Evaluation of DER integration on distribution protection with Hardware in the loop using Low energy signals

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Objective:

• To develop a hardware in the loop test setup for the deep integration of renewable energy in the power system research work.
• Understanding the impact of the distribution energy resources integration on existing protection system at distribution level.
• Develop case studies of protection issues and validate them with test bed setup.
Hardware in the Loop setup with LEA:

- Voltage and currents from simulation model
- LEA Voltage and currents from GTAO
- SEL 451 Relay
- Relay output through external DC (+5V)

*Images are taken from RTDS and SEL websites and for representative purpose only.*
Protection related issues with DER integration:

**Reverse power flow:**

**Sympathetic tripping:**
Project flow:

1. Developing a Microgrid system in Power Factory.
2. Load flow and SC study.
3. Parameter check.
4. Protection coordination study.
6. Validate the impact of DER in Power Factory.
7. Extracting the relay settings for test setup.
8. Simulating the Microgrid in RSCAD.
9. Relay configuration with the extracted settings from Power Factory.
10. Validating the study cases using HiL setup.
11. Documenting the results.
12. End.
Microgrid model in PowerFactory:
Relay operating curves:

Reverse power flow:

Sympathetic tripping:
Microgrid model in RSCAD:
Results:

Reverse power flow:

- Power output of the PV is increased from 735 kW to 1.01 MW and the relay is observed to trip on inverse time over current protection.

Sympathetic tripping:

- A 3-Ph SC fault is created at B7 bus and the fault current contribution from batteries have resulted in activation of instantaneous trip at Transformer HV side relay.
Future research:

Images are taken from RTDS and SEL websites and for representative purpose only.

RTDS Simulator
NovaCor Chassis
3 Racks mount

RSCAD Software
GUI

Voltage and currents
from simulation model

RTDS Simulator
NovaCor Chassis
3 Racks mount

Voltage and currents
from simulation model

LEA Voltage and currents
from GTAO

LEA Voltage and currents
from GTAO

GTNETx2 Card

SEL 451 Relay

IEC GOOSE Signal subscribed
in the model

IEC GOOSE Feedback
from relay to GTNETx2

IEC GOOSE Feedback
from relay to GTNETx2

CompactRIO

System status

Ethernet interface
Physical connection
Fibre optic

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