

SIEMENS

PSD01

Controlled Switching of
High-Voltage Circuit-Breakers



Controlled switching

Switching transients that occur during the switching of capacitive and inductive loads result in electrodynamic and dielectric stress on the equipment of the high-voltage system. Controlled switching with the PSD01 control unit from Siemens minimizes these stresses. The following advantages arise from the use of this control unit:

- Increased system reliability as a result of reduced voltage fluctuations and lower harmonic stress.
- Longer service life of equipment reducing switching over-voltages and inrush currents.
- Possible replacement of costly, complex mechanical auxiliary equipment, such as closing resistors.

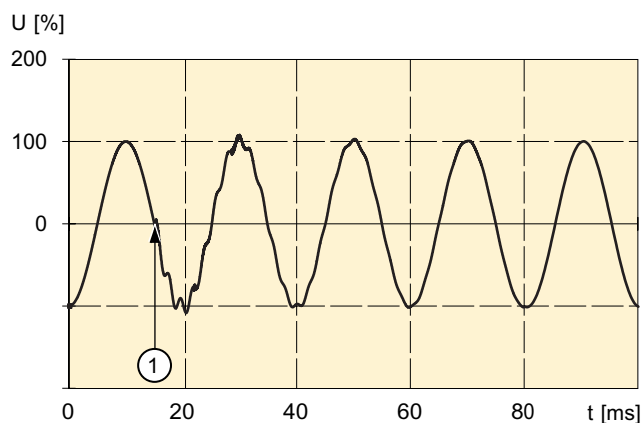
The intensity of the switching transients during switching operations depends on the phase position at the point of switching. A circuit-breaker without controlled switching switches the three phases at approximately

the same instant. As a result of the arbitrary switching instant and the phase shifts of the three phases with respect to each other, a tendency for random phase positions arises. The switching transients vary accordingly in the individual phases but, in general, unfavorable switching conditions can be expected in at least one phase.

Controlled switching allows an individual optimum switching instant to be set for each switching pole. The switching transients are thereby reduced to a minimum. With circuit-breakers with three independent drives, each switching pole receives an individual switching command from the control unit.

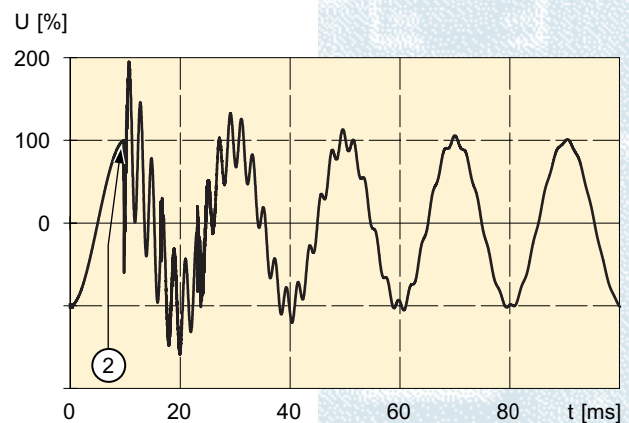
Controlled switching – Less stresses on the equipment

Non-controlled closing of a capacitor bank at a voltage peak can result in high inrush currents and over-voltages, which can greatly exceed the nominal system values. This means that the capacitors are heavily loaded both mechanically and dielectrically and age prematurely. As a result capacitors can be damaged or destroyed. Closing the contact at the optimal point in time reduces the load on the capacitor bank and improves the quality of the voltage of the network.



Switching a capacitive load

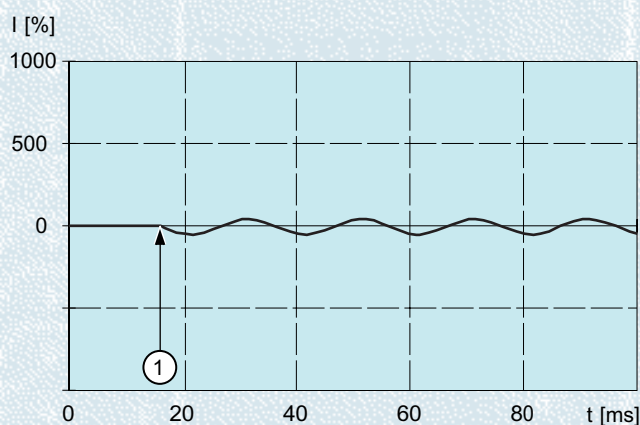
- 1 Closing time optimized
- 2 Closing time not optimized



