

OMICRON Magazine



CPX 200: THE FUTURE OF TESTING
TECHNOLOGY IS ALL YOURS



DEAR READERS,

Growth doesn't happen in our comfort zones. It requires the courage to break new ground, question existing boundaries and methods, as well as the motivation to face new challenges. In recent years, this principle has been our driving force. We haven't simply been focusing on developing another product for you. What we've created is an uncompromisingly functional solution.

Our goal is always to deliver sustainable added value with targeted innovation. We not only strive to meet your requirements, but to exceed them. The result of our approach is a perfectly coordinated ecosystem – a well-thought-out solution that elevates efficiency, safety, and usability to a new level.

As part of the development team, I'd like to share my insights about the CPX Ecosystem and its history with you. This is not only an invitation to learn about technical concepts and implementations, but also about the thoughts, challenges, and setbacks that have accompanied us on our journey. When all is said and done, it's not just algorithms and circuit diagrams, but actual people with emotions, passion, and conviction that have made this extraordinary solution possible. It's their personal stories that make it so unique.

Enjoy reading!

Yours sincerely,

Michael Rädler

Product Manager CPX Ecosystem

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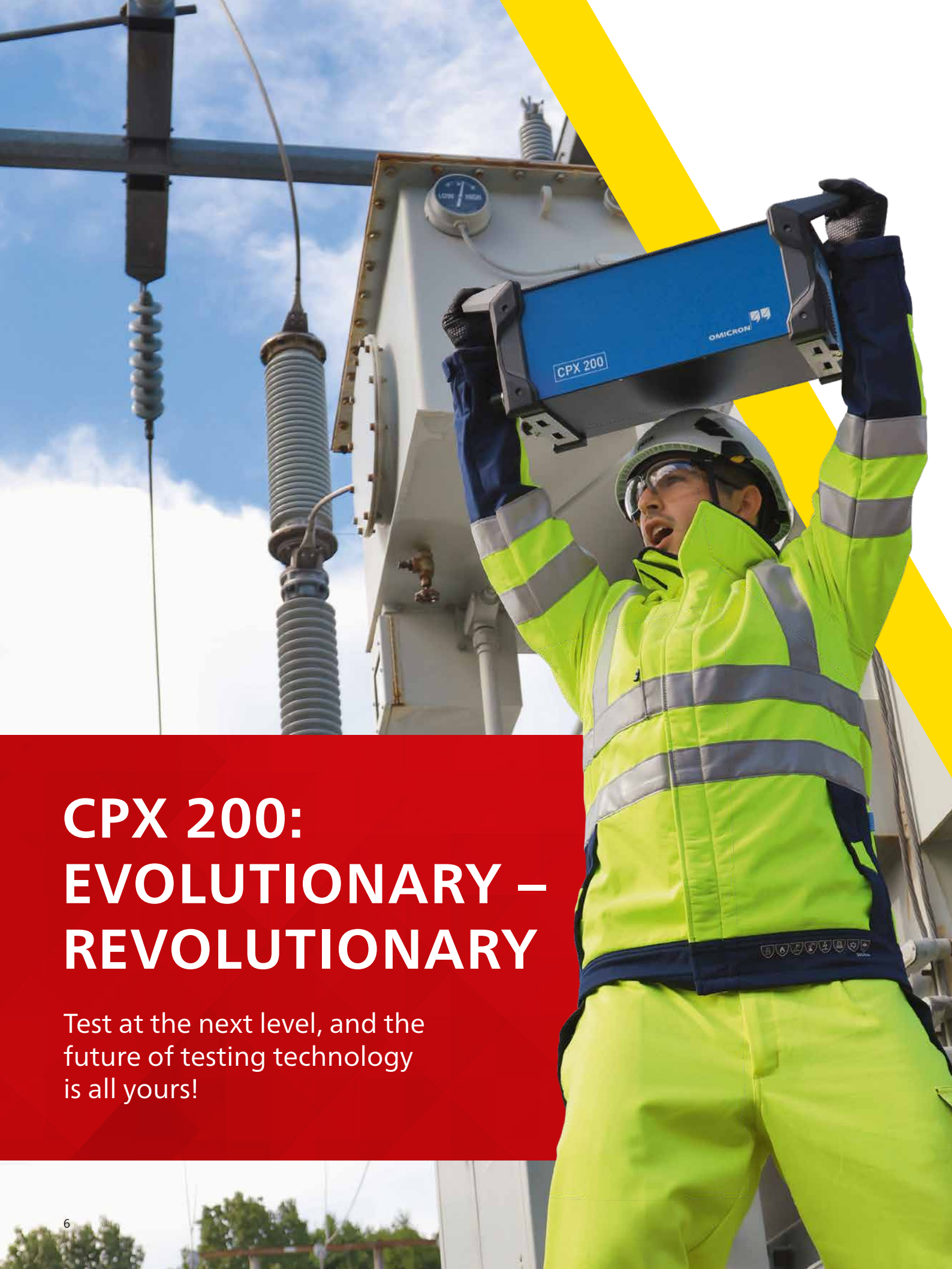
SUPPORT



INNOVATION



QUALITY



CPX 200: EVOLUTIONARY – REVOLUTIONARY

Test at the next level, and the
future of testing technology
is all yours!

“For those who empower. The CPX 200 is made for you.” is the emotive campaign slogan for our brand-new multifunctional CPX 200 test set. But what does this statement mean? It means a vast amount of technical know-how, passion and pleasure for design, the curiosity to push the boundaries of possibility, and plenty of blood, sweat, and tears. Our customers empowered us with ideas and requests, we empowered each other to expect more from ourselves, and OMICRON. Our corporate philosophy and the support we’ve received at a managerial level have empowered us to develop the CPX 200 and its ecosystem. We proudly present the next generation of generalists. One that’s ready to test high and medium-voltage assets, thanks to modular configuration and multifunctionality. A device that’s safer, stronger, modular, lighter, and easier to use than ever before – a solution that’s simply made for you.

How it all began ...

Everyone in the industry is all too familiar with current and future challenges, such as unstable, decaying power systems, the growth market of renewable energies, decentralization, loss of knowledge due to retirements, and the skills shortage. So, we asked ourselves, “How can we contribute to the future of a secure supply?” Initially, we brought together seven experts from different teams, headed by Product Manager Michael Rädler and Project Lead Reinhard Gaurig, to tackle this challenge and let their minds run wild in a “Crazy Ideas Workshop”. This resulted in a colorful variety of fantastic ideas. Many more hours of focus, analysis, and conceptual planning led to the development of hardware variations, ranging from simple to complex. These variations were the foundation of the big question: “What exactly do our customers need?”

How we found the sweet spot

In the words of Theodore Levitt: “People don’t want to buy a quarter-inch drill; they want a quarter-inch hole.” What Levitt meant by this is that customers buy products to solve problems. We took this vision one step further, with the goal of bringing it to life. So, we set about finding a solution. Thanks to our multifunctional pioneer, the CPC 100, we were able to generate a multitude of indicators. Customer feedback evaluated by our Technical Support team, sales channels, and OMICRON Academy training sessions was equally helpful. Our expertise and the analysis data provided the foundation for the evolution of a new multifunctional test set ready for the future dynamics and complexity of the market. The greatest challenge was differentiating between areas where a simple improvement would suffice

and those where completely new solutions were needed.

Modular and multifunctional – the devil’s always in the details

Long conceptual phases, intensive field tests with prototypes, and continuous evaluations led us to develop a powerful control unit with modular components and flexible, clip-on system elements. We used the final concept as the foundation for a detailed plan. It was clear from the outset that we needed a high-performance solution that was also future-proof and scalable. Although the demands for hardware and software architecture are high, forward thinking and our active participation in specialist bodies and international working groups ensure we’re closely involved in technological developments for measurements and power systems. This participation quickly gave us an idea of the direction we need to take, allowing us to target specific future topics, such as cybersecurity, in the early stages of product development. What started as a technical revolution became a consistent and sustainable evolutionary path as development progressed.

The limits of feasibility

“According to the laws of aerodynamics, a bumblebee should not be able to fly. But it doesn’t know that, so it flies anyway.” While this entertaining fact identifies limits, it also shows that they can be overcome with new, innovative solutions. We faced multiple limitations while developing the CPX 200 – but we “simply” overcame the most challenging obstacles. For example, how could we generate 1,000 amperes without an installed transformer? Transformers are slow, heavy, and resource-intensive due to the copper required, but currently ▶

still represent the state of the art. The smart alternative was using power electronics. This idea took us into the unknown, but we still had a vision. Our ambition kept us going, and new customer benefits that were lighter, future-oriented, and offered completely new testing methods were our reward. The HVX10 system component's transformer is another example. It took 150 prototypes until its function, design, and future viability satisfied our demands. When is the research phase complete? After 50? After 100 prototypes? We always had the option of being satisfied with where we were, but instead, we took it all the way until the results met our demands. We repeatedly pushed the bounds of feasibility, but ultimately, our know-how, the great trust and confidence placed in us by management, and the single-minded will to simply go further paid off.

And, suddenly, our world came to a stop ...

It was a cold, grey February afternoon when we received the news that our project leader, Reinhard Gaurig, had passed away. His death was completely unexpected, and the sheer bewilderment was visible on all of our faces. We were given time and space to grieve, allowing us to process this terrible blow. But, after a while, we had to move ahead and continue the project. Ultimately, a joint decision was made to appoint Peter Künst as the new project lead. Peter had previously focused more on software-oriented projects, but since hardware development was well underway, he received the full backing of management and the project team. As you can imagine, this was no easy task, and he had some big shoes to fill. Right



from the start, Peter brought a sense of calm to the project that built trust, in addition to a new interdisciplinary team structure. The lateral move was an extreme challenge; Peter quickly became acquainted with all areas and quickly showed that he was more than up to the task. Without Reinhard and Peter, we wouldn't be standing here today with the CPX 200 in our hands. Reinhard will certainly remain in our hearts and minds. To commemorate his contributions and accomplishments, we etched a small "Bremach Camper" on every PCB installed in the high-current module as a symbol of his passion and in remembrance of the fantastic human being he was.

When it rains it pours

The coronavirus pandemic and a component shortage were two issues that marked a turbulent period for us. The unbelievable level of uncertainty, particularly during the coronavirus

pandemic, was our greatest challenge. We didn't know what happened during a global pandemic and wondered how we could continue working together. Innovation is driven by people who interact and challenge one another; they aren't satisfied with simple solutions. So, naturally, this slowed the development process at first, but working from home was nothing new, and being able to see things from another perspective helped us quickly adapt and establish a digital plan. Having to plan our tasks at a granular level posed a significant challenge for us, but ultimately, it became our greatest strength. We previously held discussions in the hallway, at the coffee machine, or in meetings. Now, we suddenly had to define individual steps on online platforms to ensure a high degree of transparency. At the time, we were still in the prototype phase, not in the industrialization phase, and that certainly made the work easier.

THREE QUESTIONS:

Michael Rädler, Product Manager

Michael, as Product Manager, you were involved in the project from the moment it began. What impressed you most during that period?

Michael: What I found most impressive throughout the entire project was the team's unbelievable combination of innovative spirit, trust, and cohesion. We could feel it right from the very beginning: With the CPX 200, we wanted to do more than just develop another device; we wanted to set new standards. For me personally, it was the fact that OMICRON not only went down this path with us but also actively supported us, providing us with a solid foundation of confidence. I found the interdisciplinary cooperation that took place particularly inspiring. Different experts from all areas came together to work on a shared vision. Each one of them applied their expertise with exceptional attention to detail, without losing sight of the bigger picture. But what made the project particularly unique for me was the consistency of customer focus. We didn't hide our development behind closed doors. Users remained closely involved, we absorbed and scrutinized their feedback, and often, we even completely rethought our approach. This ongoing dialogue made us better, strengthening the team's cohesion. In the end, we all knew what we were doing this for: for our customers and a product we could take pride in.

If you had to choose two or three of the most challenging moments and the absolute highlights, what would they be?

If I'm honest, it wouldn't be fair to the project to only touch upon two or three things; there were simply too many unforgettable moments. You could fill an entire magazine with the highlights alone: from the first operating prototype to intensive customer feedback, and the team's excitement when a complex problem was finally solved. The journey was full of highlights, both big and small, that kept us going and motivated. Naturally, there were difficult moments too. The most difficult one was certainly the loss of Reinhard Gaurig, not only as a project manager, but as a person, mentor, and friend. The fact that he's not here to experience the achievement that we've all been working towards for so long is particularly painful now. And yet, his spirit remains part of this project. He shaped much of what we accomplished together. His passion, his humor, and his tireless energy live on in the way we work together as a team: with heart, with courage, and with a clear vision.

On a scale from one to ten, what level of engineering is involved in the CPX 200, and why?

If I had to rate the CPX 200's engineering level on a scale from one to ten, I wouldn't hesitate to give it a nine. I'm aware that, being someone who was involved in this project from the moment it began, I have a certain amount of bias. However, this isn't my way of congratulating myself. I'm looking at

its actual value and technical implementation from an objective perspective, and I believe it's truly exceptional.

We didn't get bogged down in simply creating technology for its own sake; instead, we consistently worked towards solutions that would generate sustainable added value for our customers.

Implementing requirements, whether in the field of safety, weight, multifunctionality, or performance, demands the highest level of engineering skill, and that's exactly what it received. Personally, I lean towards simplicity, as I'm fascinated by achieving as much as possible with as little as possible. But when it comes to technology, simplicity isn't a trivial matter. It denotes a reduction of the essentials, which reduces the error rate, increases robustness, and allows systems to be controlled and operated over a long period of time. The CPX 200 remains a highly complex system. However, we significantly expanded our technical and conceptual toolbox precisely to manage its complexity with precision, with a clear focus on ease of use and understanding the system. ▶





Wernich, as Business Unit Lead, you had to provide direction in delicate situations. Was there a decision you found particularly challenging? Did anything keep you awake at night?

Wernich: One of the most difficult decisions that kept me awake at night during my time as BU Lead was integrating the high-current source directly into the main device. Our road map originally provided a modular solution with an external current amplifier. This approach enabled flexibility and seemed technically appropriate. But, after receiving feedback, particularly from the distribution area, it became clear that the applications strongly supported an integrated solution. From a customer perspective, modular integration of the high-current source provided clear benefits: easier commissioning, improved operability, and a more compact design. This strategic change of direction had a major impact on our developmental planning and required considerably more adjustments than we initially expected. Despite this, we stood by our decision, knowing that ultimately, it would ben-

Wernich de Villiers, Business Unit Lead

efit our customers. At the same time, the interdisciplinary standardization of the safety concept from the CPX 200 and CMC 500 also posed a challenge.

After a long journey, you finally have the CPX 200 standing in front of you.

What's going through your head?

What inspires you when you think about the future?

Wow, what a great question! The first thing that comes to mind is innovation that offers genuine added value to our customers. When I see how far the CPX 200 has come, I'm reminded of the passion and perseverance of our team – always pushing the limit, always refining things.

What I'm most inspired by is how deeply motivated the team is. Particularly, when we feel our work is making a difference to customers. Their feedback is more than just welcome; it energizes us. It's a dialogue that defines and drives our next steps. In terms of the future, I'm inspired by having the potential to create meaningful innovation and genuine added value by continuing to focus on what truly matters: the people who use our solutions every day.

The CPX 200 and its entire ecosystem have given the world of primary testing equipment a brand-new test set. How and where do you see its application and role in the future?

I see enormous potential for the CPX 200 and its comprehensive

ecosystem. Three aspects deserve particular attention:

- › Efficiency throughout the entire test procedure: From test preparation to analysis, the goal is to simplify the test process and minimize time and effort for our customers to create a seamless and user-friendly procedure.
- › Creating added value that goes beyond testing: By actively supporting customer processes and interpreting their measurement data, we convert raw data into useful information that delivers deep insights into their assets – not just numbers.
- › Driving innovation by delivering value and exchanging ideas: This involves reconceptualizing our business model and pursuing innovative methods of collaboration and joint development with our customers.

In the future, I could imagine the CPX 200 ecosystem potentially becoming part of a larger OMICRON vision that brings together the testing experience across different platforms. A future where true value not only lies in individual tools, but in how intelligently they work together to support the daily testing activities of our customers. This might just be a wild fantasy, but it could also be exactly the kind of ambition that we need.

Peter Künst, Project Lead

Peter, your role as Project Lead began when the journey was already underway. What was your impression when you took over the project?

Peter: It was a huge step for me! It meant giving up my career as a software developer and dedicating myself to project management for years to come. I was quite naive and had no idea what I was truly in for – that at least made the decision easier at the time ...

How did you find your way – what were the obstacles, what continued to motivate you and your team?

The path turned out to be quite rocky! We were constantly battling with complexity and the challenges resulting from the compact design of the CPX 200. Fundamental components, such as the HVX10 transformer, the high-current module, and the safety interface, all took a long time to develop and, in some cases, were only finalized

at a very late stage, which constantly made planning difficult. Personally, I went through some highly stressful phases: restructuring the project in 2020, two red flags that required massive replanning, and once, even put the technical feasibility of the device in question; that wasn't an easy time for the developers, the core team, and me. Yet, despite the organizational challenges such as the coronavirus pandemic, the component crisis, and staff shortages due to other projects, seeing the product come together and how the results from different teams fed into each other to form a complete picture motivated us all! One or two project beers along the way obviously helped as well (laughs).

Now that you're approaching the end of the project – how are you feeling, what are your thoughts?

