INSTRUCTION & SAFETY MANUAL

SIL 3 Power Supply System PSS1250
24Vdc, 50-100-150-200 A
19” Rack for up to 6 power modules PSM1250
9” Rack for up to 2 power modules PSM1250
and diagnostic module PSO1250
7” Rack for up to 2 power modules PSM1250

gmi technology for safety

G.M. International s.r.l.
20852 Villasanta MB Italy

SIL 3 Power Supply System PSS1250 24Vdc, 50-100-150-200 A
19'' Rack for up to 6 power modules PSM1250 or 9'' Rack for up to 2 power modules PSM1250 and diagnostic module PSO1250
or 7'' Rack for up to 2 power modules PSM1250

General characteristics

General Description:
The Power Supply System type PSS1250 is an anodized aluminum 19" Rack unit (4U high) suitable to accept up to 6 plug-in Power Supply Modules type PSM1250 and 1 Overview module for diagnostic functions. Each module provides 24Vdc, 50 A output. Modules can be paralleled with load sharing circuits which distribute current load equally to each power supply module to increase reliability and reduce internal power dissipation. The system accepts up to two independent AC power sources with nominal voltage range 110 to 240 Vac (±10%).
Twenty configurations of 19" Rack Units are available with or without Hot Swapping: ten for wall mounting and ten for frontal rack mounting, always into a cabinet.
Two configurations of 9" Rack Units are available with or without Hot Swapping, only for wall mounting into a cabinet. Two configurations of 7" Rack Units are available with or without Hot Swapping, only for wall mounting into a cabinet.
For more information about different configurations see pages 4-6.

Hot Swap Plug-ins:
When using rack PSR1250-HS-7 (except for -HS-7-0 and -HS-7-5) or PSR1250-HS-3 or PSR1250-HS-2, each PSM1250 power supply module can be placed in Zone 2/Div. 2 Hazardous Locations without having to monitor the hazardous gas presence and without disturbing Power Supply operations.

Diagnostic:
Racks PSR1250-HS-7 or PSR1250-7 and PSR1250-HS-3 or PSR1250-3, accept a plugin module (PSO1250) dedicated to monitoring all diagnostic functions of each power supply, via a front panel touch screen LCD color display which indicates Input/Output Voltage, Current and Power; Input Line Frequency; Output current sharing percentage; Internal Temperature; alarm status. RS485 Modbus output provides full diagnostic and status conditions. PSO1250 presence or fault does not affect PSS1250 operation and functional safety application.

Overvoltage protection:
3 independent overvoltage protections:
1 voltage limiting loop at 30 Vdc and 1+1 crowbars at 30 Vdc.

EMC:
Fully compliant with CE marking applicable requirements.

High load fuses breaking capability:
In case of short circuit on the load, the Power supply system delivers a very high peak current (about 800 Amp) for a duration of 0.5 ms.
This characteristic ensures the instant breakage of the protective fuse or circuit breaker. Because of the very short peak current duration, other equipment connected to the load are not affected by the failure event and continue to operate without interruption.

Functional Safety Management Certification:
G.M. International is certified by TUV to conform to IEC61508:2010 part 1 clauses 5-6 for safety related systems up to and included SIL3.

Single module PSM1250 Technical Data

Supply:
AC Input voltage: nominal 110 to 240 Vac (±10%), with frequency range 48 to 62 Hz.
Power Factor Correction (AC input): 0.98 typ.@230Vac, 0.995 typ.@115Vac (50 A out).
Efficiency @24Vdc out (50 A out): better than 89 % @ 230 Vac and 86% @ 115 Vac.
Max. internal power dissipation @24Vdc out (50 A out): 150 W @ 230 Vac; 195 W @ 115 Vac.
AC input current (sinusoidal at 50 A out) @24Vdc out: 14.2 A @ 100 Vac input voltage, 12.2 A @ 115 Vac input voltage, 6.1 A @ 230 Vac input voltage.
Inrush current: 37 A peak @ 264 Vac; 32 A peak @ 230 Vac; 16 A peak @ 115 Vac.
AC input connection: screw terminal blocks suitable for 4mm² wires on back panel pcb.

Isolation (Test Voltage):
Input to Output isolation: 2500 Vrms (routine test).
Input to Earth-Ground isolation: 1500 Vrms (routine test).
Earth-Ground to Output isolation: 500 Vrms (routine test).
Output or Earth-Ground to Fault contact isolation: 500 Vrms (routine test)

Output:
Output voltage: 24 Vdc (adjustable from 21 to 28 Vdc).
Regulation: 0.4 % for a 100 % load change.
Stability: 0.01 % for a 20 % line voltage change.
Ripple: ≤ 250 mVpp.
Output current: 50 A nominal (*@24Vdc out*). Parallel connection for redundancy with load sharing capability within ±5 % of output voltage setting.
Only for PSS1250(-HS)-7-0 & -7-5, max 33 A out without redundant parallel connections.
Output power: *@28Vdc out*, up to 1300 W (except 900 W for PSS1250(-HS)-7-0 & -7-5).
Output Rise Time: 2.5 s.
Dynamic Response: 2 ms for 0-100% load change (overshoot ±1.5% of Vout setting).
Connection: M6 screw terminals on copper bars suitable for lug (at least 6.5 mm hole diameter) with 16mm² wire on back panel pcb.
Hold-up time (AC input): 20 ms (50A out); 30 ms (33A out).
Over voltage protection: output limited to 30 Vdc plus two redundant crowbars for over voltage protection at 30 Vdc.

Power good signaling:
Output good: 19.5 V ≤ Vout ≤ 29.5 V.
Indication: via LCD screen on PSO1250 and Modbus RTU RS-485 protocol.
Signaling: voltage free SPST normally energized relay (contact closed), de-energize in over/under voltage conditions (contact open).
Contact Rating: 2 A 50 Vac 100 VA, 2 A 24 Vdc 48 W (resistive load).
Connection, on back panel pcb:
- for all configurations except for PSS1250(-HS)-7-0 & -7-5: Fault & Comm. Fault & Modbus with screw terminal blocks suitable for 1.5 mm² wires;
- only for PSS1250(-HS)-7-0 & -7-5: Fault & Comm. Fault with push-in spring connection terminal blocks suitable for 1.3 mm² wires; Modbus with screw terminal blocks suitable for 1.5 mm² wires.

Compatibility:
CE mark compliant, conforms to Directive: 2014/34/EU ATEX, 2014/30/EU EMC, 2014/35/EU LVD, 2011/65/EU RoHS.

Environmental conditions:
Operating temperature limits: -40 to +70°C de-rated linearly 65-70% load above 50°C (see on next page the Power Output vs. Ambient Operating Temperature diagram).
Relative humidity limits: 95 %, up to 55 °C.
Transport, storage temperature limits: - 45 to + 85 °C. ***Max altitude:*** 2000 m a.s.l.

