



SYNCHROTEQ® PLUS

DATASHEET



(19" Rack mount configuration shown here)

STP030000

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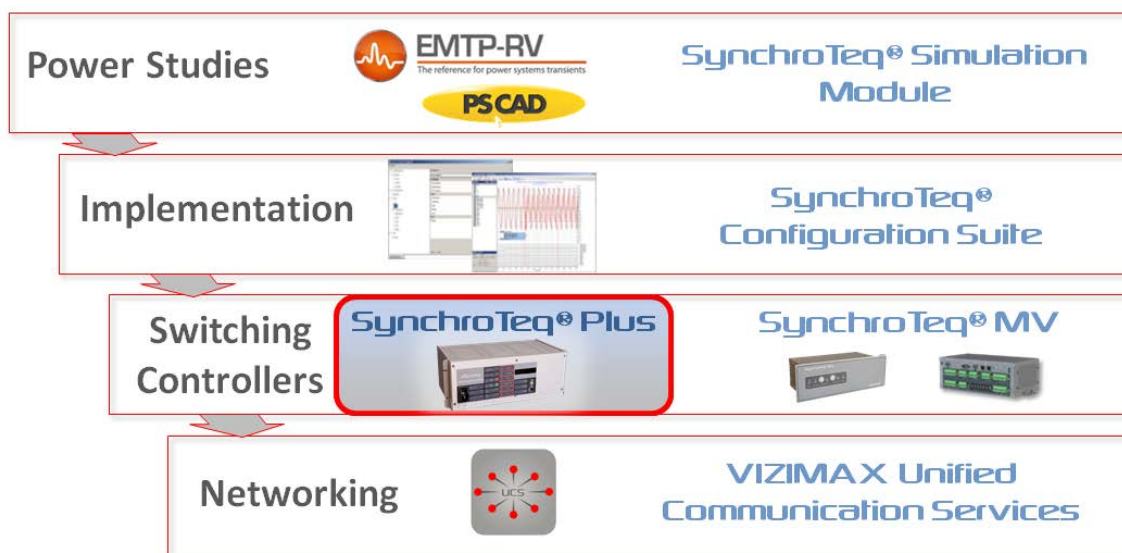
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PRODUCT OVERVIEW

SynchroTeq Plus is an extension of the SynchroTeq System Components aimed at HV, Extra High Voltage (EHV) and Ultra High Voltage (UHV) circuit breakers.



A compact Control Switching Device (CSD) for 1, 2 or 3 phase circuit breakers, the SynchroTeq Plus is specifically designed for load switching projects in HV, EHV and UHV.

The SynchroTeq Plus features a comprehensive set of Controlled Switching modes, and performs significantly well in a variety of HV, EHV and UHV applications as shown in Table 1 below:

TABLE 1 SYNCHROTEQ UNIT VS LOAD SWITCHING APPLICATION

Load Switching Application	SynchroTeq MV		SynchroTeq Plus	
	SynchroTeq MVR	SynchroTeq MVX	SynchroTeq Plus	SynchroTeq Plus + VL measurement
Discharged Capacitor Banks - MSC / MSCDN	☑		☑	
Shunt Reactors – MSR	☑		☑	
Power Transformers (Peak Voltage)	☑		☑	
Power Transformers (Residual Flux)		☑		☑
Power Transformers in Parallel (Residual Flux)*		☑		☑
Compensated / Uncompensated Transmission lines (any kV level)				☑
Cables (MV, HV, submarine)		☑	☑	
Partially Charged Capacitor Banks – MSC/FLT		☑	☑	
CB and a half (any kV level)			☑	☑
Voltage range	Up to 69kV		Up to EHV and UHV	

SynchroTeq Plus is also a manufacturer agnostic solution suitable for switchgears, circuit breakers (C/Bs) regardless of the make.

The appropriate circuit breaker / switchgear type and configuration must be carefully selected according to the considered load and application, as outlined in the following Table 2.

TABLE 2 CIRCUIT BREAKER / SWITCHGEAR TYPE VS LOAD SWITCHING APPLICATION

Load Switching Application	Circuit Breaker / Switchgear		
	Single Pole Operation (Independent poles)	Three Pole Operation w/ Pole Staggering	Three Pole Operation (Simultaneous poles)
Capacitor Banks - MSC / MSCDN Filter – SVC and STATCOM	☑	☑	
Shunt Reactors – MSR	☑	☑	
Power Transformers (Peak Voltage)	☑	☑	
Power Transformers (Residual Flux)	☑		☑
Power Transformers in Parallel (Residual Flux)*	☑		☑
Transmission lines	☑		
Cables	☑		

(*): Requires RWS055000 or TRAS

NOTE: A set of two or three unipolar switches or circuit breakers is eligible as a 1-p operated, two or three-phase switchgear configuration.

APPLICATIONS OF SYNCHROTEQ PLUS

The outstanding performance of SynchroTeq Plus devices apply to a variety of circuit breakers – regardless of the make – and can be leveraged for optimized switching of shunt reactors, discharged and partially charged capacitors bank, harmonic filters, power transformers, cables and transmission lines.

Among other applications, SynchroTeq Plus is a powerful, communication-enabled IED suitable for:

- **Power Grids:**

- Transmission lines energization
- HV, EHV and UHV power transformers in substations.
- Enhanced penetration of Renewable Energy.
- Grid connection of DERs: waste-to-energy, CHP...etc
- Capacitor bank switching.

- **HV Equipment / FACTS:**

- Fast-switching of capacitor banks (MSC), shunt reactor switching (MSR), harmonic filters (FLT) combined with power electronics (ie: hybrid STATCOMs).
- Energizing step-up transformers in Energy Storage systems.
- Capacitors bank switches for PF Correction/VAR Compensation.
- Advanced circuit breaker for power transformer energization.

- **Renewable Power Generation:**

- Wind: energizing power transformers, for inrush current/voltage drop mitigation, improved power delivery, connection to the grid, grid code compliancy, energizing step-up transformers in STATCOMs.
- Switching reactive loads, in standalone or in SVC/hybrid-STATCOM systems.
- Energizing power cables.

- **Conventional Power Generation:**

- Energizing power transformers in grid-scale waste-to-energy or CHP or genset or gas turbine projects.
- Energizing power transformers in off-grid power generation: gensets, gas turbines and more.
- Switching reactive loads.
- Energizing power cables.

- **Industry:**

- Electrical Arc Furnaces: transformer switching, MSC/MSR/FLT in SVC or STATCOM systems, reduction of switchgear wear, preservation and lifespan improvement of HV switchgears and transformers.
- Transportation & Railways: energizing power transformers for rectifiers and inverters in DC traction substations, capacitor banks for VAR Compensation.
- Oil&Gas: energizing power transformers with limited impacts of voltage disturbances/inrush currents on gensets, drives, power distribution. Capacitor bank switching, cables.

SYNCHROTEQ PLUS HIGHLIGHT

- For new or existing Circuit breakers
- CPU-demanding Apps and complex models
 - Transmission lines
 - Numerous compensation channels
 - Fast-switching of reactive loads
- Strong Engine, Web-based operation
 - Stores up to 2000 events and waveforms
- Best-in-class HV transformer energization
 - Residual flux calculation modules
 - Bushing sensors for transformer voltage measurements
- Additional Modules and Tools:
 - Bypass / Redundancy module
 - Floating SPSBO-F: Isolated coil outputs
 - Re-energization Advisory System (TRAS)
 - OPC UA server for SCADA and DCS in substation or in central sites.



CONTROLLED SWITCHING

SynchroTeq Plus units perform the controlled closing and/or opening of circuit breaker poles. They are applicable to multiple switchgear/circuit breaker types and operation modes:

- Three-pole switchgear with Single-pole operation / independent pole operation.
- Three-pole operation / simultaneous pole operation (ie: metal enclosed switchgears as per IEC62271-1, 100, 200)
- Three-pole operation with pole staggering,
- Unipolar switchgears in 1, 2 or 3 phase configurations (resulting in single-pole operation).

Closing/Opening switchgear poles at optimal angles (simultaneously or individually when feasible) results in a dramatic reduction of inrush currents, voltage transients and stresses, thus improving the quality of power delivery and preserving the health/lifespan of all HV assets such as switchgears, switched loads (power transformers, reactive loads, cables), and sensitive equipment (generators, power electronics incl. inverters, drives and more).

When receiving a command (OPEN or CLOSE) SynchroTeq Plus intercepts either a zero-crossing of the source voltage or a zero-crossing of the current, whichever is appropriate, for accurate switching synchronization. SynchroTeq Plus then computes and executes a delay/timer consisting of:

- A predicted switchgear operation time taking into account variations due to operating conditions, idle time, as well as timing measurements observed during previous operations (adaptive control for mechanical wear) and pole pre-arcing & arcing times (to avoid re-ignition while opening). When applicable, operation times are calculated for each individual pole.
- A synchronization delay.

Circuit breaker coil control output signals are then generated at very precise instants within the wave. The targeted electrical switching instants are determined according to the controlled switching strategy applicable to the considered load.

Contrary to conventional CSDs, the SynchroTeq Plus not only achieves “fixed switching strategies” (targeting predetermined switching angles – or fixed settings) but also performs advanced switching strategies with on-the-fly computation of optimal target angles according to relevant information retrieved in real time from the load status/environment.