I'm constantly impressed by the outstanding cooperation everyone's

displayed to reach one goal: to finally deliver our outstanding CPX 200 eco-system to our customers! What are my feelings about this final project phase? I'm proud and eternally grateful to have been able to work together with such a wonderful team! And the long-awaited relief? That'll probably come after the first devices are delivered – or maybe not, as further releases and products will need to be planned and developed as soon as possible. ▶



WHAT DO OUR PRODUCT MANAGERS HAVE TO SAY ABOUT THE NEW ECOSYSTEM'S FUNCTIONS?

An ecosystem that revolutionizes multifunctional testing

The CPX 200 is more than just a test set! Tough and compact hardware provides a reliable foundation in the field, combined with the CPXpert software that's been carefully tailored to hardware and applications with the most comprehensive safety functions on the market. Modular accessories such as the HVX10 system component or the slide-in High Current Module can be added at any time. CORTEX Grid combines all of your test data into a powerful, cloud-based software platform. It facilitates data management, assessments, and reporting for a variety of electrical installations. The interaction between all the components creates an exclusive next-generation test system.



Michael Rädler, CPX 200 Product Manager

You're focused on the CPX 200's hardware and accessories; what fascinates you the most about the way the components interact?

Michael: What I find most fascinating is how the interaction of all the components, such as the hardware, accessories, and software, blends together to create a complete, harmonious system. One thing was clear to us from the start: If it's not easy to use, it won't be acceptable. That's precisely why we were so focused on uncompromising functionality. For us, "Plug and Play" is more than just a marketing promise; it's a principle that can be found throughout the entire system.

We wanted to create a clear product language that's intuitive, quickly understood, and supports

the daily workflow of our customers. Every connector, every cable, every carry handle is the result of intense considerations, tests, and rounds of feedback. We know that nobody finds good hardware with poor accessories, or vice versa, impressive. So, we scrutinized each detail, held discussions with experts, iterated, and optimized. These days, the term "ecosystem" is often used carelessly. But with the CPX 200, it applies to its core: We've developed a system in which everything intertwines – functionally, physically, and digitally – to generate genuine added value. Ultimately, a chain is only as strong as its weakest link. That's why we left nothing up to chance.





Jakob Hämmerle, Product Manager Safety

**Your focus is on user safety –
how would you describe the
CPX 200's safety measures and
benefits in action?**

Jakob: The CPX 200 sets new standards in terms of safety. Externally, you can see recognizable red/green signal lights and the new INTERLOCK key. The software provides support with individually tailored wiring diagrams and preliminary tests for specific measurements that validate the wiring. But we also made life easier for users with a whole host of other, smaller features, such as an automatic brightness sensor. This ensures the efficiency of the CPX 200, while also being the safest device in its class.



Lukas Klingenschmid, CPXpert Product Manager

**With your focus on software and firmware,
what benefits do you see in the new system?**

Lukas: I consider the new system to be a finely tuned cog with three interconnected parts: software, firmware, and hardware. Each of these areas is strong, but they only create something that goes beyond the sum of individual parts when they're working together. This isn't a zero-sum game, where one gain comes at the expense of another. It's quite the opposite; the elements support and build on one another to ensure a consistently positive experience for all

users. I'm particularly proud of the scalability and flexibility of our solution. From testing engineers in the field to installation managers in the office, CPXpert is practical and saves time for all of them. We don't just provide measurement results; we create transparency, traceability, and efficiency at all levels. That's precisely what I believe lies at the core of the CPX 200 ecosystem: It thinks, it adapts and remains open to everything yet to come. ▶



Bavley Farid, CORTEX Grid Product Manager

CORTEX Grid, the long-awaited cloud solution that brings everything together, is part of the CPX 200 ecosystem. What are the benefits of the interaction between the CPX 200 and CORTEX Grid?

Bavley: The interaction between the CPX 200 and CORTEX Grid enables seamless data continuity from the test site to the cloud. The test data recorded with the CPX 200 is immediately standardized and merged with results from other OMICRON test systems, such as CPC 100, TESTRANO 600, CT Analyzer, and CIBANO 500, to create a uniform and comprehensive asset record. This comprehensive overview enables more in-depth analyses, efficient reporting, and

added value for the data in the long term throughout the entire life cycle of an asset.

But CORTEX Grid is capable of so much more! Where is the journey headed?

CORTEX Grid is constantly developing: It's becoming a central data platform that supports fleet comparisons, advanced diagnostics, and data-driven maintenance strategies that help customers convert decades of test data into actionable findings.



Projects					
Project	Substation name	Testing window	Creation date	Created by	
Project F	OMICRON Australia	1/27/2025 - 7/31/2025	7/29/2025	Bavley Farid	
Project D		1/27/2025 - 7/31/2025	7/15/2025	Bavley Farid	
Project C		1/6/2025 - 7/19/2025	7/15/2025	Bavley Farid	
Project B		1/26/2025 - 7/24/2025	7/15/2025	Bavley Farid	
Project A		7/13/2025 - 7/17/2025	7/15/2025	Bavley Farid	

Reports					
Report name	Status	Project	Last modified on	Report type	Created by
Quick Test Report	Created	Project F	7/29/2025	On-site	Bavley Farid
Demo Report	Approved	Project D	7/26/2025	Full	Bavley Farid
Report for Project D	In review	Project B	7/24/2025	Full	Bavley Farid
SWTS Diagnostics	Created	Project A	7/22/2025	On-site	Bavley Farid
Report for Project A	Reviewed	Project A	7/16/2025	Full	Bavley Farid

Assets					
Serial number	Asset	Last tested on	Project	Conflict	
92738	Transformer	4/21/2019 1:56:03 PM			
92735	Transformer	4/20/2019 2:20:02 PM			
Sample TESTRANO without LRT	Transformer	2/4/2022 4:44:44 PM			
2365993	Transformer	6/14/2022 2:48:01 PM	Project F		
66056	Transformer	4/29/2019 5:47:37 PM	Project F		
66052	Transformer	6/5/2018 12:14:12 PM	Project F		

UNLEASH THE EXPERT

The CPX 200 and its entire ecosystem were developed to solve existing and future problems. Multifunctionality, a modular structure, and its light weight help combat unstable power systems and decentralization. For example, commissioning and maintenance activities are perfect applications for the CPX 200. Service providers, manufacturers, asset managers, and test field engineers all benefit from the safest test set on the market, in

addition to new, easy transport in a backpack or flexible transport case perfect for shipping.

Many companies, including us, are facing a significant skills shortage combined with more work. Being fifty-nine percent smaller than the average test, and the world's smallest and lightest multifunctional test set, the CPX 200 provides freedom for faster and more mobile operation,

enabling users to accomplish more under safe conditions in less time. The improvements go well beyond the hardware; the CPXpert software also helps optimize test preparation, execution, and result analysis with modernized operating features. Topped off with CORTEX Grid, acquired data is available for various evaluations and interpretations worldwide in minutes, enabling the best possible condition assessments for all your assets.

Marcel Sigl, CPXpert Project Lead

Marcel, as a CPXpert Project Lead, what are your highlights from the new software? What were the main challenges faced by your team?

Marcel: Creating completely new, streamlined software architecture that provides space for future requirements, expansion possibilities, and innovation was the greatest challenge. It was and still is vital to integrate features that are powerful and flexible, while remaining simple and intuitive. Our goal was to create a technologically strong solution that could effortlessly help our users focus on the core aspect of their work: precise, meaningful measurement results. Personally, the highlights are definitely the flexibility and usability of CPXpert. We successfully created flexible and intuitive test procedures that let users save time without impacting the quality of their results. The three-phase current transformer test is another unique feature that tests all three phases with a seamless procedure.

The practical multi-window views are an additional highlight that support parallel testing while simultaneously maintaining an overview of various assets. A great deal of thought also went into reporting, where we focused on making genuine improvements for our customers. Automatic result evaluation and reporting with the click of a button increases transparency and speeds up analysis.

In addition, we had to ensure seamless automatic evaluation and synchronization with CORTEX Grid. All of this is perfectly balanced by a direct connection that ensures the central availability of all test results with up-to-date, high-quality data. Overall, finding the balance between complexity and usability was truly a team effort. ▶





Developed with safety in mind

Reduced risk of electrical dangers thanks to comprehensive safety features:

- › Red and green signal lights
- › Emergency switching off button
- › INTERLOCK key
- › Workflow according to EN 50191
- › Wiring instructions with connector indicator lights
- › Optional external signal lamp (*available soon)



Adjustable to meet your requirements

Thanks to its modular hardware, software, accessories, and customized service offers, the CPX 200 can be configured precisely to your needs. You can start with a flexible,

multifunctional test solution; later on, it can easily be converted into a specialized testing system that meets your specific requirements.



Unleash its full potential with:

- › 1,000 A AC/DC with the High Current Module
- › 10 kV AC/DC with the HVX10 system component
- › Test frequency range: 1–600 Hz and DC



Maximum power per space

All tests can be carried out with a total system weight of less than 30 kg.

- › CPX 200: 10.6 kg
- › High Current Module: 3.3 kg
- › HVX10: 14.8 kg
- › Better access in confined areas thanks to a carry or backpack solution.
- › No need for heavy lifting and transport restrictions due to the lightweight system solution.



Always ready for use

- › Combined measuring channels reduce wiring efforts
- › Real three-phase voltage and transformation ratio measurements
- › Color multi-touch display with automatic brightness adjustment for unmatched readability in every environment
- › Guided test procedures with access to nameplate data – fast and safe for proper configurations
- › Multi-asset tests via standard user interface
- › Full, automatic documentation and evaluation of test results – seamless and compliant
- › Efficient test planning and reporting



Next-generation technology

Our solution was specifically developed to meet the growing demands of modern and future power systems.

- › Developed and certified in accordance with international standards – for global application and maximum quality
- › Based on modern safety and cybersecurity guidelines for maximum protection in networked infrastructures
- › Ongoing support and reliable maintenance – for investment security and operation for years to come
- › Perfectly developed for the substation commissioning and diagnostic tests
- › High-quality components for hardware and software that include perfectly engineered accessories for professional use

Michael Siller, CPX 200 Product Owner

As the CPX 200 Product Owner, which key features do you consider particularly important? Or which ones were particularly difficult to implement?

Michael: Wow, that's a very good question – there are a few. Depending on your point of view, there are several particularly successful and challenging features.

I would put the model-based CT Excitation feature at the very top of the list, not only because it brought together all the different technical disciplines (signal processing, control technology, physics & mathematics), but also because it repeatedly generated discussions concerning sustainable software architecture. These findings helped establish a foundation for high-quality functionality and led to better, future-proof architecture for several other applications. We also took advantage of synergy potential and are perfectly equipped to handle the future challenges of other applications. Naturally, making all this possible has required a great deal of our time, sweat, and passion. In retrospect, it's been an enjoyable investment

that's paid off and justified itself many times over with the successes we achieved.

Aside from that, developing the HVX10 and its features was both a highlight and a challenge for me. We were able to learn a great deal from earlier systems, allowing us to improve and speed up a number of things from the beginning. However, the underlying electrical engineering and electronics were a significant challenge. Many issues only became apparent during development; we were able to adapt to some of them, but sometimes we had to go back to the drawing board. It was one of the first tasks that I tackled as Product Owner and one of the last that was finished. The HVX10 remained with me throughout the entire project, as both a highlight and a low point. That's why we take great pride in being able to place this solution on the market.

The most ambitious feature of the entire system is the CPX 200 High Current Module. A light-weight and flexible module that supplies 1,000 A AC and DC, in addition to constantly providing 100 A for winding resistance measurements. The final hardware concept arrived late and also contributed to the identification and resolution of the problems associated with this challenge.

I can clearly remember the first baby steps we took while the rest of the system was nearly complete. We quickly began taking larger steps and were constantly optimizing. Based on feedback I received visiting various countries during the developmental phase, no other aspect of the CPX 200's ecosystem has had the impact and history that the High Current Module has. I feel fortunate that I was able to experience that and tell you about it today. ▶



CPX 200, THE NEWEST MEMBER OF OUR TEST SET SUITE

Some of you will likely be asking how the CPX 200 will fit into other test sets from our primary test equipment portfolio. The CPX 200 and CPC 100 are two of our multifunctional flagships and modern test sets for medium- and high-voltage assets. They provide considerable added value, particularly

for current and voltage transformer segments and power transformer testing. The CPX 200 is the next generation of these devices and provides extended features with a modern platform. However, only the CPC 100 currently supports testing for grounding arrangements and rotating machines.

In contrast to expert test sets such as the CIBANO 500, TESTRANO 600, or even the CT Analyzer, generalists have a broader application, while experts offer greater in-depth testing. Our sales department is more than happy to help you find the system that meets your needs.

Michael Rädler, CPX 200 Product Manager

Michael, as Product Manager, you probably already have several ideas for further developing the CPX 200. Is there a specific challenge you'd like to tackle?

Michael: As Product Manager, I'm constantly working on ways to continue the CPX 200's development. Naturally, there are already plenty of ideas surrounding the direction that journey could take. What's particularly exciting is that the CPX 200 is a platform designed with a forward-facing approach that applies to its hardware and software. Its modular architecture opens fantastic possibilities for seamlessly integrating new applications, test methods, and features into an existing ecosystem. Targeting and exploiting this potential will be a significant

challenge in years to come, not simply from a technical perspective, but also in making sure we remain focused on our customers' actual needs.

We have a clear vision, and concrete initiatives are already on the radar, but for me, one thing is essential: active listening. Only by holding continuous discussions with our customers and partners and taking their challenges and ideas seriously can we develop solutions with pioneering technology that are also genuinely practical. As a Product Manager, this represents both my highest responsibility and the challenge I'm most attracted to. ▶





THE END OR THE BEGINNING?

As our journey nears its end, we can proudly watch our latest innovation establish itself on the market. An enormous amount of passion and even more expertise has flowed into its development. You might begin to wonder if that notorious vacuum that

often follows a peak performance is about to settle in. But wait! We're also right back at the beginning. The modular concept behind the CPX 200 only has one limitation: the limits of our creativity. Our numerous ideas, some of them already in development, our

eagerness to hear customer feedback, paired with motivation and a thirst for action, are what keep us happily pushing ahead. Join us as we look forward to the coming years! Until then: "For those who empower. The CPX 200 is made for you."

*«For those who
empower. **The
CPX 200 is made
for you.»***



Tobias Schmutzhard, Process Manager BU Prim

Tobias, what does the CPX 200 mean to you and OMICRON's further development?

Tobias: In the coming years, the CPX 200 is going to play a key role in our product portfolio. Countless ideas, customer requests, innovative passion, and plenty of emotion all flowed into the development of this test set. The team supported each other, and the cooperation between different disciplines allowed seemingly insurmountable chal-

lenges to be transformed into outstanding solutions. As one of more than 250 people involved in this project, I'm proud that I was able to play a small role in its evolution. We're looking forward to customer feedback, which helps us continuously improve the CPX 200 ecosystem.



Derek Brown, Regional Manager, North America

Derek, how do you see this product from a global perspective? What are your expectations?

Derek: Following last year's successful introduction of the CMC 500, we're looking forward to launching our next major innovation on the market: the CPX 200. This impressive product will trigger another wave of innovation that's sure to impress our customers and competitors. The initial package of features included in the CPX 200 is ideal for the service sector. Its lightweight, compact design, and high output power are significant unique selling points

that will be popular amongst users. What truly sets this market launch apart is the improved software ecosystem and modular design. These improvements don't just make the product more user-friendly; they pave the way for new business models and optimize order processing. We're convinced that the CPX 200 marks the beginning of an exciting new chapter in our innovative history.



Ahmed El Hamaky, Regional Manager, Middle East and Africa

Ahmed, how do you see this product from a global perspective? What are your expectations?

Ahmed: The CPX 200 fulfills the increasing demands and expectations of utility companies and service providers for compact all-in-one

test solutions. It offers speed, accuracy, and digital workflows that reduce downtimes and increase efficiency in the test environment. ■



External emergency
switching off button
with safety light

TEST EFFICIENTLY, WORK SAFELY

CMC 500 and CPX 200 – the benchmark in work safety

It begins with soft clicking, followed by a buzzing sound. A test cycle in an electrical installation is underway – precise automation in a fraction of a second. But an invisible force lies behind this routine: electrical power. It drives machines, supplies cities with light, and keeps entire infrastructures running. And yes, it also involves risks – especially where it is tested and connected.

A lot has happened in the past five decades: The fact that fatal electrical accidents have fallen by about 90 percent, is clear evidence that safety measures are working. But the increasing electrification of all areas of life and work places ever greater demands on protection mechanisms, especially when testing electrical energy

and protection systems, where high voltages and complex processes meet. In these areas, technicians at work are exposed to a higher risk of electrical dangers. As a result, the amount of safety in the electrical testing technology world is the benchmark for every test set that must be measured. But what exactly is personnel safety? Furthermore, how can we develop innovative safety functions that provide protection while making the test process more efficient?

Innovative safety functions – efficiency meets safety

The CMC 500 and the CPX 200 are setting new benchmarks. Their safety functions go well beyond simple compliance – they make the testing process safer and more efficient.

Operational
mode button

Status light

Interlock
key

External emergency switching off button with safety light



Status light

One of the new key features is the status light that reliably shows whether the outputs of the test set are de-energized or still potential sensing. When testing inductive assets, dangerously high levels of energy may still be present, which is why measuring the current flow after testing and before rewiring is essential. The CMC 500 and the CPX 200 have a specially designed safe return measurement function and a status light that indicates the output state, for this specific reason.

Operational mode button

Another effective safety function in the CMC 500 and the CPX 200 is the operational mode button that can switch specific signal outputs on or off when it's turned on. This allows the outputs to be de-energized with the push of a button if necessary. This provides the advantage of not having to completely switch off the test set to modify the wiring. So, disconnecting and reconnecting the test set and testing software after switching off is no longer an issue.

