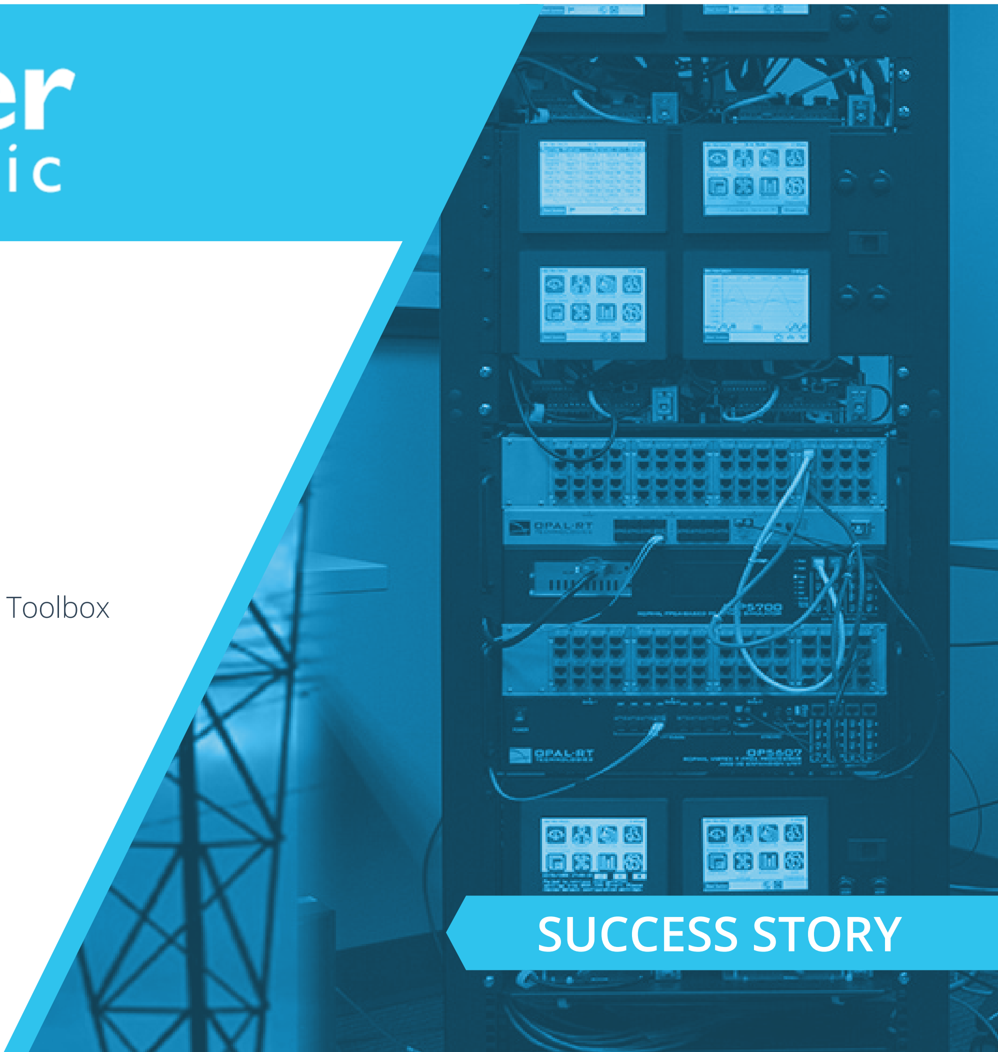
OPAL-RT TECHNOLOGIES

Schneider Electric's AccuSine: Active Harmonic Filter (AHF)

Schneider Electric



Application

- Active Harmonic Filter (AHF)

Related Products

- RT-LAB
- eHS| FPGA-Baser Power Electronics Toolbox
- OP5707

Type of Simulation

- Hardware-in-the-Loop (HIL)

SUCCESS STORY

INTRODUCTION

With the current sustained growth of electric transportation and renewable energy, power conversion applications are making global headlines, impacting financial markets, and changing society's perception of energy. But power conversion is just one part of the semiconductor story, and while power electronics improve efficiency for systems and enable applications, they can also affect power quality.