In example, SynchroTeq Plus performs dynamic target angle calculations in the following contexts:

- **Power transformers:** switching angles are derived from voltage acquisition and Residual Flux Calculation, making it a highly effective inrush current limiter for energizing HV power transformers through 1-p as well as through 3-p operated switchgears/circuit breakers.
- **Partially charged Capacitors or Filters:** switching angles are derived from voltage acquisition and computation of trapped charges, making it possible to fast-switch capacitor banks and filters (ie: enabling an instantaneous restoration of reactive capacity, or the execution of fast C-O-C cycles in bursts without capacitor discharge).

CIRCUIT-BREAKER ELECTRICAL WEAR MONITORING FUNCTION

SynchroTeq Plus measures the electrical wear of the circuit breaker at each operation (i^2t), including protection and local switching operations. The i^2t value for each phase is reported in the switching operation event. The accumulated electrical wear for each phase is also computed and stored in the unit and displayed by the web interface.

SynchroTeq Plus is not only a CSD, but also a circuit breaker monitoring tool that drastically reduces the C/B maintenance costs by allowing for scheduling maintenance only when required due to excessive wear.

OPERATING ENVIRONMENT

SynchroTeq Plus can be installed in the low voltage/control compartments of switchgears, as well as in control & relay rooms, or in independent enclosures. It is therefore offered in three housing versions for easy integration in various applications (see MOUNTING CONFIGURATIONS for details). SynchroTeq Plus is typically connected to the following subsystems:

- DC power supply: uninterruptible power source for the substation / switchgear control and protection equipment.
- Controlled HV, EHV and UHV switchgear or circuit breaker: control outputs, statuses/pole positions.
- Protection relays.
- AC measurements: system/source voltage, load current, as well as load voltage when applicable.
- Condition measurements: temperature or pressure transducer when applicable.
- Local control panels, networked SCADA/DCS systems, network infrastructure: switchgear or C/B control in substations or in equipment.

DISCHARGED / PARTIALLY CHARGED CAPACITOR BANKS, SHUNT INDUCTANCES, FILTERS AND CABLES

SynchroTeq Plus is intended for the controlled switching of shunt reactors, discharged capacitor banks, harmonic filters, power cables, power transformers, all based on fixed switching angle strategies. But **SynchroTeq Plus** also features AC voltage measurement channels suitable for the acquisition of residual charges trapped in capacitive loads such as partially charged capacitor banks or harmonic filters. Re-closing angles are dynamically computed to match the residual charge, thus avoiding voltage disturbances/inrush currents and allowing for fast-switched MSC applications.

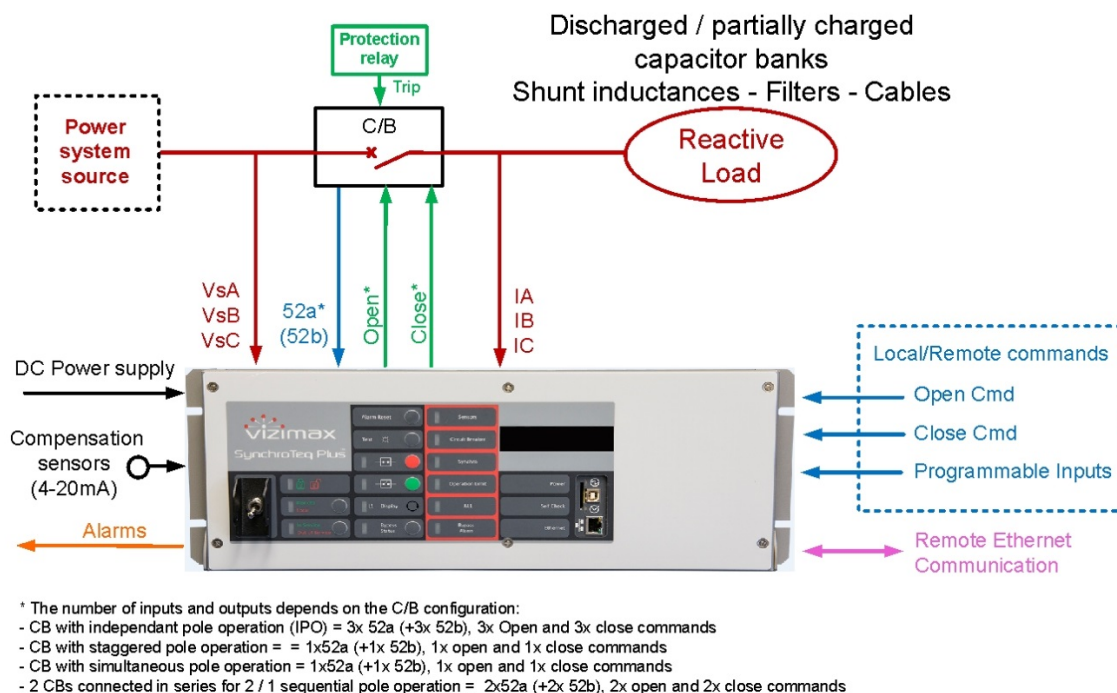
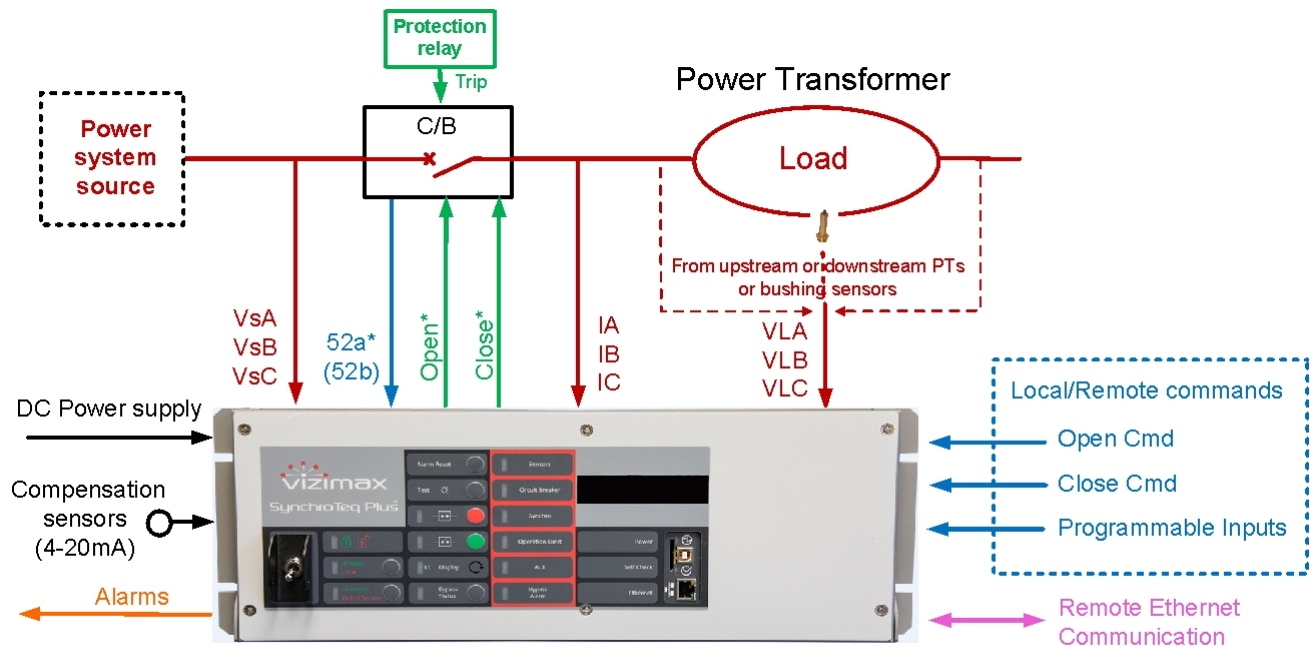


FIGURE 1 DISCHARGED / PARTIALLY CHARGED REACTIVE LOAD

ENERGIZING POWER TRANSFORMERS WITH RESIDUAL FLUX MANAGEMENT

SynchroTeq Plus features AC voltage measurement channels for the acquisition of power transformer voltage (from primary or secondary winding) and residual flux calculation for each phase. When re-energizing, the optimal closing angle is derived from the residual flux in transformer's core for the mitigation or elimination of the inrush currents.



