Fault Detection Method by Utilizing Instantaneous Power Theory for Inverter-based Distributed Generation

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INTRODUCTION

- Installation of inverter-based distributed generators (IDGs) in the power system is growing rapidly.
- This can create problems in the protection due to current limit of IDGs.
- Fault detection method is proposed to differentiate transient and fault conditions.
- Instantaneous power theory is utilized to identify fault conditions.

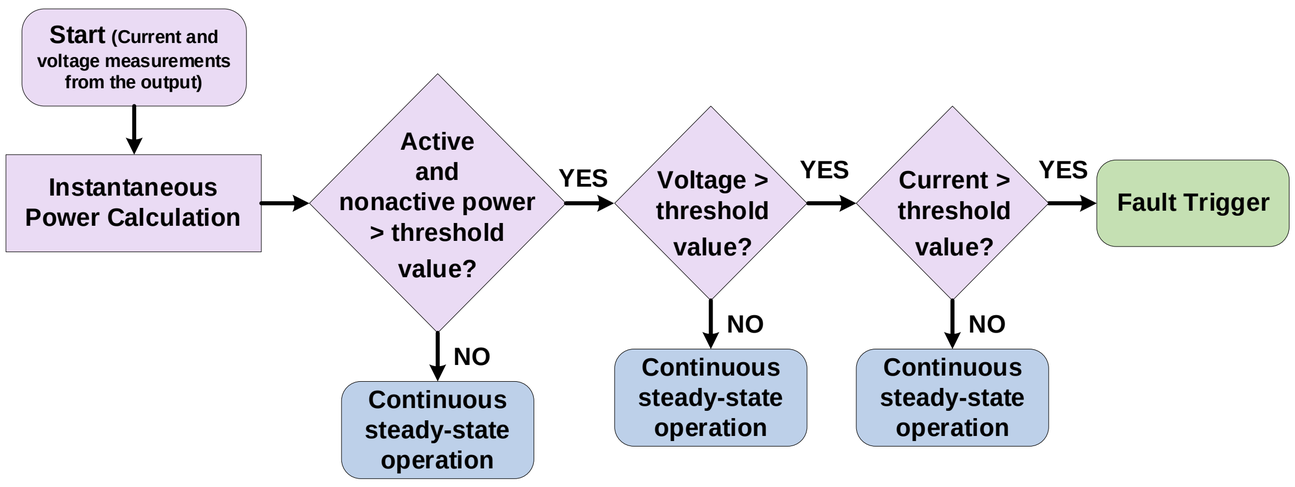

Fig. 1. Proposed fault detection method.

INSTANTANEOUS POWER THEORY

- Definition allows selection of T_c (averaging interval) and v_P (reference voltage).
- To obtain the instantaneous active and nonactive power, T_c is set to zero.

***A*verage active power**

$$P_a(t) = \frac{1}{T_c}\int_{t-T_c}^{t} p(\tau)\,d\tau = \frac{1}{T_c}\int_{t-T_c}^{t} v(\tau) i_a(\tau)\,d\tau$$

Threshold	Value (pu.)
Lower voltage	0.88
Upper voltage	1.1
Current	1.2
Active power	1.5
Nonactive power	2.5

***A*verage nonactive power**

$$P_n(t) = \frac{1}{T_c}\int_{t-T_c}^{t} v(\tau) i_n(\tau)\,d\tau$$

OBJECTIVES

- To differentiate transient and fault conditions in inverter based-systems.
- To develop a fault detection method for IDGs.
- To allow the inverter to ride through transient conditions.
- To have the protection system to trigger quickly and accurately during fault conditions.

CHALLENGES

- Different transient behaviors between IDGs and traditional generations.
- Conventional protection has been not designed for IDGs.

EXPERIMENTAL RESULTS

- Banshee microgrid with grid-connected operation.
- Microgrid system including PV inverter, BESS, and loads.
- Perform instantaneous power calculation.
- Verified fault detection method performance.

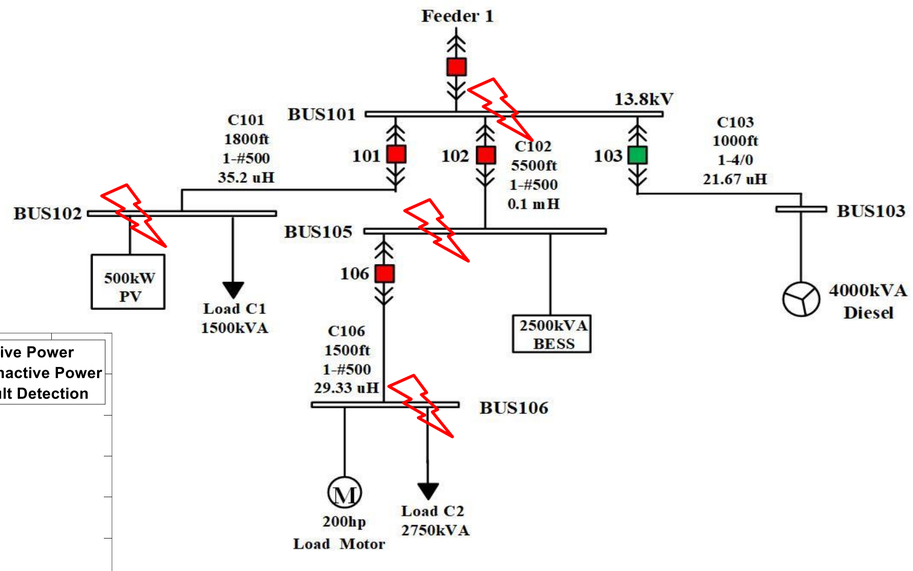

Fig. 2. Banshee microgrid emulator.