Safety Description: For all configurations (except for PSS1250(-HS)-7-0 & -7-5)
ATEX: II 3G Ex ec nC IIC T4 Gc; ***IECEx:*** Ex ec nC IIC T4 Gc. ***UL:*** NI / I / 2 / ABCD / T4; ***C-UL:*** NI / I / 2 / ABCD / T4; ***CCC:*** Ex ec nC IIC T4 Gc
Approvals: For all configurations (except for PSS1250(-HS)-7-0 & -7-5):
BVS 15 ATEX E 006 X conforms to EN60079-0, EN60079-7, EN60079-11, EN60079-15; IECEx BVS 15.0006X conforms to IEC60079-0, IEC60079-7, IEC60079-11, IEC60079-15.
UL & C-UL E498342 conforms to UL 61010-1, UL 121201 for UL and CAN/CSA C22.2 No.61010-1-12, CSA C22.2 No. 213 for C-UL.
CCC n. 2020322303000822 conforms to GB/T 3836.1, GB/T 3836.3, GB/T 3834.8
For all configurations: TÜV Certificate No. C-IS-236198-04 SIL 2 / SIL 3 conform to IEC 61508:2010 Ed. 2.
SIL 3 Functional Safety TÜV Certificate conforms to IEC61508:2010 Ed.2, for Management of Functional Safety.

Mechanical: ***Mounting:*** 7" or 9" or 19" Rack unit, 4 units high.
7" or 9" Rack unit for wall mounting, into a cabinet.
19" Rack unit for wall mounting or for frontal rack mounting, into a cabinet.
Weight: *7"* fully equipped about 7 Kg, fully equipped with 2 PSM1250.
9" fully equipped about 10 Kg, fully equipped with 2 PSM1250 and 1 PSO1250 module.
19" fully equipped about 24 Kg, fully equipped with 6 PSM1250 and 1 PSO1250 module.
Location: installation in Safe Area/Non Hazardous Locations or Zone 2, Group IIC T4 or Class I, Division 2, Group A,B,C,D, T4 (except for PSS1250(-HS)-7-0 and -7-5).
Protection class: IP 20, Open Type. ***Dimensions:*** see drawings pages 36-37 and 41-42.

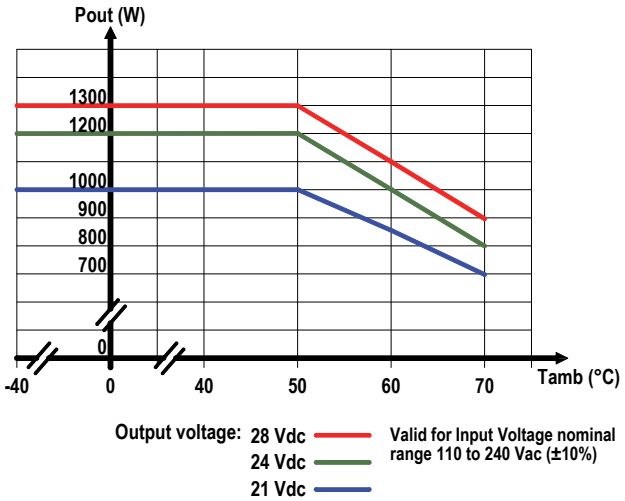
PSO1250 supply information

Supply:
AC Input voltage (each AC terminal block): nominal 110 to 240 Vac (±10%), with frequency range 48 to 62 Hz.
AC input current (sinusoidal): 45 mA @ 100 Vac input voltage, 40 mA @ 115 Vac input voltage, 15 mA @ 230 Vac input voltage.
Inrush current: 1.6 A peak @ 264 Vac; 1.4 A peak @ 230 Vac; 0.7 A peak @ 115 Vac.

Features

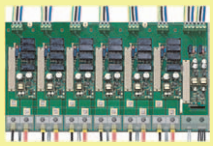
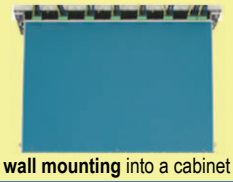
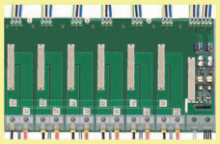
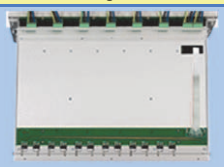
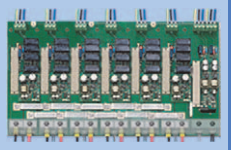
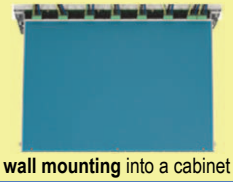
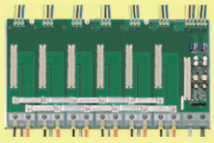
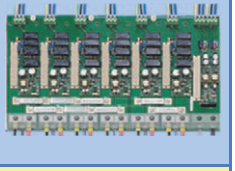
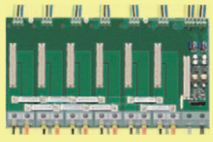
- SIL 3 for NE Load according IEC 61508:2010, with single PSM1250 module or more PSM1250 modules in redundant configuration (see pages 15-19 (with HS models) and pages 25-29 (without HS models)).
- SIL 1 for ND Load according to IEC 61508:2010, with single PSM1250 module (see page 20 (with HS models) and page 30 (without HS models)).
- SIL 2 for ND Load according IEC 61508:2010, with more PSM1250 modules in redundant configuration (see pages 21-24 (with HS models) and pages 31-34 (without HS models)).
- Systematic capability SIL 3.
- 2 universal AC Input Lines, nominal 110 to 240 Vac (±10%) (48 to 62 Hz).
- Power factor correction.
- Installation in Zone 2/Div. 2 with hot swappable modules (except PSS1250-HS-7-0 & -7-5).
- EMC Compatibility to EN61000-6-2, EN61000-6-4.
- ATEX, IECEx, UL & C-UL Certifications (except for PSS1250(-HS)-7-0 and -7-5).
- TÜV Certification for Functional Safety of Product & Management of Functional Safety.
- Tested for maritime applications.
- Highly regulated output of 24 Vdc, 50 A, for PSM1250 module.
- Under and over voltage alarm monitoring.
- 3 over voltage redundant protections.
- Redundant parallel connections with load sharing (except for PSS1250(-HS)-7-0 & -7-5).
- Reduces Power dissipation (in parallel/redundant configuration) by replacing a Schottky diode with Mosfet Active Ideal Diode.
- 89% efficiency @230 Vac input and 24 Vdc output and full load.
- Fan speed control depending on ambient temperature and output power.
- High load fuse breaking capability without interrupting operations.
- 19" or 9" or 7" Rack unit, 4U high,anodized aluminium, durable metal enclosure
- Tropicalization for electronic components.
- Modbus RTU RS-485 diagnostic output (only for 19" or 9" rack units).

