Gerardo Granada, Abril, Lima, Peru.

Controlled Switching with Switchsync™ PWC600 Point-on-Wave Controller

Range of Switchsync™ controllers

Switchsync™ controller	Main application	Controls CB operation	CB operation
E213	Shunt capacitor banks, Shunt reactors	Open and/or close	Three-pole operation
F236	Shunt capacitor banks, Shunt reactors, Transformers	Open and close	Single-pole operation
T183	Transformers	Close	Single-pole operation
L183	Uncompensated transmission lines	Close	Single-pole operation

E213

F236

T183

L183

Controlled Switching
Suitable circuit breakers

ABB live tank and disconnecting circuit breakers are well suited for controlled switching:

- Stable operating times
- High and stable dynamic dielectric withstand capability
- Controlled switching replace preinsertion resistors

”We recommend use of Switchsync™ controllers only with ABB’s SF_6 live tank circuit breakers”

Controlled switching
References


ICELAND


VIETNAM


SLOVENIEN

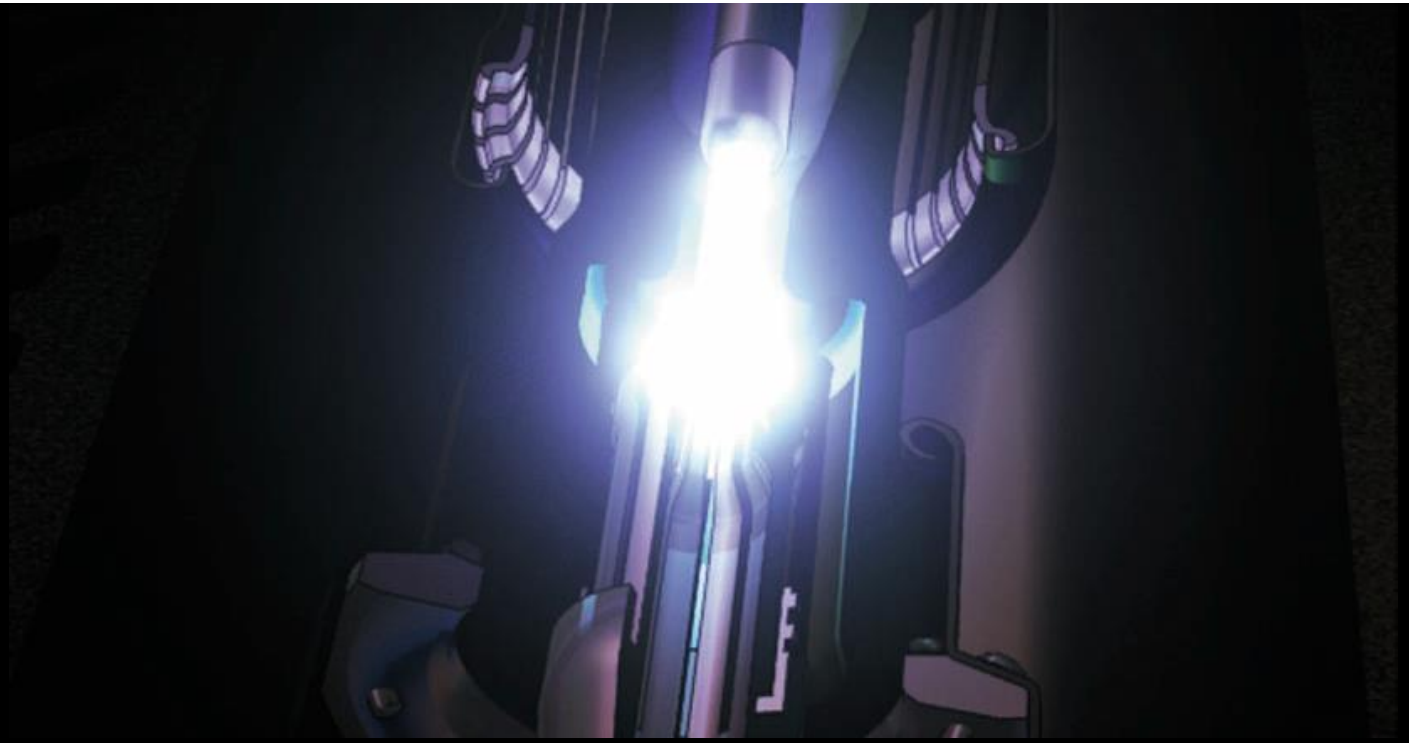

UNITED KINGDOM

- More than 3,400 units delivered
- 23,900 accumulated years in service!
- Applications all over the world

ABB is the most experienced supplier of controlled switching applications

Contents

- Controlled switching:
  - Benefits, Theory and Applications
- Introducing Switchsync™ PWC600
  - Product Description
- Switchsync™ PWC600
  - Customer Value
  - Field Experiences



Controlled Switching
Benefits, Theory and Applications

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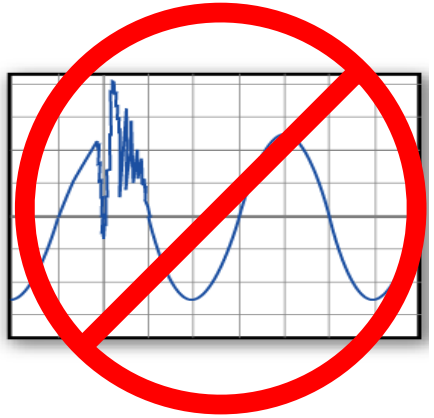
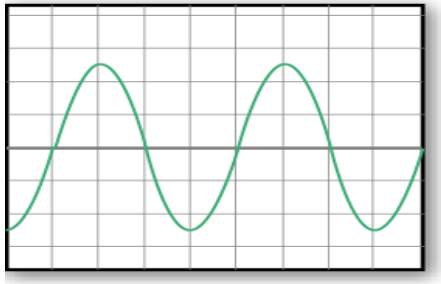
April 19, 2017 | Slide 6

Controlled Switching
Benefits

- Better power quality
  - Lower inrush currents
  - Lower voltage transients
- Longer service intervals for the circuit breaker
- Reduced electrical stress on substation equipment

