

DEVELOPMENT AND EVALUATION OF OPEN-SOURCE TESTS SCRIPTS FOR THE NEW EUROPEAN DER TEST STANDARD EN 50549-10

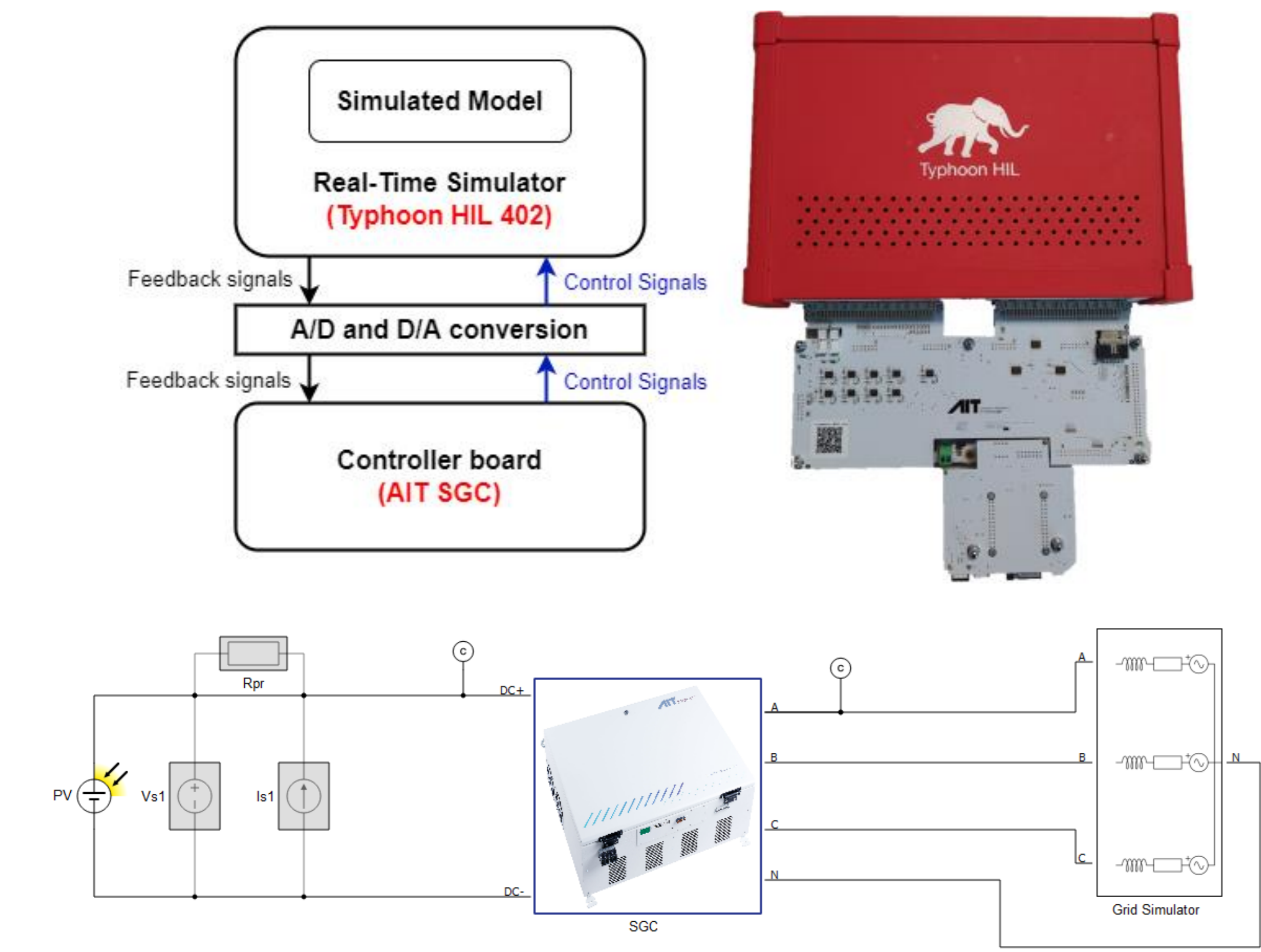
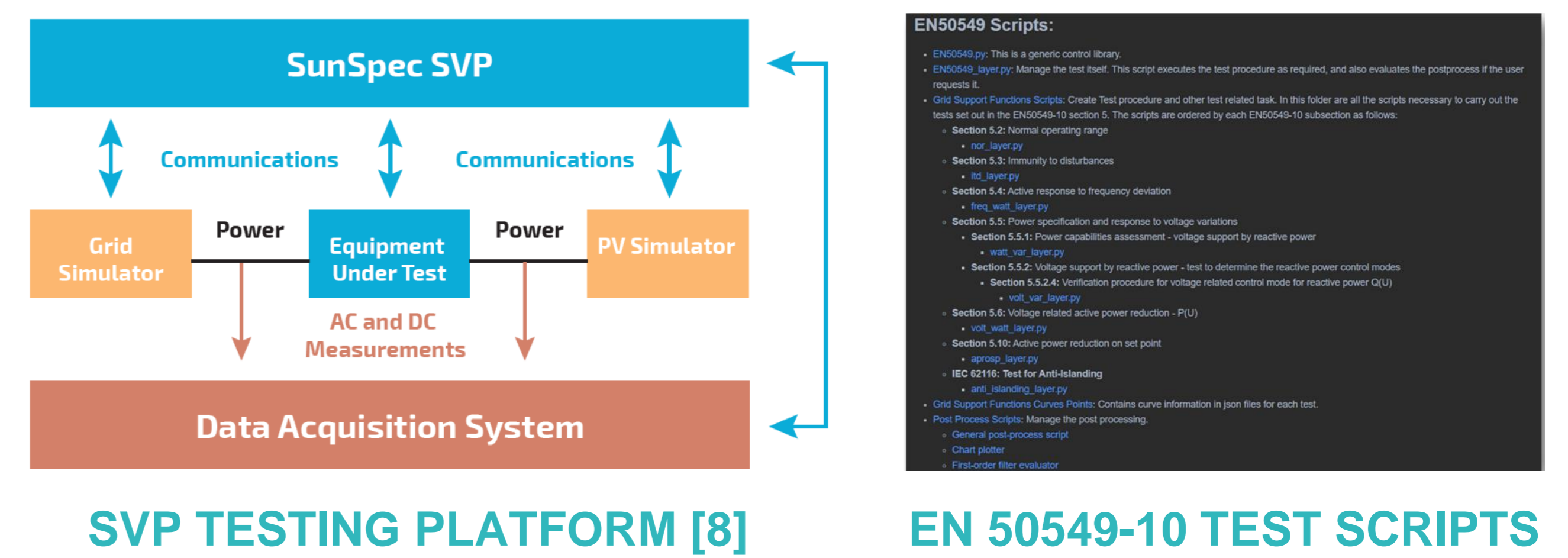
EN 50549-10: THE NEW EUROPEAN DER INTERCONNECTION TESTING STANDARD