Interlock key

The INTERLOCK key is a new safety function that is available with the CMC 500 and the CPX 200. Removing the key from the test set ensures it cannot be activated unintentionally or by any unauthorized personnel. This is a particularly important factor in situations where numerous people may be working on an installation. After reinserting the interlock key, the test set is immediately ready for operation, and work can resume without further delay.

External emergency switching off button with safety light

Available soon: The external emergency switching off button with a safety light for the CMC 500 and the CPX 200 provides additional safety. The external emergency switching off button can be positioned according to requirements and is easily accessible in the event of an emergency. It is clearly visible, and activating it is quick and easy. Therefore, test setups with multiple emergency switching off buttons in accordance with EN 50191 can also be implemented. The integrated safety lamp indicates the safety state of connected devices. ▶





How effective are these safety functions?

The effectiveness of safety functions depends on many factors. More safety functions do not automatically mean more personnel safety. The right balance between usability and protection is critical. If a safety light uses numerous signal patterns instead of displaying clear signal colors such as red and green, signals may be misinterpreted, or even ignored.

Detect dangers – reduce risks

To put it simply, people need to be protected from harm resulting from potential dangers. That's why we focus on dangers stemming from the environment, test set, or test procedure when we're developing safety functions.

Dangers posed by the environment

- › **Sight and access:** The visibility at test sites is often poor. This increases the risk that someone may accidentally enter a danger zone and identify the emergency too late.
- › **System errors:** When testing an entire system, defective components can trigger unpredictable reactions, such as faulty protection relays with incorrect signals.

- › **External influences:** Several people may often be working in the same area. In such cases, poor communication or accidental activation can be another danger source.

Danger stemming from the test set or the procedure

- › **Electrical shock:** Test sets deliver high voltages. Before work begins, the test set (or its outputs) must be disconnected from the power system. Additionally, when connecting, the safety plugs must be used and the correct sequence must be followed.
- › **Wiring errors:** Large numbers of cables are difficult to manage. Errors can lead to damage or injury. Precision during wiring is just as critical.
- › **Improper grounding:** A disconnected protective conductor places people and devices in danger. Additional grounding is mandatory.
- › **Procedural errors:** Time pressure can lead to careless actions, such as rewiring while the device is switched on.
- › **Measurement errors:** Calibration can become inaccurate due to aging or environmental influences. Regular checks are required.



LISTEN TO THE PODCAST

Interested in this topic?

Then listen to our podcast series “CMC 500 – From conceptualization to the benchmark for personnel safety”. Scan the QR code or visit:



omicron.energy/episode103

Standards are the foundation of safety

Safety standards played a fundamental role in developing safety functions for the CMC 500 and the CPX 200. The safety functions for both devices were developed in close collaboration to ensure a consistent and compliant safety concept. The IEC 61010-1, ISO 13849-1 (with IEC 61508-3), and EN 5019 standards were particularly relevant in this regard.

IEC 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use

IEC 61010-1 specifies general safety requirements for electrical measurement, control, and laboratory equipment. Its objective is to minimize the hazards for users and the environment. Among other things, it stipulates protection measures to eliminate electrical, mechanical, and thermal hazards and prevent the spread of fire that a faulty device might be cause.

ISO 13849-1 – Functional safety

This standard describes the principles for designing safety-related control system parts (including software) to mini-

mize the probability of dangerous errors. It is supplemented by IEC 61508-3, which is valid for software, and applies regardless of the technology used – whether electrical, mechanical, or hydraulic.

EN 50191 – Erection and operation of electrical test equipment

This European standard regulates the setup and operation of electrical test equipment. Among other things, it contains specifications for protection measures, personnel, test procedures, and, for example, how to use lamp states (red/green) to signal operational status.

Conclusion: Safety is not a compromise – it is a driver of innovation

Developing innovative safety functions shows that personnel safety and efficiency are not mutually exclusive. Quite the contrary: In the CMC 500 and the CPX 200, they complement one another by setting a new benchmark for safer, smarter, and more sustainable testing processes. ■



THE SOURCE OF ~~LIFE~~ DESTRUCTION

The substation is operating according to plan. No unusual incidents, everything is functioning normally. And then suddenly, a loud bang can be heard as a transformer's insulation is punctured. The most expensive asset used in power transmission and distribution has just suffered a complete failure – an asset owner's nightmare.

A precondition for safe operation

Insulation failure is one of the main causes of transformer failures. Regularly monitoring a transformer's water content can help detect impending failures early on. Water is a natural byproduct of aging cellulose insulation and, therefore, an indication of its integrity and remaining life span. When an asset's moisture content level is known, its lifetime can be estimated and – if required – extended with targeted maintenance measures, such as drying.

The measurement method of choice: dielectric frequency response

Dielectric frequency response (DFR) can be used to reliably assess the moisture in a transformer's paper insulation. The non-invasive method is scientifically proven by CIGRÉ and can determine the moisture content reliably. Determining the value directly in the cellulose, where most of the moisture is located, is what makes this method so accurate.

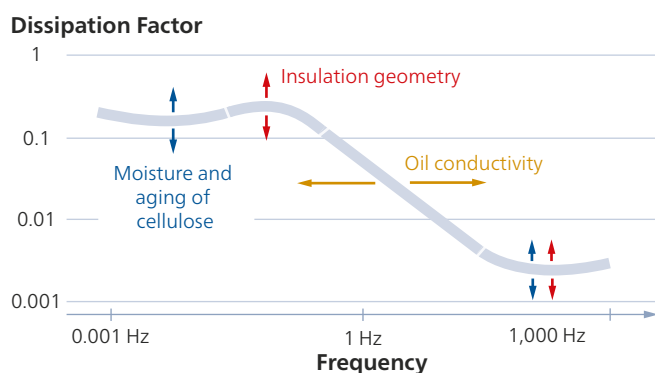


Figure 1: The dielectric frequency response curve provides information about different factors that influence the measurement result, such as the moisture content of the insulation.

Using dielectric analysis to determine the moisture content also avoids the pitfalls of other analysis methods, such as environmental influences or the final decommissioning requirements for an asset.

Informative low frequencies

Information about the insulation's dielectric response can be gathered by measuring and analyzing the dissipation factor $\tan(\delta)$ across a wide frequency range. The measurement curve has a characteristic "hump" shape at very low frequencies (Figure 1). This is due to the polarizing effects of interfaces in the oil-paper insulation. The range roughly 1 to 2 decades below this increase is primarily influenced by the dielectric response of cellulose insulation, and therefore, by the transformer's moisture content.

The crux of the measurement time

The dissipation factor can be determined using several methods. Frequency Domain Spectroscopy (FDS measurement) provides fast and precise results for frequencies above 0.1 Hz. However, at lower frequencies, this method is relatively slow. This means a measurement from the kHz down to the μ Hz frequency range lasts hours or days. ▶

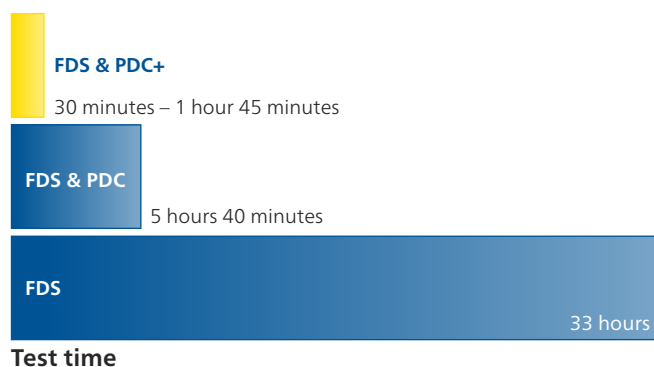


Figure 2: Thanks to the patented combination of FDS and PDC+, the DIRANA completes the dielectric analysis of a transformer insulation in 30 to 105 minutes maximum. The FDS method requires more than one day for results in the same frequency range (1 kHz to 10 μ Hz).

This obstacle can be avoided by measuring the polarization depolarization current in the time domain (PDC measurement). In this scenario, an applied DC signal stimulates all frequencies simultaneously. Analyzing the dissipation factor with this method significantly reduces the duration of lower frequency range measurements.

DIRANA moves at turbo speed

Our DIRANA combines these two measurement methods and even goes one step further: It uses an advanced version of the PDC method – the dynamic “PDC+” algorithm. Compared with the traditional PDC method, this approach calculates up to 20 times more data in the frequency range based on the same time-domain information. The result is a process with a much shorter measuring time but the same amount of data (Figure 2).

In many cases, the measurement also doesn’t need to be performed down to the smallest possible test frequency to properly assess the insulation’s state. Stopping the measurement earlier saves a lot of time. DIRANA therefore analyzes the real part of the capacitance (C'), ensuring the critical frequency range for moisture analysis is fully recorded and the measurement isn’t stopped prematurely. This way, the measurement is always performed as long as required but not longer than necessary.

No expert knowledge necessary

The method described above allows DIRANA to automatically apply the ideal frequency range for assessing the insulation. This process once required a great deal of experience, as did the subsequent assessment of the measurement results. This is due to factors such as insulation geometry, oil conductivity, and aging byproducts that influence the measurement curve (Figure 1). The DIRANA software automates all those steps: It compares the measured dissipation factor curve with modelled curves from a comprehensive database. The assessment automatically considers all these factors, and the temperature is all that an operator needs to enter.

DIRANA also evaluates the results in accordance with national and international standards and prepares individually configured reports. Thanks to this pioneering test solution, comprehensive expert knowledge is no longer necessary for reliable assessments of transformer insulation’s moisture content which is the basis for assessing the remaining lifetime of the transformer. ■

*«Compared with the traditional PDC method, **PDC+ calculates up to 20 times more data in the frequency range based on the same time-domain information.**»*



DIRANA

- › Reliable, non-invasive moisture content measurements for power transformers and oil-impregnated paper insulation (OIP)
- › Significantly shorter measurement times due to a combination of innovative test procedures and automatic frequency range determination
- › Simple, automated analysis that doesn’t require expert knowledge



LESS CABLES. MORE SAFETY. MAXIMUM EFFICIENCY.

Measure cable impedance safely and efficiently with the CIB1 for the COMPANO 100

2024 set a global record: More than 1.3 million new public charging points were installed with 585 gigawatts of additional renewable energy capacity, 452 gigawatts of which was generated from solar power. This momentum is creating new challenges for power grids: more power, more complexity. To meet these requirements, existing grid structures need to be comprehensively modernized, converted, or expanded.

For grid operators and test teams, this current development requires a significant increase in testing time and effort amid a skilled labor shortage.

In consultations, users have repeatedly expressed their desire for optimized, automated, and guided test processes. The goal isn't simply about saving time; it is also about reducing the error rate and making overall test procedures

more efficient and safer with fewer resources. This premise was the starting point for developing the new CIB1 accessory for the COMPANO 100. It enables simple, efficient, and safe line impedance measurements for cable systems and short medium-voltage overhead lines up to 10 km long. As the CIB1 is optimized for medium-voltage power cables, we use the term cable impedance. ▶

Optimized for ease of use

When developing the CIB1, great emphasis was placed on user-friendly operation, a high level of automation, a straightforward test setup, and direct result calculations. This led to a system that is easy to use, significantly speeds up measurements, and can be used reliably and efficiently in daily operations.

Automated switching for saving time and improving safety

One of the most time-consuming steps when measuring cable impedance is manually reconnecting the test leads between various measuring loops. During measurements using the four-wire method, this process also needs to be carried out for the current and voltage circuits. Complying with the mandatory safety distances is often challenging in practice. Additionally, couplings from neighboring systems can generate dangerously high voltages. Therefore, the end of the cable needs to be grounded and subsequently disconnected before every reconnection to ensure safety. This critical safety sequence is time-

consuming and needs to be repeated for each individual measuring loop.

To optimize this process, an automated switching matrix was integrated into the CIB1. The use of six relays for each voltage and current circuit, enables safe and contactless reconnection between all relevant measuring loops without any manual intervention. This results in significantly reduced measuring times and enhanced safety for the test personnel.

Combined measurement cables for maximum efficiency

Measuring cable impedance with standard measuring leads generally requires three pairs of cables from the test set to the unit, which includes the protection and matching circuits: one for the power supply and two for the voltage and current measurement.

Two additional pairs are required for a four-wire measurement. The setup and removal of these test leads is very time-consuming.

Combined cables with a common plug at one end were developed for the

CIB1. This enables much faster and easier setup and removal, as only two cables are required rather than a minimum of ten, as was previously the case.

Result calculations directly in the device

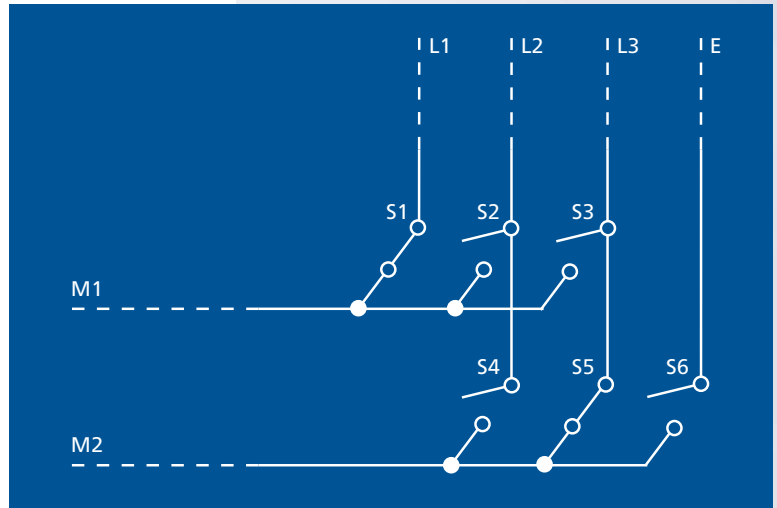
Another optimized feature is calculating measurement results directly in the COMPANO 100. As all CIB1 measurements are fully automatic without manual intervention via the integrated switching matrix, evaluation is carried out as part of the measurement. The positive-sequence impedance (Z_1) and zero-sequence impedance (Z_0) are determined based on different measurement loops. In addition, the COMPANO 100 calculates relevant settings for protection relays, known as K factors, directly in the device. Alternative cable models can also be calculated if needed.

This enables direct result validation, for instance, with a consistency check for resistance and reactance values (R and X) as well as the cable length in consideration of the positive-sequence impedance (Z_1).

*«The use of six relays for each voltage and current circuit, enables safe and contactless reconnection between all relevant measuring loops **without any manual intervention.**»*

Detection and warning for coupled voltages

The CIB1 has separate controllable relays that enable a delayed activation for the current and voltage circuits. This architecture allows the voltage circuit to be activated first, while a coupled voltage check takes place before the current circuit is connected. If a transgression is detected in the permissible voltage, the system issues a warning and aborts the measurement. This automatic procedure not only increases user safety; it also reliably protects the connected test set from damage.



Integrated switching matrix with six relays each

Cable impedance: fundamentals, impact & relevance

Cable impedance is the frequency-dependent complex resistance of a cable. It is measured in ohms and measures resistance (real) and reactance (imaginary). At low frequencies, the impedance is primarily determined by the conductor's resistance. At higher frequencies, the capacitance between the cable and its shield, and the inductance of the magnetic field, increase the reactance. ▶



Simple connection with two combined cables



Calculating measurement results directly in the COMPANO 100.



Cable systems in a medium-voltage switchgear

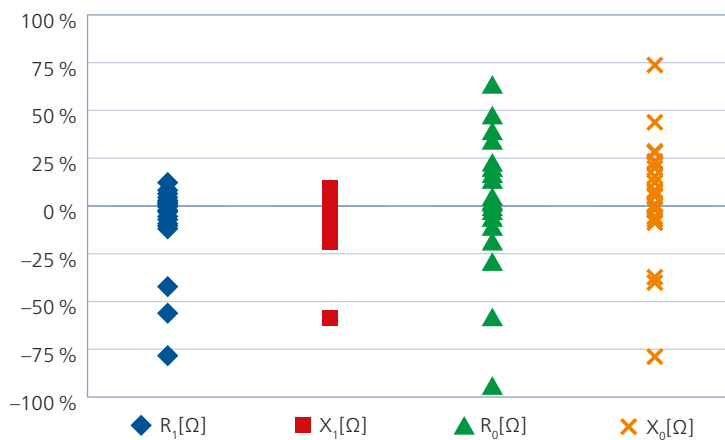
In a three-phase system, the impedance of individual conductors can be measured. However, in symmetrical components, the impedance is usually indicated for the entire three-phase system. In this case, the positive-sequence impedance (Z_1) is primarily determined by the cable configuration. In contrast, the zero-sequence impedance (Z_0) depends on the cable shield and the protective ground.

Why is cable impedance relevant?

Cable impedance serves various purposes. It is an important starting value for distance relays, which determines the location and direction of a fault, based on its impedance measurement and the set cable impedance value. When a fault occurs, they either rapidly trip the circuit breaker, or only after a set delay time that depends on the fault's location and direction. During this delay time, another relay closer to the fault location may potentially trip its circuit breaker to limit the effects of the fault. The respective trip regions (zones) and delay times are coordinated in a tripping schedule that covers all affected relays. Ideally, only the necessary area is switched off during a fault.

If the values used for cable impedance are inaccurate, an incorrect fault location may be determined, and the distance relay either trips unnecessarily, with a delay, or not at all. If a distance relay fails to react in time, an upstream relay usually trips after a set time. In these cases, the settings may cause much larger parts of the power grid to be switched off than necessary.

Besides the settings for the protection relay, the cable impedance is also used in fault localization methods, for load flow calculations, and for grid simulation.