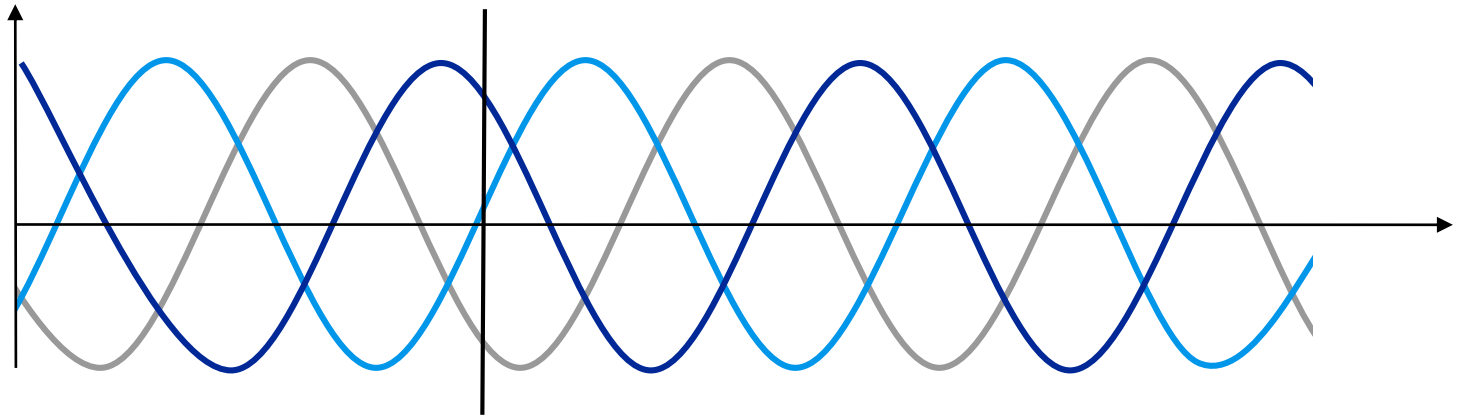
→ Cost savings





Controlled Switching
How It Works

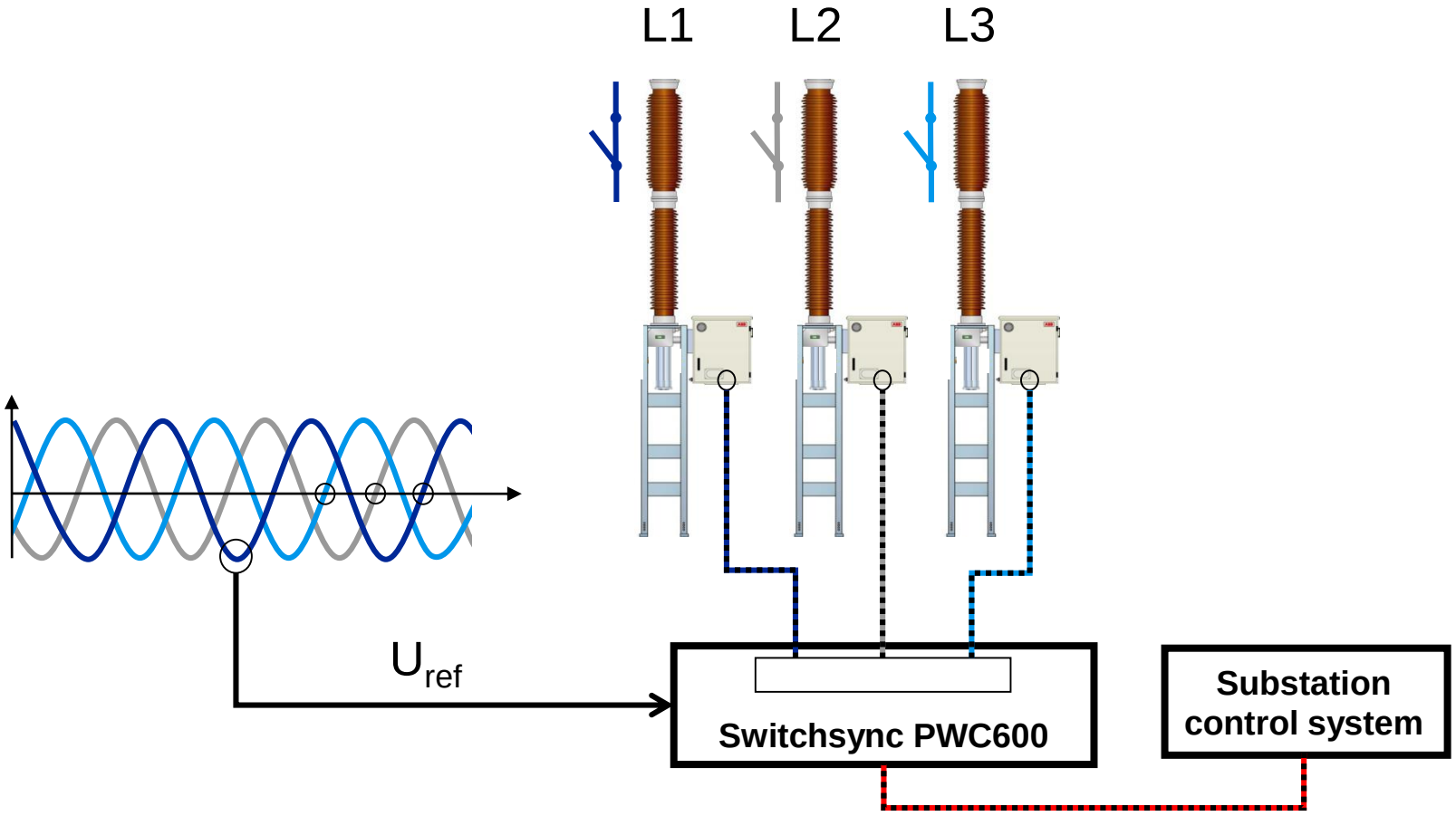
All three-phase systems have a 120 electrical degree phase shift between each phase.



A standard circuit breaker switches all three phases at the same time.

