PCS-996

Phasor Measurement Unit

In order to improve the dynamic stability monitoring and analysis abilities, Phasor Measurement Units (PMUs) are installed in the corresponding substations and power plants. Furthermore, the use of a wide area measurement system (WAMS) serves to view the system's state from the dispatching center.

The PCS-996 Phasor Measurement Unit (PMU) is mainly applied for the measuring synchronized phasor, and the recording dynamic process of the power system. The PCS-996 consists of Phasor Measurement Units (PMU) and phasor data concentrators (PDC). The core phasor measurement unit characteristics include the synchronized phasor measurement, based on standard clock signals and timekeeping capacity without the standard clock signal. In addition, the system is designed to achieve high-speed communication capacities between the localized PMUs and the central WAMS. The standard communication protocol is IEEE C37.118. A PDC is used to collect data from several PMUs, and then the PDC sends the data to the WAMS control center. In addition, the auxiliary function of the local storage of the phasor data can be equipped with PDCs. WAMS consists of PCS-996 series PMUs and PDCs, a clock synchronization system, high-speed communication network equipment and the analysis systems of the master substation. Furthermore, WAMS can realize dynamic process monitoring and analysis of the regional electric network and the cross-regional electric network.

Distributed architecture is adopted for the application of PCS-996. Therefore, PCS-996 can be easily implemented for system measuring and recording in wide area substations or power plants.

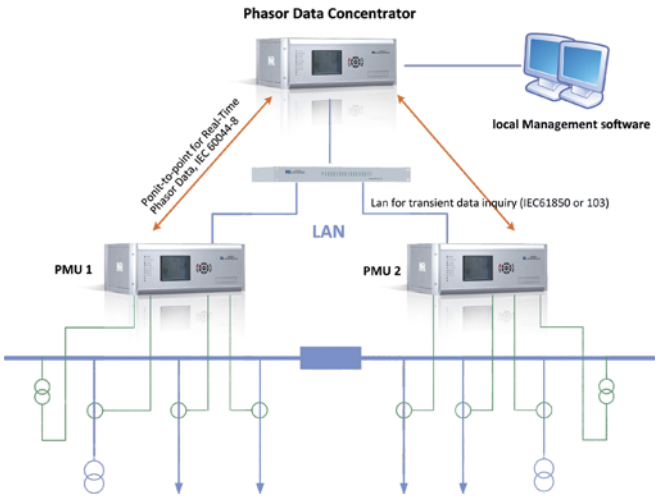

Figure 1 PMU in Substation/Power Plant

The PCS-996 Phasor Measurement Unit (PMU) relies on GPS time signals in order to provide extremely accurate time-stamping for the power system's information. The measured vector quantities are sent to the control center in effort to provide a basis for monitoring, protecting and controlling power networks.

PMUs are installed in substations and power plants as a part of the Wide Area Measurement System (WAMS). PMUs improve the system's economic operation and enhance power stability and protection against any severe disturbances. PMUs installed

in different locations are synchronized by a GPS clock. If the GPS source is lost, an internal high-precision clock source is used as a fallback.

Phasor Data Concentrators (PDCs) receive and store the synchronized phasor data from PMUs throughoptical fibers, and send the collected information to the WAMS in real-time. One phasor data concentrator can communicate with more than eight WAMS stations.

The PCS-996 is hosted on the advanced UAPC multiprocessor platform, fully complying with IEEE Std C37.118-2005, C37.118.1-2011, C37.118.2-2011, C37.118.1A-2014,IEC 60870-5-103 and IEC 61850 standards in order to ensure open communication and enable easy integration into any system.

NR Electric provides the following models for PMUs and PDCs:

- PCS-996A
  The phasor measurement unit is used to measure the synchronized phasor in the substation. It collects and records the phasor and binary inputs of the bus, line, main transformer and so on.

- PCS-996B
  The phasor measurement unit is utilized in the measuring of the synchronized phasor of the power plant. It collects and records the phasor and binary inputs of the generator, including internal voltage potential, power angle, the terminal voltage, current and so on. In addition, it collects and records 4-20mA signals, which can be excitation voltage, current, rotating speed, frequency modulation and so on. PCS-996B can measure two generators and two AC bays.

- PCS-996G
  The phasor data concentrator receives and stores the synchronized phasor data from PCS-996A and PCS-996B through direct connections via optical fibers. Meanwhile, it can communicate with the WAMS station or the monitoring system and send synchronized phasor data to them in real-time. The PCS-996G provides at least four independent network ports and can communicate with more than eight WAMS stations. Through the extension of communication plug-ins, it can accomplish further communication with more WAMS stations.

Functions for PCS-996 PMU

- Phasor calculation function
  - Calculate amplitudes and phase angles of phasor, such as Ua, Ub, Uc, U1, Ia, Ib, Ic, I1, Eq, etc.
  - Calculate measurement values, such as P, Q, f, df/dt etc.
  - Supervise binary signals, such as disconnector status, protection operation signal, PSS operation signal, etc.

- Real-time communication function: send phasor data to PDC or WAMS control center through IEEE C37.118 protocol.