In Europe, the EN 50549-1 [1] and -2 [2] standards, published in 2019 define the specific requirements for Distributed Energy Resources (DER), including detailed description of grid-support functions, interface protection, ride-through capabilities, and remote information exchange.

In line with these requirements, the new standard EN 50549-10, published in October 2022 [3] provides technical guidance for tests to evaluate electrical characteristics of DER units and components such as Solar PV power conversion systems (PV-PCS). These test procedures will eventually be used to certify the compliance of DER products on European DER markets.

TEST SCRIPTS ENABLE FULLY AUTOMATED TESTING AND QUALIFICATION OF DER UNITS

In this work, open-source test scripts for the EN 50549-10 were implemented, tested and validated using the SunSpec System Validation Platform (SVP).



AIT SMART GRID CONVERTER CHIL TESTBED

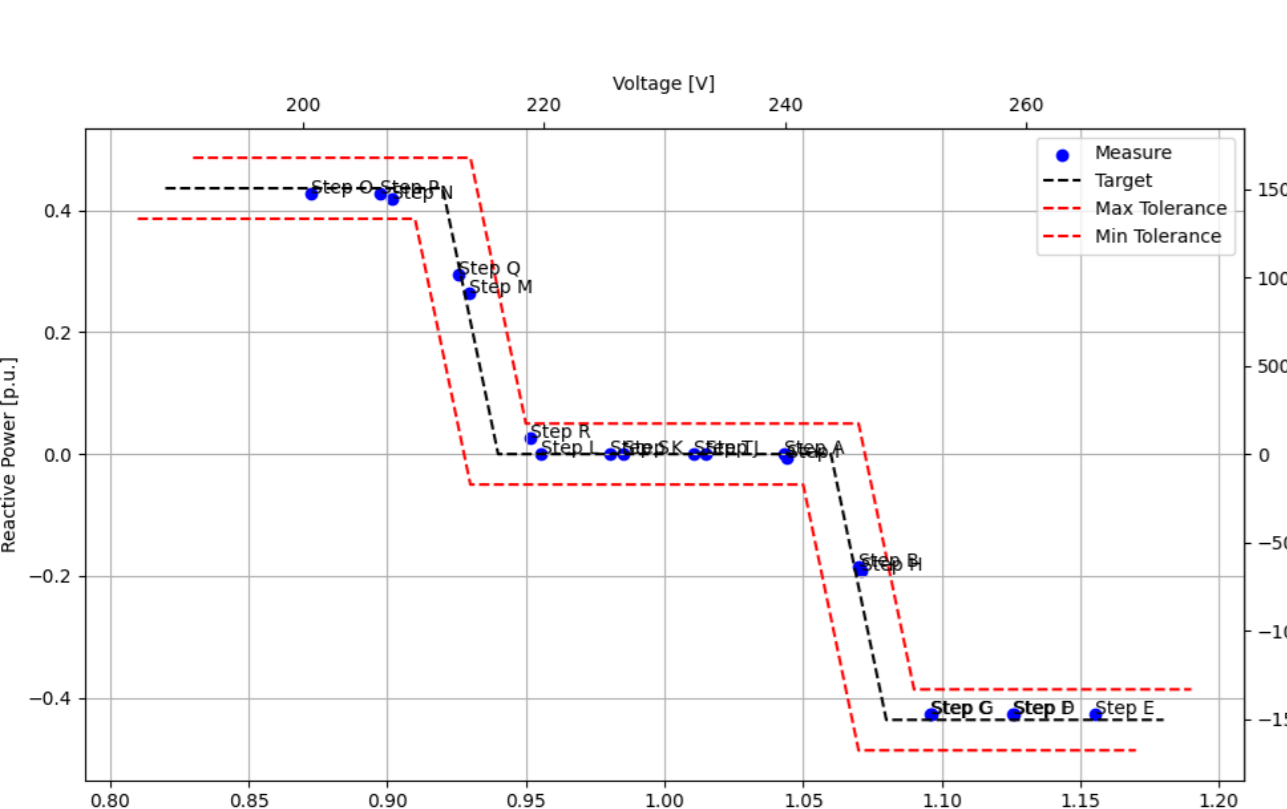
The open-source test scripts were tested on AIT's integrated Controller Hardware-In-The-Loop (CHIL) testbed [5]. The complete setup consisted of a Typhoon HIL Digital Real-Time-Simulator connected to the AIT Smart Grid Converter (SGC) [6], which acted as Device-Under-Test (DUT).

Controlled through the SunSpec System Validation Platform, the setup enables fully automated testing, data-acquisition, and analysis of all relevant DER grid support functions.

The test scripts implement using Python include the complete testing logic required to change settings on the DUT, the simulated grid, and the primary source (Solar PV). In addition, the scripts control the data acquisition and provide the automated evaluation of the measurement results.

