC Converters fail if reverse polarized is the body diode in the FET. This substrate diode conducts when reverse connected and allows a very large current I_{R} to flow, which can lead to the destruction of components on the primary side. To avoid this potential danger, several options are available.

**Series Diode Reverse Polarity Protection**

The easiest way to protect a DC/DC converter from reverse connection damage is to add a series diode. Fig. 4.2 shows the circuit. If the supply voltage is reversed, the diode D1 blocks the negative current flow and no fault current can flow through the input circuit of the DC/DC converter. Obviously, by replacing the diode with a bridge rectifier, then the converter will function irrespectively of the input voltage polarity.

The series diode protection has a disadvantage, especially at low input voltages, due to the voltage drop across the diode. Depending on the choice of diode, a forward voltage drop of 0.2V to 0.7V can be expected, with an associated power loss = V_{f} × I_{IN}, which reduces overall efficiency by 20%.

**Figure 4.1. Reverse Polarity Flow**

**Figure 4.2. Series Diode Reverse Polarity Protection**
both the conversion efficiency and the usable input voltage range. If the input current is 1A, then a standard power diode with $V_f = 0.5V$ dissipates 0.5W, equal to about a quarter of the dissipated power of a typical 15W converter, thus reducing the overall efficiency by 20%.

In some applications, the voltage drop across the diode is an advantage. Rally cars often use a 16V battery to increase the brightness of the headlamps. The alternator is modified to deliver 11 - 20V, outside the range of a standard 9 - 18V DC/DC converter. By using three diodes in series, the effective input range can be dropped to match the standard 18V input voltage range.

**Shunt Diode Reverse Polarity Protection**

An alternative to the series diode is the shunt diode reverse polarity protection. The forward voltage drop across the diode is avoided, but the primary supply must either be overload protected or a series fuse must be fitted (Fig. 4.3). Although this arrangement might seem at first sight to be a better solution than the series diode form of protection, in practice it has several disadvantages. One disadvantage is that although the voltage across the converter when reverse polarity connected is limited to –0.7V, even this low level of negative voltage can be sufficient to damage some converters. Secondly, the choice of fuse is not a trivial task (see section 4.3) and its effect on performance is often underestimated. A fuse is, in effect, a resistor that is designed to burn out at a certain current. As with all resistors, there will be a volt drop across it that is current dependent. A fuse may have an insertion loss similar or even higher than the forward drop of a diode (see next section).

**P-FET Reverse Polarity Protection**

A third option for reverse polarity protection is to use a series P-FET. The FET is the most expensive solution, but it is still inexpensive in comparison to the cost of the converter. The FET must be a P-channel MOSFET with an internal body diode otherwise this solution will not work. The maximum gate-source voltage $V_{GS}$ should exceed the maximum supply voltage or reversed supply voltage. The FET should also have an extremely low $R_{DS,ON}$ resistance, around 50mΩ is an acceptable compromise between component cost and effectiveness. With the supply correctly connected, the FET is biased full on and even with an input current of over an amp it will exhibit a volt drop of only a few tens of millivolts.

To examine the differences between the three different methods of reverse polarity protection, measurements were made using a 12W converter with full load with a worst case 9V input to give a nominal 1.5A input current. As can be seen from Table 4.1, the P-FET solution efficiency is very similar to the circuit with no reverse polarity protection.

To read all of Chapter 4 of the DC/DC Book of Knowledge, visit: http://www.recom-power.com/downloads/book-of-knowledge

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**Table 4.1.** Measured Values using a RECOM RP12-1212SA converter for different reverse polarity protection methods.

<table>
<thead>
<tr>
<th>Reverse Polarity Protection</th>
<th>Supply Voltage*</th>
<th>Converter Input Voltage</th>
<th>Converter Input Current</th>
<th>$V_{OUT}$ (V)</th>
<th>Power In</th>
<th>Power Out</th>
<th>Conversion Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Protection</td>
<td>9.0V</td>
<td>9.0V</td>
<td>1561mA</td>
<td>11.98V</td>
<td>14.05W</td>
<td>11.96W</td>
<td>85.3%</td>
</tr>
<tr>
<td>1. Series Diode (IN4400)</td>
<td>9.7V</td>
<td>8.5V</td>
<td>1660mA</td>
<td>11.98V</td>
<td>16.10W</td>
<td>11.96W</td>
<td>74.4%</td>
</tr>
<tr>
<td>2. Shunt Diode + 3A Fuse</td>
<td>9.1V</td>
<td>8.5V</td>
<td>1667mA</td>
<td>11.98V</td>
<td>15.17W</td>
<td>11.96W</td>
<td>78.9%</td>
</tr>
<tr>
<td>3. P-FET (IRF5309)</td>
<td>9.0V</td>
<td>8.9V</td>
<td>1572mA</td>
<td>11.98V</td>
<td>14.15W</td>
<td>11.96W</td>
<td>84.7%</td>
</tr>
</tbody>
</table>