- Triggered recording function: electric quantities or binary inputs can trigger the recording function with COMTRADE standard.

- Fault Recording Function
  - Event records including 1024 IO events, 1024 alarm events and 1024 device logs.
  - Disturbance recording (also called triggered recording) function: 1024 fault reports, and 1024 disturbance waveforms, and file format of waveform is compatible with COMTRADE file.

Functions for PCS-996 PDC

- Data concentration function: The PCS-996 PDC receives real-time phasor data from several PMUs. Then the PDC sends this accumulated data to the WAMS.

- Dynamic recording function: store and backup phasor data locally.

Communications

- Two RJ-45 Ethernet port and two fiber Ethernet ports, which support IEC60870-5-103, or IEC61850 protocol. These two RJ-45 Ethernet ports can also be used for FTP service.

- One RS-485 serial port is used for clock synchronization.

- One front RS-232 serial port is used to test and configure the device.

Features

- The robust hardware platform adopted for PMU and PDC is the same one as in NR Electric's protection and control system, which has been well proven in field.

- PCS-996 PDC can be connected to at least 1-8 PMUs and at least four control centers. Furthermore, a 128G storage disk can be integrated to the PDC.

- The high-precision IRIG-B code is adopted for GPS clock synchronization through optical fiber or RS-485 ports.

- The PCS-996 supports the communication standards of IEEE C37.118 and IEC60870-5-103.

Integration to WAMS

The PCS-996 fully supports communications to the Wide Area Measurement System (WAMS) based on international protocols (IEEE Std C37.118-2005, IEC 60870-5-103 and IEC 61850). The measured phasors are transmitted from PCS-996 to WAMS via a communication network and assembled for advanced supervision and analysis. This allows direct phasor comparison from various locations in the power system.

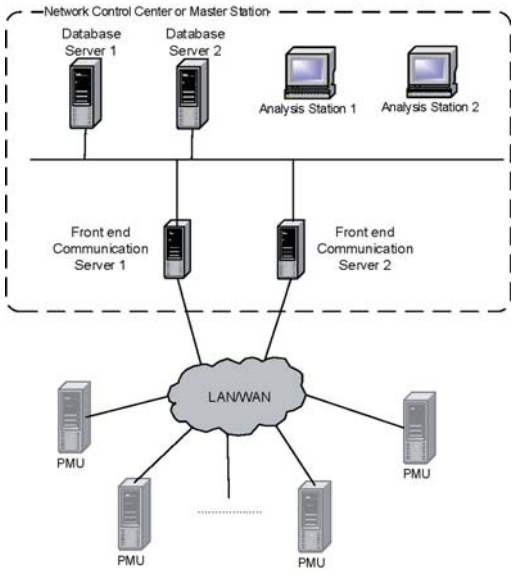

Figure 2 Typically Architecture for Integration in WAMS

Integration to PSCS

The measured phasors can be transmitted from PCS- 996 to the Power Stability Control System (PSCS) for stability control. In case of an imbalance between power generation and load or severe power oscillations due to system disturbances, PSCS can take fast and reliable emergency actions, such as: generator shut-down, load-shedding, etc. These actions are taken in effort to ensure the system's stability and in defending the power system against blackouts.

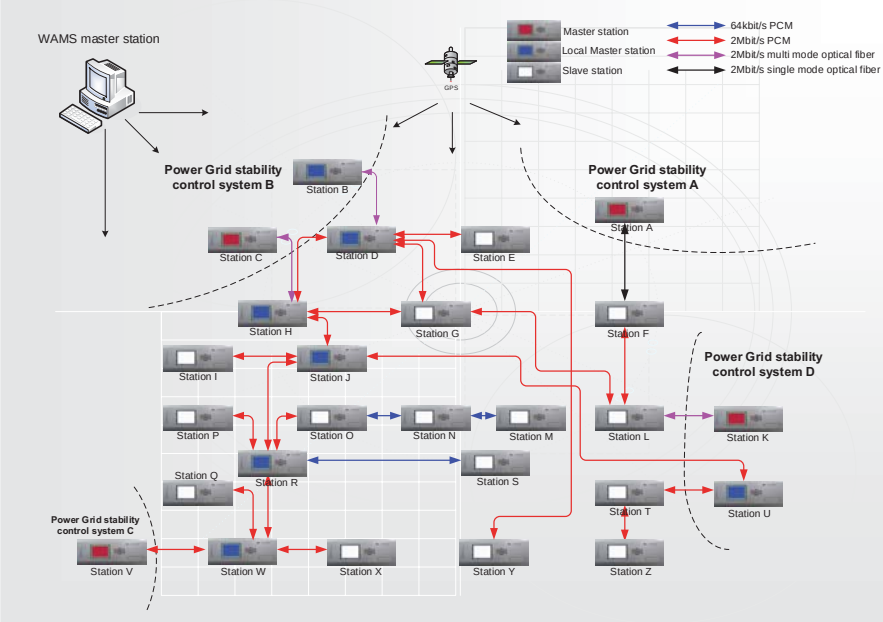

Figure 3 Typically Architecture for Integration in PSCS