PUBLIC

Implementation Considerations for Negative-Sequence Current Injection (NSCI) Requirements for IBRs in ERCOT

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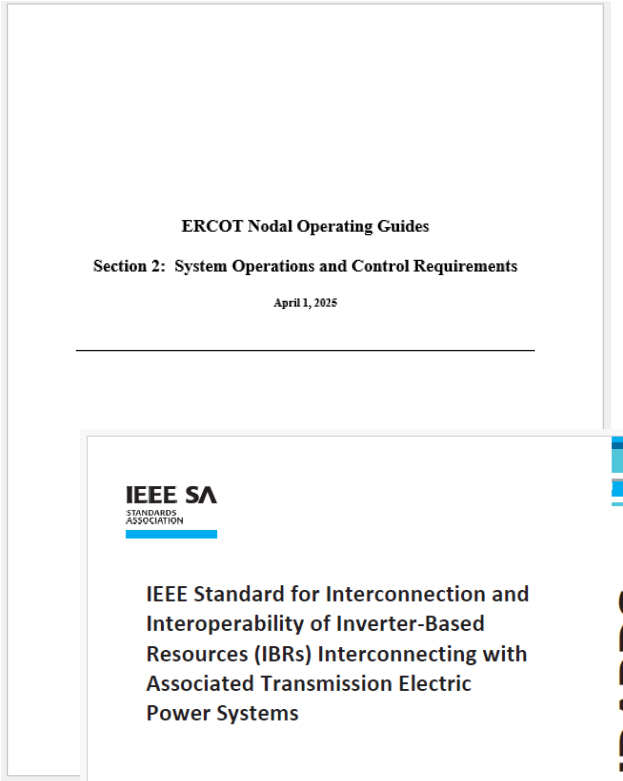
Background and Purpose

- ERCOT presented the background, problem statement, and objectives for evaluating implementation gaps associated with Negative-Sequence Current Injection (NSCI) at the November 2025 SPWG meeting. SPWG Survey on Protection System Practices for IBR Negative Sequence Current Injection Implementation
- NSCI is required for applicable new and modified IBR projects under the ERCOT Nodal Operating Guide.
- Detailed NSCI performance characteristics must be defined based on transmission system needs, including protection performance, ride-through requirements, and modeling capabilities.
- ERCOT conducted a TSP survey through SPWG in December 2025 to support this effort.
- Identify key implementation gaps and recommended actions to ensure NSCI requirements improve transmission protection performance and support system reliability.


ERCOT Nodal Operating Guides

Section 2: System Operations and Control Requirements

April 1, 2025


IEEE SA
STANDARDS ASSOCIATION

IEEE Standard for Interconnection and Interoperability of Inverter-Based Resources (IBRs) Interconnecting with Associated Transmission Electric Power Systems

IEEE Power and Energy Society

Developed by the
Energy Development & Power Generation Committee, Electric Machinery Committee, and Power System Relaying & Control Committee

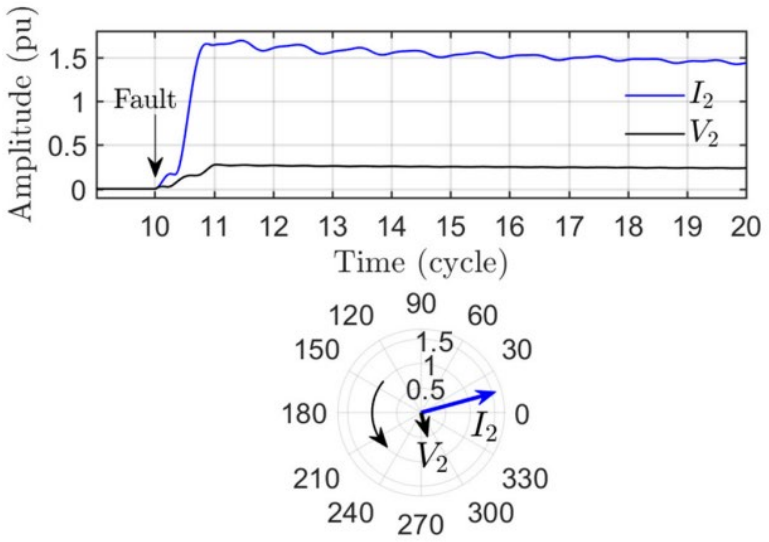
IEEE Std 2800™-2022

IEEE

STANDARDS

Fault Response of Generating Resources

Synchronous Generators: behavior is governed by the negative-sequence impedance of the generator, and the surrounding power system.