*9V or minimum input voltage for a stable regulated output, whichever is the higher.
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We have all heard about pirated copies of electronic products. One company started to notice a larger number of returns on a particular internet router. Upon further investigation, it found the returns were a poor copy of its product but still they kept coming in: same box, same product and same literature. Even though the company took the blame from unsatisfied customers and initiated a serial number return policy, the damage to its reputation was done. The question is: how can a company protect itself from those who attempt to copy products?
One strategy is to use available technologies to make a product hard to copy. Most pirates do not want to spend the money to redesign a product if it costs too much. They want to make quick money by doing an easy reverse engineering job and then make a few hundred thousand cheap knockoffs. By making it difficult to copy a design you can increase the thieves’ cost and reduce their potential to make money. Time is their enemy.

The first step in slowing down the possible theft of your product, is to customize the printed circuit board (PCB). Most PCBs have green solder mask because, in the past, it was believed people did a better job assembling green boards. However, in today’s world of machine-placement, the circuit board color does not matter. Therefore, one easy trick to prevent fraud is to request a custom blended mask color. Solder mask companies make many different colors of solder mask, allowing you to create your own spectacular color by simply supplying the PCB manufacturer with the ink. It may cost a few cents more per board, but the vividly different color may slow down potential piracy.

On the board assembly side, it may be possible to slow down pirates by adding a tamper-proof coating to both sides of the most important chip areas. A good tamper-proof coating will be dense enough to stop x-ray examination, i.e. contain tungsten carbide ceramic nano-particles. It should also be hard enough to deter easily picking it away and be opaque enough to stop easy tracing of the PCB tracks.

To add additional speed bumps to the pirates’ progress, further techniques can be used. For example, you can have a series of resistors and capacitors made that display the wrong value. These have been used on special protected government products where the resistor clearly was printed as a 10 ohm but actually was a 47 mega-ohm resistor, put across a couple of signal lines. While this may seem easy to get around, a pirate will have no idea that the number is intentionally incorrect. The pirate will copy the easy parts first and then spend valuable time troubleshooting. This can also be done for RF designs, with capacitors marked as one value while the correct value is across the important signal.

Another way to make it more difficult for the pirates is to use multi-layer board. There is a unique design number for every circuit board. This number is intentionally incorrect. The pirate will have no idea that the number is intentionally incorrect. The pirate will copy the easy parts first and then spend valuable time troubleshooting. This can also be done for RF designs, with capacitors marked as one value while the correct value is across the important signal.

One military agency used many tricks when an extremely secure product was required. It would have taken someone years to reverse engineer the circuit boards. The circuit boards had fake traces, hidden micro-sized wire bond wires over the chip and then tamper-proof coatings. When someone would grind off the coating, they cut the near invisible 10 micron wires, which added difficulty in tracing the signal direction. They had mislabeled parts and even had fake chips, which did nothing but add to the confusion. The PCBs sometimes featured an on-board battery that kept the memory of the chip active, with more of the very fine wire bonding wires over embedded memory chips. If you cut into or damaged the tamper-proof coating, it erased the chip program memory.

While this level of misdirection may not be practical for the majority of consumer products, when you design the packaging, you might think about adding less complicated yet still effective countermeasures. A hard-to-copy feature such as a security stripe sticker, similar to that found in dollar bills is reasonably simple to implement. They can be made with your name in an invisible QR type code; not impossible to copy but tough. Or you can use a high security smart label. These feature a 64 bit security code exchange or use a non-removable RFID label. When you try to remove or reverse engineer the label, it rips and destroys the circuits inside. The RFID label receives a special signal from a reader which exchanges security codes and it sends an encrypted data code to ensure the product is not counterfeit. Your stores and warehouse can scan any product box and determine if the part is fake or real.

Depending on the level of confidence you have with your manufacturers and the sensitivity of your designs, special precautions may be necessary with the PCB supplier or plastic case manufacturer. Some pirates will try to buy boards, plastic cases, and products from your suppliers. Never buy all of...
Advanced Assembly was founded to help engineers assemble their prototype and low-volume PCB orders. Based on years of experience within the printed circuit board industry, Advanced Assembly developed a proprietary system to deliver consistent, machine surface mount technology (SMT) assembly in 1-5 days. It’s our only focus. We take the hassle out of PCB assembly and make it easy, so you can spend time on other aspects of your design.

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So Go Ahead, We Dare You.

