- Reliable data transmission via PRP and HSR redundancy protocols
- Extensive cybersecurity functionality, such as role-based access control (RBAC), logging of security-related events, signed firmware, or authenticated IEEE 802.1x network access.
- Simple, fast, and secure access to the device via a standard Web browser to display all information and diagnostic data, vector diagrams, single-line and device display pages
- Up to 4 pluggable communication modules, usable for different and redundant protocols (IEC 61850-8-1, IEC 61850-9-2 Client, IEC 60870-5-103, IEC 60870-5-104, Modbus TCP, DNP3 serial and TCP, PROFINET IO, PROFINET IO S2 redundancy)
- Virtual network partitioning (IEEE 802.1Q - VLAN)
- Intelligent terminal technology enables prewiring and an easy device replacement

Applications

The fault recorder is for use in medium-voltage systems, high-voltage systems, and systems for very high voltage and in power plants with comprehensive trigger and recording functions. With the SIPROTEC 7KE85 fault recorder, you receive a clearly organized and event-related evaluation and documentation of your power-system processes. You are thereby able to analyze failures in a targeted manner and optimize your power system.

Typical processes to be monitored and documented:

- System incidents, such as critical load cases or short circuits
- Failures of the supply quality
- Dynamic behavior of generators
- Closing and breaking operations of transformers (saturation response)
- Power fluctuations and power-swing cycles
- Test runs during commissioning

Application Templates

DIGSI 5 provides application templates for standard applications. They include basic configurations and default settings.

The following application templates are available:

Fault recorder 4 V/4 I/11BI

- Application templates related to the monitoring of a total of 8 current/voltage transformers

Fault recorder 8 V/11 BI

- Application templates related to the monitoring of a total of 8 voltage transformers