With controlled switching the phases are independently operated at the most favorable time instant for minimizing electrical transients

Controlled Switching
How It Works



Controlled Switching
Applications Overview

Capacitor bank

Minimize voltage and current transients

Shunt reactor

(Minimize inrush currents)

Prevent re-ignitions

Power transformer

Minimize inrush currents

Transmission line

Minimize overvoltages

Switchsync™ PWC600-M 1.0
Product Description

General description
Switchsync PWC600-M 1.0

- **Newest generation of point-on-wave controllers**
  - Based on the successful **Relion®** platform of protection and control products
  - Offers the **full functionality** and reliability of previous Switchsync products
  - Includes **Ethernet interfaces**, intended for use with communication protocols
  - **Enhanced functionality** (WHMI / LHMI) towards the user. Web HMI (based in browser), Local HMI (based in LCD). HMI = Human-Machine-Interface.
  - Designed for **single-pole operated** circuit breakers, controlling each pole to close and/or open at the point on wave that is optimal for the switched load, the circuit breaker, and/or power quality

- **Switchsync PWC600-M 1.0 controlled switching applications** (essential switching operation in parentheses)
  - Capacitor bank (energization near voltage zero, to avoid high inrush currents and voltage transients)
  - Shunt reactor (de-energization at optimal arcing time, to prevent re-ignitions)
  - Power transformer (energization for symmetrical magnetic flux, to avoid high inrush currents)
  - Transmission line or power cable (energization near voltage zero, to avoid high switching overvoltages)

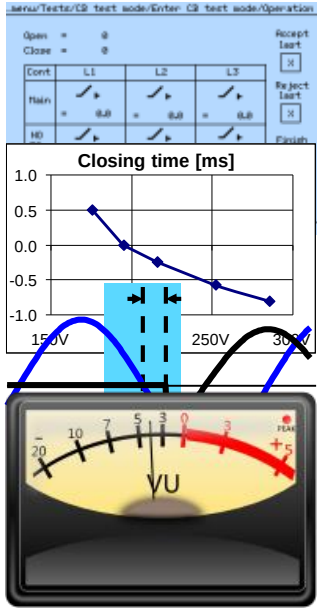
Switchsync PWC600-M 1.0
Main Features (1)

- Controlled closing and opening in one device for all common switching applications
- Accepts voltage and current signals from conventional voltage transformers / current transformers, and/or sampled values according to IEC 61850-9-2(LE) from electronic voltage or current transducers
- Web interface (WHMI) allows online viewing of operation data
- Station bus communication according to IEC 61850-8-1, including GOOSE messaging and Parallel Redundancy Protocol (PRP)
- Local interface (LHMI) including LCD, push-buttons, and LEDs, for direct access to settings and operation data
- Time synchronization: 1PPS (for IEC 61850-9-2), SNTP, IRIG-B

1PPS: Pulse per second signal/SNTP: Simple Network Time Protocol/IRIG.B: Inter-range Instrumentation Group.

- Setting wizard (PC based) for guided entry of application data
- Seamless integration in ABB's Protection and Control Manager PCM600

Switchsync PWC600-M 1.0
Main Features (2)



- Semi-automatic learning feature for acquisition of circuit breaker operating times, and detection of wiring errors, for faster commissioning.
- Possibility to compensate for common system variations (i.e. influence of control voltage, circuit breaker idle time, temperature, drive energy, etc) on switching times*
- Adaptive correction of systematic variations in switching times.
- Possibility to perform circuit breaker operation monitoring, based on auxiliary contact signals and current / voltage signals, no need for separate CB monitoring device*
- Stores waveforms of last 100 operations, and operation data of last 1000 operations
- *Additional feature not part of standard delivery

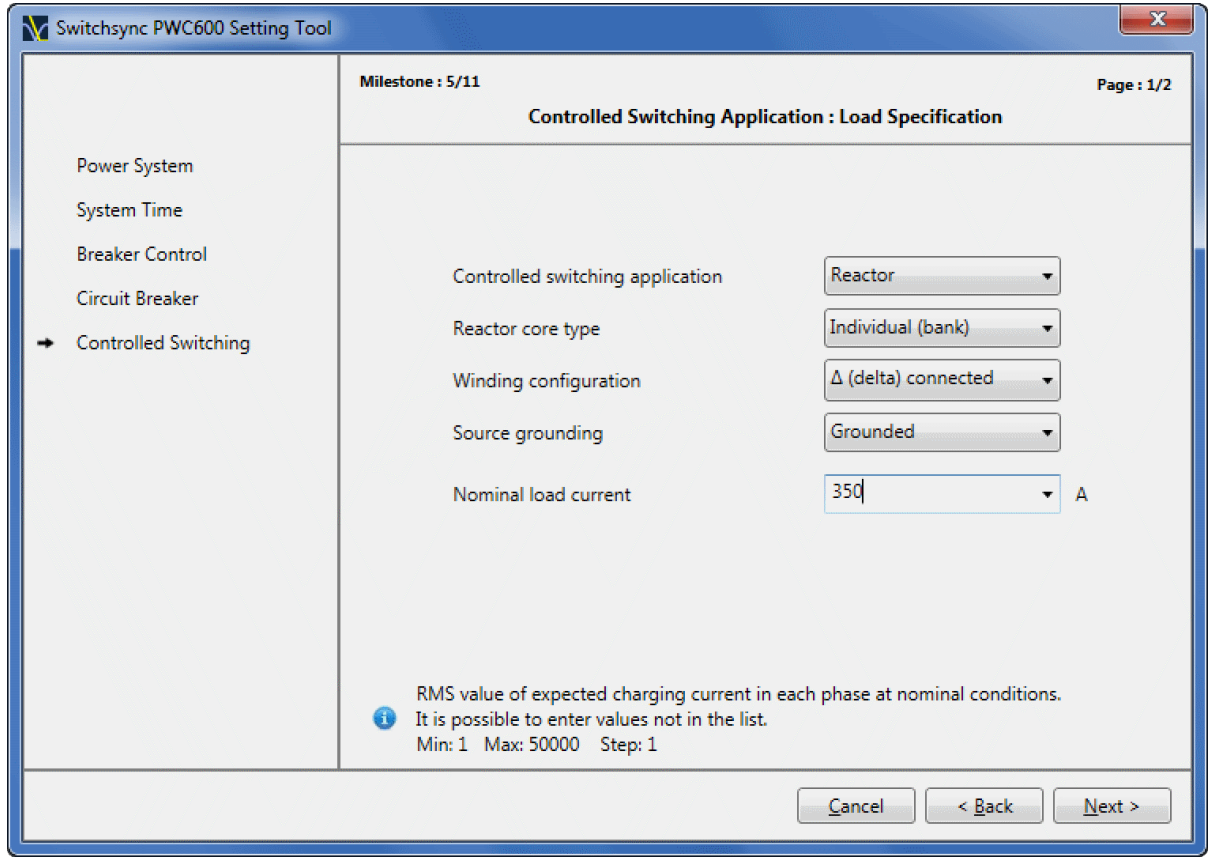
Controlled Switching with Switchsync PWC600
Circuit Breaker Properties

- ABB’s high-voltage circuit breakers are well suited for controlled switching:
  - Stable operating times
  - High and stable dynamic dielectric withstand capability (RDDS, RRDS)
- RDDS: Rate of Decrease of Dielectric Strength
- RRDS: Rate of Rise of Dielectric Strength
- Library of commonly used ABB circuit breakers included with Switchsync PWC600
  - Includes all relevant data for optimal controlled switching performance and condition monitoring
  - Possibility to add custom Circuit Breaker types and configurations by end user.

