SIGUARD PDP
Phasor Data Processor

Energy Automation

Catalog SR 10.7 · V2.0

Answers for energy.

SIEMENS

Contents

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Description and Applications

SIGUARD PDP – Reliable System Operation with Wide Area Monitoring

The load on electricity supply systems has increased continuously over the past few years. There are many reasons for this:

- Increased cross-border power trading in Europe, for example, is placing new demands on the tie lines between control areas. For example, power transmission on tie lines in the European grid increased almost 6-fold from 1975 to 2008 (source: Statistical Yearbook of the ENTSO-E 2008)
- Increased input of wind power and the planned shutdown of existing power plants will extend the transmission distances between generation and consumers.
- Severe weather and storms can put important lines out of operation, for a short time exposing the remaining grid to increased load quickly.

This means that the power system is increasingly operated closer to its stability limit and new load flows arise that are unfamiliar to network control center operators.

This is where SIGUARD PDP (Phasor Data Processor) comes in.

This system for network monitoring using synchrophasors helps with fast appraisal of the current system situation. Power swings and transients are indicated without delay to help the control center personnel find the causes and take countermeasures.

Highlights

- Phasor data processor per IEEE C37.118 standard
- 2 selectable monitoring modes:
  – Online mode
  – Offline mode (analysis of past events)
- Vector view or time chart view can be selected for all phasors
- Calculation and display of the power system status curve
- System monitoring, incl. communication links and PMU status
- Geographic overview (based on Google Earth)
- Basis for fast reporting after faults
- Flexible analysis with formula editor for calculations based on measured values
- Limit values that can be changed online
- Runs under Windows XP and Windows 7, as a pure PDC (without user interface) also under Windows Server 2008.

Applications

- Analysis of the power flows in the system
  SIGUARD PDP can display a clear and up-to-date image of the current power flows in the system with just a few measured values from widely distributed phasor measurement units (PMU). This requires no knowledge of the network topology. The power flows are shown by means of phase angle differences.

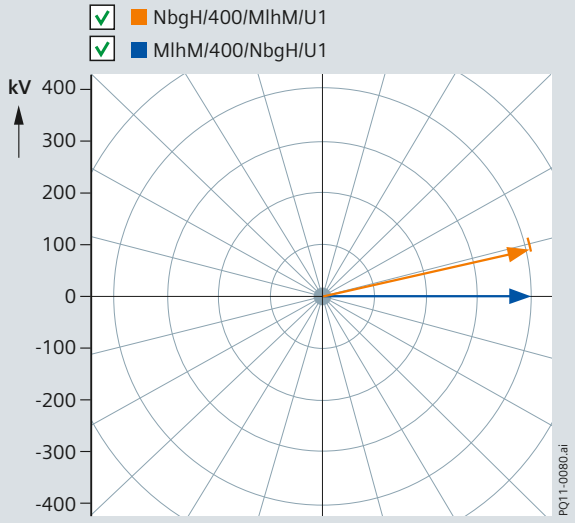

Figure 1 Voltage vector of two measurement points in the network

- Monitoring of power swings
  All measured values from PMUs can be displayed and monitored with easy-to-configure phasor diagrams and time charts. Any power swings that occur are quickly and reliably detected. The zone being monitored can be flexibly adjusted to the current situation in terms of time, geography, and content.
- Evaluation of the damping of power swings
  Using the function “Power Swing Recognition” (available as from Version V2.1), an incipient power swing is detected and the appropriate damping determined. Detection of a power swing and, if applicable, its insufficient or non-existent damping is signaled (alarm list).

Applications (cont.)

- Monitoring of the load on transmission corridors
  The voltage-stability curve is especially suitable for displaying the instantaneous load on a transmission corridor. The currently measured operating point is shown on the work curve of the line (voltage as a function of the transmitted power). In this way, the remaining reserve can be shown at any time. This requires PMUs at both ends of the line.

