

Sungrow Negative-Sequence Current Injection OEM Capability and Representative AG-Fault Evidence

SUNGROW



OEM capability discussion

Sungrow's response is organized around confirmed high-level implementation, representative EMT evidence, converter limitations, and practical model-to-field boundaries.

Five ERCOT questions guide the presentation.

- 1 How is NSCI implemented?
- 2 How are positive- and negative-sequence currents coordinated?
- 3 What converter and control limitations constrain the response?
- 4 What model and validation evidence is practical?
- 5 What implementation and change-management issues should be considered?

1 Control-driven response

NSCI is generated by inverter controls and configured through the applicable model and project settings. It is not a fixed physical fault-current contribution.

2 Shared converter capability

Positive- and negative-sequence current commands share finite converter current capability and must be coordinated during unbalanced VRT.

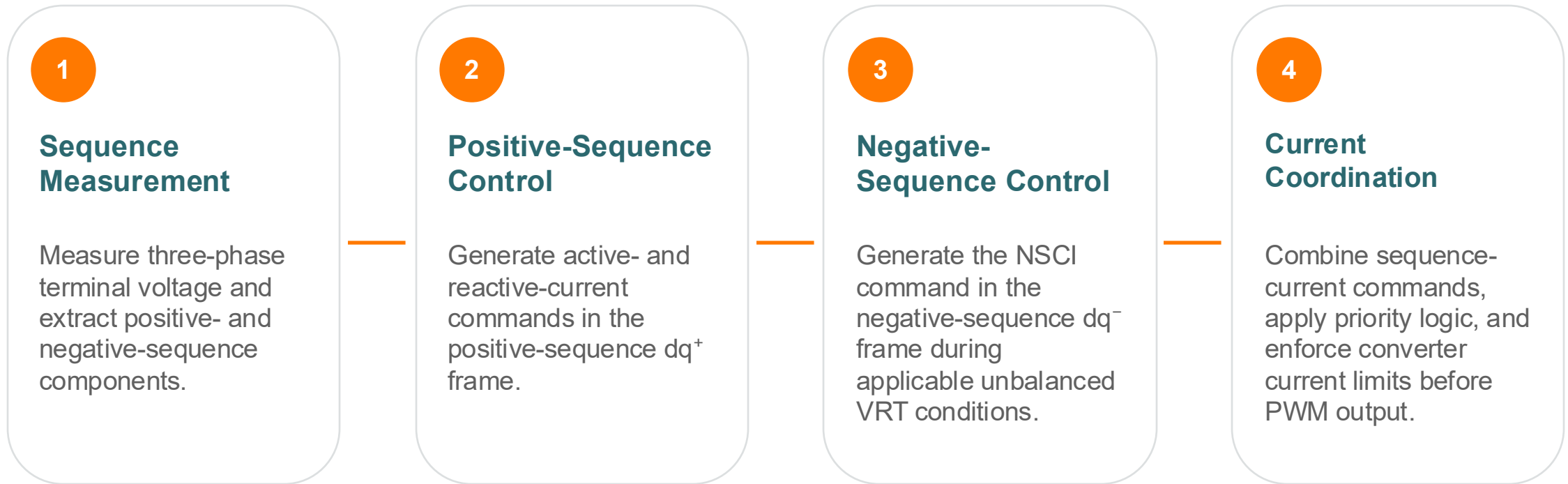
3 Measurable external behavior

A practical ERCOT profile should define terminal behavior, consistent evaluation conditions, and model-to-field traceability without prescribing one internal algorithm.

Regulatory context: NOGRR245 applies relevant IEEE 2800-2022 Sections 5, 7, and 9 requirements to applicable IBRs. NSCI during unbalanced ride-through conditions is addressed in IEEE 2800 Clause 7.2.2.3.4.