Controlled Switching with Switchsync PWC600
Application Engineering

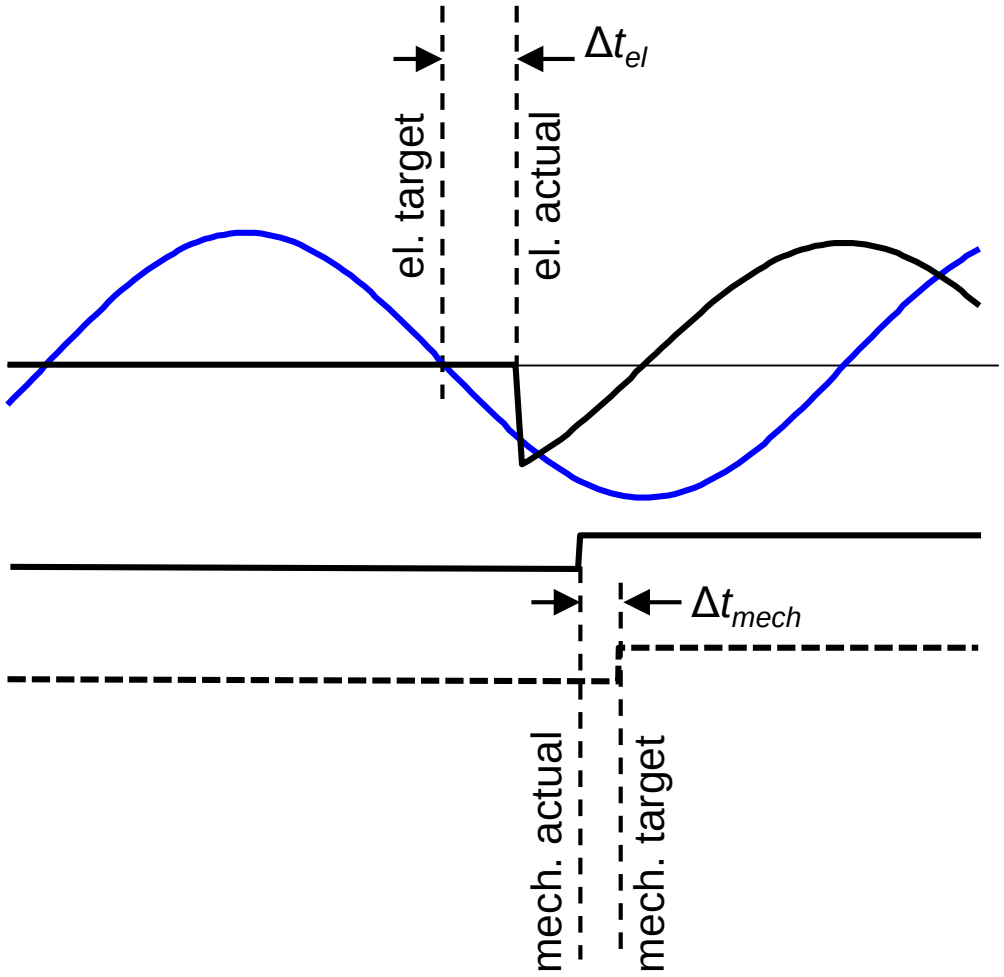
- **Switchsync PWC600 is focused on applications and engineering**
  - One pre-configuration for all controlled switching applications
  - Guided data entry by dedicated **Switchsync Setting Tool (SST)** software.
  - Maintains long-term accuracy of controlled switching operations through adaptive correction of switching times
  - Maintenance information of circuit breaker based on extensive recording and analysis of switching operations

Switchsync Setting Tool
Easy Configuration for All Controlled Switching Applications



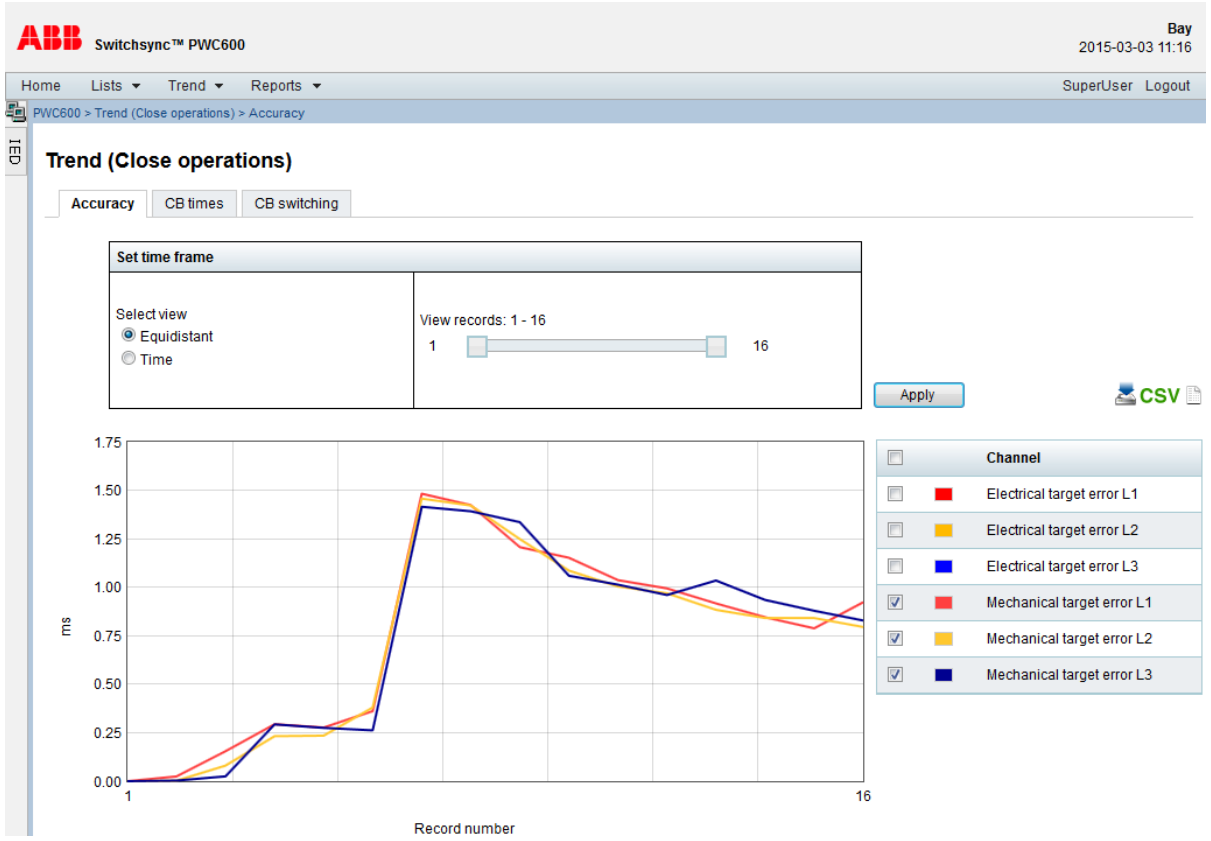
- Matched to specific application by settings
- Switchsync Setting Tool (SST)
  - Wizard-style tool for guided entry of data
  - Online explanation of each parameter
  - Immediate validation of entered data

