

**A contribution to
ISGT 2020 Panel session on
Real-time simulation and hardware-in-the-loop testing**

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Title

Hardware-in-the-loop testing of innovative under-frequency load shedding with TOR 300 device

Abstract

In 2018, University of Ljubljana (UL) has developed an innovative algorithm for under-frequency load shedding (UFLS) protection based on rate-of-change-of-frequency (RoCoF). In August 2019, Relematika Ltd. agreed to support UL efforts by implementing the algorithm into their Intelligent Electronic Device (IED) from the TOR 300 series. This presentation will provide the results of hardware-in-the-loop (HIL) testing of the algorithm with real-time digital simulator (RTDS). We were observing how the algorithm affected the UFLS scheme as a whole, i.e. from the system-integrity protection scheme (SIPS) perspective. Testing setup tried to mimic the real-life situation by combining both the physical IED and the software-based replica of the algorithm, since realistic conditions involve different kinds of IEDs in diverse locations across the EPS. We represented two different electric power system (EPS) testing environments in the RTDS simulator: *i*) IEEE 9-bus test system as one of most widely used internationally accepted UFLS testing model and *ii*) a microgrid test system as a typical representative of extremely low inertia networks. Both helped to prove that the UFLS innovation is robust, efficient and offers a very useful way of utilizing RoCoF for UFLS purposes. An exceptionally positive side-product of the project was establishment of improved RoCoF filtering technique that cleared all doubts regarding the algorithm's potential.

Keywords

Hardware-in-the-loop; real-time simulation; under-frequency load shedding protection; rate-of-change-of-frequency; intelligent electronic device; RoCoF filtering technique.

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