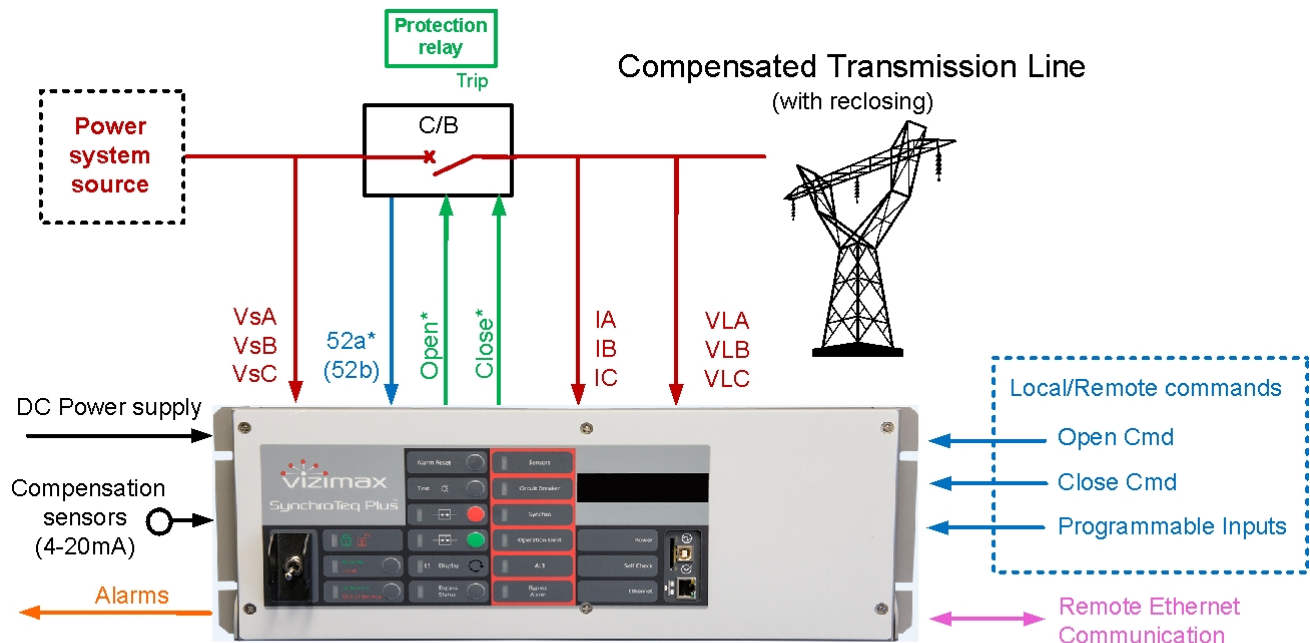
* The number of inputs and outputs depends on the C/B configuration:

- CB with independant pole operation (IPO) = 3x 52a (+3x 52b), 3x Open and 3x close commands
- CB with staggered pole operation = 1x52a (+1x 52b), 1x open and 1x close commands
- CB with simultaneous pole operation = 1x52a (+1x 52b), 1x open and 1x close commands
- 2 CBs connected in series for 2 / 1 sequential pole operation = 2x52a (+2x 52b), 2x open and 2x close commands

FIGURE 2 EXAMPLE OF SYNCHROTEQ PLUS FOR ENERGIZING A POWER TRANSFORMER

ENERGIZING UNCOMPENSATED AND COMPENSATED TRANSMISSION LINE

SynchroTeq Plus controls the energization of uncompensated and compensated transmission line to minimize the switching overvoltage both during line energization and re-closing. Mitigating the switching overvoltage during line energization is particularly desirable in EHV systems where the switching surge voltage is the determining factor for insulation coordination of the lines. Furthermore, SynchroTeq Plus reduces the possibilities of CB re-strikes during voluntary line de-energization. During line energization, it also decreases the line inrush current to almost the steady-state current value.



* The number of inputs and outputs depends on the C/B configuration:

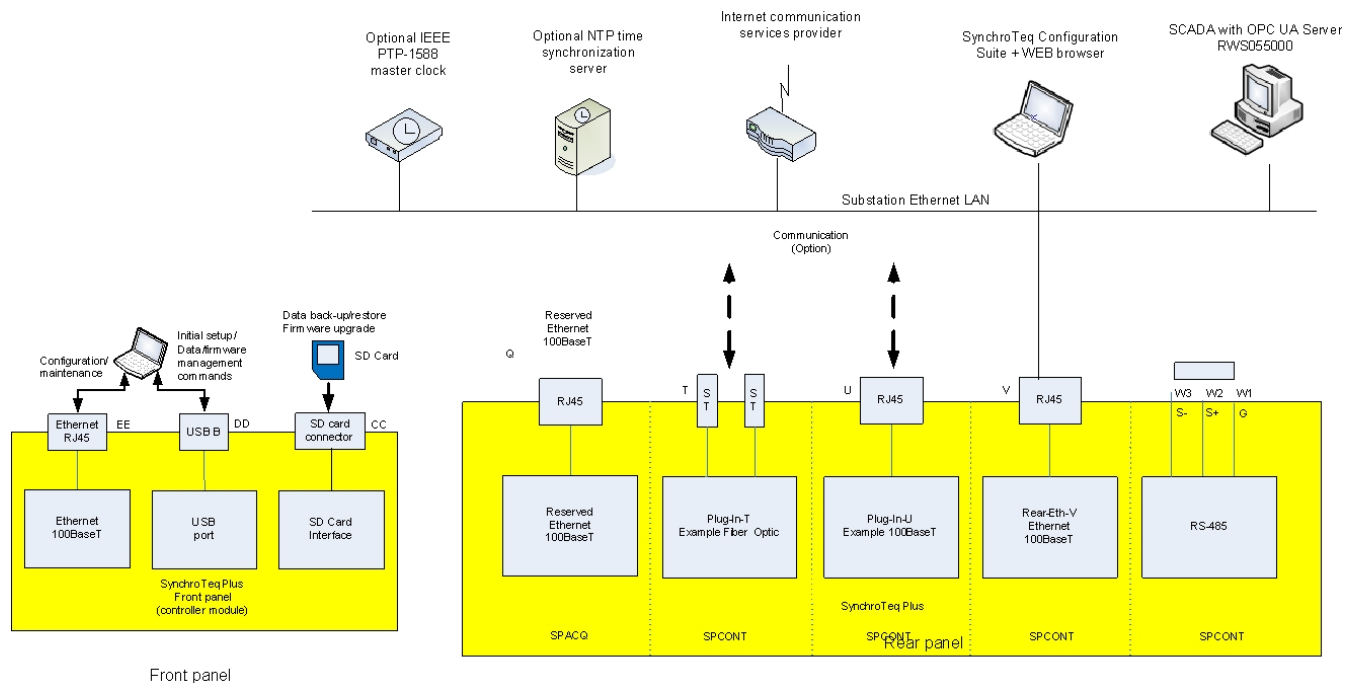
- CB with independent pole operation (IPO) = 3x 52a (+3x 52b), 3x Open and 3x close commands
- CB with staggered pole operation = 1x52a (+1x 52b), 1x open and 1x close commands
- CB with simultaneous pole operation = 1x52a (+1x 52b), 1x open and 1x close commands
- 2 CBs connected in series for 2 / 1 sequential pole operation = 2x52a (+2x 52b), 2x open and 2x close commands

FIGURE 3 EXAMPLE OF SYNCHROTEQ PLUS FOR ENERGIZING A COMPENSATED TRANSMISSION LINE

COMMUNICATION LINKS – TIME SYNCHRONIZATION - SOFTWARE

All SynchroTeq Plus units feature built-in communication ports for network integration and external devices:

- 2x 100Base-T Ethernet ports
 - One in front panel for maintenance
 - One in rear panel for general use
- 2x optional Ethernet ports 100BASE-FX, 100BASE-LX10 or 100BASE-T on rear panel
- 1x serial port on rear panel
 - 1x RS-485 serial for local service operation (console port)



TIME SYNCHRONIZATION

The SynchroTeq Plus time synchronization can be achieved with either:

- PTP-1588 (IEEE Standard Precision Time Protocol) service over the Ethernet network. Supported profile is: "PTP/IEEE-1588v2 UDP/IPv4, Multicast, End-to-End, Slave Only".
- IRIG-B time synchronization protocol using the optional RWC0Y0000 module over either:
 - BNC connector with a compliant IEC 60044-8 TTL signal
 - Fiber optic ST type connector with a compliant IEC 61869-9 signal

The IRIG-B supported formats are:

- IRIG-B000/B004 IEEE C37.118
- IRIG-B000/B004 IEEE-1344
- IRIG-B003
- NTP (Network Time Protocol) service over the Ethernet network
- Protocol using the optional SynchroTeq Communication module RWK000016.

Any one of these approaches allows to time stamp recorded operational events for remote data analysis.

FRONT PANEL / LOCAL HMI - REMOTE CONTROL

SynchroTeq Plus can be managed locally (front panel and built-in HMI) and/or remotely through either:

- The SynchroTeq web-based operation interface (requires a web-browser)
- Local PC computers/servers with optional licenses of the Vizimax Unified Communication Services (RWS055000)
- Remote PC computers/servers with optional licenses of the Vizimax Unified Communication Services (RWS065000)
- Substation automation protocols: requires the optional SynchroTeq Communication Module (RWK000016)
- Dry contacts (commands) and relay outputs (statuses).

OPC UA SERVERS (RWS0x5000) - PC/SERVER COMMUNICATION SOFTWARE FOR SCADA/DCS

The VIZIMAX Unified Communication Services install on PC or Server platforms (MS Windows), within the local network (LAN) or at Control Centers, and make it easier to retrieve statuses, events, waveform recordings, files from VIZIMAX SynchroTeq Plus and SynchroTeq MV units.

When used on local PCs/Servers in substations, the VIZIMAX Unified Communication Services makes it possible to fully control SynchroTeq Plus and SynchroTeq MV units in real time.

The SynchroTeq data model (status/control/measurement/calculations) is published and shared using the OPC UA protocol and is made available for easy integration and control of SynchroTeq platforms in SCADA or DCS environment.

The VIZIMAX Unified Communication Services leverage non-proprietary yet highly secure HTTPS communication and tunnelled protocols thus enabling two-way transfer and store operations between computers/servers and SynchroTeq units over a variety of local/remote communication infrastructure, and are run and controlled as background services.