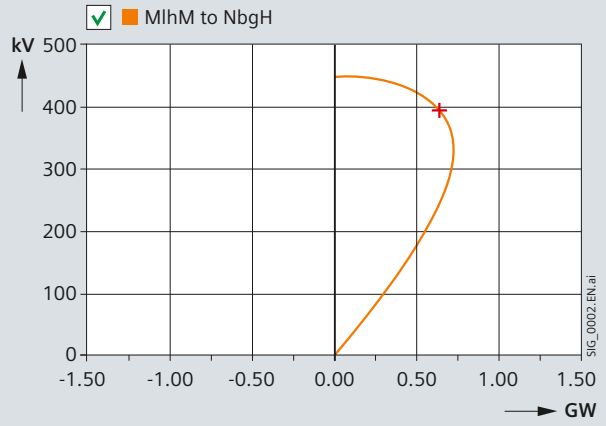

Figure 2 Voltage stability curve

- Island state detection
  This function automatically indicates if parts of the network become detached from the rest of the network. For this purpose, frequency differences and rates of frequency changes can be automatically monitored. If islands are detected, warnings and event messages are output.

11:09:52....	2010-...	Island Detection	ISD potential network subsplit	appearing
11:09:52....	2010-...	Island Detection	ISD network subsplit	appearing
11:09:52....	2010-...	Island Detection	ISD potential network subsplit	disappearing

- Retrospective event analysis
  SIGUARD PDP is ideal for analyzing critical events in the network. After switchover to offline mode, the entire archive can be systematically analyzed and the events played back as often as necessary. This makes dynamic events transparent, and reports can be quickly and precisely compiled. Simply copy the informative diagrams from SIGUARD PDP into your reports.
- Alarming on limit value violation with an alarm list and color change in the geographic network overview map
  This allows you to locate the position and cause of the disturbance quickly. This function is also available for analyzing the archive.
- Display of the power system status as a characteristic value for the stability of the power system
  Due to the constant availability of the power system status curve in the upper part of the screen, the operator is constantly informed about trends in system dynamics and any remaining reserves. This curve shows a weighted average of the distances of all measured values, to their limit values.

Synchrophasor Technology, PMU

Synchrophasor technology

Synchrophasors are vector measured values, that is, the magnitude and phase of the current and voltage are measured and transmitted. Applying a time stamp to the transmitted vector measured values allows a comparison of the measured values from different locations in the network. The figure 3 shows how vector measured values are collected from different regions in the network and brought together at a central location.

To enable further processing of the information obtained from the synchrophasors, time stamping must be extremely precise. For that reason, the PMUs feature GPS-based time synchronization.

Basic differences from "conventional" measuring points (substation automation, RTU):

Measured values from substation automation systems or a remote terminal unit	Synchrophasor from a PMU
Slower updating cycle (e.g. typically once every 5 sec)	Continuous updating (measured value stream), for example, typically 10 values per second (reporting rate)
Measured values without time stamp	Each measured value with precise time stamp
rms values without phase angle	Current and voltage are supplied as a vector value with amplitude and phase

With these characteristics, the synchrophasors can provide a dynamic view in real-time of power swings and other phenomena in network operation.

Figure 4 SIMEAS-R PMU

Phasor Measurement Units (PMU)

A phasor measurement unit (PMU, figure 4) is a device for measuring and transmitting synchrophasors. The frequency and the frequency change (*df*/*dt*) are also detected. A PMU can be an independent device, or integrated in a protection unit, or in a fault recorder. For this purpose, Siemens offers the SIMEAS-R PMU, a fault recorder with integrated PMU functionality. The SIMEAS-R PMU complies with the IEEE C37.118 standard that primarily describes the communication protocol of the synchrophasors. A supplement to this standard with dynamic requirements for the PMUs is being prepared.

