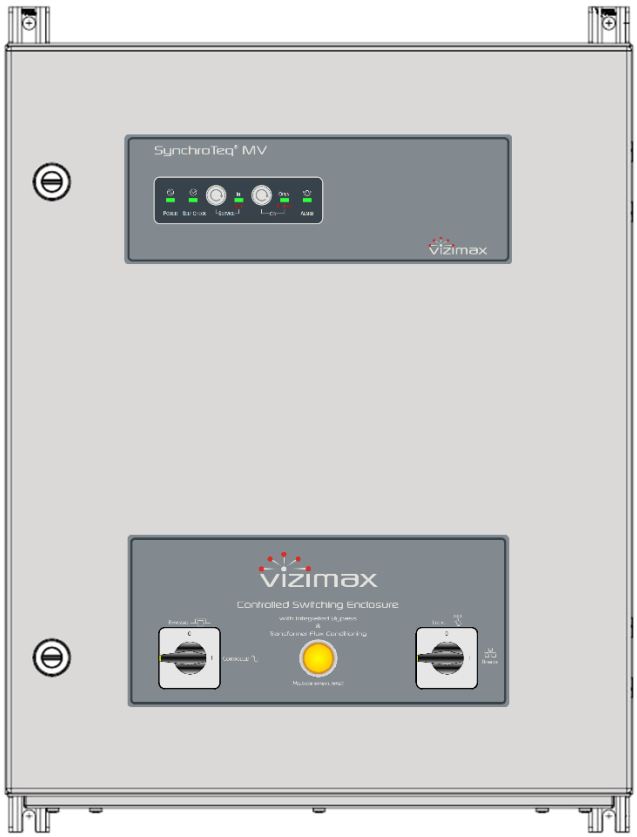


Controlled Switching Enclosure with Transformer Flux Conditioning & Integrated Bypass

DATASHEET

STM046000-SP

2021-08-23

www.vizimax.com

TABLE OF CONTENTS

PRODUCT OVERVIEW

The VIZIMAX Transformer Flux Conditioning enclosure - STM046000 – is a ready to use, control solution for 3-phase, indoor or outdoor Medium Voltage (MV) switchgear or circuit-breaker, with spring-loaded or electromagnetic mechanisms.

The STM046000 cabinet is dedicated to LV-MV power transformer energization with a 3-pole operated (Gang Operated) switchgear. This type of LV-MV power transformer is widely used in the renewable energy sector: wind or solar farm, battery energy storage systems (BESS).

The STM046000 offers a specific flux conditioning function, aiming to minimize inrush current when closing power transformer with a 3-pole operated (Gang Operated) switchgear.

THE CHALLENGE: POWER TRANSFORMER ENERGIZATION

VIZIMAX's SynchroTeq® MV series of controlled switching devices (CSD) are often used with three-pole operated (gang operated) circuit breakers in MV switchgear. They make it possible to perform controlled CLOSE (and TRIP when relevant) operations.

When energizing an MV power transformer, closing simultaneously the 3 poles of a circuit breaker at an optimal instant (controlled switching) will achieve lower inrush currents, compared to the high currents observed when randomly switching.

The maximum inrush currents (and the mitigation thereof) depend on several factors, which encompass the residual flux in the power transformer at the time of closing. The Figure 1 below shows a typical example of such current distribution (the absolute peak values and overall shape may change according to actual project and transformer data).

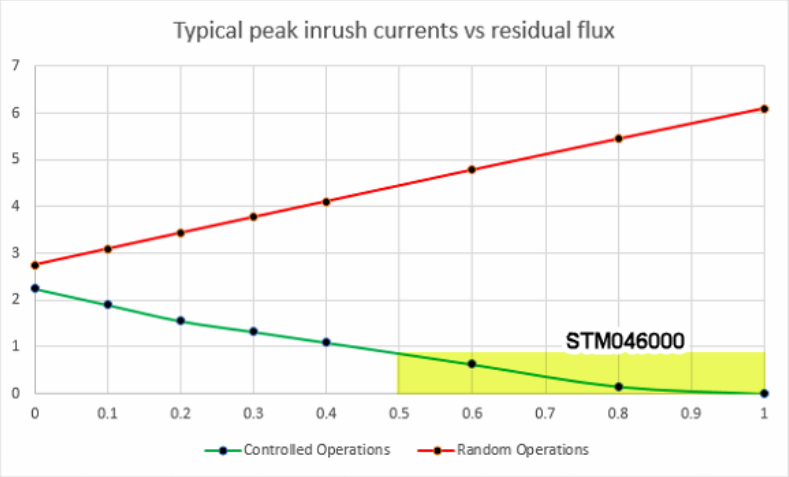


FIGURE 1 INRUSH OF POWER TRANSFORMER BASED ON RESIDUAL FLUX

The horizontal axis is the magnitude of the residual flux (from 0 to 1 per unit, or 0 to 100%) and the vertical axis is the inrush current in a specific transformer. The red line represents the worst-case random switching inrushes, and the green line represents the inrush currents observed with controlled closing operations.

One can note that the higher the residual flux, the lower the currents produced when the closing is controlled (controlled operations), leading to near-zero inrush currents.