PSM1250
Maximum Output Power vs. Ambient Operating Temperature

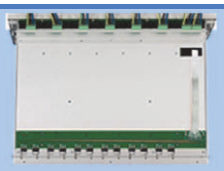
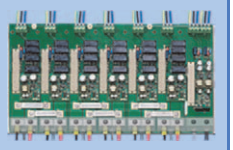
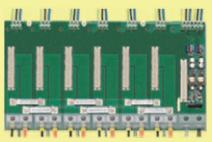
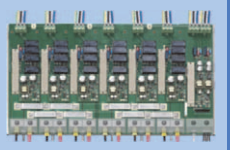
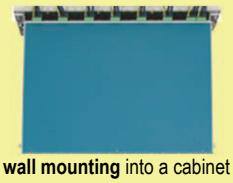
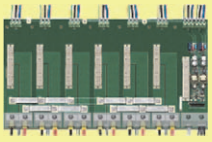
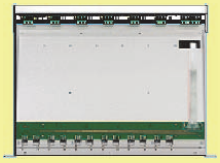
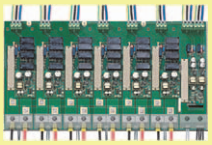
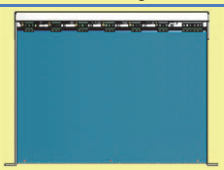
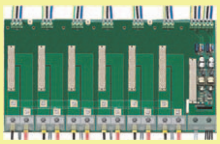
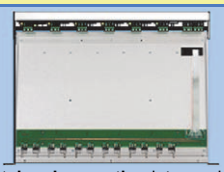
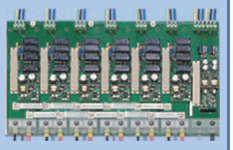
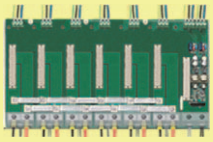
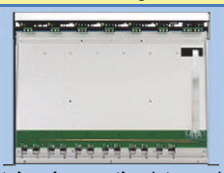
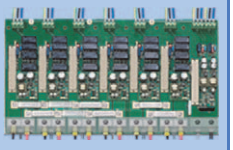
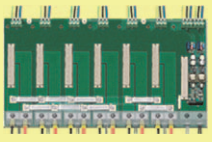


With 50% redundant configuration (two PSM1250 with paralleled outputs), each module can give 600 W power output up to 70°C operating ambient temperature, with output voltage range 21÷28 Vdc and input voltage nominal range 110÷240 Vac (±10%).
Only for PSS1250(-HS)-7-0 & -7-5, a single PSM1250 can be give 900 W (@ 28 Vdc) or 800 W (@ 24 Vdc) or 700 W (@ 21 Vdc) power output and 33 A output up to 70°C operating ambient temperature, with input voltage nominal range 110÷240 Vac (±10%).

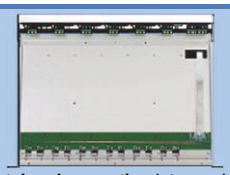
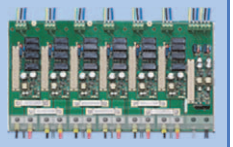
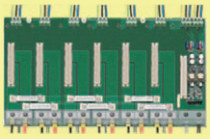
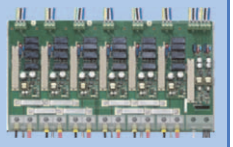
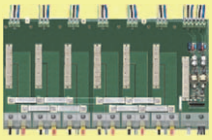
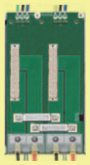
Ordering Information:

Rack unit & Back panel	Back Panel PCB	Configuration	Hot Swapping	Ordering code of PSS1250	NOT included rack slot items
 **wall mounting** into a cabinet		19 inches wide rack with 7 slots 6 outputs 24 Vdc up to 33 A without redundance 1 diagnostic module (optional)	YES	**PSS1250-HS-7-0-D**	**PSM1250** : needed from 1 to 6 pieces plugged into slots from 1st to 6th position **PSO1250** : 1 piece (optional) plugged into 7th slot **MCHP228** : needed from 5 to 0 pieces + 1 piece plugged into 7th slot if PSO1250 is not required
 **wall mounting** into a cabinet			NO	**PSS1250-7-0-D**	
 **wall mounting** into a cabinet		19 inches wide rack with 7 slots 1 output 24 Vdc up to 150 A with redundance 1 diagnostic module (optional)	YES	**PSS1250-HS-7-1-D**	**PSM1250** : needed from 2 to 6 pieces plugged into slots from 1st to 6th position **PSO1250** : 1 piece (optional) plugged into 7th slot **MCHP228** : needed from 4 to 0 pieces + 1 piece plugged into 7th slot if PSO1250 is not required
 **wall mounting** into a cabinet			NO	**PSS1250-7-1-D**	
 **wall mounting** into a cabinet		19 inches wide rack with 7 slots 2 outputs 24 Vdc up to: 1 x 100 A with redundance; 1 x 50 A with redundance; 1 diagnostic module (optional)	YES	**PSS1250-HS-7-2-D**	**PSM1250** : needed 2 or 4 or 6 pieces plugged into slots: from 1st to 4th position for up to 100 A output; on 5th & 6th positions for up to 50 A output **PSO1250** : 1 piece (optional) plugged into 7th slot **MCHP228** : needed from 4 to 0 pieces + 1 piece plugged into 7th slot if PSO1250 is not required
 **wall mounting** into a cabinet			NO	**PSS1250-7-2-D**	

Ordering Information:

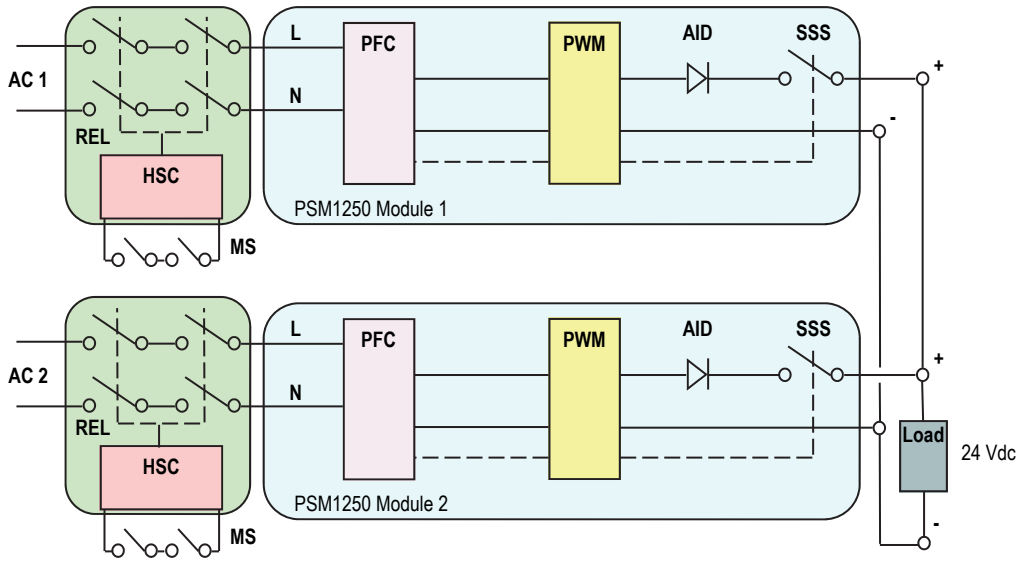
Rack unit & Back panel	Back Panel PCB	Configuration	Hot Swapping	Ordering code of PSS1250	NOT included rack slot items
 **wall mounting** into a cabinet		19 inches wide rack with 7 slots 3 outputs 24 Vdc up to: 3 x 50 A with redundance; 1 diagnostic module (optional)	YES	**PSS1250-HS-7-3-D**	**PSM1250** : needed 2 or 4 or 6 pieces plugged into slots: on 1st & 2nd positions for up to 50 A 1st output; on 3rd & 4th positions for up to 50 A 2nd output; on 5th & 6th positions for up to 50 A 3rd output **PSO1250** : 1 piece (optional) plugged into 7th slot **MCHP228** : needed from 4 to 0 pieces + 1 piece plugged into 7th slot if PSO1250 is not required
 **wall mounting** into a cabinet			NO	**PSS1250-7-3-D**	
 **wall mounting** into a cabinet		19 inches wide rack with 7 slots 2 outputs 24 Vdc up to: 2 x 100 A with redundance (2+1=100A+50A) 1 diagnostic module (optional)	YES	**PSS1250-HS-7-4-D**	**PSM1250** : needed 3 or 6 pieces plugged into slots: on 1st & 2nd & 3rd positions for up to 100 A 1st output; on 4th & 5th & 6th positions for up to 100 A 2nd output; **PSO1250** : 1 piece (optional) plugged into 7th slot **MCHP228** : needed from 3 to 0 pieces + 1 piece plugged into 7th slot if PSO1250 is not required
 **wall mounting** into a cabinet			NO	**PSS1250-7-4-D**	
 **frontal rack mounting** into a cabinet		19 inches wide rack with 7 slots 6 outputs 24 Vdc up to 33 A without redundance 1 diagnostic module (optional)	YES	**PSS1250-HS-7-5-D**	**PSM1250** : needed from 1 to 6 pieces plugged into slots from 1st to 6th position **PSO1250** : 1 piece (optional) plugged into 7th slot **MCHP228** : needed from 5 to 0 pieces + 1 piece plugged into 7th slot if PSO1250 is not required
 **frontal rack mounting** into a cabinet			NO	**PSS1250-7-5-D**	
 **frontal rack mounting** into a cabinet		19 inches wide rack with 7 slots 1 output 24 Vdc up to 150 A with redundance 1 diagnostic module (optional)	YES	**PSS1250-HS-7-6-D**	**PSM1250** : needed from 2 to 6 pieces plugged into slots from 1st to 6th position **PSO1250** : 1 piece (optional) plugged into 7th slot **MCHP228** : needed from 4 to 0 pieces + 1 piece plugged into 7th slot if PSO1250 is not required
 **frontal rack mounting** into a cabinet			NO	**PSS1250-7-6-D**	
 **frontal rack mounting** into a cabinet		19 inches wide rack with 7 slots 2 outputs 24 Vdc up to: 1 x 100 A with redundance; 1 x 50 A with redundance; 1 diagnostic module (optional)	YES	**PSS1250-HS-7-7-D**	**PSM1250** : needed 2 or 4 or 6 pieces plugged into slots: from 1st to 4th position for up to 100 A output; on 5th & 6th positions for up to 50 A output **PSO1250** : 1 piece (optional) plugged into 7th slot **MCHP228** : needed from 4 to 0 pieces + 1 piece plugged into 7th slot if PSO1250 is not required
 **frontal rack mounting** into a cabinet			NO	**PSS1250-7-7-D**	