Non-controlled energizing of a reactor or a transformer close to the voltage zero crossing may result in a very high direct current component. The induction flow thus generated saturates the iron core and induces an inrush current that presents a high load for the transformer or the reactor. Controlled switching at the voltage crest will also prevent switching transients from occurring and consequently the equipment is protected. Non-controlled de-energizing of inductive

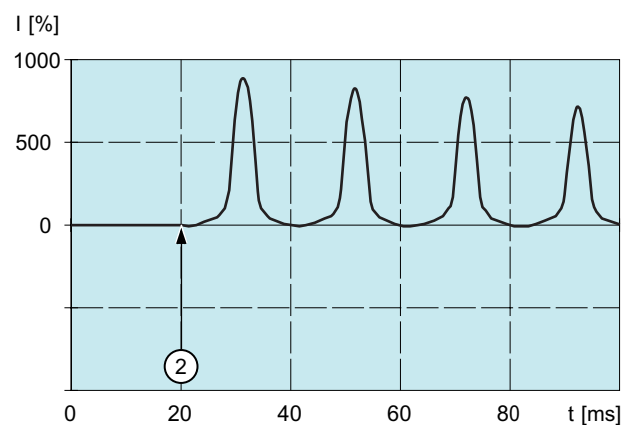
loads such as shunt reactors or transformers means that the circuit-breaker can interrupt small currents before the natural zero crossing. This process is known as current chopping and leads to steeply rising over-voltage. This can result in a re-ignition across the open breaker contacts if the clearance at this instant is not sufficient to withstand the dielectric load. Over-voltages are inevitable. Controlled switching also offers a remedy in this case.

Optimization of the switching instant prevents re-ignitions and the over-voltages are minimized. In the cases described above, non-controlled making or breaking can lead to increased stress on the equipment. Closing resistors and reactors that were previously used to reduce these stresses may no longer be required. Controlled switching offers an economical alternative.



