

MV-TPS

Heat Control System

60 - 350A, 2,300 - 13,800V



Instruction Manual

Ver. 0325

MV-TPS Instruction Manual

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3. SAFETY & WARNINGS

3.1 Safety

	1	Read this manual carefully before operating the equipment and follow its instructions.
	2	Installation, operation and maintenance should be in strict accordance with this manual, national codes and good practice.
	3	Installation or operation not performed in strict accordance with these instructions will void manufacturer's warranty.
	4	Disconnect all power inputs before servicing the MV-TPS and/or the load.
	5	After installation, check and verify that no foreign parts (bolts, washers, etc.) that have fallen into the Power Section (IP00) of the MV-TPS
	6	The Cabinet Must remain closed under operating conditions.
	7	Make sure that the protective Earth terminal shall be connected to the protective conductor before any other connection that is made.

3.2 Warnings

	1	Internal components and PCBs are at mains potential when the MV-TPS is connected to mains. This voltage is extremely dangerous and contact with it will cause death or severe injury.
	2	When the MV-TPS is connected to mains full voltage may appear on the MV-TPS's output terminals and load's terminals, even if control voltage is disconnected!
	3	The MV-TPS must be grounded to ensure correct operation, safety and to prevent damage.
	4	Check that capacitors and/or surge arresters are not connected to the output side of the MV-TPS (U, V, W busbars).

The company reserves the right to make any improvements or modifications to its products without prior notice.

4. INTRODUCTION

This Document describes the Installation, operation and configuration of **Solcon-IGELs'** Medium Voltage Thyristor based Power System (MV-TPS) , a heavy duty fully digital, Zero-crossing, Phase Control or Phase Control-Power, three phase control power unit for all types of **Resistive** loads (temperature control of heaters, etc.).

Note: The load must have a Power Factor of 1.

For loads with a different power factor, please consult the factory.

Output voltage can be controlled using an input signal of 0–10 VDC, 4–20 mA, 0–20 mA, a potentiometer (optional), or communication (optional) for precise temperature control.

An optional digital synchronization system enables load sharing and prevents excessive loading in multi controller applications.

Fully programmable with 16 protection functions, including a “Load Unbalance” alarm to detect a faulty element, even in parallel connected element system and “Under power level” alarm to identify faulty elements in systems designed for unbalanced operation.

A two line, 16 character LCD display is used for the MV-TPS programming, displaying actual values, statistical & maintenance data.

The MV-TPS is manufactured at the highest quality level. Its design, production and delivery process, including construction, manufacturing, order processing, and logistics—are certified ISO 9001:2015.

The enclosed versions of the MV-TPS are provided as ready-to-connect cabinet metal-enclosed type units (example shown in [Figure 1](#)) or, for OEM only, chassis type OEM kits (example shown in

[Figure 2](#)) are available for integration into custom enclosures or other relevant equipment.

Note: The complete interface engineering is the user's responsibility.



Figure 1 – MV-TPS Cabinet Type IP31 (NEMA1)
For illustration purposes only

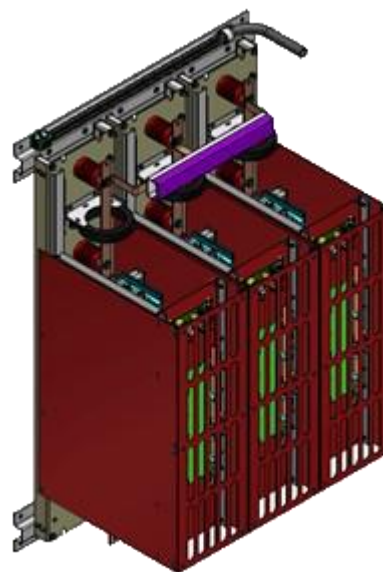


Figure 2 – MV-TPS Chassis Type (IP00)
For illustration purposes only

4.1 Ordering Information

MV-TPS	<u>300-</u>	<u>4160-</u>	<u>115-</u>	<u>115-</u>	<u>0-</u>	<u>S</u>
	Full load Current	Mains Voltage	Control Voltage	Control inputs Voltage	Options	Front Panel

Full load Current	
Specify	Description
MV-TPS - [A]	60, 70, 140, 200, 250, 300, 350 ⁽¹⁾
Note:	⁽¹⁾ For other load currents - consult factory.

Mains Voltage	
Specify	Description
2,300	2,300 VAC, +10% -15%, 50/60Hz
4,160	4160 VAC, +10% -15%, 50/60Hz
6,600	6600 VAC, +10% -15%, 50/60Hz
13,800	13,800 VAC, +10% -15%, 50/60Hz
Note:	For other mains voltage - consult factory.

Control Voltage	
Specify	Description
115	115 VAC, 50/60Hz, +10% -15%
230	230 VAC, 50/60Hz, +10% -15%
Note:	For DC control voltage - consult factory.

Control inputs voltage

Specify	Description
115 <u>or</u> 230	90 – 230 VAC, 50/60Hz

Options	
Specify	Description
0	No options
3M	Communication RS-485 (MODBUS)
5	Analog card
Sync.	Synchronization between up to 10 MV-TPS units. ⁽²⁾
RU	Russian alphabet characters in the display. ⁽²⁾
P	Potentiometer control. (No need for external power source) ⁽²⁾
Note:	⁽²⁾ Must be factory ordered – cannot be installed on site.

Front Panel	
Specify	Description
S	Standard

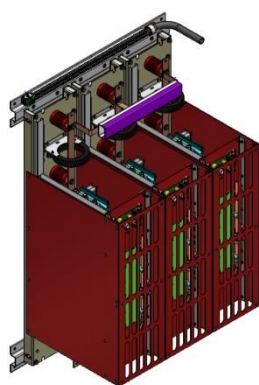
Example:

MV-TPS rated 300A, mains voltage - 4160V, control voltage- 115VAC, control inputs- 115VAC Modbus communication card, Synchronized MV-TPS and standard front panel:

MV-TPS 300 - 4160 – 115 - 115 - 3M+SYNC – S

5. TECHNICAL DATA

5.1 MV-TPS IP00 Unit (OEM Kit)



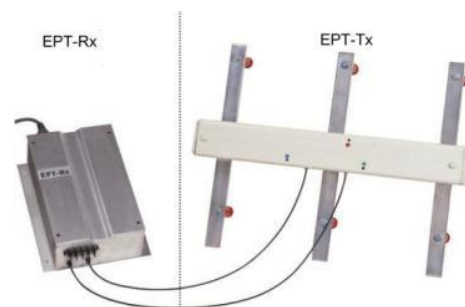
Power Section and
Connection Harness



Control Module



Firing Trans-
former



EPT-Tx and EPT-Rx

Figure 3 – MV-TPS IP00 Unit (OEM Kit)

The IP00 unit (OEM kit) is available for integration into custom enclosures or other relevant equipment.

It consists of the following (see Figure 3 above):

- **Power Section** - Consists of the three identical phase stacks, including firing PCBs including power supplies, EPT-Tx and 3 CTs.

The power section is delivered with a connected harness (6 Fiber optic wires and 6 copper wires) ready for connection to the low voltage compartment. The Power Section is installed in the medium voltage compartment of the cabinet.

- **Control Module** - The “brain” of the MV-TPS. It consists of the main CPU PCB, fireboard PCB, power supply, optional PCBs (when ordered) and input/output interface terminals.
The Control Module for MV-TPS is identical for all ratings and suitable for mounting in the L.V. compartment of the cabinet which should be fully segregated from the M.V. compartment.
Interposing relays should be connected to all MV-TPS auxiliary programmable contacts.
 - **Firing Transformer** - This transformer is applicable for 115VAC or 230VAC control voltages.
The MV-TPS Firing transformer is installed in the low voltage compartment of the cabinet and supplies control power to the firing PCBs located in the Power Section of the MV-TPS in the medium voltage compartment of the cabinet.
 - **EPT-Tx** (transmitter) and **EPT-Rx** (receiver) are used instead of the traditional voltage transformer to measure the input voltage.
The EPT-Tx is installed in the medium voltage compartment and is part of the Power Section (see above).
The EPT-Rx is installed in the low voltage compartment of the cabinet.
The EPT-Tx and EPT-Rx are connected by 2 Fiber optic wires which are part of the connection harness.
 - **Reactor** (not shown in *Figure 3* above) – installed at the output of the power section to limit the di/dt (consult factory).
-

5.2 Typical Connection of the MV-TPS IP00 Unit (OEM Kit)-Up to 6.6kV.

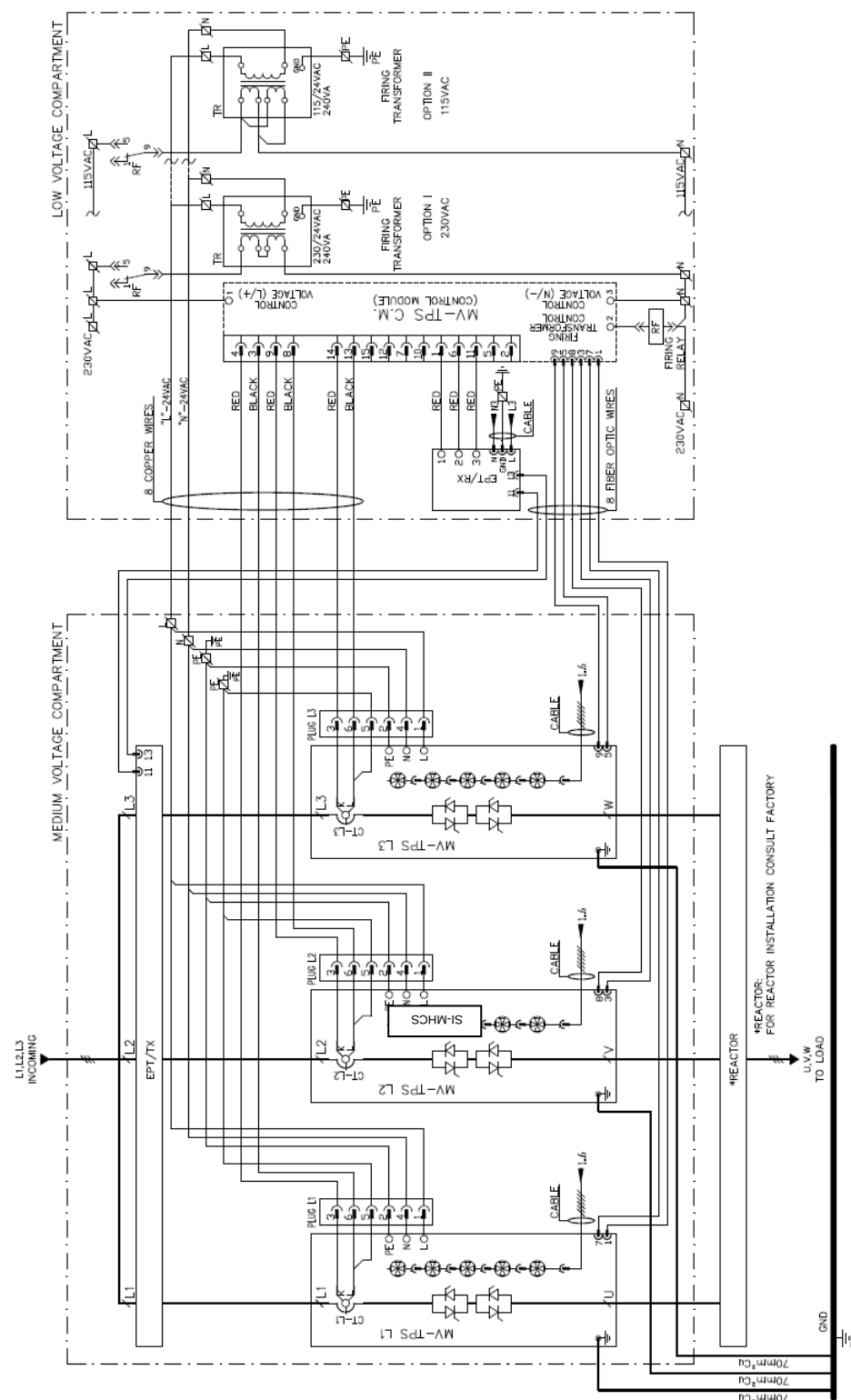


Figure 4 – Typical Connection of MV-TPS IP00 Unit (OEM Kit)

5.3 Mains and Control Description

Display	Description	Remarks
Power connection description		
L1, L2, L3	Connection to mains voltage 4160V or 6600V	For other mains voltage consult factory

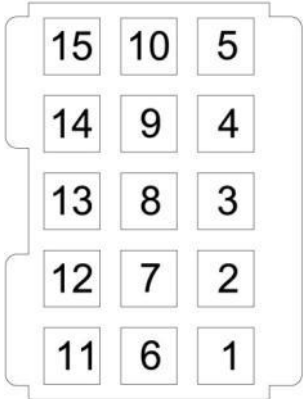
Display	Description	Remarks
U, V, W	Connection to resistive load only (for other loads consult factory)	The Load connection must be programmed into the MV-TPS. Refer to section 6.1 page 14.
G	Connection to Ground.	

Control connection description

Refer to **Figure 5 page 13** for Control Module terminals indication.

Terminal 1	Control phase	Available Control Voltages are: 115VAC (50/60Hz), 230VAC (50/60Hz),
Terminal 3	Control Neutral (Return)	
Terminal 2	Firing control	An internal relay connects the control voltage from terminal 1 to terminal 2 when firing is required during operation. Typically, an external relay controlled by this terminal connects the firing transformer which feeds the firing system.
Terminal 4	Input – RUN command.	The “Run” command is initiated by a normally open (NO) contact of the Control Input Voltage. When the Control Input Voltage is applied to terminal 4 the MV-TPS will start to operate.
Terminal 5	Input - Auxiliary programmable input.	Auxiliary Input can be programmed as one of the following options: • REMOTE RESET (default setting) • SYNC. • AUTHORIZED KEY • N.C. EXT. FAULT • N.O. EXT. FAULT • N.C. INTERLOCK • N.O. INTERLOCK • FIRING TEST Each command is initiated by applying Control Input Voltage to terminal 5. Refer to section 9.6.2 page 38 for programming AUX. IN TYPE.
Terminal 6	Common.	This terminal is the Control Input Voltage reference to terminals 4 & 5.
Terminal 7	Programmable output relay A – Common.	Any of the output relays A, B or C can be programmed to one of the following functions: • RUN (IMMEDIATE) (default setting) • KWH PULSE RELAY • TRIPPING/ALARM • TRIP FAIL SAFE • TRIP • ALARM FAIL SAFE • ALARM Refer to section 9.6.2 page 38 for programming output relays.
Terminal 8	Programmable output relay A – Normally open (NO).	
Terminal 9	Programmable output relay A – Normally closed (NC).	
Terminal 10	Programmable output relay B – Common.	
Terminal 11	Programmable output relay B – Normally open (NO).	
Terminal 12	Programmable output relay B – Normally closed (NC).	
Terminal 13	Programmable output relay C – Common.	

Display	Description	Remarks
Terminal 14	Programmable output relay C – Normally open (NO).	
Terminal 15	Programmable output relay C – Normally closed (NC).	
Terminal 16	Analog input signal (+)	Terminals 16 & 17 are used for 0-10V, 0-20mA and 4-20mA Analog input signals. Terminals 16, 17 are used also when the potentiometer option is installed. Refer to section 9.6.2 page 36 for the Analog input programming. Notes: - Set the internal jumpers JP1-JP4, on the main control board, for the selected Analog input signal. Refer to section Error! Reference source not found. page Error! Bookmark not defined. **need to check** - When the MV-TPS is programmed to controlled by input via communication, these inputs are not operative. Refer to section 9.6.6 page 45. Caution Damage may occur if the jumpers are not properly set! Jumpers are factory set for 4-20mA input.
Terminal 17	Analog input signal (-)	
Terminal 18	Synchronization signal (+) (Optional)	The signal uses Shielded twisted pair, for daisy chaining. Up to 10 MV-TPS units can be connected for the Master-Slave configuration. The Master-Slave configuration is designed for units located in the vicinity of 20 meter maximum. Refer to section 5.7 page 16.
Terminal 19	Synchronization signal (-) (Optional)	
Terminal 20	POT. CW - Output voltage for potentiometer connection (Only when option "P" is installed.) (Optional).	When option "P" is installed connect the potentiometer CW to terminal 20, potentiometer slide to terminal 16 and potentiometer CCW to terminal 17. For the potentiometer input control refer to: Section Error! Reference source not found. page Error! Bookmark not defined. for jumper settings Section 9.6.2 page 38 for Analog input programming. Notes: A potentiometer of 10kΩ must be used! Use a high precision potentiometer for better resolution. When the MV-TPS is programmed to be controlled by input via communication, this input is not operative. Refer to section 9.6.6 page 45.
Terminal 21	Not connected	
Terminal 22	Comm. Ground (Optional)	Communication uses Shielded twisted pair, for daisy chaining. Up to 32 units can be connected for Modbus RS485 communication. For reliable communication, units should be installed in the vicinity of 200m maximum, from the first to the last unit.
Terminal 23	RS-485 Communication (-) (Optional)	
Terminal 24	RS-485 Communication (+) (Optional)	
(+) OUT	Analog output (+) (Optional)	This output is used when the analog output option is installed. The analog output can be configured as 4-20mA, 0-20mA or 0-10V. Refer to section 8.4 page 28 for hardware settings.
(-) OUT	Analog output (-) (Optional)	

Display	Description	Remarks
		The analog output can be programmed as a signal proportional to: • Output power • Average of 3-phase currents • I1, I2, or I3 • Or as a reflection of the Analog input to the MV-TPS. Refer to section 9.6.2 page 38 for programming Analog output.
Fiber optic output #1	Phase L1 firing control via Fiber optic wire.	
Fiber optic output #3	Phase L2 firing control via Fiber optic wire.	
Fiber optic output #5	Phase L3 firing control via Fiber optic wire.	
Fiber optic Input #7	Feedback signal from phase L1.	
Fiber optic Input #8	Feedback signal from phase L2.	
Fiber optic Input #9	Feedback signal from phase L3.	
15 pins connector		Pin 1 – L1 Voltage Pin 2 – No Connection Pin 3 – CT – L1(grounded) Pin 4 – CT – L1 Pin 5 – No Connection Pin 6 – L2 Voltage Pin 7 – No Connection Pin 8 – CT – L2 (grounded) Pin 9 – CT – L2 Pin 10 – No Connection Pin 11 – L3 Voltage Pin 12 – No Connection Pin 13 – CT – L3 (grounded) Pin 14 – CT – L3 Pin 15 – No Connection
G	Connection to ground	For proper operation and for safety reasons the Control Module must be properly grounded.

5.4 Control Module Input / Output

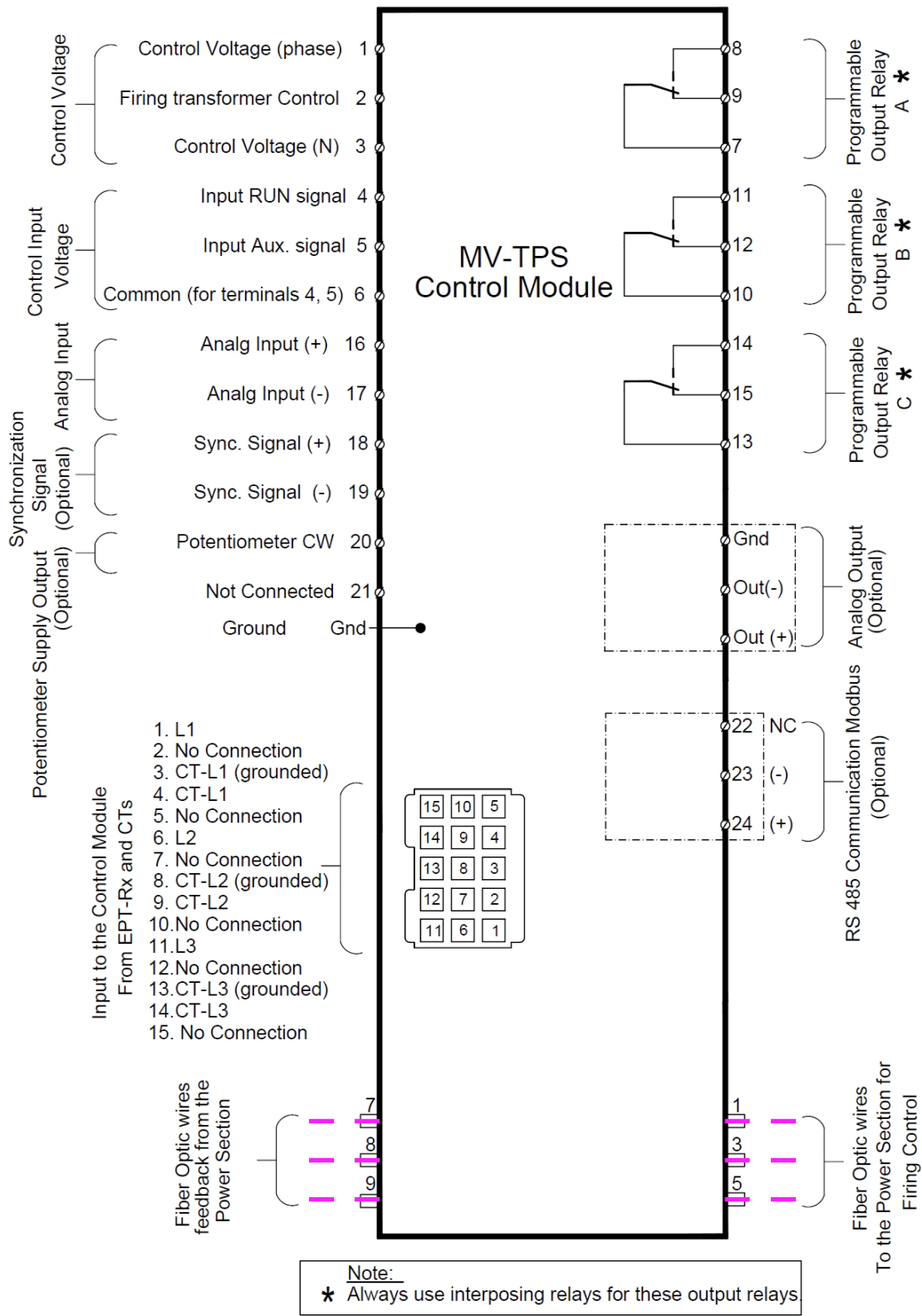


Figure 5 –MV-TPS IP00 Control Module Terminals and Connections

5.5 Load Connections

The load, controlled by the MV-TPS, can be of several configurations:

- Wye with Neutral Connected
- Wye with Neutral Not Connected
- Delta
- or inside Delta (consult factory before using in inside delta!)

Refer to section 6.1 on page 19 for available load configurations.

Load connection type must be programmed into the MV-TPS. Refer to section 9.6.1 page 36.

Note:

Any number of parallel branches can be connected in the shown connection types provided that the total connected load does not exceed the current rating of the MV-TPS unit.

WARNING!