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Your company’s new circuit board does not work, and it’s your job to find out why. Where do you start? First, remember the best advice in solving a problem is to cut it in half, and then cut that in half. By cutting your problem in half, you will constantly reduce the size of the problem and more easily determine where the actual fault lies. A useful trick is to consider building two PCBs. The second PCB can be tested and compared to the original circuit board. If both boards have the same problem, then it’s a design fault in either the PCB layout or the circuit. If the second PCB works you have a bad PCB, a faulty component or an assembly defect in the first circuit. Inspect both boards carefully going over each solder joint and part. Also check the direction of diodes and large caps or any component that has polarity.
To cut the problem in half, have your PCB design personnel do a thorough net comparison between the designed circuit drawing to the actual PCB Gerbers. Test the PCB, or at a minimum the problem area, with an ohmmeter and check the circuit drawing so you can say with confidence that the PCB is correct as far as trace/via connections. Use a yellow marker on the circuit drawing and identify each correct connection (this will help eliminate confusion). One of the most difficult faults are intermittent ones where the circuit works, then stops. A can of Freeze-It will pinpoint a bad via or inter-board connection or even a bad component. Your second test PCB can help. If it works, then the intermittent board is a PCB fault. Freeze each small section of the board with the spray. It will pinpoint the area quickly by either causing the circuit to work or fail. You can also use Freeze-It on the chips and components to find intermittent problems.

There are many hidden electrical problems within a PCB of which you may not be aware. The problems that can cause faults on an operation circuit are numerous and not necessarily caught by the PCB shops electrical testing. Wicking of the electroless solution after drilling causes high resistance shorts between vias and close traces. There is no cure; the boards are garbage. Inner-layer intermittent shorts are created when thin prepreg is used, and a copper sliver off a trace penetrates the prepreg, shorting an upper trace to a lower one. A sliver short scenario can also happen during solder mask where an overhanging trace breaks off and shorts to an adjacent trace that is then epoxied in place by the solder mask.

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Wrong impedance is a tough one to find at the test bench. PCB manufacturers use an off the panel coupon, located along the side of the PCB panel to measure the impedance of a set of predetermined trace widths and spacing. A time domain reflectometer (TDR) will at least show a particular trace impedance on the actual circuit. However, it may be hard to relate that to the PCB test coupon. Conductive anodic filament (CAF), growth only appears after the circuit is powered up and usually takes a few days to weeks to rear its ugly head. The DC power sets up a small plating tank when moisture is present. If your circuit worked and then stopped, look for little tree branch-like shorts that grew between DC traces.

Once you have eliminated the PCB as the potential problem, your next step is to look for power supply noise. An oscilloscope will show noise. Move the probes around and check the power right at the chip V+ or solder on bypass capacitors right to the chip power and ground to see if it fixes the problem. Keep soldering bypass caps to the board to find a noise problem. Ball grid array (BGA) devices are one such component that benefit from having the bypass capacitors on the bottom of the board, close to the power and ground leads.

If your problem takes a bit of time to show up, look for thermal issues. A low-cost IR thermal temperature meter will spot if a chip or trace is overheating. Replace the chip and retest.

If the problem still persists, look at the parts that were used by the initial designer. Make sure that you have not substituted a part that is not quite the same. This is one good reason to keep the layout peg board that the initial engineer used. You should be able to scope various signals and clocks between the two circuits and find, or at least understand, the problem. Check values, manufacturer part numbers and date codes on the physical components.

Grounding can be a major reason a new circuit does not work, especially when you’re processing high-speed circuits and tricky clock signals with high power switching. Running wires from grounds to other chip grounds at various points can show you where your signals are going wrong. Ringing and noise can be a major problem when you don’t have the grounds right.

Of course, the obvious thing to look for on power systems is correct connections with low resistance. A trick is to measure the voltage across a connection by placing one lead on the wire and one lead on the screw terminal. You should have almost 0 millivolts. Any voltage across the contact will be indicative of a current loss causing measurable voltage.

In many high-speed circuits, outside electromagnetic noise or radio signals can affect your testing. You can make a simple Faraday shield enclosure by covering a cardboard box with copper or metal mesh and join all corners and ground well. Put your circuit over an insulated metal tray and then place the cardboard Faraday shield over the troubled circuit. Re-test and you might be surprised at the effects that the large amount of spurious RF signals that we get these days can have on a circuit.

Think like special agents on NCIS. The signs of why the circuit is not working may be staring you in the face; they might be yelling at you, “Hey you! It’s a signal integrity problem. Add a few bypass capacitors and I will work.”