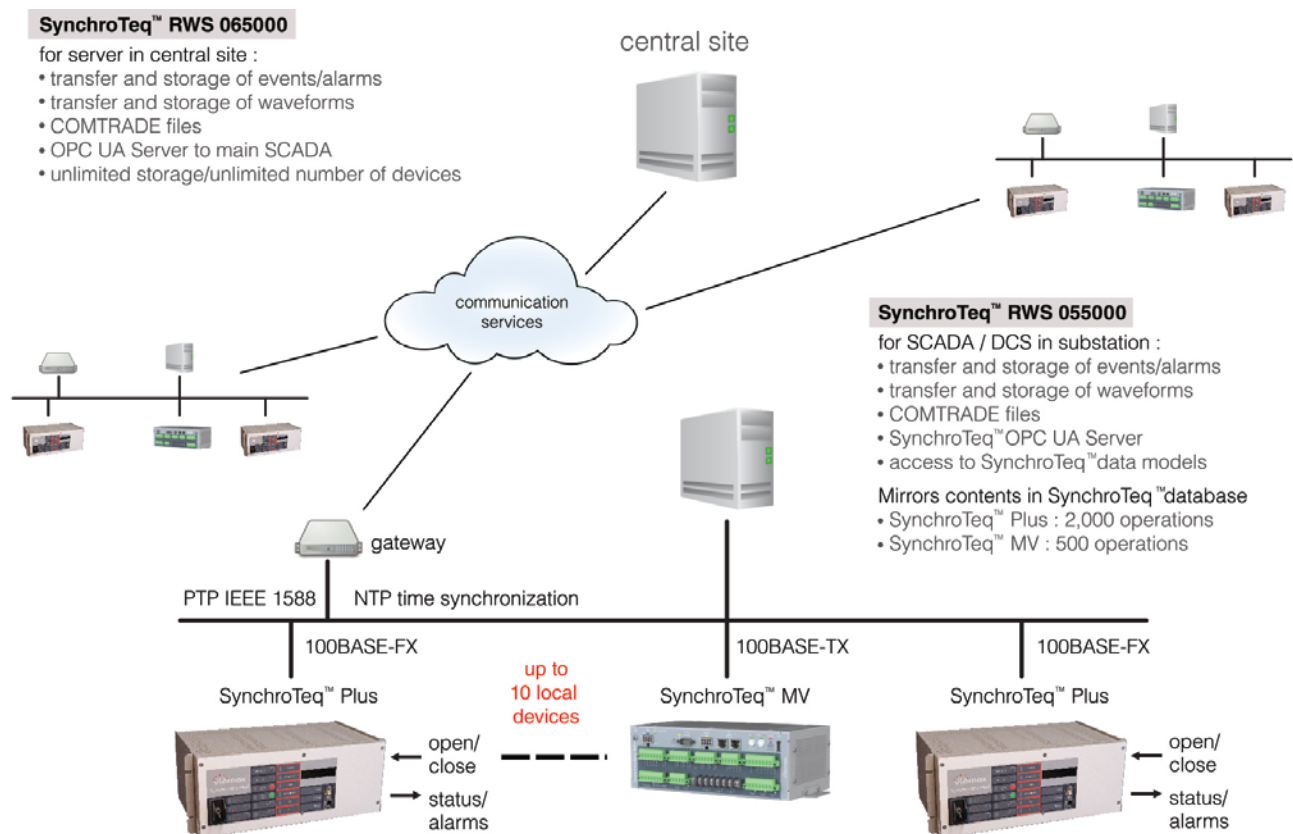


FIGURE 4 VIZIMAX UNIFIED COMMUNICATION SERVICE – OPC UA SERVERS

The VIZIMAX Unified Communication Services allow for:

- Transfer and store of statuses, events/alarms, waveform recordings and COMTRADE files from a limited (RWS055000) or an unlimited (RWS065000) number of SynchroTeq Plus and SynchroTeq MV units over IP-based communication networks.
- Automatic download and archive of SynchroTeq Plus and SynchroTeq MV contents. Data contents from limited (RWS055000) or unlimited (RWS065000) numbers of switching events (SynchroTeq Plus and SynchroTeq MV) are collected and stored. In substations (RWS055000) data contents mirror the current contents of local SynchroTeq Plus and SynchroTeq MV units. In Control Centers/Central Sites (RWS065000) the stored data volumes will be only capped by the available storage capacity.
- Seamless integration of SynchroTeq Plus and SynchroTeq MV data models in central SCADA or HMI solutions in control rooms through OPC UA Server interface and rich data management features allowing for real-time control, exchange, visualization and event generation from statuses, commands, parameters, set points, calculated data.
- The most appropriate communication and data refresh rate with respect to the available network infrastructure and performances (on-demand/manual, timed, scheduled).

Please contact your VIZIMAX representative for more details on the VIZIMAX Unified Communication Services software (RWS055000 and RWS065000).

SYNCHROTEQ COMMUNICATION MODULE (OPTION RWK000016)

For application requiring substation protocol such as DNP3, Modbus, IEC 60870-5-101 & -104 or IEC 61850 protocols, VIZIMAX offers an optional SynchroTeq Communication Module (RWK000016).

Please contact your VIZIMAX representative for more details on the SynchroTeq Communication Module (RWK000016).

SYNCHROTEQ CONFIGURATION SUITE AND WEB INTERFACE

The SynchroTeq Configuration Suite is a user interface for configuring and operating the SynchroTeq product family. This multi-language software is composed of the following components:

- PC based configuration tool software for operation parameters (SynchroTeq Configurator);
- VIZIMAX Event Analyzer waveform viewer, which displays the waveform captured by SynchroTeq (COMTRADE format) for operation and functional analysis;
- USB port driver for the SynchroTeq product family;
- Documentation in PDF format

The SynchroTeq Configurator is used to customize the operation of the SynchroTeq Plus and its Web interface using system and application configuration files. It supports both offline and online modes of operation and provides features to exchange these configuration files with the SynchroTeq Plus unit. Typically, the configuration files are designed and managed offline on a maintenance PC and are uploaded to the SynchroTeq Plus as part of the system commissioning.

The VIZIMAX Event Analyzer is a COMTRADE compatible enhanced waveform viewer that displays the waveforms and the C/B operation simultaneously.

SYNCHROTEQ WEB INTERFACE

The unit status, alarms, readings values and event list can be displayed on any PC using a Web browser such as Internet Explorer or Firefox. The SynchroTeq Plus Web interface is secured (https://) and access is granted only to authenticated users.

The SynchroTeq Web interface is dedicated for remote operation, control and analysis of the SynchroTeq units. The Web interface offers several dedicated panels:

- **Dashboard:** This page displays real time status of the SynchroTeq unit, the circuit breaker and the load.
- **Details:** This page provides access to detailed statuses, including the SynchroTeq and C/B alarms and the C/B operating time predictions.
- **Events:** List of the most recent 2000 events recorded and stored in the SynchroTeq Plus.
- **Snapshot:** List of the most recent waveform captures manually triggered by the user.
- **System:** System page used to manage the SynchroTeq configuration files and provides hardware information.

EVENTS AND WAVEFORM RECORDING

At each switching operation, SynchroTeq Plus records current and voltage waveforms including the C/B interface signals (52a/52b/Trip/Close/inputs/commands) over a period of 1250 ms (250 ms pre-trigger). These waveforms are part of the events list which includes alarms and operations performed on the unit (for example, alarm reset, in/out of service). Each event includes the SynchroTeq Plus's complete status and operating environment to allow for detailed further analysis. The SynchroTeq Plus has a memory capacity of 2000 events, including waveforms.