When load is connected in WYE NEUTRAL NOT CONNECTED asymmetrical loads can cause damage. Use the MV-TPS unbalance protection (refer to section 9.6.3 page 41) to trip the unit in case the load becomes unbalanced when connected in WYE NEUTRAL NOT CONNECTED.

5.6 Modes of Operation

5.6.1 Zero Crossing

In this mode of operation thyristor's firing is performed so that current starts at its zero crossing point.

Main advantages of this mode are:

- Minimizing RFI noise.
- Minimizing current THD.

Main disadvantages are:

- No "Soft start".
- High inrush current in case of load with temperature dependant characteristic (lower resistance when cold)
- Current may vary in time.

In this mode of operation, the MV-TPS is programmed to operate in a cycle. (T_{cy})

When the analog input is set to maximum during this cycle, The MV-TPS will conduct continuously. When the Analog input is lower, a proportional number of waves will be delivered to the load during T_{cy} .

The firing method must be programmed to MV-TPS. Refer to section 9.6.1 page 36.

Note:

$T_{cy} = 1-10\text{Sec.}$ (Adjustable in 0.1 sec steps)

$T_{on} = 2 \text{ cycles} - T_{cy} \text{ Seconds}$

(Minimum conducting time is 2 cycles)

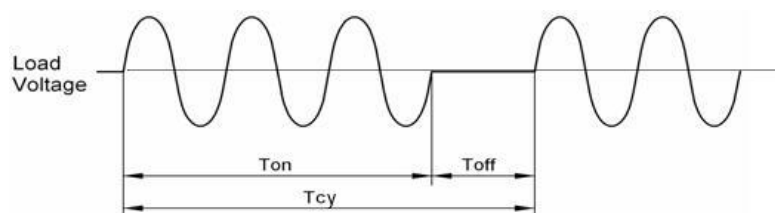


Figure 6 – Zero Crossing Operation

5.6.2 Phase Control

In this mode of operation, the thyristor's firing is performed in every half cycle proportional to the Analog input.

Maximum Analog input will cause a full wave to load. When the Analog input is lower, a proportional part of the sine wave will be delivered to the load.

Main advantages of this mode are:

- Enables "Soft start"
- Current variations are limited.

Main disadvantages are:

- Relatively high RFI noise.
- Relatively high current THD.

Notes:

1. When the load is connected in WYE NEUTRAL NOT CONNECTED or in LINE DELTA (both connections are without a neutral point) and MV-TPS is in PHASE CONTROL it is impossible to go to zero output. Minimum possible firing for such case gives 30-40% of output voltage. This is since in this case the firing of each phase depends on the three phases mains and we cannot control each phase voltage down to zero.

In this case, zero input in the Analog input causes the minimum possible voltage to appear in the output. Then, upon increasing the Analog input voltage, output voltage/current increases monotonically.

2. When the load is connected in WYE NEUTRAL NOT CONNECTED or in LINE DELTA Asymmetrical load can cause Asymmetrical voltage on the load's phases potentially damaging the load!!

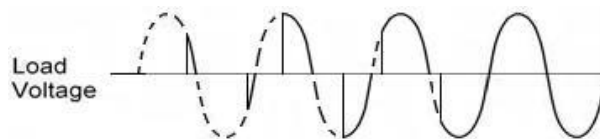


Figure 6 – Phase Control Operation

Firing method must be programmed into MV-TPS. Refer to section 9.6.1 page 36.

5.6.3 Phase Control to Zero Crossing

The user can program a time of which the MV-TPS will function in PHASE CONTROL before switching to ZERO CROSSING mode.

This mode is recommended when the load resistance has a temperature dependant characteristic (lower resistance when cold).

Program PHASE CONTROL TO ZERO CROSSING time to a value from 1-3600 seconds.

During the start of the MV-TPS, for the first 1-3600 seconds, MV-TPS will operate in PHASE CONTROL mode. Thyristor's firing is performed in every half cycle proportional to the Analog input.

The result of this process will be a small current withdrawal from the supply and slow heating of the heat element which increases its resistance and lowers the current.

The firing method must be programmed into the MV-TPS. Refer to section 9.6.1 page 36.

5.6.4 Phase Control-Power

In this mode of operation, the MV-TPS functions in PHASE CONTROL (See explanations above).

In PHASE CONTROL-POWER the output power of the MV-TPS will be kept linear to the Analog input of the MV-TPS.

Firing method must be programmed into the MV-TPS. Refer to section 9.6.1 page 36.

5.7 Synchronized Mode

This mode of operation is applicable only if the mode of operation is set to ZERO CROSSING.

In this mode of operation, the MV-TPS Sync. Terminals 18 & 19 should be wired in “daisy chain” configuration as shown in section 0 on page 20. This mode is used to time share the ON time (Ton) period between the units.

In this mode, the beginning of the ON cycles of the connected TPSs is equally shifted.

For example:

No. of MV-TPS units : 3

Cycle time when MV-TPS is in ZERO CROSSING (Tcy – see section 5.6.1 page 14) : 3 seconds.

In this example MV-TPS#1 will be set to master and MV-TPS#2, MV-TPS#3 will be set to slave.

When system is started

- MV-TPS#1 will go to ON first
- MV-TPS#2 will go to ON after 1 second (3 seconds/3)
- MV-TPS#3 will go to ON after 2 seconds.

Therefore, if the required duty cycle (Ton/Tcy) is less than 1/3, only one MV-TPS will be in the ON state.

Refer to [Figure 7](#) showing the total power consumption in this example.

The Master is transmitting a “Sync” signal”, received by all connected TPSs (Sync group members).

Only one unit of the group should be set as Master. All others should be set as slaves.

Refer to section 9.6.4 Load Shedding Parameters Settings– Page 49.6.4 for programming.

The below parameter shows the parameters setting for this example:

LOAD SHED. PARA. SETTINGS MV-TPS #1	LOAD SHED. PARA. SETTINGS MV-TPS #2	LOAD SHED. PARA. SETTINGS MV-TPS #3
CURRENT LIMIT OFF	CURRENT LIMIT OFF	CURRENT LIMIT OFF
MASTER/SLAVE MASTER	MASTER/SLAVE SLAVE	MASTER/SLAVE SLAVE
NO. OF SYNC UNITS 3	NO. OF SYNC UNITS 3	NO. OF SYNC UNITS 3
SYNC. NUMBER 1	SYNC. NUMBER 2	SYNC. NUMBER 3

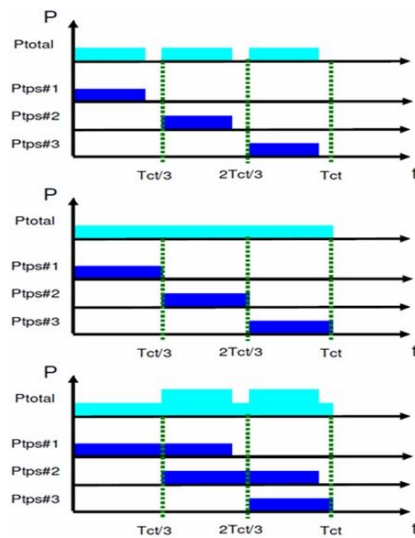


Figure 7 – Synchronized Mode Showing 3 MV-TPS Units

Notes:

1. Sync. LED will light up once function is enabled.
2. In order to have a full number of ON cycles, it is recommended to program the ON-OFF CYCLE TIME such that the number of cycles (50 or 60 Hz) divided by the number of connected MV-TPS units will result in an integer. e.g. if 3 MV-TPS units are connected with 50Hz mains, the ON-OFF CYCLE TIME can be 1.2 Sec (60 cycles), 3Sec (150 cycles).
3. If the ON-OFF CYCLE TIME is changed to MAX # OF INTRVLs, then the number of mains cycles in the ON-OFF CYCLE TIME is fixed to 100 (both at 50Hz and 60Hz).

5.7.1 Analog Input Connection in Synchronized Mode

If several Analog input current sources are available use each Analog input current source to control a single MV-TPS. Refer to Figure 8.

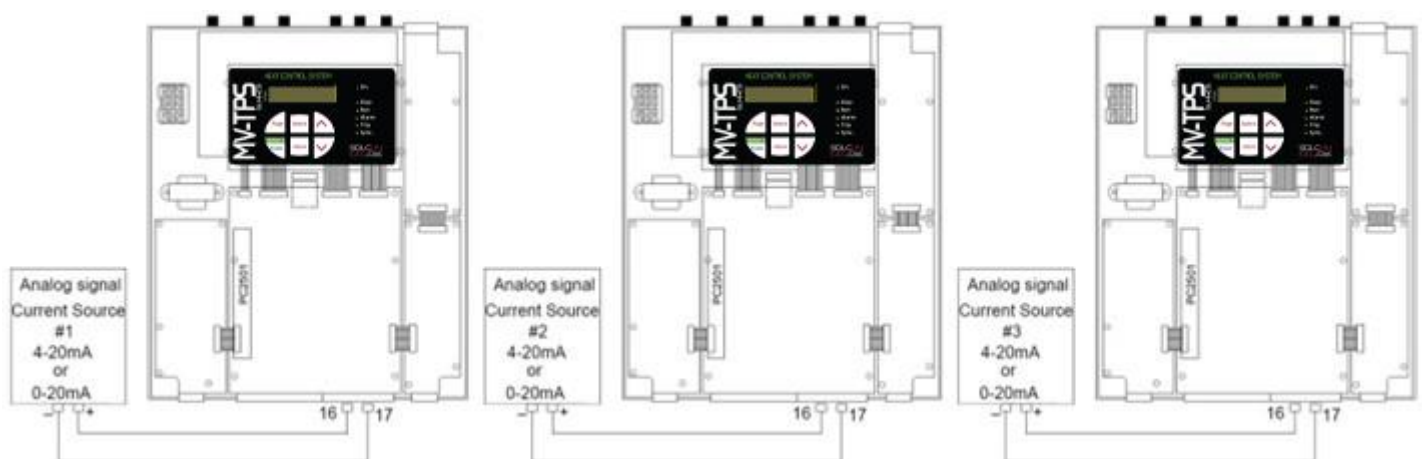


Figure 8 – Synchronized Mode - Several Analog Input Current Sources

If a single Analog in current source is available use the Analog output PCB in the MV-TPSs to reflect the Analog input signal. Synchronized mode cannot be implemented if a single Analog input **current** source is connected to several MV-TPS units in series.

For Synchronization, floating (isolated) inputs must be used. Refer to Figure 9.

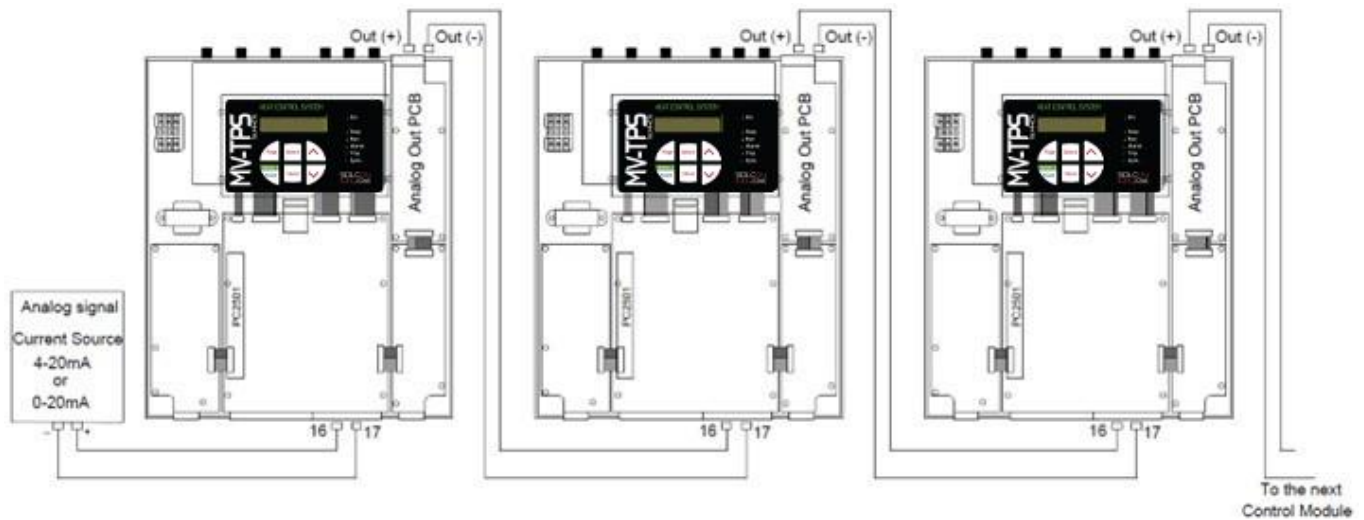


Figure 9 – Synchronized Mode - Single Analog In Current Source

Figure 11 shows The **INCORRECT CONNECTION** of a single Analog input current source connected in series to several MV-TPSs Analog input.

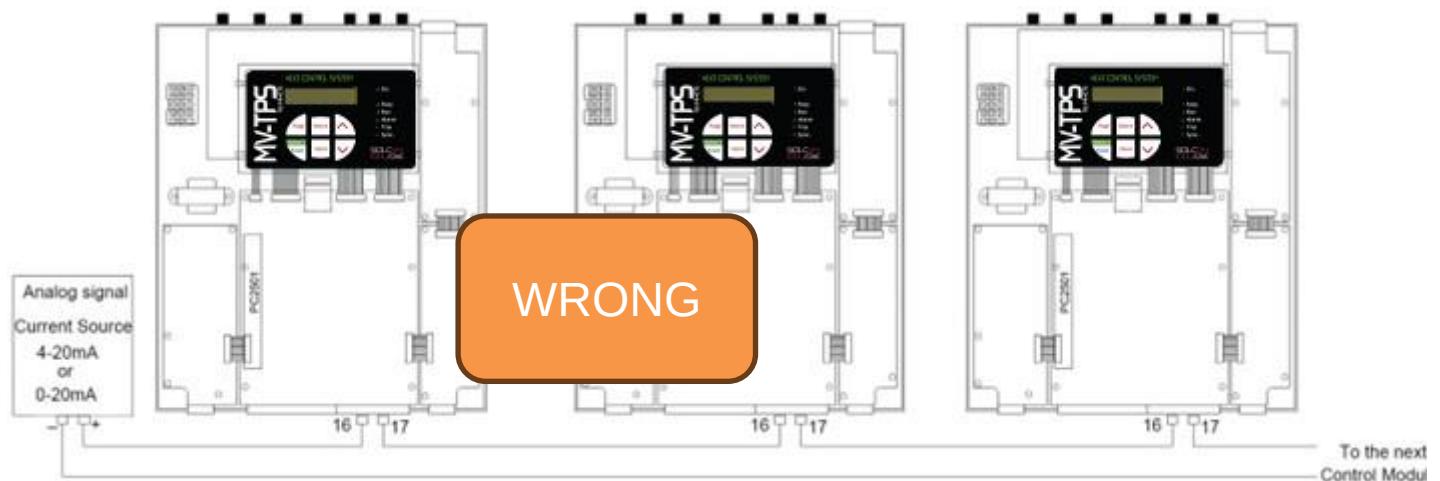


Figure 10 – Synchronized Mode - Single Analog In Current Source- **INCORRECT CONNECTION**

Figure 11 – Synchronized Mode - Single Analog In Current Source- **INCORRECT CONNECTION**

Figure 12 shows a single voltage source 0-10V for Analog input connected in parallel to several MV-TPS Analog inputs.

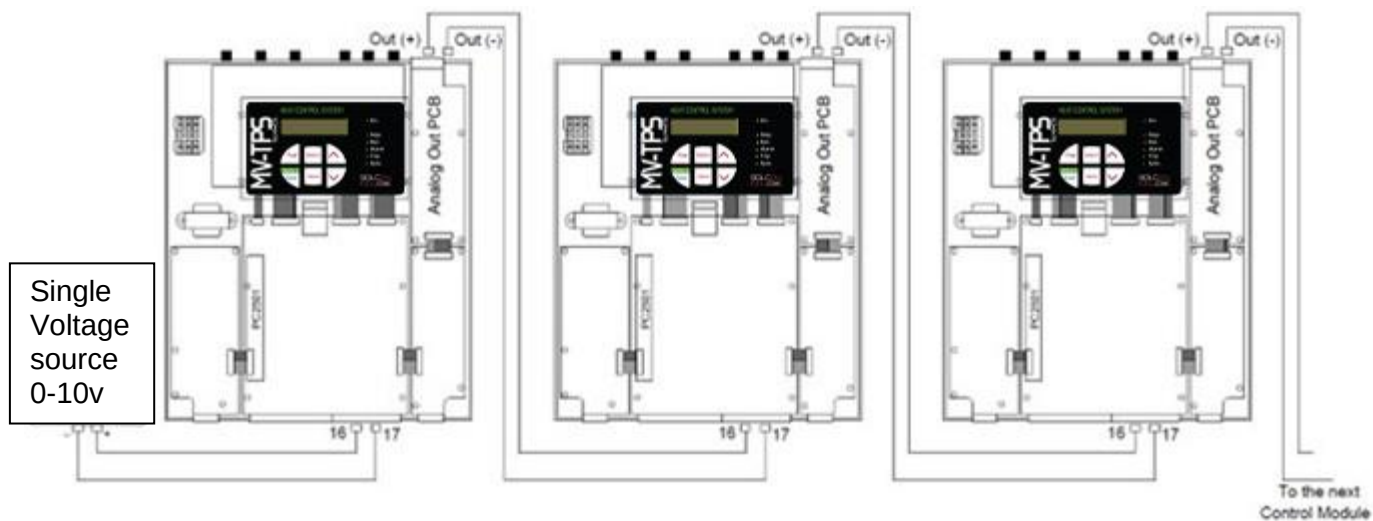


Figure 12 – Synchronized Mode - Single Analog In Voltage Source to Several MV-TPSs

6. RECOMMENDED WIRING SCHEME

6.1 Load Connection Schemes

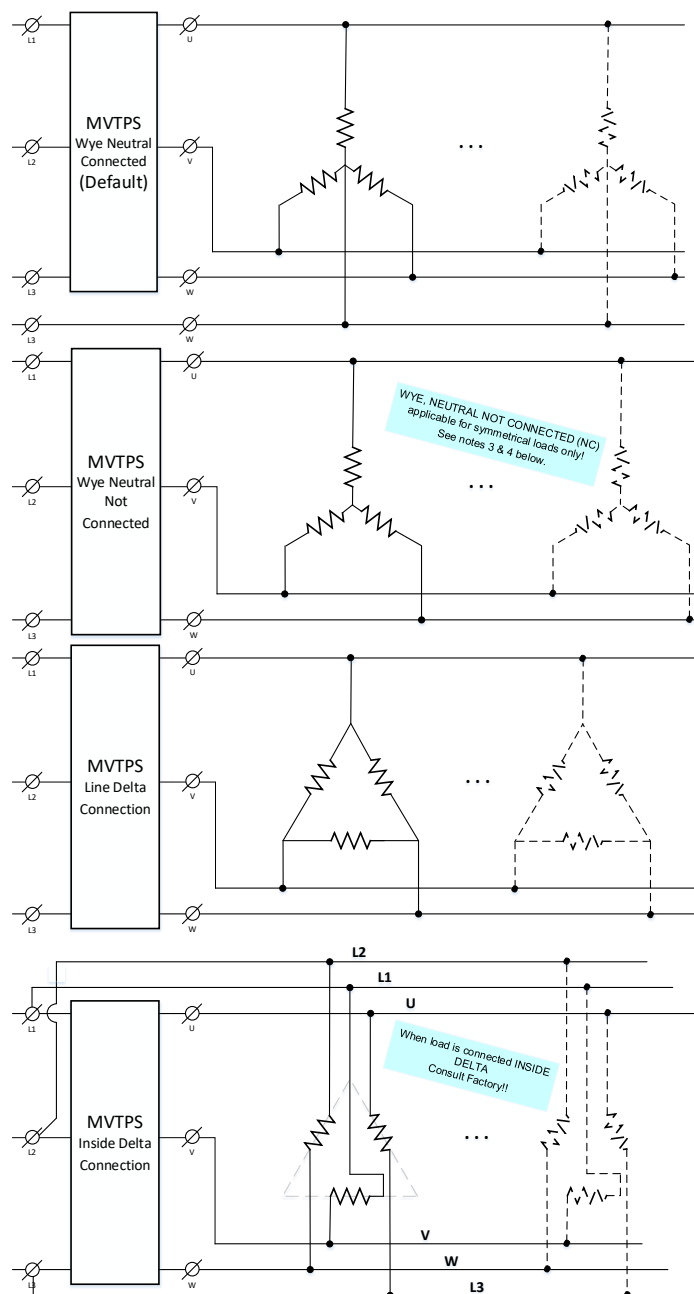


Figure 13 – MV-TPS Load Wiring Schemes

Notes:

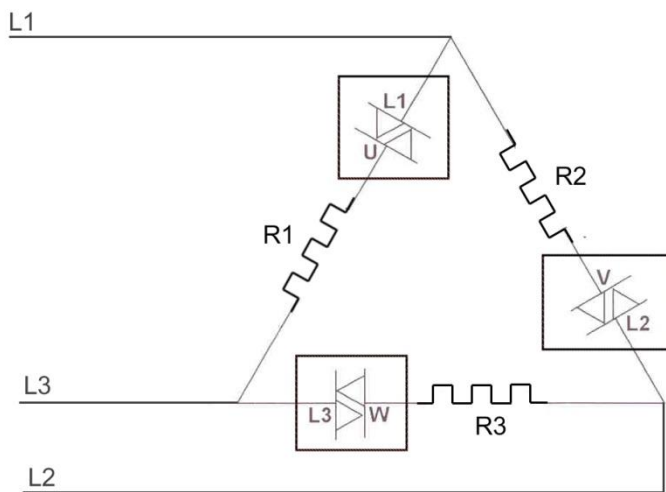
- (1) Set connection type to MV-TPS. Refer to section 9.6.1 on page 36.
- (2) When the load is connected in WYE NEUTRAL NOT CONNECTED or in LINE DELTA (both connections are without a neutral point) and MV-TPS is in PHASE CONTROL it is impossible to go to zero output.
- (3) The minimum possible firing for such a case gives 30-40% of output voltage. This is because the firing of each phase depends on the three phases mains and thus it is not possible to control each phase voltage down to zero.
- (4) In this case, zero input in the Analog input causes the minimum possible voltage to appear in the output. Then, upon increasing the Analog input voltage, output voltage/current is monotonically increased.
- (5) WYE, NEUTRAL NOT CONNECTED (NC) is applicable for symmetrical loads only. Connecting to non-symmetrical loads might damage the load!
- (6) When WYE, NEUTRAL NOT CONNECTED (NC) applies set the UNBALANCE protection to the lowest practical value and trip the MV-TPS upon UNBALANCE or else load will be damaged. Refer to section 9.6.3 on page 41.
- (7) Refer to section 6.2 (next page) for INSIDE DELTA wiring instructions.

6.2 INSIDE DELTA Wiring

When the MV-TPS is connected INSIDE DELTA wiring must be exactly as in the following diagram:

WARNING!

Do not use INSIDE DELTA unless the factory is consulted!!