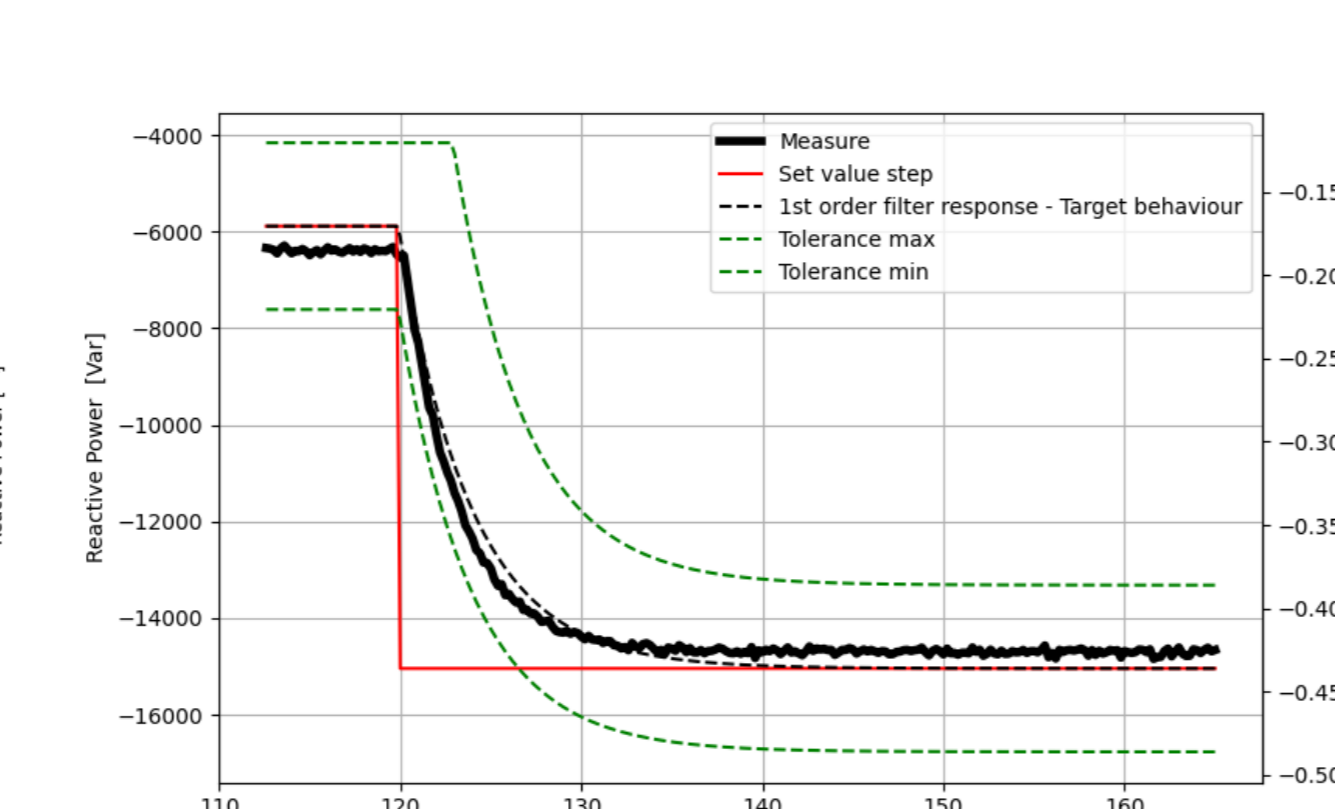
VALIDATION RESULTS

Steady state response of reactive power and EN 50549-10 tolerance bands [7]