At quite low residual flux regime, the relative mitigation factor of inrush currents brought by the controlled closing will decrease, to reach its minimum near zero residual flux.

In applications where a voltage-trapping resource such as an underground cable or a DC to AC inverter is connected to the low-voltage side of the power transformer, this voltage-trapping resource will keep back-feeding the transformer for a certain amount of time after the circuit breaker will have tripped. This will in turn demagnetize the core of the attached power transformer, thus leading to a power transformer being in the least favorable situation for controlled switching, near-zero residual flux. This situation is quite frequent in the case of step-up transformers attached to a photovoltaic solar farm or type-4 wind turbine generators or battery energy storage systems.

For those situations, VIZIMAX introduces a controlled switching enclosure with transformer flux conditioning to greatly improve the performance by virtually eliminating energization inrush currents.

THE VIZIMAX SOLUTION: THE STM046000 ENCLOSURE

In installations where inverters/power electronics tend to demagnetize the power transformer, it is observed that the low-voltage side of the power transformer has voltages ranging from 400 to 800 Vac (L – L). This is the result of the economics of the inverter design.

The VIZIMAX STM046000 enclosure is designed for such application cases, with direct connections to the transformer's load-side voltage for the required load voltage acquisitions.

Upon transformer de-energization (and inverter shut down), the SynchroTeq MV will automatically seek a final core flux situation to be used for the next controlled closing operation. This is the transformer flux conditioning operation.

Before this conditioning operation occurs, the STM046000 activates two interlock relays that may be used to block the closing of the circuit breaker (on the high voltage side of the power transformer) and to signal to the inverter that it shall not power up. These interlock relays are released once the flux conditioning operation is completed, in a matter of tens of seconds.

In the event the power transformer residual flux is modified by external devices, like when using a transformer diagnostic tool (for frequency response, leakage reactance, demagnetization, etc.), a manual transformer flux conditioning operation can be performed to recondition the transformer to the optimal condition. This can be done remotely (using IEC61850 command or the VIZIMAX Commissioning Tool) or by local activation on the enclosure, after the unit is turned to local mode.

The transformer flux conditioning operation will not be authorized if the SynchroTeq CSD is bypassed or out of service.

Benefits:

- Power transformers: mitigate inrush currents, voltage dips, dissipated energy and stresses, reduce transients, improve power quality and power grid stability
- Grid code compliance and Grid resilience: energize power transformers and meet the requirements of Distribution System Operators without any special design nor special transformers
- Integration of RES - wind, solar, hydro, biomass…: allow DSOs, power producers, project developers, manufacturers (WTGs, PV solar inverters, BESS…) to maximise the use of existing grid infrastructures and power equipment

Cabinet features:

- Construction: painted steel enclosure (L 500 x H 600 x D 250mm) for wall mount, indoor installation, bottom cable gland plate, panel mount controller, hinged door.
- Terminals suitable for 3-pole operated (simultaneous operation) apparatuses.
- Multi-voltage, potential free and isolated SSR outputs (1x Close and 1x Open) for Controlled CLOSE, Controlled OPEN operations.
- Built-in Bypass logic: Controlled / Bypassed mode selector on front panel (padlockable), system health relay output (dry contact). External (uncontrolled) OPEN operations are performed when bypassed (External CLOSE can be authorised by jumper selection).
- Terminals for: DC power supply input (from MV switchgear of from a substation), digital I/Os, current and voltage measurements.
- Native IEC61850 MMS Server Ed.2 protocol with 'Local / remote' function selector on the cabinet door. Manual TFC activation by the front panel pushbutton is available only when the cabinet is set in 'Local' mode by the front panel selector.
- Optional communication connectivity (100BASE-TX or 100BASE-FX connectivity) and time-synchronization (IRIG-B) Please refer to the smart coding document.

Built-in controller:

- Extreme ruggedness: designed for MV power substations, -40°C to +70°C operating temperature range
- Local/remote web-based operation interface: event journals, statuses and alarms, dashboard, system menu. The last 500 events are stored with waveforms when relevant.
- Waveform recording: Review via VIZIMAX's Waveform Analyzer or COMTRADE export.

COMPLIANCE AND CERTIFICATIONS

TYPICAL PRODUCT ENVIRONMENT

A typical STM046000 installation aims at a 3-leg power transformer – actual MVA capacity is not relevant - with LV side ranging from 400 to 800 Vrms (L-L).

Typical transformer vector group is in the form of Dyn(x)*, but all Wye, Wye-grounded or Delta topologies are supported on both sides of the power transformer.

*: Where (x) represents the phase shift in clock notation, and for example Dyn1 or Dyn11.

The high side voltage, typically 12 to 35 kV (L-L), is switched on and off from a switchgear panel including at least one (1) three-pole operated (Gang Operated) circuit breaker suitable for controlled switching (conditions apply: see “MV Switchgear-CB specifications for STM046000 applications.pdf”) and a relevant disconnect switch/grounding switch.

The Figure 2 shows a typical STM046000 environment, illustrating the case of a Dyn(x) power transformer stepping-up the 400-800Vac voltage produced by a power generation resource’s inverter.