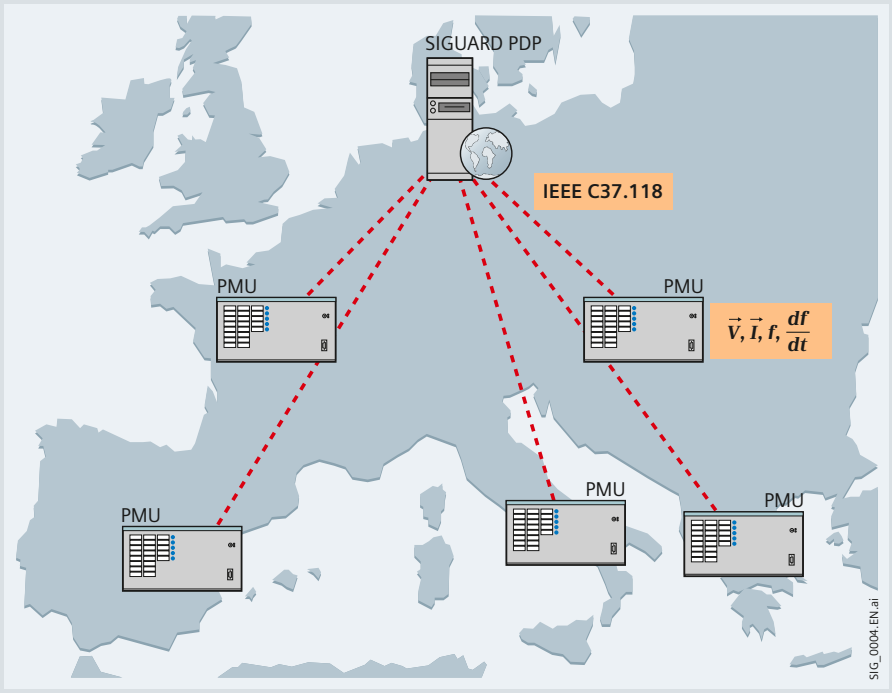

Figure 3 Principle of geographically distributed measured values

SIGUARD Phasor Data Processing System
The SIGUARD Phasor Data Processing (PDP) System has a modular structure and can be distributed over multiple computers. The system structure is shown in figure 5.

SIGUARD PDP server
The central component of SIGUARD PDP is the server. It is used both as the communication hub and the archive link. It also provides basic services such as system monitoring. The configuration can include multiple operator stations (SIGUARD PDP UI), which can be remote from the server or operated on the same computer.
In a typical configuration, the server will run on a server computer with a backed-up power supply (UPS) while the operator station is located in an office environment or in the network control center.

SIGUARD PDP UI operator station
The operator station is normally remote from the Phasor Data Concentrator. Multiple operator stations can be connected. On an operator station, the measured values can be viewed in online mode. In offline mode, significant events can be replayed for precise analysis. All windows run concurrently. Figures 6 and 7 show examples of the operator interface.
The operator interface can be quickly and simply adapted during operation. The power system status curve (upper portion of the screen) shows the weighted sum of the distances of all measured values from their limits, thus providing a view of the network status and the trend. If the curve exceeds the limit value, it will be colored red. Network areas that are in a critical state are displayed in the lower part of the screen in a geographic overview. Next to this is the work area in which phasor diagrams, time charts, and application curves (e.g. voltage stability curves) can be positioned. Further windows show the selection of measured values, pending messages, or the formula editor. The operator interface can be distributed over multiple screens, if necessary.

