



# PCS-994

## Frequency & Voltage Controller

PCS-994 is a frequency-voltage controller, which performs control functions for under-frequency, under-voltage, over-frequency and over-voltage. It can be used to perform load shedding in case of under-frequency or under-voltage conditions. It can also execute hydro-generator self-starting in a under-frequency scenario. Furthermore, it can conduct generator shut-down in case of over-frequency and system-separating in case of over-frequency or over-voltage conditions. The controller performs calculations and analysis based on the system's voltage. Under-frequency load shedding and under-voltage load shedding provide 8 stages respectively, over-frequency provides 5 stages, and over-voltage provides 3 stages. The output of each stage can be configured via the output matrix. This relay has a total of 30 groups of outputs; each group can be configured for load shedding or generator shut-down independently.

The PCS-994 controller adopts the advanced multi-processor platform, supporting IEC 61850-8-1 MMS. In addition, RJ-45 faceplate port for testing and setting to make commissioning and maintenance easier.

## Functions

### Protection & Control

- Under-frequency load shedding function  
It serves in case of frequency decrease due to lack of active power in a power system. This relay will automatically shed some loads according to the frequency decrease value, so that the generation and loads regain equilibrium. The under-frequency load shedding function provides 8 stages, which include 5 basic stages and 3 special stages.
- Accelerated under-frequency load shedding function  
In the case of serious lack of generation, this relay will accelerate load shedding according to  $df/dt$ , so that stage 2 and/or 3 can be accelerated to operate after stage 1 to promptly stop frequency decrease as soon as possible.
- Over-frequency protection function  
In case of frequency increase due to surplus active power in the power system, this relay will automatically shut down some generators according to the frequency increase value, so that the system's frequency can be restored to normal levels. Over-frequency generator shut down function provides 5 stages.
- Under-voltage load shedding function  
In case of voltage decrease due to lack of reactive power in the power system, this relay will automatically shed some loads according to the voltage decrease value, so that system's voltage is restored to normal levels. Under-voltage load shedding function provides 8 stages including 5 basic stages and 3 special stages.
- Accelerated under-voltage load shedding function  
In case of accelerated decrease in system voltage, this relay has the capability to accelerate load shedding according to  $dU/dt$ , so as to stop the system voltage decrease as early as possible. Thus, avoid voltage collapse, and restore voltage to optimal operating range.
- Over-voltage protection function  
In case of a voltage increase due to rising reactive power in the power system, this relay will automatically divide the system, so that system voltage can be restored to normal levels. The over-voltage protection function provides 3 stages.

- $df/dt$  and  $du/dt$  blocking functions  
They are used to prevent possible undesired operations due to short circuit, load feedback, or abnormal frequency or voltage. Additional, blocking functions against VT circuit failure are also provided.

## Monitoring and Measurement

- VT circuit supervision (VTS)
- Self diagnostic
- Event recorder including 1024 change-of-binary-input events, 1024 supervision events and 1024 operating logs
- Disturbance recorder including 32 disturbance records with waveforms (The format of disturbance recorder is compatible with COMTRADE.)

## Communication

- Up to 4 10Base-T/100Base-TX copper Ethernet ports using IEC 61850 protocol, DNP3.0 protocol or IEC 60870-5-103 protocol over TCP/IP
- Up to 2 100Base-FX optical Ethernet ports using IEC 61850 protocol, DNP3.0 protocol or IEC 60870-5-103 protocol over TCP/IP ( Sharing with 2 copper Ethernet ports)
- 2 RS-485 serial ports using IEC 60870-5-103 protocol
- 1 RS-485 serial port for clock synchronization

## User Interface

- HMI interface with large-size LCD and 9-button keypad on the front panel
- 1 front RJ-45 port for testing and setting
- 1 RS-232 or RS-485 rear port for printer
- Language selection – English + selected language
- Assistant software - PCS-Explorer

## Features

- The PCS-994 can accelerate load shedding to prevent power system collapse when the system's voltage or the frequency decreases sharply. Thus, restoring voltage back to optimal operating rang.

- Five basic stages and three special stages are provided for under-frequency load shedding and under-voltage load shedding respectively. The 30 groups of tripping output can be flexibly set to corresponding stages via software.
- Five basic stages are provided for over-frequency generator cutting. The 30 groups of tripping output of this relay can be flexibly set to corresponding stages via software.
- Five independent stages of rate-of-change of frequency protection, each stage can be used for load shedding or generator shut-down independently.
- Three basic stages are provided for over-voltage system separating. The 30 groups of tripping output of this relay can be flexibly set to corresponding stages via software.
- Since the decrease of three-phase voltages due to insufficient reactive power is basically symmetric, and no large sudden variation occur, the under-voltage element of this relay makes judgments based on positive-sequence voltage. If a negative-sequence voltage exceeds  $0.15U_n$  or a positive-sequence voltage changes suddenly, the under-voltage load shedding function is blocked. Therefore, the relay will not execute system separation during faults.
- The power swing blocking function, based on the analysis of  $df/dt$  and  $du/dt$ , can prevent mal-operation caused by short-circuit fault or abnormal conditions of voltage and frequency.
- A patented adaptive floating threshold method is adopted, which is insensitive to system unbalance and disturbance. The measuring element can achieve both high levels of security and speed simultaneously.
- Unique two-out-two logic is adopted in the hardware design to improve security, while the redundant scheme improves dependability. The two independent data acquisition paths are provided to prevent mal-operation caused by component failure. One works as a fault detector and the other is designed for protection logic. Tripping outputs are supervised by both data acquisition paths.
- The relay is designed based on NR Electric's well established and proven hardware platform with multi-processor architecture. The multi-CPU technology supports parallel operation.