Adaptive Correction of Switching Times
Maintaining Long-Term Accuracy of Controlled Switching



- Compensate for systematic changes (ageing, drift, etc)
- PWC600 assesses success of last operation, based on current or voltage signal (electrical) and auxiliary contacts (mechanical, if available)
- Internal correction values for tracking deviations in CB operating times are updated with every controlled closing operation based on measured deviation Δt
- Adaptive correction of opening times based on detection of re-ignition / re-strike

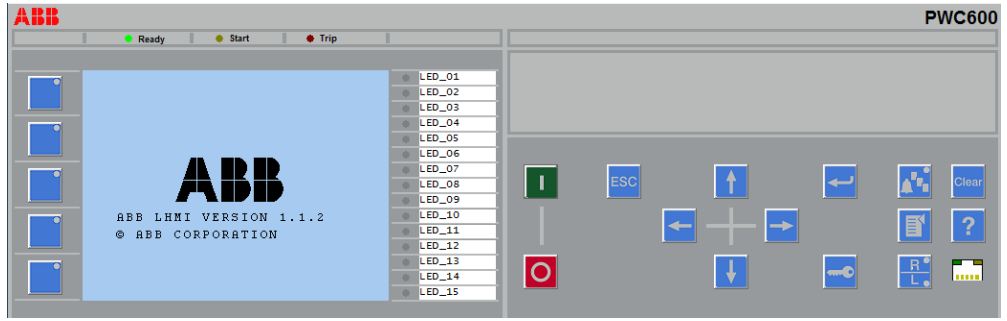
Recording and Analysis of Switching Operations
Providing Maintenance Information of Circuit Breaker



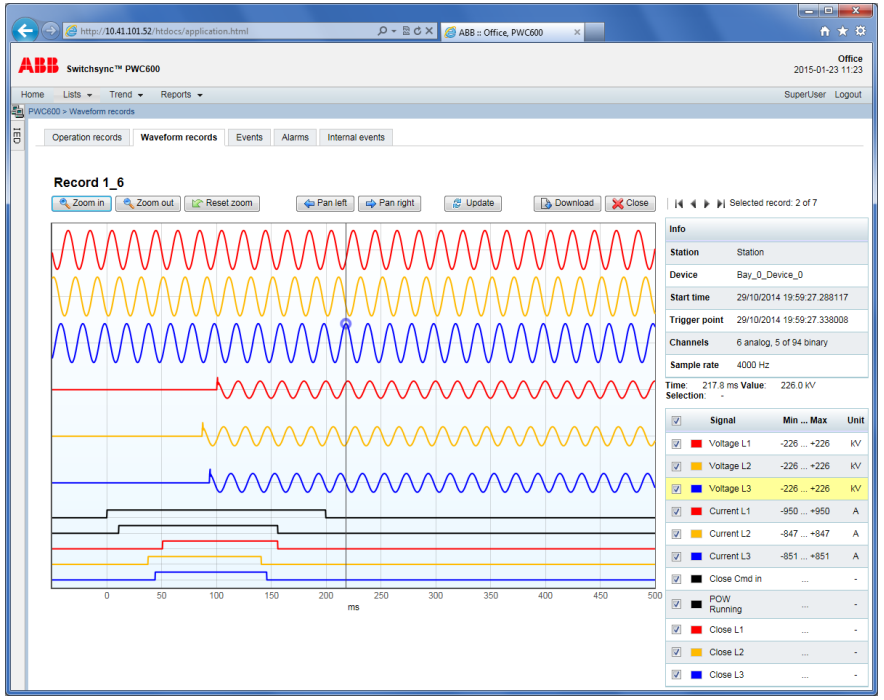
1. Monitoring of events and signal properties
   - e.g. instants of contacts changeover, current making, current interruption; current RMS
2. Derivation of performance parameters
   - Electrical and mechanical operating times
   - Occurrence of a disturbance, eg. re-ignition / re-strike
   - Operation count
3. Threshold supervision on any specified parameter
4. Warning is issued when performance is nearing threshold.
5. Alarm is issued when threshold is exceeded.
6. Graphical trends can point out developing issues

Switchsync PWC600-M 1.0
User Interfaces

Local Human-Machine Interface (LHMI)



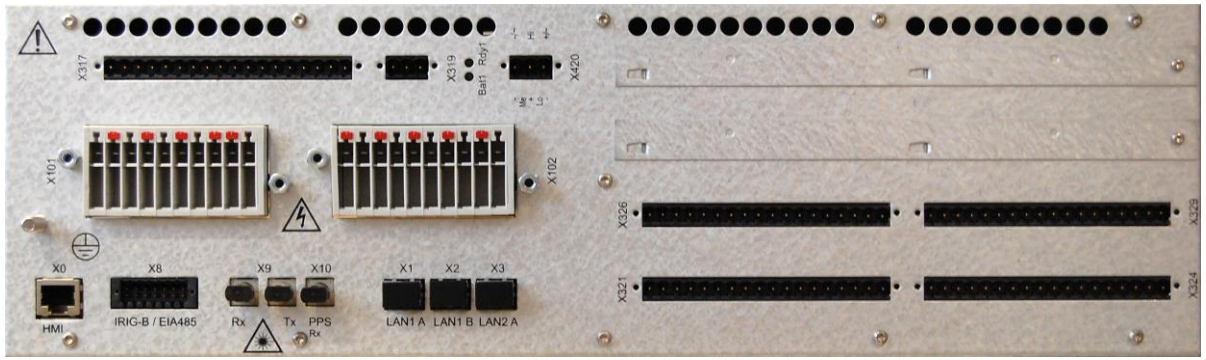
Web-HMI (any modern web browser)



SCADA via IEC 61850-8-1: CPOW, XCBR, etc.