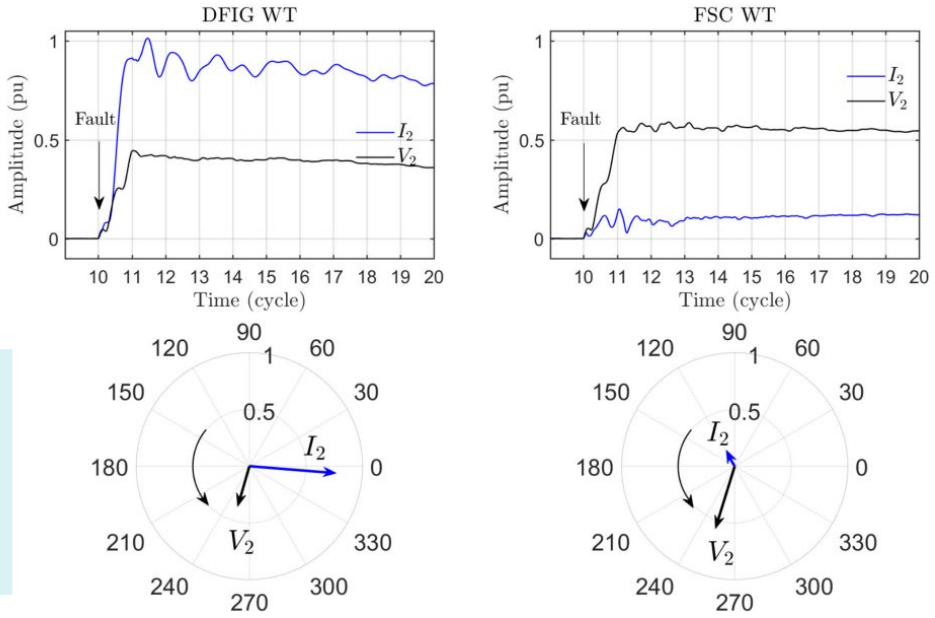


Reference: EPRI Report- Impact of Inverter-Based Resources on Protection Schemes Based on Negative Sequence Components

Key Takeaway: IBRs generally provide lower and more control dependent I_2 than synchronous generators, and the V_2–I_2 angle may not match the assumptions used in legacy protection schemes.

IBRs: behavior depends on site-specific settings such as:

- Control mode (grid-following vs grid-forming),
- Current priority logic,
- OEM-specific implementations
- Current limits in the hardware
- Balance of plant impedances



Protection Impacts with NSCI from IBRs

- Protection functions (selected) potentially impacted include:
  - 50Q/51Q (negative sequence overcurrent)
  - 67Q (negative sequence directional)
  - Communication assisted pilot schemes (POTT, PUTT, DCB/DCUB, rely on directional supervision)
  - Phase selection / Fault identification (FID)

- Example Protection Misoperation

  A publicly reported Dominion Energy event on September 22, 2022
  - A single-line-to-ground fault occurred on a radial system with IBR facilities
  - IBR-side relays did not operate to clear the fault
  - Directionality elements did not pick up the fault due to insignificant negative-sequence current

Key Takeaway: Adequate and predictable NSCI is important to support overall protection coordination in weak-source or high-IBR areas.

Key Findings from TSP Survey Feedback

- 14 TSP responses received
- Feedback shows converging protection practices and common NSCI implementation gaps:
    1. Shift Toward Weak-Source-Tolerant Protection
    2. Legacy Directional Elements Need Review
    3. NSCI Performance Must Be Explicitly Defined
    4. Utility Guidance Remains Limited
    5. Model and Data Gaps Remain a Barrier

Recommended Action Items

#	Owner	Action Item	Description
1	**SPWG**	Develop TSP-informed NSCI performance guidance	Define acceptable NSCI profiles based on local protection needs, including $I_2(V_2)$ magnitude, phase-angle window, response time, duration, and current-priority behavior.
2	**ERCOT**	Update short-circuit modeling and data collection processes	Update ERCOT modeling practices and data submittal requirements to support Type-3 WTG, CIR, and black-box model representation of NSCI behavior in ASPEN and related tools.
3	**SPWG**	Establish NSCI-related misoperation monitoring and reassessment	Track protection misoperations, identify NSCI-related root causes, and trigger reassessment of NSCI profiles and model performance using field event data.
4	**ERCOT**	Coordinate industry implementation through working groups	Use SPWG, IBRWG, and related forums to align ERCOT, TSPs, GOs, developers, OEMs, and relay manufacturers on NSCI profiles, modeling requirements, validation methods, and implementation timelines.

Summary and Next Steps

- Distributed the draft white paper on NSCI implementation considerations to SPWG on June 9
- SPWG to review and provide comments by June 30 to support final revisions.
- Publish the finalized white paper on the ERCOT public website.
- SPWG to consider adopting recommended action items.
- Send input or suggestions to: Jimmy.Zhang@ercot.com.