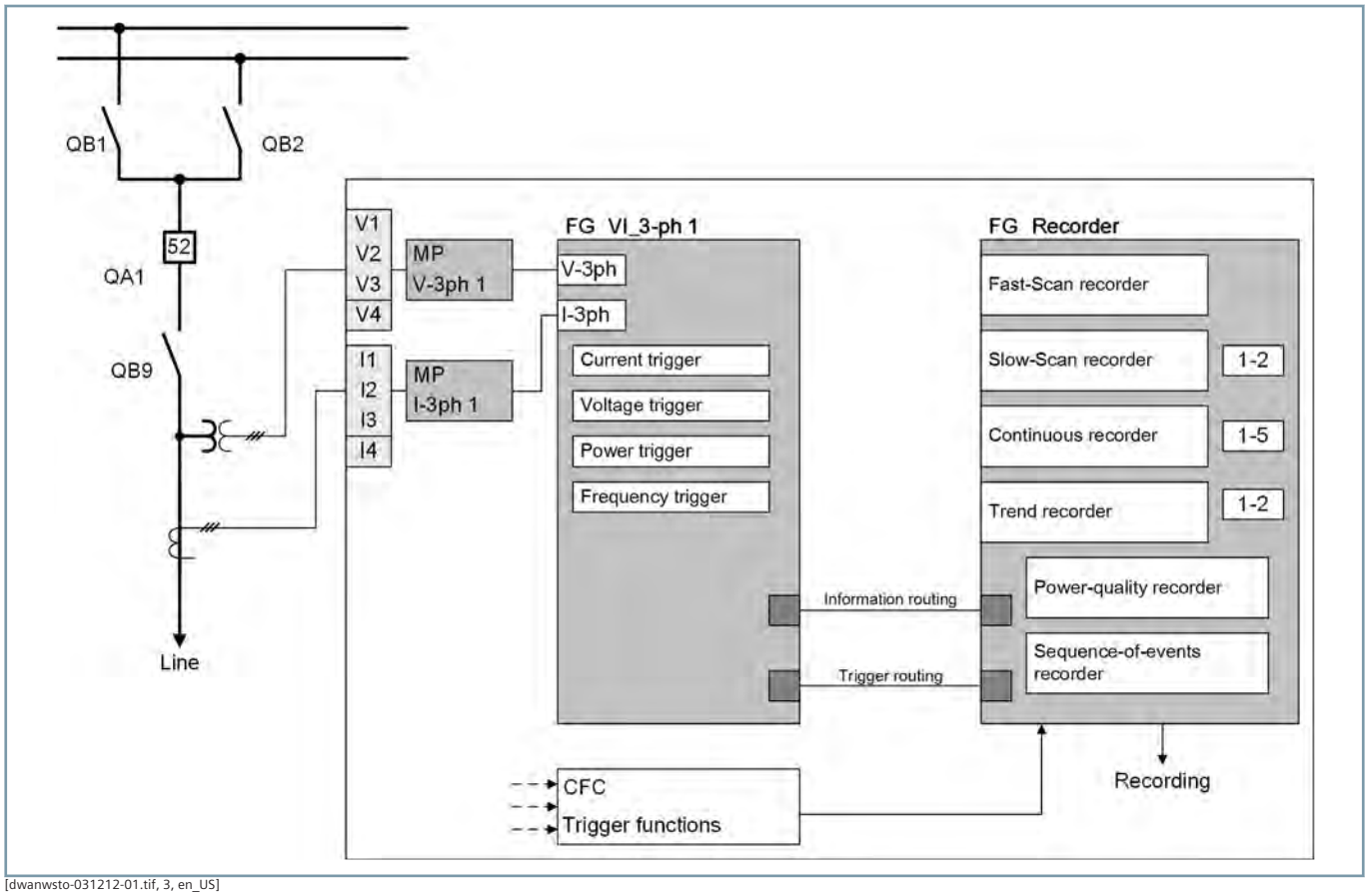
Fault recorder 8 V/8 I/19 BI

- Application templates related to the monitoring of a total of 16 current/voltage transformers

Fault recorder 20 V/20 I/43 BI

- Application templates related to the monitoring of a total of 40 current/voltage transformers