Ordering Information:

Rack unit & Back panel	Back Panel PCB	Configuration	Hot Swapping	Ordering code of PSS1250	NOT included rack slot items
 **frontal rack mounting** into a cabinet		19 inches wide rack with 7 slots 3 outputs 24 Vdc up to: 3 x 50 A with redundance; 1 diagnostic module (optional)	YES	**PSS1250-HS-7-8-D**	**PSM1250** : needed 2 or 4 or 6 pieces plugged into slots: on 1st & 2nd positions for up to 50 A 1st output; on 3rd & 4th positions for up to 50 A 2nd output; on 5th & 6th positions for up to 50 A 3rd output **PSO1250** : 1 piece (optional) plugged into 7th slot **MCHP228** : needed from 4 to 0 pieces + 1 piece plugged into 7th slot if PSO1250 is not required
 **frontal rack mounting** into a cabinet			NO	**PSS1250-7-8-D**	
 **frontal rack mounting** into a cabinet		19 inches wide rack with 7 slots 2 outputs 24 Vdc up to: 2 x 100 A with redundance (2+1=100A+50A) 1 diagnostic module (optional)	YES	**PSS1250-HS-7-9-D**	**PSM1250** : needed 3 or 6 pieces plugged into slots: on 1st & 2nd & 3rd positions for up to 100 A 1st output; on 4th & 5th & 6th positions for up to 100 A 2nd output; **PSO1250** : 1 piece (optional) plugged into 7th slot **MCHP228** : needed from 3 to 0 pieces + 1 piece plugged into 7th slot if PSO1250 is not required
 **frontal rack mounting** into a cabinet			NO	**PSS1250-7-9-D**	
 **wall mounting** into a cabinet		9 inches wide rack with 3 slots 1 output 24 Vdc up to 50 A with redundance 1 diagnostic module (optional)	YES	**PSS1250-HS-3-D**	**PSM1250** : needed 2 pieces plugged into slots on 1st & 2nd positions **PSO1250** : 1 piece (optional) plugged into 3rd slot **MCHP228** : 1 piece plugged into 3rd slot if PSO1250 is not required
 **wall mounting** into a cabinet			NO	**PSS1250-3-D**	
 **wall mounting** into a cabinet		7 inches wide rack with 2 slots 1 output 24 Vdc up to 50 A with redundance	YES	**PSS1250-HS-2**	**PSM1250** : needed 2 pieces plugged into slots on 1st & 2nd positions
 **wall mounting** into a cabinet			NO	**PSS1250-2**	

Photos	Ordering code of rack slot items
	**PSM1250** power supply module with 24 Vdc – 50 A output
	**PSO1250** diagnostic module with touch screen LCD color display
	**MCHP228** blank panel to fill not used rack slot, where a PSM1250 or PSO1250 is not installed

Hot swapping capability



Legend:

AC1:	Mains line
AC2:	Mains backup line
PFC:	Power Factor Controller
PWM:	Power Module
HSC:	Hot Swappable Circuit
AID:	Active Ideal Diode
SSS:	Solid State Switch
MS:	Micro switches on rack unit
REL:	Relays on back plane pcb
L:	Line
N:	Neutral

PSS1250 Power Supply System is able to provide power and installed in Zone 2/Div. 2 (valid for all configurations except for PSS1250(-HS)-7-0 & -7-5), without the need to monitor hazardous gas presence and without disturbing power supply operations, because it is fully protected from the Hot Swapping of any power, or diagnostic, module. This protection system operates for both the insertion and disconnection of the modules. When inserting the module, the mains voltage is only applied when mechanical and electrical module connections are completely and correctly positioned, while before disconnecting the module the external electrical connections have to be at zero voltage level. To achieve this result, a sophisticated 1oo2 mechanical and electrical protection circuit, using micro switches (MS), relays (REL) and special hot swapping circuits (HSC), has been designed. All power modules have a mains terminal block for Line-Neutral-Earth/Ground, placed in the back panel pcb that can be used for two independent mains lines (AC1 and AC2). The Line and Neutral are connected to the power module via two couples of 1oo2 series contact relays, driven from hot swapping circuit according to closed or open state of 1oo2 series mechanical switches. Two micro switches for each power module are placed in the front part of the 7" or 9" or 19" Rack unit and are activated (closed) by front panel top screws used to fix the module at rack. 24 relays (4 for each power module) are installed on the back panel pcb, close to the mains terminal blocks, in 1oo2 architecture for safety purposes. For further safety, close to the relays, for each position, there is a red LED (total 6 LEDs). Before inserting a power module, the operator must verify that related red LED is OFF (see page 45). If the red LED is turned ON, a failure is present on a couple of series relays. Therefore no power module shall be inserted and fixed into that position of the rack unit in Zone 2/Div.2, because it can be a danger. The opening of the micro switches, operated by unscrewing at least one of two front panel top screws, initiates the following two actions:

1. Mains line is disconnected from the power module, because hot swapping circuit de-energizes relays, opening their contacts;
2. Voltage on the power module connectors is brought to 0 volts, to avoid any sparking possibility. This is done by a MOSFET solid state switch (SSS) connected in series with the *active ideal diodes (AID)*, which disconnects the output from the DC output bus. The internal voltage in the disconnected power module remains completely isolated from the output connections and therefore, even if an operator shorts the connections with a screw driver or any other tool, this will not generate a spark.