Specifically, the power electronics within these systems can produce harmonics that may negatively affect the power quality on both utility and load/source sides, which may ultimately result in several problems:

- Unwanted nuisance protection device tripping
- Oversizing of load equipment to compensate
- Equipment damage
- Increased power consumption or reduced efficiency
- Fines, power limitation or disconnection by the line-side power utility

For problems affecting the grid line-side, the IEEE has developed standards (IEEE-STD-519 and IEEE-STD-1547) that include power quality requirements to limit the harmonics injected into the grid at points of common coupling. Schneider Electric's AccuSine® product development team in Portland, OR are helping clients meet these standards and improve operations with their solutions.

The AccuSine® PCS+ Active Harmonic Filter (AHF) brings reliability and efficiency to electrical systems. They are designed to mitigate harmonics and reduce voltage fluctuations particularly in less harsh environments such as commercial buildings and light industry.

OPAL-RT is proud to be one of the key providers of leading-edge simulation platform for testing the Schneider Electric's product. This success story is based on a previous interview with John Batch (JB, below), Firmware Engineer at Schneider Electric.

"With HIL, one of the biggest advantages is being able to test the actual product. We can simulate all sorts of use cases: 50 Hz grids, multiple stacked units, different grid impedances, balanced and unbalanced loads--all kinds of situations."

John Batch, Firmware Engineer at Schneider Electric

CHALLENGE

Harmonics are caused by power electronic devices, such as Variable Frequency Drives (VFDs), that have rapid and frequent load variations. While these devices provide process control and energy saving benefits, they introduce harmonics and rapid change of reactive power requirement to electrical distribution systems. Harmonics can disrupt normal operation of other devices and increase operating costs.

Symptoms of problematic harmonic levels include overheating of motors, drives, cables, thermal tripping of protective devices and logic faults of digital devices. In addition, the life span of many devices can be reduced by elevated operating temperature caused by excessive voltage distortion.

OPAL-RT: What causes these harmonics and why might we want to remove them?

JB: Power electronic devices with frequent load variations have become abundant due to their process control related and energy saving benefits. However, they also bring major drawbacks in electrical distribution systems: harmonics and rapid change of reactive power requirements. Harmonics may disrupt normal operation of other devices and increase operating costs. Rapid reactive power requirement changes demand timely var compensation. Our products must additionally be tested and validated for use in a wide range of operating environments--in North America and around the world. Also, our PCS+ and PCSn product lines can be stacked in parallel using up to eight units to increase the total injected current up to 2400A, delivering negative and zero sequence currents. This adds significant complexity when developing the product.

OPAL-RT: How does paralleling work?

JB: Paralleling means that we use an ethernet cable to connect each of our units to each other. Using proprietary protocols, the units communicate with one device acting as a master device that sends a reference signal to all the other devices connected. In this way, each unit is doing the same thing and in synch.

THE VALUE OF HIL

Hardware-in-the-Loop (HIL) simulation is the standard for developing and testing the most complex control, protection, and monitoring systems. HIL's rise is the result of two major factors currently affecting product development across all industries: time-to-market and system complexity.

OPAL-RT: So how does Hardware-in-the-Loop (HIL) help with your development and testing? How does it compare with how you were working before?