Application Examples

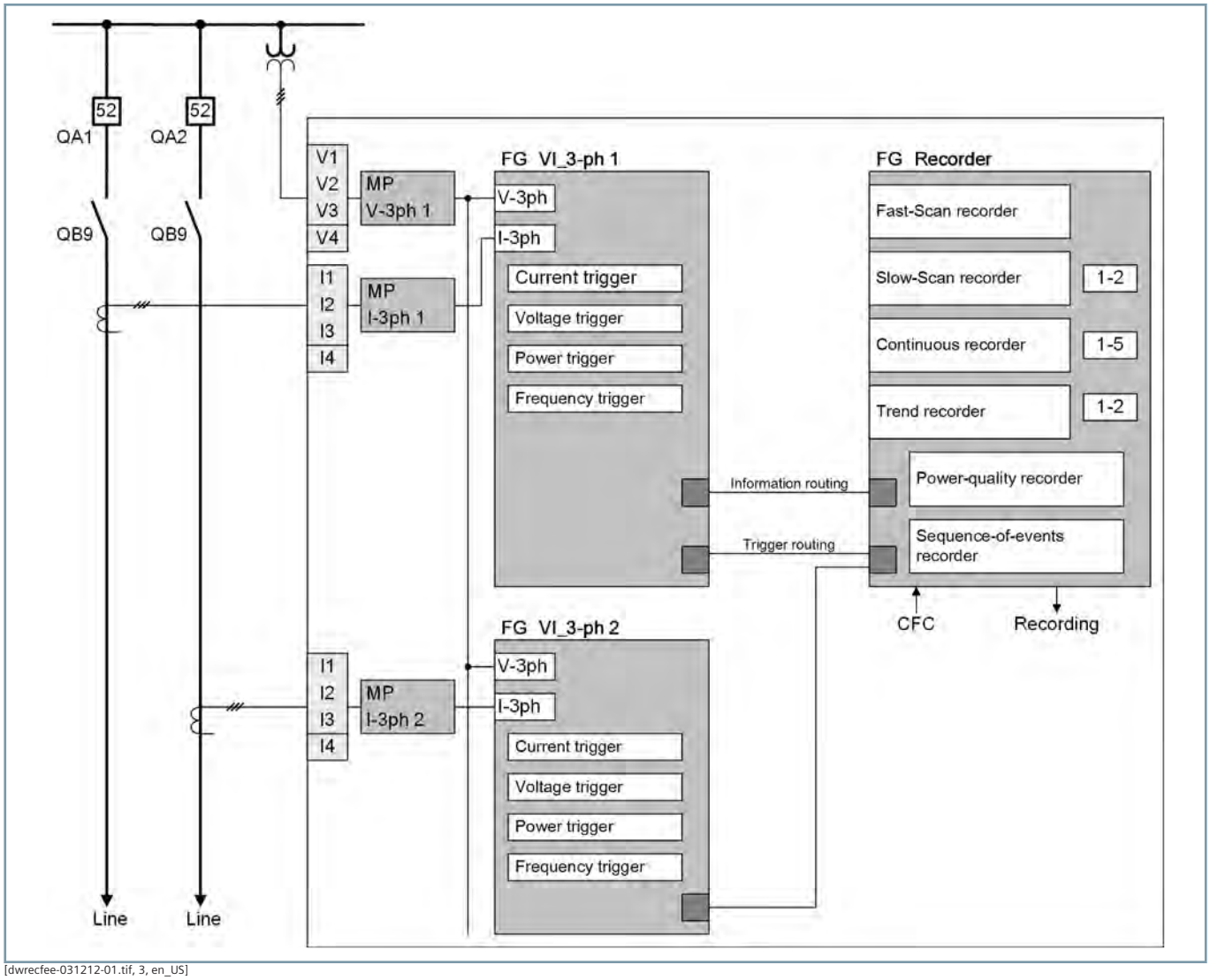


[dwanwsto-031212-01.tif, 3, en_US]

