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Power System Focus

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Monitor and Manage your Power System with Ease.

L-PRO Line Protection Relay

Enabling Dynamic Swing Recording

Introduction

Dynamic power swings occur on the transmission system as generators adjust to system conditions that change with short circuits, auto-reclosures, or line switching. A dynamic power swing is a balanced, three-phase response to the changing conditions, with fluctuations in both magnitude and angle of currents and voltages, along with variations in system frequency. Locally, dynamic power swings can affect the impedance measured by protection relays. These fluctuations can cause normal load impedance to move towards, and into, the tripping zones of impedance relays, and can result in an incorrect tripping operation of the relay.

The L-PRO Line Protection Relay from NxtPhase has the ability to detect and record these dynamic power swings. A power swing record can be used to verify correct non-operation of the impedance relay, by showing that the impedance due to a power swing remains outside of the tripping zone, or incorrect operation of a relay, by showing when the impedance due to a power swing moves into a tripping zone. In addition, this type of recording can be used to verify the correct operation of power swing blocking or tripping protection, as well as providing data to fine-tune impedance zone settings.

Dynamic Power Swing Recording in the L-PRO

One aspect of power swings is the relative slowness of the changes occurring during an event. Fault events happen instantly, while power swings take seconds or minutes to occur. Protective relays typically only include transient recording that records current and voltage waveforms for short durations (<2 seconds) with a high sampling rate. These records are not long enough to capture power swing events. The L-PRO Line Protection Relay, like the TESLA Disturbance Recorder, includes a power swing recording feature. The L-PRO records power swing data once per cycle, with records up to 2 minutes long. These power swing records include the positive sequence current and voltage phasors, the system frequency, positive sequence three-phase real and reactive power, and the positive sequence impedance.

Enabling Power Swing Recording in the L-PRO

There are two steps to enabling power swing recording in the L-PRO.

1. Set the power swing record length. This setting is located under “Record Length” in the L-PRO. Use the maximum record length of 120 seconds, to ensure the L-PRO will capture a complete power swing event.
2. Set functions in the Output Matrix to initiate a power swing recording. Any element present in the Output Matrix can initiate a power swing recording.

Device	Output Contact 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Block & Initiate 79B	79I	BFI	Recording Fault	Swing
60 Alarm	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Dead Line Pickup	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Z Circle Trigger	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☒
Self Check Fail	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Comm. Scheme Trip	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Comm. Scheme Send	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Z Circle Trigger configured to trigger power swing recording

Our multi function relays and recorders provide smart solutions to your protection, monitoring and control needs.

ERLPhase (formerly a division of NxtPhase), is a subsidiary of Easun Reyrolle Ltd with over 60 years of power management expertise.

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smart solutions that empower you

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Recommended Elements to Trigger Power Swing Recording

While any element in the Output Matrix can initiate a power swing recording, there are two elements in the L-PRO that are the ideal elements to initiate recording. The Z Circle Trigger element is specifically intended to trigger a power swing recording. Set the Z Circle Trigger to its maximum value of 50 secondary ohms to capture some of the small, regular power swings that occur on the transmission system. Otherwise, set the Z Circle Trigger approximately 20% larger than the largest forward-tripping impedance zone. This allows the L-PRO to capture, and document, power swing events that may possibly encroach on a relay tripping zone. The other element to configure to trigger a power swing recording is the largest forward-tripping phase impedance zone. This will ensure a power swing record exists for events that cause possible incorrect operations of the relay. Configure both the trip and alarm indications of this zone. If the L-PRO is set up to use the available Power Swing Blocking or Power Swing Tripping features, set the 68 Outer Blinder and 68 Inner Blinder alarms to trigger a power swing recording. A power swing record is the only acceptable fault record for Power Swing Blocking or Power Swing Tripping.