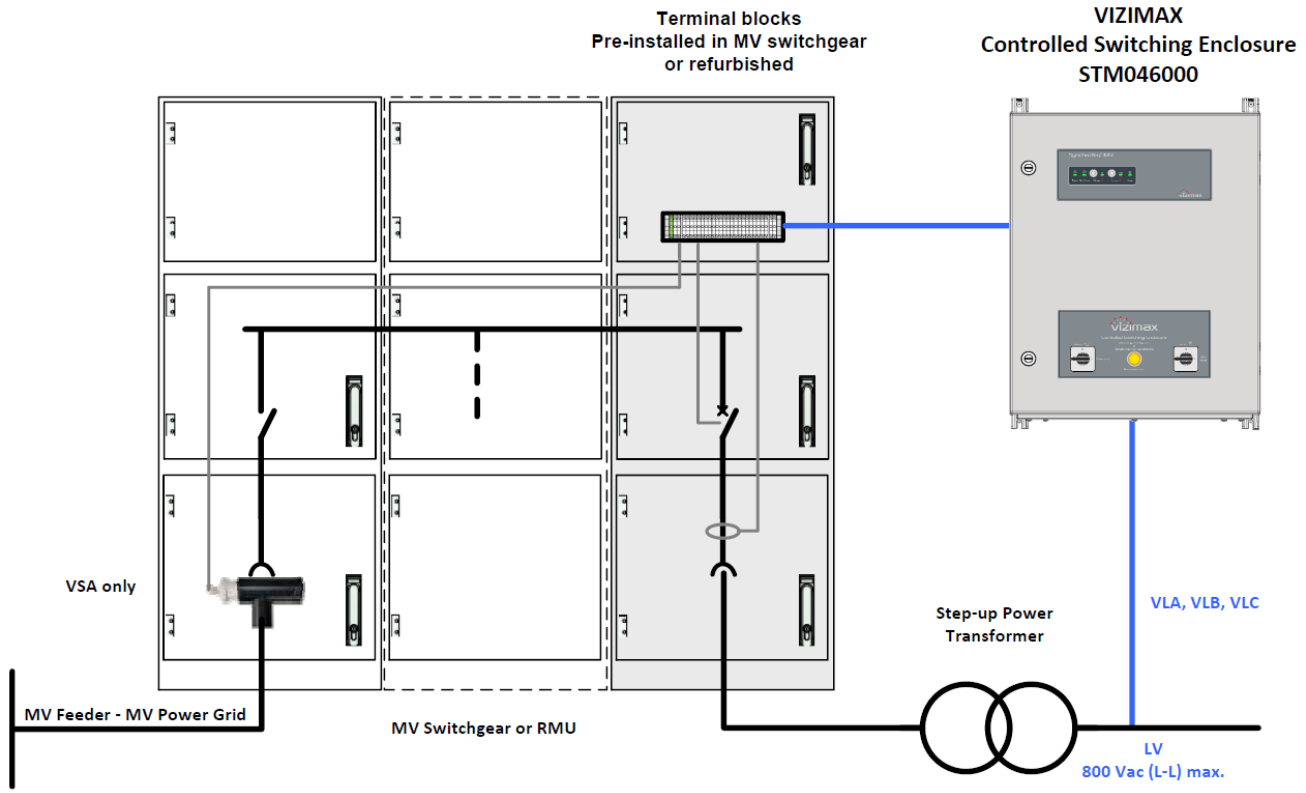


FIGURE 2 TYPICAL STM046000 INSTALLATION

AC Measurements:

- Source voltage: One (1) voltage (VS), Phase A only
  - Source from wound PT (inductive), capacitive divider, resistive divider
  - Dual range: traditional instrument transformer (0 to 200VAC) or Low Energy Analog "LEA/LPIT" (0 to 20VAC)
- Three (3) currents: 1Amp or 5Amp, from inductive current transformer cores
- Load voltage: Three (3) voltages (VL), Phases A, B, C
  - Direct connection from low voltage transformer side: 400 to 800 Vac (L-L)

Sensors: allows monitoring, alarm and compensation functions

- Ambient temperature (where relevant)
- DC control voltage – C/B coil control voltage

Interlocks and Bypass:

- Two independent interlock outputs (dry contacts, Form-C), for example to prevent unexpected circuit breaker closing and/or inverter activation during the transformer flux conditioning operation.
- Built-in bypass logic with padlockable front panel selector.

Manual TFC in local mode:

- Manual transformer flux conditioning operation (TFC) activation on front panel cabinet. For safety feature, manual TFC pushbutton can be activated only when the cabinet is in 'Local' mode (front panel selector) and the SynchroTeq is 'In-service' mode.
- Front panel padlockable selector for Local / Remote TFC operation.

Auxiliary 52b position contact option:

- One additional 52b_A contact input: This optional C/B phase A position status, 52b (normally closed when the C/B is opened) provides an additional safety feature to ensure that the circuit breaker is opened before the Transformer Flux Conditioning is performed. If the 52b is not used, then SynchroTeq will only use the 52a input to check if the breaker is opened. If the breaker is closed but the 52a wire is damaged (or the connection is loose), then SynchroTeq will see the breaker as opened and available to be conditioned; this would result in damaging the STM046000 injection circuit. Using the 52b_A contact input ensure that the circuit breaker position is seen as opened, closed, invalid or intermediate and the TFC operation can only be done if the breaker is OPENED.