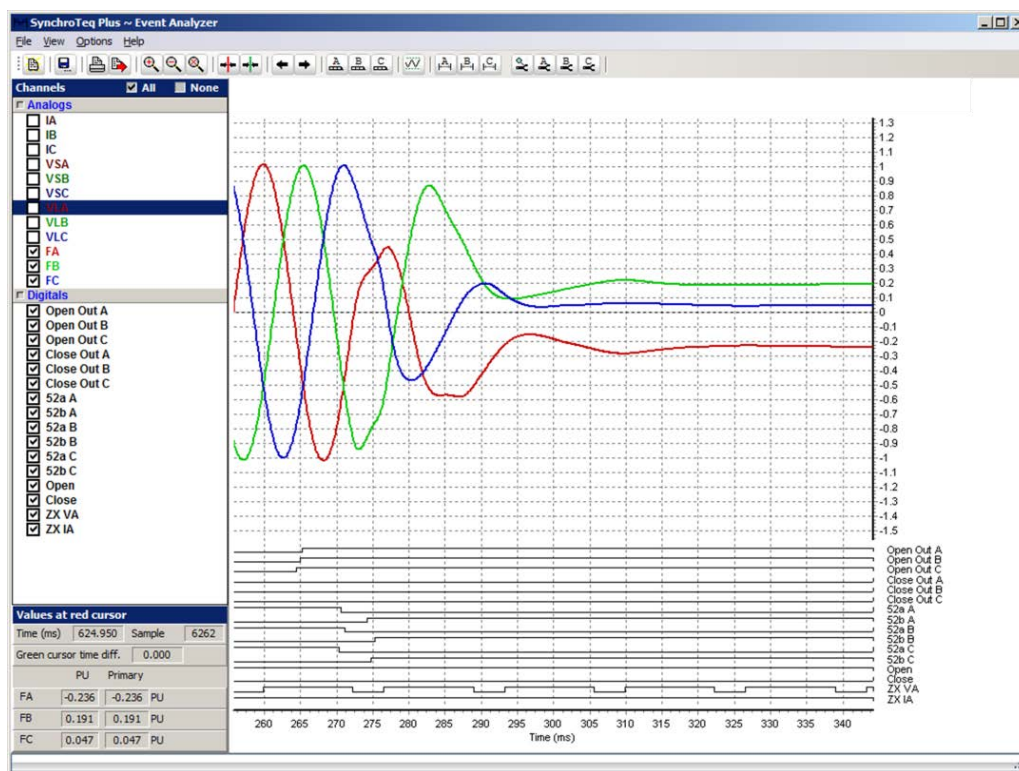
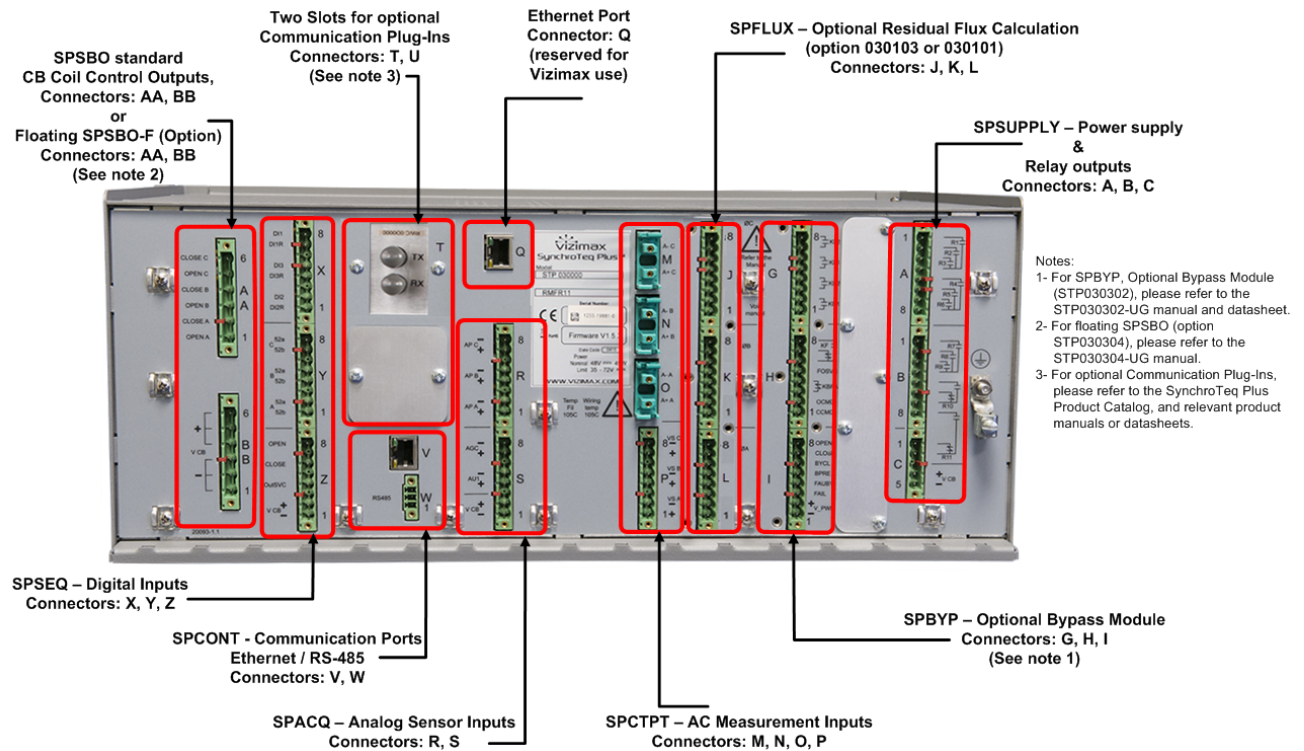


FIGURE 5 VIZIMAX EVENT ANALYZER

SYNCHROTEQ PLUS CONNECTORS AND HMI IDENTIFICATION

BACK PANEL CONNECTORS IDENTIFICATION



FRONT PANEL USER INTERFACE



TECHNICAL SPECIFICATIONS

COMPLIANCE AND CERTIFICATIONS



ENVIRONMENTAL

Climatic	Standard	Level
Cold	IEC 60068-2-1	Tests Ad: -50 C 16hr.*
Dry Heat	IEC 60068-2-2	Tests B: +70 C 16hr.*
Damp Heat	IEC 60068-2-30	+55C, 95% R.H. 6 cycles 144 hr.
Ingress Protection	IEC 60529	IP30
Maximum Altitude	MEAS CAT III	2000 m
Storage temperature		-50 to +85 °C

* See Temperature Derating Table

MECHANICAL STRESS

Mechanical Stress	Standard	Level
Sinusoidal Vibration	IEC 60068-2-6 IEC60255-21-1	Class2 Tests Fc: 10 to 150 Hz at 1.0G Response 1 sweep/axis Class1 Withstand 20 sweep / axis
Shocks	IEC 60068-2-27 IEC 60255-21-2	Class1 Withstand 5g/11ms (3) Repetitive bump 10g/16ms (1000) Response 15g/11ms (3)
Seismic	IEC 60255-21-3	Method A , class 1
Drop & Topple	IEC 60068-2-31	Drop 100mm Edge/Corner/Face

ELECTROMAGNETIC COMPATIBILITY (EMC)

Emissions	Standard	Level
Radiated Emissions	EN55011,22 CISPR 11, 22 60255-26 FCC	Class A 30MHz-1GHz (FCC part15: 2010 B, up to 2GHz)
Conducted Emissions	EN55011 CISPR 11	Class A 150kHz - 30MHz

Immunity	Standard	Level
Radiated Immunity	IEC 61000-4-3 IEC 61000-6-5 IEC 60255-26	Level 3 10V/m (80MHz - 1GHz) 80%modulated (1 kHz)
Radiated Immunity	IEC 61000-4-3 IEC 61000-6-5 IEC 60255-22-3 IEC 60255-26	Level 3 10V/m (1.4 – 2.7GHz) 3V/m (5.15 - 5.75GHz)
Conducted Disturbance, HF	IEC 61000-4-6 IEC 61000-6-5 IEC 60255-22-6 IEC 60255-26	Lev.3 10 Vrms (150kHz - 80 MHz) 80% modulated (1 kHz)
Conducted Disturbance, LF	IEC 61000-4-16 IEC 61000-6-5 IEC 60255-26	Level 4 30V & 300V Short term Power Line Freq. 60Hz Only
Surge Immunity	IEC 61000-4-5 IEC 60255-22-5 IEC 61000-6-5 IEC 60255-26	Level 4 LN-PE 4KV , L-N 2Kv I/O: 40Ohm-0,5uF
D.C. Power Ripple	IEC 61000-4-17 IEC 61000-6-5 IEC 60255-11 IEC 60255-26	Level 3 10% UT – 10min.
D.C. Power Voltage Dip & Interrupts	IEC 61000-4-29 IEC 61000-6-5 IEC 60255-11 IEC 60255-26	Level 3 Dips. 0, 40, 70% UT Slow variations 60 sec.
Electrostatic Discharge	IEC 61000-4-2 IEC 60255-22-2 IEC 61000-6-5 IEC 60255-26	Level 4 8KV Contact / 15kV Air Discharge.
Fast Transient	IEC 61000-4-4 IEC 60255-22-4 IEC 61000-6-5 IEC 60255-26	Level 4 4 kV 2.5kHz (Power Supply) 2 kV 5.0kHz (Other) 2kV 100kHz
Power Magnetic Field	IEC 61000-4-8 IEC 61000-6-5 IEC 60255-26	Level 4 30A-m continuous 300A-m short term

SURGE WITHSTAND CAPABILITY (SWC)

	Standard	Level
Impulse Voltage	IEC 60255-5 IEC61180-1	OVC CAT IV 5KV 1.2/50 μ s - 500Ohm
Insulation Dielectric Insulation Resistance	IEC 60255-5 IEC61180-1	2000V _{RMS} – 1 minute 100M Ω @500Vdc
Oscillatory Wave, High Frequency Disturbance	IEC 61000-4-18 IEC 60255-22-1 IEC 61000-6-5 IEC 60255-22-6	Level 3 2.5 kV CM/1kV DM (1 MHz/400 Hz) 200 Ω 1min. duration +/- polarity

SAFETY

	Standard	Level
Safety (Phase1)	IEC 61010-1 (Test & measurement)	Complete evaluation performed by Regulatory Agency: Nemko CB Report TR230362, IEC 61010 2nd edition
Safety (Phase 2) w/ Bypass card and Active Junction Box options	IEC 61010-1 (Test & measurement)	Complete evaluation performed by Regulatory Agency: UL IEC Report E362524-A2-IT-1, IEC 61010 2nd edition Equipment marked CE, c-UL-us

TEMPERATURE DERATING

Specifications		Standards	Value
Temperature range	Operating temperature	IEC 60068-2-1	-50 to +70 °C
		IEC 60068-2-2	
		IEC 61010-1	-40 to +55 °C for UL applications

MEAN TIME BEFORE FAILURE (MTBF)

Specifications	Value
MTBF	13 years estimated

POWER SUPPLY

The SynchroTeq Plus power supply (**SPALIM**) module input is set according to the voltage option selected at order: 48, 110, 125 or 220-250 Vdc.