Advanced Assembly was founded to help engineers assemble their prototype and low-volume PCB orders. Based on years of experience within the printed circuit board industry, Advanced Assembly developed a proprietary system to deliver consistent, machine surface mount technology (SMT) assembly in 1-5 days. It’s our only focus. We take the hassle out of PCB assembly and make it easy, so you can spend time on other aspects of your design.

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Remember that old saying, the more things change, the more they stay the same? Well, forget that. Things are changing and they will never be the same, at least in electronic product development.

Newer technology led by very advanced computing abilities, including enough power to enable new software with semi-artificial intelligence, has been combined with very forward-thinking concepts to enable an unstoppable new factory environment. The new vision systems are a major improvement in manufacturing, utilizing all aspects of electronics with character recognition able to see parts, read numbers and find holes to calculate scaling. The new smart vision systems on pick and place machines, as well as PCB manufacturing tools such as laser drills, enables advanced manufacturing precision and greater tolerance, allowing smaller holes and finer lines at high production speeds.
The new ink jet solder paste printer eliminates the time and cost of stencil production. In general, inkjet printing technology has advanced so significantly in such a short time that these machines are now the favorite with PCB manufacturers for printing solder mask and identification marking inks, along with recent inroads into image printing, replacing dry film exposure and developer machines.

All this new high technology to buy and play with is right here waiting to burst onto the scene with unbelievable, major disruptive changes to PCB manufacturing and electronic assembly. The biggest game changer will be 3D printing. The most advanced car racing teams of Formula 1 now transport fewer parts to the races. They instead arrive with trailers hauling huge 3D printing machines, each worth many millions, printing upon demand large carbon fiber nose pieces, titanium parts so precise they don’t need machining, and tough fiber reinforced plastic thingamajigs on the car that get damaged in minor scuffles.

**THE FUTURE IS HERE...NOW!**

Imagine the factory of the future; a dedicated 3D printer is manufacturing the exact part you need at the side of the assembly line. There would be no stock to store, almost zero shipping headaches and parts would be available on demand.

In fact, factories such as Boeing are already placing 3D printers on their assembly lines. Parts print and go directly onto the plane. One factory stated 20 percent of its parts were 3D printed. All this will be coming our way very soon to various industries. Even bakers now have 3D printers that print the icing on cakes and pastries, from simple messages to 3D flowers. We haven’t quite reached the point of replicating our every desire, like in Star Trek, but we’re not far from it. In the electronics business, we are very close to 3D printed PCBs with printed layers of dielectric fiber glass and printed layers of copper including micro vias in hours, not days.

One of the biggest changes to productivity must be the Internet. Where else can you find the quick answer to any question, no matter how complicated? The Internet allows you to bond with others in the same occupation through forums, to ask important questions and get instant knowledgeable answers. The days of shipping films and rolls of pick and place CNC punched tape are over. The computerized world has taken over. Let’s sit back in our autonomous self-driving electric car while it communicates with other cars, on the Internet, to coordinate each other’s moves while we enjoy the ride.

Even electronic design has changed dramatically over the last few years. In the past, we sat at electronic benches for days, even weeks, soldering and testing the circuit until it worked. Today, we have computer design tools, which allow the designer to create a circuit in the cloud. The design engineer knows how the complicated circuit works, and he did not solder a single component. The finite-element structural analysis program design tools engineers now use daily, allow for complicated thermal profiling and high-speed computations that few humans can do.

**A SMART FACTORY IN CLOUD**

One new idea coming from Europe is Industry 4.0, which is a new way of thinking about technologies and concepts by evaluating their importance in the value chain. By using the technological concepts of the Internet, you create the vision of the smart factory in the cloud, creating modular structured, smart factories that make decentralized decisions while manufacturing varied products. Multiple smart computerized machinery are communicating over the Internet by autonomous systems, co-operating with each other and humans in real time.
The new smart factory utilizes powerful advances in computing, information and communication systems created by the Internet revolution.

Advantages of the smart factories all interconnected are cross-use R&D, instant operating information, parts supply, human utilization, accounting and maintenance before the machine needs it in one neat package. The aim of the smart factory is to enable physically separate manufacturing units to form collaborative R&D, implementation and skunk work groups for quick development of new products, new advanced manufacturing standards and shared infrastructure of manufacturing knowledge. The new smart factory utilizes powerful advances in computing, information and communication systems created by the Internet revolution. It combines three elements, which are the very essence of the Industrial Internet: highly intelligent machines, advanced analytics and energetic, informed people at work.