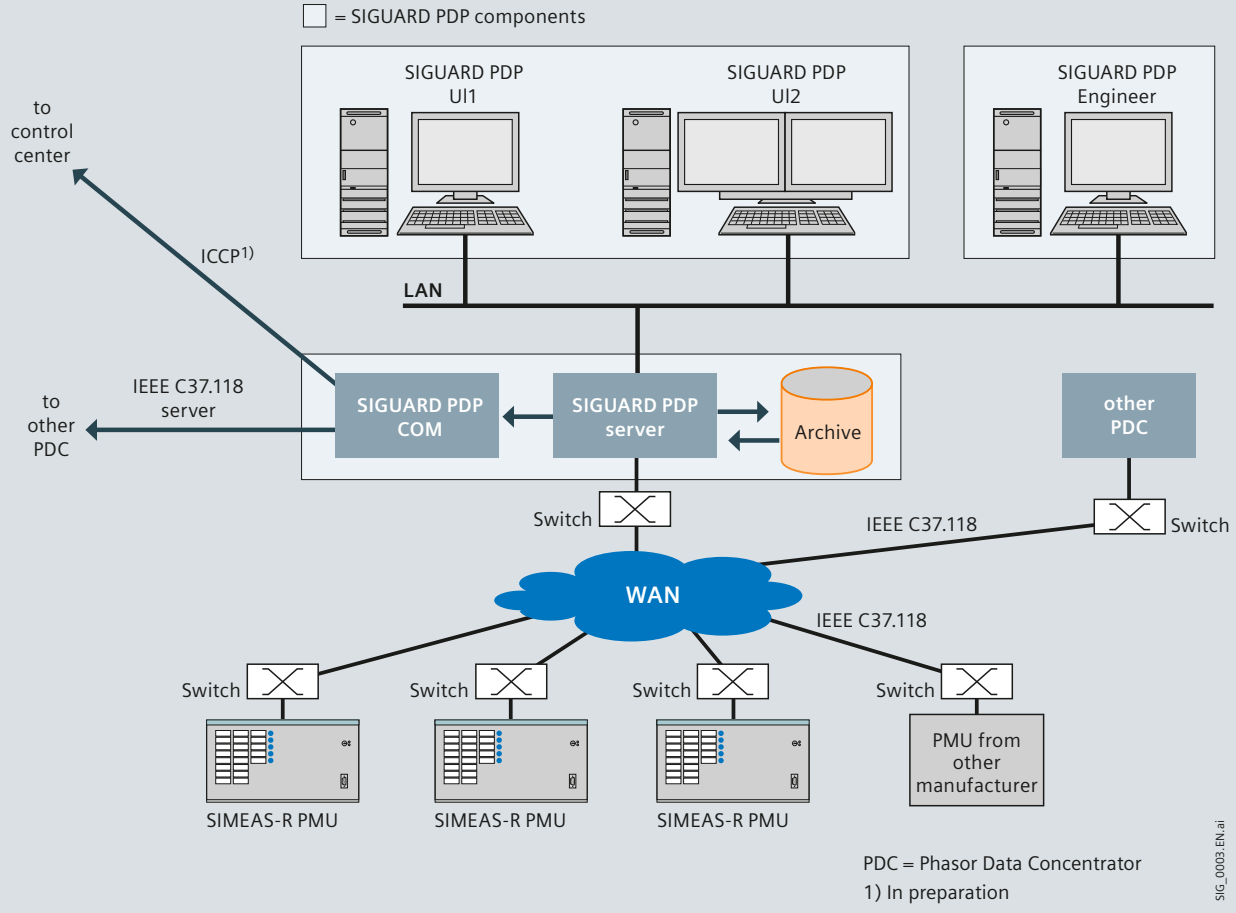

Figure 5 Structure of the SIGUARD Phasor Data Processing System