Deviation between setpoints (usually calculated) and measured values for R_1/X_1 and R_0/X_0 from different cable systems

tion. The latter is becoming increasingly relevant due to the rapid growth of the distribution grid, for instance, with decentralized power production and additional charging infrastructure for electric vehicles. Correct grid calculations help prevent overloads and keep voltage in a permissible range.

Should cable impedance be calculated or measured?

A cable's impedance depends on the type of cable and the type of installation. Manufacturers usually provide cable-specific data, but in practice, actual values are influenced by many factors. So, while calculating impedance values is possible, depending on the setup, the calculations are often inaccurate.

While positive-sequence impedance ($Z_1 = R_1 + jX_1$) can generally be reliably calculated, zero-sequence impedance ($Z_0 = R_0 + jX_0$) depends heavily on the local ground connection conditions, and precise determination is often dif-

ficult. The measurement provides much higher accuracy for mixed or upgraded cable systems, particularly with joint installations. It provides reliable values, especially for older or extended grids

where a reliable calculation basis does not exist. Therefore, in many cases, it is the safest method for determining cable impedance with precision. ■

«Manufacturers usually provide cable-specific data, but in practice, actual values are influenced by many factors. So, while calculating impedance values is possible, depending on the setup, the calculations are often inaccurate.»

SHAPE THE FUTURE OF TESTING – WITH YOUR EXPERIENCE!

The CIB1 was developed to make your test processes easier, safer, and more efficient. But we still have a long way to go – because no one knows the everyday challenges better than you.

- › What features would make your workflow even easier?
- › What are the specific needs for your daily testing activities?
- › What are your processes missing for seamless integration?

Your opinion counts!

By participating in our short, anonymous survey, you can help us as we continue to better tailor our test sets to your needs. Duration: Just 3 minutes. Impact: Permanent. Our gratitude: Infinite!

Scan the QR code and contribute your expertise – to our solutions.

 omicron.energy/survey



DRIVING INNOVATION ACROSS BORDERS

Transforming miles into meaningful
customer value

Wherever electrical power systems are tested, measured, or understood, our OMICRON Roadshow Truck is ready to roll. Designed as a mobile training and demonstration platform, it brings expert knowledge, practical experience, and interactive learning directly to your doorstep. Equipped with our latest testing and monitoring devices, including our CMC product family – the newest CMC 500 – as well as the CPX 200, TESTRANO 600, MONTESTO 200, and MPD systems, it delivers hands-on training experience tailored to our customers' needs.

Instead of requiring our customers to travel, the truck creates a professional, hands-on environment on site. Whether in a substation yard, company parking lot, or training center, it transforms any location into a space for meaningful exchange and skill development. The truck delivers consistent, high-quality training wherever it goes.



«DRIVEN BY PASSION» – A LOOK BEHIND THE SCENES AT OMICRON'S ROADSHOW TRUCK DRIVER

Since 2013, Robert Rademakers has been driving the OMICRON Roadshow Truck across Europe and beyond. What sounds like an extraordinary job is, for him, a true calling. With enthusiasm, years of experience, and a deep curiosity for people and culture, he brings cutting-edge testing technology directly to customers on-site. In this interview, the friendly Dutchman shares his insights about the daily routine on the road, talks about his favourite countries, the challenges at national borders – and recalls a truly unforgettable experience in Romania.

What does a typical Roadshow day look like for you?

Robert: The day starts in a very conventional way: a shower, a good cup of coffee, then breakfast. After that, I get on the truck and drive to the customer's location. Once there, we set up the Roadshow Truck, which usually takes about 30 minutes. Then the presentations begin, and I support the speakers throughout the sessions.

At lunchtime, we typically eat with the customer, which is always a great opportunity for a more personal exchange. In the afternoon, there are usually more presentations. After that, we dismantle everything and move on to the next customer location. In the evening, the team has dinner together, and the next morning, it starts all over again. On average, a typical day is about 11 hours long.

Is there a country you particularly enjoy?

In terms of food, Italy, Portugal, and Spain offer meal breaks that are a real highlight.

When it comes to landscapes, Norway is my favorite. The natural beauty there is simply breathtaking.

What's the biggest challenge on the road?

Customs paperwork, especially at borders, is particularly important, as it often involves ATA Carnet documents, which are international customs permits that allow for the temporary import and export of goods without incurring duties or taxes. It can become quite complex and often requires a lot of time and patience.

How do you feel about constantly being on the road?

I still love it, even after more than 40 years on the road. The variety is what makes it exciting: meeting new people, visiting different places, and working with a wide range of customers. I appreciate the personal contact and exchange with my colleagues. It keeps me young and motivated.

How long have you been driving the OMICRON Roadshow Truck?

Since 2013, it's a unique task that's more than just a job for me.

What do you enjoy most about your work?

The diversity! I get to experience so many different cultures, travel to various countries, and must constantly adapt to new situations. This flexibility at each customer site keeps things dynamic and interesting.

Is there a particularly memorable experience that stands out to you?

Yes, one particularly memorable experience took place in Romania. Following one of our presentations, a celebratory gathering was held in our honor, featuring a whole lamb roasted on a skewer. The story behind it was equally remarkable: a local farmer receives freshly cut grass from our client to feed his livestock, and in return he provides them with a lamb each year. That lamb was prepared and shared among 25 to 30 guests after the Roadshow – a gesture that went far beyond culinary appreciation. It was a moment of genuine warmth and hospitality that left a lasting impression. ▶



Robert Rademakers,
Truck driver,
OMICRON electronics GmbH

«INNOVATIVE, COLLABORATIVE, SOLUTION-ORIENTED» – ACTEMIUM CEGELEC MITTE GMBH MUNICH'S BUSINESS UNIT SITE MAN- AGER ABOUT HIS EXPERIENCE WITH THE OMICRON ROADSHOW TRUCK

Sven Keller has been with Actemium Cegelec Mitte GmbH for nearly a decade and has led the Munich (Germany) site for six years. In this interview, Sven discusses how his team has grown, the importance of the partnership with OMICRON electronics GmbH, and why the Roadshow Truck feels like a "tech lover's paradise".

How long have you been with Actemium Cegelec Mitte GmbH and in your current role?

Sven Keller: I've been with Actemium Cegelec Mitte GmbH for nine years, and I've been the site manager of the Munich Business Unit for six years. I took on that role just as the pandemic started, and two weeks later, we went into lockdown. Back then, we had 38 employees on site, and today, that number has grown to 58. That's something I'm proud of.

Which OMICRON electronics GmbH products or services are you currently using?

We're currently using our newly purchased CMC 500, as well as a CMC 356. The CIBANO 500 is also part of our equipment pool. These devices are essential for consistently meeting our customers' high demands with reliability.



Sven Keller,
Site Manager,
Actemium Cegelec Mitte GmbH

You've hosted the OMICRON Roadshow Truck twice now. What was your experience like?

Yes, the truck has already visited us twice. The first time left a lasting impression on me, not only as an event, but also on a personal level. We've never seen OMICRON electronics GmbH as simply being a supplier, but as a true partner, and that was clearly reinforced by the Roadshow.

In your view, what makes the Roadshow Truck so unique?

The concept is simply outstanding. Everything is right there on-site: state-of-the-art technology, expert contacts, and a space for real exchange. Whether it is our employees or our customers, everyone feels like they've stepped

into a tech paradise. It's not just about product displays; it's also about discussing real challenges and developing solutions together. That's real added value.

If you had to describe the event in three words, what would they be?

Innovative, collaborative, and solution-oriented.

Was there a personal experience or anecdote that stands out to you?

What continues to impress me is the close collaboration, from consultation and support to technical exchanges. It's having a partnership on equal terms that really makes a difference for me.



«INFORMATIVE, INSIGHTFUL AND ENTERTAINING» – A LOOK INSIDE THE ROADSHOW EXPERIENCE WITH ACTEMIUM CEGELEC MITTE GMBH AND OMICRON ELECTRONICS GMBH

Since 2022, André Lechner has been part of Actemium Cegelec Mitte GmbH. He started as a Project Engineer and was promoted to Project Manager after only a year. Since the beginning of the year, he's been leading a unit in Nuremberg (Germany). In this interview, he discusses his experiences with the OMICRON Roadshow, current trends in testing technology, and why close collaboration between manufacturers and service providers is so essential.

Which devices do you use within your team, and in your daily work?

André Lechner: We work with the CMC 256plus, among others. We've become increasingly reliant on the COMPANO 100 for primary current

transformer testing, as grid operators have been demanding them more frequently. So far, we haven't had the need to call the 24/7 customer service line, but knowing that the reliable support is available is very appealing to us.

You've taken part in two OMICRON Roadshows. What was that experience like?

The first Roadshow was a classic setup: each project manager invited specific customers, and technical presentations were held inside the truck. It was very hands-on with an array of testing setups that were all well-received, most notably by existing customers already familiar with OMICRON equipment. The second event had a slightly different format, taking place alongside

other exhibitors. That was exciting as well, but the setup was more compact.

Do events like this help you make better-informed decisions?

Absolutely. These events allow us to explain to customers what is really achieved with certain testing procedures. Many people tend to think that an electrical technician shows up and just runs some checks. But there's much more to it than that.

As a service provider working with the Roadshow Truck, we can explain that these checks are based on regulatory requirements. OMICRON electronics GmbH provides the technical expertise and equipment, and we bring hands-on experience from the field. This combination works extremely well.

And finally, if you had to describe the Roadshow in three words, what would they be?

Informative, insightful, and yes, entertaining!

Thank you for sharing these inspiring insights and stories from your roadshow experience. ▶



André Lechner,
Project Manager,
Actemium Cegelec Mitte GmbH



HISTORY

In 1991, the OMICRON Roadshow Truck launched its first “roadshows” throughout German-speaking countries. These events were seminar-style product presentations held in selected business hotels. Each Roadshow typically lasted two weeks and was held annually.

The venues were strategically chosen to be approximately four to five hours apart by car. This allowed our team to conduct the events efficiently in succession, while also making it convenient for participants to attend without requiring an overnight stay. On average, each event attracted around 25 to 30 attendees.

In 1997, we came up with the idea of no longer hosting customers at Roadshow events in pre-selected hotels, but instead bringing the event directly to their doorstep, more specifically, to their company parking lots. This marked the beginning of a new chapter for the OMICRON Roadshow Truck. The team began searching for a suitable vehicle and eventually found a used presentation bus that could be converted to meet their needs.

Since its launch in the mid-1990s, the OMICRON Roadshow Truck has been on the road all year-round, visiting customers across Central Europe, Europe, and the Middle

THE NEW ROADSHOW TRUCK'S TECHNICAL SPECIFICATIONS

› Dimensions:

- › Length: 9.8m (32.2 ft)
- › Width (extended): 4.8m (15.7 ft)
- › Height: 3.8m (12.5 ft)

› Weight: approx. 18t (19.8 short tons)

› Power supply:

Ideally connected to a power socket
(400 V AC, 16 A or 230 V)

› Interior capacity: up to 10–15 people

East. Its journey has also taken it to different locations throughout Portugal, Spain, Italy, Switzerland, Germany, Turkey, the Balkan region, and many other countries.

Starting this fall, that journey will continue through Denmark, Norway, the Benelux countries, and France – with the same commitment to quality, accessibility, and customer focus. ■

Would you like to learn more or schedule a visit?

Contact us at:

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Retired OMICRON
Roadshow Truck on display

THE SECRET LANGUAGE KEEPING OUR LIGHTS ON!

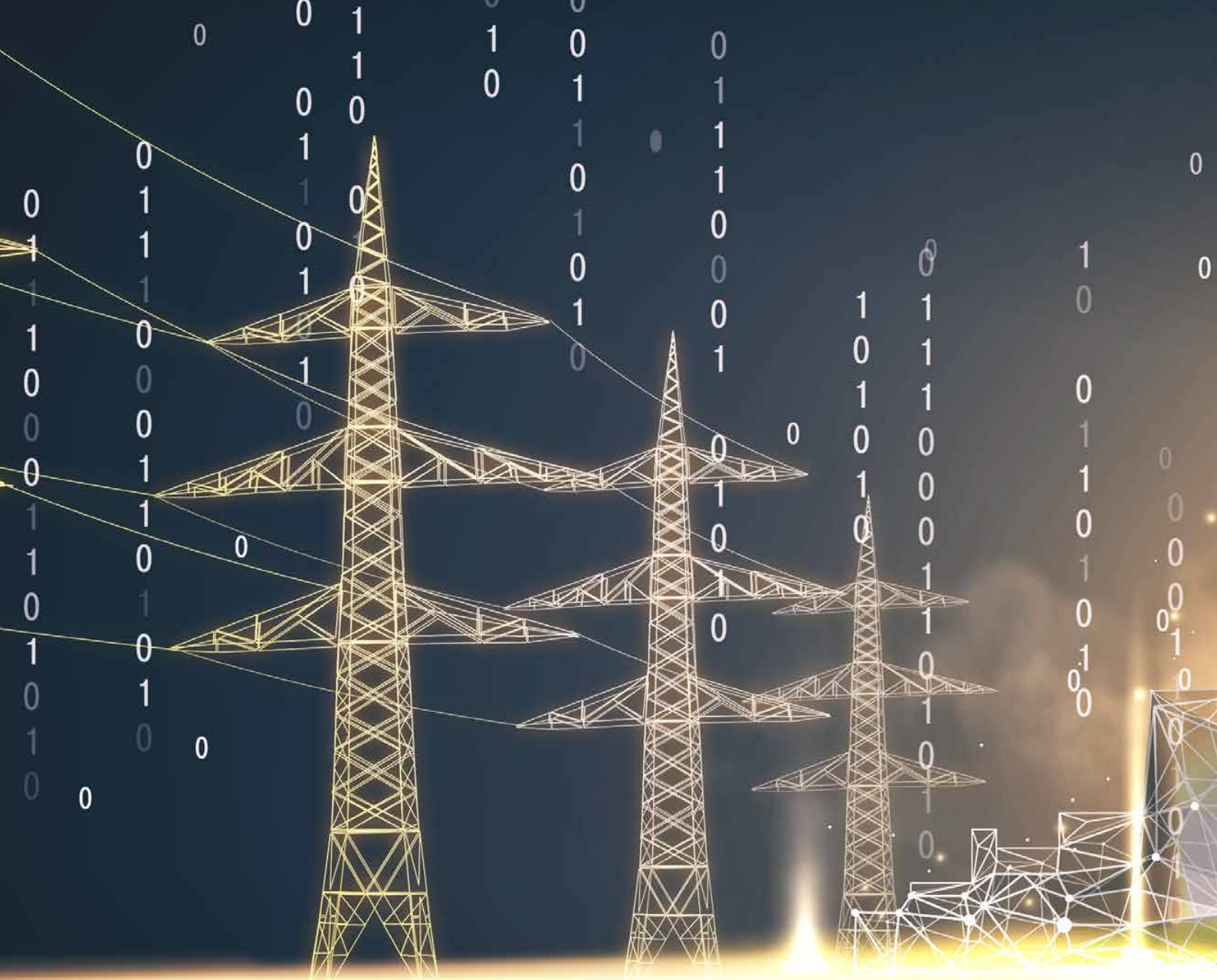
The digital backbone that powers the grid and
outsmarts cyber threats



It's like flipping a switch and turning on a light.
You don't think twice about it.

Behind that simple flick of a switch is a silent promise:
a commitment embedded deep within the grid. It's
not just wires and relays. It's trust, engineered layer
by layer, by minds that understand that milliseconds
matter. This promise is powered by a language

that's not English or Spanish, but a digital dialect.
It's called IEC 61850, a standard whispering in the
background, in real-time harmony. It's already
transforming the grid by streamlining design, accel-
erating testing, and enabling real-time intelligence
that's dynamic, digitized and decentralized. But first,
let's decode what it is, and why milliseconds matter
more than ever. ▶



THE LANGUAGE OF STRUCTURE

Turning partnership into protocol

IEC 61850 is more than just a technical specification. Our substations are full of smart devices, but smart devices aren't enough. Like language itself, words have power, but without grammar (syntax, punctuation), they're just noise. They cannot convey complex instructions or tell a story without structure and context. Grammar gives them structural meaning that allows for universal understanding. IEC 61850 is an invisible grammatical framework connecting the entire grid. It lets devices understand real-time status, react

instantly, and collaborate without confusion. It fosters the creation of a grid that, despite countless components, adheres to the same rules of engagement. It's what allows our digital grid to speak in a singular voice. This protocol not only enables communication but also enables understanding. It gives the grid the ability to coordinate, react, and evolve in real-time. **One rulebook, one structure, and one voice** aren't simply improved efficiency or compatibility features – they're interoperability by design.



THE LANGUAGE OF SECURITY

Cybersecurity and the future of the grid

The grid isn't only physical, it's digital as well. Anything digital is vulnerable because every new connection, every sensor, every relay, and each remote access point is a potential doorway for an attack. And in a world where threats evolve faster than hardware can be replaced, protection isn't only about preventing faults – it's about defending trust. **IEC 61850 is a language of resilience built on modern, layered communication models.** While IEC 61850 provides devices with grammar required for clear speech, we apply robust cybersecurity frameworks, such as those found in IEC 62351,

to further strengthen that communication. This means adding encryption to scramble messages, authentication to verify a speaker's identity, and role-based access that ensures only authorized entities can issue commands. This isn't patchwork security – it's engineered trust. This integrated approach doesn't hold IEC 61850 back but allows it to grow alongside the grid. New threats emerge, new technologies arrive, and **IEC 61850 provides a foundation that flexes without fracturing.** While the world races toward renewables, decentralization, and digital transformation, it only needs to continue speaking the correct language, securely.