The light-speed advancements we are now experiencing will be a major game changer in the next few years. Those who can see and are willing to take a chance in the future will be at the forefront of significant jumps in manufacturing electronic products.
The Next Revolution:
How Rittal Plans to CHANGE INDUSTRIAL AUTOMATION As We Know It

Founded in 1961 by Rudolf Loh, Rittal started out as a family-owned operation that supplied standard enclosures for tooling and machinery. After Rudolf’s son Friedhelm Loh took over the company more than 40 years ago, Rittal has grown into a multi-billion-Euro company with a presence in 58 countries around the world. This steady growth has opened up new market opportunities for the company that extend far beyond enclosures—from cooling units and power distribution to IT infrastructure—that have poised Rittal to partake in what experts are calling “Industry 4.0,” or the fourth industrial revolution. By adding intelligence and simulation capabilities to its enclosure and infrastructure products, Rittal is offering its clients a value chain that spans far beyond a typical enclosure—rather, its technology offerings will help revolutionize factory automation as we know it, and will usher in a new age of smart factories and robotics. EEWeb spoke with Gregg Holst of Rittal about its unique system-based approach to enclosures, some unique features of products, and how they will enable the smart factories of the future.
**What is Rittal’s core business operation?**

Rittal is the largest global manufacturer of mechanical protection systems, or what are commonly known as enclosures, for electrical, hydraulic, pneumatic assets or IT equipment. For any of our customers that have expensive control computing equipment or sensitive electronics, Rittal provides both the mechanical (electrical) protection around those assets and environmental control within the electrical enclosures.

**What makes your enclosures different than those of your competitors?**

By design, we use what is called a modular enclosure system. Our competitors typically provide very large, welded, fixed-form metal boxes that most people are familiar with—and within that box, they mount all of the components to the walls of the mounting panels. Our enclosures instead use a modular design concept that offers far more flexibility to the design engineer. For instance, our TS 8 modular system allows users to configure loads that are mounted inside the enclosure—up to 2,300 pounds. The user then has the option to purchase the skins on the outside of that frame, which determine the end usage or the NEMA rating. The skins can be NEMA 4, NEMA 12, and the doors can be slotted or glass, but the frame inside that we are mounting the components to is identical across the line. The engineer decides he or she needs an extra 4 inches or so of depth or width, they can easily add a new back panel or side to the enclosure and keep all the remaining parts and frame, rather than having to start with an entirely new enclosure cabinet as they would with our non-modular competitors.

**Another key value proposition of Rittal is that we are the only global manufacturer of enclosure systems with seven manufacturing sites across the globe. Any part number that Rittal sells anywhere is fully transportable or purchasable anywhere else in the world.**

From a global point of view, especially for the OEMs, if you are manufacturing with a Rittal solution, your product, no matter where it goes in the world, is supportable by a local Rittal office. If something gets damaged, if the customer is missing a part, or something needs fixed on-site, Rittal can service the customer anywhere in the 58 different countries where we have a presence.

**What benefits do portability and modularity offer to the engineer?**

From an engineering aspect, the modularity allows a customer to build their systems in a panel shop and then break them down into shipping sections, which makes the enclosures much easier to ship as well as fit into tighter locations. We have a lot of equipment that is going offshore or onto marine vessels or into data centers, so this modularity and flexibility is important for so many applications. Another beneficial aspect for engineers is the scalability of the product. If the customer is designing within a certain sized frame and all of a sudden they need a little bit more room, they can buy a larger frame off the shelf—they do not have to go back and re-manufacture that to their custom dimensions. We like to use the term “custom from standard.”

Many of our global customers buy a single part number that is comprised of many Rittal parts that have been put together or assembled by Rittal or by our partners into a single part number. With the traditional grey box enclosure, if the customer needs another six inches of space, they would need the lead time to re-design and re-manufacture the enclosure. With the Rittal enclosure, all the customer has to do is buy a larger frame and the larger side walls. There is a tremendous amount of flexibility far closer to the manufacturing and shipping time with a modular, off-the-shelf solution, than there is with a traditional solution.

**Apart from providing modular enclosures, what other services does Rittal provide its customers?**

Aside from the enclosures and components that we have for power distribution and climate control inside the enclosure, Rittal, as an enclosure company, is affiliated with three important sister companies: Cideon, EPLAN, and Kiesling. Those three companies provide the entire control panel design and manufacturing value chain all the way from your ERP connection for managing your costs and..."
We are the only manufacturer that offers a seamless, interconnected value chain that has technology that allows us to produce systems even with our competitors’ products.

On top of that, Rittal has an engineering group in the United States called System Consulting. This is a no-charge, value-added engineering design and consulting team that works in partnership with customers to build robust Technology Roadmaps for their products. With this team, we go out to customers and ask questions about what they are trying to accomplish—their price points, what type of environment they are designing for, where the enclosures are going, if they want protection against vandalism, earthquakes and so on. From there, we will collaborate with them on detailed 2D and 3D modeling for them using various design tools, such as SolidWorks and EPLAN, and ultimately give them their desired solutions. (This consultative team that goes out to help customers identify the exact solution for their needs is something that Rittal is starting to emphasize with all of our customers.)