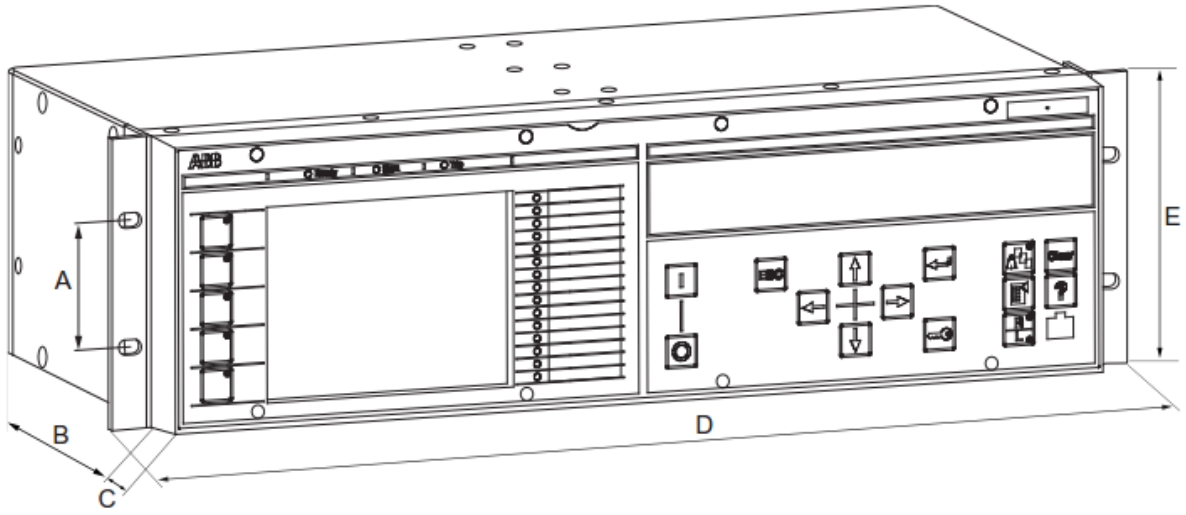
- Graphical display of waveforms and trend data
- Lists of operation records, events, alarm, etc.

Switchsync PWC600-M 1.0
Hardware Interfaces



- **2 command inputs (Close, Open)**
- **6 command outputs (3 Close, 3 Open)**
- 3 reference voltage transformer inputs
- **3 current transformer inputs**
- **3 load voltage transformer inputs (optional)**
- Ethernet interface (optical, LC) for IEC 61850-9-2(LE) process bus communication
- 2 Ethernet interfaces (optical, LC) for station bus communication including PRP redundancy
- Ethernet interface (electrical, RJ45) for local communication
- 10 binary outputs (relay contacts) for status/alarm indication
- 12 precision binary inputs for circuit breaker auxiliary contacts, main contacts, etc.
- Power supply 48…125 VDC or 110…250 VDC

Switchsync PWC600-M 1.0
Installation Data



- Dimensions w/o mounting brackets:
  442 x 132 x 249.5 mm
  (17.4 x 5.2 x 9.8”),
  for installation in 19” rack (3U high)
- Net weight: 10 kg (22 lbs)
- Protection class of enclosure: IP 21
- Ambient temperature:
  - -25…+55°C (-13…+131°F) continuous
  - -40…+70ºC (-40…+158°F) for <16 h

Switchsync™ PWC600
Customer Value

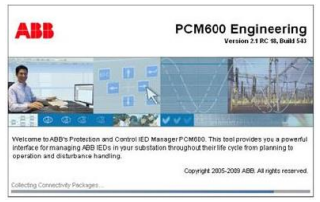
Customer Value
Reliability, Availability and Safety

- Switchsync PWC600 is ABB's newest generation of **point-on-wave controllers**, based on the successful **Relion® platform** of protection and control products. It is designed for **single-pole operated circuit breakers**, controlling each pole to close and/or open at the **point on wave** that is optimal for the switched load, the circuit breaker, or power quality.
- ABB's **high-voltage circuit breakers** are well suited for controlled switching due to their **excellent properties**, including stable operating times as well as high and stable dynamic dielectric withstand capabilities (RDDS, RRDS).
- Switchsync PWC600 provides the same high reliability, availability and safety of previous Switchsync products, **complying with highest requirements** of any ABB HV product.
- The **new set-up wizard** is guiding the entry of application data entry. A library of ABB circuit breakers is included containing all relevant data for optimal controlled switching performance and condition monitoring.

Customer Value
Flexibility

- Switchsync PWC600 increases the **flexibility with included Ethernet interfaces** acc. to
  - IEC 61850-8-1 station bus, including GOOSE messaging and Parallel Redundancy Protocol (PRP)
  - IEC 61850-9-2(LE) process bus, accepting voltage and current signals from conventional instrument transformers, and/or sampled values from electronic instrument transformers including time synchronization of 1PPS acc. to IEC 61850-9-2, SNTP, IRIG-B

Customer Value
Ease of use



- The **ease of use** is fundamentally increased with
  - **Local interface (LHMI)** including LCD, push-buttons, and LEDs, for direct access to settings and operation data
  - **Web interface (WHMI)** allows online viewing of operation data
  - **Setting wizard** (PC based) for guided entry of application data
  - Seamless integration in ABB's Protection and Control Manager PCM600