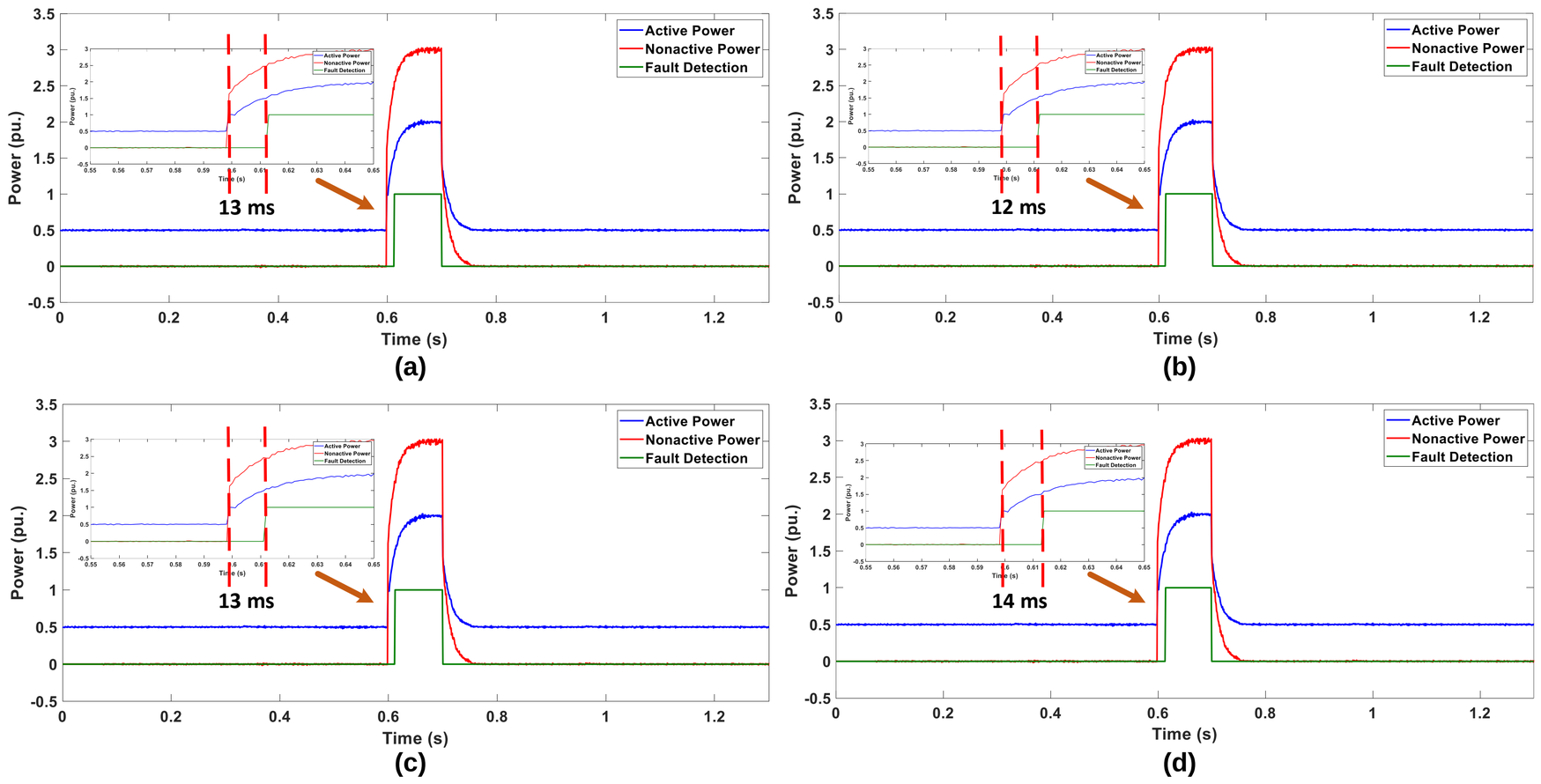

Fig. 4. BESS Instantaneous power calculation and fault detection during fault events. (a) BUS 101, (b) BUS 102, (c) BUS 105, and (d) BUS 106

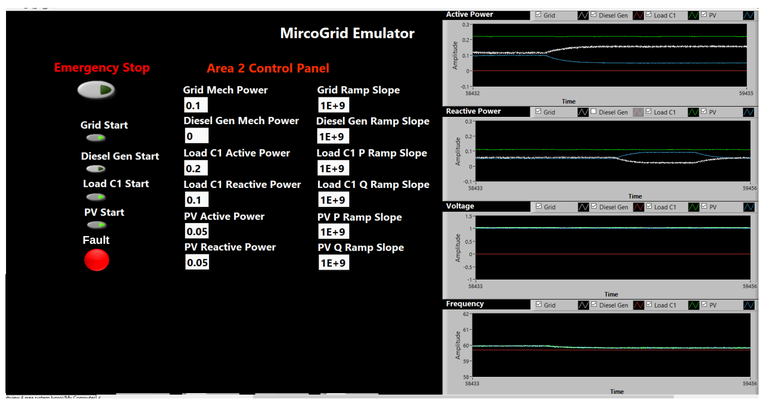

Fig. 3. Control center screen for microgrid emulator.

CONCLUSION

- Fault detection method has been emulated in HTB.
- Fault detection method has been implemented in IDGs (PV and BESS).
- Fault detection method allows IDGs to operate during transient continuously and detect faults accurately.

FUTURE WORK

- Verify with different fault scenarios.
- Operate microgrid in islanding mode
- Test the fault detection method in islanding operation.