MIST Case Study

Validation of Australian Standards Test Methods

ERGON ENERGY NETWORK
Part of Energy Queensland

The Challenge

As part of Ergon Energy Network's contribution to the development of AS/NZS 4777.2:2020, we performed inverter testing to help validate the test procedures proposed by the Standards Australia Committee EL-042. This standard specifies the product requirements and technical performance of grid-connected inverters. The objective was to assist the technical committee in identifying any potential challenges that could arise from the proposed test procedures and how the inverters were being assessed for compliance with the methods detailed in the standard.

Test Procedures for Validation

The specific test procedures we were tasked to validate in the Microgrid and Isolated Systems Test (MIST) facility included:

- F.1.2 Fixed Reactive Power Mode: Assessment of inverter operation under a fixed reactive power setting.
- I.3 Voltage Disturbance Withstand Tests: Evaluation of inverter response to voltage disturbances.
- I.5 Voltage Phase Angle Shift Test: Examination of inverter behaviour during abrupt changes in voltage phase angle.
- J.3.2 Increase in Frequency for Inverters without Energy Storage: Testing inverter performance when grid frequency increases, specifically for units lacking energy storage capability.
- G.2.2 Combined Volt-Var and Volt-Watt Response Modes: Verification of inverter functionality when simultaneously responding to both volt-var and volt-watt requirements.

Our Approach

To ensure thorough validation of the proposed test methods, we adopted a power hardware in the loop (PHIL) methodology. This strategy was selected to deliver comprehensive end-to-end assessment, confirming the practicality and robustness of each test procedure.

The PHIL setup incorporated our real-time digital simulator (RTDS) together with a linear power amplifier, enabling the creation of a highly configurable three-phase grid simulator. Through this arrangement, intricate network scenarios could be designed and managed within the RTDS, then accurately reproduced as physical inputs to the inverter via the amplifier.

Additionally, a solar simulator was used to conduct solar-related tests under controlled and repeatable conditions, effectively eliminating the variability from actual solar panels. As a result, our approach provided a reliable means of validating test methods without the influence of external environmental factors. An overview of the test circuit is provided in Figure 1 and some of the physical test setup is shown in Figure 2.

MIST Facility

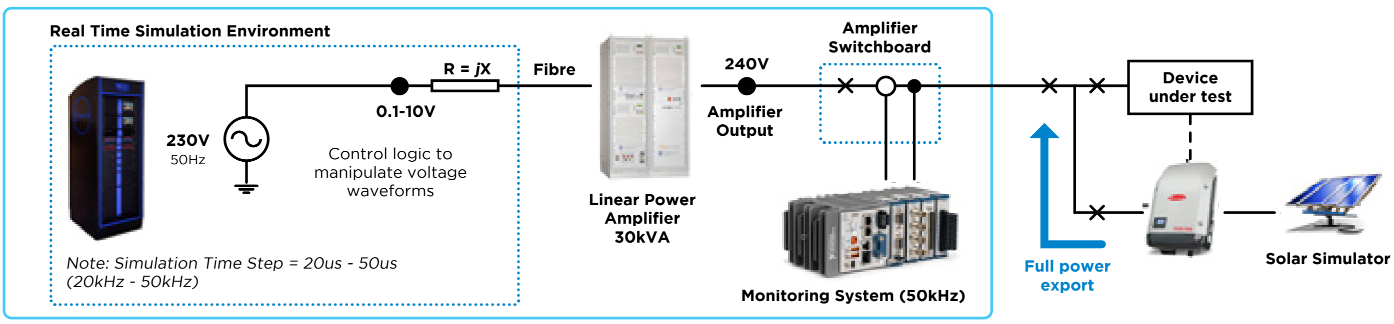

Figure 1: Overview of the test setup.