When a power module is inserted and fixed to rack unit by its screws, the MOSFET solid state switch remains open until the power supply starts to operate correctly, then it closes itself applying voltage to the load.

Reasons for using an Ideal Diode-OR Controller circuit, in N+1 redundant power supply applications with high availability systems

High availability systems often employ power supply modules connected in parallel to achieve redundancy and enhance system reliability.
ORing diodes have been a popular means of connecting these supplies at a point of load. The disadvantage of this approach is the forward voltage drop and resulting efficiency loss. This drop reduces the available supply voltage and dissipates significant power.
Replacing Schottky diodes with N-channel MOSFETs reduces power dissipation and eliminates the need for expensive heat sinks or large thermal layouts in high power applications. In the Ideal Diode-OR Controller circuit (*active ideal diode*), the voltage across source and drain is monitored by IN and OUT pins, and GATE pin drives the MOSFETs to control their operation. In effect the MOSFET source and drain serve as the anode and cathode of an ideal diode.
In the event of a power supply failure, for example if the output of a fully loaded supply is suddenly shorted to ground, reverse current temporarily flows through the MOSFETs that are ON. This current is sourced from any load capacitance and from the other supplies. The active ideal diode quickly responds to this condition turning off the MOSFETs in about 0.5µs, thus minimizing disturbance and oscillations to the output bus.
Using Oring diodes to parallel two, or more, 24 VDC power supply modules for redundancy, one Schottky diode is used for each module. The voltage drop across the diode can reach about 0.8 V at 50 A, this means about 40 W dissipation for each module. Then, if six 50 A paralleled modules are used for full 150 + 150 A redundancy, a total power of about **240 W** is dissipated for this purpose. This reduces efficiency, reliability and increases space for heat sinks. Moreover, in case of module failure, diodes take time to recover and consequently they do not preserve the load from transients during the backup operation.
To avoid all these problems G.M. International has introduced, in the new PSS1250 Power Supply System, the use of *active ideal diodes*.
The MOSFETs resistance for *active ideal diodes* is about 1.2 mΩ resulting in 3.6 W dissipation for each power module. Then, if six 50 A paralleled modules are used for full 150 + 150 A redundancy, a total power of about **22 W** is dissipated for the purpose resulting in about **ten times less** dissipation compared to Schottky diodes solution.
This increases efficiency, reliability, availability and reduces space for heat sinks.
This circuit provides also very smooth voltage switchovers without oscillations with fast turnoff, minimizing reverse current transients.

Output voltage setting - Fault indications - Diagnostic information

For each PSM1250 power module, the output voltage can be set to 24 Vdc +18%; -14% via a front panel trimmer (see page 46 (for system with HS) or page 49 (for system without HS) for more information about voltage adjust procedure).
Under voltage threshold is set to 19.5 V, while Over voltage threshold is set to 29.5 V.
A front panel power ON green LED signals mains voltage is applied to the power module and normal DC output voltage is present on DC output bus.
Power module Fault conditions are signaled by opening contact of NE relay (contact closed in normal condition), positioned on back panel pcb "Fault" terminal block.
Faults can be:

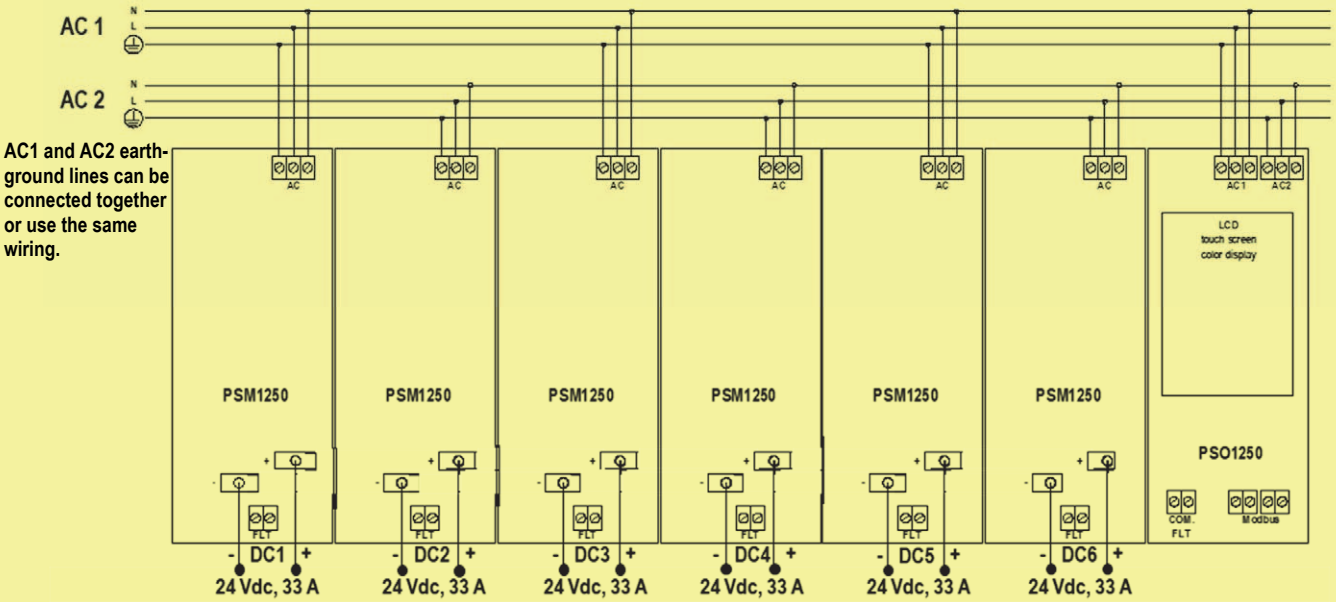
- Under voltage Vout < 19.5 V.
- Over voltage Vout > 29.5 V.

In absence of under / over voltage fault, the green Power ON LED is ON if output voltage is within 19.5 V - 29.5 V range.
If output voltage goes below 19.5 V, the green Power ON LED blinks and holds this condition as long as output voltage goes over 20 V.
If output voltage goes over 29.5 V, the green Power ON LED is OFF and holds this condition as long as output voltage goes below 29 V.
After under / over voltage fault, coming back to normal condition, the green Power ON LED is ON if output voltage is within 20 V - 29 V range.
Communication with six (for PSS1250-xx-7-x-D) or two (for PSS1250-xx-3-D) power modules is achieved via PSO1250 diagnostic module, which incorporates a front panel color touch screen. The diagnostic module is able to query each power modules (using an internal proprietary bus) and read data such as, Input/Output Voltage, Current and Power; Input Line Frequency; Output current sharing percentage; Internal Temperature; alarm status (under/over out voltage, AC line absence, internal PFC or PWM stage in OFF state, internal high temperature, fans malfunctioning). This information is available via front panel LCD and externally via Modbus RTU on related wall mounting terminal block.
Alarm status of one or more power modules is signalled by opening contact of NE relay (contact closed in normal condition), positioned on back panel pcb "Comm. Fault" terminal block. The diagnostic module **does not interfere** with the Power system functional safety. The power system can perfectly work without the diagnostic module and any failure of the diagnostic module does not affect system performance, reliability and SIL level of Functional Safety applications.