SIGUARD System Structure

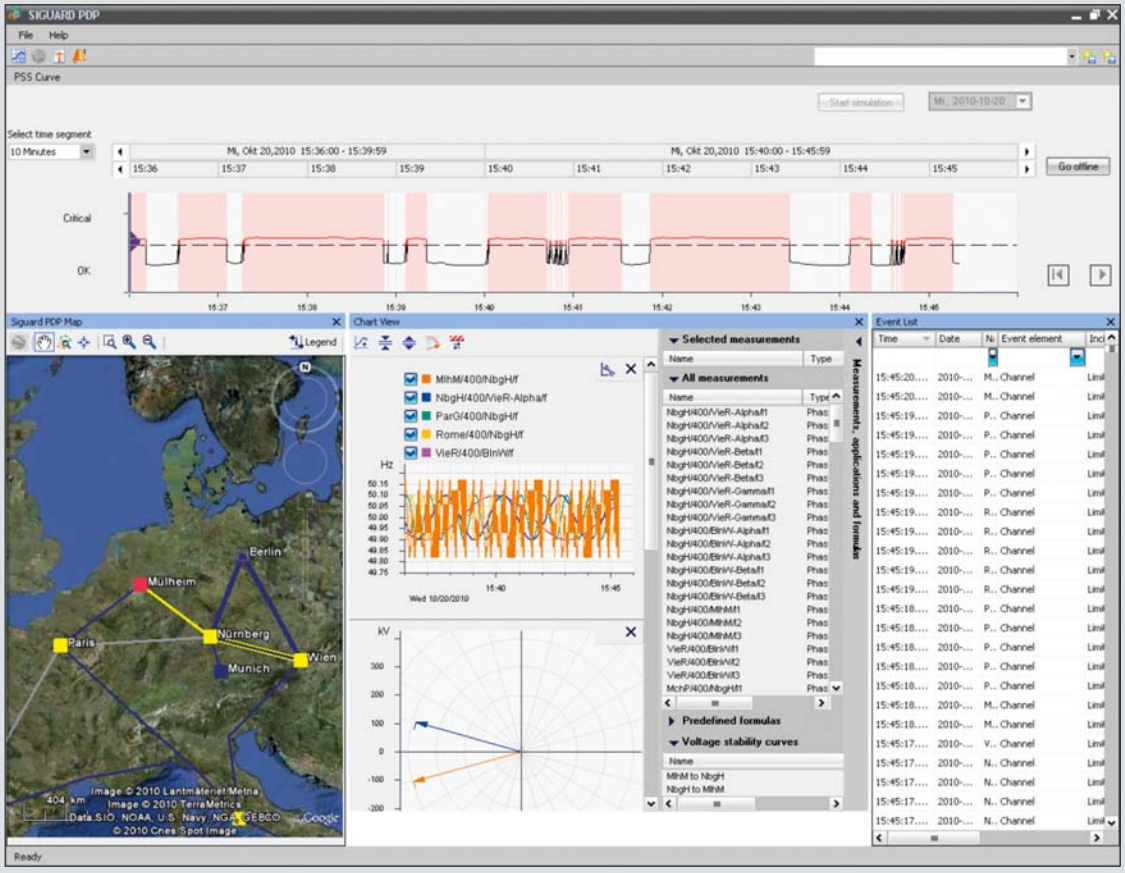

Figure 6 User interface of SIGUARD PDP (example 1, online)