What are some of the main issues or requirements that your customers come to your design teams with?

Our customers often want to understand regulatory requirements and technology challenges around issues like Arc Flash or designing for seismic environments. They also need help determining how different materials perform in different environments, which will impact the choice between using fiberglass or 316 stainless, for example. These questions are of high importance to our customers because they almost always have price targets that they have to meet and we are trying to find the right material for the environment it will be used in.

Environmental control inside the enclosure is also a lot more complex than hanging an air conditioner inside of it. With the tools and expertise that Rittal has, we are actually able to model the environment or weather patterns for a particular enclosure. You can have an enclosure that has something with a very high heat generation load in it, like a variable frequency drive, and if you mount an air conditioner right in front of it, you will experience tremendous disruption of the cooling in that enclosure. The hot air will knock right into the cool air coming in and nothing else will be cooled within the enclosure. Customers aren’t experts in enclosure thermal management systems, and they depend upon us to know that when they build an enclosure using our solution, we can help them to be sure it will perform reliably in the field.

With our solutions, we are able to model these factors before we even build it.

Rittal recently introduced a climate-control technology that is supposed to save up to 75 percent of energy. How is Rittal able to achieve such an impressive energy savings?

In the work we are doing in consulting with both IT and industrial clients on environmental control, we are developing products that are best in class. Around five years ago, we introduced what we called our Blue e climate control line; this product line offered 45 percent energy reduction over the competition. The new Blue e+ that we just previewed at Hanover Fair is truly groundbreaking—it uses heat-pipe technology, which is passive cooling, as well as inverter technology. When it’s introduced, this product is going to be up to 75 percent more energy efficient than our Blue e line, which is already a leader in the market.

Our new technology uses a completely new active-passive cooling technology. It cools actively only when the passive cycle does not achieve the desired temperature. Therefore, it is no longer necessary to cool at full power, then switch off, and then cool again, but operate at a continual partial load.
only when necessary. The partial load operation results in less energy use, less thermal stress for the electronic components, less strain on motors and fans and much lower service and maintenance costs. Another big advantage is that we can use just one inverter from a power input side, wherever in the world that climate control unit is shipped. For any voltage or any frequency—50 or 60 Hz, 208 V, 480 V, or others—our inverter will work. This becomes really important to panel builders and OEMs because if a customer is installing a system in North America, they may be using 208 V 3-phase and they are going to have to use transformers to power the air conditioner to be compatible with the voltage requirements of wherever the product is going. If the product is going to Russia for an oil and gas project, they will have a completely different power grid to connect to. To test it here in North America, with this new technology, they can power the unit locally off of 6 Hz and ship it to Russia—or wherever it may be—and hook it up to a 50 Hz grid, and it will work perfectly.

The energy savings of the Blue e+ will be so significant that it will make it worthwhile to replace perfectly good air conditioners. For instance, automotive plants may have hundreds of air conditioners in them. We just launched a campaign in the North American market where we are doing enclosure thermal audits for our customers. We are then going to be able to quantify the ROI that proves there is a very rapid return on investment to replace their perfectly functioning air conditioners. That is very important to our customers who are trying to stay ahead of constantly increasing energy costs.

How does Rittal plan on aiding oil and gas industry customers with its recently launched Oil and Gas Competency Center?

Even though Rittal is a German-based company, we realized the world headquarters for the oil and gas industry is in Houston. So the idea of locating an Oil and Gas Competency Center there is to allow customers to see our products up close, work on design and engineering applications for them specific to this very demanding application, and receive training on enclosure applications in oil and gas. Whether the application is upstream, midstream, downstream, offshore, or subsea—the materials used in enclosure design and the protection specifications are very important. Within the Competency Center, we have on-staff industry expertise that is able to talk with customers about the industry’s regulations and spec requirements. This is our first Competency Center in the USA and we believe it is the only Competency Center in operation that was developed by an enclosure company.

While Rittal has 58 locations worldwide, where does a majority of the manufacturing take place?

Rittal is very focused on manufacturing locally to our customers. We have seven manufacturing centers around the world. Our Urbana, Ohio, facility manufactures more than 80 percent of the product that is sold and consumed in North America. We also export a lot of our products to South America and Central America. We have manufacturing centers in China, India, and in Eastern Europe that are for those markets. The other 15–18 percent of our manufacturing is in Germany. The company operates in North America as an independent company, Rittal Corporation, and we are encouraged by our owner, Friedhelm Loh, to be a local, “Made in America” company.