Switching of a transformer

- 1 Closing time optimized
- 2 Closing time not optimized



Control unit

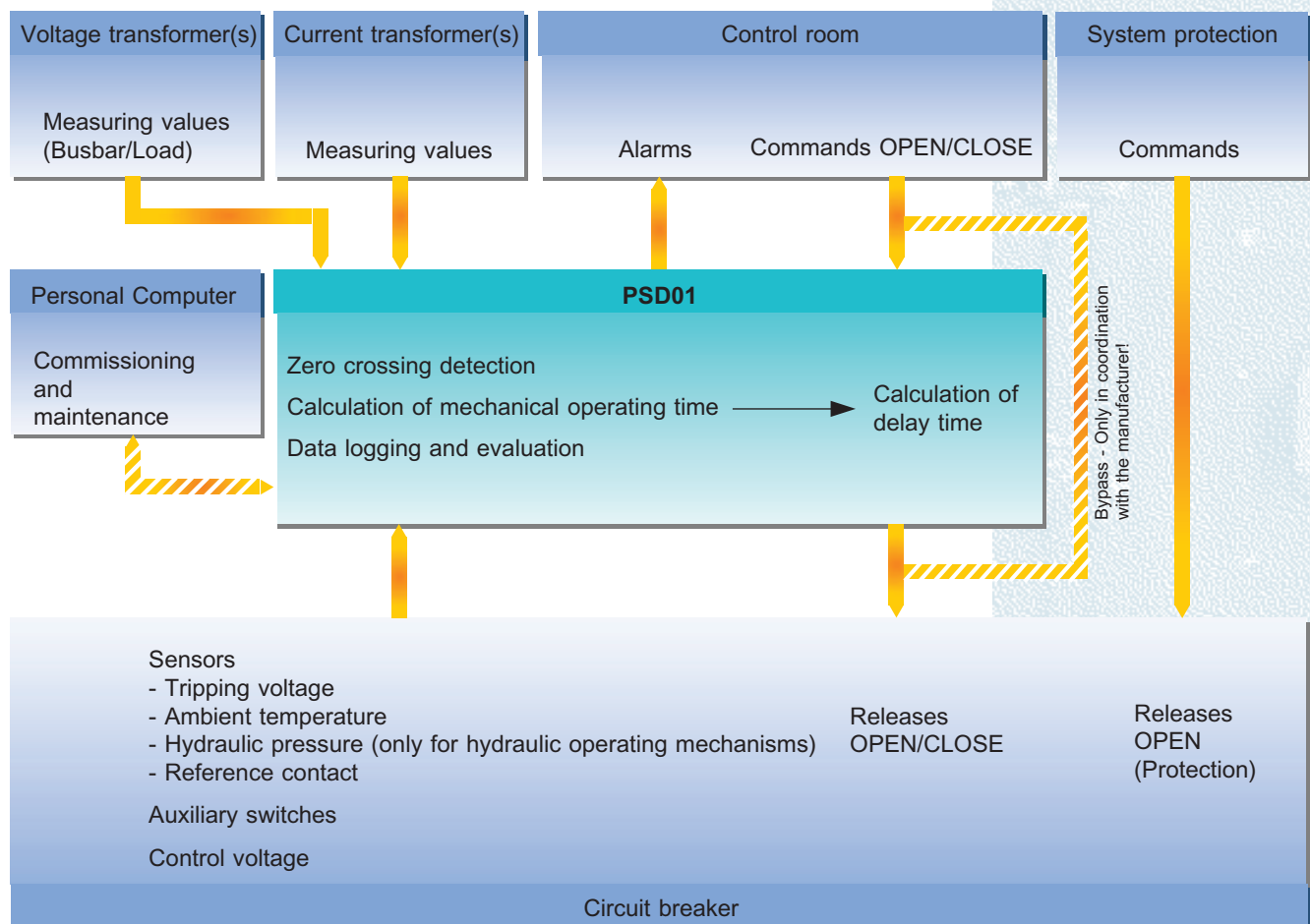
By taking current values into consideration, the PSD01 control unit optimizes the switching operations of circuit-breakers with respect to the phase relative to the current or voltage. Controlled switching takes the present opening and closing times of the circuit-breaker into account. Commands from the system protection are passed directly onto the circuit-breaker.

Closing is carried out with an optimal phase position relative to the voltage. The phase position is selected based on the actual switching duty so that switching transients can be avoided.

When opening small inductive currents, the contact separation is controlled with respect to the voltage cycle so that the contact clearance during interruption is sufficiently large to prevent re-ignition.

Integration into the substation

The PSD01 control unit is integrated into the substation control system so that the switching commands that are given for operational reasons are processed. Opening commands that are generated by the system protection in case of short circuit are passed directly onto the circuit-breaker. In such cases there is no control of the switching instant.



The functions and features of the PSD01 control unit

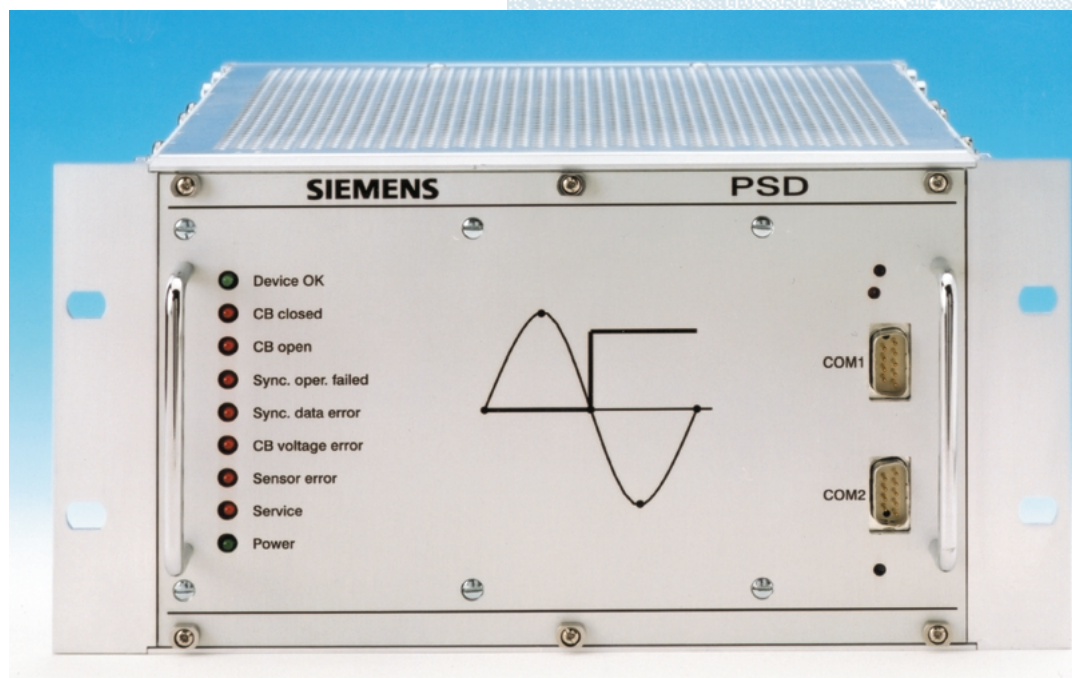
The PSD01 control unit offers wide-ranging functionalities. It offers the possibility to select and set the opening and closing instant for each switching pole individually.