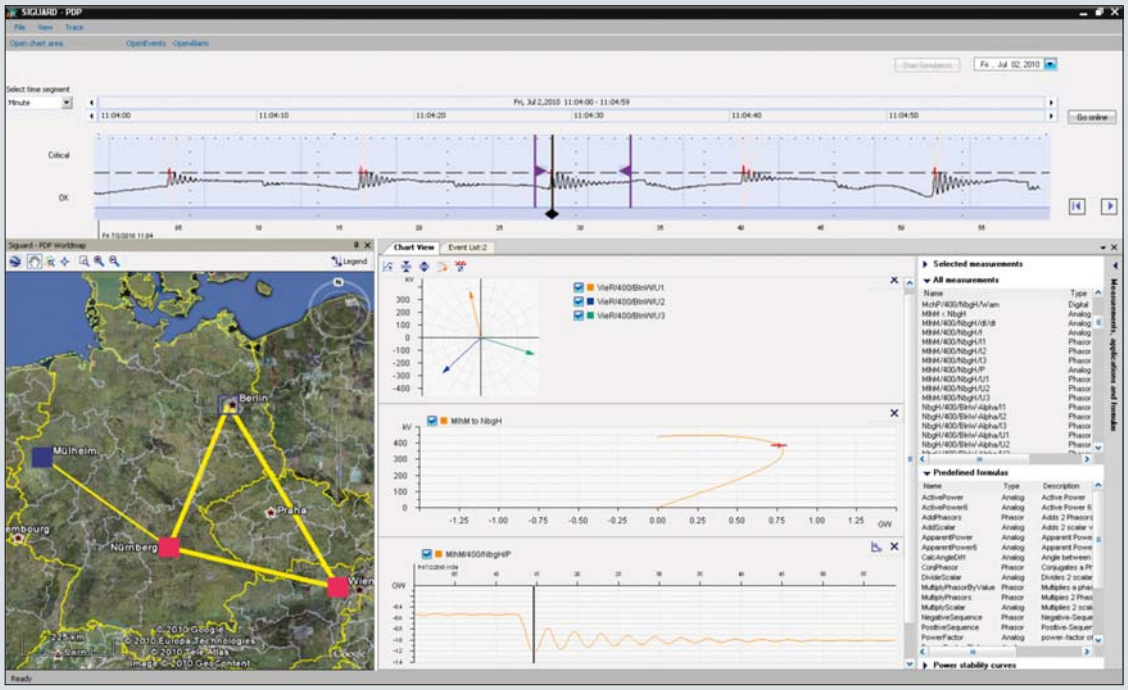

Figure 7 Operator interface of SIGUARD PDP (example 2, offline)

SIGUARD PDP COM
This system module provides the communications link to the other PDCs. Again, protocol IEEE C37.118 is used. SIGUARD PDP COM sends the configured data to up to five recipients at a settable transmission rate (frames per second). The transmission rates can be set separately and the measured values to be transmitted can be selected from all the available PMU measured values for each channel.

SIGUARD PDP Engineer
SIGUARD PDP Engineer is a user-friendly configuration tool for the entire SIGUARD PDP system. The five work areas on the main screen clearly designate the task groups:
- PMU configuration
- Mathematical calculations
- Graphics for the geographical overview
- Applications (voltage stability curve, island state detection)
- Communication, data distribution

An integrated plausibility check ensures the consistency of the configuration.

Power Swing Recognition (available soon)
Power swing recognition analyzes the progression of the active power curve and outputs alarm messages if damping is too low or negative.

Communication links
- IEEE C37.118 server / client
- OPC-to-OPC clients (application: automation functions), in preparation
- ICCP (to network control centers), in preparation