Industry 4.0 is setting the stage to revolutionize the industry. What is Rittal doing to anticipate this trend and help its customers?

Back in 2010, the German government reached out to industry leaders there, and our owner, Friedhelm Loh, was a part of that initial group of advisors. Their challenge was to explore and define what was next for German industry and manufacturing. In 2011 at the Hanover Fair, executives from Robert Bosch GmbH did a read-out of what this group had defined as Industry 4.0. The name hints that this will be the fourth industrial revolution; the first revolution was around steam power, the second revolution was around electrification, and the third revolution was centered on digitization of automation in which we moved from the analog world to digital and started to see networks coming into the factory.

We are able to simulate the operation of a factory, but using real input from the factory I/O—which means the intelligent equipment physically installed in the factory.
Industry 4.0 characterizes the fourth industrial revolution as being adaptive manufacturing. What this really signifies is the move toward decision-making and equipment awareness within the actual machinery and system. An Industry 4.0 factory has machinery that is aware of itself and what it is doing as well as the health and activity of the equipment surrounding it. The motor may be overheating and it can tell other equipment upstream or downstream that it is having a problem, and that it needs to adapt to what is going on. And an industry 4.0 factory is amidst a connected world that consists of the entire product chain—from first customer expectations, the engineering, the production, to the delivery of the product to the customer.

The second huge factor of Industry 4.0 is simulation and virtualization. This is where Rittal comes into play, seeing that we have developed simulation tools for real-life panel-building automation. We are able to simulate the operation of a factory, but using real input from the factory I/O—which means the intelligent equipment physically installed in the factory. I recently attended a seminar that was put on by Robert Hardt, who is the President/CEO of Siemens Canada, on Industry 4.0. In this seminar, he showed a video of a Maserati factory that was recently built in Italy that is using Industry 4.0 as a design premise. The video talked about the awareness of its robots and how the robots will know their next movements and actions throughout the assembly line. This is even more evolved than industry trends like the Industrial Internet of Things, where devices are able to communicate with each other. Industry 4.0 is more about what these devices actually do with the information.

In what ways is Rittal implementing Industry 4.0 compatibility?

With our value chain around automated control panel design and manufacturing, we are allowing customers to fully simulate and virtualize the control panel design before building it. We are allowing customers to fully simulate and virtualize the control panel design before building it. If you look up Industry 4.0, you will find it has six tenets. The first is interoperability, or the ability for cyber-physical systems, material handling and assembly equipment, humans, and factories to connect and communicate. This is the “Internet of Things” portion of Industry 4.0. The second portion is virtualization, where a virtual copy of the factory links sensor data and plant models for simulation. Rittal is engaging in this area on the design side with our virtualization tools for control panel design. The third is decentralization, which is the ability for cyber-physical systems to make their own decisions based on inputs that they are getting. The fourth is real-time capability and the ability to collect and analyze data to provide immediate insights. Within the Rittal value chain, we have EPLAN and the EPLAN Data Portal, which holds the technical, mechanical, electrical, and physical information on components from all of the industry’s automation leaders. The fifth tenet is around service orientation, which means offering services via the Internet of Service. The final tenet is modularity, which is the flexible adaptation of smart factories to change your requirements by replacing or expanding individual models.

In the Industry 4.0 world, if the user were to decommission a certain piece of equipment or part of the factory, the factory would be flexible and adapt to the new conditions. Within Rittal’s Industry 4.0 play, we are bringing the Industry 4.0 value chain to the control panel designer of any size and showing that you don’t have to be a GE, Trumpf, or a Siemens to benefit from Industry 4.0.

Rittal’s motto is “Faster, Better, Everywhere.” In what ways does Rittal carry out this motto?

“Faster, Better, Everywhere” is our mission. We want to be faster to the market—in fact, our owner mandates to us that he wants us to be able to supply a customer with any Rittal product in 48 hours. He is challenging us with rigor and vigor to figure out how we are able to uphold this standard.