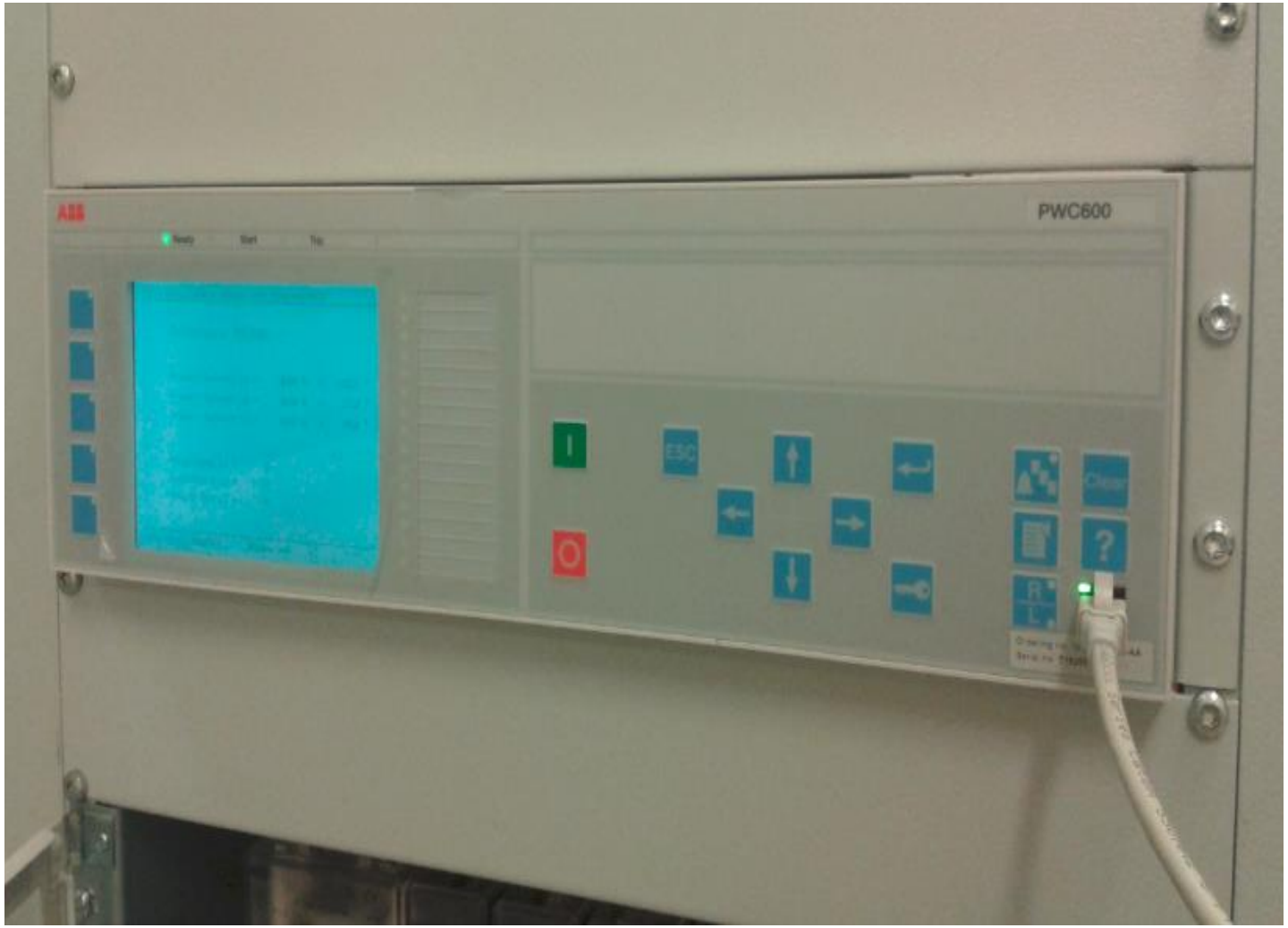
Customer Value
Ease of maintenance

- The **ease of maintenance** is strongly supported by
  - **Circuit breaker operations monitoring**, based on auxiliary contact signals and current / voltage signals providing maintenance information about interrupter wear and electrical as well as mechanical performance of drive and breaker
  - **Storing waveforms** of last 100 operations, **and operation data** of last 1000 operations enables trend analysis for easy supervision and maintenance scheduling.