Device	Output Contact														Block & Initiate			Recording	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	79B	79I	BFI	Fault	Swing
21P1 Trip	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
21P2 Trip	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
21P3 Trip	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☒	☒
21P4 Trip	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
21P2 Alarm	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
21P3 Alarm	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☒	☒

Zone 3 Phase element configured to trigger power swing recording

Device	Output Contact														Block & Initiate			Recording	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	79B	79I	BFI	Fault	Swing
68 Out of Step	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☒
68 OuterBlnd Alarm	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☒
68 InnerBlnd Alarm	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☒
79 Main Reclose	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
79 Aux. Reclose	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
81-1 Trip	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
81-2 Trip	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
81-3 Trip	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
81-4 Trip	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
60 Alarm	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Dead Line Pickup	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Z Circle Trigger	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☒
Self Check Fail	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

68 Power Swing functions configured to trigger power swing recording

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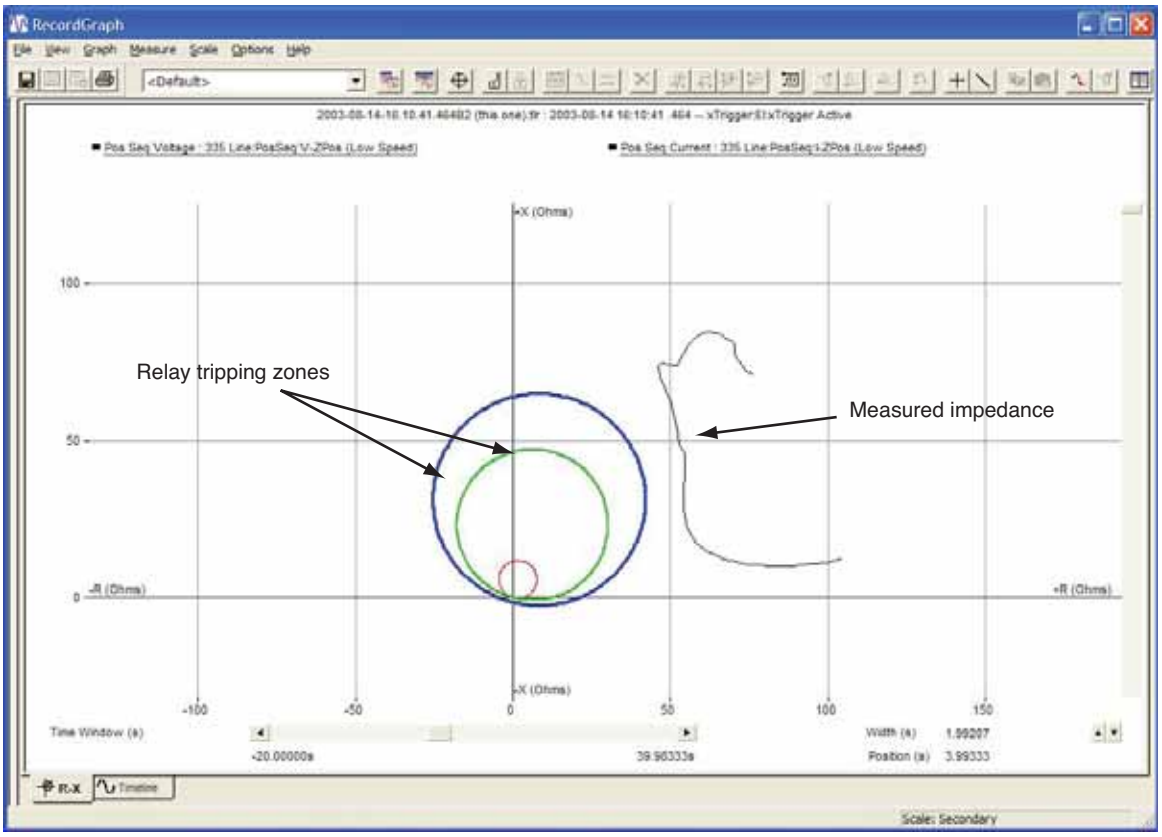
Use of Power Swing Records

Power swing records may be used to document the performance of the L-PRO during wide-area disturbances, switching events, auto-reclosing, or short circuits. A power swing record can provide root-cause analysis of relay operations, showing the changing impedance due to a power swing moving into the relay tripping zone. Power swing recording can show the correct non-operation of the L-PRO for a power swing event, illustrating how the impedance measured by the relay during a power swing stays outside of a relay tripping zone.



Power swing impedance vs. relay tripping zones

This power swing record illustrates the positive sequence impedance as seen by the relay. The impedance due to the power swing is outside of Zone 3, the largest relay tripping zone, documenting the correct non-operation of the L-PRO for this event.

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