Figure 2.17/3 Fault Recorder SIPROTEC 7KE85 for Monitoring a Feeder

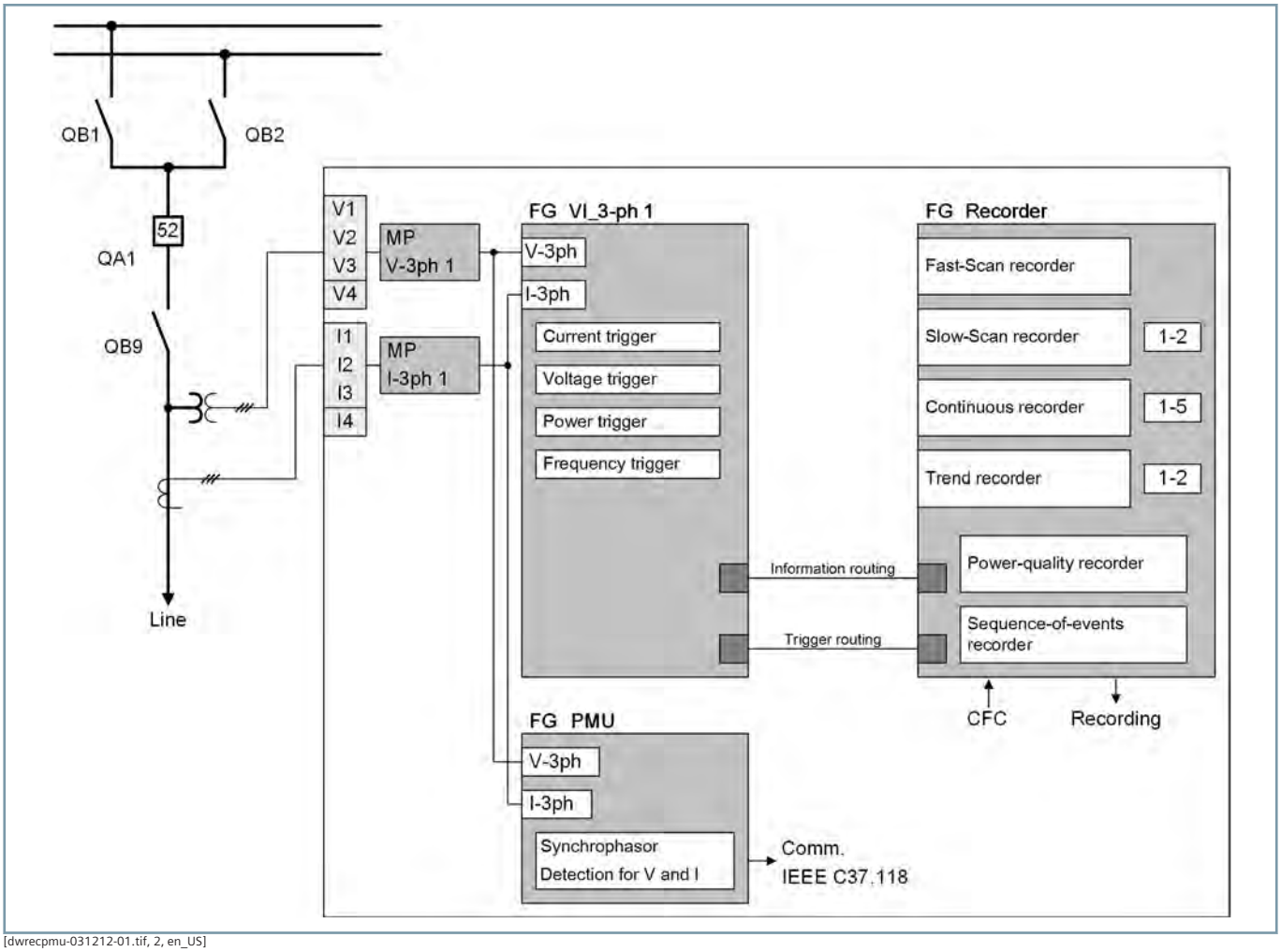
Fault Recorder for Monitoring Feeders

Figure 2.17/3 and *Figure 2.17/4* show simple application examples with a SIPROTEC 7KE85, which is connected for monitoring feeders. In these examples, the various triggers are provided via function group **FG VI_3-phase** and are available to the function group **FG Recorder** and, thus, to the event-triggered recorders. In parallel, individually generated trigger functions (combination of GOOSE messages, single-point/double-point indications, binary signals, etc.) can start a recorder via the CFC and thus generate a fault record.



[dwrecfee-031212-01.tif, 3, en_US]

Figure 2.17/4 Application Example: Fault Recorder for Several Feeders



[dwrecpmu-031212-01.tif, 2, en_US]

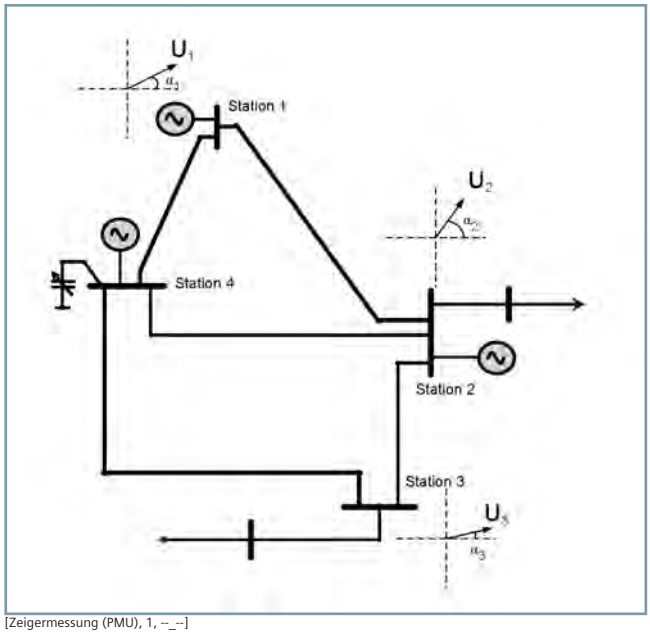
Figure 2.17/5 Double Busbar with SIPROTEC 7KE85 Used as a Fault Recorder and Phasor Measurement Unit (PMU)

Fault Recorder with PMU

When the PMU function is used, a "FG PMU" function group is created in the device, see *Figure 2.17/5*. This function group calculates the phasor and analog values, performs time stamping and transmits the data to the selected Ethernet interface via the protocol IEEE C37.118. There, they can be received, saved, and processed by one or more clients. Up to 3 IP addresses from clients can be assigned in the device.