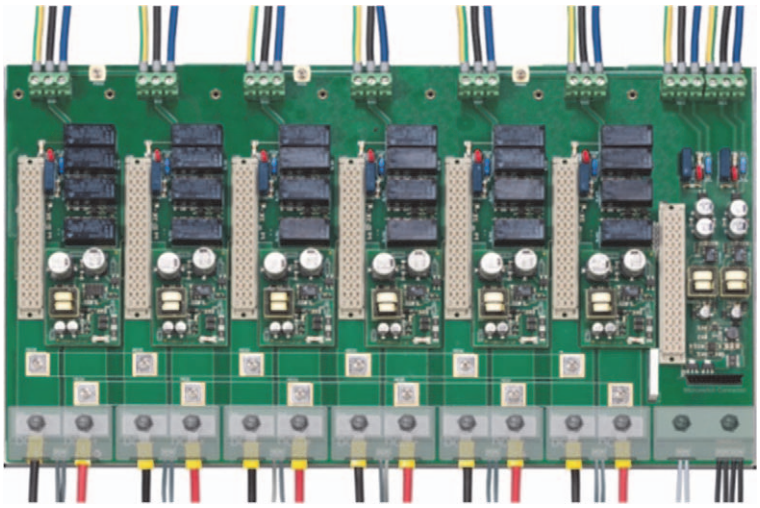
Function Diagram Dual AC Supply wiring architecture for PSS1250-HS-7-0/5-D or PSS1250-7-0/5-D fully equipped:

SAFE AREA / NON HAZARDOUS LOCATIONS

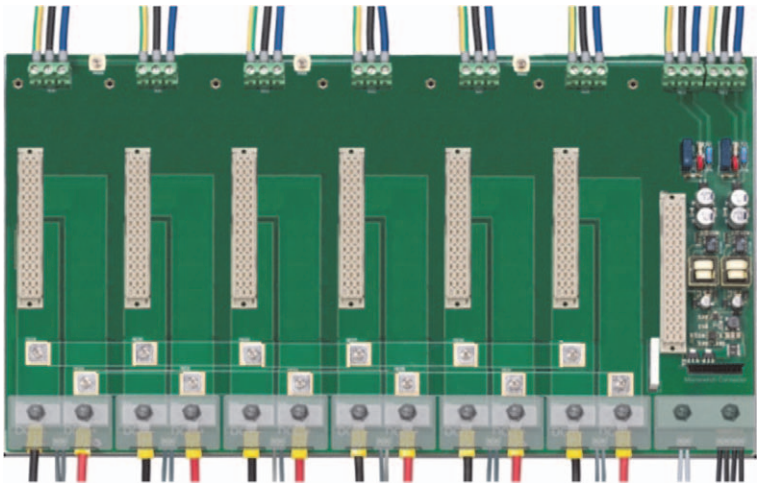
PSS1250-HS-7-0-D or PSS1250-HS-7-5-D or PSS1250-7-0-D or PSS1250-7-5-D, dual AC supply, 6 x 33 A Outputs, PSO1250 overview module
six independent power modules to provide six independent 33 A outputs.



Back Panel PCB of PSS1250-HS-7-0-D or PSS1250-HS-7-5-D with Hot Swapping circuits:



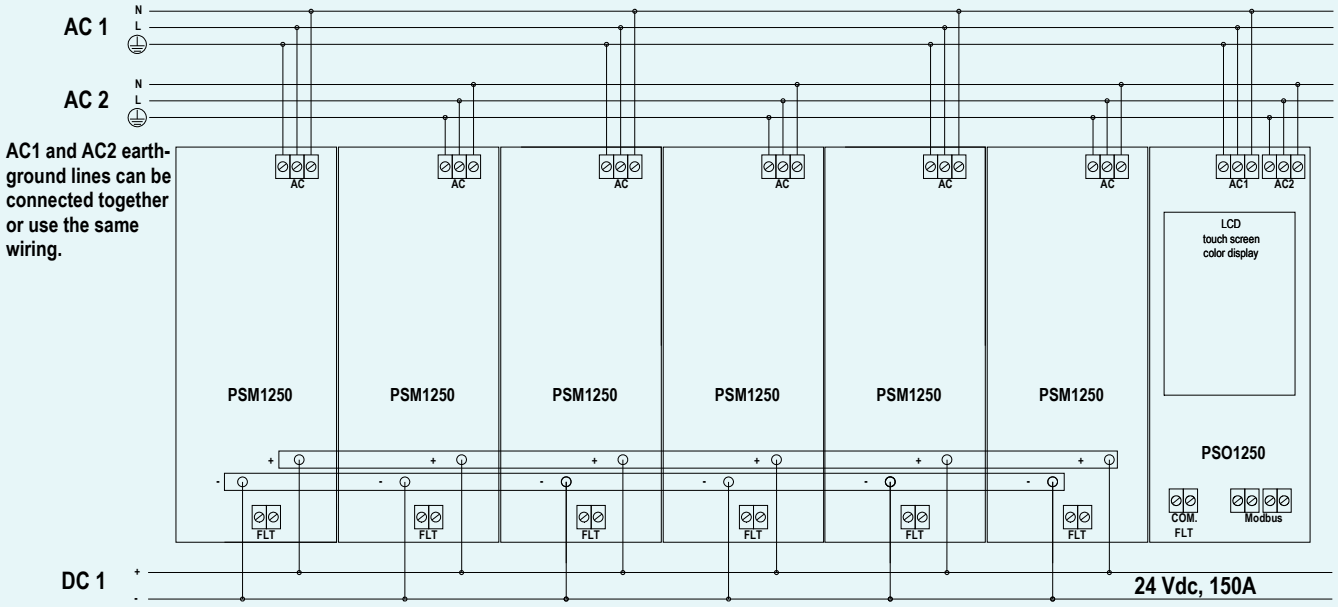
Back Panel PCB of PSS1250-7-0-D or PSS1250-7-5-D without Hot Swapping circuits:



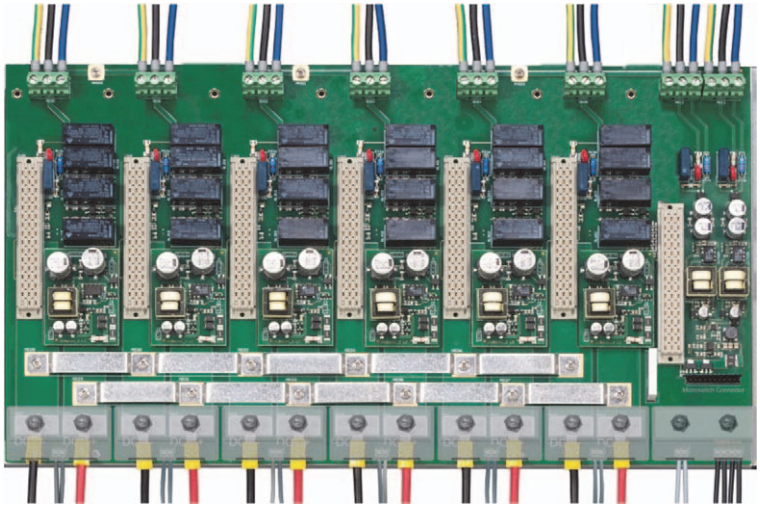
Function Diagram Dual AC Supply wiring architecture for PSS1250-HS-7-1/6-D or PSS1250-7-1/6-D fully equipped:

SAFE AREA / NON HAZARDOUS LOCATIONS or
ZONE 2 GROUP IIC T4 or CLASS I, DIVISION 2, GROUPS A, B, C, D T-Code T4

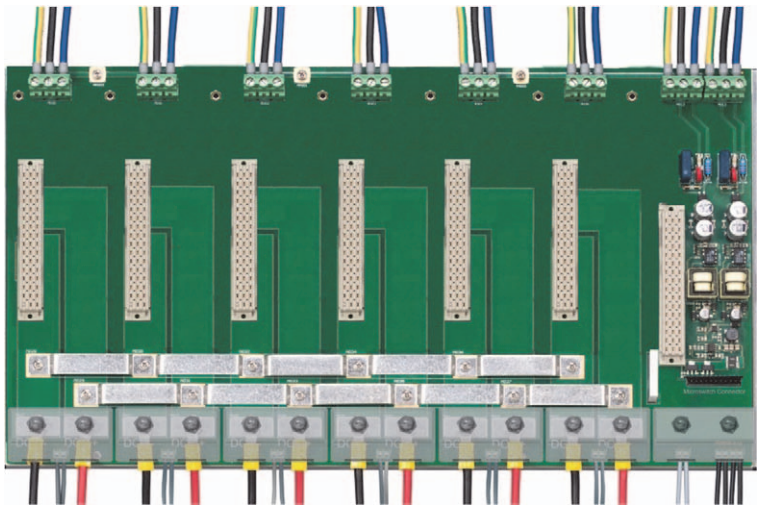
PSS1250-HS-7-1-D or PSS1250-HS-7-6-D or PSS1250-7-1-D or PSS1250-7-6-D, dual AC supply, 1 redundant 150 A Output, PSO1250 overview module
six power modules connected in parallel to provide full redundancy on AC lines (AC1 and AC2) and one 150 A redundant output.



Back Panel PCB of PSS1250-HS-7-1-D or PSS1250-HS-7-6-D with Hot Swapping circuits:



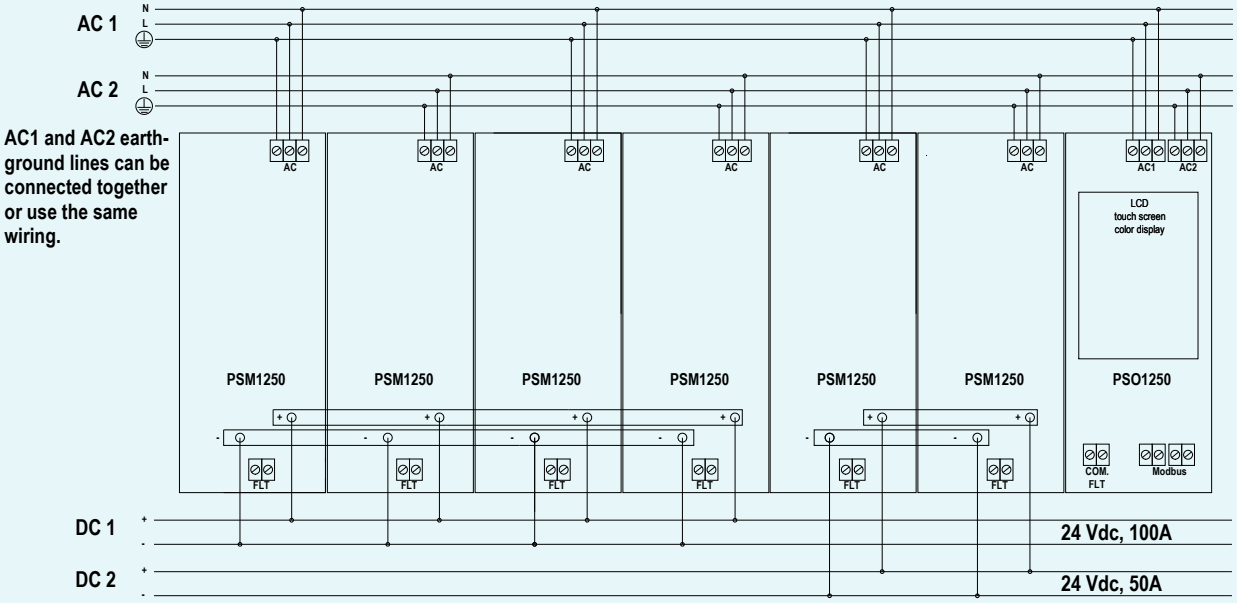
Back Panel PCB of PSS1250-7-1-D or PSS1250-7-6-D without Hot Swapping circuits:



Function Diagram Dual AC Supply wiring architecture for PSS1250-HS-7-2/7-D or PSS1250-7-2/7-D fully equipped:

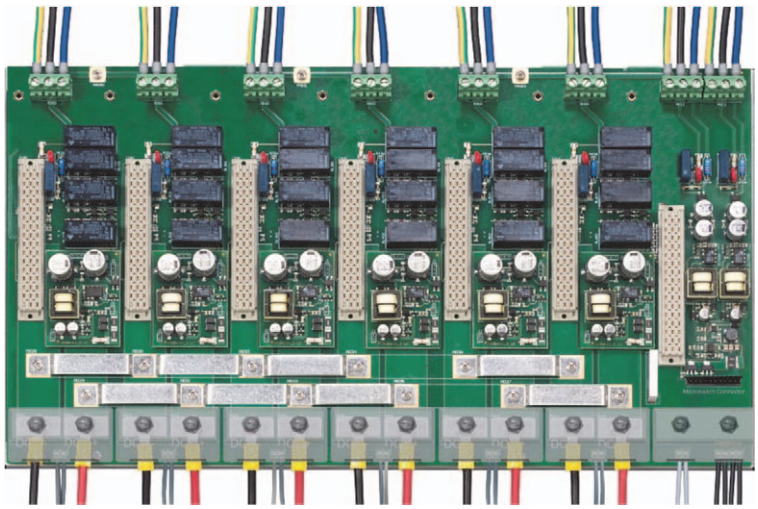
SAFE AREA / NON HAZARDOUS LOCATIONS or
ZONE 2 GROUP IIC T4 or CLASS I, DIVISION 2, GROUPS A, B, C, D T-Code T4

PSS1250-HS-7-2-D or PSS1250-HS-7-7-D or PSS1250-7-2-D or PSS1250-7-7-D, dual AC supply, 1 redundant 100 A Out + 1 redundant 50A Out, PSO1250 overview module
four power modules connected in parallel to provide full redundancy on AC lines (AC1 and AC2) and one 100 A redundant output.
two power modules connected in parallel to provide full redundancy on AC lines (AC1 and AC2) and one 50 A redundant output.