BUILT-IN BYPASS LOGIC

The VIZIMAX Controlled Switching Enclosure - STM046000 – includes a bypass logic being activated through several modes.
Once the bypass mode is activated, Open / Close commands are processed as 'external' uncontrolled commands.

Note: the switchgear Close operation when bypassed can be enabled by jumper selection.

- **Automatic bypass mode**:
  The SynchroTeq controller is automatically bypassed if a system failure or an operational fault condition is detected and reported on the signalization relay output 'R4'.

- **Remote bypass mode** (by DI via the 'CSD Enable' input, or by web command):
  The SynchroTeq controller is forced 'Out of Service' / 'Bypassed' when the 'CSD Enable' contact input circuit is opened or when an 'Out of Service' command is sent by the commissioning tool (VCT) or through the IEC61850 MMS protocol (if activated).

- **Manual bypass**:
  The SynchroTeq unit can be manually bypassed using the 'Bypassed/Controlled' selector on the front panel. The 'Bypassed/Controlled' selector is padlockable.

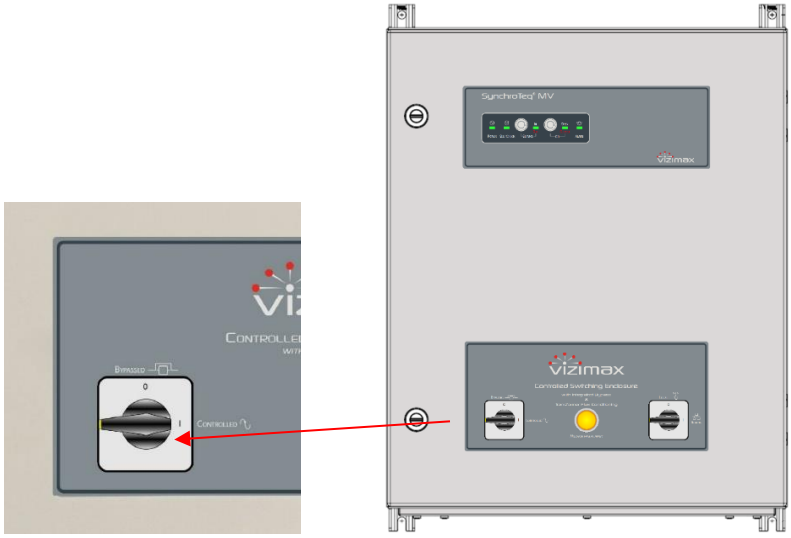


FIGURE 3 FRONT PANEL PADLOCKABLE BYPASS SELECTOR

PASSIVE BYPASS OPTION

With no impact on the price, the passive bypass option (see options) makes it possible to operate the switchgear-C/B even though the connected STM046000 cabinet is unpowered or defective.

NOTE: when specifying this passive configuration, equipment issuing the OPEN and CLOSE command must be able to supply and sustain the switchgear coil currents.

This option must be specified in the smart coding form when ordering the STM046000 enclosure.

LOCAL/REMOTE FUNCTION SELECTOR

A front panel padlockable selector allows to manually set the unit in 'Local or Remote' mode.

This selector activates both:

- The front panel cabinet in local mode (Only manual TFC button and SynchroTeq buttons are enabled, depending on the parameterization)
- The 'local mode' of the native IEC61850 MMS Server Ed.2 protocol.

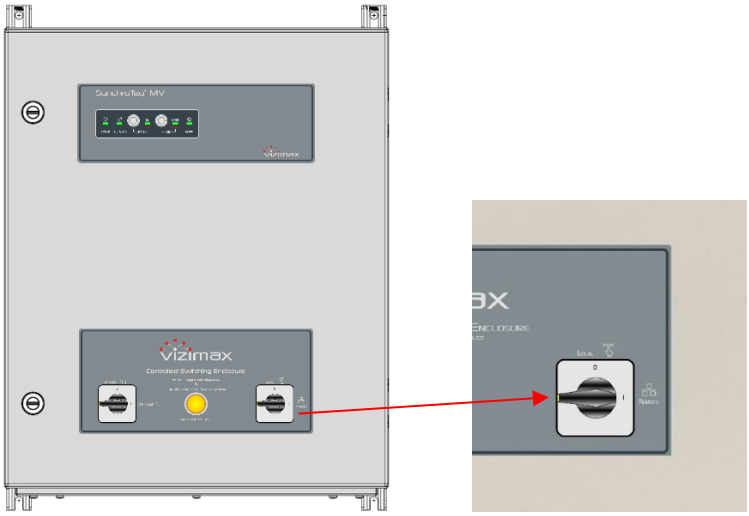


FIGURE 4 FRONT PANEL PADLOCKABLE LOCAL/REMOTE SELECTOR

COMMUNICATION PORTS AND OPTIONS

The SynchroTeq MV controller in the VIZIMAX Controlled Switching enclosure - STM046000 – features two (2) 100BASE-TX Ethernet ports (RJ45 connectors).

The following options are available:

STAMMST00 - 100BASE-FX communication port: one 100BASE-FX / multimode fiber-optic interface with ST connectors.