Use as a Phasor Measurement Unit

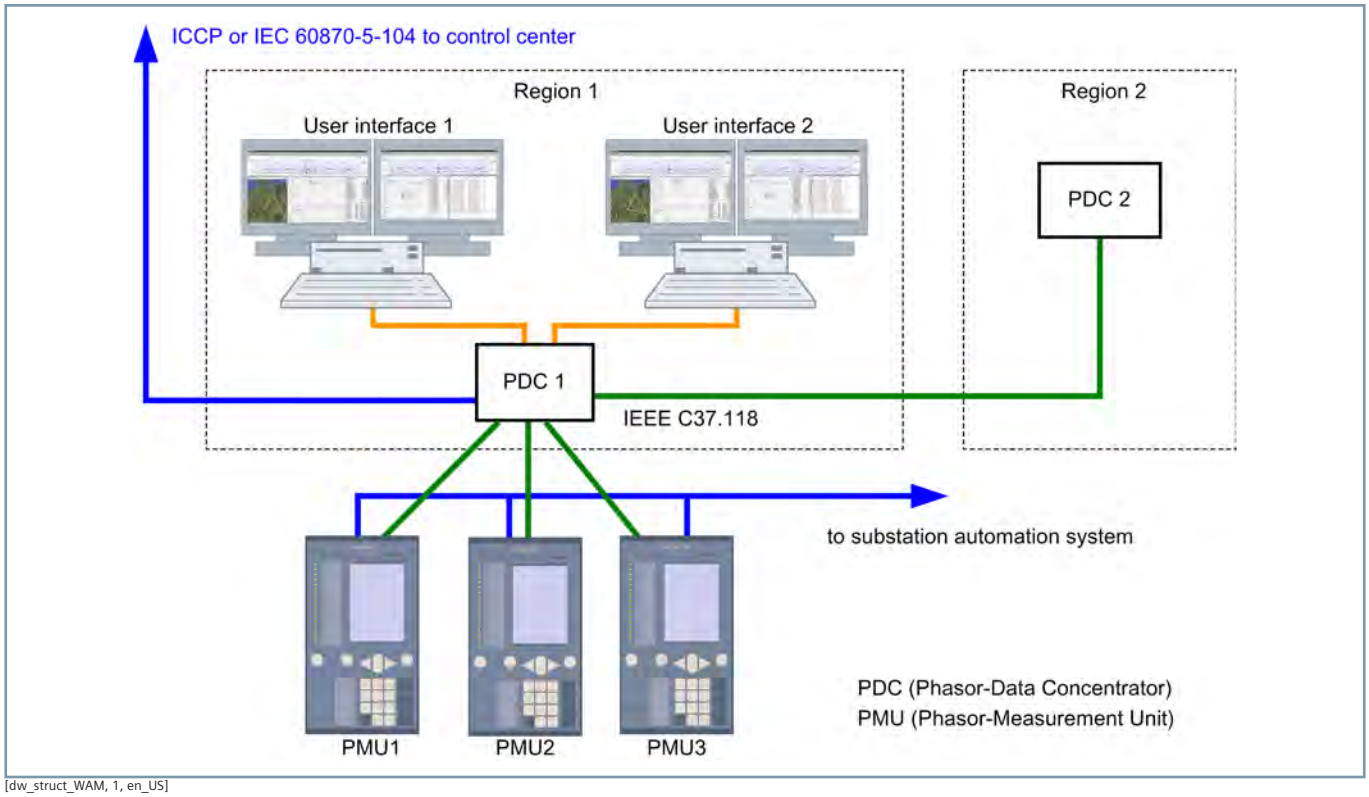
At selected stations of the transmission system, a measurement of current and voltage for absolute value and phase is carried out using PMUs. Due to the high-precision time synchronization (via GPS), the measured values from different substations that are far away from each other are compared, and conclusions about the system state and dynamic events, such as power fluctuations, are drawn from the phase angles and dynamic curves.



[Zeigermessung (PMU), 1, --_--]

Figure 2.17/6 Principle of the Distributed Phasor Measurement

If you select the **Phasor Measurement Unit** option, the devices determine current and voltage phasors, add high-precision time stamps, and send these together with other measured values (frequency, rate of change of frequency) to an evaluation station via the communication protocol IEEE C37.118, see *Figure 2.16/12*. With the aid of the synchrophasor and a suitable analysis program (for example, SIGUARD PDP), it is possible to detect power swings and trip alarms automatically which are sent to the network control center, for example.



[dw_struct_WAM, 1, en_US]

Figure 2.17/7 Connecting 3 Phasor Measurement Units with 2 Phasor Data Concentrators (PDCs) SIGUARD PDP

When the PMU function is used, a **FG PMU** function group is created in the device. This function group calculates the phasor and analog values, add time stamps, and transmits the data to the selected Ethernet interface via the protocol IEEE C37.118.

There, they can be received, saved, and processed by one or more clients. Up to 3 IP addresses from clients can be assigned in the device.

Recorder

Fast-scan recorder

Transient processes, short circuits, or ground faults and also the behavior of protection devices can be analyzed with the fast-scan recorder. Transient processes can be tripped, for example, by switching operations. The fast-scan recorder can record the history of the sampled values of all analog inputs, internally calculated measured values, and binary signals when an error occurs for over 90 s with a pre-trigger time of 3 s. The sampling rate can be set from 20 to 320 sampled values per cycle. This corresponds to a sampling frequency of 1 kHz to 16 kHz.