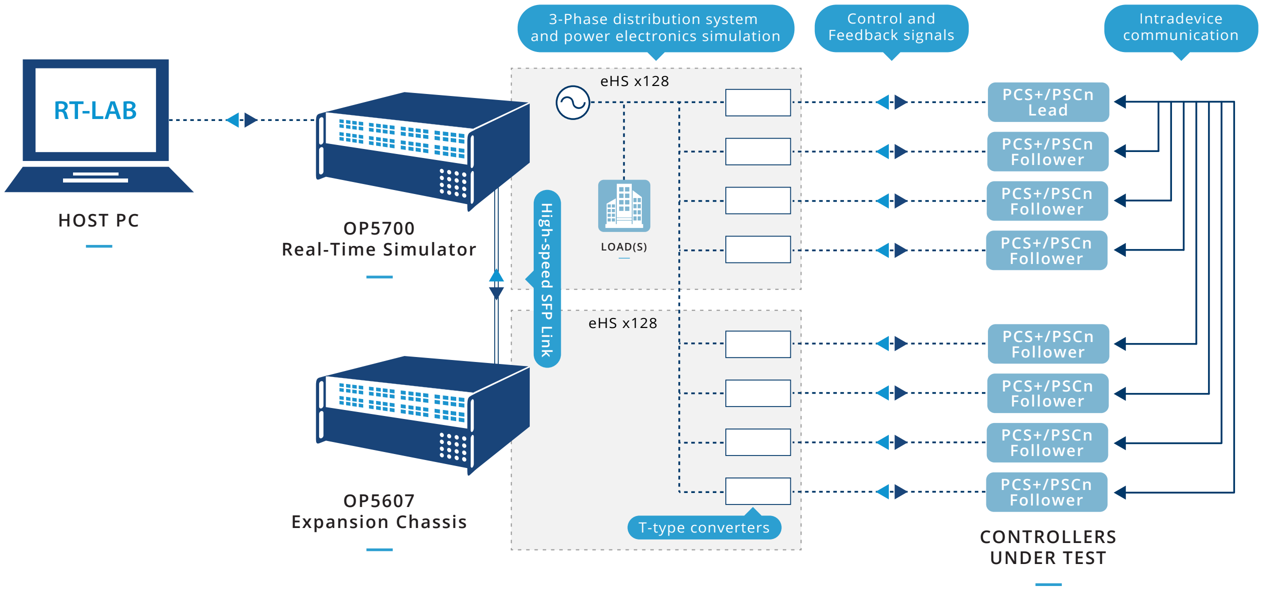
JB: HIL is important—we need to simulate a variety of environments to make sure our firmware or control is working correctly. Before HIL, we tested products at our factory's transformer. Since our grid is 60 Hz, this is not ideal since we also serve 50 Hz markets. Also, the power from the grid to the transformer we use is not capable of handling eight stacked 300-amp units. We used Software-in-the-Loop testing, but it isn't as useful for testing real hardware.

With HIL, one of the biggest advantages is being able to test the actual product. We can simulate all sorts of use cases: 50 Hz grids, multiple stacked units, different grid impedances, balanced and unbalanced loads--all kinds of situations.

OPAL-RT: Why did you decide to use OPAL-RT as an HIL supplier?

JB: Given that our AccuSine PCS+ and PCSn units can be configured with up to 8 units in parallel, we needed a HIL platform capable of simulating such system without introducing instabilities, and Opal RT responds to that need well.

On a technical level, we chose OPAL-RT because you can simulate more of our converters without decoupling, which can introduce instability. While we do run two of your eHSx128 cores on two separate systems (OP5700 and OP5607) to simulate 8 units, there is only one physical decoupling point with no impact to the overall stability and fidelity of the simulation. Also, we felt that having two different HIL providers gives us the benefit of leveraging the strength of each HIL platform, further expanding our validation capabilities.



SOLUTION

OPAL-RT: So how has HIL and the OPAL-RT system worked out for you?

JB: We've been very satisfied with the OPAL-RT simulator. It allows us to simulate all eight PCS+/PCSn units in parallel, to simulate customer issues with more accuracy, to test and improve our firmware before we release it, and to start product development before we have hardware for new designs. In general, HIL has been a great asset and timesaver. For example, now when we take a unit to Europe, we have confidence that it is going to work when we get there. When on a customer site, we can focus on testing that's more beneficial than just getting it to work at 50 Hz.

When we first commissioned the system, I made an error, and our grid impedance was off. So, we tuned our control and figured out that it was an incorrect parameter in the HIL. My control colleague's comment was, 'That's exactly how I would expect it to behave if we had that many units on an extremely weak grid.' So, the OPAL-RT system has been very good. We have used it to simulate field issues where a specific set of harmonics were causing problems. We were able to inject those harmonics into the simulated grid so we could understand what the customer was seeing. And as I said, the only thing I can complain about is that it doesn't consider real-world tolerance differences—and that's not really a complaint.

SUPPORT & SERVICE FIRST!

OPAL-RT: How has it been working with the OPAL-RT staff?

JB: It's been great. Your staff has been very responsive. I was skeptical you would be able to handle the 8-unit case as promised, but you did. You improved the eHS solver to improve the accuracy of our testing. Also, your technical support team, Sergio Atayde in particular, spent a lot of time commissioning the unit and was really good.