RWK000016 - SynchroTeq Communication Module: one 100BASE-TX port (RJ45) + one 100BASE-FX / multimode fiber optic port (ST connectors) + two serial ports. Supported protocols: IEC61850 Server Ed.1, Modbus Slave (TCP and RTU), DNP3 Slave.

Both options are mounted in the STM046000 cabinet, and they are mutually exclusive. They are installed at VIZIMAX factory and must be ordered with the STM046000 enclosure. Please refer to the STM046000 smart coding form.

TERMINAL BLOCKS & WIRING (STM046000 ENCLOSURE)

The interconnection between the VIZIMAX STM046000 enclosure and the MV switchgear is achieved using:

- Instrument cables, connected to the MV switchgear bays / to the switchgear control modules and to the terminal blocks (Blue shape) in the STM046000 enclosure.
- Line cables, connected to the transformer low voltage side phase signals and to the terminal blocks (Red shape) in the STM046000 enclosure.

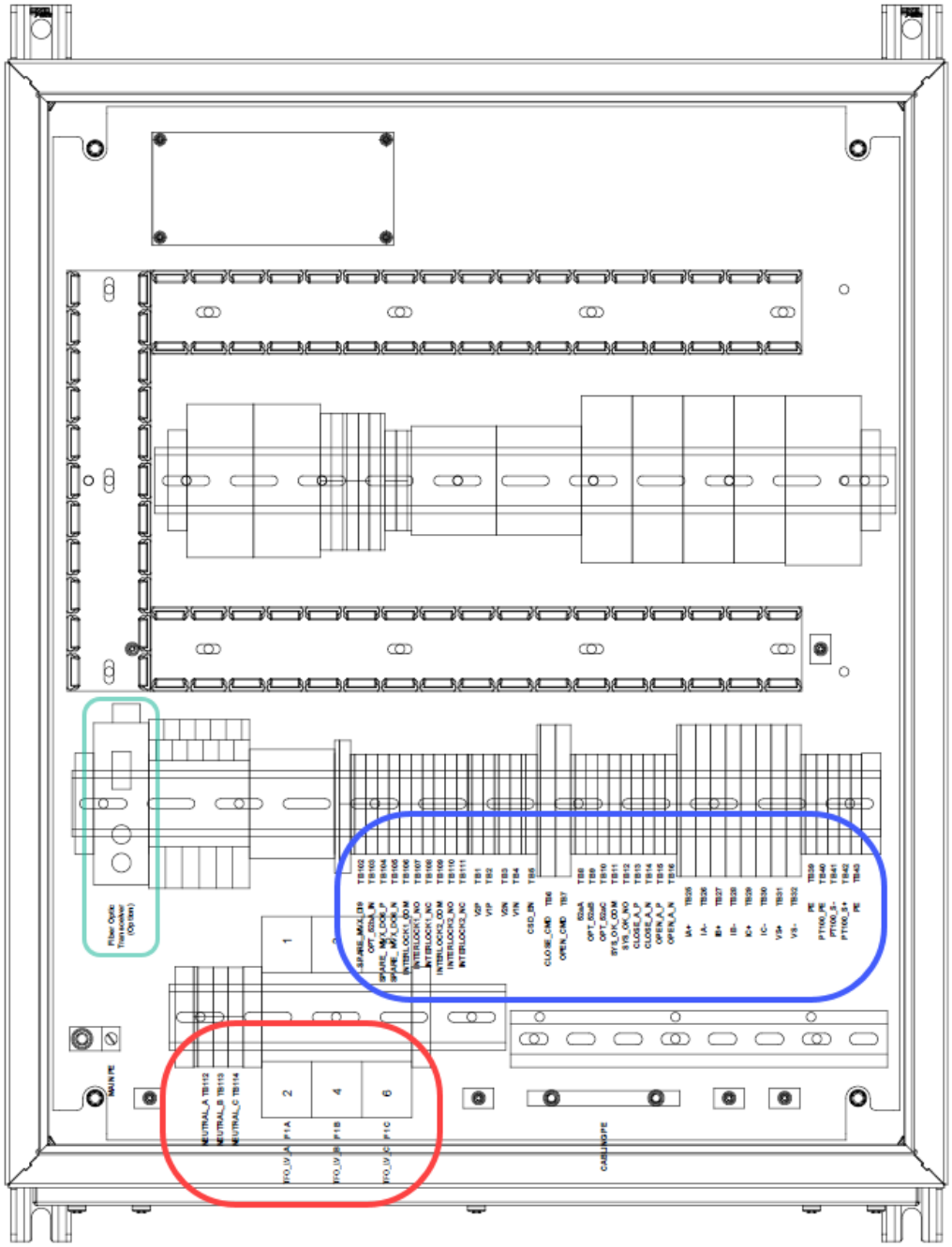


FIGURE 5 TERMINAL BLOCKS LOCATION IN STM046000 ENCLOSURE

STM046000 TERMINAL BLOCKS

The VIZIMAX Controlled Switching enclosure - STM046000 – includes the following terminals.