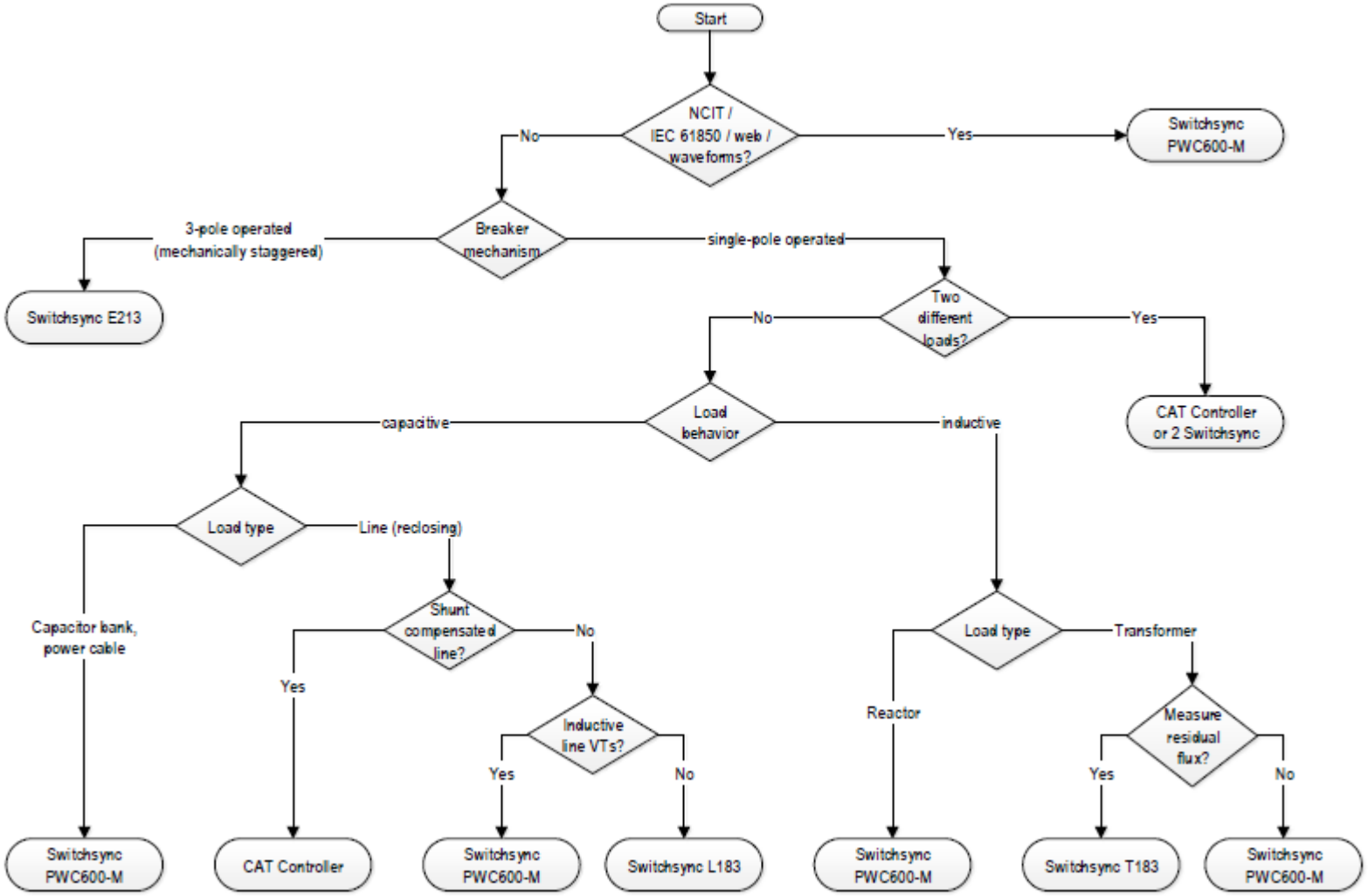
Field experiences

- First Switchsync PWC 600 commissioned in Sweden in November 2015 (400 kV Live Tank circuit Breaker, 150 MVAr shunt reactor application)
- Subsequent cases:
  - 300 kV, 98 MVAr Shunt Reactor (Germany)
  - Several power transformer applications (765/400 kV level) in India
  - Commissioning currently ongoing in Sweden. A total of 15 Switchsync PWC 600 will be installed and commissioned by summer 2016.
  - Capacitor bank application (400 kV level) planned for Germany in 2016.
  - Line Switching applications also planned by fall 2016
  - SAM? Colombia or Chile?

Switchsync PWC600-M 1.0
Installation Pictures



Switchsync PWC600-M 1.0



Switchsync PWC600-M 1.0

2.7 Technical aspects

2.7.1 Ambient conditions

PWC600 is designed for installation in an LCC, i.e. not directly on the switchgear.
Rated ambient conditions for operation are given in [1]. In particular, the ambient temperature should not exceed the range specified there. Note that this refers to the air surrounding PWC600, i.e. inside the LCC.

2.7.2 Circuit breaker

In principle, PWC600 will work with any circuit breaker whose drive is triggered by solenoids. This includes ABB drive types HMB, HMC, AHMA, BLG, BLK, and more. Drives without solenoids (e.g. motor drive) can also be used provided the interfaces for Close and Trip commands are electrically similar.

To optimize accuracy, PWC600 can compensate for changes of the mechanical switching times caused by variations in:

- control voltage
- temperature
- idle time
- drive pressure
- spring charge
- additional (user-defined) quantities

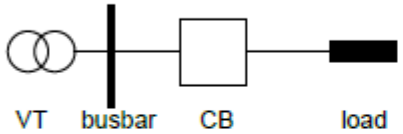
See also section 2.7.5 below.

Compensation curves and other relevant data of common ABB CB models are included in a CB library that is part of the PWC600 software. For CB types not in the library (ABB or other), these and other data can be entered manually, which is rather straightforward. Higher effort may be required for collecting the raw data. These services can be provided by ABB PPHV as an option, they should be charged based on actual effort.

Switchsync PWC600-M 1.0

2.7.3 Voltage transformers

For every load that is to be switched by PWC600, a voltage transformer (VT, PT, CVT) or voltage sensor must be available on the opposite end (source side) of the breaker – usually on the busbar. See the sketch below.



Usually a single-phase VT is sufficient but three-phase VTs can also be connected, which is beneficial to signal recording. Recommended VT accuracy class is 3P or better. Rated output voltage is given in [6].
For certain load types, it is recommended to connect a three-phase VT on the load side of the CB as well. See [6] for details.
Due to the very high impedance of the VT inputs, PWC600 may be connected in parallel to other secondary equipment.
Alternatively, digital voltage signals (sampled values) may be received from an IEC 61850-9-2(LE) compliant merging unit at 80 samples per cycle.

2.7.4 Current transformers

Wherever possible, it is recommended to connect the signals from a three-phase CT (in series with the controlled circuit breaker) or current sensor to PWC600. The current signals are used for adaptive correction of the operating times (except possibly for transformers and short lines/cables) and for monitoring. Rated input current under nominal load conditions is 0.5…5A; other values need to be considered individually.
For switching of capacitor banks or shunt reactors, measuring cores of accuracy class 5P (IEC) / 1.2 (ANSI) or better should be used. For switching of transformers or transmission lines or cables, protection cores of accuracy class 3P (IEC) / C (ANSI) or better should be used.
Due to the very low impedance of the CT inputs, PWC600 may be connected in series to other secondary equipment.
Alternatively, digital current signals (sampled values) may be received from an IEC 61850-9-2(LE) compliant merging unit at 80 samples per cycle.

Switchsync PWC600-M 1.0

2.8.3.1 Front panel (LHMI)

The front panel (LHMI = Local Human/Machine Interface) can be supplied in IEC style [3] or in ANSI style [4] (for the North-American market). The difference is in the labeling of certain pushbuttons.

IEC style (OL 8000)

ANSI style (OL 7000)

Note that even with ANSI-style front panel, the rest of the product (text strings in software, user documentation, etc.) is always provided in IEC style.

2.8.3.2 Power supply module

Upon ordering, the choice of power supply module must be specified.

Power supply module designation	Nominal supply voltage range(s)	Recommended supply voltage range
PSM02	48…125 V DC	48…110 V DC
PSM03	110…250 V DC, 100..240 V AC (50…60 Hz)	125…250 V DC

2.8.4 Shipping data

The complete shipping unit (box) has the dimensions 50.0 x 17.7 x 31.7 cm (19.7 x 7.0 x 12.5 inches) and weighs 11.5 kg (25.3 lbs).

Power and productivity
for a better world™

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