Characteristics	Value
Overvoltage category	OVC CAT III
Maximum power consumption	45 W
Polarity inversion	No damage

48 V_{DC}

Characteristics	Value
Voltage range	36 Vdc to 72 Vdc
Tolerance to power interruption (IEC 61000-4-29)	Short voltage interruption and voltage variation of 30 %, 60 % and 100 % 100 ms

110 V_{DC}

Characteristics	Value
Voltage range	88 Vdc to 140 Vdc
Tolerance to power interruption (IEC 61000-4-29)	Voltage dip 30% Short voltage interruption and voltage variation of 60 % and 100 % No impact 100 ms

125 V_{DC}

Characteristics	Value
Voltage range	104 Vdc to 140 Vdc
Tolerance to power interruption (IEC 61000-4-29)	Voltage dip 30% Short voltage interruption and voltage variation of 60 % and 100 % No impact 100 ms

220-250 V_{DC}

Characteristics	Value
Voltage range	180 Vdc to 280 Vdc
Tolerance to power interruption (IEC 61000-4-29)	Short voltage interruption and voltage variation of 30 %, 60 % and 100 % 100 ms

CONTROL AND COMMUNICATION

CONTROLLER

Parameter	Value
Main processor	3x independent CPU boards features : 32-bit, 384 MHz
OS	Linux
Memory	1024 MB Flash memory / 128 MB RAM
Real time clock	±3 ppm initial accuracy. Stability is ± 5 ppm across the complete operating temperature range. Autonomy is 300 hours without power (no battery required)
RTC synchronization	IRIG-B protocol using the optional RWC0Y0000 module LAN synchronization: NTP or IEEE 1588 (see Note) or SynchroComm (RWK000016)
Field upgrade	Field upgradable firmware available from VIZIMAX web site, support section

NOTE: Several different configurations (profiles) are defined with the PTP-1588 protocol. SynchroTeq Plus supports version 2 using UDP (layer 3) as defined by: "PTP/IEEE-1588v2 UDP/IPv4, Multicast, End-to-End, Slave Only".

LOCAL USER INTERFACE

Parameter	Value
Eight push buttons (Front panel)	<ul style="list-style-type: none"> - Remote / Local - In service / Out of service - Alarm Reset - Test - Circuit breaker control (Open / Close) - Display refresh - Bypass status
Fifteen DEL (Front panel)	<ul style="list-style-type: none"> - Lock / Unlock - Remote / Local - In service / Out of service - Open circuit breaker - Close circuit breaker - Alarms (x2) - Sensor alarm - Circuit breaker alarm - Synchronization alarm - Operation limit alarm - Bypass module alarm - Alarms - Power - Self Check

COMMUNICATION PORTS

Port	Characteristics	Value
USB Front panel	Interface compatibility	2.0
	Maximum speed	480 Mbit/sec
	Connector type	Type B
	Voltage isolation level	N/A
SD card Front panel	Interface	2.0 high speed
	Connector Type	SD/SDHC board
	Voltage isolation level	N/A
100Base-T Ethernet Front panel	Interface	10/100 Mbps
	Connector name	Front-Eth
	Connector type	RJ-45
100Base-T Ethernet Rear Panel	Interface	10/100 Mbps
	Connector type	RJ-45
RS-485 serial Rear Panel	Connector family	Phoenix MC 1.5/..-STF 3.81 mm
	Connector type	Pluggable terminal block with screw flange, cage clamp

The SynchroTeq Plus supports up to two (2) additional optional communication ports on rear panel:

- **RWC0D0000** : 100BASE-FX Ethernet on Multimode Fiber Optic with ST Connector
- **RWC0P0000** : 100BASE-LX10 Ethernet on Single mode Fiber Optic with LC connector
- **RWC0C0000** : Isolated 100BASE-Ethernet with RJ45 connector

AC MEASUREMENTS INPUTS

Measuring inputs are defined by IEC Standard 61010 (Safety – Equipment for measurement, control, and laboratory use):

- Measurement category 3 is marked as MEAS CAT III (Highest expected transient voltage = 2.5 kV).
- Measurement category 4 is marked as MEAS CAT IV (Highest expected transient voltage = 4 kV)

Overvoltage category 3 is marked as OVC CAT III.

The SynchroTeq Plus **SPCTPT** module inputs are used to measure the C/B current using current transformers (CTs), and the source (line or bus) voltage using potential transformers (PTs).

CT INPUTS

Characteristics		Value
Number of inputs		3
Connector type		Auto-shorting pluggable connector, screw clamp
Current	Rated current	1 A or 5 A
	Saturation current	2 x I _n
	Maximum current for 1 second	20 x I _n
Measurement category		MEAS CAT III
Max Burden	At rated current I _n = 1 A/5 A	0.1 VA/1 VA
Asymmetrical current	During 100 ms	100 %
	Reading after 100 ms	80 %
Nominal frequency		50 Hz or 60 Hz
Bandwidth (-3 dB)		3.5 Hz to 4 KHz
Sampling frequency		10,000/s
Conversion resolution		16 bit
Full scale	Accuracy at 23 °C	0.3 %
	Rated noise level	0.15 %
Zero crossing detection	Range (frequency)	10 to 70 Hz
	Range (current)	5 % to 200 % I _n
	Accuracy	10 µs
Insensitivity to harmonic contents		Up to 7 % I _n for 2nd to 10th harmonics
Crosstalk isolation between channels		76 dB minimum

PT INPUTS

Characteristics		Value
Number of inputs		3
Rated voltage		100 Vac, 110 Vac, 120 Vac, 100/ $\sqrt{3}$ Vac, 110/ $\sqrt{3}$ Vac, 120/ $\sqrt{3}$ Vac
Thermal capacity (1 minute)		167 Vac
Measurement category		MEAS CAT III
Maximum Burden		1 VA
Nominal frequency		50 Hz or 60 Hz
Bandwidth (-3 dB)		3.5 Hz to 4 KHz
Sampling frequency		10,000/s
Conversion resolution		16 bit
Full scale	Accuracy at 23 °C	0.3 %
	Rated noise level	0.05 %
Zero crossing detection	Range (frequency)	10 to 70 Hz
	Range (voltage)	37.5 % to 150 % Vn
	Accuracy	10 μ s
Insensitivity to harmonic contents		Up to 50 % Vn for 2nd to 10th harmonics
Crosstalk isolation between channels		84 dB minimum

ADDITIONAL THREE PHASE VOLTAGE MEASUREMENT REQUIRED FOR POWER TRANSFORMER AND TRANSMISSION LINE SWITCHING APPLICATIONS

The function boards (**SPFLUX** module) are used to calculate optimum C/B closing time based on the residual flux in the transformer core after the transformer is de-energized or to measure the transmission line voltage. The residual flux measurement option reduces the inrush current to a magnitude comparable to the magnetization current. SynchroTeq Plus calculates the residual flux from the voltage measurement on the transformer winding or measure the transmission line voltage using either PTs or from high voltage bushing sensors installed on the test tap of the power transformer's bushing or on the test tap of the shunt reactor.

There are two function boards' versions:

- **Acquisition & Residual Flux Calculation Module** for PT with 3 x Analog Inputs (STP030103): Three (3) additional PT inputs, plus three (3) 4 to 20 mA inputs. The 4 to 20 mA inputs can be used for two-wire sensor monitoring.
- **Acquisition & Residual Flux Calculation Module** for High Voltage Bushing Sensors (STP030101): Three (3) additional High Voltage Bushing Sensors inputs suitable for VIZIMAX bushing sensors. For power transformer application, the residual flux calculation is made using measurements from the bushing sensors.

ACQUISITION & RESIDUAL FLUX CALCULATION MODULE FOR PT W/ 3 X ANALOG INPUTS (STP030103)

PT inputs

Characteristics	Value
Number of inputs	3
Input operating range	57 Vac (or $100/\sqrt{3}$ Vac) to 120 Vac
Measurement category	MEAS CAT III
Thermal capacity (1 minute)	167 Vac
Maximum Burden	3 VA
Rated frequency	50 Hz or 60 Hz
Bandwidth (dc component included)	0 to 3.6 KHz
Sampling frequency	10,000/s
Conversion resolution	16 bit
Full scale accuracy at 23°C	0.5 %
Full scale rated noise level	0.1 %

4 to 20 mA inputs

Characteristics	Value
Number of inputs	3
Input operating range (4 to 20 mA nominal)	0 to 25 mA
Temperature measurement range	-50°C to +80 °C
Sensor supply	24 Vdc / 60 mA provided by the SPFLUX card
Measurement category	MEAS CAT III
Temporary overvoltage for 2 seconds	50 Vac
Input impedance	220 Ω
Independent power supply loop numbers	3
Bandwidth (dc component included)	0 to 3.6 KHz
Sampling frequency	10,000/s
Conversion resolution	16 bit
Full scale accuracy at 23°C	0.5 %
Full scale rated noise level	0.2 %

ACQUISITION & RESIDUAL FLUX CALCULATION MODULE FOR VIZIMAX BUSHING SENSORS (STP030101)

Bushing sensor inputs

Characteristics	Value
Number of inputs	3
Voltage operating sensor range	4 to 20 mA
Transformer bushing sensor supply	24 Vdc provided by the SPFLUX card
Measurement category	MEAS CAT III
Temporary overvoltage for 2 seconds	50 Vac
Input impedance	220 Ω
Independent power supply loop numbers	3
Bandwidth (dc component included)	0 to 3.6 KHz
Sampling frequency	10,000/s
Conversion resolution	16 bit
Full scale accuracy at 23°C	0.5 %
Full scale rated noise level	0.2 %