“Better” comes from being a better provider to customers and our partners. We strive to be easier to do business with and provide more value across the board. “Everywhere” refers to our global presence and our ability to provide support on all of the continents where we have a presence. We have a phenomenal organization in place globally where we have a single-point contact that the customer can reach and get support from, no matter where they are located.
Tesla’s Powerwall Solar Battery Revolutionizes the Utilities Sector

By Rob Riemen, EEWeb Contributing Writer

With the release of the Powerwall this past April, Tesla Motors is aiming to bolster solar as a viable utility killer. The device is a lithium-ion rechargeable battery that connects with renewable energy sources as well as the power grid to store energy for future use. It comes in a 7-kWh daily cycle or a 10-kWh weekly cycle model. The goal of the Powerwall is not just to have an emergency power system, it is to be used to actually power the home. The battery has the capacity to serve as a power source during the hours of the day where electricity prices are the highest, or, for that matter, any time the user has a need to use extra electricity. Technology has been ever improving from faster and smaller computers to smarter automation. With rising computing and technology demands, an energy overhaul is needed to keep with growing demand and the Tesla Powerwall is this first product of its kind to address that.
Lithium-ion batteries are by no means new. The development of the technology started in the late 1970’s, when engineers demonstrated electrochemical intercalation of lithium in graphite. It wasn’t until Sony released the first commercial lithium-ion battery in 1991 that lithium-ion technology started to become worthwhile. Lithium-ion batteries use positive and negative electrodes to interact with a conductive medium of electrolytes, which then move between the electrodes using this medium. The ions move back and forth during the intercalation and de-intercalation process, which is basically an insertion and extraction process.

During the charging process of a lithium-ion battery, the electrical source supplies the battery with a higher voltage than the battery can produce itself. This means that the current is then forced to pass in the reverse direction giving the lithium-ions the push to go from the positive electrode. The lithium-ions are now dispersed across a porous electrode material and are waiting to be pulled back to the positive electrode. When this happens, a useable current materializes.

When referencing the Tesla Powerwall, there are several lithium-ion cells in series. This type of battery works in three stages: the constant current, balance, and constant voltage phases. There is a constant current supplied by the charge while increasing the voltage over time. Once the voltage limit is reached, the system enters the balance phase. During the constant current phase, the charging is done unequally because the cells are in series rather than parallel. So, the battery has to balance the charges across each cell. By reducing the charging current—or, in some cases, cycling the charging on and off—the cells can reach an equilibrium. The constant voltage phase requires the power source to supply a voltage equal to the maximum the battery can hold. This is determined by the maximum cell voltage times the number of cells in the battery—all of which must be in series. As the current tapers off to zero, the voltage is continually applied, and once these phases complete, the battery is charged.

The Tesla Powerwall can only be charged this way using a unique method. Software combined with a renewable energy source and an inverter allow for the ability to charge and then use energy during certain times of the day. When considering renewable energy, solar is the clear choice, and the renewable of the future. If considering solar, there are three significant peaks of energy during the day—two of which apply to energy consumption of humans. In the morning, and even more in the evening, electricity usage is at its highest. Lights, screens, and utilities are all used more often during between sleep and work hours, contributing to a higher demand for energy.
The third peak deals with the peak solar output. This is almost always mid-day, where the sun is at the highest possible location in the sky, which allows for the ability to harness more energy. This also happens to be the same time of the day that energy usage is at the lowest. The software of the Tesla Powerwall monitors these energy trends to help focus on keeping a fully charged battery. During peak solar output, the lithium-ion batteries can successfully complete their charging sequence as there will not be a demand to use this energy at the time of the charging.

When producing this energy during the peak time of the renewable source, the energy source sends direct current (DC) to the battery pack. In turn, the batteries release their energy in the form of DC. But, many of today’s electronics use alternating current (AC) as the form of electrical power. This is why the inverter is a necessary piece of equipment when buying an energy storage. The inverter converts the DC power to AC. In reference to the Powerwall, the renewable energy source stores the power it creates in the form of DC. Then the circuit pulls DC from the battery pack and then converts the energy source to AC through the inverter and transfers it to the power circuit of the home.

In order to move away from burning fuels and polluting the Earth’s atmosphere, the switch over renewable energy is inevitable. Today, renewables are horribly inefficient, with fossil fuels and natural gas still being very abundant, and when things are cheap to produce, it is hard to move away from the products using them. Tesla is attempting to change all of that by making grid electricity more accessible and affordable. By utilizing any sort of renewable and maybe even combining some renewable energy sources, a significant amount of energy can be produced. When harnessing these energy sources during prime hours, the energy can be stored in high amounts. Tesla’s Powerwall opens the opportunity to store this renewable energy to be used during the more expensive times of electricity usage. While this solution may not cover all personal electricity needs, it gives the user the ability to produce and store their own energy and remove themselves from the grid, while also reducing pollution.
Game Show

I think it's time for another round of...

Ooh, yes!

What's wrong with this Picture?

I'll take 'soldering iron'.

Survey says...

What's the Game Show with Stan?

Toy Modification (Part 2)

Scalpel... Tweezers... Solder...

Shew... that should do it?

Now it has a much better tempo...

Curious Bert (Part 1)

That toy reminds me of how I got into electrical engineering.

Uh, how?

Poor R2, he never ran again.