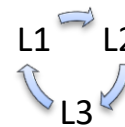
L1-U, L2-V, L3-W represent the three controlled MV-TPS phases.

R1, R2 R3 represent the load.

L1, L2, L3 are mains voltage.

Verify the following:

- Phase sequence as below:



- Phase L1-U of the MV-TPS is connected between L1 and L3 of the mains.
- Phase L2-V of the MV-TPS is connected between L1 and L2 of the mains.
- Phase L3-W of the MV-TPS is connected between L2 and L3 of the mains.

Figure 14 – MV-TPS INSIDE DELTA Connection

When connected INSIDE DELTA wiring scheme must be followed! See note 5 below.

(Don't know where to see note 5 below – need to update this).

6.3 Communication and Synchronization Wiring

WARNINGS!

When the mains voltage is connected to the TPS, even if control voltage is disconnected, full voltage may appear on the TPS load terminals. Therefore, for isolation purposes, it is necessary to connect an isolating device upstream the MV-TPS.

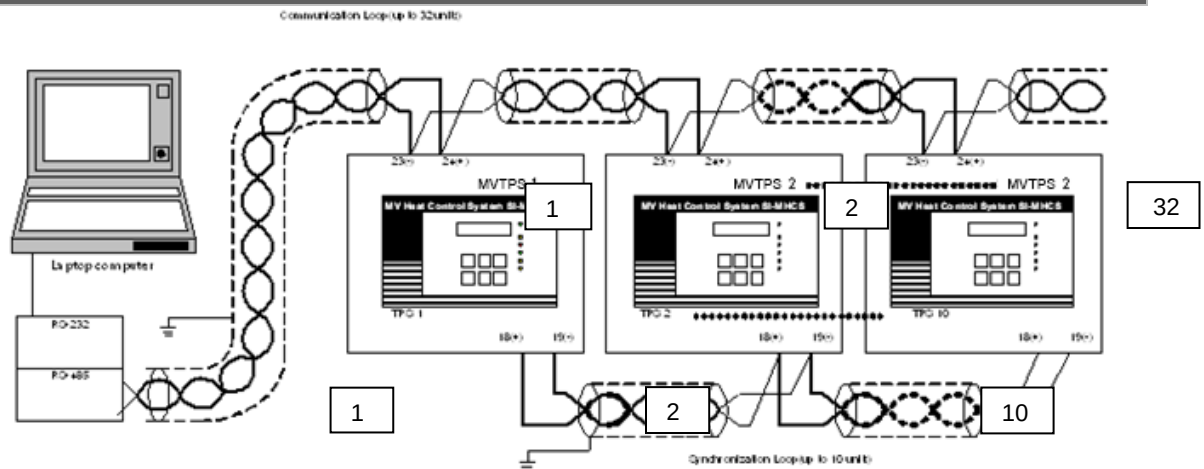


Figure 15 – MV-TPS Synchronization Loop

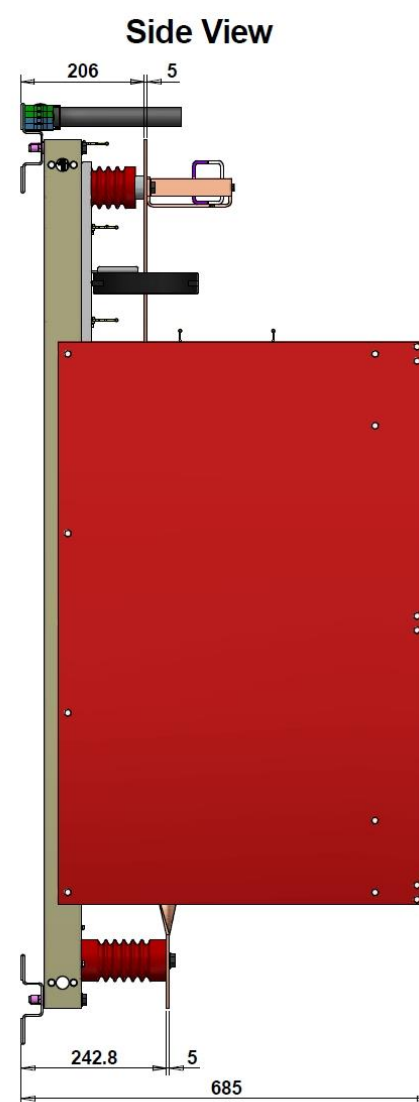
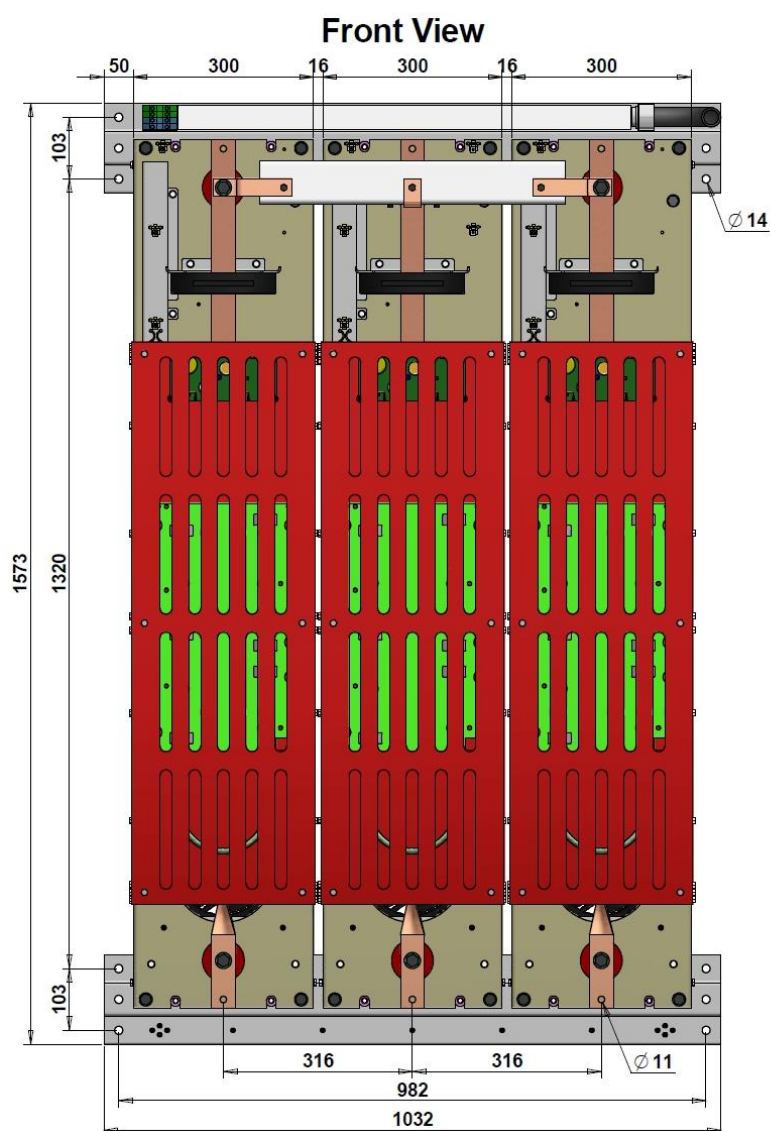
Notes:

- (1) – Use shielded twisted pair for Synchronization loop and for RS485 communication.
- (2) – For communication cabling length of cables should not exceed 200m.
- (3) - For Synchronization cabling length of cables should not exceed 20m.
- (4) - Synchronized mode cannot be implemented if one current Analog input is connected to several MV-TPS units in series. Use Floating (Isolated Analog Inputs).

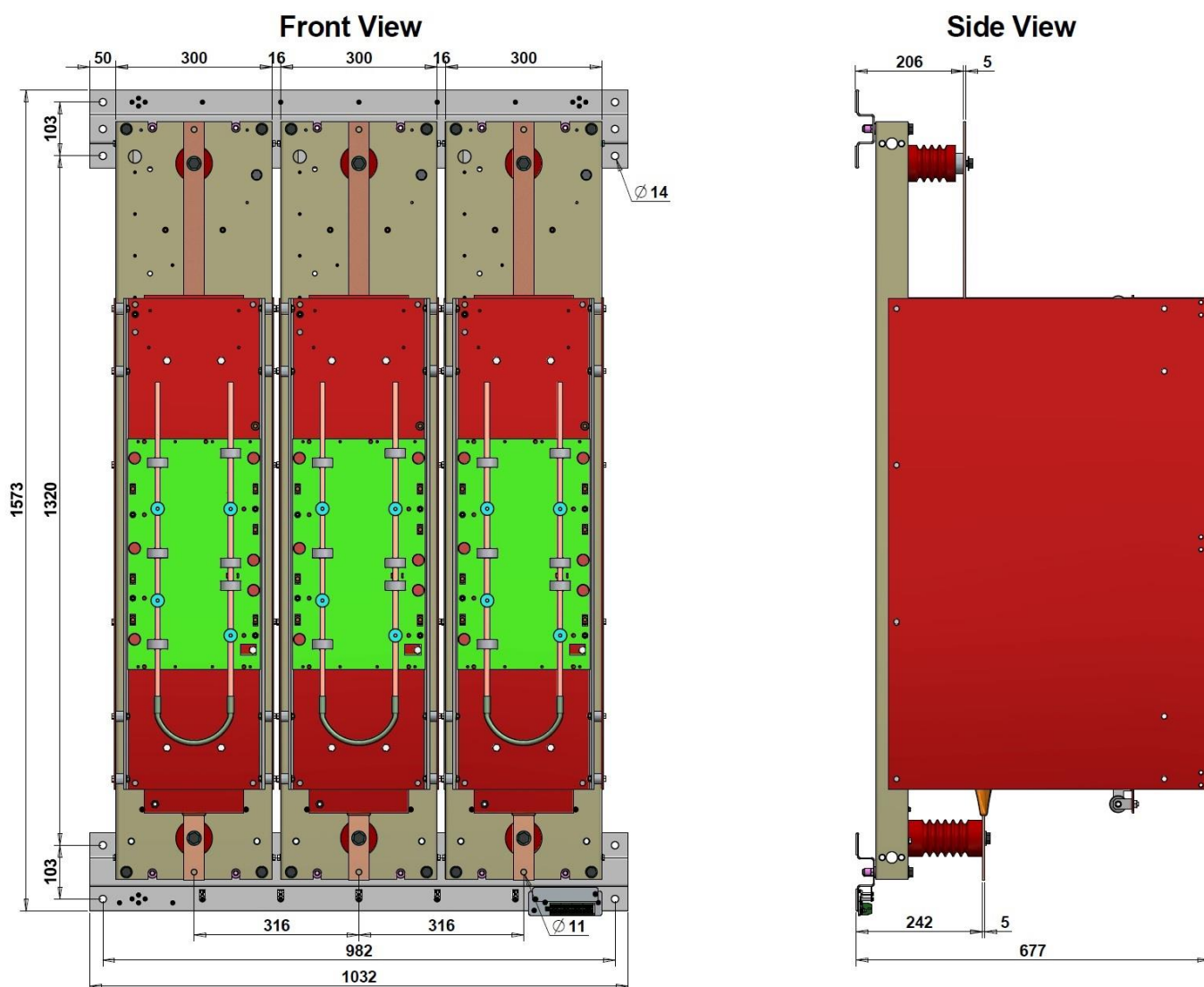
6.4 Wiring Notes

7. DIMENSIONS

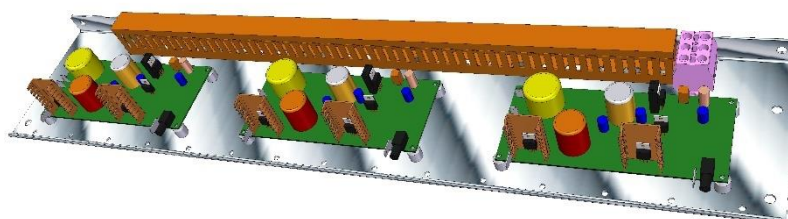
7.1 4.16kV, 60-350A Model Power Section



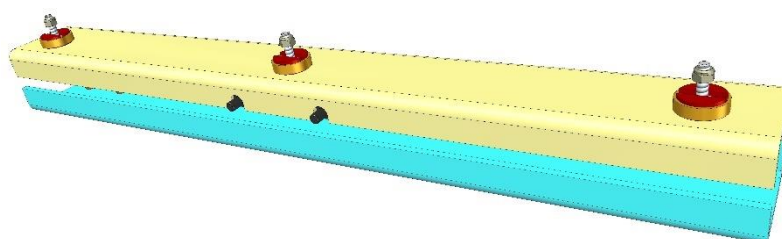
7.1.1. 6.6kV, 60-300A Model Power Section



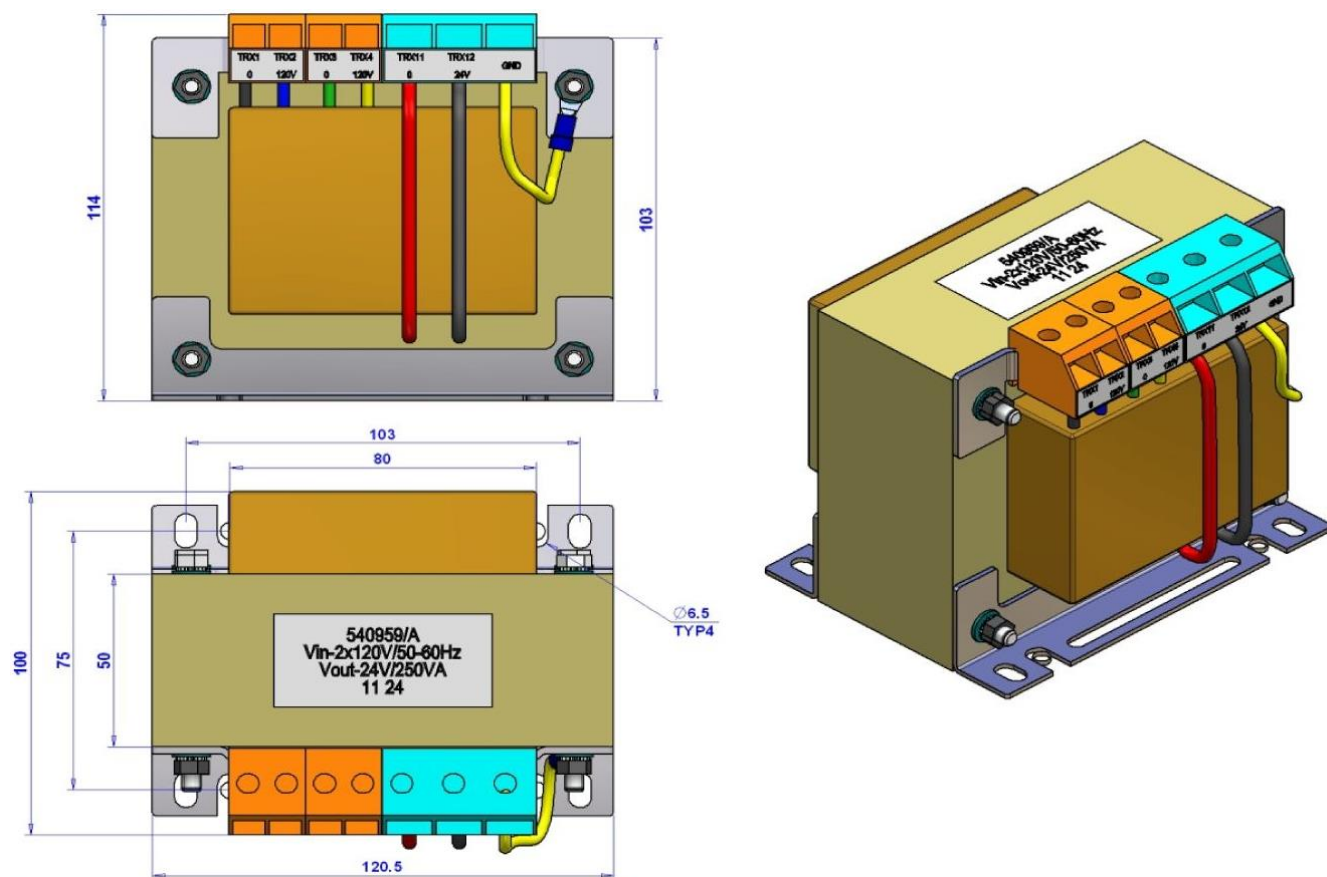
7.1.2. Power Supply Unit For Firing.



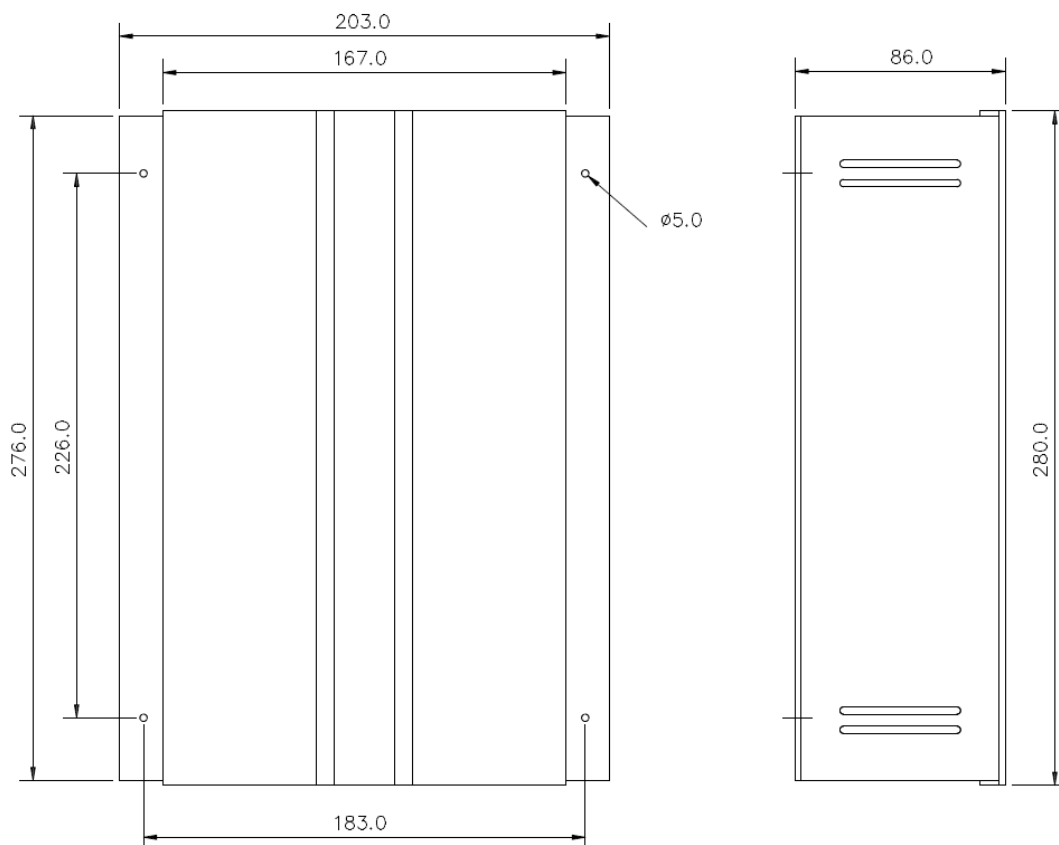
7.1.3. EPT Tx – Transmitter.



7.3 Firing Transformer



7.4 EPT-Rx



8. INSTALLATION OF IP00 (OEM KIT) IN A CABINET

8.1 Mounting

The MV-TPS must be mounted vertically.

Ensure that there is sufficient space for proper airflow above and below the MV-TPS.

Verify that the minimum clearances specified in the applicable codes/standards are applied.

In addition, when glass epoxy of any-type or thickness is used within the cabinet assembly, the minimum clearances specified in the applicable codes/standards are not lowered.

Notes:

- (1) Do not mount the MV-TPS near heat sources.
- (2) Ensure the cabinet's internal temperature does not exceed 50°C.
- (3) Protect the MV-TPS from dust and corrosive environments.
- (4) To perform a low voltage test, apply the following provisions:
 - a. If a step-down transformer is used to provide the Control Voltage, make sure that an external source can also supply the Control Voltage.
 - b. To facilitate phase disassembly, observe the following assembly precautions (Refer to *Figure 16*) for:
 - i. Install a horizontal support bar on the inner side of the MV door.
 - ii. Use two support rods 850mm length with M12 thread.

These support rods will brace the horizontal support bar at the front of the cabinet.

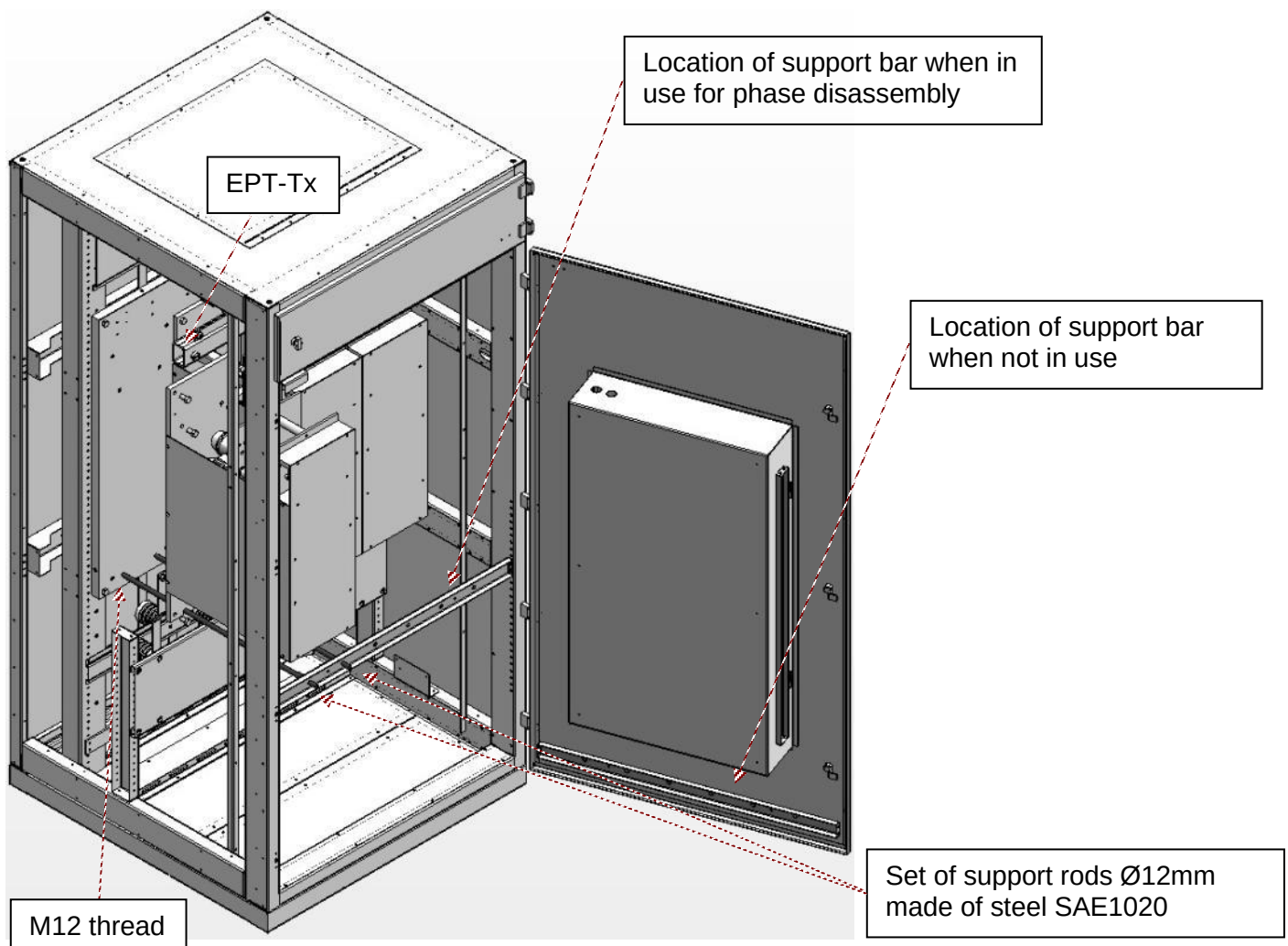


Figure 16 – MV-TPS up to 6.6kV - Phase Disassembly Accessories (optional)

8.1.1 Low Voltage Section

- (1) Install the Control Module in a convenient place allowing access from every direction (this is achieved by mounting it on a hinged plate).
- (2) Because fiber optic cables are fragile, insert them only when assembly is complete.
- (3) Avoid fiber optic wires bending or stretching by maintaining a minimal bending radius of 4 cm.
- (4) Avoid installing fiber optic wires near heat sources.
- (5) Ensure that both the Control Module and the EPT-Rx cases are well grounded.