Confirmed High-Level NSCI Implementation

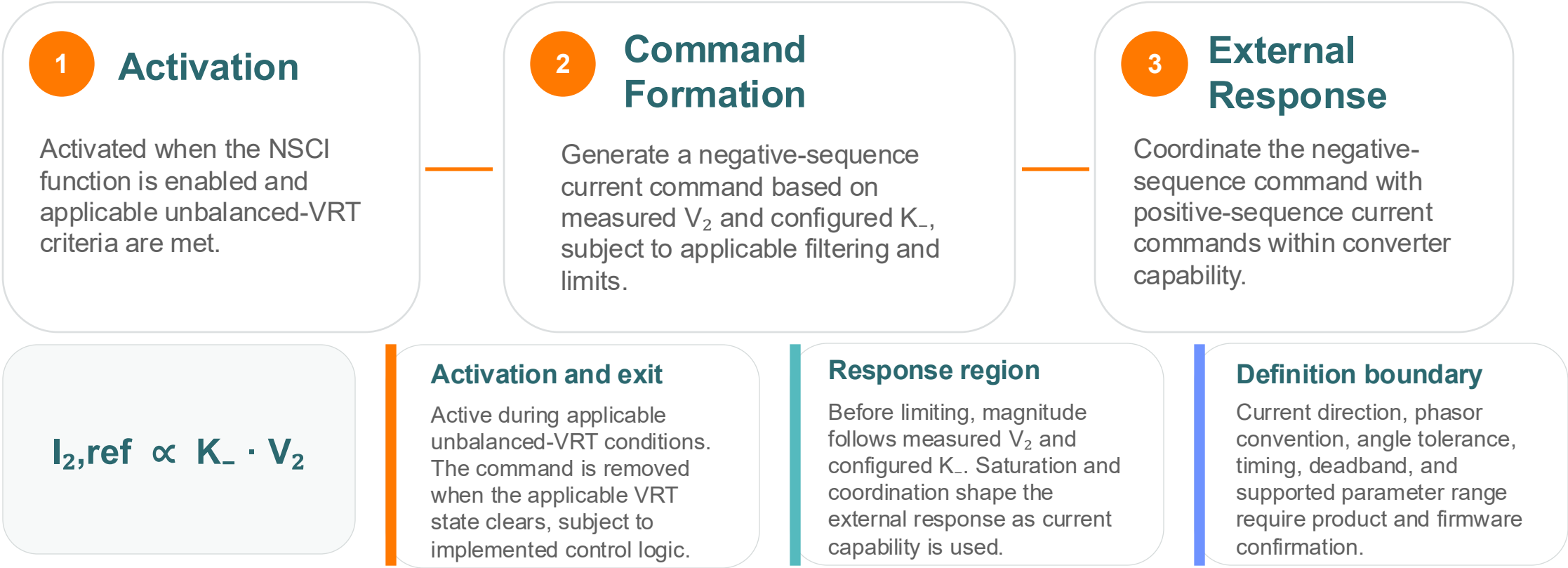
Sungrow separates positive- and negative-sequence quantities and coordinates both current commands within converter current capability.



Implementation details and supported parameter ranges may depend on product platform, model release, firmware, and project configuration.

External NSCI Response Characteristics

The external response is governed by applicable unbalanced-VRT activation, the configured K_- relationship, and converter current coordination.



ERCOT focus: specify measurable terminal behavior and consistent evaluation conventions, without prescribing one internal controller architecture.

Current Coordination and Converter Limits

NSCI and positive-sequence ride-through support share the converter's finite current capability.

Current Commands

- I_1P Positive-sequence active current
- I_1Q Positive-sequence reactive current
- I_2Q Negative-sequence reactive current

Positive- and negative-sequence commands are generated by their respective controls.

Coordinated Current Limiter

Terminal Behavior as Current Capability Is Used

Shared capability: Increasing NSCI uses part of the converter's finite current capability.

Implemented coordination

Positive- and negative-sequence commands are allocated by the applicable product and firmware control logic.

What the final evidence should show

Native PSCAD traces should show the sequence-current response and, when available, the corresponding positive-sequence reactive-current behavior.

