

## Features

- Uses well proven  $\Delta Z/\Delta t$  method for detecting power system oscillations
- Detects pole slips with increasing slip frequency up to 10Hz
- Distinguishes between motoring and generating oscillations
- Controlled incoming or outgoing tripping at selectable phase angle between oscillating sources
- Comprises two operating zones, each with independent oscillation counters
- Detects oscillations in healthy phases during the dead time of single-pole automatic reclosing
- Provides all necessary signals for the cooperation with the distance protection

## Application

Sudden events in an electrical power system such as large jumps in load, fault occurrence or fault clearance, can cause oscillations referred to as power swings. In a recoverable situation, the power swings will decay and stable operation will be resumed; in a non-recoverable situation, the power swings

become so severe that the synchronism is lost, a condition referred to as pole slipping. The main purpose of the PSP pole slip protection is to detect, evaluate, and take the required action for pole slipping occurrences in the power system.

## Functionality

The PSP function comprises an inner and an outer quadrilateral measurement characteristic. It detects oscillations in the power system by measuring the time it takes the transient impedance to pass through the impedance area between the outer and the inner characteristics. Oscillations are identified by transition times longer than timer settings. The impedance measuring principle is the same as that used for the distance protection zones. The impedance and the transient impedance time are measured in all three phases separately. One-out-of-three or two-out-of-three operating modes can be selected permanently or adaptively according to the specific system operating conditions.

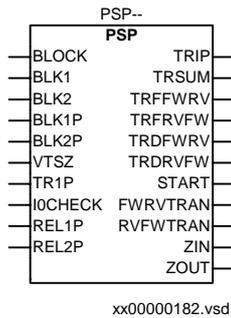
Oscillations with an oscillation period as low as 200 ms (i.e. with a slip frequency as high as 10% of the rated frequency on a 50 Hz basis) can be detected for normal system operating conditions, as well as during the dead time of a single-pole automatic reclosing cycle. Different timers are used for initial

and consecutive pole slips, securing a high degree of differentiation between oscillation and fault conditions.

It is possible to inhibit the oscillation detected output on detection of earth fault current. This can be used to release the operation of the distance protection function for earth faults during power oscillation conditions.

The PSP function has two tripping areas. These are located within the operating area, which is located within the inner characteristic. On detecting a new oscillation, the issue of a trip output will depend on the applied settings. These determine the direction of the transition for which tripping is permitted, whether tripping will occur on entry of the measured impedance into a tripping area, or on its exit from the tripping area, and through which tripping area the transition must be measured for tripping to occur. The applied settings also determine the number of pole slips required before the trip output is issued.

Function block



Input and output signals

Table 1: Input signals for the PSP (PSP--) function block

Signal	Description
BLOCK	Blocks function
BLK1	Blocks the inhibit condition controlled by the tR2 timer
BLK2	Blocks the inhibit condition based on residual current detection, unless within tEF timer following 1-pole trip
BLK1P	Blocks one-out-of-three phase detection of the oscillation
BLK2P	Blocks two-out-of-three phase detection of the oscillation
VTSZ	Blocks the operation of the PSP on fuse failure detection
TR1P	Starts the tEF timer for 1-pole trip
I0CHECK	Residual current detection used to inhibit PSP-START output
REL1P	Releases one-out-of-three phase detection of the oscillation
REL2P	Releases two-out-of-three phase detection of the oscillation

Table 2: Output signals for the PSP (PSP--) function block

Signal	Description
TRIP	Trip output
TRSUM	Delayed trip caused by transitions passing either delayed or fast tripping area
TRFFWRV	Fast trip for forward to reverse transition
TRFRVFW	Fast trip for reverse to forward transition
TRDFWRV	Delayed trip for forward to reverse transition
TRDRVFW	Delayed trip for reverse to forward transition
START	Oscillation detected
FWRVTRAN	Forward to reverse direction transition detected
RVFWTRAN	Reverse to forward direction transition detected
ZIN	Measured impedance within the inner characteristic boundary
ZOUT	Measured impedance within the outer characteristic boundary

## Technical data

**Table 3: Pole slip protection**

Parameter	Setting range
Reactive and resistive reach for all setting parameters at $I_r=1$ A (for $I_r = 5$ A, divide values by 5)	0.1-400 $\Omega$ /phase in steps of 0.01 $\Omega$ /phase
Timers	0-60s in steps of 0.001s
Counters	0-10 in steps of 1

Parameter	Accuracy
Reset ratio for impedance measuring elements	105% typically

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