8.2 Prior to Installation

Select the MV-TPS according to the load Full Load Ampere (FLA).

MV-TPS Load Current (FLC) must be $\geq$ Load Full Load Ampere (FLA).

8.3 Temperature Range & Heat Dissipation

The MV-TPS is rated to operate within a temperature range of -10°C (14°F) to $+50^{\circ}\text{C}$ (122°F).

Relative non-condensed humidity inside the enclosure must not exceed 95%.

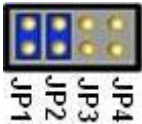
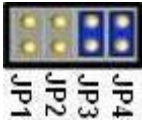
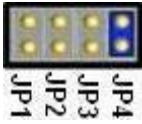
ATTENTION!

Operating the MV-TPS in an environment with a surrounding air temperature that is higher than 50°C will cause derating.

Operating the MV-TPS in an environment with a surrounding air temperature that is higher than 60°C may cause damage to the MV-TPS.

During operation, the maximum heat dissipation (when Analog input is at its maximum) in Watts is as follows:

- $4,160\text{V} - 12 \times \text{FLA} + 400$ [Watt]
- $6,600\text{V} - 18 \times \text{FLA} + 400$ [Watt]
- For example: $4,160\text{V}$ 300A unit's heat dissipation at full load is $12 \times 300 + 400 = 4,000$ Watts

	Description	Use
	JP1 and JP2 are closed JP3 and JP4 are open. * Factory default setting.	Use when 0-20mA or 4-20mA is connected to terminals 16 & 17. Refer to section 9.6.2 on page 38 for programming MV-TPS ANALOG IN TYPE.
	JP3 and JP4 are closed. JP1 and JP2 are open.	Use when 0-10V is connected to terminals 16 & 17. Refer to section 9.6.2 on page 38 for programming MV-TPS ANALOG IN TYPE.
	JP4 is closed. JP1, JP2 and JP3 are open.	Use when potentiometer input is connected to terminals 16 & 17 and 20. MV-TPS must be programmed as "voltage input" 0..10V. Refer to section 9.6.2 on page 38 for programming MV-TPS ANALOG IN TYPE.

Note:



- Indicates closed jumper.

- Indicates open jumper.

8.4 Dip Switches Settings for Analog Output Optional PCB

See next page for Analog output optional PCB location.

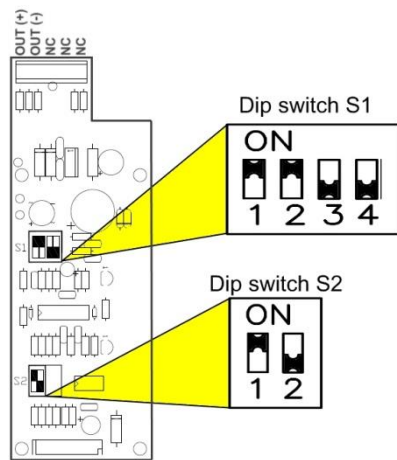


Figure 17 – Analog P.C.B Layout

Analog Output (terminals Out (+), Out (-))

Dip switches allow selection between: 0-10VDC, 0-20mA, 4-20mA

Analog value can be programmed via the key pad in I/O PROGRAMMING SETTINGS page to one of the values as follows (refer to section 9.6.2 on page 38.):

- A. Power, 0-100% OF P_n (Default setting)
- B. I average, 0-100% OF LOAD RATED CURRENT.
- C. I₁, 0-100% OF LOAD RATED CURRENT.
- D. I₂, 0-100% OF LOAD RATED CURRENT.
- E. I₃, 0-100% OF LOAD RATED CURRENT.
- F. ANALOG INPUT (reflection of Analog input to the MV-TPS)

Dip No.	4-20 mA*	0-20 mA	0-10VDC
Dip-Sw. S1 # 1	On	On	Off
Dip-Sw. S1 # 2	On	On	Off
Dip-Sw. S1 # 3	Off	Off	On
Dip-Sw. S1 # 4	Off	Off	On
Dip-Sw. S2 # 1	No use	No use	No use
Dip-Sw. S2 # 2	No use	No use	No use

* Factory default setting

8.5 Control Module Main PCB and Optional PCBs

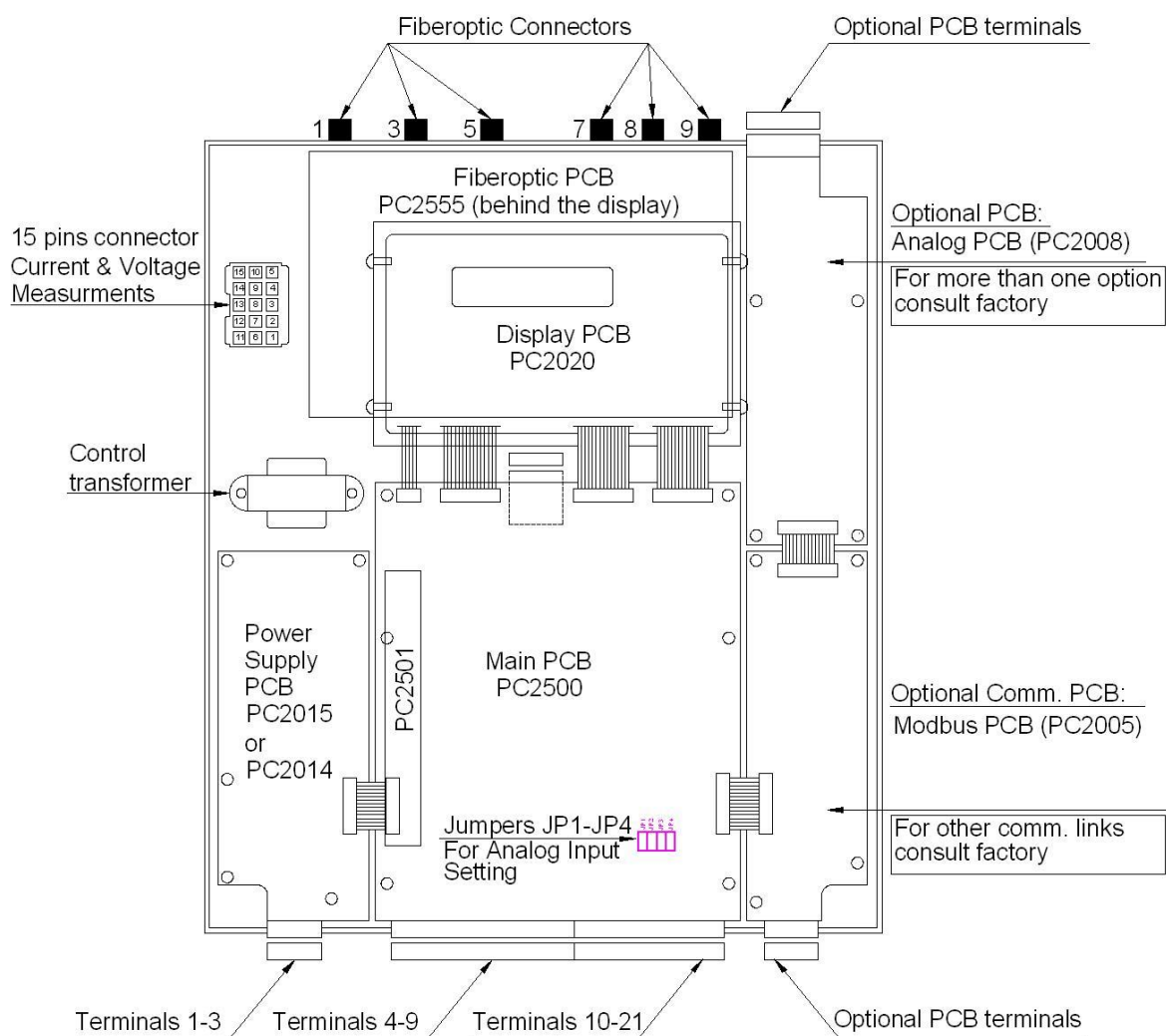


Figure 18 - MV-TPS Control Module

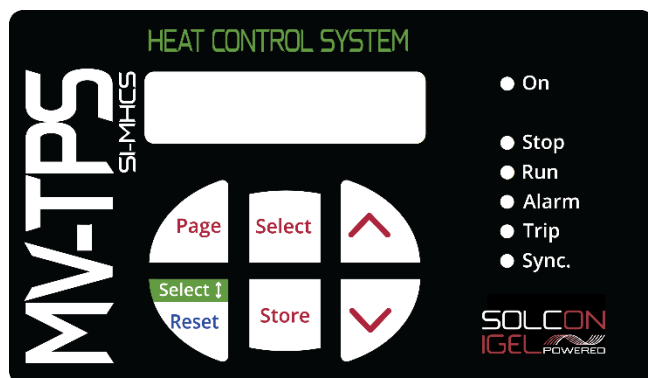
Remove top cover of the Control Module to access the main PCB, optional PCBs, dip switches and jumpers.

9. CONTROL KEYPAD

The control keypad serves as the interface between the MV-TPS and the user.

The MV-TPS control keypad includes the following features:

- Two lines of 16 alphanumeric characters each with two selectable languages – English or Russian (Russian characters must be ordered from factory and cannot be installed on-site).
- Six pushbuttons (**Page**, **Select/Reset**, **Select**, **Store**, Up (▲) and down (▼) keys).
- Six indication LEDs (*On*, *Stop*, *Run*, *Alarm*, *Trip* and *Sync*)



LCD Arrangement

UNDER CURRENT
0% OF FLA

Upper line displays function.

Lower line displays setting and/or measured values.

9.1 Push-buttons

Mode	Allows the operator to navigate through the display and programming menus available in the MV-TPS.
Select	Allows the operator to select a function within each Page . Note: Pressing the Select button continuously will cycle through the parameters continuously.
▲	Allows the operator to increase adjusted values that are displayed. The operator should press this button momentarily, for slow value changes, or continuously, for rapid value changes.
▼	Allows the operator to decrease adjusted values displayed. The operator should press this button momentarily, for slow value changes, or continuously, for rapid value changes.
Store	Allows the operator to store modified parameters in the non-volatile memory.
Select↑ Reset	This key has two functions: Toggle Between "Backward" and "Forward" • The Select key, toggles between "backward" and "forward" navigation. • An underline on the first digit of the second row indicates "backward" mode • If the underline mark is not visible, the key operates in "forward" mode. Reset the Unit • When the MV-TPS is in a latched trip or alarm status, this key resets the unit. • To reset, press and hold the key for 1 second. Note: Alarm/Trip cannot be reset if RUN input signal (terminal 4) is ON.

9.2 Status LEDs.

	Green	<i>On</i>	Lights when Control Supply voltage is connected to the MV-TPS
	Red	<i>Stop</i>	Lights when MV-TPS is in stop condition. (Before RUN command is initiated)
	Green	<i>Run</i>	Lights when MV-TPS is feeding the load.
	Yellow	<i>Alarm</i>	Lights during alarm condition. Note: LED can be latched on/off as per AUTO RESET ENABLE/DISABLE setting.
	Red	<i>Trip</i>	Lights during trip condition. Note: LED can be latched on/off as per AUTO RESET ENABLE/DISABLE setting.
	Green	<i>Sync.</i>	Lights when MV-TPS is programmed to MASTER or SLAVE mode of operation.

9.3 Reviewing and Modifying Parameters

Press **Page** key several times until you reach the required Mode page.

Press **Select** key to review parameters of this Mode.

When reaching the required parameter, modify its values with the ▼ or ▲ keys.

Once the value is set press **Store key**. Once data was properly stored in the non-volatile memory, the LCD will display DATA SAVED OK for 2 seconds.

Additionally, modified parameter/s can be stored at the end of every mode page. Press **Select** key until STORE ENABLE XXX PARAMETERS is displayed, then press **Store** key.

The LCD will display DATA SAVED OK for 2 seconds.

9.4 Special Actions Performed by the Key-pad.

9.4.1 Run Self-Test, Software Version, Default Parameters and Clear Statistical Data

Press **Page** and **▼** keys simultaneously.

The LCD will display:

```
TEST / MAINTENANCE
*****OPTIONS*****
```

Press **Select** key.

The LCD will display:

```
RUN SELF TEST?
PUSH UP ARROW
```

To perform a self-test push **▲** key.

If self-test OK, display will show:

```
SELF TEST PASSED
```

Press **Select** key.

The LCD will display the software version: **(Latest software VER: MV-TPS 29-01-24)**

```
BTL-R-17/05/2009
MV-TPS-180713
```

Press **Select** key.

The LCD will display:

```
STORE NOW?
DEFAULT PARAMETERS
```

To obtain “default parameters” press **Page+Store** Simultaneously.

The LCD will display:

```
DATA SAVED OK
```

At this point (If “default parameters” were obtained) the MV-TPS goes back to the root menu.

To continue the TEST/MAINTENANCE procedure press **Select** several times until LCD displays:

```
CLEAR NOW?
STATISTICAL DATA
```

To clear “statistical data” press **Reset+Store** Simultaneously.

The LCD will display:

```
DATA SAVED OK
```

CAUTION!

Obtaining Default Parameters erases all previously modified settings.

The operator must configure the following parameters to restore factory settings:

- Enter the MAIN PARAMETERS mode page. set:
- RATED LINE VOLT. – As indicated on the MV-TPS label
- TPS RATED CURR. – As indicated on the MV-TPS label

9.5 Mode Pages

Upon initiation of the MV-TPS, the LCD displays:

MAIN PARAMETERS SETTINGS

By pressing the **Page** key all mode pages can be reviewed:

MAIN PARAMETERS SETTINGS
I/O PARAMETERS SETTINGS
PROTECTION PARA. SETTINGS
LOAD SHED. PARA. SET- TINGS
TRIPPING/ALARM ***OPTIONS***
COMM. PARAMETERS SETTINGS
ACTUAL DATA _ **** _
STATISTICAL DATA _ **** _
FAULT DATA _ **** _

Notes:

1. Pressing the **Store** key while the LCD displays an "Actual Data" parameter, saves it as the default display. If no key is pressed for more than five minutes, this parameter will be constantly displayed.
 2. Pressing the **Store** key, while the LCD displays a header, saves it as the default display. If no key is pressed for more than five minutes this header will be constantly displayed.
-

9.6 Mode Pages, Parameters & Default Values

MAIN PARAMETERS SETTINGS	I/O PARAMETERS SETTINGS	PROTECTION PARA. SETTINGS	LOAD SHED. PARA. SETTINGS	TRIPPING/ALARM ***OPTIONS***
See page 36	See page 38	See page 41	See page 43	See page 44
Display and default values	Display and default values	Display and default values	Display and default values	
LINE VOLTS (Vn) 6600V	ANALOG IN TYPE 4 ... 20mA	UNDER CURRENT 0 % OF FLA	CURRENT LIMIT OFF	
LINE FREQUENCY 50 Hz	ANALOG IN T. CONST 1,0 SEC.	U/C DELAY 10.0 SEC.	MASTER/SLAVE OFF	
TPS RATED CURR. 300 AMP.	AUX. IN TYPE FAN FAILURE	OVER CURRENT 120 % OF FLA	NO. OF SYNC UNITS 4	
LOAD RATED CURR. 300 AMP.	CONFIG OUT A RUN (IMMEDIATE)	O/C DELAY 5.0 SEC.	SYNC. NUMBER 4	
LOAD RATED POWER 3425.0 KW	OUT A RELAY DLY 0.0 SEC.	UNBALANCE LVL 1 10% OF FLA	STORE ENABLE LOAD SHED. PARA.	
CONNECTION TYPE DELTA	CONFIG OUT B ALARM	U/B LVL 1 DELAY 10.0 SEC.		
LOAD POWER FACTOR 1.0	OUT B RELAY DLY 0.0 SEC.	UNBALANCE LVL 2 20% OF FLA		
FIRING METHOD ZERO CROSSING	CONFIG OUT C TRIP	U/B LVL 2 DELAY 5.0 SEC.		
CONTROL MODE INPUT SIGNAL	OUT C RELAY DLY 0.0 SEC.	UNDER VOLTAGE 80 % OF Vn		
ON-OFF CYCLE T 2.0 SEC.	KWH PER PULSE OFF	U/V DELAY 5.0 SEC.		
TURN ON DELAY 4 SEC.	AN. OUT PARAMETER P, 0-100% OF Pn	OVER VOLTAGE 115 % OF Vn		
TURN OFF DELAY 0.0 SEC.	STORE ENABLE I/O PARAMETERS	O/V DELAY 1.0 SEC.		
PARAM. SETTING NOT LOCKED		PHASE LOSS DELAY 2.0 SEC.		
LANGUAGE ENGLISH		GND FAULT LEVEL 10 % OF FLA		
STORE ENABLE MAIN PARAMETERS		GND FAULT DELAY 2.0 SEC.		
		UNDER POWER LVL 0 % OF Pn		
		UNDER POWER DLY 10.0 SEC.		
		EXT. FAULT DELAY 5.0 SEC.		
		PWR ON & NO STRT ENABLE		
		STORE ENABLE PROTECTION PARA.		

COMM.PARAMETERS SETTINGS	ACTUAL DATA _****_	STATISTICAL DATA _****_	FAULT DATA _****_
See page 45	See page 46	See page 47	See page 47
Display and default values	Display	Display	Display
COMM. PROTOCOL MODBUS	Vp1 Vp2 Vp3 0 0 0 V	TOTAL RUN TIME 0 HOURS	LAST TRIP NO DATA
BAUD RATE 19200	VL12 VL23 VL31 0 0 0 V	TOTAL # OF TRIPS 0	LAST ALARM NO DATA
PARITY CHECK EVEN	ANALOG INPUT 26%	TOTAL ENERGY 0 KWH	TRIP I1 I2 I3 0 0 0 A
SERIAL LINK NO. 248 (OFF)	ON I1 I2 I3 0 0 0 A		TRIP GND CURRENT 0 AMP.
S. LINK PAR. SAVE ENABLE	GROUND CURRENT 0 AMP.		TRIP Vp1 Vp2 Vp3 0 0 0 V
SER.LINK CONTROL START STOP ONLY	FREQUENCY 50 Hz		LAST 10 TRIPS: NO DATA
			PHASE LOSS (-1)
STORE ENABLE COMM. PARAMETERS	POWER 0 KW		PREVIOUS TRIP -2 NO DATA
	LOAD CURRENT 0 % OF FLA		.
			PREVIOUS TRIP -9 NO DATA
	UNBALANCE CURR. 0 %		

9.6.1 Main Parameters Settings – Page 1

MAIN PARAMETERS SETTINGS		
Display and default values	Range	Description
LINE VOLTS (Vn) 4160V	2300V-13800V	Sets the MV-TPS mains voltage
LINE FREQUENCY 60 Hz		
TPS RATED CURR. 300 AMP.	20A-1800A	Sets the MV-TPS RATED CURRENT (FLC) MV-TPS RATED CURRENT should be as shown on the MV-TPS Name plate. (Refer to section 8.2 on page 27)
LOAD RATED CURR. 200 AMP.		
LOAD RATED POWER 1440 KW	10A-1800A	Sets the LOAD RATED CURRENT (FLA). Should be programmed as shown on load's name plate. Note: LOAD RATED CURRENT ≤ MV-TPS RATED CURRENT in <u>all</u> 3 phases.
LOAD RATED POWER 1440 KW	40kW-20000kW	Sets LOAD RATED POWER. This parameter is used to: Close a control loop when in PHASE CONTROL-POWER mode of operation. Refer to section 5.6.4 on page 16. Calculate the Analog output when set as P, 0-100% OF Pn
CONNECTION TYPE WYE, NEUTRAL NC	WYE, NEUTRAL CON WYE, NEUTRAL NC DELTA INSIDE DELTA	Sets connection mode of the MV-TPS. Refer to section 6.1 on page 19. Caution: WYE, NEUTRAL NC applicable for symmetrical loads only. Connecting to non-symmetrical loads might damage the load! When WYE, NEUTRAL NC applies set the UNBALANCE protection to the lowest practical value and trip the the MV-TPS upon UNBALANCE to prevent damage to the load. Refer to section 9.6.3 on page 41. Consult factory before using in INSIDE DELTA.
LOAD POWER FACTOR 1.0	0.99-1.0	Sets load rated power factor. Note that load must be of pure resistive! In case of load with a different power factor – consult factory.
FIRING METHOD ZERO CROSSING	Zero Crossing Phase Control Ph Ctrl to ZC in 1 sec . . Ph Ctrl to ZC in 3600s PH. CTRL – POWER	Sets the MV-TPS mode of operation Refer to section 5.6 on page 14.
CONTROL MODE INPUT SIGNAL	INPUT SIGNAL	Reserved for future enhancement.

MAIN PARAMETERS SETTINGS		
Display and default values	Range	Description
ON-OFF CYCLE T 2.0 SEC.	1.0sec. – 10sec.	Sets the MV-TPS cycle time, TCY, when operating in ZERO CROSSING. Refer to section 5.6.1 on page 14.
TURN ON DELAY 1.5 SEC.		
TURN OFF DELAY 0.0 SEC.	0.0sec. – 60sec.	Sets the MV-TPS OFF DELAY. This feature is used when several units receive the OFF command instantaneously. Programming different delays will prevent sudden un-loading of the supply.
PARAM. SETTING NOT LOCKED		
LANGUAGE ENGLISH	ENGLISH RUSSIAN	Enable language selection. Note that Russian language requires hardware modification therefore must be factory ordered.
STORE ENABLE MAIN PARAMETERS		
		Storing modified parameters To store selected parameters, press Store key. Note: Storing more than one parameter is possible only when the MV-TPS is not running. While the MV-TPS is running each parameter can be changed individually by pressing the Store key after modifying the parameter. When the parameters are correctly stored, the LCD will read: DATA SAVED OK <u>This concludes MAIN PARAMETER settings.</u> Pressing Select key after DATA SAVED OK returns to the first display in this mode. <u>Note:</u> In case of a failure in parameter storing, the LCD displays: STORAGE ERROR In this case refer to section 14.4 page 69 for trouble shooting.