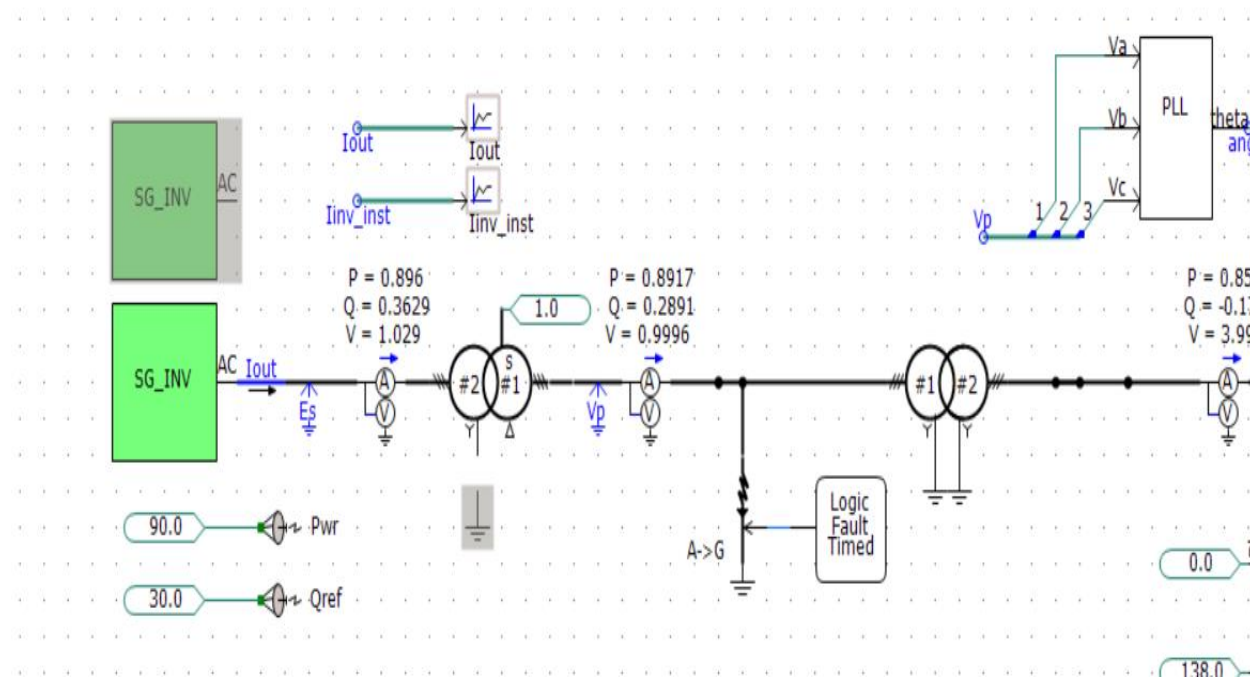
Boundary

No selectable priority strategy or universal proportional-scaling rule is claimed here.

Key point: NSCI capability should not be interpreted as an independent current source in addition to the converter rating.

Representative PSCAD Test Setup

Representative evidence uses the same inverter EMT case and AG bolted fault for NSCI disabled and $K_{-} = 1, 2$, and 5.



Representative PSCAD network used in the existing Sungrow NSCI verification material.

Test Definition

- **Disturbance**
AG bolted fault; identical network and pre-fault operating condition for all four cases.
- **Measurement**
Use the same measurement location, pu base, and sequence convention for all cases.
- **Recorded Signals**
Signals summarized: V_2 , I_{q2} , I_{d1} , and average active power.
- **Comparison**
Compare NSCI disabled with $K_- = 1$, 2, and 5.

Representative EMT capability evidence; not a project-specific conformity assessment.