4 to 20 mA inputs

Characteristics	Value
Number of inputs	3
Input operating range (4 to 20 mA nominal)	0 to 25 mA
Temperature measurement range	-50°C to +80 °C
Sensor supply	24 Vdc / 60 mA provided by the SPLUX card
Measurement category	MEAS CAT III
Temporary overvoltage for 2 seconds	50 Vac
Input impedance	220 Ω
Independent power supply loop numbers	3
Bandwidth (dc component included)	0 to 3.6 KHz
Sampling frequency	10,000/s
Conversion resolution	16 bit
Full scale accuracy at 23°C	0.5 %
Full scale rated noise level	0.2 %

DC MEASUREMENT INPUTS

The SynchroTeq Plus acquisition (**SPACQ**) module performs the following functions:

- Monitor C/Bs using analog measurements (SF6 pressure, hydraulic pressure, temperature) from 4 to 20 mA sensors connected to the apparatus. Each analog input provides features to calibrate and define the operating range for alarming (sensor alarm).
- Predict the C/B operating time influenced by external conditions such as the ambient temperature, isolation gas or drive mechanism pressures. The compensation is done from the analog inputs and can be activated or deactivated through the system configuration

4 TO 20 mA ANALOG/COMPENSATION INPUTS

Characteristics	Value
Number of inputs	5
Operating range (4 to 20 mA nominal)	0 to 25 mA
Input impedance (resistive)	220 Ω
Temporary overvoltage for 2 seconds	50 Vac
Measurement category	MEAS CAT III
Frequency response (-3 dB)	0 to 3 Hz
Full scale accuracy at 23 °C	2 %
Full scale rated noise level	1 %
Sensor supply	24 Vdc/60 mA

C/B COIL VOLTAGE COMPENSATION INPUT

Characteristics	Value
Number of inputs	1
Rated voltage	0 Vdc to 300 Vdc
Input impedance (resistive)	166 K Ω
Overvoltage category	OVC CAT III
Frequency response (-3 dB)	0 to 3 Hz
Full scale accuracy at 23°C	0.5 %
Full scale rated noise level	0.05 %
Polarity inversion	no damage

SYNCHROTEQ PLUS INTERNAL TEMPERATURE MONITORING

Characteristics	Value
Number of sensors	1
Operating range	-55 °C to +85 °C
Frequency response (-3 dB)	0 to 3 Hz
Full scale accuracy	1 %
Full scale rated noise level	0.5 %

DIGITAL INPUTS AND OUTPUTS

DIGITAL INPUTS

The **SPSEQ** module is a processor circuit board with 12 opto-isolated digital inputs as follows:

- Six inputs for the C/B position (52a/52b contacts)
- Two inputs for the control of the C/B (OPEN/CLOSE commands)
- One input to force the SynchroTeq Plus Out of Service
- Three isolated general purpose contact inputs for C/B monitoring (for example, SF6 lock-out contact, heater contact and low pressure alarm)

Characteristics		Value			
Number of inputs		12			
Number of supervised inputs with opto-coupler tests		9			
Rated voltage		48 Vdc	110 Vdc	125 Vdc	220 -250 Vdc
Input voltage range	For idle state	24 Vdc	69 Vdc	69 Vdc	150 Vdc
	For active state	31 Vdc	87 Vdc	87 Vdc	173 Vdc
Maximum input Voltage		72 Vdc	150 Vdc	150 Vdc	280 Vdc
Overvoltage category		OVC CAT III			
Maximum Burden		1 W			
Typical Input Impedance	48 Vdc, 110 Vdc (min, max)	24 K Ω , 49 K Ω			
	110 Vdc, 220 Vdc (min, max)	70 K Ω , 170 K Ω			
Capacitive coupling rejection		Cx >0.5 μ F			
Protection against grounding		Yes			
Polarity reversal		no damage			
Activation delay	For OPEN and CLOSE inputs	2 ms			
	Of other inputs (max)	0.15 ms			

CIRCUIT BREAKER COILS COMMAND OUTPUTS

The SynchroTeq Plus **SPSBO** module drives the circuit breaker (C/B) coils and has the following characteristics:

Characteristics	Value
Number of outputs	6
Output driver technology	Solid State, Select Before Operate (SBO)
Rated voltage	48 Vdc, 110 Vdc, 125 Vdc, 220-250 Vdc
Overvoltage category	OVC CAT III
DC rated continuous current (tmax= 300 s)	5 A
Maximum making current (tmax=5 ms)	35 A
Maximum breaking current (L/R=0 ms)	20 A
Maximum breaking current when (L/R=40 ms)	20 A
Over current supervision	45 A
Maximum output leakage current	1 mA
Voltage Burden	5 Vcc
Output activation time	10 ms to 100 ms (Programmable increments of 10 ms) 100 ms to 1000 ms (Programmable increments of 100 ms)
C/B coil supervision	3 mA

NOTE: The optional floating **SPSBO-F module** (STP030304) provides 6 potential free isolated solid state outputs. These outputs are designed to “push” the current or to “pull” the current from the C/B coils connected to the positive bus or to drive a C/B electronic controller that has floating inputs. This option allows for isolating the open and close circuits, powered by different power supplies.

SIGNALING OUTPUTS

Up to 11 electromechanical relays are provided to signal alarm conditions to external devices such as RTUs and annunciators. They can also drive the external bypass logic when the SynchroTeq Plus is defective or out of service.

The signaling outputs have the following functions:

- **R1:** For bypass unit
- **R2:** C/B opening alarm
- **R3:** C/B closing alarm
- **R4:** Reserved
- **R5:** Controlled opening problem
- **R6:** Controlled closing problem
- **R7:** Local mode
- **R8:** Circuit breaker interface alarms
- **R9:** Sensor alarms
- **R10:** Out of Service
- **R11:** SynchroTeq Plus Failure

Parameter		Value
Number of outputs		11
Rated voltage		24 Vdc to 300 Vdc
Minimum operation voltage		24 Vdc
Overvoltage category		OVC CAT III
Rated current	At 125 Vdc	0.3 A
	At 300 Vdc	0.2 A
Current	Maximum making ($t_{max.} = 200\text{ ms}$)	1 A
	Maximum breaking ($L/R = 40\text{ ms}$) at 125 Vdc	0.3 A
	Maximum leakage	0.02 mA

FUNCTIONAL ANALYSIS TOOLS

WAVEFORM CAPTURE

Parameter	Value
Memory capacity	Up to 2000 events (waveforms are stored in events)
Capture trigger	C/B commands from SynchroTeq Plus (OPEN and CLOSE) Voltage changes on switched side of C/B (for residual flux calculation on power transformer applications) Manual trigger using snapshot capture
Sampling rate	167 samples/cycle at 50 Hz and 60 Hz
Recording time	1250 ms with 250 ms pre-trigger
Recorded signals	Voltages from PTs on unswitched side of C/B (3) Load current (3) Option: Voltages on switched side of C/B (3) Option: Residual flux calculation (3) C/B control commands (3 x Open, 3 x close) C/B position contacts (3 x 52a, 3 x 52b) SynchroTeq Plus command inputs (OPEN and CLOSE) Phase A synchronization (1 x I, 1 x V)

EVENT MEMORY

Parameter	Value
Memory capacity	2000 events, including waveforms when applicable
Recording trigger sources	C/B commands from SynchroTeq Plus Voltage changes on switched side of C/B (for residual flux calculation on power transformer applications) Status change (local/remote, in/out of service, cold start, reset, etc.) Alarms (self-check, sensors, C/B timing problems, C/B interface problem, loss of synchronization signal, etc.) Configuration changes (new parameters) Operation failure (rejected commands) Manual waveform capture Operation commands to SynchroTeq Plus (alarm reset, operation counters reset, set residual flux, etc.)
Search and display filtering capabilities	The event display can be filtered using one or the combination the following criteria: By event sequential number By date By type (open command, close command, residual flux calculation, sensor problem, etc.) By alarm type (sensor out of range, excessive inrush current, synchronization loss, etc.)
Time tagging display resolution	1 millisecond with time zone management
Time tagging synchronization	IRIG-B clock source Using the optional IRIG-B RWC0Y0000 module: <ul style="list-style-type: none"> - IRIG-B000/B004 IEEE C37.118 - IRIG-B000/B004 IEEE-1344 - IRIG-B003 NTP time server on Ethernet IEEE PTP 1588 clock source on Ethernet Manual synchronization from PC computer
Real time clock autonomy	Approximately 1 week without power (protected with maintenance free super capacitor)

MOUNTING CONFIGURATIONS

SynchroTeq Plus is available in a 19" 'Rackmount' (RM) or in 'Stand-alone' (SA) configuration.



The SynchroTeq Plus unit is cooled by convection; it does not have a built in fan. For this reason, install the SynchroTeq Plus unit well away from any heat producing equipment

NOTE: The SynchroTeq Plus is equipped with an internal temperature sensor used to determine if the system is operated outside its rated operating range (-40°C to +75°C).

