Power System Monitoring and Analysis

The DIgSILENT PowerFactory Monitor

Integrated, multi-functional Dynamic System Monitor

- Network Performance Supervision
- Long-term Trend Monitoring
- Fault and Disturbance Recording
- Voltage Stability Monitoring
- Power Oscillation Detection
- Phase Angle Supervision
- Supervision of Connection Condition
- Grid Quality Monitoring
- System Parameter Identification
- Automated Post Processing
- Integrated with PowerFactory

Flexible Hardware and Software Concept

- Cabinet-based and portable Systems
- Flexible Signal Unit Configuration
- Advanced 16 Bit A/D Technology
- Local- and Remote Operation Technology
- Master Station Supervision Concept
- PowerFactory based Software Technology
Unbundling of electricity supply systems and the introduction of new technologies in all areas of generation, transmission and distribution has made power system operation more complex. Supervision of generator performance according to Grid Codes and Connection Conditions, the stability supervision of large transmission networks at specific locations, verification of power quality criteria in distribution as well as the determination and analysis of key system parameters has generated the need for power system monitoring and grid supervision beyond classical fault recording and SCADA based trending systems. Under those aspects, wide area monitoring (WAM) via phase measurement units (PMU) is just one special feature out of all monitoring applications. The PowerFactory Monitor fully integrates with DlgSILENT PowerFactory software offering easy access to recorded data, analysis of trends, verification of system upset responses and test results.

The PowerFactory Monitor interacts perfectly with the DlgSILENT power system analysis software PowerFactory featuring seamless integration of system and plant tests, plant modelling and parameter identification.

FUNCTIONAL OVERVIEW

The DlgSILENT PowerFactory Monitor is an integrated, multifunctional data acquisition system that covers recording, monitoring and analysis of signals in all relevant time frames. It is especially designed to cover all needs of Transmission, Distribution and Generation on all voltage levels. Flexible hardware and software components allow for the configuration of portable systems, stand-alone cabinet mounted installations as well as LAN based multiple units, multiple location systems being coordinated and supervised via Master Stations.

Typical PowerFactory Monitor Applications:

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<th>Application</th>
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<td>Generation outage, load rejection and system frequency response analysis</td>
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<td>Voltage stability monitoring and steady-state instability supervision</td>
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<td>Power oscillation detection and analysis</td>
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<td>System frequency control supervision, analysis and classification</td>
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<td>Tie-line power exchange and network control characteristics</td>
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<td>Control performance supervision and identification</td>
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<td>Voltage dip classification and analysis</td>
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<td>Power quality monitoring</td>
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<td>Load parameter identification</td>
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<tr>
<td>Supervision of Connection Conditions and Ancillary Services</td>
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<td>Wide Area Monitoring (WAM) via coordinated Phasor Measurement Units (PMU)</td>
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In addition to on-line grid supervising functions, the PowerFactory Monitor is an excellent high-end general purpose measurement instrument for all kind of plant tests typically performed to support device and plant modelling as well as parameter identification to allow for precise power systems simulation tasks.

Among these applications are:

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<td>Generator, motor and general feeder load tests and parameter identification</td>
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<td>Power plant measurements and identification (AVR, exciter, PSS, turbine, boiler, hydraulic systems)</td>
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<td>Determination of wind turbine characteristics and control behaviour</td>
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<td>Optimal tuning of Power System Stabilizers (PSS)</td>
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Any quantity deviating from normal conditions is recorded and analysed. In addition, on-line analysis of signals is provided featuring the detection of inherent problems like system and control oscillations, deviations from connection conditions or power quality aspects. The PowerFactory Monitor is a stand-alone system including all necessary hardware and software functions for signal conditioning, signal conversion, data storage and processing, calculation and documentation. In addition, remote access is possible via modem, TCP/IP networks, WWW and special SCADA interface techniques. Several monitoring systems can be synchronized to 1μs using GPS clock for precise parallel sampling, e.g. a basic requirement for system wide area phasor measurements.
The PowerFactory Monitor

TECHNICAL OVERVIEW

Hardware Configuration
The PowerFactory Monitor is based on a Control and Monitoring Unit (CMU) which can be equipped with up to 4 Signal Units (SU) supporting in total up to 128 analogue channels (32 channels for the portable system) and 64 event inputs being processed and analysed with a maximum scan rate of 15.36 kHz per channel at a 16 Bit resolution. Each Signal Unit can accommodate different types of signal conditioning devices featuring highest flexibility for direct connection of current- and voltage transformers but also low level AC/DC-voltage and -current signals.

Various PowerFactory Monitoring (PFM) Systems can communicate with the PowerFactory Master Station for supervising the status of the PFM network, for collecting essential recorded information or for building a two level monitoring structure for selective and most vital display and analysis functions.

Multi-time Frame Recording
Based on high speed signal data acquisition the PowerFactory Monitor generates a number of different data streams that allow for fault and disturbance recording, event recording, power system performance supervision, power quality recording as well as special on-line signal generation such as real time phasors and frequency monitoring.

Power System Performance Supervision
Fundamental frequency and phasor quantities (RMS) are determined on basis of high precision soft-transducers with scan rates of up to 2-4 samples per cycle being time tagged with a 1us resolution. High-speed recording of large amount of quantities is typically triggered via threshold criteria on primary signals or on basis of any criteria being derived from flexible equations or analysis functions incl. oscillation detection. Intelligent re-trigger functions are provided to guarantee capturing of disturbance sequences which may occur during catastrophic and extended network upset conditions. Triggering is reported to the Master Station initiating automatic upload of data should this be requested by the overall monitoring setup.