AG Bolted Fault: Native PSCAD Traces

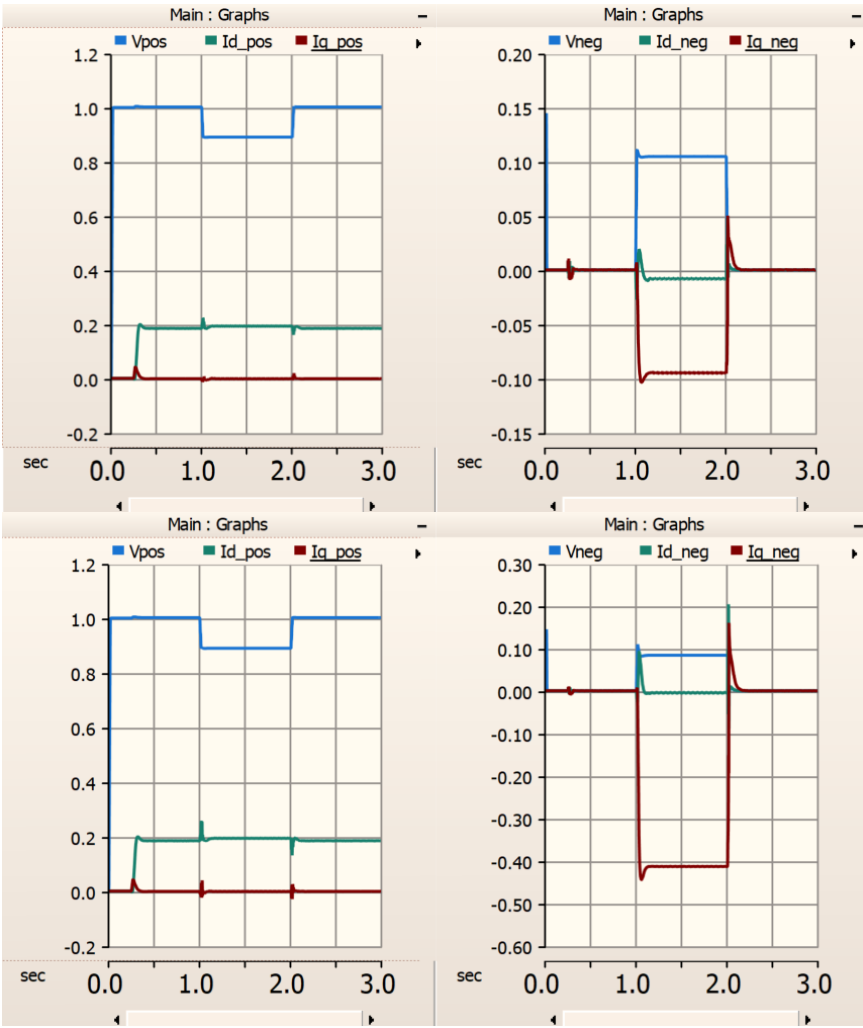


Disabled



K- = 2

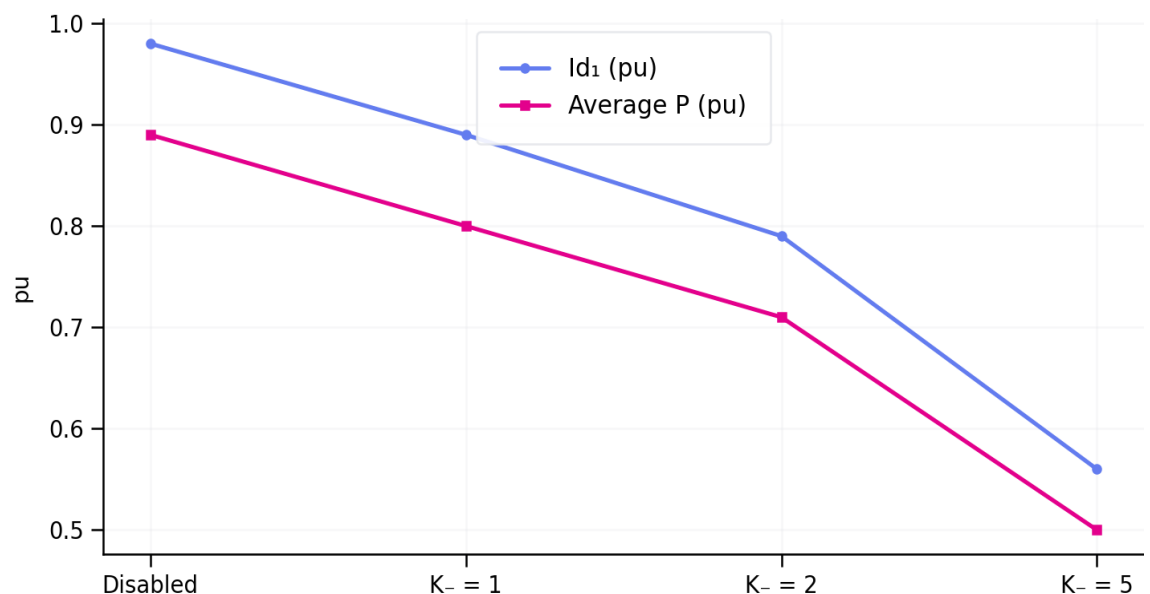
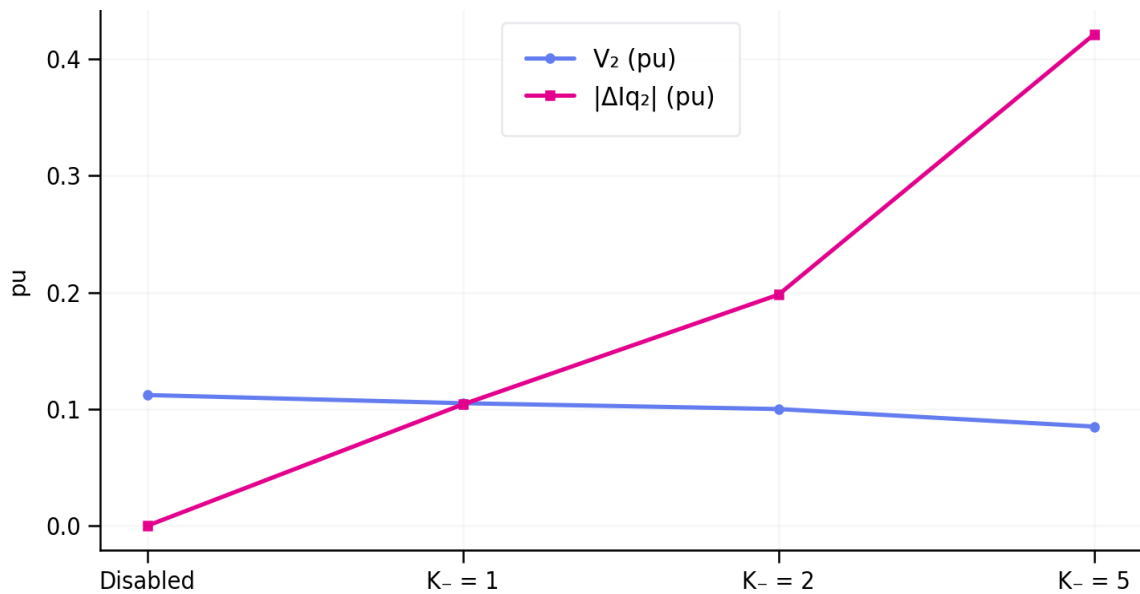
K- = 1