Binary changes are recorded at a resolution of 1 ms. The input signals are analyzed according to the specified trigger conditions and recorded if the limiting values are violated. This recorded fault record includes the pre-trigger time, the trigger point, and the fault recording. In addition, the cause that trips the trigger is saved. The trigger limiting values and record times can easily be set with DIGSI 5.

Slow-scan recorder

The function principal is similar to that of the fast-scan recorder, but the values are calculated every 10 ms and averaged over a configurable interval. The averaging time can be configured from a rated period up to 3000 rated periods. The averaged values are stored by the slow-scan recorder as a recording in the mass storage. Binary changes are recorded, in a similar way to the fast-scan recorder, with a resolution of 1 ms.

Slow-scan recorders are therefore well-suited for detecting, for example, the load conditions before, during, and after a failure and, thus, also power-swing cycles.

The slow-scan recorder can record the history of sampled values from all analog inputs, internally calculated measured values, and binary signals when an error occurs for over 90 minutes with a pre-trigger time of 90 s. Here, too, the input signals are analyzed according to the specified trigger conditions and recorded if the limiting values are violated. These fault records include the pre-trigger time, the trigger point, and the fault recording. In addition, the cause that trips the trigger is saved. The user sets trigger values and record times in DIGSI 5 for this purpose. Furthermore, up to 2 independent instances of the slow-scan recorder can be created.

Continuous recorder

The SIPROTEC 7KE85 has up to 5 continuous recorders. They are used for data acquisition of analog parameters and internally calculated measured values over longer time frames. This makes it possible to perform an exact long-term analysis of the system behavior.

An average value is formed over an adjustable time range and stored in memory for each recorded quantity of the continuous recorder. Each of these recorders can be activated separately. The user can set the available storage capacity in the ring archive specifically for each recorder.

Trend recorder

The SIPROTEC 7KE85 has up to 2 trend recorders that are used for long-term recording and monitoring of the process of voltage change within parameterizable tolerance ranges. The flicker measurement can be determined and stored in the trend recorder. The trend recorder can also be used as sequence-of-events recorder. The sequence-of-events or status change of binary signals, GOOSE messages, or messages (SPS) for example is stored in chronological sequence in the recorder. The user can set the available storage capacity in the ring archive specifically for each recorder.

	Common Data Class (IEC 61850)	Pre-Trigger Time (Max.)	Seal-in Time (Max.)	Sampling/Resolution	Posting Time
Fast-scan recorder	SMV/MV	3 s	90 s	1 kHz to 16 kHz	–
	SPS	3 s	90 s	1 ms	–
Slow-scan recorder	MV	90 s	5400 s	MVs every 10 ms	1 period to 3000 periods
	SPS	90 s	5400 s	1 ms	-
Continuous recorder	MV	–	–	MVs every 10 ms	1 s to 900 s
Trend recorder	SPS	–	–	–	–
	MV	–	–	–	–
SMV = Sample Measured Values SPS = Single Point Status MV = Measured Values					

Table 2.17/1 Overview of the Recorders

Trigger Functions

The event-triggered recorders (fast-scan and slow-scan) have a large number of analog and binary triggers that enable the user to record the particular system problem exactly and avoid unnecessary recordings. The input signals are thus queried corresponding to the trigger conditions and start the fault recording. In the SIPROTEC 7KE85, all triggers can also be assigned multiple times to the various recorders.

Analog trigger

The analog triggers are essentially subdivided into level triggers and gradient triggers. Level triggers monitor measurands for conformity to the configured limiting values (min/max). As soon

as the measurand exceeds or falls below the respective limiting value, the trigger is tripped. Gradient triggers respond to the level change over time.

Each analog trigger can be configured as primary, secondary, or percentage value. A distinction is made here between frequency, voltage, current, and power triggers. With current and voltage as trigger variables, it is possible to select between fundamental, RMS, or symmetric components.

Binary trigger

A binary trigger starts a recording via the logical status change of a binary signal. Along with the manual trigger, which can be tripped via the device keypad, DIGSI 5, or any IEC 61850 client (for example, SICAM PAS/PQS), the triggering can occur via binary input (external trigger) or IEC 61850 GOOSE messages via the communication network. The logic triggers are implemented via the powerful graphical logic editor (CFC). In this case, the free combination of all available analog values (absolute values or phases), binary signals, Boolean signals, GOOSE messages, single-point and double-point indications is possible via Boolean or arithmetic operations.