Real Time Phasors
Based on the flexible setup of the PowerFactory Monitor, frame and high level slot function definitions, various specific measuring devices can be configured. A typical application of such flexibility would be the real time phasor measurement where various phasor quantities are derived from local information, stored, analysed or passed on to remote systems for coordinated stability evaluation.

Power Quality Recording
Capturing of voltage sags and high voltage conditions along with the continuous monitoring and recording of harmonic distortion, phase unbalance and other quantities of interest, continuous power quality monitoring is provided. Any recording such as captured voltage sags or daily 24 hours power quality records can be kept locally at the PFM or may be transferred automatically to the Master Station for centralized storage and review.

Automatic Analysis
On basis of standard PowerFactory DPL scripts, the PowerFactory Monitor features the automatic analysis of monitoring data streams as well as recorded, event triggered data sequences. This will allow a preprocessing of the many recordings to determine it’s severity and relevance for further expert analysis. A typical standard feature of the automatic event and monitoring analysis would be the performance of automated printing of all recorded data sequences.

TECHNICAL SPECIFICATION

Overview
Up to 128 analog and 64 digital input channels
Up to 32 relay outputs for alarms
Scan rates up to 15.36 kHz, 16 bits resolution
Self-diagnostic, watch-dog and auto-boot
2x750 GByte RAID, dual-CPU, 3 GB DRAM
15” TFT screen

Enclosure
Control and Monitoring Unit, CMU (19” x 12HU)
Signal Unit, SU (19” x 4 HU)

Supply Voltage
24-300 VDC and 110 / 220 VAC

Relay Outputs
48 alarm output with Form C contacts

Analog Channels
32 analog channels / Signal Unit (max. 4 SU per CMU);
flexible input configuration

Currents:
1/5 A (nominal)

Voltage:
150V (nominal)

Small signals:
1mV, 10mV, 1V, 10V, ±20mA

Accuracy
Better than 0.3%, CMR >85db

Digital Channels
Each Signal Unit is equipped with 8 relay outputs and 16 digital inputs.

Communication
Ethernet network 10/100/1000Mb/s, TCP/IP protocol

Control and Monitoring Unit
Dual CPU system, 3 GB DRAM, 2x750 GB RAID
15” TFT screen

Recording Functions
Sampling Rate
Up to 256 samples per cycle
50 cycles: up to 12.8 kHz
60 cycles: up to 15.36 kHz

Fault-/Event Recording Stream
Pre-fault time: user selectable (typical: 0.1-5s)
Fault time: user selectable (typical: 1-20s)
Post-fault time: user selectable (typical: 0.1-5s)
Re-trigger: supported, various setting options

RMS-/Phasor/PQ Recording Stream
Pre-fault time: user selectable (typical: 1-100s)
Fault time: user selectable (typical: 10-900s)
Post-fault time: user selectable (typical: 10-900s)
Re-trigger: supported, various setting options

Continuous RMS/Phasor/PQ Monitoring
Sampling rate: 0.1-100 samples per second
Storage capacity: Up to 5 years (minimum)
Variables: Full flexibility (user defined)

Triggering
Threshold and gradient on any input and user defined signal
Triggering on calculated quantities (signal oscillation, PQ criteria, etc.)
Manually triggering on visually observed signals and test commands

Variables:
- Full flexibility (user defined)
DIGSIENT GmbH is a consulting and software company providing engineering services in the field of electrical power systems for transmission, distribution, generation and industrial plants.

DIGSIENT GmbH was founded in 1985 and is a fully independent, privately owned company located in Gomaringen/Tübingen, Germany, where the new offices have been in operation since early 2002. DIGSIENT continued expansion by establishing offices in Australia, South Africa, Italy, Chile and Spain, thereby facilitating improved service following the world-wide increased use of its products and services. DIGSIENT has established a strong partner network in many countries such as Mexico, Malaysia, UK, Switzerland, Colombia, Brazil, Peru, Argentina, Iran, Venezuela and China. DIGSIENT services and software installations have been conducted in more than 110 countries.

DIGSIENT PowerFactory
DIGSIENT develops the leading integrated power system analysis software PowerFactory, which covers the full range of functionality from standard features to highly sophisticated and advanced applications including wind power, dispersed generation, real-time simulation and performance monitoring for system testing and supervision. For wind power applications, PowerFactory has become the power industry’s de-facto standard tool, due to PowerFactory models and algorithms providing unmet accuracy and performance.

DIGSIENT StationWare is a reliable central protection settings database and management system for the complete power system substation data based on latest .NET technology. StationWare stores and records all settings in a central database, allows modelling of relevant workflow sequences, provides quick access to relay manuals, interfaces with manufacturer specific relay settings software and integrates with PowerFactory software, allowing powerful and easy-to-use settings co-ordination studies.

DIGSIENT Consulting
DIGSIENT GmbH is staffed with experts of various disciplines relevant for performing consulting services, research activities, user training, educational programs and software developments. Highly specialized expertise is available in many fields of electrical engineering applicable to liberalized power markets and to the latest developments in power generation technologies such as wind power and dispersed generation. DIGSIENT has provided expert consulting services to several prominent wind-grid integration studies.

PowerFactory Monitor is a flexible performance recording and monitoring system that copes easily and efficiently with the special requirements for system test implementation, system performance supervision and the determination and supervision of connection characteristics. Numerous Monitoring Systems installed at various grid locations can be integrated to a Wide-Area-Measurement-System (WAMS). The PowerFactory Monitor fully integrates with the PowerFactory.

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