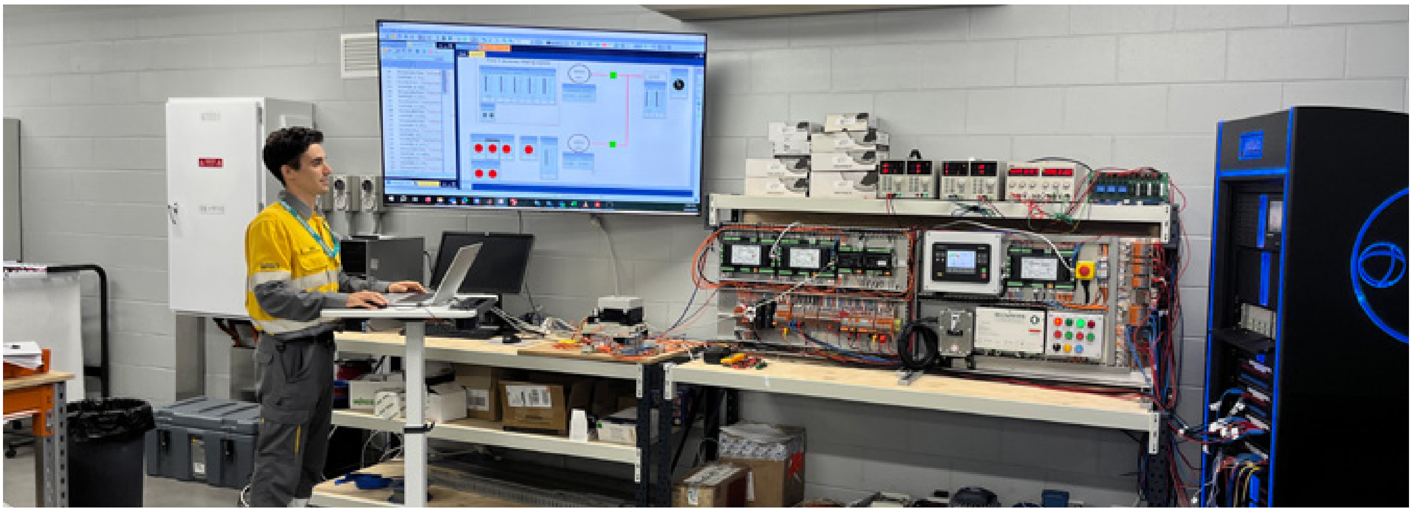

Figure 2: Test setup within the MIST facility.

Test Results and Analysis

The PHIL testing process enabled us to deliver rapid feedback on the standard's proposed test procedures and results to the EL-042 committee. This quick turnaround supported their ability to make timely, informed decisions regarding critical test methodologies.

Voltage Phase Angle Shift Test

During the Voltage Phase Angle Shift Test, we utilised the RTDS to exercise precise, individual control over the phase angles of each voltage phase. This allowed us to perform phase jumps both at voltage zero-crossing points and within 45-degrees of the waveform peaks and troughs, as stipulated by the test procedure. The combination of the RTDS and the linear power amplifier enabled us to detect zero-crossings reliably and apply instantaneous voltage phase shifts with a high degree of accuracy. An example of a 45-degree temporary phase jump being applied to A-Phase is provided in Figure 3. Figure 4 shows the measured response of the inverter to this phase jump.

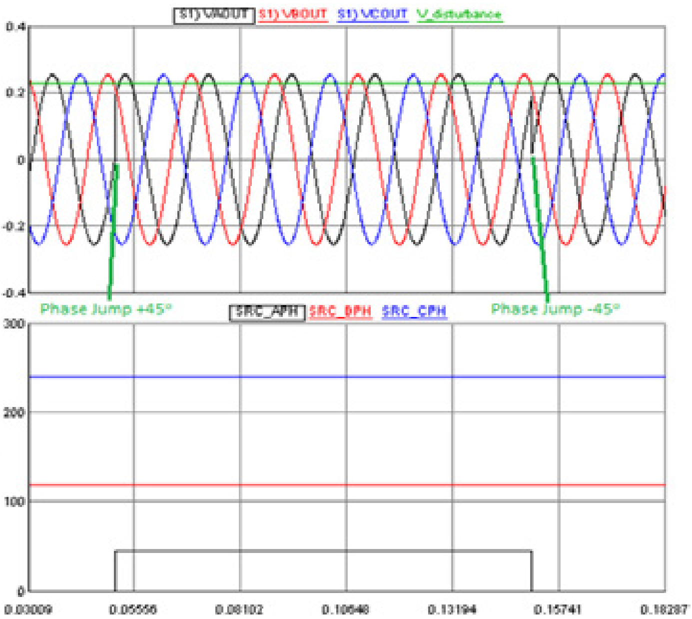

Figure 3: Demonstration of 45-degree phase jump on A-Phase

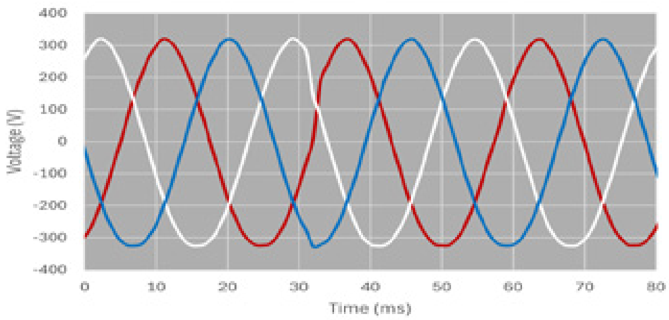

Figure 4a: Measured inverter voltage waveform during phase jump.

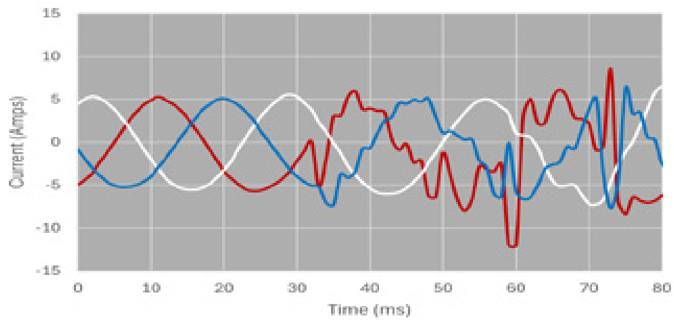

Figure 4b: Measured inverter waveform during phase jump.

Feedback on Assessment and Compliance

Based on our findings, we provided feedback to Standards Australia Committee EL-042 concerning both the inverter's compliance with the assessed draft test procedures and the inherent complexity of performing the required test procedures. Our test equipment, capable of precise voltage waveform manipulation including detecting zero-crossings and executing instantaneous phase jumps across multiple phases at once, proved essential in evaluating the inverter's adherence to the required procedures.

For more information visit:
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