THE LANGUAGE OF SPEED

How IEC 61850 speaks during emergencies

In protection engineering, time is not just money – it's safety, stability, and what stands between a mere blip and a blackout. IEC 61850 introduced the **Generic Object-Oriented Substation Event (GOOSE)** to meet this demand. GOOSE is a high-speed digital alert messaging system that lets devices instantly broadcast critical alerts, like "Danger! Fault detected!" across the

substation network in less than four milliseconds (one hundred times faster than the human brain)! When it's time for an upgrade, ripping out cables and switching logic are a thing of the past due to digital language and modular upgrades. Configurations are no longer found in tangled cables; they're stored in files. **That means faster deployments, easier testing, and systems that evolve as fast as the grid itself.**



THE LANGUAGE OF CHANGE

Renewables and cross-differential protection

The grid used to be a one-way street with power flowing from several large plants to millions of homes. Today, that world has vanished, and energy is everywhere. It's on rooftops, wind farms, and behind meter storage systems. Today's grid is more like a conversation than a pipeline. And that conversation has become louder, faster, and more complex. Renewable sources have introduced variability and bidirectional flows, requiring a grid that's not only intelligent, but also capable of a real-time response. **Differential protection addresses these requirements with speed and precision.** By comparing current measurements at both ends of a protected line, line-differential protection instantly detects imbalances and isolates faults,

without delay or negotiation. It's able to make quick decisions because it's based on the current conservation principle. Cross-differential protection, a specialized variant used in machines with parallel winding sections, applies the same principle to more complex internal fault scenarios. IEC 61850 supports both abilities by providing a standardized communication framework that allows protection devices to exchange data seamlessly in real-time. It doesn't simply enable communication but enables coordination. Together, these schemes form a critical layer of defense in modern substations which are fast, deterministic, and adaptable to evolving grid conditions. **In a grid increasingly driven by renewables, rapid, self-contained fault isolation is essential! ▶**



THE LANGUAGE OF RESULTS

Getting from design to defense faster

The grid's evolution mirrors IEC 61850's journey. The data models in IEC 61850 provide fertile ground for integrating artificial intelligence algorithms, allowing us to move beyond reactive responses to proactive insights. Now we can monitor grid behavior in real-time, detect anomalies before they become failures, and even prevent cyberattacks using **functional security, a pioneering concept championed by experts like Dr. Alex Apostolov.**

This isn't a theory, it's a metamorphosis. The table shows what happens when the grid speaks the same language, from the first design sketch to the last line of defense. However powerful this digital dialogue may be, it isn't a light switch we've already turned on; it's a conversation we're still learning to have. Real change, the kind that builds truly intelligent, resilient grids seamlessly embracing renewable-ready solutions, doesn't happen by accident. It's the culmination of designs, decisions, and choosing to speak the same language.

Problem	IEC 61850 Solution	Result
Complex system designs	Standardized communication and data models	40% faster design, fewer errors
Troubleshooting delays	Real-time data access via GOOSE and MMS; unified diagnostics	Quicker fixes, less downtime
Costly upgrades	Plug-and-play integration	Easier adoption of green energy and new tech
High training overhead	Standardized tools and training programs	50% faster onboarding
Installation bottlenecks	60% less cable pulling	20% faster installation, lower labor costs
Commissioning delays	Automated testing and configuration validation	20% faster commissioning, fewer field errors
Cybersecurity risks	Layer 2 isolation, routable GOOSE with encryption, functional security	Controlled risk, enhanced grid resilience

Summary of IEC 61850 benefits across the power system lifecycle
(Source: Forthcoming Generation Station using IEC 61850 Process Bus and Instrumentation Close to the Data Sources | PAC World)



THE LANGUAGE OF CHOICE

- › **Choose IEC 61850 compliant devices:** Speak this language from the start. Reduce configuration time and eliminate friction.
- › **Leverage standardized data models:** See your system clearly. Act before problems arise. Maintenance should be proactive, not reactive.
- › **Implement IEC 61850-based engineering tools:** Build a future-ready ecosystem that evolves as quickly as the world around it. ■

«The grid is learning to talk. The question is – are we listening?»

Alex Apostolov, Principal Engineer at OMICRON Electronics, is a globally recognized expert in power system protection. A member of the U.S. National Academy of Engineering, he holds five patents, has authored 600+ technical papers, and serves as Editor-in-Chief of PAC World magazine. His 2022 book, *Digitalizing the Electric Power Grid*, reflects his visionary role in shaping the future of resilient, renewable-ready energy systems.



Alex Apostolov,
Principal Engineer,
OMICRON

LISTEN TO THE PODCAST

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And if you think this is just a protocol, ask Dr. Alex Apostolov. He's not just an expert; he's one of the architects of this transformation, and a functional security pioneer. In Episode 99 of Energy Talks, Dr. Alex Apostolov shares how milliseconds, not megawatts, are shaping the future of protection engineering. Listen to the full conversation in Episode 99 of the Energy Talks Podcast now!



 omicron.energy/episode99

SPARKING JOY IN SUBSTATION AUTOMATION SYSTEM TESTING

Why smarter testing means happier engineers and safer systems

Testing substation automation systems (SAS) is not exactly what most people would call fun – yet it is one of the most critical tasks involved in engineering, commissioning, and maintenance. Over the years, these systems have become increasingly complex. The old wiring check – circling circuits on paper while poking around in panels – no longer cuts it. Now, wiring is mostly digital, streaming across communication networks. That is why a new approach is required, one that verifies digital wiring files by comparing them with real network messages.

Enter StationScout, designed to slash the time and effort needed for testing by bringing a fresh method to the table: automated closed-loop testing.

What is automated closed-loop testing?

Put simply, closed-loop testing closes the loop where data is born, right at the process level in a substation. It tracks a signal's journey, from physical events to digital conversion, all the way to the control center.

Substation automation has evolved – and testing must too. Where signals once slowly trickled over proprietary serial lines, they now flood fast Ethernet networks, utilizing modern standards such as IEC 61850, IEC 104, and DNP3. The number of signals has exploded, and with it, the challenge has as well.

While future direct IEC 61850 communications to control centers are



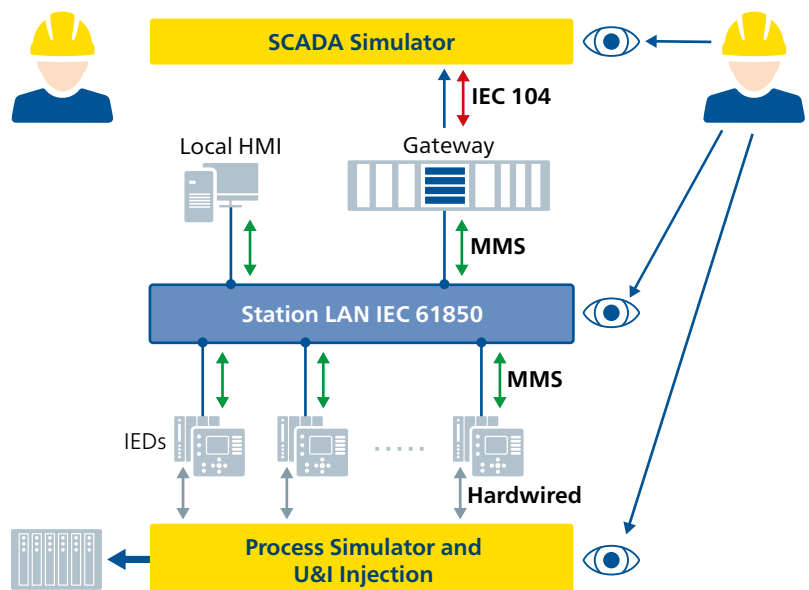
being discussed, the robust IEC 104 and DNP3 are recognized as today's heroes – the workhorses holding the network together.

Why do users need automated testing?

With great power comes great responsibility – and more signals that need to be tested. Testing 20,000+ signals is not only time-consuming, but also a laborious task. Someone must keep an eye on process simulators, monitor voltage injectors, and oversee digital conversions – a tedious and error-prone job.

Testing often feels like a never-ending manual marathon: technicians shouting “sent” and “received”, copying and pasting in Excel, and endlessly verifying test results. Why is a supposed digital world still being run so manually?

The problem runs deeper: many utilities delay critical firmware updates ▶



Closed-loop testing process

«Where signals once slowly trickled over proprietary serial lines, **they now flood fast Ethernet networks, utilizing modern standards such as IEC 61850, IEC 104, and DNP3.**»



because testing is too cumbersome. Cybersecurity warnings go unheeded, and vulnerabilities linger. Sampled testing in the early stages is not enough; the rest of it is up to engineers to fix during commissioning, which can lead to frustration and increased risk.

How does StationScout automate testing?

StationScout automates signal testing by binding signals and creating test cases with just a few clicks:

1. Import your mapping scheme – StationScout visualizes signals and links them to process simulators and IEC 104 servers.

2. Define the steps based on signal type.
3. Set the test route.
4. Configure execution parameters for automatic run and assessment.
5. Run the test – no more monitoring every move.
6. Get automatic, standardized reports – so you can validate your work without breaking a sweat.

The real benefit? Satisfied engineers and higher quality

This is what users can expect:

- › Up to 70% less engineering time thanks to automation and reusability.
- › Lower costs due to reduced human resources and project adaptation time.

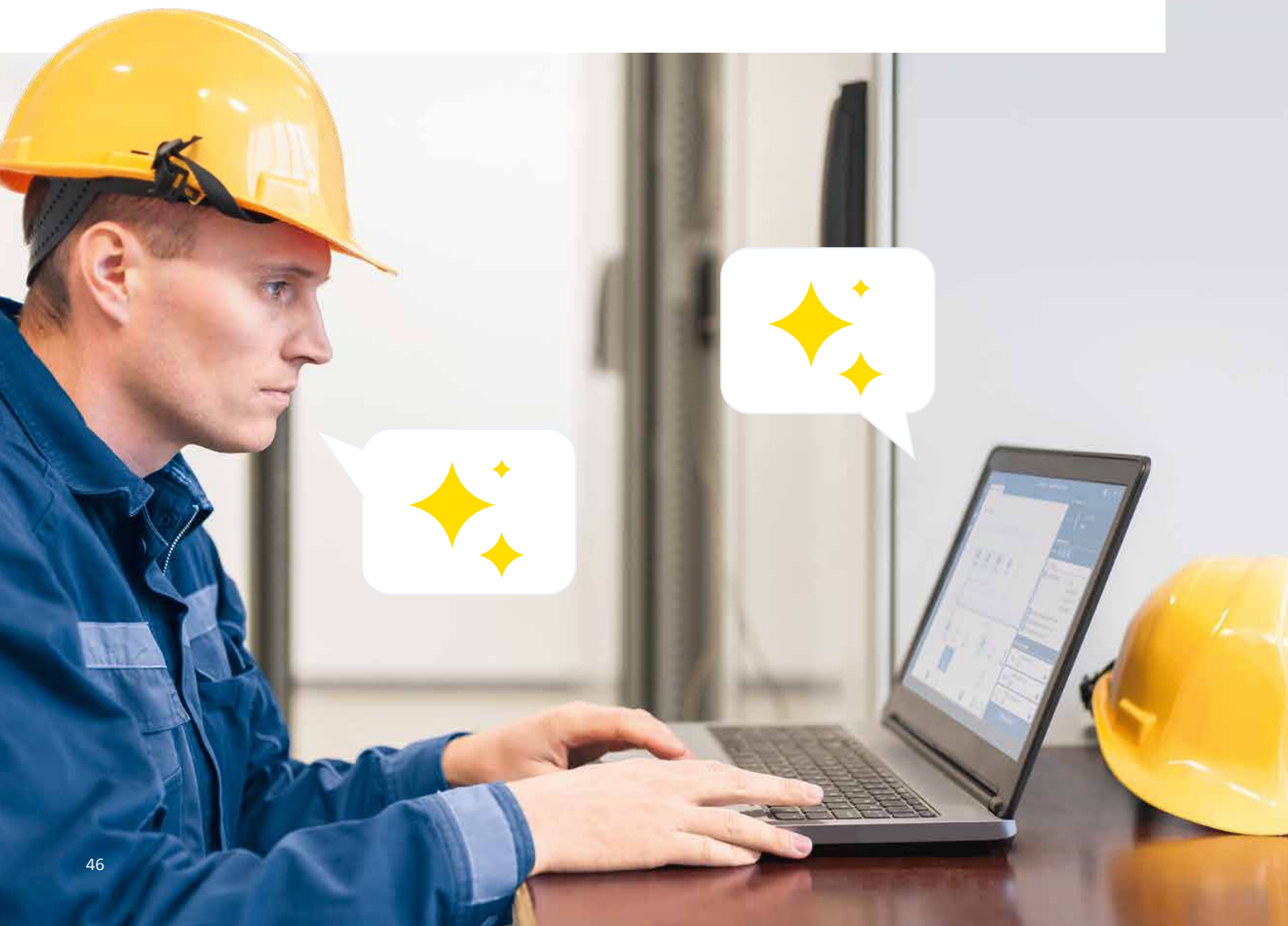
- › Higher quality with fewer errors and consistent reporting formats.

Instead of manually juggling tens of thousands of signals, engineers can focus on their core work. Testing becomes repeatable, reliable, and transparent.

The result: fewer errors, increased security, and – most importantly – satisfied application engineers. When testing is smart, efficient, and automated, joy can be found in even the most cumbersome tasks. ■

Discover how StationScout can fit into your workflow:

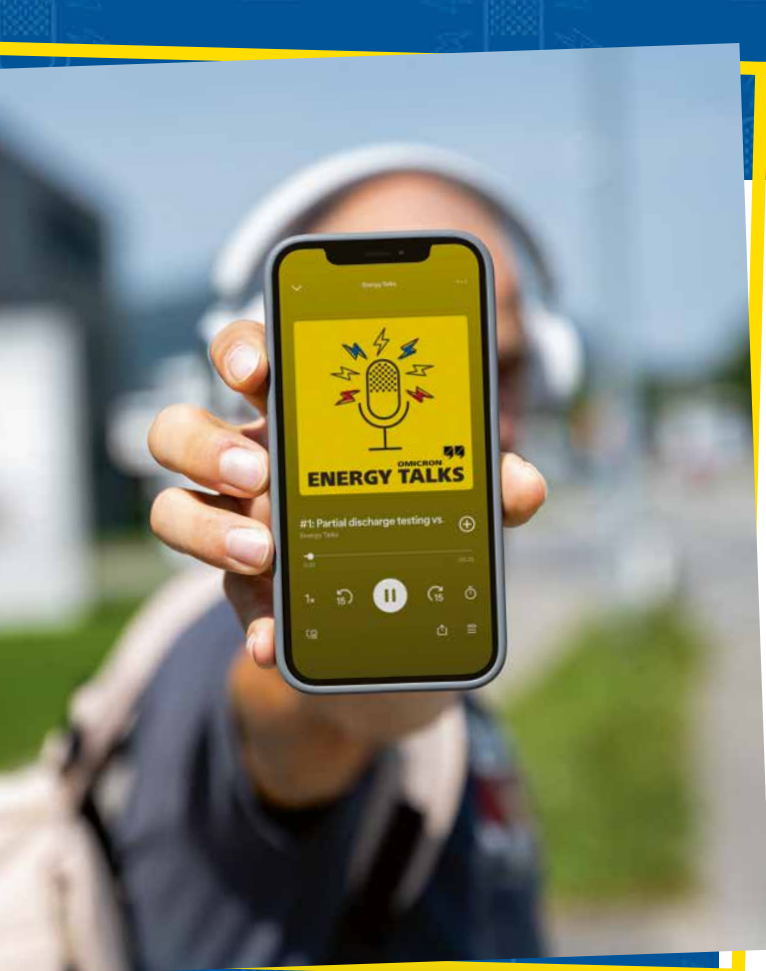
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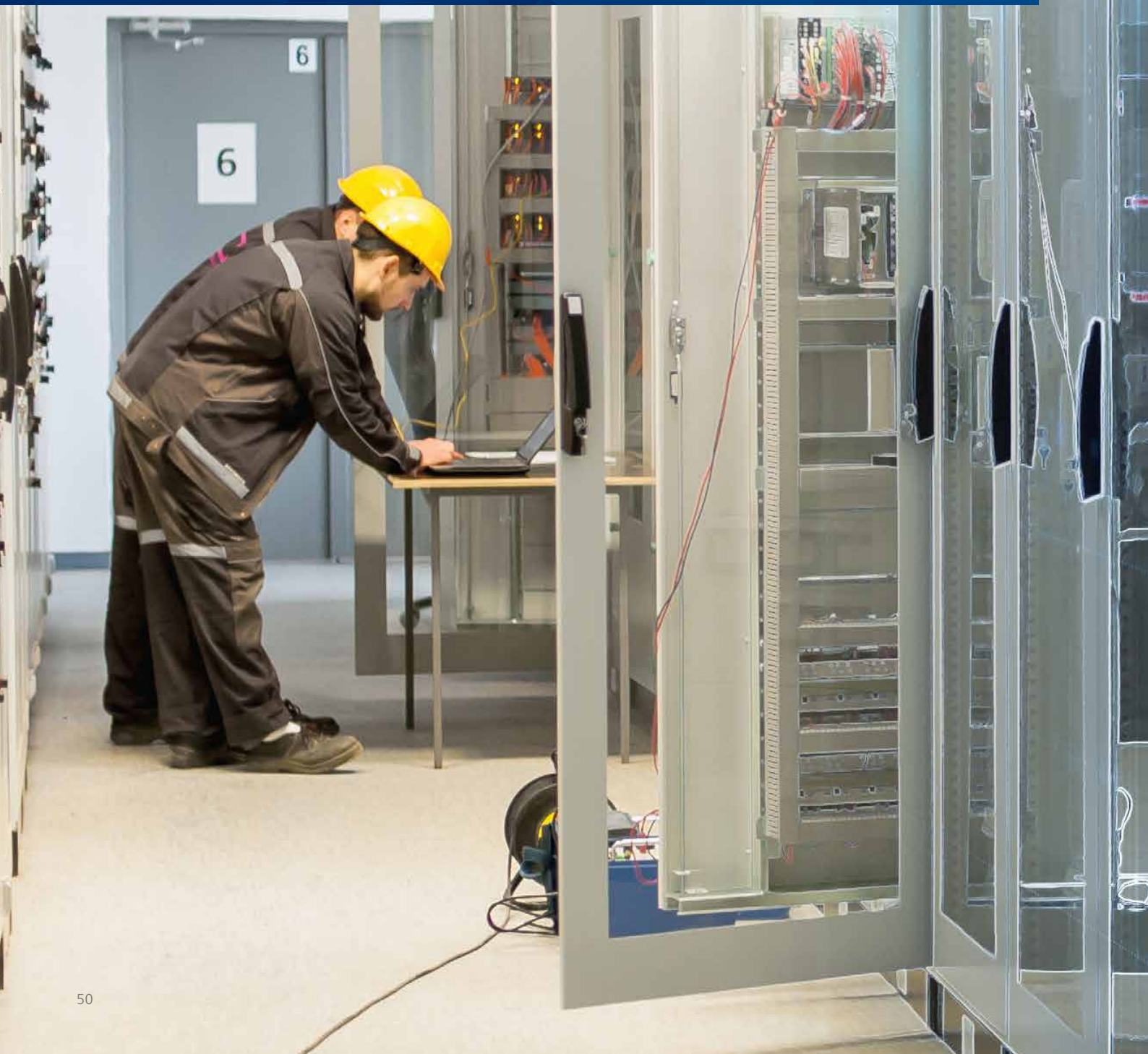
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ENGINEERING THE FUTURE IEC 61850-BASED SUBSTATIONS

SCL-driven engineering enables cross-vendor reusability and template-based testing.