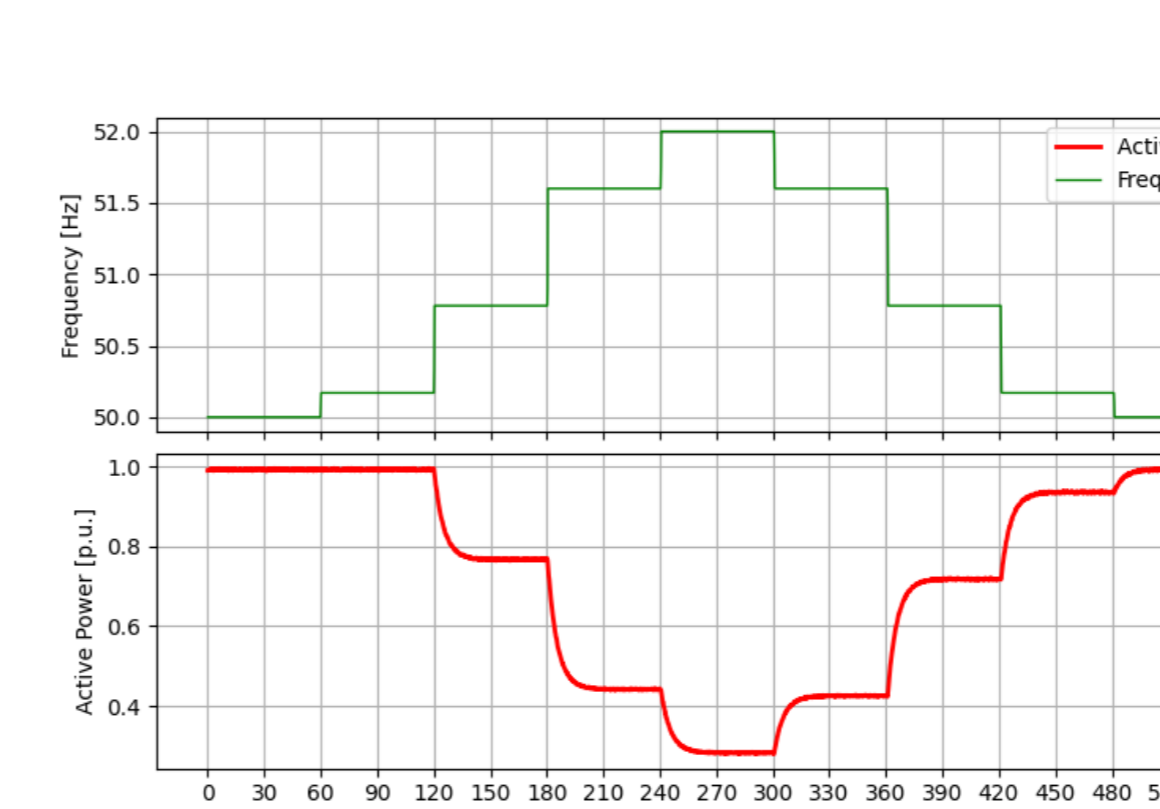
VOLT-VAR

Reactive power response to a step-change of the grid voltage together with dynamic tolerance bands (first-order behavior) [7]