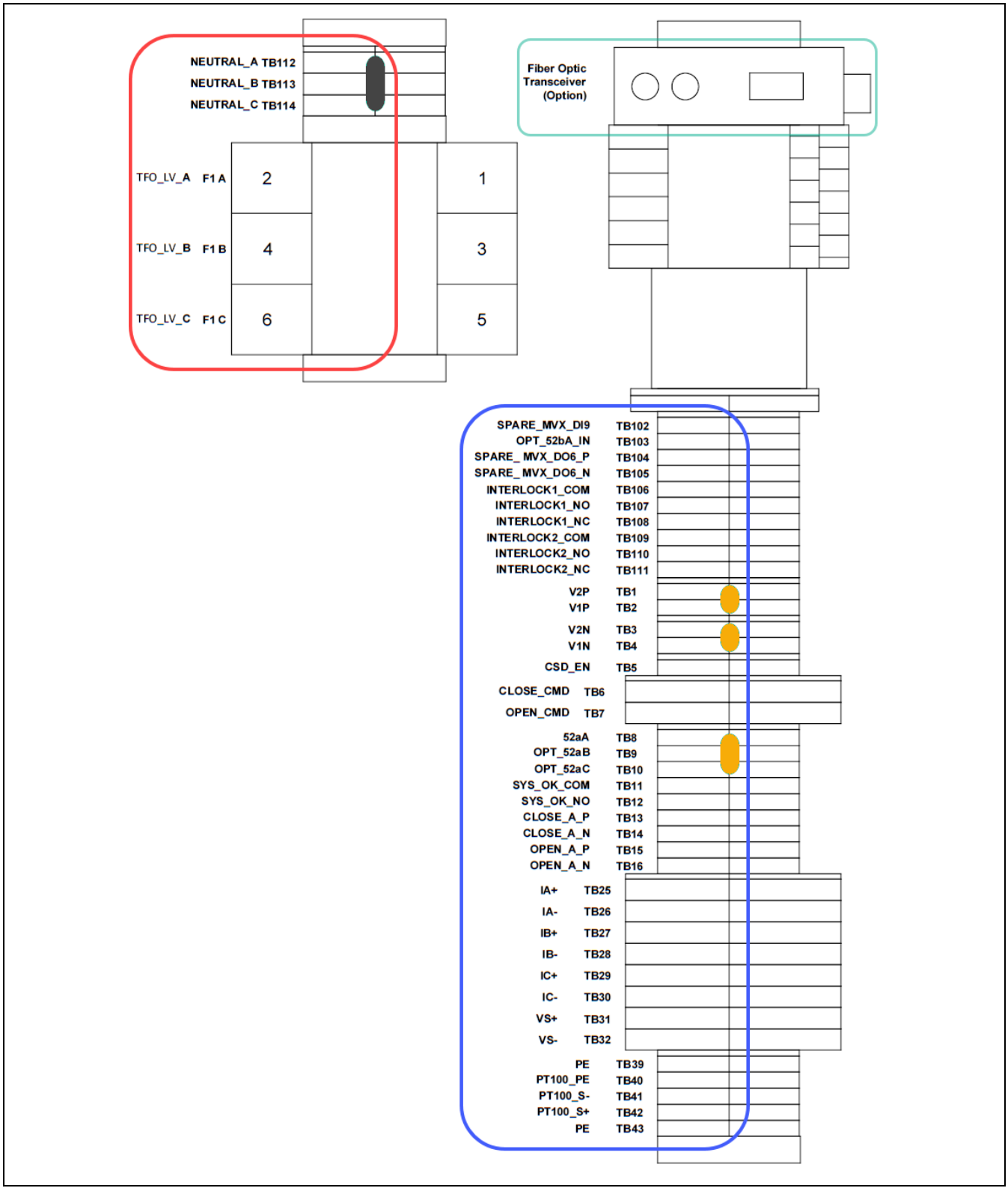


FIGURE 6 SIGNAL NAMES AND TERMINAL BLOCKS IDENTIFICATION

Table 1 below provides VIZIMAX STM046000 terminal blocks wiring identification for the transformer low voltage side phase signals.

TABLE 1 STM046000 TERMINAL BLOCKS WIRING IDENTIFICATION FOR LINE SIGNALS

Terminal Block Id	Signal Name	Description	Note
TB112	Neutral phase A	Neutral phase A	Bridged altogether. See note* below
TB113	Neutral phase B	Neutral phase B	
TB114	Neutral phase C	Neutral phase C	
	Spacer		
F1 A (2)	TFO_LV_A	Transformer low voltage side phase A	Fuse holder
F1 B (4)	TFO_LV_B	Transformer low voltage side phase B	Fuse holder
F1 C (6)	TFO_LV_C	Transformer low voltage side phase C	Fuse holder
	Spacer		

Note*: Neutral signals (A-B-C) are bridged altogether inside the STM046000 enclosure (bridge is not done on the terminal blocks)

Table 2 below provides VIZIMAX STM046000 terminal blocks wiring identification for instrument cables.