Designing, specifying, building, and testing the new generation of Substation Protection, Automation and Control Systems was a complex task for the IEC61850@TenneT Project lead, Hans-Jürgen Gruber, and the project team. Located at the Northwest European energy crossroads, TenneT TSO GmbH, Germany connects: North and South. Offshore and Onshore. Germany and Europe. With over 5,000 employees – internal and external – the company builds, maintains and operates Germany's largest transmission grid spanning over 14,000 km and connecting more than a third of the European Union's total offshore wind capacity.

With the primary goal of introducing and enhancing the use of the IEC 61850 standard in TenneT TSO GmbH Germany (TTG) substations, the engineering team has designed a manufacturer-independent Substation Automation System (SAS). It is usable for the entire German TTG grid, both on-shore and offshore, including networks (process and station busses) as well as interfaces for primary components, grid control systems and network management systems.

To accomplish the project's goals, the team at TTG developed the conceptual design for a typical substation, based on well-established internal control and protection concepts, but adapted it to the IEC 61850 "world". This adaptation is achieved by creating a new set of Basic Application Profile (BAP) documents to describe the main substation

functions, the internal Logical Nodes involved, and their relationships with external components. Additionally, it includes the required communication services and the communication sequences. The project team also developed a Functional Naming concept as the baseline for a unique Data Model to be used independently from the IED (intelligent electronic device) vendor and the device where a function is located.

To implement this new concept, TTG relied on the expertise of OMICRON Engineering Services as a subcontractor. They were tasked with trialing the Functional Naming concept and with implementing the functionality as defined in the BAPs. Their responsibilities also included testing communications, control, and protection. Finally, they followed the Top-Down engineering approach to complete the configuration using the detailed specifications described in the SCL files.

Since the Top-Down approach played a key role in this project, it is important to understand how it compares to the traditional Bottom-Up method. In simple terms, there are two main options for building an IEC 61850 system: Bottom-Up, where the system is constructed based on the IEDs available; or Top-Down, where the system is specified according to the utility's needs, and IEDs are selected from the market to meet those specifications. While these two engineering approaches may appear similar, their outcomes differ significantly, particularly when it comes to enabling standardized implementations, regardless of the IED vendor.

For the first phase of this project, TTG developed detailed specifications using the System Configuration Language (SCL), defining specific functions, logical devices (LDs) with their logical nodes (LNs), and communication requirements in a vendor-independent format. This was achieved using a so-called Specification IED (S-IED), with the file extension IED Specification Description (ISD).

These ISD files not only contain the system data model defined by the Functional Naming concept, but also describe the communication relationships between system components, including datasets and control blocks for Sampled Values, GOOSE, and Reports. ▶

«While the two engineering approaches – Top-Down and Bottom-Up – may appear similar, their outcomes differ significantly, particularly when it comes to enabling standardized implementations, regardless of the IED vendor.»



This new type of SCL-based specification opens the door to a new testing approach, where test plans can be defined based on specified functions and IEC 61850 signals, making them completely vendor- and project-independent. As a result, this approach enables faster and more consistent reusability of IEC 61850-based test plans across different vendors and projects. (figure 1)

The SCL-based specifications, refined during the project execution, include, among others, the following details:

- › Specific support for services (Sampled Values (SV), GOOSE, Reports, Flexible LDNaming)
- › A complete definition of functions/LN to be included in each device
- › A predefined set of rules for RCB, GCB, SVCB, and Datasets
- › A predefined set of VLANs and MAC addresses for each application/bay type
- › Clear definitions of Dataset content for GOOSE and Report applications
- › Inclusion of GOOSE testing signals
- › Extensibility considerations for different substation sizes

To clarify the differences from a reusability standpoint compared to a conventional Bottom-Up IEC 61850 project, it is essential to recognize the limitations of relying on vendor-specific data models. Additionally, allowing complete freedom when defining communications can further hinder interoperability and standardization. Due to the top-down approach in this IEC61850@TenneT project, a vendor-independent SCD file is available. With a bottom-up approach, there are no specification-based SCL files available. As a result, IEC 61850 test plans cannot be defined in a vendor-agnostic way during the design phase. And if any test plans are reused, they typically come from previous projects under the assumption that the same vendor and implementation style will be used again.

However, if a different IED vendor or model is selected, or even if the implementation style changes, the data model and messages may vary significantly. In such cases, the signal mappings used within the test plans become invalid

«This new type of SCL-based specification opens the door to a new testing approach, where test plans can be defined based on specified functions and IEC 61850 signals, **making them completely vendor- and project-independent.**»

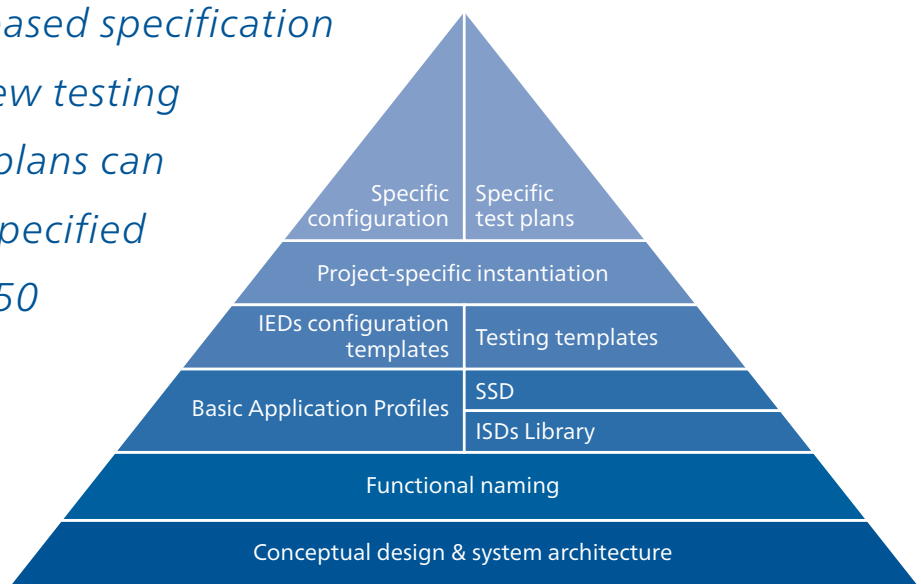


Figure 1: Specifications and templates as baseline for more efficient projects

or cannot be updated automatically, leading to a loss of reusability and efficiency.

During the second phase of the project, these challenges were addressed by defining Test Universe and StationScout test plans based on specification files. Since these test plans followed a Top-Down approach aligned with the SCL specifications, they were not expected to change during IED configuration. The resulting test plans could be directly applied to real IEDs in the lab with almost no modifications. Moreover, their applicability across a wide range of substations could be foreseen, thus facilitating the deployment of new projects and bringing significant benefits in terms of standardized testing methods.

One of the project's additional milestones was achieving function-based isolation for testing purposes. This is a concept well-defined by the IEC 61850 standard, but it is not often achieved without proper engineering. To enable this, the BAPs were described as independent functionalities, where signals are produced and consumed within the same function across different IEDs. Each function communicates using its own dedicated GOOSE and Report messages, which allows testing and isolating specific Functions without impacting others. A good example of this is the synchro-

nization function, described in a specific BAP, defined by a function code within the Functional Naming concept and contained within the ISD files.

To start a synchronization sequence, it is necessary to interact with the 1ooN function between the bay and the Central Unit. In a traditional testing approach, setting the entire IED to Test Mode affects the quality of the 1ooN request and the switchgear positions transmitted with GOOSE, which blocks their reception by the 1ooN and interlocking functions in the Central Unit. Alternatively, setting the Central Unit to Test Mode may fulfill the test requirement, but it introduces an even more critical issue: it blocks all commands from other bays that are not under test, due to 1ooN and interlocking maloperations.

As illustrated in figure 2, with isolated functionalities, it is possible to set only the synchronization function to Test Mode, while the 1ooN and interlocking functions remain in normal operation. This method of isolating GOOSE messages is known as "Functional" GOOSE.

This test plan can be fully automated by including the Client/Server commands to set the corresponding function to Test Mode, activating the Simulation option to switch ►

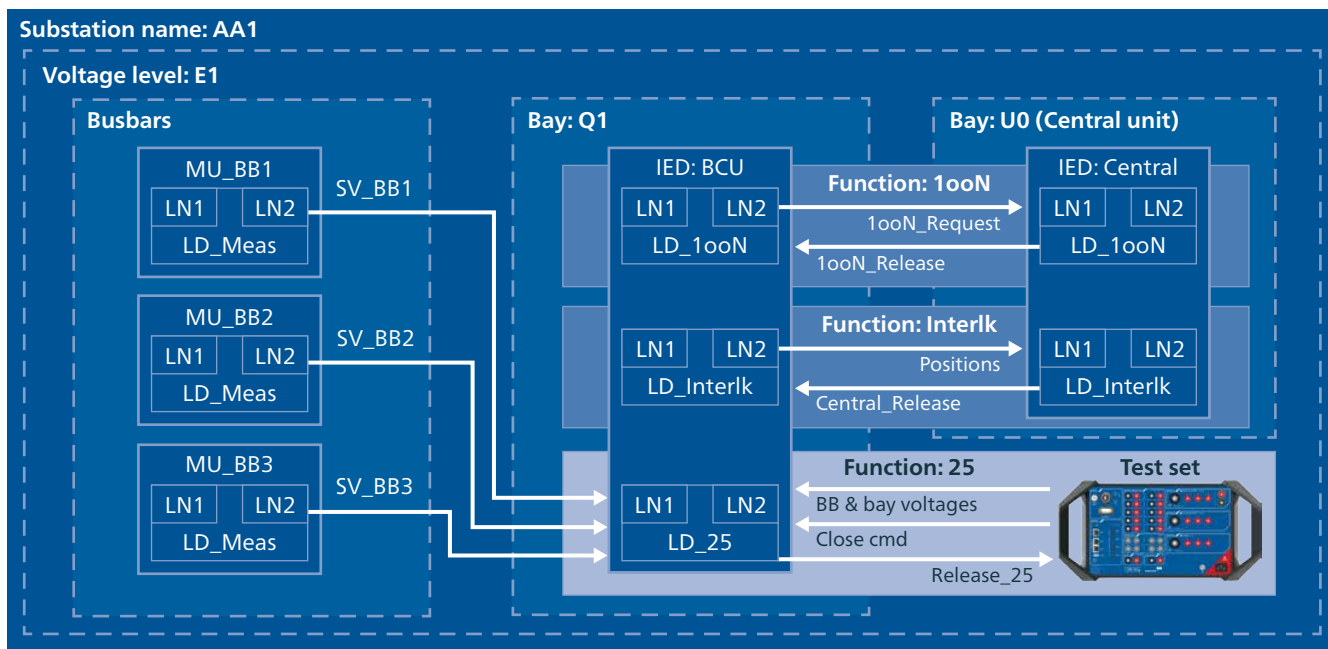


Figure 2: Isolated functions testing approach

from Sampled Values provided by the busbar MUs (merging units) to those of the Test Set, executing the synchronization test sequence, and finally restoring both the Test Mode and Simulation option to their normal states.

Some challenges that utilities can overcome by real top-down engineering to facilitate implementing test plan templates from the specification stage include:

- › Maintaining or improving testing quality
- › Reducing time and costs
- › Easier comparison of test results
- › Facilitating regression tests, for example, maintenance activities such as before and after patching
- › Enhancing knowledge transfer

This project has focused on creating IED's configuration files, IEC 61850 files, and test plan templates for typical bays, demonstrating its effectiveness. Nevertheless, it is expected that a real substation project will introduce additional bays and parameters that will directly affect signal names used for horizontal and vertical communications and will certainly influence the testing

templates. Below is a summary of tasks required to adapt the templates for real projects:

1. Create project-specific instances of ISD files while maintaining vendor independence by updating LDNames consider the specific substation, voltage level, and bay identifiers.
2. Merge ISD files to an SSD file, and modify network elements to be project-specific, including VLANs and destination MAC addresses for GOOSE and Sampled Values.
3. Instantiate IED configuration templates for the specific substation topology, updating the IED names and IP addresses.
4. Import customized SSD files into the vendor-specific IED configuration tool to reuse all DataSets, RCBs, GCBs, SVCBs, and GOOSE/SV subscriptions defined in the specifications (there should be no need to re-engineer what is written in the specifications). When importing specifications is not supported, the SSD files will serve as reference points to compare against the manual creation of all subscriptions in the vendor tool.
5. Instantiate and update test plans by re-importing ISD files. Since all signals remain available in the same DataSets but

with new LDNames and network parameters, the process should be straightforward and retain the signal mapping as defined in the template (as shown in figure 3).

The outcome and conclusion of this article highlight that by following a top-down engineering process, utilities can define their system requirements using Specification IEDs (S-IED) written in ISD and SSD files, establishing a homogeneous data model that is applicable across different vendors. This approach enables the pre-engineering of horizontal and vertical communications for well-known applications, providing implementers with machine-readable, importable specification SCL files that serve as guidelines for building future substations. With a well-defined data model and pre-engineering, protection and automation test plans can be created to be fully reusable with different bays, substations, and IED vendors.

Template-based PAC testing offers utilities numerous advantages, including standardized testing methods, centralized template repositories, and simplified update management. Furthermore, the use of “functional” GOOSE messages facilitates isolated testing of individual functions without disrupting others in service. The reusability of test plans throughout the entire project lifecycle – from tendering to commissioning and maintenance – streamlines workflows, while the adoption of test templates simplifies result analysis and reduces the learning curve for new team members. ■

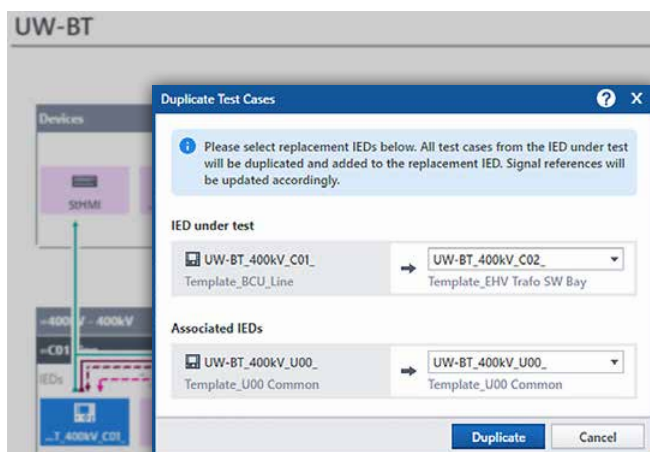


Figure 3: “Duplicate test cases” options



VULNERABILITY MANAGEMENT IN POWER SYSTEMS

Correctly prioritize risks instead of blindly reacting to events

Substations used to be analog and largely isolated, but these days, power systems are ruled by digital systems. More convenience, more data, more speed – but more vulnerability to attacks. Hackers use:

- › maintenance access points that are often inadequately secured,
- › connections to control centers to gain access to an entire power system,
- › infected maintenance laptops,
- › compromised test PCs or devices that upload malware.

These complex systems and their interconnections make protection measures a balancing act, particularly when it comes to vulnerability management.

Often, it is “common” vulnerabilities, not highly specialized attacks that cause problems: Some deprecated firmware here, some unpatched software there, and, just like that, attackers have the open door they need. The worst part is, these vulnerabilities often remain undetected until it’s too late.

Why patches can be problematic for the OT segment

OT systems are not normal IT devices. They need to be in constant opera-

tion – often for decades. An update that interrupts operation or disables protection functions is not an option. What’s more, patches can introduce new errors and need to be thoroughly tested – ideally in a laboratory.