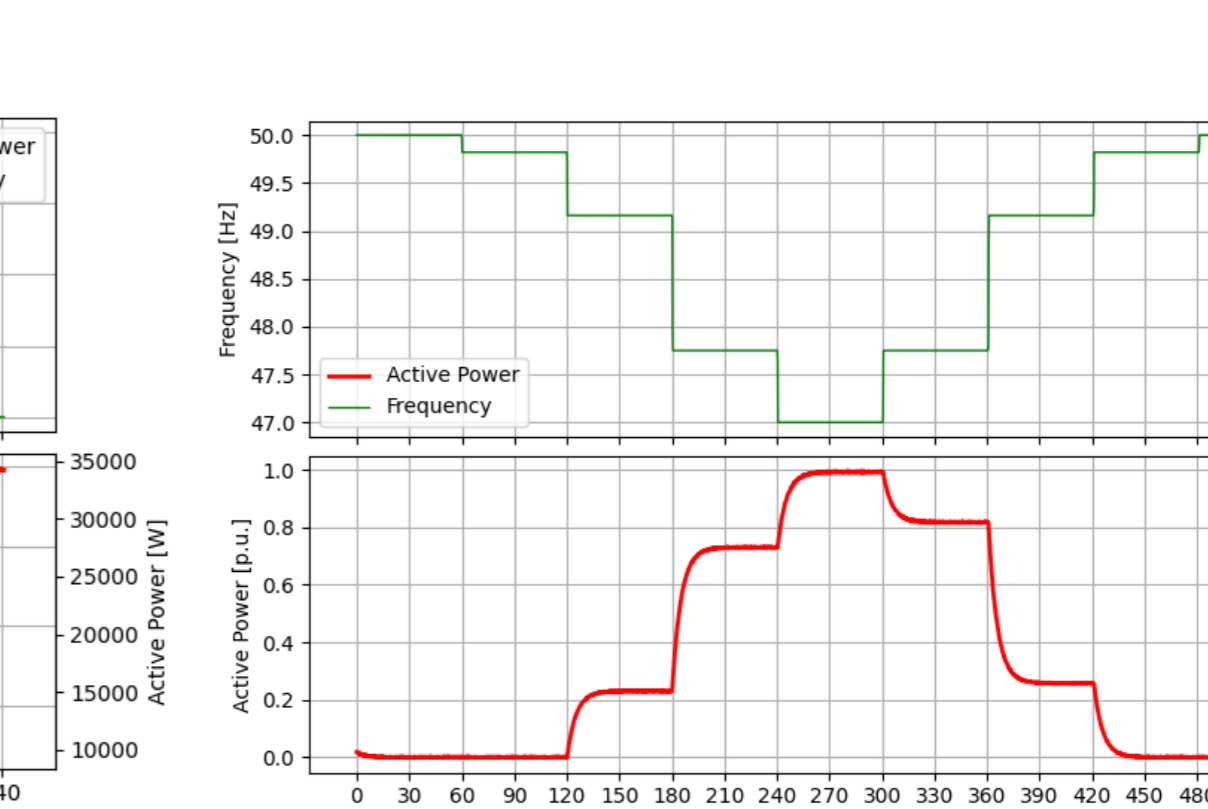
VALIDATION RESULTS

Active power response to over-frequency (limited frequency sensitive mode – over frequency) [7]



FREQUENCY-WATT

Active power response to under-frequency (limited frequency sensitive mode – under frequency) [7]



CONCLUSIONS & OUTLOOK

- Open-Source EN 50549-10 Test Scripts can be universally applied in all DER testbeds supported by SVP.
- New, improved data post-processing methods were created that allow the evaluation of the test results in a faster and more efficient way.
- The EN 50549-10 test scripts will be made publicly available on SIRFN's SVP Open-Source SVP GitHub repository

[1] Requirements for generating plants to be connected in parallel with distribution networks - Part 1: Connection to a LV distribution network - Generating plants up to and including Type B," EN50549-1:2019, 2019.
 [2] "Requirements for generating plants to be connected in parallel with distribution networks - Part 2: Connection to a MV distribution network - Generating plants up to and including Type B," EN50549-2:2019, 2019.
 [3] "Requirements for generating plants to be connected in parallel with distribution networks - Part 10 Tests demonstrating compliance of units," EN 50549-10:2022, 2022.
 [4] SunSpec Alliance, "SunSpec SVP," <https://sunspec.org/svp-lab/>. (Accessed on 01/06/2022).
 [5] J. Johnson, R. Abinger, R. Bründlinger, B. Fox, and J. Flicker, "Design and evaluation of SunSpec-compliant smart grid controller with an automated hardware-in-the-loop testbed," Technology and Economics of Smart Grids and Sustainable Energy, vol. 2, 09 2017.
 [6] R. Bründlinger, Z. Miletic, and R. Abinger, "AIT smart grid converter(SGC) controller featuring SunSpec protocol support utilizing hardware-in-the-loop (HIL) technology," 09 2016.
 [7] F. J. Salazar Hamze, "Development and Evaluation of Open-Source prEN50549-10 Test scripts for improved Solar Integration", Master Thesis, ULL University of La Laguna, Department of Applied Physics, Spain, September 2022.
 [8] Johnson, Jay. (2018). International Development of a Distributed Energy Resource Test Platform for Electrical and Interoperability Certification. WCPEC, 2018.