TABLE 2 STM046000 TERMINAL BLOCKS WIRING IDENTIFICATION FOR INSTRUMENT CABLES

Terminal Block Id	Signal Name	Description	Note
TB102	Spare_MVX_DI9(+)	Spare Digital input SynchroTeq MVX – DI9 (+)	
TB103	Opt_52b_A	52b / CB position contact input (Phase A)	Optional signal
TB104	Spare_MVX_DO6(+)	Spare Output SynchroTeq MVX - Out6 (+)	Future use
TB105	Spare_MVX_DO6(-)	Spare Output SynchroTeq MVX - Out6 (-)	Future use
TB106	Interlock1_Com	Common Interlock1	
TB107	Interlock1_NO	Dry contact NO – Interlock1	
TB108	Interlock1_NC	Dry contact NC – Interlock1	
TB109	Interlock2_Com	Common Interlock2	
TB110	Interlock2_NO	Dry contact NO – Interlock2	
TB111	Interlock2_NC	Dry contact NC – Interlock2	
	Spacer		
TB1	V2P (+)	Power supply to STM046000 (+)	TB1-TB2 bridged See Note 1
TB2			
	Spacer		
TB3	V2N (-)	Power supply to STM046000 (-)	TB3-TB4 bridged See Note 2
TB4			
	Spacer		
TB5	CSD EN	CSD Enable input signal (Active high)	See Note 3
	Spacer		
TB6	CLOSE_CMD	CLOSE Command input	With test plug and disconnect switch
TB7	OPEN_CMD	OPEN Command input	With test plug and disconnect switch
	Spacer		
TB8	52a_A	52a / CB position contact input (Phase A)	TB8-TB9-TB10 bridged See Note 4
TB9	Opt_52a_B	52a / CB position contact input (Phase B)	
TB10	Opt_52a_C	52a / CB position contact input (Phase C)	
TB11	System_OK_COM	SynchroTeq MV System OK – Dry contact (system OK = Contact is Closed)	
TB12	System_OK_NO		

Terminal Block Id	Signal Name	Description	Note
TB13	Close_A OUT+	CLOSE coil command outputs (Phase A)	
TB14	Close_A OUT-		
TB15	Open_A OUT+	OPEN coil command outputs (Phase A)	
TB16	Open_A OUT-		
	Spacer		
TB25	IA+	Current input, phase A	With test plug and disconnect switch and shorting bar
TB26	IA-		
TB27	IB+	Current input, phase B	With test plug and disconnect switch and shorting bar
TB28	IB-		
TB29	IC+	Current input, phase C	With test plug and disconnect switch and shorting bar
TB30	IC-		
TB31	VS (+)	Source Voltage input (phase A)	With test plug and disconnect switch
TB32	VS (-)		
	Spacer		
TB39	GROUND	Ground	
TB40	Pt100_PE	Pt100 RTD sensor common to P.E. ground	See Note 5
TB41	Pt100_S-	Pt100 RTD sensor common to measurement input	See Note 5
TB42	Pt100_S+	Pt100 RTD + wire connected to measurement input	See Note 5
TB43	GROUND	Ground	
Protective Earth (GND / PE)		Enclosure chassis to be bonded to External Ground Stud 6mm	

NOTES:

Note 1: if the coil voltage differs from power supply voltage a) remove the bridge TB1-TB2, then b) connect the C/B coil voltage (+) to TB2.

Note 2: if the coil voltage differs from power supply voltage a) remove the bridge TB3-TB4, then b) connect the C/B coil voltage (-) to TB4.

Note 3: CSD_Enable input in series with the Bypass switch on the STM046000's front panel. Connect TB5 to TB1 (V2P) if the remote Bypass control is not used.

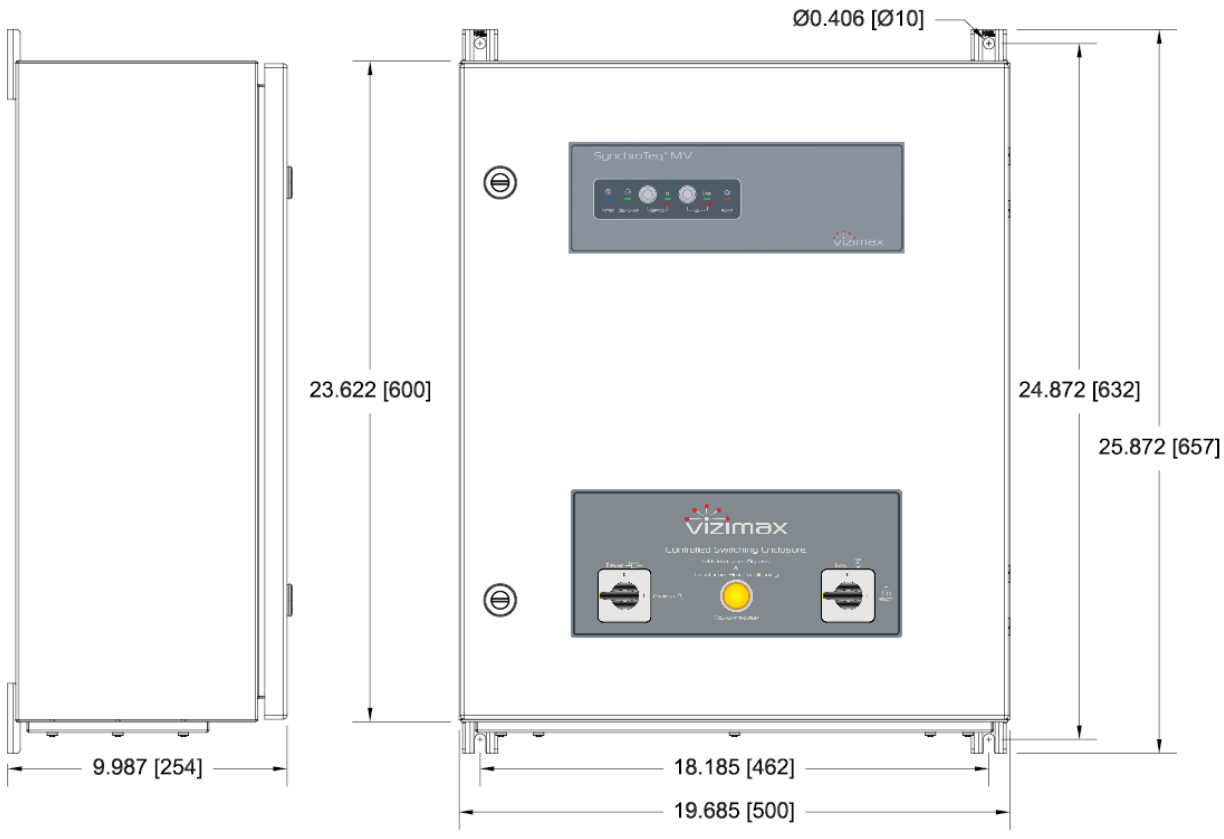
Note 4: By default, terminals 52a_B and 52a_C are bridged to 52a_A terminal. This wiring allows for electrical wear calculation based on 52a_A. Optionally and when they exist, all three 52a signals can be wired for additional safety.