The PSD01 control unit is suitable for use with all high-voltage circuit-breakers. This includes already installed circuit-breakers with a minimum stability of the opening and closing time and a sufficiently steep pre-arcing characteristic curve.

With the help of two separately configured parameter sets in the control unit it is possible to control a circuit-breaker which is used for two different switching tasks. Automatic selection between the two switching tasks during operation takes place via a mode input.

To compensate for possible deviations in the opening and closing of a circuit-breaker, the PSD01 control unit offers two functions to perform making and breaking at the optional instant for each pole:

- The PSD01 compensates for the dependence of the opening and closing times in opening and closing on the ambient temperature and the control voltage. With hydraulically driven breakers, the drive energy (hydraulic pressure) is also compensated. It is possible to choose between different compensation characteristics.
- The *Adaptive Control* function allows the self-adaptation of the control unit in response to changed circuit-breaker properties, for example, with the help of reference contacts. The reference contacts reproduce the closing or opening of the main contacts of the circuit-breaker.



Functions

In order to monitor the success of the controlled switching operations and the internal functions, the PSD01 has a wide range of monitoring and evaluation functions:

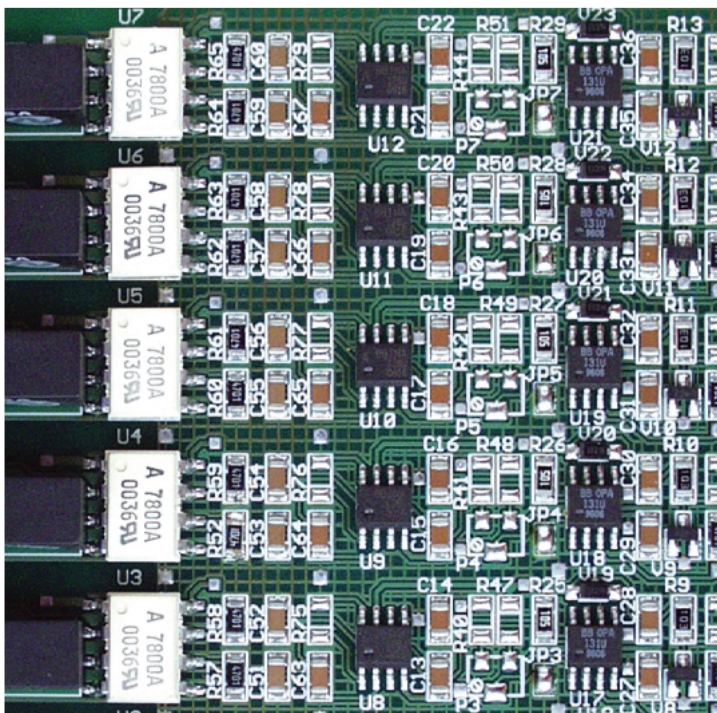
- Evaluation of up to 4 voltage channels and 3 current channels
- Assessment of the effected closing or opening operations is possible
- Data-acquisition of the last 4 switching operations is performed. The signals for all in- and outputs are recorded. This includes the current and voltage time curves and the process curves of the switching commands (inputs from the control room and outputs on the circuit-breaker) and the reference contact signals. The oscillograms are placed in a buffered memory and are available even after supply interruption.
- Easy graphical evaluation of all recorded signals of the switching operations with the help of Windows-compatible software.
- Individual detection of the positions of the individual circuit-breaker pole with a monitoring function by means of 4 auxiliary switch inputs.
- Data-acquisition of the most important data from approximately 400 events and switching operations by means of the History function. In History, the data are acquired cyclically and event-controlled and stored in a nonvolatile memory.
- Option of inputting limits for the individual