9.6.2 I/O Parameters – Page 2

I/O PARAMETERS SETTINGS		
Display and default values	Range	Description
ANALOG IN TYPE 4 - 20mA/ 0 – 10V	0 - 10 V 0 - 20 mA 4 - 20 mA	Sets the MV-TPS type of input control input. (Terminals 16-17) 0 - 10V is programmed when the Analog input is 0 - 10V or potentiometer option is installed. 0 - 20mA is programmed when the Analog input is 0 - 20mA. 4 - 20mA is programmed when the Analog input is 4 - 20mA. Notes: 1. The customer must set jumpers settings to set the MV-TPS hardware for programmed ANALOG IN TYPE. Refer to section Error! Reference source not found. on page Error! Bookmark not defined. 2. When using the potentiometer option program ANALOG IN TYPE to 0 - 10V. 3. Synchronized mode cannot be implemented if a single current Analog input is connected to several MV-TPS units in series.
ANALOG IN T. CONST 1.0 SEC.	0.0 SEC. – 10.0 SEC.	Sets the MV-TPS time constant. These parameters control the response time of the unit to the Analog input changes from one value to the other. When starting the MV-TPS, even if the Analog input is high, the ANALOG IN T. CONST function will gradually increase the “internal” value of the Analog input to prevent rapid changes in the output. This parameter setting active in PHASE CONTROL as well as in ZERO CROSSING.
AUX. IN TYPE REMOTE RESET	FIRING TEST FAN FAILURE AUTHORIZED KEY REMOTE RESET N.C. EXT. FAULT N.O. EXT. FAULT N.C. INTERLOCK N.O. INTERLOCK	Sets MV-TPS AUX IN TYPE. (Terminal 5). SYNC. Is for future enhancement. AUTHORIZED KEY is programmed to prevent parameter modifications. N.O./N.C. EXT. FAULT is programmed when auxiliary fault signal is initiated to the MV-TPS. N.C./N.O. INTERLOCK is programmed to interlock the MV-TPS with auxiliary signals. FIRING TEST is programmed to run a firing test after factory installation or in trouble shooting. Refer to section 14.3 page 67.
CONFIG OUT A RUN (IMMEDIATE)	KWH PULSE RE-LAY	Sets the MV-TPS functions of output relay A (Terminals 7, 8, 9)

I/O PARAMETERS SETTINGS		
	TRIPPING/ ALARM TRIP-FAIL SAFE TRIP ALARM-FAIL SAFE ALARM RUN (IMMEDIATE)	The KWH PULSE RELAY is programmed to provide an output pulse for KWH metering. The rated KWH per pulse is configured in the KWH PER PULSE parameter (refer to the section below). TRIPPING/ALARM is programmed when this OUT RELAY is programmed as TRIPPING/ALARM. Refer to section 9.6.5 page 44. TRIP-FAIL SAFE is programmed when this OUT RELAY is programmed as TRIP-FAIL SAFE. TRIP is programmed when this OUT RELAY is programmed as TRIP. ALARM-FAIL SAFE is programmed when this OUT RELAY is programmed as ALARM-FAIL SAFE. ALARM is programmed when this OUT RELAY is programmed as ALARM. RUN (IMMEDIATE) is programmed when this OUT RELAY is programmed as RUN (IMMEDIATE) and closes when the MV-TPS is in RUN mode.
OUT A RELAY DLY 0.0 SEC.	0.0 SEC.-60.0 SEC.	Sets delay time for this OUT RELAY.
CONFIG OUT B ALARM	Same as CONFIG OUT A – See above.	Sets the MV-TPS functions of output relay B (Terminals 10, 11, 12)
		Same as CONFIG OUT A – See above.
OUT B RELAY DLY 0.0 SEC.	0.0 SEC.-60.0 SEC.	Sets delay time for this OUT RELAY.
CONFIG OUT C TRIP	Same as CONFIG OUT A – See above.	Sets the MV-TPS functions of output relay C (Terminals 13, 14, 15)
		Same as CONFIG OUT A – See above.
OUT C RELAY DLY 0.0 SEC.	0.0 SEC.-60.0 SEC.	Sets delay time for this OUT RELAY.
KWH PER PULSE OFF	OFF, 1KWH - 100KWH	Sets the KWH/Pulse for KWH metering. OUT A or OUT B or OUT C must be programmed to KWH PULSE RELAY in order that this function will be effective (See above).
AN. OUT PARAMETER P, 0-100% OF Pn AN. INPUT OFFSET 1/0 AN.IN = 0.2%	P, 0-100% OF Pn I, 0-100% OF FLA. I1, 0-100% OF FLA. I2, 0-100% OF FLA. I3, 0-100% OF FLA. ANALOG INPUT	Sets the MV-TPS Analog output terminals out (+), out (-) (optional). Dip switches on the Analog output PCB allow selection between 0-10VDC/ 0-20mA/ 4-20mA Refer to section 8.4 page 28 for dip switch settings. P, 0-100% OF Pn - is programmed when Analog output is related to Pn (LOAD RATED POWER). Pn (LOAD RATED POWER) is set in MAIN PARAMETERS SETTINGS. Refer to section 9.6.1 page 36. I, 0-100% OF FLA - is programmed when Analog output is related to average I as a percentage of LOAD RATED CURRENT. I1(I2, I3), 0-100% OF FLA - is programmed when Analog output is related to I1 (I2, I3) as a percentage of LOAD RATED CURRENT. ANALOG INPUT - is programmed when Analog output is a reflection of Analog input.
STORE ENABLE I/O PARAMETERS		Same as STORE ENABLE MAIN PARAMETERS On page 37.

9.6.3 Protection Parameters – Page 3

PROTECTION PARA. SETTINGS		
	Note: The settings of the PROTECTION PARAMETERS listed below are related to the level and time delay of each protection parameter. The functionality of each protection must be programmed in the TRIPPING /ALARM OPTIONS. Refer to section 9.6.5 page 44.	
Display and default values	Range	Description
UNDER CURRENT 0 % OF FLA	0 %-95%	Sets the value in % of “load rated current” below which the UNDER CURRENT protection is triggered. Note: When the MV-TPS is in ZERO CROSSING mode of operation, the measured current used for this function is the ON state current value.
U/C DELAY 10.0 SEC.		Sets the time delay for the UNDER CURRENT protection after current has reached the pre-set level.
OVER CURRENT 120 % OF FLA	50 %-150%	Set the value in % of load rated current above which the OVER CURRENT protection is triggered. Notes: 1. When the MV-TPS is in ZERO CROSSING mode of operation, the measured current used for this function is the ON state current value. 2. O/C includes also fast (< 60mS) O/C with fixed level of 180% MV-TPS RATED CURRENT.
O/C DELAY 5.0 SEC.		Sets the time delay for the OVER CURRENT protection after current has reached the pre-set level.
UNBALANCE LVL 1 10% OF FLA	1%-100%	Sets the protection for unbalanced load conditions such as disconnected (failed) load resistor(s). This function is calculated according to the ratio of $100X(I_{MAX}-I_{MIN})/I$ where: I_{MAX} - The highest of the 3 phases currents I_{MIN} - The lowest of the 3 phases currents I – In case $I_{MAX}>LOAD\ RATED\ CURRENT$, $I= I_{MAX}$ – In case $I_{MAX}<LOAD\ RATED\ CURRENT$, $I= LOAD\ RATED\ CURRENT$ Notes: When the MV-TPS is in ZERO CROSSING mode of operation, the measured current used for this function is the ON state current value. When the WYE, NEUTRAL NOT CONNECTED (NC) applies set this protection to the lowest practical value and trip the MV-TPS upon UNBALANCE or else load will damage.
U/B LVL 1 DELAY 10.0 SEC.		Sets the time delay for the CURRENT UNBALANCE LEVEL 1 protection after current unbalance has reached the above set level.
UNBALANCE LVL 2 20% OF FLA	1%-100%	Same as UNBALANCE LVL 1.
U/B LVL 2 DELAY 5.0 SEC.	1.0 SEC.-60.0 SEC	Sets the time delay for the CURRENT UNBALANCE

PROTECTION PARA. SETTINGS		
	Note: The settings of the PROTECTION PARAMETERS listed below are related to the level and time delay of each protection parameter. The functionality of each protection must be programmed in the TRIPPING /ALARM OPTIONS. Refer to section 9.6.5 page 44.	
Display and default values	Range	Description
		LEVEL 2 protection after current unbalance has reached the pre-set level. Note: Set the parameter at a higher value than U/B LVL 1 time delay.
UNDER VOLTAGE 80 % OF Vn	50 %-95%	Sets the value in % of line rated voltage below which the UNDER VOLTAGE protection is triggered. Active during RUN conditions only.
U/V DELAY 5.0 SEC.	1.0 SEC.-60.0 SEC	Sets the time delay for the UNDER VOLTAGE protection after voltage has reached pre-set level.
OVER VOLTAGE 115 % OF Vn	100 %-120%	Sets the value in % of line rated voltage above which the OVER VOLTAGE protection is triggered.
O/V DELAY 1.0 SEC.	0.1 SEC.-60.0 SEC.	Sets the time delay for the OVER VOLTAGE protection after voltage has reached pre-set level
PHASE LOSS DELAY 2.0 SEC.	1.0 SEC.-60.0 SEC	Sets the time delay for the PHASE LOSS protection after phase loss has been detected.
GND FAULT LEVEL 10 % OF FLA	10 %-100%	Sets the GROUND FAULT protection level in % of the vector sum of the three-phase current (zero sequence). Note: Not active when WYE NEUTRAL CON connection type is programmed.
GND FAULT DELAY 2.0 SEC.	1.0 SEC.-60.0 SEC	Sets the time delay for the GROUND FAULT protection after current has reached above set level
UNDER POWER LVL 0 % OF Pn	0 %-95%	Programmable value in % of load actual power below which the UNDER POWER protection is triggered. Note: When the MV-TPS is in ZERO CROSSING mode of operation, the measured power taken for this function is the ON State power X ON time/ (ON time+ OFF time).
UNDER POWER DLY 10.0 SEC.	5.0 SEC.-60.0 SEC	Sets the time delay for the UNDER-POWER protection after power has reached above set level.
EXT. FAULT/ FAN DELAY 5.0 SEC.	0.0 SEC.-60.0 SEC	Programmable time delay for EXTERNAL FAULT signal after control voltage has been applied to terminal 5 (AUX. IN) and NO or NC EXTERNAL FAULT has been programmed (Refer to section 9.6.2 page 38 for programming AUX. IN TYPE)
STORE ENABLE PROTECTION PARA.		Same as STORE ENABLE MAIN PARAMETERS On page 37.

9.6.4 Load Shedding Parameters Settings– Page 4

LOAD SHED. PARA. SETTINGS		
Display and default values	Range	Description
CURRENT LIMIT OFF		This function is for future enhancement.
MASTER/SLAVE OFF	MASTER SLAVE OFF	Program the MV-TPS to work in a synchronization mode. Refer to section 5.7 page 16 for more details. OFF – Load Shedding feature is disabled. SLAVE – The MV-TPS unit is controlled by another MV-TPS unit programmed as MASTER. MASTER – The MV-TPS unit controls a number (up to 9) of other MV-TPS units Note: Synchronized mode cannot be implemented if one current Analog input is connected to several MV-TPS units in series.
NO. OF SYNC UNITS 5	2-10	Programmable to the number of units to be connected together as one synchronized group. e.g. - Set to 4, when one master and three slaves are used. Note: When setting this parameter, take into consideration, the % of rated power, required for maintaining the temperature at the “steady state” condition. If, for example the required power is 25% of rated, then setting "no. of sync units" = 4 (1 master + 3 slaves), is reasonable.
SYNC. NUMBER 2	1-10	Programmable “Sync communication” address of each MV-TPS unit. MASTER unit must be set to 1. TPSs programmed as SLAVE should be set for addresses 2 and up to 10.
STORE ENABLE LOAD SHED. PARA.		Same as STORE ENABLE MAIN PARAMETERS On page 37.

9.6.5 **Tripping/Alarm Parameters – Page 5**

For easy viewing, tripping/alarm pages are not listed as in other pages but as a table.

Notes:

1. The below table shows the default settings of the tripping and alarm options. Should the customer prefer alternate settings, this can be performed on this Mode Page.
2. Each of the faults listed below can be programmed as DISABLED (-) or ENABLED (+)
3. The table below shows factory defaults.

FAULT	Trip	Alarm	Auto Reset	Panel Reset	Remote Reset	Output A	Output B	Output C
UNDER CURRENT	-	-	-	+	+	-	-	-
OVER CURRENT	+	+	-	+	+	-	-	-
UNBALANCE LVL 1*	-	-	-	+	+	-	-	-
UNBALANCE LVL 2 *	-	-	-	+	+	-	-	-
UNDER VOLTAGE	-	+	-	+	+	-	-	-
OVER VOLTAGE	+	+	-	+	+	-	-	-
PHASE LOSS	+	+	+	+	+	-	-	-
GROUND FAULT	-	-	-	+	+	-	-	-
UNDER POWER	-	-	-	+	+	-	-	-
SHORTED SCR	-	-	-	+	+	-	-	-
WRONG CONCT TYPE "WRONG CONNEC- TION"	-	-	-	+	+	-	-	-
HEAT SINK OVER T.	+	+	-	+	+	-	-	-
EXTERNAL FAULT	-	-	-	+	+	-	-	-
COMM PORT FAILED	-	-	-	+	+	-	-	-
INTERNAL FAILURE	-	-	-	+	+	-	-	-
PWR ON & NO STRT	-	+	-	+	+	-	-	-

* For calculation method of UNBALANCE LVL1&2 refer to section 9.6.3 on page 41.

9.6.6 Comm. Parameters – Page 6

COMM.PARAMETERS SETTINGS	All below settings only applicable of optional Modbus PCB (option 3M) is installed.	
Display and default values	Range	Description
COMM. PROTOCOL MODBUS	MODBUS	Sets the MV-TPS communication PROTOCOL.
BAUD RATE 19200		Sets the MV-TPS BAUD RATE.
PARITY CHECK EVEN		Sets the MV-TPS communication PARITY CHECK.
SERIAL LINK NO. 248 (OFF)	1 – 248 (off)	Sets the MV-TPS communication SERIAL LINK NO.
S.LINK PAR. SAVE DISABLE	ENABLE DISABLE	When set to DISABLE, it prevents parameter setting through serial link communication. When set to Enable, parameter setting through serial link is enabled.
SER.LINK CONTROL DISABLE		When DISABLE is selected control via serial link is not possible. When START/STOP is selected, a START, STOP and RESET commands can be initiated via the serial link. When FULL is selected, all commands as in START/STOP option can be initiated via the serial link and, in addition, the value of the Analog input is taken from the serial link. Note: When FULL option is selected, the wired Analog input (Terminals 16, 17 and 20) of the MV-TPS is not active.
STORE ENABLE COMM. PARAMETERS		Same as STORE ENABLE MAIN PARAMETERS On page 37.

9.6.7 Actual Data – Page 7

ACTUAL DATA __****__				
Display				Description
Vp1	Vp2	Vp3		Displays system phase voltage. If no neutral in the system, a “virtual ground” is used for measuring phase voltage.
0	0	0	V	
VL12	VL23	VL31		Displays system line voltage.
0	0	0	V	
ANALOG INPUT 26%				Displays ANALOG INPUT rate.
ON	I1	I2	I3	Displays currents of 3 phases. The current shown is when the MV-TPS is in ON during the ON-OFF CYCLE T in ZERO CROSSING mode. This display (with ON shown on top left of the display) shown in ZERO CROSSING mode. In PHASE CONTROL mode the ON is not shown on the display.
0	0	0	A	
GROUND CURRENT 0 AMP.				Display calculated GROUND CURRENT. Notes: Not active when WYE NEUTRAL CON is programmed. When the MV-TPS is in ZERO CROSSING mode of operation, the calculated current used for this function is the ON state current value.
FREQUENCY 60 Hz				Display measured system frequency.
POWER 0 KW				Display measured system power.
LOAD CURRENT 0 % OF FLA				Display measured current as a ratio of LOAD RATED CURRENT (FLA).
UNBALANCE CURR. 0 %				Display unbalance current as a ratio of $100X(I_{MAX}-I_{MIN})/I$ where: I_{MAX} - The highest of the 3 phases currents I_{MIN} - The lowest of the 3 phases currents I – In case $I_{MAX}>LOAD\ RATED\ CURRENT$, $I= I_{MAX}$ – In case $I_{MAX}<LOAD\ RATED\ CURRENT$, $I= LOAD\ RATED\ CURRENT$

9.6.8 **Statistical Data – Page 8**

STATISTICAL DATA _ **** _	
Display and default values	Description
TOTAL RUN TIME 0 HOURS	Displays TOTAL RUN TIME of the MV-TPS since last statistics reset.
TOTAL # OF TRIPS 0	
TOTAL ENERGY 0 KWH	Displays TOTAL ENERGY drawn by the MV-TPS in KWH since last statistics reset.

9.6.9 **Fault Data – Page 9**

FAULT DATA _ **** _	
Display and default values	Description
LAST TRIP NO DATA	Displays MV-TPS LAST TRIP cause.
LAST ALARM NO DATA	
TRIP I1 I2 I3 0 0 0 A	Displays MV-TPS I1, I2, I3 when LAST TRIP occurred.
TRIP GND CURRENT 0 AMP.	Displays MV-TPS calculated GND CURRENT when LAST TRIP occurred.
TRIP Vp1 Vp2 Vp3 0 0 0 V	
LAST 10 TRIPS: NO DATA	Displays MV-TPS last trips.
PREVIOUS TRIP -2 NO DATA	
.	
PREVIOUS TRIP -9 NO DATA	

10. COMMISSIONING AND OPERATION MANUAL

WARNING!

The information in this manual does not aim to cover all details or variations of the equipment, nor does it address every possible contingency related to installation, operation, or maintenance.

If additional information is needed or if specific issues arise that are not sufficiently addressed for the purchaser's needs, please contact your local Solcon-IGEL representative.

Furthermore, the contents of this manual do not form part of, nor modify, any existing agreements, commitments, or relationships. The sales contract outlines the full obligations of Solcon-IGEL. The warranty specified in the contract between the parties is the sole warranty provided by Solcon-IGEL. Any statements within this manual do not create new warranties nor alter the existing warranty.

Safety Precautions!

- Read this manual carefully before operating the equipment and follow its instructions.
- Installation, operation and maintenance should be in strict accordance with this manual, national codes and good practice. Installation or operation not performed in strict accordance with these instructions will void manufacturer's warranty.
- Never open the medium voltage doors of the cabinet while medium voltage is connected to the cabinet.
- Do not open the medium voltage doors, even if the load is not running and the Line Contactor is open. Medium voltage may still be connected to the cabinet (upstream the contactor)!
- Ensure, before opening the medium voltage doors, that the input medium voltage lines are disconnected from mains and grounded.
- Before closing the doors for medium voltage operation, ensure that the low voltage Test Harness is not connected. The Test Harness is only used for the low voltage test. As a rule, always disconnect the harness immediately after ending the low voltage test. It should be mounted inside small plastic bag in the drawing pocket. This Test Harness is equipped with long tape, intended to prevent forgetting it connected. Never cut this warning tape. Leave open for its full length and laid in such a way that the harness will not be forgotten connected after the low voltage test.
- The Line Contactor is not designed for disconnecting high short circuit currents. Therefore, a programmed trip relay must be used to open the upstream breaker. Alternatively, upstream fuses can be used.
- The software of the external PLC (if used) controlling the MV-TPS must check the status of the programmed trip relay. Upon detecting a trip signal, the PLC should remove RUN command (terminal 4) immediately.

10.1 Operational Notes

- The Logic Inputs of the Control Module (terminals 4-5-6) are high impedance inputs. Add an auxiliary relay for each Logic Input connected through long wire to a remote location outside the MV-TPS cabinet.
- Perform a Megger test to the load and its cables while disconnected from the cabinet. After the end of test, leave the cable unconnected to enable the low voltage test.

Warning!

- Internal components and PCBs are exposed to high potential when the MV-TPS cabinet is connected to mains voltage.
- Never connect medium voltage to the cabinet, while any of the medium voltage doors are open.
- This high voltage is extremely dangerous and can cause death or severe injury if contacted.
- The unit must be grounded to ensure correct operation, safety and to prevent damage.
- This medium voltage unit must be tested and operated only by authorized and licensed personnel.
-

10.2 Parts Identification in the MV-TPS Cabinet

This section describes a typical cabinet comprising of: input bus bars, disconnecter, fuses, line Contactor, Power Section, low voltage compartment and output bus bars.