PHYSICAL DIMENSIONS

Specifications	Value
Width	444 mm/17.5 inch for standard; 483 mm/19 inch for Rackmount installation
Height	4 UM (modular units: 177 mm/7 inch)
Depth	299 mm (12 inch)
Weight	7.5 kg (16.5 lbs.) with optional Residual flux and Bypass options

RACKMOUNT CONFIGURATION

The SynchroTeq Plus rackmount (RM) model is installed on an EIA 482.6 mm (19 in) rack in the substation control building.

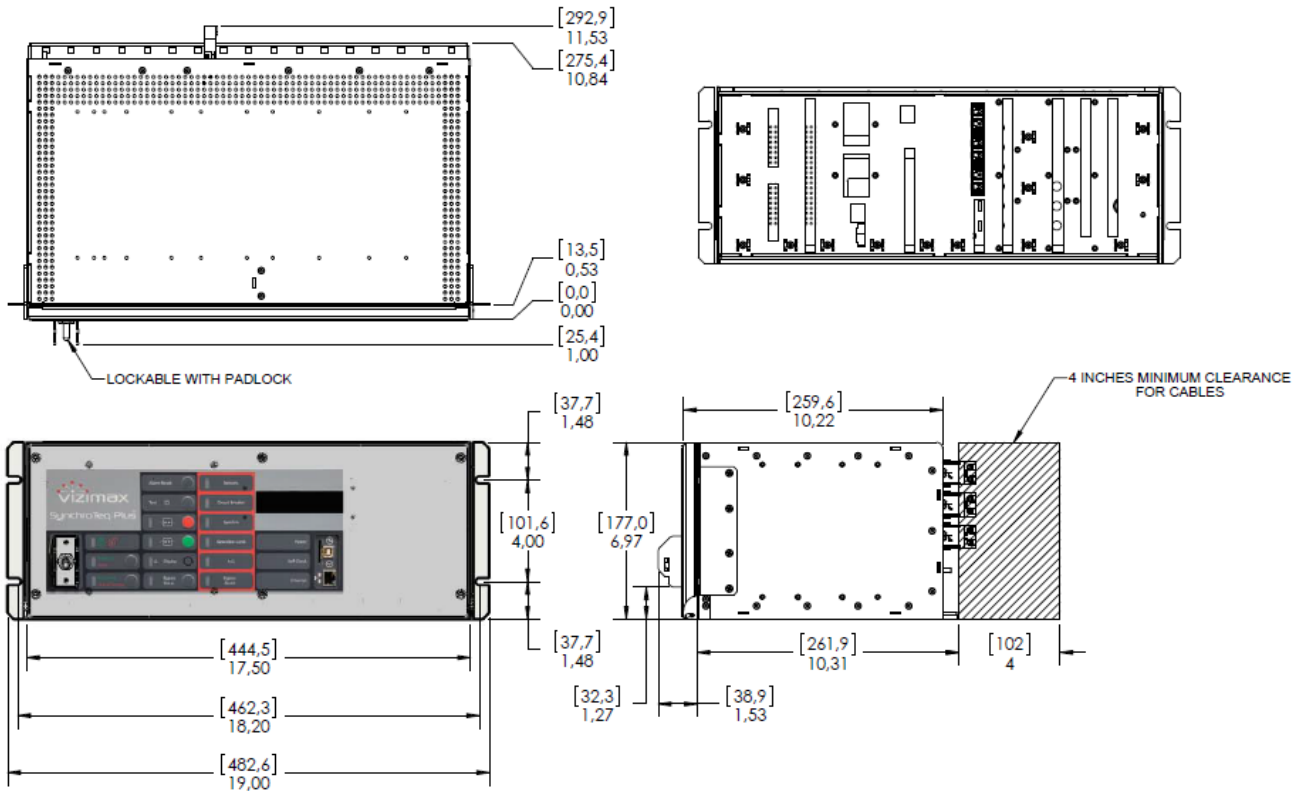


FIGURE 6 SYNCHROTEQ PLUS RACKMOUNT DIMENSIONS

NOTE: For RM installation, the mounting ears can be installed in the front of the unit, but they can be moved to the back or bottom of the unit for panel mount installations.

STAND-ALONE CONFIGURATION

The SynchroTeq Plus standalone (SA) unit is installed in the C/B switchyard, typically within the high voltage C/B control cabinet. Vertical mounting to a fixed panel or swing door is possible. A splash guard is provided with the unit.

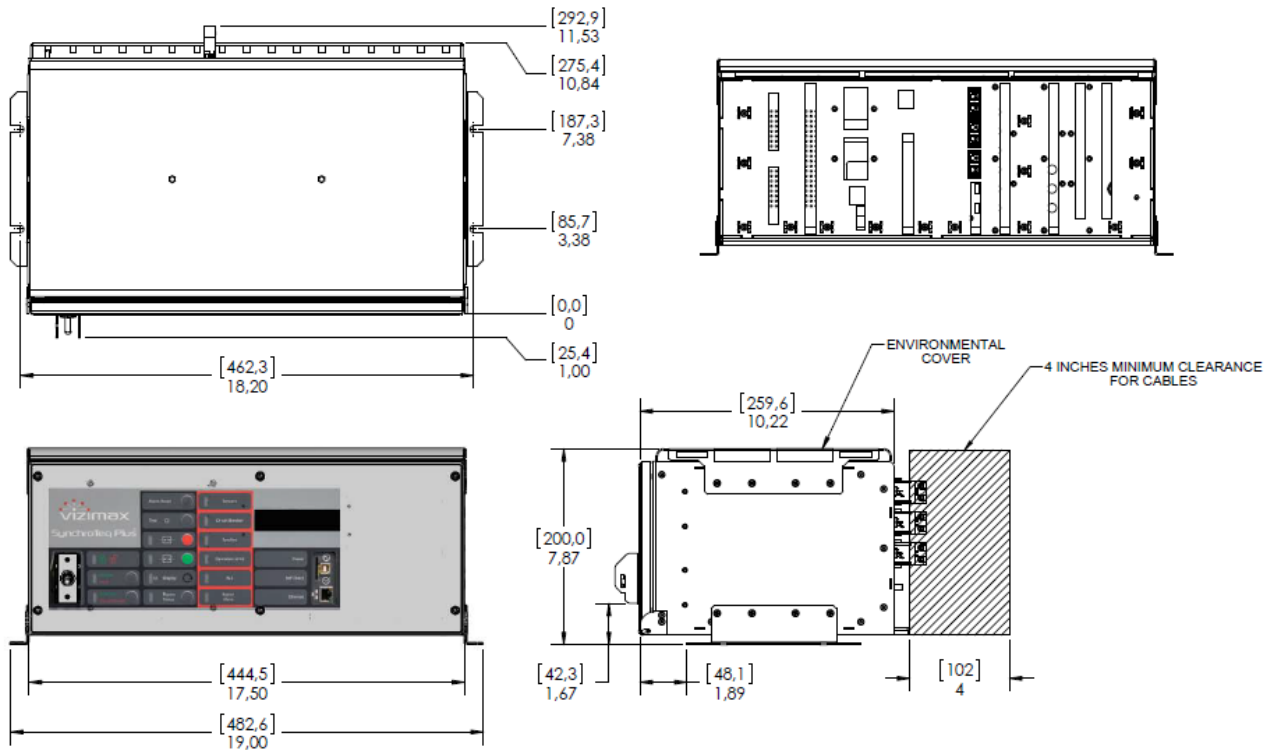


FIGURE 7 SYNCHROTEQ PLUS STAND-ALONE DIMENSIONS

NOTE: SA version should be installed in a water protected shelter together with the C/B. The SA option provides conformal coating of the electronic circuit boards plus an additional environmental protective cover.

ORDERING INFORMATION

STP030000: SynchroTeq Plus base unit (smart coding to be confirmed at order) - Compatible w/ either Rackmount or standalone mounting, -40 °C to 75 °C (-40 °F to 165 °F)

To select ordering options, please refer to the 'smart coding' document 'STP030000-SC'.

To download the smart coding document, please use the following link:

<https://www.vizimax.com/support/download?id=213>

VIZIMAX also offers commissioning and training services: for more details please contact us.

Options:

RWS055000	SynchroTeq Unified Communication Services in substations: Data Transfer and OPC UA Server. For up to ten (10) SynchroTeq Plus/MV units on substation's LAN. Automatic transfer and mirroring of event/waveform/COMTRADE files. OPC UA Server interface for SCADA/DCS
RWS065000	SynchroTeq Unified Communication Services in Central Sites: Data Transfer and OPC UA Server. Accommodates an unlimited number of remote SynchroTeq Plus/MV units and automatic transfer and mirroring of event/waveform/COMTRADE files. OPC UA Server interface and rich tools for SCADA/HMI in central sites.
RWK000016	Standard SynchroTeq Communication Module for the STP030000 (2 x Ethernet 100BASE-T + 1 x Ethernet 100BASE-FX multimode + 2 x serial ports) – Protocols DNP3 client and IEC 61850 server + GOOSE – integrated XCBR LN, -40 °C to 75 °C (-40 °F to 165 °F)
RWC0Y0000	IRIG-B time synchronization optional module
STP030101	Acquisition & Residual Flux Calculation Module for VIZIMAX Bushing Sensors
STP030103	Acquisition & Residual Flux Calculation Module for PT w/ 3 x Analog Inputs
STP030302	SHL-1 - DCO Type - Bypass module
STP030304	Floating SPSBO-F option
STP030200	Active Junction Box
STP030400	Bushing Sensors for HV Power Transformer

NOTE: Specifications are subject to change without notice



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