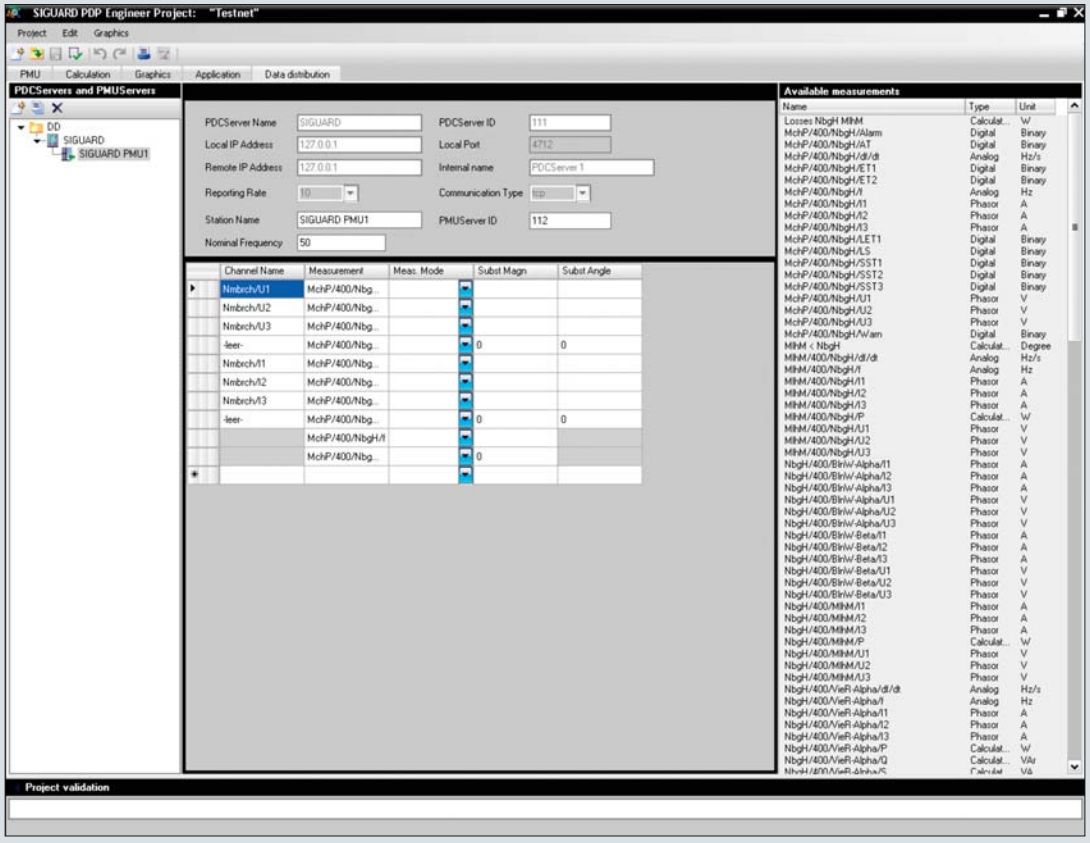

Figure 8 SIGUARD PDP Engineer

Selection and Ordering Data

We offer SIGUARD PDP in a compact version "Substation PDC" as a communications machine or in its full user interface with the applications "Enhanced PDC."
You can also select your own a tailor-made solution from these product families.

The Substation PDC is intended as a low-cost basic version for applications without an operating station. SIGUARD PDP is used in this variant as a data node for synchrophasor measured values.

The full version "Enhanced PDC" of SIGUARD PDP includes all the options for connecting one or more operating stations and use of the applications.
(Version V2.0 includes island state detection, other applications are to follow).

Version	MLFB body number	Description
SIGUARD PDP – Substation PDC	7KE6041	Low-cost PDC version, without operating station and no application such as e.g. island state detection possible. Use in the substation as data node for synchrophasor measured values.
SIGUARD PDP – Enhanced PDC	7KE6042	Full version including all options for connecting operating stations and use of applications
SIGUARD PDP – Funktions Upgrade	7KE6040	By upgrade the desired options can exactly be added to a basic license or a pre-defined combination.

The following table shows the complete order numbers of the basic licenses, pre-defined combinations and the function upgrades.

Order No.	Designation	Description
7KE6041-0AA00-2AA0	Basic license "SIGUARD PDP Substation PDC"	Substation PDC, no UI and no application possible, max. 5 PMUs, max. 2 PDC connections, version V2.0
7KE6042-0AA00-2AA0	Basic license "SIGUARD PDP Enhanced PDC"	Enhanced PDC, 2 UIs, max. 5 PMUs, max. 2 PDC connections, version V2.0
7KE6041-0BA00-2AA0	Pre-defined combination "SIGUARD PDP Substation PDC"	Substation PDC, no UI and no application possible, max. 14 PMUs, max. 2 PDC connections, version V2.0
7KE6042-0CB10-2AA0	Pre-defined combination "SIGUARD PDP Enhanced PDC"	Enhanced PDC, max. 100 PMUs, max. 3 PDC connections, 3 UIs, version V2.0
7KE6042-0CD21-2AA0	Pre-defined combination "SIGUARD PDP Enhanced PDC"	Full functionality: Enhanced PDC, max. 100 PMUs, max. 5 PDC connections, 5 UIs, application "island state detection", version V2.0
7KE6040-0BA00-2AA0	Function Upgrade "6 to 14 PMUs"	Connection of 6 to 14 PMUs
7KE6040-0CA00-2AA0	Function Upgrade "15 to 100 PMUs"	Connection of 15 to 100 PMUs
7KE6040-0AB00-2AA0	Function Upgrade "max. 3 PDCs"	Connection to up to 3 other PDCs as PDC server
7KE6040-0AC00-2AA0	Function Upgrade "max. 4 PDCs"	Connection to up to 4 other PDCs as PDC server
7KE6040-0AD00-2AA0	Function Upgrade "max. 5 PDCs"	Connection to up to 5 other PDCs as PDC server
7KE6040-0AA10-2AA0	Function Upgrade "max. 3 UIs"	Connection of up to 3 operating stations
7KE6040-0AA20-2AA0	Function Upgrade "max. 5 UIs"	Connection of up to 5 operating stations
7KE6040-0AA01-2AA0	Function Upgrade "island state detection"	Release of the application "island state detection" (only possible with existing UI)

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Document version: 01

Release status: 01.2011

Version of the product described: V2.0

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