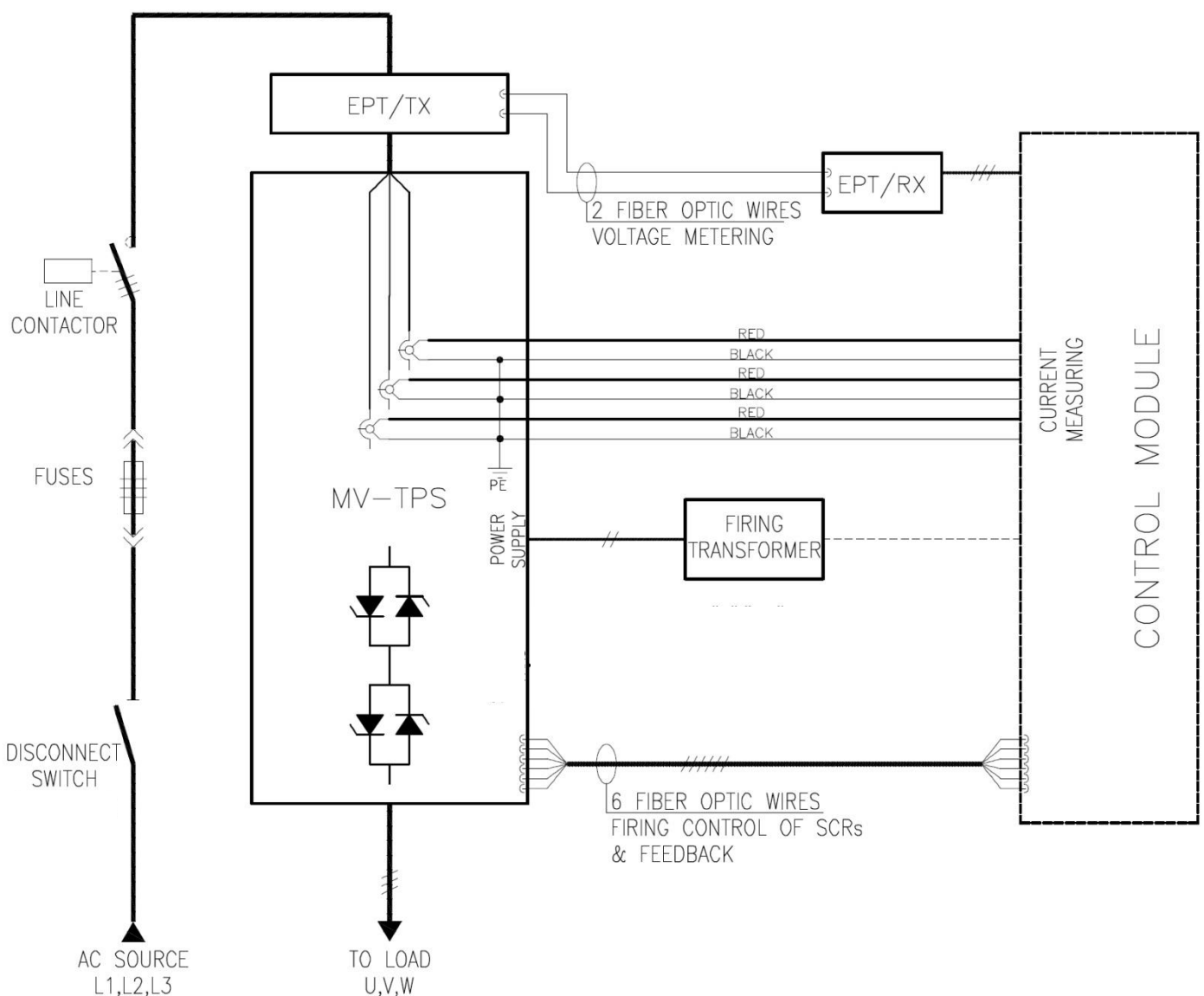
Parts Identification in the MV-TPS Cabinet

Figure 19 – MV-TPS up to 6.6kV Standard Cabinet – One Line Diagram

This typical cabinet includes one frame with five doors. Two of the doors are medium voltage compartments doors (incoming compartment and MV-TPS compartment) and three doors are for low voltage: Incoming compartment customer terminals, MV-TPS customer terminals and MV-TPS low voltage compartment.

Warning!

You are only allowed to open the low voltage compartment door and customer terminal compartments doors when medium voltage is connected to the cabinet!

It is strictly forbidden to open the medium voltage compartments doors at any time when medium voltage is connected to the cabinet!

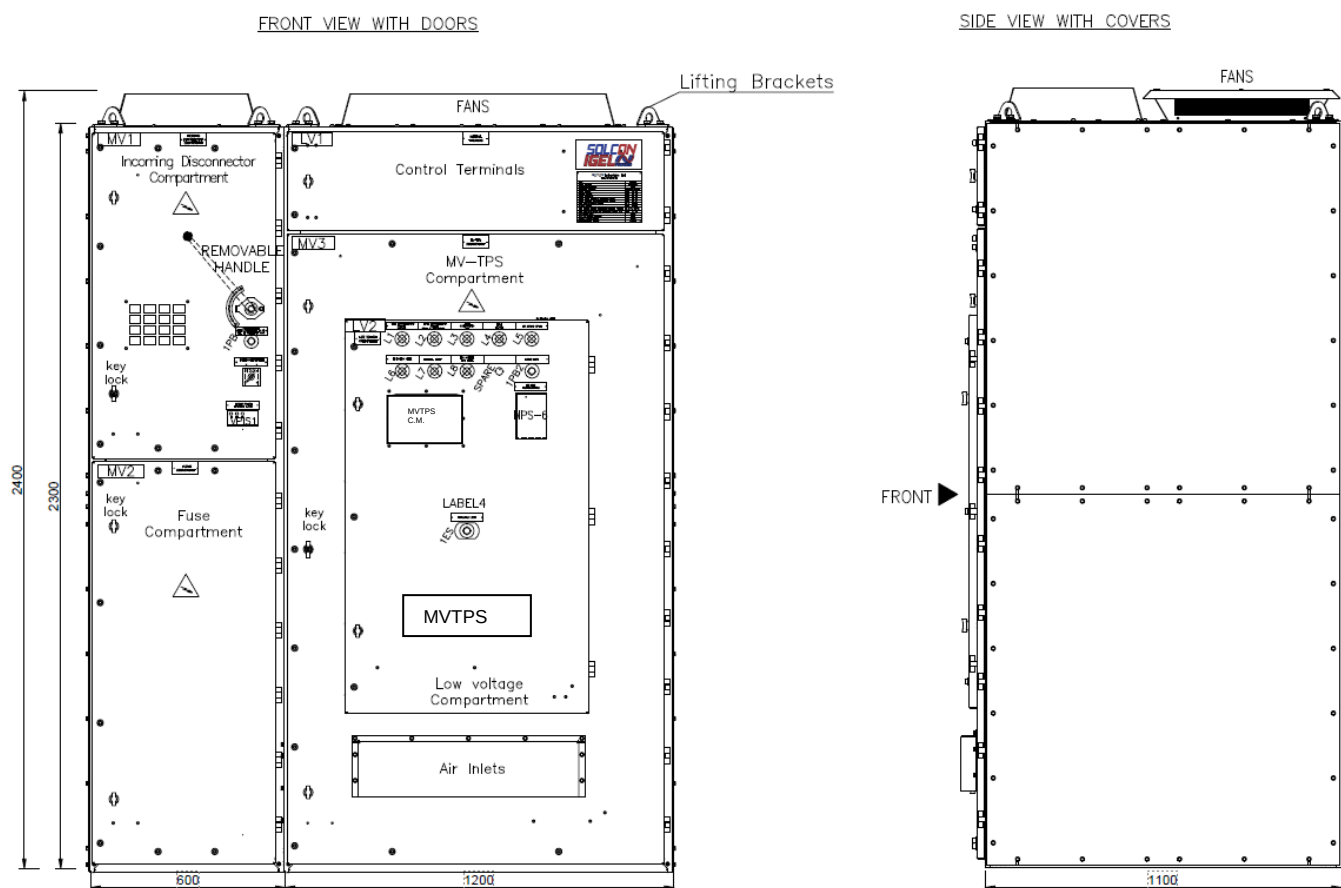


Figure 20 - MV-TPS up to 6.6kV Typical Cabinet – Doors Closed

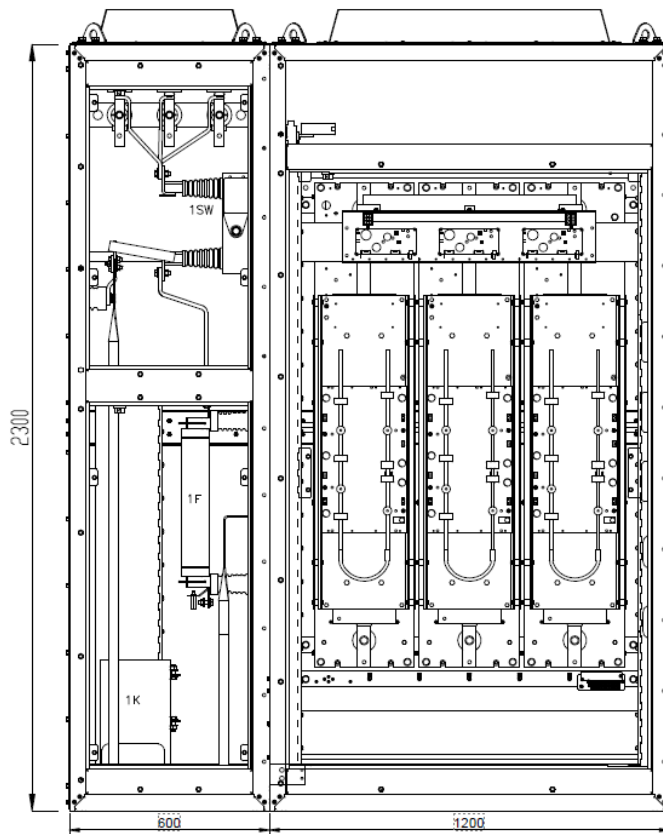


*Figure 21 - MV-TPS up to 6.6kV Typical Cabinet –
Doors Open and Removed Walls*

View with medium voltage door open and customer terminals compartment door:

- Customer terminals are located in a dedicated compartment on the top of the cabinet.
- The Line Contactor is mounted on the top of the medium voltage incoming compartment.
- The EPT-Tx (Electronic Potential Transformer Transmitter) is mounted on the medium voltage bus bars downstream of the Line Contactor at the input to the Power Section of the MV-TPS thus measuring the input voltage to the Power Section.

The output of the EPT-Tx consists of two fiber optic wires running to the EPT-Rx (Electronic Potential Transformer Receiver) which is located in the low voltage compartment.

The harness runs out of the Power Section to the low voltage compartment and includes both fiber optic wires and copper wires.

- Note that the Power Section is actually composed of three identical modules, one per phase. The input bus bars to the Power Section are located at its top side and are labelled L1,L2, L3. The output busbars at the bottom of the MV-TPS and are labelled U,V,W. Verify on the cabinet label that both the medium voltage and control voltage, are according to the supplied mains voltage and control voltage.

10.2.1 Low Voltage Compartment

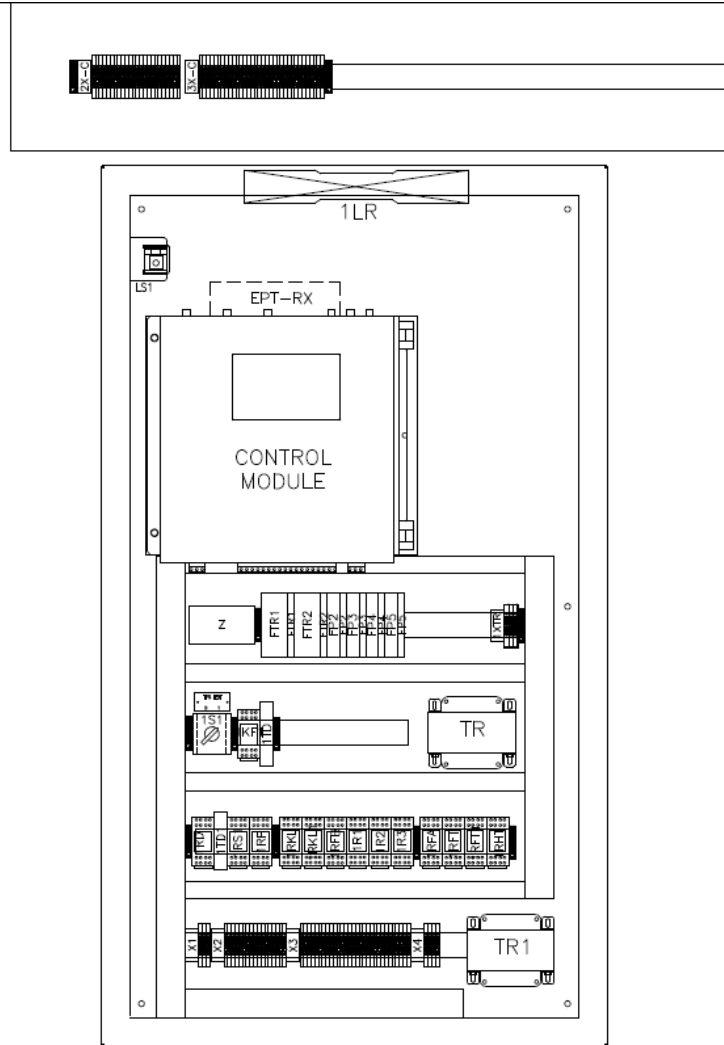


Figure 22 - MV-TPS Low Voltage Compartment

- The Control Module is the heart of the MV-TPS responsible for the controlling of the firing angle of the thyristors that are located in the Power Section.
- **Warning:** The six fiber optic wires located on top of the control unit are sensitive to bending and heat.
- The EPT-Rx (Electronic Potential Transformer Receiver) is located behind the Control Module (not shown on Figure 22).
- Note that the two fiber optic wires connecting the EPT-Rx to the EPT-Tx (Electronic Potential Transformer Transmitter) are located in the Power Section. The EPT-Rx is equipped with a fused supply voltage connector.
- The EPT-Rx provides three phase replicas of the mains voltages in level of 120VAC (line to line). Interposing relays connect the commands and indications to/from the Control Module.
- The Firing Transformer is located on the right side of the low voltage section.
- The control terminals in the low voltage compartment are NOT for customer use.

10.2.2 Low Voltage Fuses

The MV-TPS includes four fuses:

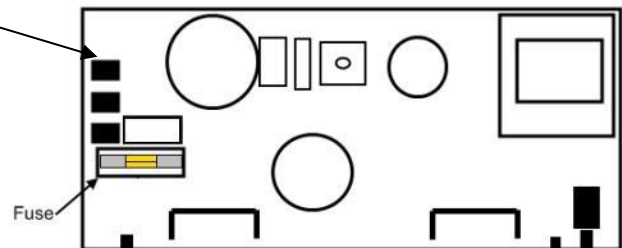
- Three fuses located in the medium voltage Power Section, one per phase. They are located at the smaller PCBs PC2075 (for 110VAC, 230VAC control voltage. These fuses are connected at the input side of the firing switched mode power supplies and rated 10A.
- To check these fuses:
 - In MV-TPS rated up to 6.6kV it is required to disassemble the phases cover by opening the plastic screws as shown on *Figure 23*.

Note:

For 110VAC, 230VAC, control voltage a blown fuse will prevent firing supply for its own phase only.



Front View of the Power Section



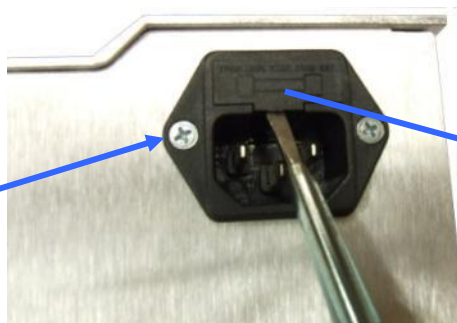
Power Supply to Firing PCB

Figure 23 – Power Supply to Firing PCB (MV-TPS Models up to 6600V).

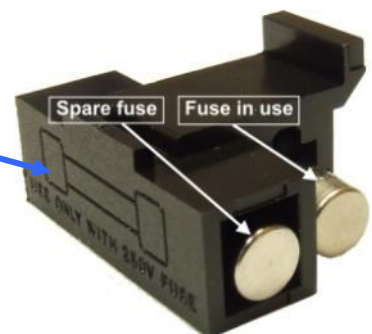
- One fuse 10A rated located in the Low voltage compartment, inside the input connector of the Electronic Potential Transformer Receiver (EPT-Rx). The EPT-Rx is located behind the Control Module.



Bottom view of the EPT-Rx



Use 5mm screwdriver to remove the fuse holder from the socket



Fuse holder with fuse in use and a spare fuse

Figure 24 – EPT-Rx Fuse Replacement Procedure

10.3 Standard Control Diagram

Standard cabinet design is shown on **Error! Reference source not found.** page **Error! Bookmark not defined.**.

Note!!

- The following diagram shows a standard wiring for a 115VAC and 230V control voltage.
- This drawing is given for demonstrating purposes only.
- **Note that the cabinet you have might be wired differently!!**

11. HIGH-POT TEST OF THE MV-TPS CABINET

Note:

The high-pot test is performed in the factory as a part of the cabinet FAT. (Factory Acceptance Test). Therefore, it is not recommended to do the high-pot test at customer site.

High-pot test levels and duration are as follows:

- Up to 7.2kV: 20kVAC for 60 seconds

Two options for high-pot test are available:

- With the EPT-Tx connected only one test can be conducted. In this case, when the MV-TPS is short connected as one unit (L1 to U, L2 to V, L3 to W and L1 to L2 to L3)
- With EPT-Tx disconnected it is possible to perform the high-pot test between each of the phases while the other two phases are grounded.

11.1 High-Pot Test in MV-TPS up to 6.6kV, EPT-Tx Connected

Preparations (refer to *Figure 25*):

Short circuit the L1 and U busbars of phase L1.

Short circuit the L2 and V busbars of phase L2.

Short circuit the L3 and W busbars of phase L3.

Short circuit input-output phases of the Line Contactor.

Short circuit U, V, W bus bars at the output of the MV-TPS.

High-pot test procedure:

Connect the ground cable of the High-pot tester to the cabinet ground (earth).

Connect the live cable of the High-pot tester to the MV-TPS busbars.

Set the tester for the correct testing voltage, as specified above.

Perform the test for 60 seconds.

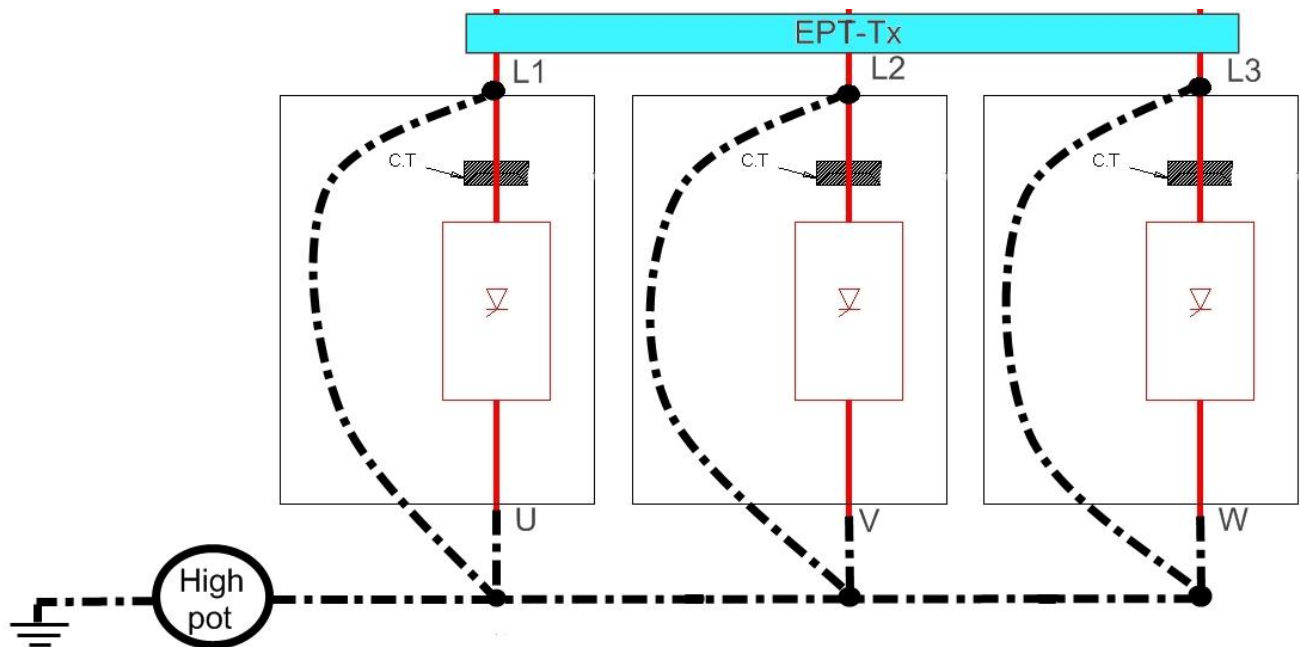


Figure 25 – MV-TPS up to 6.6kV – Preparations for High-pot Test

Megger test:

You can perform a Megger test (5kVDC) between the three phases connected together as a single group and ground. This Megger test should yield a very high resistance result.

Additionally, you can perform a Megger test between the individual phases. To do this you should connect L1-U, L2-V, L3-W.

Since the EPT-Tx is connected between the phases, the following resistance values are expected (all values are $\pm 5\%$):

MV-TPS Rated Voltage	L1 – L2	L2 – L3	L1 – L3
4.16kV	1.33M Ω	8M Ω	9.13M Ω
6.6kV	2M Ω	12M Ω	14M Ω

11.2 High-Pot Test in MV-TPS up to 6.6kV, EPT-Tx Not Connected

High-pot test procedure for L1 ([refer to figure 29](#))

Dismantle the EPT-Tx

Short circuit the L1 and U busbars of phase L1.

Short circuit the L2 and V busbars of phase L2.

Short circuit the L3 and W busbars of phase L3.

Short circuit input-output phases of the Line Contactor.

Connect to ground L2 and L3

Connect the ground cable of the High-pot tester to cabinet ground (earth).

Connect the live cable of the High-Pot tester to the MV-TPS busbars of L1.

Set the tester to the correct testing voltage, as specified above. Perform the test for 60 seconds.

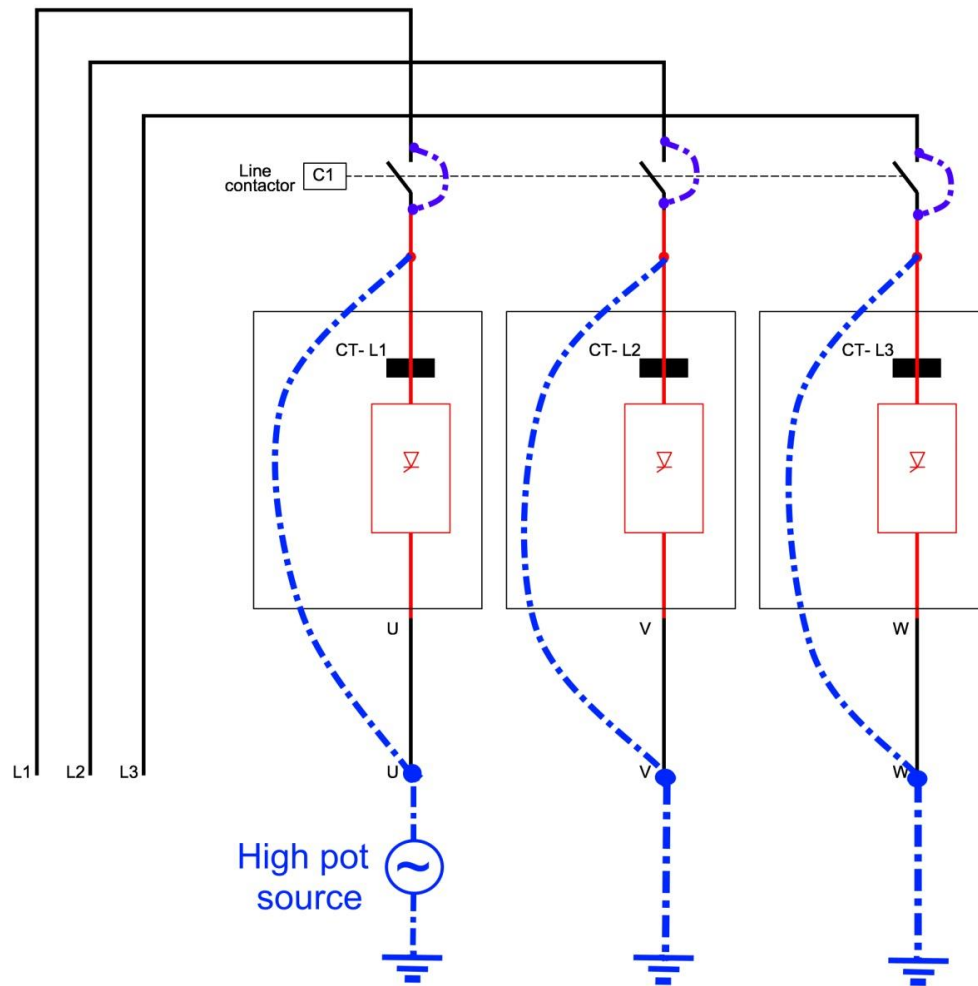


Figure 26 – MV-TPS up to 6.6kV – EPT-Tx not Connected Preparations for High-pot Test, Testing L1

High-pot test procedure for L2 (refer to figure 30)

Dismantle the EPT-Tx

Short circuit the L1 and U busbars of phase L1.

