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Introduction

The changing nature of the power grid means that components can no longer be deployed after only completing component-only testing [1], it is necessary for these components to be tested for their response to and effect on a system. An example of this is distributed energy resource (DER) protection systems, especially the loss of mains/ anti-islanding system.

With the increasing penetration of large numbers of convertor connected generation it becomes more complicated (if not impossible) to physically test the effect, for example, that a suburban street's worth of inverter connected PV arrays may have on the network and the performance of protection and automation schemes. Therefore a new way of confirming the technical performance of devices must be found. The method proposed in this poster is to use real-time power hardware-in-the-loop (RT-PHIL) to test devices and ensure their compliance with the relevant standards.

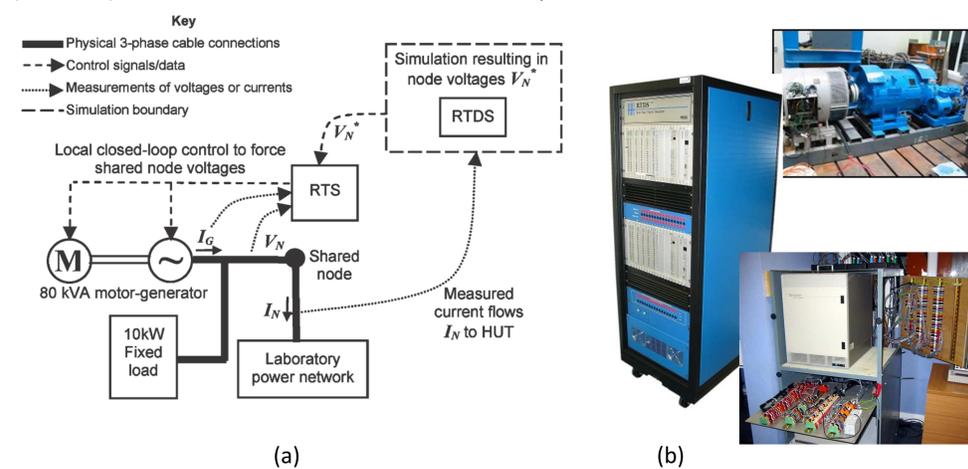


Figure 1: (a) Diagram of RT-PHIL closed loop system,[2] (b) Pictures of RTDS [3], MG set and ADI Real Time Station [4].

Real-Time Power-Hardware-in-the-Loop

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The method proposed in this poster is to use real-time power hardware-in-the-loop (RT-PHIL) to test devices and ensure their compliance with the relevant standards. RT-PHIL is relatively new development in power system component testing and results from the integration of a real-time digital simulator running a power system simulation with a real power interface such as a motor-generator (MG) set or four-wire inverter.

Islanding Detection Testing

If embedded generation systems are to be embedded in the grid then it is necessary for the change of state from grid connected to islanded (microgrid) to be reliably detected so the control system can disconnect the generator. Currently embedded generators connected to the low voltage distribution network within the United State's electrical supply system must meet the IEEE 1547 standard and those within the UK must meet the G83 Engineering Recommendation.

Each of these standards has a requirement for detection of loss of mains and for the generator to disconnect on detection, in a microgrid scenario this would change to opening of the point of common coupling agreed with the distribution network operator. IEEE 1547.1-2005 defines a set of conformance tests as does GB ETR 139 for G83. IEEE 1547 requires the testing of the full generation system, where as GB ETR 139 only requires the testing of the protection system.

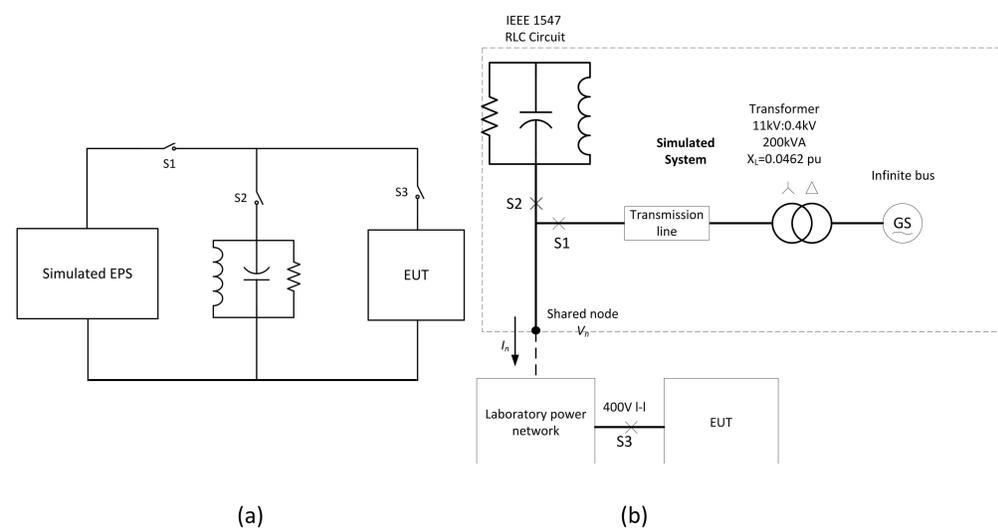


Figure 2: (a) Diagram of the defined test set-up for IEEE 1547.1-2005 LOM conformance test, (b) Diagram of the experimental test set-up proposed for using RT-PHIL for testing conformance.

Conclusions and Future Work

This proposed method for applying the LOM tests of ETR 139 (applied to LV networks in the first case) and IEEE 1547 represent the future for power system component testing in the face of more complicated network topologies with larger levels of interconnection. Suitable methods of assessing the impact of increased complexity will be required.

The benefit of this method is to allow the full system testing of an embedded generator (s) connected to a live electrical network in which a variety of remote faults and disconnection scenarios can be run through in real-time

The University of Strathclyde is constructing a new smart grids research centre, The Power Networks Demonstration Centre. This will have an 11kV HV network along with an MG set and RTDS system. The RT-PHIL system will be implemented here.



References

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