But realistically replicating a specific situation with all installations is often virtually impossible. Even if a patch is available, it can only be installed if the affected components are disconnected first, and such disconnections are difficult to implement in a heavily utilized power grid. At the same time, pressure is increasing as new vulnerabilities (common vulnerabilities and exposures, CVEs) are constantly being identified, and there is an ongoing threat of zero-day attacks.

This impossible choice between security and availability is one of OT cybersecurity’s greatest challenges. After all, the operational risks created by an untested patch may outweigh the security risks that it is reducing.

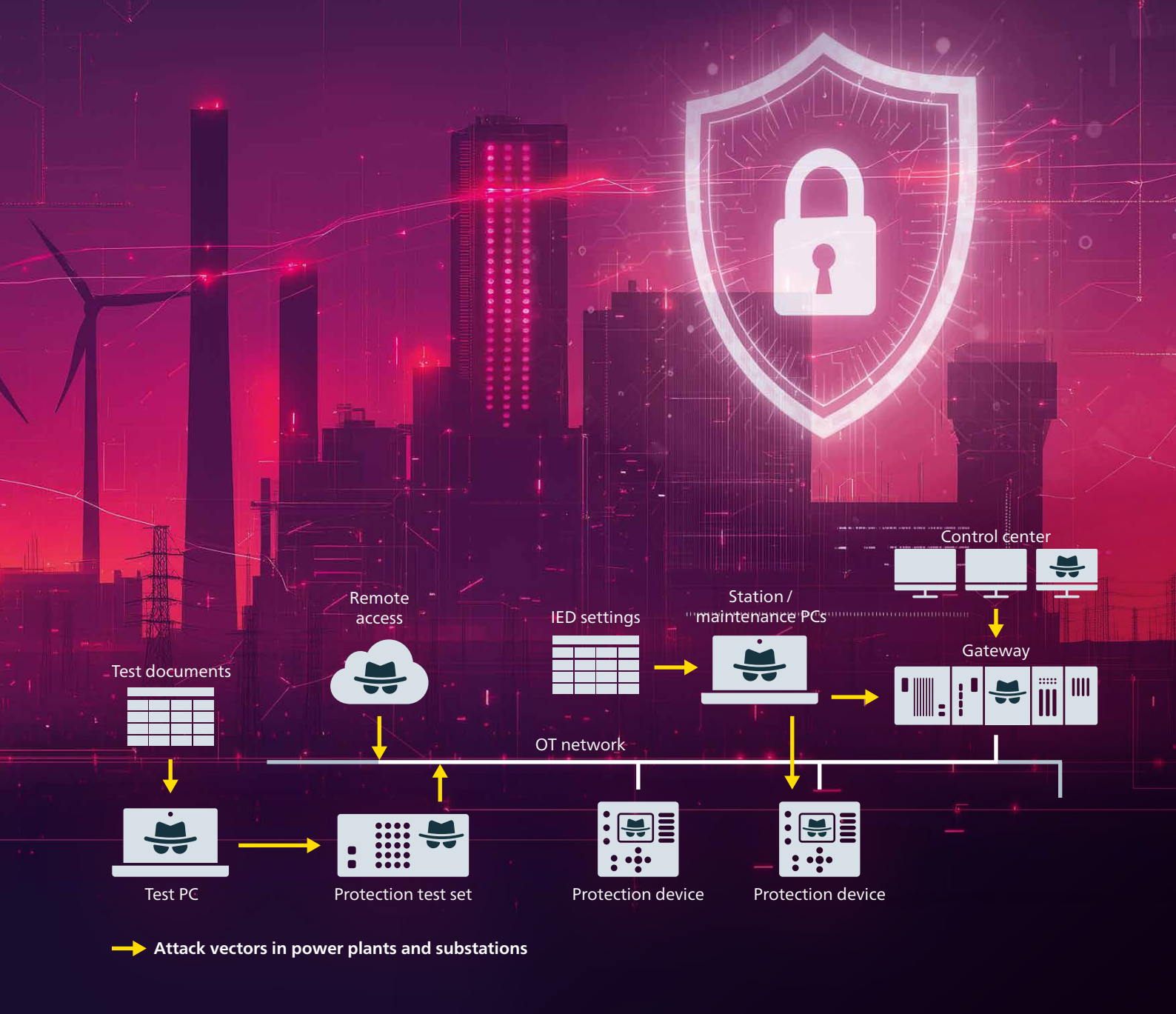
The nightmare: Which security advisories (do not) affect me?

Security advisories come from everywhere – often in proprietary, confusing formats. Device types and firmware versions are unclear; the same model numbers can contain different versions.

Manually comparing vulnerabilities with thousands of devices may be the first error source, and that is simply not feasible for large grid operators that utilize many different manufacturers.

The problem is exacerbated by the fact that many installations have documentation that is not always up to date. Missing or inconsistent inventory data means that safety teams are often flying blind. They cannot conclusively say whether a critical vulnerability is affect-





ing their system, or if it is a false alarm. Anyone working without the right tools is going to spend a lot of time searching in vain – time is the difference between success and catastrophe in an emergency.

How do we solve the problem?

We rely on automation and precision: The StationGuard GridOps vulnerability database is always up to date, reliable, and has been created specifically for OT systems. ▶

«Often, it is *common* vulnerabilities, not highly specialized attacks that cause problems: Some deprecated firmware here, some unpatched software there, and, just like that, attackers have the open door they need.»

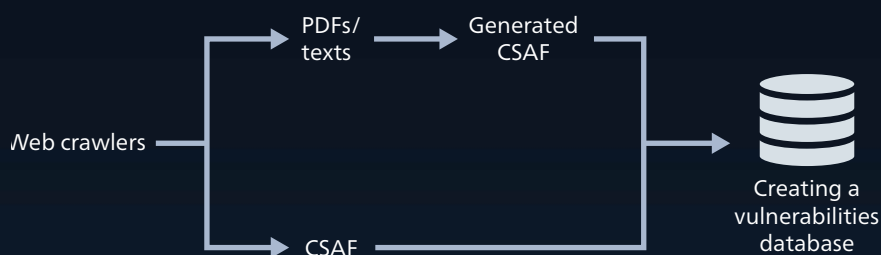
- › Web crawlers regularly search manufacturer websites for new security advisories.
- › Documents are automatically converted to a machine-readable, uniform format (CSAF).
- › OT experts add metadata concerning models and device types.
- › Security experts carefully check and validate all information.

The result: We have collected more than 12,000 vulnerabilities in our database, but only those that occur in your installation are displayed.

The time-consuming and error-prone manual reconciliation of security advisories with device and firmware information is a thing of the past: GridOps automates this task and clearly displays relevant vulnerabilities.

This allows security managers to quickly check which systems are affected and make risk-based decisions based on urgency and exposure. Does a vulnerability need to be dealt with immediately, or can it be monitored for the time being or classified as an acceptable residual risk?

If those considerations sound time-consuming, that's because they are. Data constantly needs to be updated, assessed, and prepared for the relevant context. After all, not every vulnerability is relevant for every system. That is what distinguishes good cybersecurity from bad cybersecurity: Operations that simply collect data will accumulate a mountain of data, operations that classify data, gain clarity and certainty to guide their actions.



Risk-based patching: don't panic, prioritize

Finally, decision-makers possess clear information for prioritizing their actions. Having to guess which update needs to be installed first, or which systems should remain isolated, is no longer necessary.

If patches are technically or economically unfeasible, alternatives, such as isolating affected devices in the station network, can be helpful. If a situation gets tight, StationGuard's intrusion detection watches over

unpatchable vulnerabilities, like a digital guard dog.

This is far more than another technical gadget, it is another mindset; a move away from the hectic "patching craze" and towards a deliberate, risk-based security approach. We've turned security that once obstructed availability into an integral component.

Conclusion: Cybersecurity in the power grid needs a new mindset

The energy sector is facing a monumental task: protecting decades-old OT systems from cutting-edge cyber threats. Traditional patch management, like the kind used in IT, is ineffective – whether from a technological or organizational perspective.

Modern vulnerability management must ...

- › be automated and permanent,
- › use precise, current asset data,
- › assess risks based on context,
- › and enable alternative protection measures.

StationGuard proves this works. The secure power supply of the future won't rely solely on technology; it is going to require transparency, close cooperation between IT and OT, and

a new awareness that comes with a sense of responsibility for OT security.

Digitalization challenges

Digitalization has completely up-ended our power supply. These days, substations and switchgears use IP-based communication, automated controllers, and remote access. This makes the power system more efficient, particularly with an increasingly decentralized infeed. However, this is also precisely where new risks lurk. The fact that a cyber attack on critical infrastructure can do more than simply damage assets is not a new development – it can paralyze whole regions, resulting in immense costs.

Matching vulnerabilities and assets with precision

Accuracy starts with asset data. StationGuard combines ...

- › passive reading from device communication in the power system,
- › active requests via IEC 61850/MMS for precise device information, and
- › importing project files for adding asset details.

This allows vulnerabilities to be specifically allocated to affected devices – putting an end to guesswork and false alarms once and for all. ■

«It is another mindset; a move away from the hectic «patching craze» and towards a deliberate, risk-based security approach. We've turned security that once obstructed availability into an integral component.»

ON SITE: OMICRON IN CROATIA

Ivan Visic from Pro Integraris shares his insights about the power sector with us.

Pro Integraris is a full-service engineering and consulting company providing services for energy automation, founded in 2007 in Split, Croatia. The company's clients are generation, transmission and distribution organizations, and a variety of industry companies and associations. Pro Integraris is a specialized distributor for OMICRON solutions, providing expert support, product sales, training, and consultation throughout the region.

How is the energy grid structured?

Ivan Visic: The Croatian energy grid is divided into four main segments: generation, transmission, distribution, and consumption. The company HEP is responsible for the generation, distribution, and supply of energy. HOPS is a Transmission System Operator (TSO) with almost 7,800 km of high voltage lines. Our system is interconnected with Slovenia, Hungary, Serbia, and Bosnia and Herzegovina.

What resources are being used to generate power?

Croatia produces electricity from: hydropower (largest share), thermal power plants (coal, gas, oil), wind and solar energy, biomass, and geothermal (smaller share). We co-own the Krško Nuclear Power Plant in Slovenia. Croatia imports electricity to meet demands, especially during peak periods.

What are the current hot topics in the energy supply market?

Croatia's energy supply market in 2025 is navigating a dynamic mix of challenges and opportunities. The key hot topics shaping the landscape are rising energy imports and declining domestic production, untapped renewable poten-

tial, challenges in grid modernization, energy efficiency, and geopolitical influences. There's also an increased focus on cybersecurity and regulatory changes.

What kinds of challenges are your customers facing?

Our customers face challenges such as integrating renewable energy sources, aging infrastructure, skills shortages, and maintaining grid stability. Additionally, there's growing pressure to improve testing efficiency and ensure compliance with evolving standards and regulations.

When looking towards the future, where do you see the biggest challenges in the power sector, and in general?

The biggest challenges ahead include managing the energy transition, ensuring grid resilience, securing the energy supply, and handling the increasing complexity of systems. Digitalization and cybersecurity are also critical areas requiring constant attention and innovation.

Thank you for the interview. ■



Ivan Visic,
Managing Director, Pro Integraris
prointegraris.hr



FACTS

Capital: Zagreb

Inhabitants: 3.8 million people

Currency: Euro (EUR)

Language: Croatian

National Dish: Pasticada, strukle, sarma, cobanac (shepherd's stew), Istrian fuži with truffles, turkey with mlinci

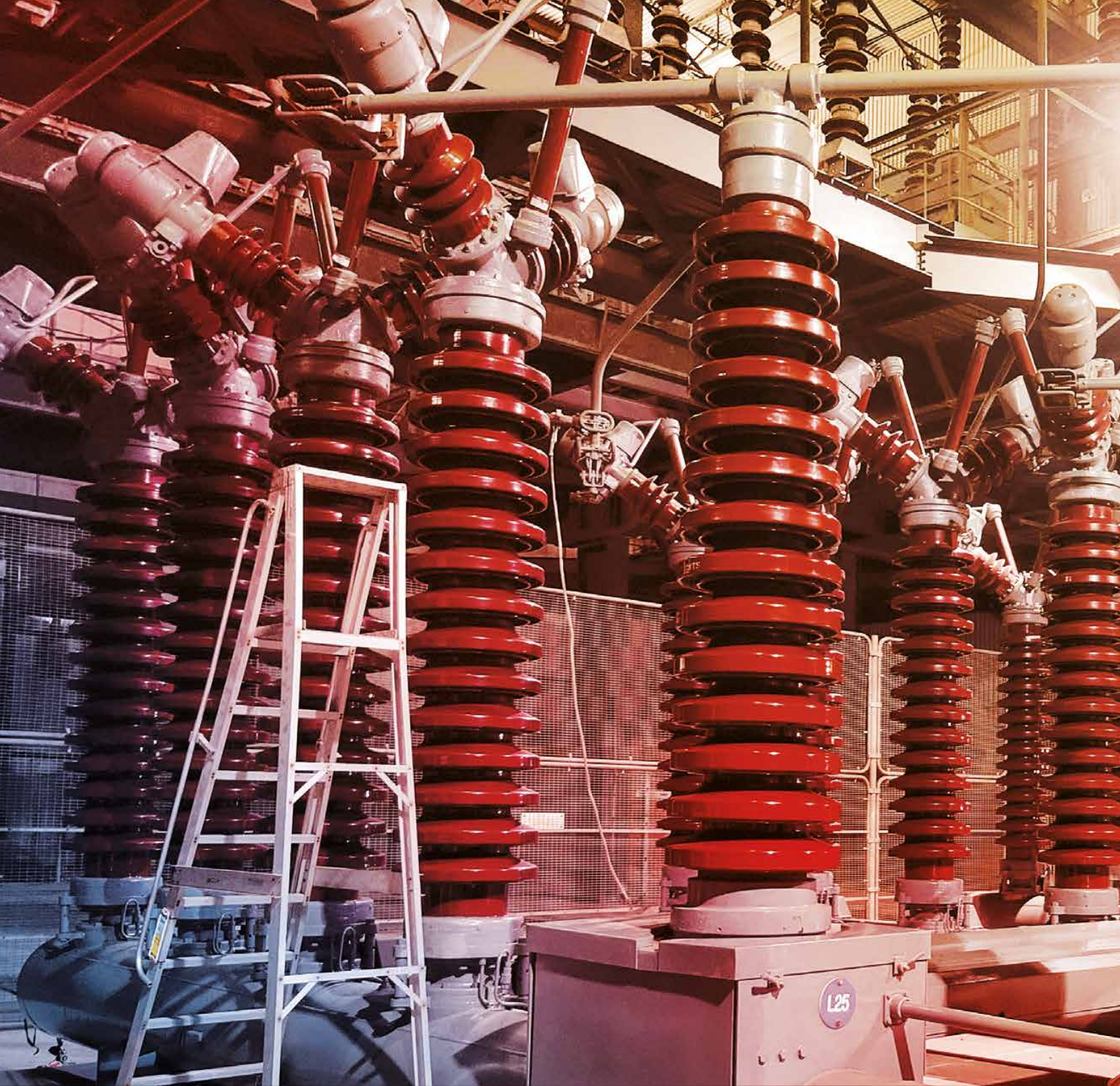
National Drink: Rakija (fruit brandy), Plavac mali, Teran, Tribidrag (Zinfandel), Malvazija and Grasevina (white wine).

National Sport: Football (soccer)

DOS AND DON'TS IN CROATIA

- › Try the local **food and wine**.
- › Enjoy **coffee culture**.
- › Visit the Croatian **coast, swim, hike, explore**.
- › Visit Croatia's **UNESCO World Heritage sites** and centuries-old towns, museums, and cultural events.
- › **Avoid taking sides** in the local football debates.
- › **Avoid wearing flip-flops** when hiking.
- › **Don't talk** during the weather forecast.
- › **Don't say water** if you're talking about the sea.

Saint Domnius Bell Tower, Split



MEETING EXPECTATIONS

Testing air blast circuit breakers?
No problem with CIBANO 500!



CIBANO 500 product manager and circuit breaker testing enthusiast Andreas Nanning and Technical Support and Applications Engineer Elias Alber, recently packed up their equipment and travelled from OMICRON in Klaus, Austria, to a power utility in the United Kingdom to demonstrate how our CIBANO 500 meets the challenges of testing air blast circuit breakers.

"Many air blast circuit breakers were installed in the 1950s. So, if you're still testing air blast circuit breakers, it not only means that the equipment is very old, but that it's reliable, long-lasting technology," explains Andreas.

"You need to consider that the kinds of malfunctions and errors that can happen in most circuit breakers are not unique to air blast circuit breakers, so they should be tested like other types of circuit breakers to assess their condition," he adds. "However, testing air blast circuit breakers is more complex due to the presence of eight interrupters in each phase. Performing tests on all these points requires more testing equipment than what's usually necessary for other types of circuit breakers."

The big question: Can we handle it?

Andreas recalls, "When a UK utility asked me what the maximum number of interrupters we could test simultaneously was, my response was twelve. Up until that point, we thought twelve was the limit our customers needed. The test device that this UK utility had been using to test their air blast circuit breakers wasn't capable of testing that many interrupters at once," Andreas explains. "Even though we were aware that our CIBANO 500 system could handle more, we placed

a twelve interrupters limit in our Primary Test Manager (PTM) software user interface to ensure system stability. We made the necessary adjustments to handle more interrupters and seized the chance to verify the effectiveness of our solution.