Short circuit the L2 and V busbars of phase L2.

Short circuit the L3 and W busbars of phase L3.

Short circuit input-output phases of the Line Contactor.

Connect to ground L1 and L3

Connect the ground cable of the High-pot tester to cabinet ground (earth).

Connect the live cable of the High-Pot tester to the MV-TPS busbars of L2.

Set the tester to the correct test voltage, as specified above. Perform the test for 60 seconds.

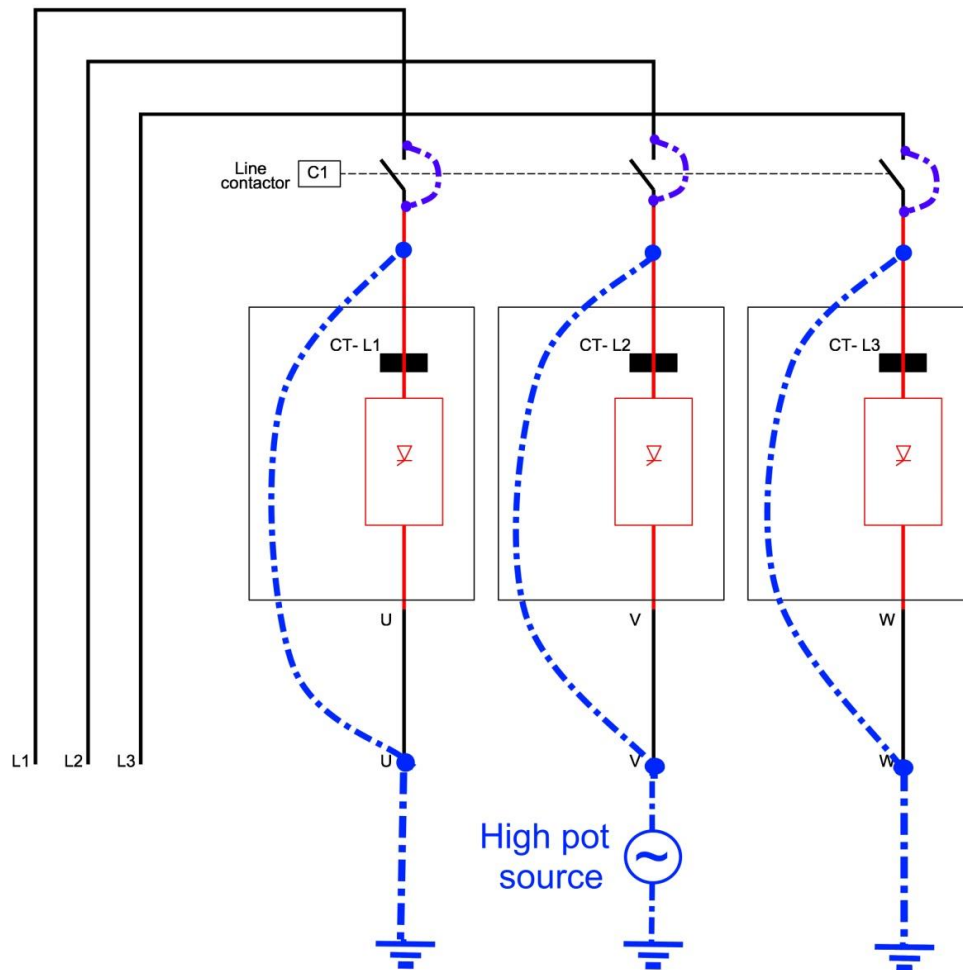


Figure 27 – MV-TPS up to 6.6kV – EPT-Tx not Connected Preparations for High-pot Test, Testing L2

High-pot test procedure for L3 (refer to figure 31)

Dismantle the EPT-Tx

Short circuit the L1 and U busbars of phase L1.

Short circuit the L2 and V busbars of phase L2.

Short circuit the L3 and W busbars of phase L3.

Short circuit input-output phases of the Line Contactor.

Connect to ground L1 and L2

Connect the ground cable of the High-pot tester to cabinet ground (earth).

Connect the live cable of the High-Pot tester to the MV-TPS busbars of L3.

Set the tester to the correct test voltage, as specified above. Perform the test for 60 seconds.

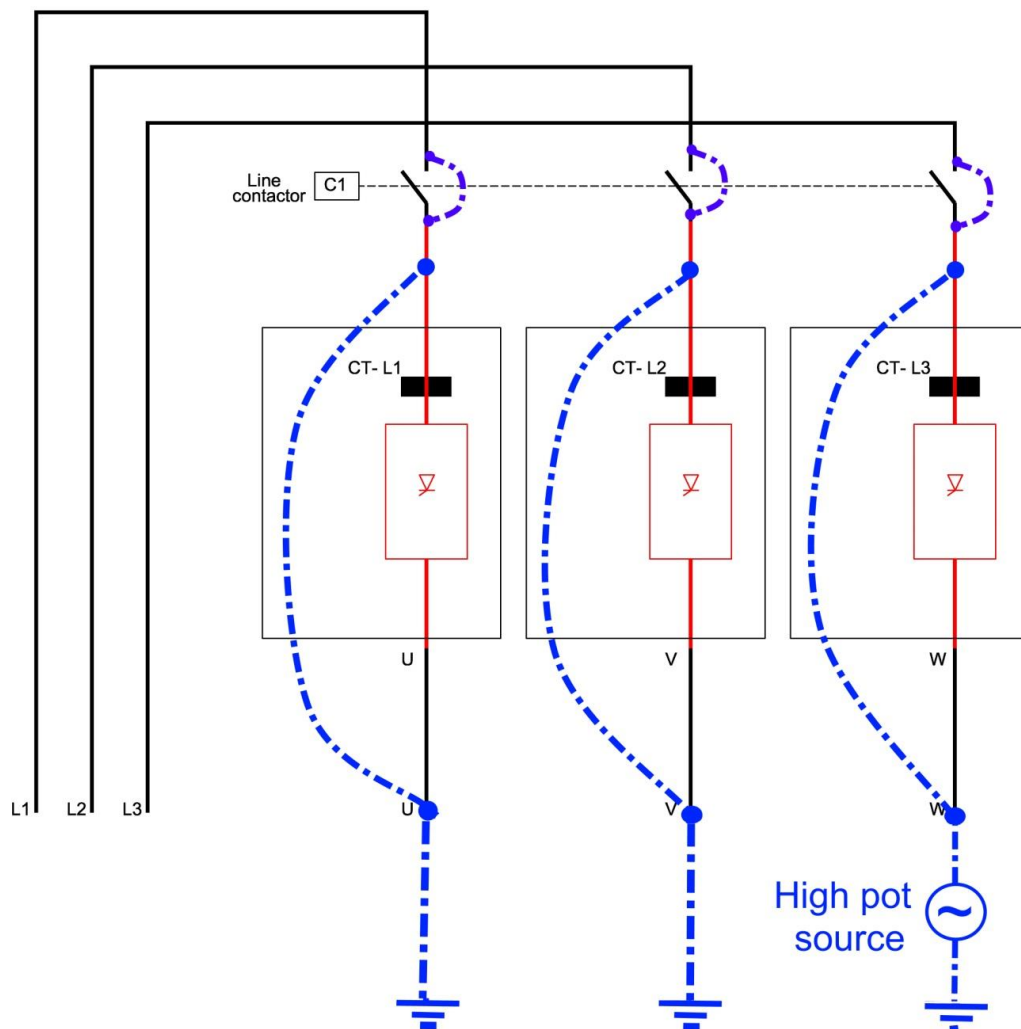


Figure 28 – MV-TPS up to 6.6kV – EPT-Tx not Connected Preparations for High-pot Test, Testing L3

Megger test:

You can perform a Megger test (5kVDC) between each phase to ground.

12. LOW VOLTAGE TEST PROCEDURE

WARNING!

- Make sure that the Medium Voltage is disconnected and secured.
- Ensure that the control voltage is applied during the Low Voltage test is equal to the rated control voltage.
- Incorrect control voltage levels can result in immediate damage.
- Ensure that the three phase mains testing voltage is 400VAC $\pm$ 10%, (the standard testing voltage). Immediate damage may occur if the mains voltage deviates from this range. If the low voltage tested voltage exceeds 400VAC a test harness for the specified voltage should be ordered from the factory.
- Read the MV-TPS instruction manual carefully.

12.1 Accessories Required for LOW VOLTAGE Testing of the MV-TPS and Cabinet.

- Control cable – three wires (two wires + ground) and a switch, to connect the control voltage (115VAC or 230VAC).

Note:

The control power source should have a minimum rated power of 2.5 kW to ensure that all inrush currents to the MV-TPS do not cause a voltage drop in the control circuitry.

- Power cable - A five-wire cable (3 phases + Neutral + ground) with a fused three phase switch, required to connect the low voltage 400VAC three phase mains voltage to the cabinet. One end of the cable should be equipped with a connector to the mains voltage compatible with the connectors used in the field. The other end with cable lugs or, more conveniently, with adequate alligator clips to fit the bus bar size.
- Three single - phase 230VAC heaters each rated at approx. 2.5kW should be connected in a WYE NEUTRAL CONNECTED configuration as shown on *Figure 13* page 20.
- Digital multi-meter.
- A test Harness with three coloured wires is supplied with the cabinet and can be found in a small plastic bag in the drawings pocket).

Note:

Test harnesses for voltages other than 400VAC (in the range of 480VAC to 690VAC) can be ordered. The test voltage if different than the standard 400VAC is indicated on the tape of the test harness.

- 10k Ω potentiometer to imitate the Analog input signal to the MV-TPS. Use a high precision potentiometer for better resolution.

12.2 Notes and Warnings

Notes:

- MV-TPS unit and the cabinet are designed to ensure a complete, convenient and safe test procedure for the MV-TPS and for the cabinet, using only the accessories mentioned above.
- The next procedure should be used for the following:
 - To ensure that the unit functions properly.
 - To learn the operational modes and options of the cabinet.
 - To test the cabinet together with the external control system (Factory Scada system, external PLC, etc.). It is strongly recommended to perform as many tests as possible in the low voltage mode to debug the external control system hardware and software in this low voltage mode until the entire system operates satisfactorily.

12.3 Low Voltage Test Procedure

The following instructions refer to the drawings shown in **Error! Reference source not found.** on page **Error! Bookmark not defined.** These are typical drawings that do not represent all available options. The customer should test the cabinet according to the actual wiring configuration they have.

If in doubt – Consult factory!

1.	☐ Disconnect mains voltage from the MV-TPS cabinet.
2.	☐ Ground the medium voltage lines at the incoming.
3.	☐ Put warning signs that will prevent anyone from connecting the medium voltage lines to the MV-TPS cabinet.
4.	☐ The MV-TPS cabinet inputs bus bars (marked L1, L2, L3) should be kept free from any connection. Do not ground them, since low testing voltage should be connected to these input lines.
5.	☐ Disconnect the medium voltage load lines from the output bus bars of the cabinet (marked U, V, W).
6.	☐ Double check that the cabinet is free from any voltage connection and is disconnected also from the medium voltage load.
7.	☐ Disassemble the clear plastic cover in the front of the MV-TPS Power Section.
8.	Visual test. Make sure that there is:
	☐ No mechanical damage
	☐ No loose screws
	☐ No excessive dust
	☐ No loose parts
	☐ No cut wires
	☐ No open fiber optic wires
	☐ No broken insulators
9.	☐ Connect the low voltage test harness to the EPT-TX. Refer to section 12.3.1 page 62.
10.	☐ Connect the load cable to the output bus bars U, V, W, and ground. Load neutral wire is directly connected to the input cable. Note that the load, consists of three 2.5kW each heaters connected in WYE NEUTRAL CONNECTED as shown on <i>Figure 13</i> page 20.
11.	☐ Connect the three-phase cable to the input bus bars (L1, L2, L3 of the cabinet), neutral wire to the neutral point of the <u>load</u> and the grounding wire to the grounding busbar of the cabinet.
12.	☐ Close the On-Load switch 1S in the incoming cabinet.
13.	☐ Connect the control voltage cable to customer terminals 1 & 2 located in customer terminal compartment.

14.	☐ Connect the remote-control switches wires to customer terminals 4, 5 & 6 located in customer terminal compartment.
15.	☐ Verify that the external emergency stop signal is jumpered (customer terminals 3 & 4).
16.	☐ Verify that the Emergency push button (SES) is in the normal operating position.
17.	☐ Set the Local/Remote/Off selector switch (S1) to Local.
18.	☐ Release the four screws at the corners of the front cover of the MV-TPS control module and remove the front cover. Refer to <i>Figure 18</i> page 29. Identify Main PCB - PC2500 and Fiberoptic PCB – PC2555.
19.	☐ Set the jumpers on the main PCB- PC2500 to: JP4 is closed; JP1, JP2 & JP3 are open. Refer to section Error! Reference source not found. page Error! Bookmark not defined.
20.	☐ Disconnect wires from terminals 16, 17 of the control module and connect the 10kΩ potentiometer as shown on page 8 (field 8) in the attached drawings.
21.	☐ Put the cover of the control module back in place.
22.	☐ Turn on the control voltage switch.
23.	☐ The control module should be powered now.
24.	☐ In the MAIN PARAMETERS SETTINGS mode page set CONNECTION TYPE to WYE, NEUTRAL CON.
25.	☐ In the MAIN PARAMETERS SETTINGS mode page set FIRING METHOD to PHASE CONTROL.
26.	☐ In I/O PARAMETERS SETTINGS mode page set ANALOG IN TYPE to 0...10V
27.	☐ While the 400VAC mains voltage is still disconnected from the cabinet, press the Start push button. The Line Contactor (1KL) will be energized for a short time and then trips. PHASE LOSS message is displayed on the screen of the MV-TPS's control unit. <i>Fault</i> lamp (L4) lights on the external door.
28.	☐ Press Reset on the Control Module. The fault indications are distinguished.
29.	☐ Turn on the (three phase) mains low voltage.
30.	☐ Verify that the Line Contactor (1KL) is open and indication light on the external door (L1) is lit.
31.	☐ Press the Start push button (ST). The Line Contactor is energized and after a short time (about 1.5 second) the RUN process begins. The indication light (L1) will indicate that the contactor is now closed and L2 will indicate that the MV-TPS is running.
32.	☐ Measure with a voltmeter on terminal 2XTR L and N 24VAC (this will verify that the primary of the firing transformer is wired in the right way)
33.	☐ Now you should be able to control the output current according to the position of the 10kΩ potentiometer. In ACTUAL DATA mode page you may view all actual readings according to the Analog input signal from the 10kΩ potentiometer.
34.	☐ Press the Stop (SP) pushbutton. The Line Contactor (1KL) opens, and the process stops.
35.	☐ In MAIN PARAMETERS SETTINGS mode page set FIRING METHOD to ZERO CROSSING.
36.	☐ Press the Start (ST) push button. The Line Contactor is energized and after a short time (about 1.5 second) the RUN process begins. The indication light (L1) will indicate that the contactor is now closed and L2 will indicate that the MV-TPS is running.
37.	☐ Now you should be able to control the output current according to the position of the 10kΩ potentiometer. Verify correct operation in ZERO CROSSING. In ACTUAL DATA mode page you may view all actual readings according to the Analog input signal from the 10kΩ potentiometer.
38.	☐ Press the Stop (SP) pushbutton. The Line Contactor opens, and the process stopped.

39.	☐ When the load is stopped, change the Local/Remote/Off selector switch (S1) to Remote. Now, the local Start / Stop pushbuttons (ST & SP) have no effect. Verify that REMOTE indication light (L6) on the external door is lit on.
40.	☐ Repeat the start / stop process using the external remote-control switch.
41.	☐ In case MV-TPS can be controlled via communication as well (not shown in the attached typical drawings) repeat the start / stop process using the communication link.
42.	☐ Clearing out of the low voltage test:
	☐ Verify that both mains and control voltages are turned off and their plugs are pulled out.
	☐ Disconnect the Test Harness from the EPT transmitter. Put it back in the small plastic bag and return to the drawing pocket.
	☐ Disconnect the mains and load external cables.
	☐ Reconnect the MV power cables to the mains.
	☐ Connect the MV load cables to the output bus bars.
	☐ Reassemble the clear plastic cover on top of the MV-TPS power section.
	☐ Close the medium voltage compartment doors and secure the screws.
	☐ Remove the cover of the control module and set the jumpers JP1-JP4 according to the actual Analog input type per your application.
	☐ Disconnect the 10k Ω potentiometer and reconnect the wires to terminals 17 & 18 of the control module.
	☐ Connect the control voltage to the cabinet.
	☐ Enter TEST/MAINTENANCE OPTIONS (press Mode+▼) press Select 3 times until STORE NOW? DEFAULT PARAMETERS shows. Press Page + Store. Verify that DATA SAVED OK message appears.
	☐ Enter TEST/MAINTENANCE OPTIONS (press Mode+▼) press Select 4 times until CLEAR NOW? STATISTICAL DATA shows. Press Reset + Store. Verify that DATA SAVED OK message appears.
	Enter MAIN PARAMETERS mode page and set: ☐ RATED LINE VOLT. – As indicated on the MV-TPS label ☐ TPS RATED CURR. – As indicated on the MV-TPS label ☐ LOAD RATED CURR. – As indicated on the medium voltage load label. ☐ LOAD RATED PWR – As indicated on the medium voltage load label. ☐ Browse all the way down until you see the message: STORE ENABLE MAIN PARAMETERS. ☐ Press the Store button and wait for the message: DATA SAVED OK.
	☐ To confirm that the parameters have been correctly stored, it is recommended to turn off the control voltage and then turn it on, after 10 seconds. Verify that all the above parameters have been properly stored, and that the statistical data is erased. (NO DATA message is displayed when browsing the STATISTICAL DATA)
43.	☐ Turn off the Control voltage.

12.3.1 Test Harness Installation

Warning: The Standard test harness is designed for testing with low voltage mains, rated 400V. When the test harness is ordered for voltages higher than 400V, internal resistors are normally connected in the middle of the wires. Never use the standard 400V Test Harness to perform low voltage tests with test voltages that exceed 400V. Higher than the specified voltage may cause damage to the EPT transmitter.

12.3.1.1 Test Harness Installation in MV-TPS up to 6.6kV

The Test Harness includes three coloured wires: blue, red and green wires.

These wires are used to change the resistors voltage dividing ratio in the EPT-Tx (Electronic Potential Transformer Transmitter).

At one end of each coloured wire there is banana plug with the same colour as of the wire.

At the other end of the blue wire there is an alligator clip.

The other ends of the red and green wires are clamped together and connected to a second alligator clip.

On the front side of the EPT-Tx you will see three coloured round stickers: blue, red and green.

On the rear side of the EPT-Tx, located exactly where the stickers are, there are three small holes. These holes have an internal banana jack for the banana plugs.

Connect the three banana plugs the banana jacks at the rear side of the EPT-Tx. Ensure that the wire colours match the round sticker colours at the front of the EPT-Tx.

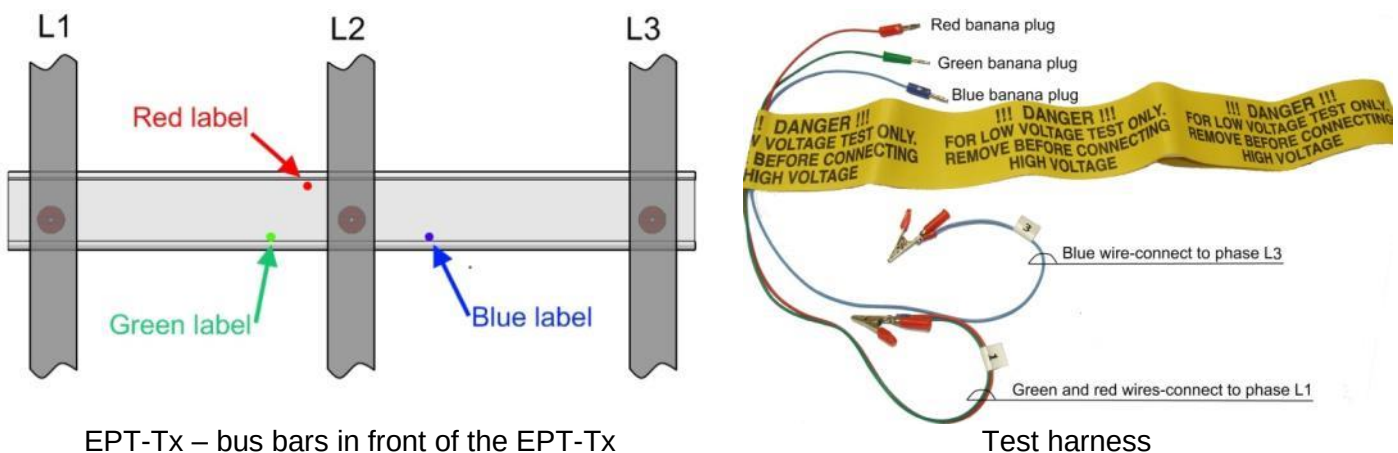
Connect the alligator clip marked “1”, with red and green wires to phase L1.

Connect the alligator clip marked “3”, with blue wire to phase L3.

The Test Harness is equipped with a long warning tape, to prevent forgetting it is connected. Never cut this warning tape. Leave the warning tape open fully extended and laid in such a way that prevents accidental reconnection of the harness after the low voltage test.

As a rule, always disconnect the harness immediately after ending the low voltage test. It should be stored inside a small plastic bag in the drawing pocket mounted on the front door.

Refer to *Figure 29* below.



EPT-Tx – bus bars in front of the EPT-Tx

Figure 29 – MV-TPS up to 6.6kV – EPT-Tx and Test Harness

13. MEDIUM VOLTAGE OPERATION

13.1 Special Attention Notes

Special Attention!

- Make sure that you know where the Emergency stop button is located, so you can stop immediately if needed.
- Verify that the Emergency stop button is operative and push the Emergency stop button disconnecting the load from the mains.
- Carefully read the MV-TPS Instruction Manual.
- When mains voltage is connected to the MV-TPS, even if control voltage is disconnected, full voltage will appear on the MV-TPS load terminals. Therefore, for isolation purposes an isolating device must be connected upstream to the MV-TPS.
- Do not interchange line and load connections. Verify correct connections to the MV-TPS terminals: L1, L2, L3, U, V, W.
- Prior to RUN procedure, make sure that the line voltage and control voltage match the ones shown on the label of the MV-TPS.