Note 5: for 3 wires Pt100 RTD temperature sensor type.

SPECIFICATIONS

ENVIRONMENT AND PHYSICAL DIMENSIONS

Characteristics	Value	Standards reference no.
Operating temperature	-40 to +70 ºC	IEC 61010-1
Storage temperature	-50 to +85 ºC	
Maximum altitude	2000 m	
Maximum Relative humidity (R.H.)	95 % without condensation	IEC 60068-2-30
Enclosure	IP54	
Dimension (L-H-D)	500mm x 600mm x 250mm	
Weight	Approx. 30 kg (66.0 lbs)	



POWER SUPPLY

Characteristics	Value
Voltage rating	As per STM046000 smart code
Power	Steady state: 30W max including options Flux conditioning sequence: 115W max for 60 seconds max

DIRECT AC VOLTAGE MEASUREMENT INPUTS (VL)

Characteristics	Value
Name	TFO_LV_A – TFO_LV_B – TFO_LV_C (Neutral A – B -C)
Connector type	screw type AWG 10-24 (6.0 mm^2 – 0.2 mm^2)
Rated voltage	400 Vac to 800Vac (L-L)
Isolation	2000 Vrms

TWO INTERLOCK OUTPUTS (DRY CONTACT, FORM-C)

Characteristics	Value
Names	Interlock1, Interlock2
Connector type	Dry contact – Form-C AWG 13-24 (2.5 mm^2 – 0.2 mm^2)
Rated voltage	250 V
Isolation	2000 Vrms
Contact capacity	Continuous : 5A Breaking capacity (resistive) : 0.42A Breaking capacity (inductive DC13) : 0.22A

NOTE: Please refer to SynchroTeq MV datasheet for SynchroTeq MV unit specifications.

ORDERING INFORMATION

STM046000 **Controlled Switching enclosure with transformer flux conditioning:** This metal paint enclosure includes a SynchroTeq MV unit and a built-in Bypass logic, for controlled operations of LV-MV power transformer with a 3-pole (gang operated) switchgear.
Standard communication link: 100BASE-TX (copper Ethernet / RJ45 connector).
Time synchronization via NTP-SNTP time server on Ethernet, via IEEE PTP 1588 clock source on Ethernet, or via manual synchronization from a connected computer.
Native connectivity: via IEC61850 MMS Server Ed.2 protocol.

To select ordering options such as, power supply voltage, bypass configuration, IRIG-B synchronization or communication options, please refer to the 'smart coding' document 'STM046000-SC' available on the VIZIMAX web site https://VIZIMAX.com

Power supply versions:

- 24 VDC / 48 VDC / 110 VDC / 125 VDC

Bypass configurations:

- Magnetic contactors bypass logic or
- Passive bypass logic (with diodes)

Available options:

RWC0Y0001 –IRIG-B time-synchronization interface:

- IRIG-B000/B004 IEEE C37.118
- IRIG-B000/B004 IEEE-1344
- IRIG-B003

STAMMST00 – Media converter – 100BASE-TX to 100BASE-FX / fiber-optic interface – Fiber-optic: multimode type with ST connectors.

RWK000016 - SynchroTeq Communication Module - supporting IEC 61850 Server Ed.1, Modbus slave (TCP and RTU), and DNP3 slave protocols and providing one 100BASE-TX (RJ45) and one multimode fiber optic 100BASE-FX (ST connectors) Ethernet ports, and two serial ports.

VIZIMAX also offers commissioning and training services: please inquire.

NOTE: These specifications are subject to change without prior notice.

CUSTOMER SUPPORT

Please contact us at:

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Fax	+1 450-679-9051

NOTE: Certain charges and conditions may apply depending on the nature of the services requested.

Support contact: support@vizimax.com
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