This was our first attempt testing air blast circuit breakers in the field, so the technical demonstration at the customer's site also served as a sort of BETA test for us. Ensuring the CIBANO 500 and its PTM user interface could manage the data load was crucial," he explains.

Despite preparations, improvisation prevailed

Although Andreas and Elias were well prepared to ensure reliable and complete testing outcomes, a fair amount of improvisation is often necessary during on-site testing, and they encountered a few surprises.

Elias recalls, "Since Andreas visited the same testing site a year earlier, he told me what to expect. Still, you never know. When you perform a test, it's not always cut and dried, and you end up doing a lot of improvising."

Pressed for time with only one ladder

"Before we could actually begin, we had to wait a while because there was a meeting at the utility, so the setup couldn't start effectively until about 11:00 AM. We were also informed that we had to complete our measurements and be packed up by 4:00 PM. So, we had very little time. The initial setup alone took about three hours," remembers Elias.

"We split up into groups to work more efficiently. However, only having one ladder available during setup was challenging. A ladder was necessary because ▶



«This was our first attempt testing air blast circuit breakers in the field, **so the technical demonstration at the customer's site also served as a sort of BETA test for us.**»

Andreas Nenning,
Product Manager, OMICRON



the interrupters were positioned about three meters above the ground – not extremely high, but just out of reach. Since we only had one ladder, the setup process was slow, with only one person able to work at a time. If we had three ladders, the setup could've been completed in one hour instead of three.”

A thick layer of paint

“There was an additional challenge that was quite limiting for us,” Elias recalls. “The individual interrupters surrounding the air blast circuit breakers hadn’t been tested in a very long time, and the metal housing had been painted. There was a thick layer of paint covering the connection points. Even though we used screw clamps, we couldn’t completely penetrate the paint to perform proper measurements.”

Taming the beast

“During the test, tripping and closing operations seemed to transform the air blast breakers into some kind of mechanical dragon,” Andreas describes. “The switching noises were louder than any breaker sounds I’ve ever heard. You could feel the sound wave with your entire body as it travelled through the substation hall, and the steam rising from the interrupters only intensified the illusion.”

Elias remembers, “Our UK sales applications engineer, Alan White, joined us during the demonstration. He was

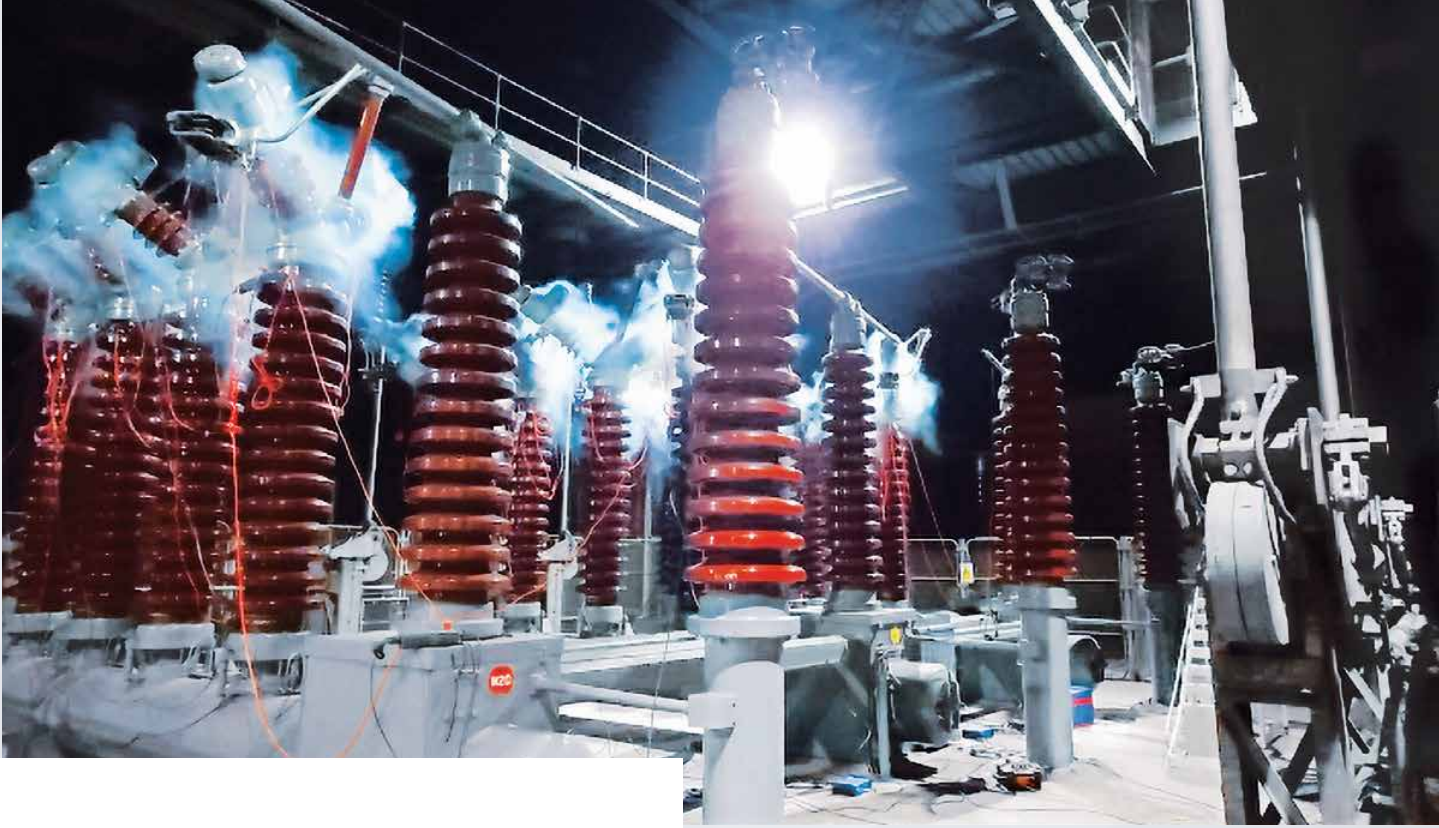
more prepared than we were, since he served in the army and was no longer fazed by loud blasts. He just standing right at the gate without flinching, while the rest of us remained startled.

It was the first time I saw a breaker like this in action, which was something quite intense to behold. When you’re dealing with circuit breakers, you’re used to saying something like ‘cover your ears, it’s going to be loud.’ However, the volume of this breaker can’t even be compared to the ones I’ve tested before it.” Elias adds, “You simply can’t imagine how loud it actually is, especially indoors where it echoes.”

Testing device synergy

“Our test setup included one CIBANO 500 main device, 15 MC2 main contact modules, and one TN3 transducer node for a motion measurement. To connect the CIBANO 500 to the 15 MC2s, we had to use three EHB1 EtherCAT hubs and the EtherCAT ports on the main device,” explains Andreas. “The challenge was that the CIBANO 500 only has four EtherCAT ports, but the EtherCAT hubs can handle more device connections and supply power to them.

In total, we had one CIBANO 500 with 15 MC2s and one TN3. It was important for us and the utility to see that all the equipment was working together,” Andreas adds. The utility also wanted to get a feeling for the equipment, so



we guided them through as much as we possibly could during setup and testing.”

The testing device the utility normally used was older and only performed timing measurements,” explains Andreas. “So, we showed them how CIBANO 500 could also perform dynamic contact resistance, static contact resistance, and motion measurements. When you do everything at once, much more condition status information can be obtained.”

Spotting trouble before it strikes

Andreas takes a deep dive into the diagnostic power of each measurement, revealing how they help uncover hidden issues within air blast circuit breakers:

“Static resistance measurements detect problems when there’s a significant value difference between a previous and current measurement, or between phases, or even between interrupters in the same phase. For example, a standard value is around 40 micro-ohms. So, let’s say phase B is suddenly 120 micro-ohms, then you know there must be something wrong.”

With dynamic contact resistance measurements, you can evaluate the inner part of the primary current. Combining it with the motion measurement ►

A BRIEF HISTORY OF AIR BLAST CIRCUIT BREAKERS

Circuit breakers have moving and stationary contacts that open and close to interrupt the current flow. The space between the contacts is often filled with a medium that helps extinguish the arc that forms when the contacts separate, such as air, oil, vacuum, or SF_6 . This is why there are different types of circuit breakers. Each one is based on a particular technique that was developed and has been used throughout different periods of circuit breaker history.

Air blast circuit breakers, or ACBs, were the standard for high voltage between 1950 and 1980 until the advent of SF_6 circuit breakers. ACBs utilize a blast of compressed air to extinguish and cool the arc between contacts when a fault occurs. This was a valuable principle because compressed air has a higher dielectric strength and better thermal properties than atmospheric air. During that time, they were installed all over the world. In the UK, they played an important role in building the super grid, which is the foundation of today’s modern UK electrical transmission system.

provides precise information about the circuit breakers' arcing contacts.

And lastly, motion measurements determine if there are any mechanical issues in the breaker path. Motion measurements also evaluate quick switching or reaction times, which are essential for preventing equipment damage to the surrounding grid."

Andreas recalls, "When we performed the motion measurement, we attached a magnetic strip to a long rod to detect abnormalities in the circuit breaker's moving components, such as the contacts. The magnetic strip consists of various permanent magnets. When it moves, the changes are detected by magnetic sensors, which convert the changes in the field to electrical signals acquired by our CB TN3 transducer node. Then these signals are processed to determine the moving component's position and velocity."

Proven efficiency

"The UK utility told me that when they tested breakers like these using equipment from our competitors, it required two days. But we only needed half a day to cover the same number of interrupters. Since we had the additional limitation of having only one ladder and how long it took to decompress the breaker, this makes it even more impressive. It's crazy when I think about it, but we were able to get everything done in far less time."

Expectations met

Andreas concludes, "In the end, the utility was pleased to see our solution could handle testing air blast circuit breakers with that many interrupters. We told them about the benefit of regular testing every couple of years or in specified intervals, and why removing the paint from their connectors in the future would get them more reliable results."

"Our utility colleagues were impressed by the demonstration and recognized the potential for performing many more three phase measurements in far less time with our CIBANO 500 test set," concludes Elias. ■

«Our utility colleagues were impressed by the demonstration and recognized the potential for performing many more three phase measurements in far less time with our CIBANO 500 test set.»

Elias Alber,

Technical Support and Applications Engineer,
OMICRON



CIBANO 500

The CIBANO 500, is a 3-in-1 test system that can be used to test all types of circuit breakers by performing a variety of electrical and mechanical diagnostic tests. Ideally, the CIBANO 500 should be used with our Primary Test Manager (PTM) software. The PTM software allows you to define, parametrize, and execute various tests, some of which are automated. This simplifies the testing process and provides a structured approach. Additionally, comparing recent test data to that of previous tests can detect deviations that can indicate electrical or mechanical defects.

More information:

 omicronenergy.com/cibano500

SAFE AND EASY CONNECTIONS

Plug-and-play partial discharge testing and monitoring



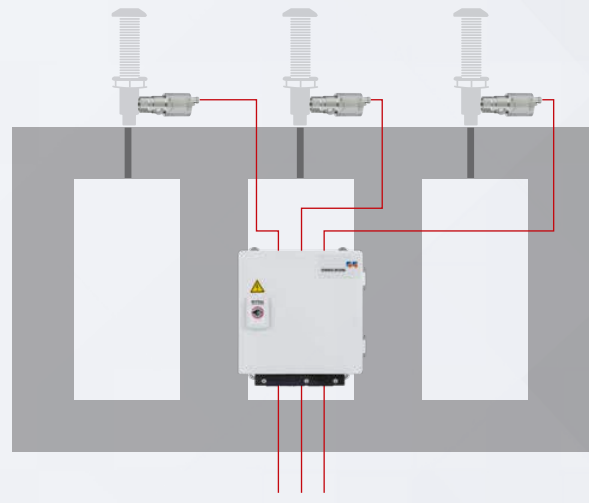
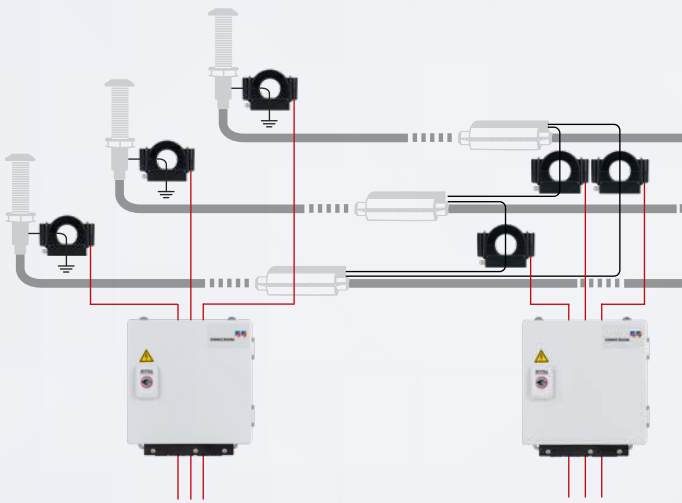
Our newly optimized Terminal Box provides a safe, reliable, and convenient method for performing online partial discharge (PD) measurements as well as online temporary and permanent PD monitoring on generators, motors, power cable joints and terminations, power transformers, and other electrical assets.

Avoid unnecessary downtime

The Terminal Box reliably connects our PD measurement and monitoring devices with permanently installed PD sensors when these electrical assets are operating. As a result, unnecessary downtime can be avoided, operator safety is ensured, and assets can be evaluated under normal operating conditions. The plug-and-play ►

DID YOU KNOW?

PD measurements, whether online or offline, provide valuable insights into the condition of electrical assets, enabling the identification of potential issues before they lead to failures. Regular PD testing and monitoring can help ensure the long-term reliability and performance of electrical assets. By analyzing PD data, asset managers can make informed decisions about maintenance schedules and optimize resource allocation to prevent unexpected outages.



Terminal Box configurations: The Terminal Box is easily mounted on your electrical asset near the permanently installed PD sensors. You can easily connect our PD detection devices to the Terminal Box for convenient plug-and-play online PD testing or monitoring.

*«Easy plug-and-play online PD measurements and monitoring can be performed interchangeably on rotating electrical machines, power cable joints and terminations, as well as other electrical equipment **without interrupting operation.**»*

operation enables you to easily switch from continuous PD monitoring to performing PD measurements for more detailed diagnosis.

Used with a variety of PD detection devices and sensors

For online PD testing, the Terminal Box can be used with our diagnostic MPD series of PD measurement devices. For continuous online PD monitoring, our MONTESTO 200 temporary PD monitoring system or our MONCABLO and MONGEMO permanent PD monitoring systems can be connected without interrupting operation.

These PD measurement and monitoring solutions are connected via the Terminal Box to permanently installed PD sensors, such as our CPL 844 bushing adapter for power

These PD measurement and monitoring devices can be connected interchangeably to the Terminal Box to collect data from the permanently installed PD sensors, which are also connected to it.



MPD 800



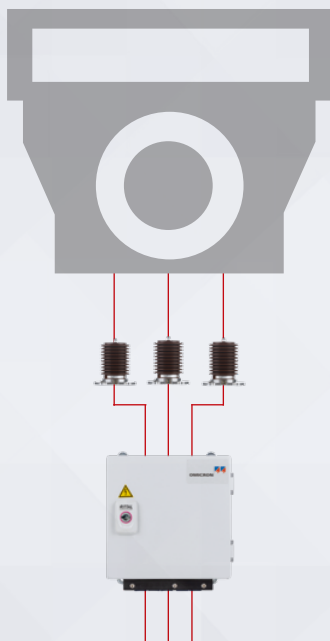
UHF 800



MONTESTO 200



**MONCABLO and
MONGEMO**



TERMINAL BOX BENEFITS

- › Simplified setup: Quick and easy connections that minimize the time and effort required for setting up PD measurements and monitoring.
- › Enhanced safety: The permanent installation of the Terminal Box and PD sensors greatly improves safety by reducing the need to handle the asset while energized.
- › Optimized convenience: The plug-and-play design allows you to quickly switch between online PD measurement and monitoring on the same electrical asset without service interruption.

transformers; our MCT 085 and MCT 120 high-frequency current transformers for power cable systems; and our MCC family of coupling capacitors, including the MCC 112, MCC 117-C, and MCC 124-C for rotating electrical machines.

One-time set-up for PD sensors and terminal box

During a routine maintenance outage, you can permanently install the PD sensors on each phase of your equipment and connect them to the Terminal Box, which can easily be mounted on a surface near the sensors. After that, future setup efforts for PD testing and monitoring will be very minimal and won't require further outages. You can simply plug in the PD measurement or monitoring device you need and start collecting data.

Rugged and flexible

Our rugged, IP65-rated Terminal Box is protected from moisture and dust, making it suitable for outdoor use and harsh industrial environments. One Terminal Box is used for a single electrical asset. It is available with either 3-channel or 4-channel outputs that match the number of PD sensors installed on the electrical asset. ■

More information:

 omicronenergy.com/terminal-box



LISTEN TO THE PODCAST

Interested in this topic?

In Episode 110 of our Energy Talks podcast series, OMICRON PD testing and monitoring expert Daniel Gebhard discusses the practicalities of permanently installing PD sensors and a terminal box on electrical equipment for performing safe and easy online PD diagnostic testing and continuous PD monitoring without interrupting service. Simply scan the QR code and enjoy listening!

 omicron.energy/episode110



WHAT'S GOING ON

We are continuing to share our knowledge. We are going to reach out to you physically or digitally with our events, trade shows, conferences, webinars and training courses. Keep yourself up to date by checking out our events and training courses.

Scan QR-Code to get fast access to all links:



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WE ARE LOOKING FORWARD TO SEEING YOU.