13.2 Prior to Commissioning in Medium Voltage

Verify that the Full Load Ampere (FLA) of the load is lower than or equal to the Full Load Current (FLC) of the MV-TPS, and that the mains and control voltages are as indicated on the side and/or front label of the MV-TPS.

13.3 Medium Voltage Test Procedure

1.	☐ Verify that a Megger test was performed to the load and its cables. This test should be carried out when the MV-TPS is not connected to the load.
2.	☐ Verify that low voltage Test Harness and cables are disconnected and removed.
3.	☐ Verify that you haven't forgotten any tools/objects in the MV compartment.
4.	☐ Verify that the MV compartment doors are closed and screwed .
5.	☐ Verify that control voltage is disconnected.
6.	☐ Release the four screws at the corners of the front cover of the MV-TPS control module and remove the front cover. Refer to Figure 18 page 29. Identify Main PCB - PC2500 and Fiberoptic PCB – PC2555.
7.	☐ Set the jumpers on the main PCB- PC2500 to the actual Analog input on-site. (note that in case a 10k Ω potentiometer is used, set JP4 is closed; JP1, JP2 & JP3 are open). Refer to section Error! Reference source not found. page Error! Bookmark not defined..
8.	In MAIN PARAMETERS SETTINGS mode page set: ☐ LINE VOLTS. – As indicated on the MV-TPS label ☐ LINE FREQUENCY – As in the mains ☐ TPS RATED CURR. – As indicated on the MV-TPS label ☐ LOAD RATED CURR. – As indicated on the medium voltage load label. ☐ LOAD RATED POWER – As indicated on the medium voltage load label. ☐ CONNECTION TYPE – St as explained on section 5.5 page 14. LOAD POWER FACTOR – Only a purely resistive load with a power factor of 0.99-1 can be connected. For loads with a different power factor – consult factory. ☐ FIRING METHOD – Choose the required firing method ☐ Browse all the way down until you see the message: STORE ENABLE MAIN PARAMETERS. ☐ Press the Store button and wait for the message: DATA SAVED OK. In the MAIN PARAMETERS SETTINGS mode page set: ☐ ANALOG IN TYPE – According to the available Analog signal on site. Note that this setting must comply with the jumpers settings in the control module. See item 7 above. Note that the above settings are basic settings only. You might want or need to set other parameters according to your application.
9.	☐ Verify that all other parameters are set properly for the application.
10.	☐ Be sure to know where an Emergency stop button is located, so you can stop immediately if needed.
11.	☐ Start the application and verify its correct operation.
12.	☐ In any problem occurs, look at the following troubleshooting instructions.
13.	☐ It is strongly recommended to go back to the low voltage test if in doubt.

14. TROUBLE SHOOTING

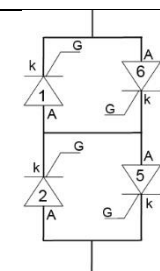
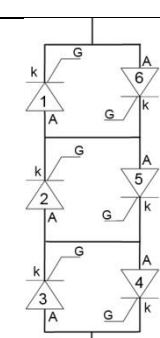
The following procedures should only be done the event of a fault and when troubleshooting is required.

14.1 In-Out Resistance and Cathode-Cathode Resistance

Disconnect load cables/wires from the output of the MV-TPS.

Disconnect the cabinet mains isolator switch or fuses, if installed.

In-Out resistances should be the same for all three phases in each model. Cathode-Cathode resistances are indicated in the following table:

MV-TPS Rated Voltage	Measurement	Expected Result	
4.16kV	L1→U L2→V L3→W	135kΩ ±10%	
	SCR#1 Cathode→ SCR#2 Cathode	67.5kΩ ±10%	
	SCR#2 Cathode→ SCR#5 Cathode	67.5kΩ ±10%	
	SCR#1 Cathode→ SCR#5 Cathode	135kΩ ±10%	
6.6kV	L1→U L2→V L3→W	300kΩ ±10%	
	SCR#1 Cathode→ SCR#2 Cathode	100kΩ ±10%	
	SCR#2 Cathode→ SCR#3 Cathode	100kΩ ±10%	
	SCR#3 Cathode→ SCR#4 Cathode	100kΩ ±10%	
	SCR#1 Cathode→ SCR#4 Cathode	300kΩ ±10%	

Refer to Figure 30 In order to identify the Cathode terminals of all 4 or 6 SCR's on the firing PCB.

A number is written on the firing PCB to identify the SCR's.

Verify that the values correspond to the above table.

14.2 RGK (thyristors Gate-Cathode) Resistances.

Thyristors Gate-Cathode resistances can easily be measured from the firing PCB's.

To access the testing points the front cover of the Power Section needs to be dismantled.

Gate-Cathode connection points of SCR#1 are illustrated in Figure 30. Measure all SCR's' Rgk resistances in each of the phases.

Rgk values should be about the same for all thyristors in the phase, and in the range of 4-20 Ω.

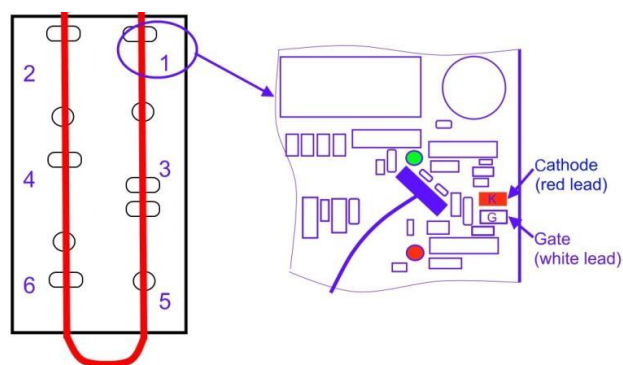


Figure 30 – Firing PCB – SCR#1 Gate-Cathode Measuring

14.3 Firing Test

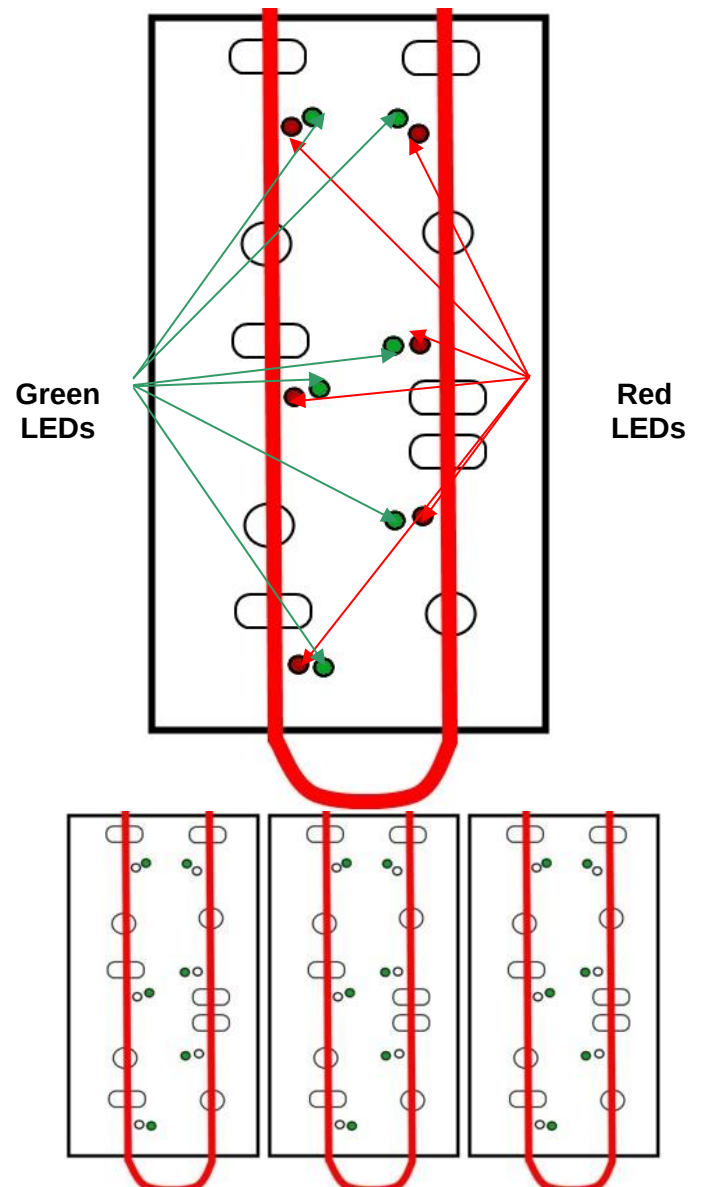
The purpose of this test is to check that the firing system of all thyristors function properly. This procedure requires control supply voltage only (Three-phase mains are not required). The below procedure shows for MV-TPS 6.6kV. Procedure for MV-TPS 4.16kV is the same.

- Disconnect mains and verify that all safety issues are resolved.
- Remove the 10 hexagon headed white plastic screws holding the front cover of all 3 phases.
- Dismantle the front cover of all three phases.



- Identify 6 green LEDs and 6 red LEDs as shown in the picture.
- The number of LEDs varies depending on the voltage models.
- In I/O PARAMETERS SETTINGS mode page set AUX. IN TYPE (terminal 5) to FIRING TEST. (Remember to store the parameter! Refer to page 37.)
- Connect the control input voltage to aux input (terminal 5). The Test LED on the control keypad will be lit.
- Press the Mode key until the following appears in the display:

FIRING TEST
DISCONNECT MAINS



Press the Select button.
The display will show:

FIRING PWR SUPPLY
CHECK GREEN LEDS

Press the Select button a second time.
The display will show:

FIRING NOW CHECK
GREEN & RED LEDS

Press the Select button a third time.
The display will show:

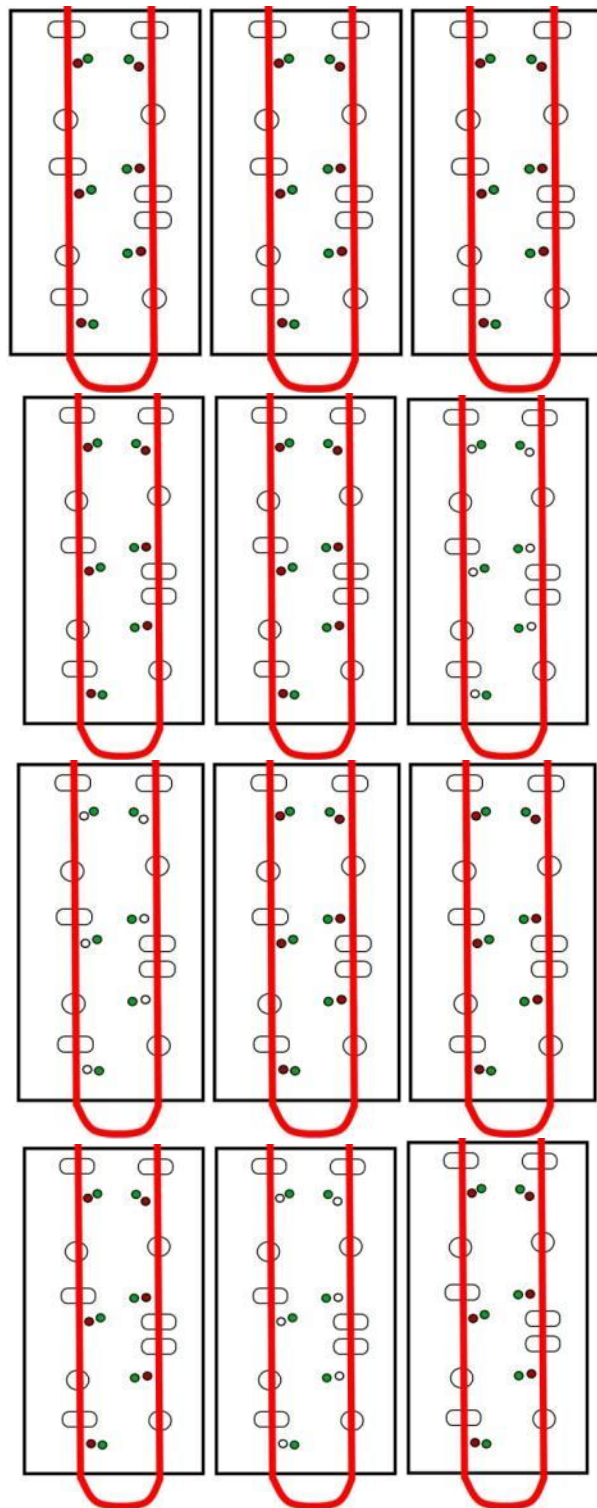
FIRING NOW CHECK
ALL LEDS OF PH1

Press the Select button a fourth time.
The display will show:

FIRING NOW CHECK
ALL LEDS OF PH2

Press the Select button a fifth time.
The display will show:

FIRING NOW CHECK
ALL LEDS OF PH3



Note:

- The firing test is limited to 60 seconds. If the test is not completed within this time, it can be repeated until all 5 stages are finished.

If the firing test fails:

- Check the fuses in the switch mode power supplies (PC2075).
- Check that fiber optic wires # 1, 3 and 5 (firing phases 1, 2 and 3) are properly connected according to the markings on the Control Module.
- Check that the fiber optic wires are inserted into their connectors to the full depth and not damaged.
- Check that the fiber optic wires of the power modules that are connected between the individual power supplies (PC2075) and the firing PCBs are properly inserted.
- When Control Voltage is turned ON, the green LEDs in the power modules may blink shortly. This is normal.

14.4 Medium Voltage Trouble shooting

This troubleshooting table is intended for Medium Voltage testing, when both the Medium Voltage and load are connected to the cabinet. It should only be used after successfully completing the low voltage tests.

WARNING!

It is strictly forbidden to open one or more of the medium voltage doors, even if the load is not running and Line Contactor is open.

Troubleshooting the system while connected to the medium voltage mains is not recommended. Should any issues other than operational or minor problem occur, it is advisable to return to the low voltage test.

Before starting, recheck rated mains voltage and current, and compare them to the MV-TPS rated values.

Problem	What To Do
MV-TPS Control Module is not powered after external control voltage is connected.	• Verify that the cabinet MCBs are set to ON position. • Verify that the Emergency Stop push button is released. • Verify that the customer terminals for external emergency stop, terminals 5 & 6 are shorted. • Verify that the rated control voltage is connected to customer terminals 1 & 2. • Verify the correct polarity for DC control voltage.
Upon control voltage connection the MV-TPS Control Module trips immediately	• Disconnecting the control voltage from the Control Module and reconnecting the control voltage does not reset the MV-TPS if tripped. • Reset the MV-TPS by pressing the Reset key.
Local RUN command does not cause any action.	• Verify that the Local/Remote/Off Selector switch is set to Local and remote light is not illuminated. • Verify that the Fault light is not active on the front panel, or on the MV-TPS control panel or on the MPS-6. • If the Fault light is illuminated: ○ Verify that there are no fault messages on MV-TPS & MPS displays. ○ Reset if necessary. ○ Check the setting of the trip relay logic (FAULT/FAULT FAIL-SAFE) of the MV-TPS
Remote RUN command does not cause any action.	• Verify that the Local/Remote/Off Selector switch is set to Remote, and the Remote indication light is on. • Verify that the Fault indication light is not illuminated on the door and unit. • If the trip indication light is illuminated: ○ Verify that there are no fault messages on the MV-TPS display. ○ Reset if necessary. ○ Check setting of the trip relay logic (FAULT/FAULT FAIL-SAFE) of the MV-TPS.
PWR ON & NO STRT Trip occurs before starting.	This occurs, when the main voltage is connected to the MV-TPS for more than 30 sec. without a start signal. • It may also occur during the low voltage test if the mains voltage is connected downstream (“below”) the Line Contactor instead of upstream (“above”) the Line Contactor. The unit protects itself from overheating. • Can be disabled for special applications (consult factory).

Problem	What To Do
UNDER/NO VOLT-AGE	• Verify that all three main phases are properly connected. • During low voltage testing a missing phase can cause UNDER/NO VOLT-AGE trip. • During low voltage testing verify that the test harness is connected to the EPT-Tx. • Verify that the Line Contactor is closed, at least for a short time, at the beginning of the RUN process. • If an external line (mains) contactor is used, ensure that its auxiliary contact is wired back to the MV-TPS cabinet and used (in series with RS relay contact) to initiate the RUN command (this contact should not be bridged in the customer terminals). • Check the UNDERVOLT. TRIP setting level in the PROTECTION PARAMETERS page. • Verify that the Electronic Potential Transformer Receiver (EPT-Rx) fuse located in the Receiver auxiliary supply plug is OK. • Verify that the fiber optics wires connecting the EPT-Tx and EPT-Rx are properly secured. • During the low voltage testing move the external mains connection from upstream to downstream of the Line Contactor and turn on the mains voltage. Check for 120VAC line to line between EPT-Rx output terminals. • Take out fibers 11 and 13 from the EPT-Rx, they should emit red light with the same intensity. • Check that the 15-pin white connector is properly connected, at the back of the Control Module.
OVER VOLTAGE	• During the low voltage testing make sure that the main testing voltage is 400V or as indicated as on the test harness. • If it is higher, disconnect the mains voltage immediately. • Check the OVERVOLT. TRIP setting level in the PROTECTION PARAMETERS page.
SHORTED SCR	This may occur when the load is not connected or when the thyristor is shorted. • Verify that the fiber optic wires 1,3 & 5 are properly connected. • Check the fuses and the fuse holders in the phases firing power supplies. • Verify that the actual connection type matches the programmed connection type.
WRONG CONCT TYPE	Trips/Alarms when the MV-TPS microprocessor senses a different connection type then the one programmed. • Verify that the fiber optic wires 1,3 & 5 are properly connected. • Verify that the actual connection type matches the programmed connection
PHASE LOSS	• Verify that all three phases are within range. • Verify that the EPT-Tx and EPT-Rx fiber optic wires are properly connected. • If the low voltage mains is powered from a generator, check that frequency is within the range of $46\text{Hz} < f < 64\text{Hz}$.

Problem	What To Do
UNBALANCE LVL1, UNBALANCE LVL2	• Verify that the three current readings on the display are identical before the trip. • Check that the fiber optic wires 1, 3 & 5 are properly connected to the Control Module. • Verify that current flows in all three phases. • If there is no current display on one phase: ◦ <i>This alarm can be used for detecting faulty elements in a symmetrical load.</i> ◦ <i>For a-symmetrical load disable this protection.</i> • Check the load for faulty elements.
GROUND FAULT	Trips/Alarms occur when the measured line currents do not sum to zero. This alarm does not function when using WYE NEUTRAL CONNECTED. • Check the load for ground fault. Note: <i>This alarm is very sensitive.</i> <i>Disable this protection if consecutive nuisance alarms occur.</i>
UNDER POWER	Trips/Alarms occur when the power derived from mains is lower than the power programmed into the MV-TPS. <i>This alarm can be used to detect faulty elements in an a-symmetrical load.</i> <i>Check load for faulty elements.</i>
HEATSINK OVER T.	Trips/Alarms occur when the MV-TPS thyristor heat sinks are over heated. • Stop the unit and check for overload conditions and check the right operation of fans.
OVER CURRENT	Trips/Alarms occur if the MV-TPS OVER CURRENT conditions exist.
UNDER CURRENT	Trips/Alarms occur if UNDER CURRENT conditions exist.
EXTERNAL FAULT	Trips/Alarms occur when the MV-TPS receives an external input indicating a fault.
COMM PORT FAILED	Trips/Alarms are triggered when a communication error occurs. • Check wiring, Reset the MV-TPS and try again. • If this failure happens again consult factory.
INTERNAL FAILURE	Trips/Alarms occur when an internal failure is detected by the microprocessor. • Get factory defaults and reprogram the MV-TPS.
STORAGE ERROR	When attempting to store parameters at the end of a mode page or after loading DEFAULT PRAMETERS. • <i>Press Reset and try again.</i> • <i>Load DEFAULT PARAMETERS. Refer to section 9.4 page 32 for more details on loading default parameters.</i>
Current reading as displayed on MV-TPD's panel is not correct.	• Verify that the MV-TPS FLC setting parameter is configured according to the rated current of the unit. • Set the parameters to default parameters and re-program the MV-TPS.
Unit runs immediately after resetting a trip.	This might occur when the Local / Remote switch is set to remote, and the remote contact is closed.

Problem	What To Do
	Note: It is the responsibility of the remote controller to open the remote RUN/stop contact immediately upon trip.
No control via Analog Input	• Check if the Analog input jumpers and settings in I/O OPARAMETERS is set correctly.
Output voltage/current does not go to zero even though Analog input is lowest.	Output voltage/current does not drop to zero even though the Analog input is at its lowest setting. • When the load is connected in <u>WYE NEUTRAL NOT CONNECTED</u> or in <u>LINE DELTA</u> (both without a neutral point) and the MV-TPS is in <u>PHASE CONTROL</u> it is impossible to achieve zero output. The minimum possible firing in this configuration results in 30-40% of the output voltage. This limitation occurs because the firing of each phase depends on the three phases mains preventing control individual phase voltage down to zero. In such cases a zero input in the Analog input results in the minimum possible output voltage. As the Analog input voltage increases the output voltage/current increases monotonically.

15. TECHNICAL SPECIFICATIONS

1. General

1.1	Rated Current	60-350A (to be specified in order)
1.2	Utilization Category	AC-51: 1,4 x I _e – 1 s, uninterrupted duty
1.3	Rated Voltage	2300 - 13800VAC +10% -15% (to be specified in order)
1.4	Control Voltage	120 or 220VAC, +10% -15% (to be specified in order)
1.5	Frequency	50 / 60 Hz
1.7	Controlled Phases	Three
1.8	Ambient. Temp.	-10 – + 50°C (operating), -20 – + 70°C (storage)
1.9	Altitude	To 1000 m ASL W/O de-rating
1.10	Cooling	Forced air (fans)
1.11	Number of CT's	Three
1.12	Connection Modes	Wye - Neutral connected / not connected Line Delta, Inside delta, number of parallel branches each connection type

2. Control

2.1	Control Method	Digital
2.2	Firing Method	Zero crossing, Phase control, Phase control-power
2.3	On-Off Time Cycle	1000 – 10000mSec. (Programmable)
2.4	Analog Input	Floating inputs 0-10V >100KΩ / 4-20 mA, 0-20mA <100Ω, Potentiometer input (programmable +int. jumper) with programmable time constant exponential response.
2.5	Control Inputs	RUN/Stop (with internal 0-60 sec time delays), Aux. contact (Programmable)
2.6	Output Relays	3 programmable (1-C/O) (8A/250VAC)
2.7	Synchronization (optional)	One master and 2-9 connected slaves

3. EMC Requirement

- 3.2 External surge arresters should be applied to terminals 16-20 inputs to meet EMC requirements.

4. Main, Protection & I/O parameters (see parameters settings)

5. LEDs

Power ON (Green), Stop (Red), Run (Green), Alarm (Yellow), Trip (Red), Sync. (Green)

6. LCD Display

Local on Front panel, 2 lines 16 characters each.

7. Communication - RS-485 (Optional)



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