As a user, you can thus set the trigger conditions appropriate for your problem and start the recording.

Fault Recorder – SIPROTEC 7KE85

ANSI	Function	Abbr.	Available	Application Templates			
				1	2	3	4
	Expandable hardware quantity structure	I/O	■	■	■	■	■
	Process bus client protocol (hint: PB client requires a separate ETH-BD-2FO plug-in module, from V8.0)	PB client	■				
	IEC61850-9-2 Merging Unit Stream (hint: Each stream requires a separate ETH-BD-2FO plug-in module, from V8.0)	MU	■				
	IEC61850-9-2 Merging Unit Stream 7SS85 CU (hint: Only for communication with a 7SS85 CU. A separate ETH-BD-2FO plug-in module is required starting with V8.40)	MU	■				
50EF	End-fault protection (hint: For use only in decentralized busbar protection with a 7SS85 CU starting with V8.40)		■				
PMU	Synchrophasor measurement	PMU	■				
	Measured values, standard		■	■	■	■	■
	Measured values, extended: Min, max, average		■	■	■	■	■
	CFC (standard, control)		■	■	■	■	■
	CFC arithmetic		■				
	Circuit-breaker wear monitoring	ΣIx, I²t, 2P	■				
	Circuit breaker		■				
	Fault recording of analog and binary signals		■	■	■	■	■
	Monitoring		■	■	■	■	■
FSR	Fast-scan recorder	FSR	■	■	■	■	■
SSR	Slow-scan recorder	SSR	■	■	■	■	■
Change request	Continuous recorder	Change request	■	■	■	■	■
TR	Trend recorder	TR	■				
PQR	Power Quality recordings (functions)	PQR	■				
	Split bar for harmonic and interharmonic components (starting with V8.01)		■				
	Sequence-of-events recorder	SOE	■	■	■	■	■
ExTrFct	Expanded trigger functions	ExTrFkt	■	■	■	■	■
	Frequency group tracking (from V7.8)		■				
	Cyber security: Role-Based Access Control (from V7.8)		■				
	Temperature recording via communication protocol		■				
	Cyber security: Authenticated network access using IEEE 802.1X (starting from V8.3)		■				
Function point class:				0	0	0	0
The configuration and function point class for your application can be determined in the SIPROTEC 5 order configurator at *www.siemens.com/siprotec*.							

Table 2.17/2 SIPROTEC 7KE85 – Functions, Application Templates

(1) Fault recorder 4 V / 4 I / 11 BI

(2) Fault recorder 8 V / 11 BI

(3) Fault recorder 8 V / 8 I / 19 BI

(4) Fault recorder 20 V / 20 I / 43 BI

Hints on **ANSI PQR**: 150 function points per measuring point /
One measuring point = 4 V and 4 I

Standard Variants for SIPROTEC 7KE85		
N1	1/3 x 19", 4 V, 4 I, 11 BI, 9 BO	
	Housing width 1/3 x 19" 4 voltage-transformer inputs 4 current-transformer inputs 11 binary inputs 9 binary outputs (1 life contact, 2 standard, 6 fast) Contains the following modules: base module with PS201 and IO202	
N2	1/3 x 19", 8 V, 11 BI, 3 BO	
	Housing width 1/3 x 19", 8 voltage-transformer inputs, 11 binary inputs, 3 binary outputs (1 life contact, 2 standard) Contains the following modules: base module with PS201 and IO211	
N5	1/2 x 19", 8 V, 8 I, 19 BI, 15 BO	
	Housing width 1/2 x 19" 8 voltage-transformer inputs 8 current-transformer inputs 19 binary inputs 15 binary outputs (1 life contact, 2 standard, 12 fast) Contains the following modules: base module with PS201 and IO202 Expansion modules IO202	
N6	1 x 19", 20 V, 20 I, 43 BI, 33 BO	
	Housing width 1/1 x 19" 20 voltage-transformer inputs 20 current-transformer inputs 43 binary inputs 33 binary outputs (1 life contact, 2 standard, 30 fast) Contains the following modules: base module with PS201 and IO202 Expansion modules IO202	

You can find the technical data of the device in the manual:
www.siemens.com/siprotec