parameters (e.g. frequency, voltages, temperature). When the limits are exceeded or not reached, an alarm signal is displayed.

- Output of error messages (alarms), e.g. if a switching operation is not successfully performed, if no zero crossing of the reference voltage has been detected, or if an input signal has not been received.
- Monitoring of sensors, hardware, and the voltage supplies.

Experience

Our years of experience in the use and development of control units have gone into the development of the PSD01. The PSD01 control unit has been subjected to comprehensive electrical, mechanical, and climatic tests. The EMC test in accordance with IEC 61000 and IEC 60255 and the test for low noise emission in accordance with EN 55011 have been passed successfully. Climatic and mechanical tests in accordance with IEC 60068 and IEC 60255 demonstrate unlimited functionality even under disruptive environmental influences.



Technical Data

Housing:

42HP/3U HF module support with perforated cover plate	
Protection category:	IP2
Height:	133.35 mm (3U)
Width:	219 mm (9.5") (269 mm with securing bracket)
Depth:	225 mm
Weight:	4 kg

Ambient conditions:

- 40 °C to +70 °C
Free air convection, non-condensing

Voltage supply:

Voltage:	42...360 Vdc
Power consumption:	15 W
Mains buffering, protected against polarity reversal, short-circuits, no-load and over-load, monitoring of supply interruption	

Analog inputs:

1x temperature	4...20 mA, 24 V	internal supply
3x oil pressure	4...20 mA, 24 V	
3x reserve	4...20 mA, 24 V	
1x control voltage	0...300 Vdc	same reference dimensions/insulated
1x CLOSE-trip voltage	0...300 Vdc	
1x OPEN-trip voltage	0...300 Vdc	
4x voltage transformer	0...212 Vac	$f_o=1$ kHz, $R_{in}=2.4$ M Ω , insulated $f_o=1$ kHz, $R_{in}=10$ m Ω , insulated, 100 A, 5 ms, $I_{max}=14$ Adc
3x current transformer	± 12.5 Adc	

Digital inputs:

1x MODE	
1x AUX-close-contact pole A	
1x AUX-close-contact pole B	
1x AUX-close-contact pole C	32...300 Vdc, $R_{in}=20$ k Ω , protected against polarity reversal, insulated
1x AUX-open-contact poles ABC	
1x CLOSE-command	
1x OPEN command	
3x Reference contact	4...20 mA, 24 V internal supply

Outputs:

3x power outputs CLOSE	24...300 Vdc, 20 A, 2.5 s or 25 A, 200 ms (90°C),
3x power outputs OPEN	$I_{max}=35$ A, short-circuit interrupt time < 10 μ s
8x relay contact	1 two-way contact, switching capacity 2000 VA constant current 8 A, operating range 300 Vdc / 0.5 A
8x LED display	

Communication interfaces:

DTE/DCE communication

2x EIA RS-232, DTE, 115000/57000 bps, serial modem, SUB-D9

Resolution, sampling rate

10 kHz, 10 Bit, 250 ms, sensor inputs 1 s, 10 Bit
Switching precision: 0.1 ms

System:

16-Bit microcontroller - C167CR, 20 MHz, RTC, 512K SRAM, 512K FLASH, capacitor-buffered

Connection technology:

COMBICOM PHOENIX contact system – recommended connection cross-section: 2.5 mm²
Type MSTB 2.5/..-STF, 0.2-2.5 mm², AWG 24-12
1 x 6-pole, 8 x 16-pole

Accessories:

1x serial modem cable

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