K- = 5

AG Bolted Fault: Configured K_- and Measured Response

Four AG bolted-fault cases are compared using the same EMT model and disturbance. Values are approximate fault-period readings.



Case	V_2	I_{q2}	$ \Delta I_{q2} $	Approx. observed ratio	I_{d1}	P_{avg}
Disabled	0.112	+0.011	baseline	—	0.98	0.89
$K_- = 1$	0.105	-0.093	0.104	0.99	0.89	0.80
$K_- = 2$	0.100	-0.187	0.198	1.98	0.79	0.71
$K_- = 5$	0.085	-0.410	0.421	4.95	0.56	0.50

Takeaway: higher configured K_- is accompanied by higher incremental I_{q2} in the representative cases.

Observed ratio = $|I_{q2}(K_-) - I_{q2}(\text{disabled})| / V_2(K_-)$. The disabled residual is an approximate comparison baseline because fault-period V_2 differs slightly among cases. The disabled case is shown only as a baseline; tested K_- values are representative model settings, not ERCOT-prescribed settings or project compliance limits.

What the comparison shows

- Configured K_- is reflected in the measured negative-sequence q-axis response.
- The observed incremental ratios are approximately 0.99, 1.98, and 4.95 for $K_- = 1, 2$, and 5.
- Terminal V_2 changes with the injected response in this representative network.

What remains unresolved

- A small residual measured I_{q2} exists in the disabled case. Its source is not isolated in this comparison.
- Positive-sequence reactive-current sharing is not quantified in the available summary data.
- Detailed priority and limiting behavior is not established by these plots.

How to use the evidence

- Treat results as representative EMT capability evidence.
- Use native PSCAD traces for the final presentation.
- Confirm product, firmware, settings, and evaluation convention before applying results to a project.

Practical Modeling and Validation Approach

Separate product-level capability demonstration from project-level parameter verification and field implementation records.

1

Product-Level Capability

Representative EMT tests for applicable unbalanced disturbances

Documented external NSCI behavior, limits, and dependencies

Applicable product platform and firmware identification

2

Project-Level Verification

NSCI enable status and applicable response settings

Current limits, priority assumptions, and evaluation location

Project model version and parameter record

3

Traceability and Change Control

Field evidence is not included in this presentation; use commissioning or event evidence when available and approved.

A product-level demonstration can reduce repetitive testing, while each project still needs a controlled record of the settings and model version that define its implemented response.

Commissioning and settings

- Verify NSCI enable status and project-specific settings.
- Record the applicable firmware and parameter revision.
- Confirm current direction, sequence convention, and evaluation location.

Model-to-field alignment

- Match the submitted model to implemented settings.
- Confirm whether field sequence-component measurements are available and sufficiently accurate.
- Define how an applicable event would be compared with the model.

Current evidence boundary

- No approved field NSCI case is included in this presentation.
- Practical field evidence may depend on monitoring capability and event availability.
- Product-specific behavior should be confirmed through the applicable engineering process.

Sungrow Recommendations for an ERCOT NSCI Performance Profile

Define measurable terminal behavior

- Electrical evaluation location and pu bases
- Voltage deadband, gain, phase angle, timing, duration, recovery, and saturation
- Current-direction and sequence-phasor conventions

Define current coordination

- Positive- versus negative-sequence current allocation
- Expected behavior as converter current capability is used
- Limiter-inactive and limiter-active test conditions

Standardize evidence and evaluation

- Filtering and evaluation windows
- Product-level capability versus project-level parameter verification
- Models that reproduce the intended sequence-current behavior

Maintain implementation traceability

- Product and firmware identification
- Project settings and submitted-model alignment
- Change control through commissioning and field operation

Recommendation: specify measurable external performance without prescribing one internal controller architecture when equivalent terminal behavior can be demonstrated.

Thanks! Q/A
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