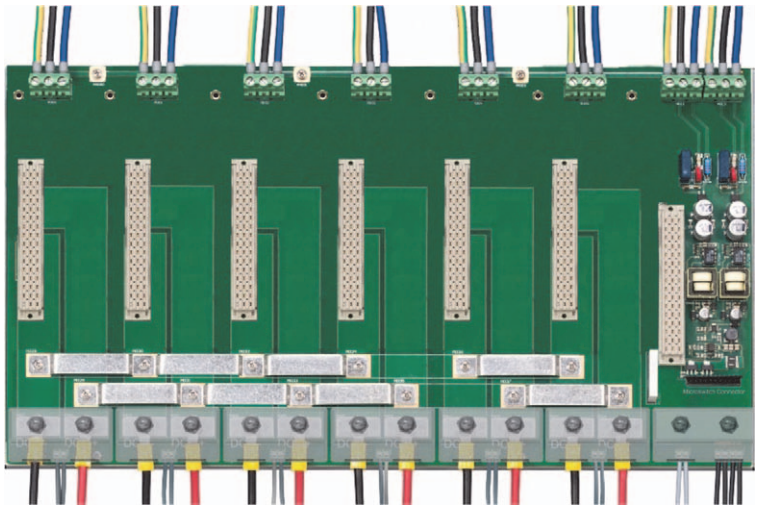


If electrical isolation between paralleled output groups is not required, DC 1 (-) and DC 2 (-) negative lines can be connected together or use the same wiring.

Back Panel PCB of PSS1250-HS-7-2-D or PSS1250-HS-7-7-D with Hot Swapping circuits:



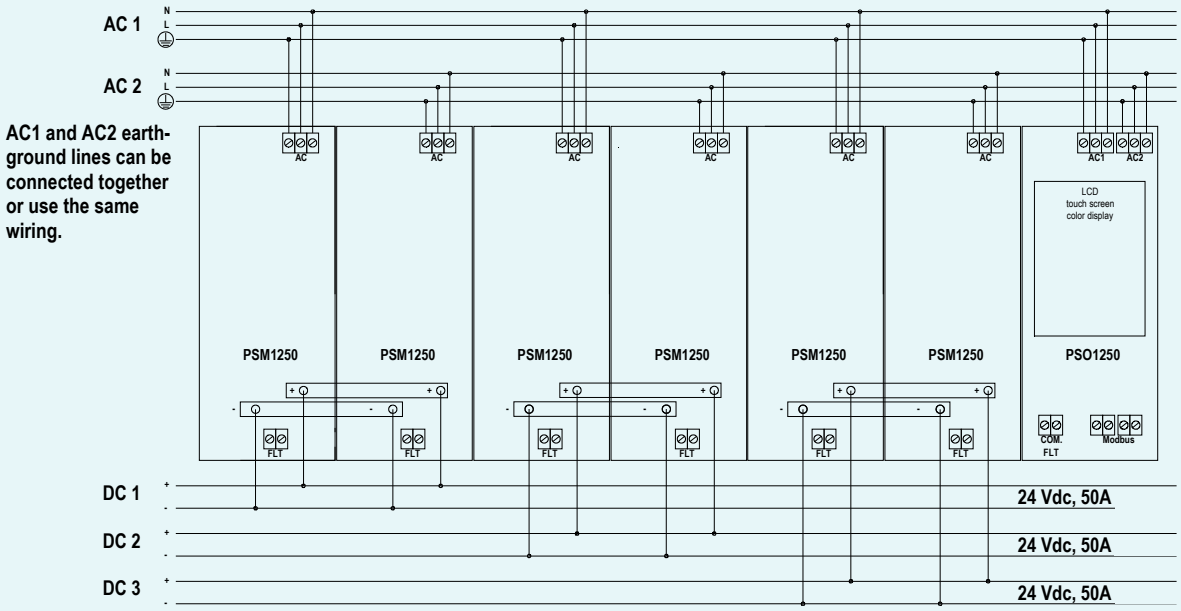
Back Panel PCB of PSS1250-7-2-D or PSS1250-7-7-D without Hot Swapping circuits:



Function Diagram Dual AC Supply wiring architecture for PSS1250-HS-7-3/8-D or PSS1250-7-3/8-D fully equipped:

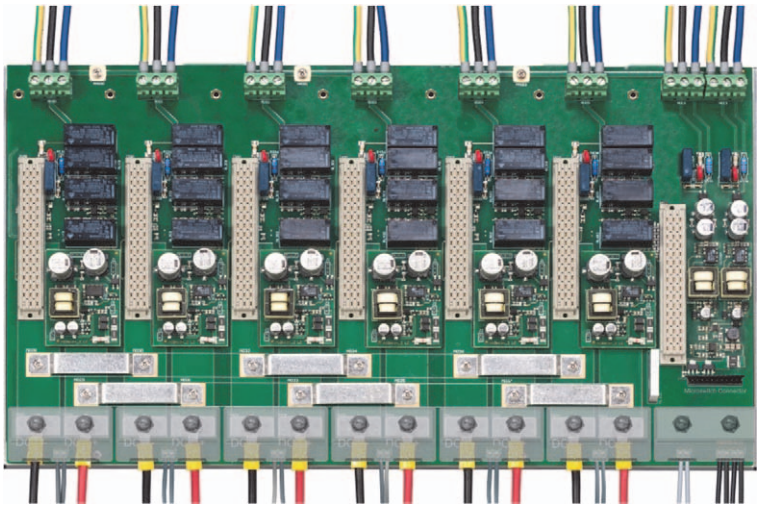
SAFE AREA / NON HAZARDOUS LOCATIONS or
ZONE 2 GROUP IIC T4 or CLASS I, DIVISION 2, GROUPS A, B, C, D T-Code T4

PSS1250-HS-7-3-D or PSS1250-HS-7-8-D or PSS1250-7-3-D or PSS1250-7-8-D, dual AC supply, 3 redundant 50 A Outputs, PSO1250 overview module
six power modules connected in parallel in groups of two to provide full redundancy on AC lines (AC1 and AC2) and three independent 24 Vdc, 50 A redundant outputs.

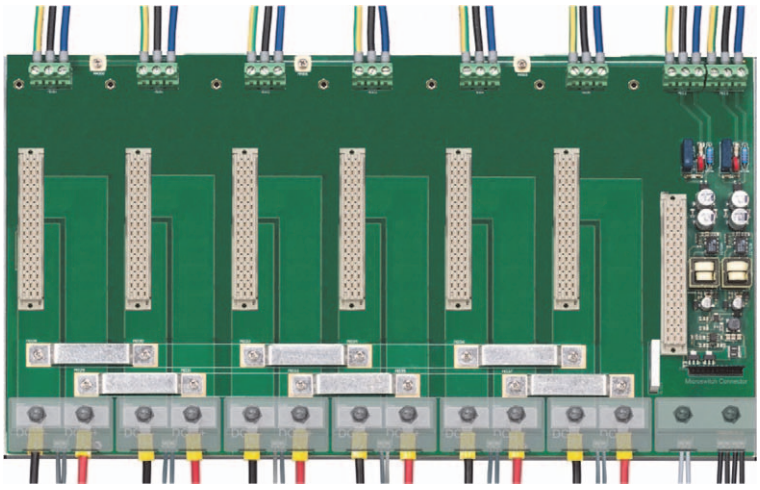


If electrical isolation between paralleled output groups is not required, DC 1 (-), DC 2 (-) and DC 3 (-) negative lines can be connected together or use the same wiring.

Back Panel PCB of PSS1250-HS-7-3-D or PSS1250-HS-7-8-D with Hot Swapping circuits:



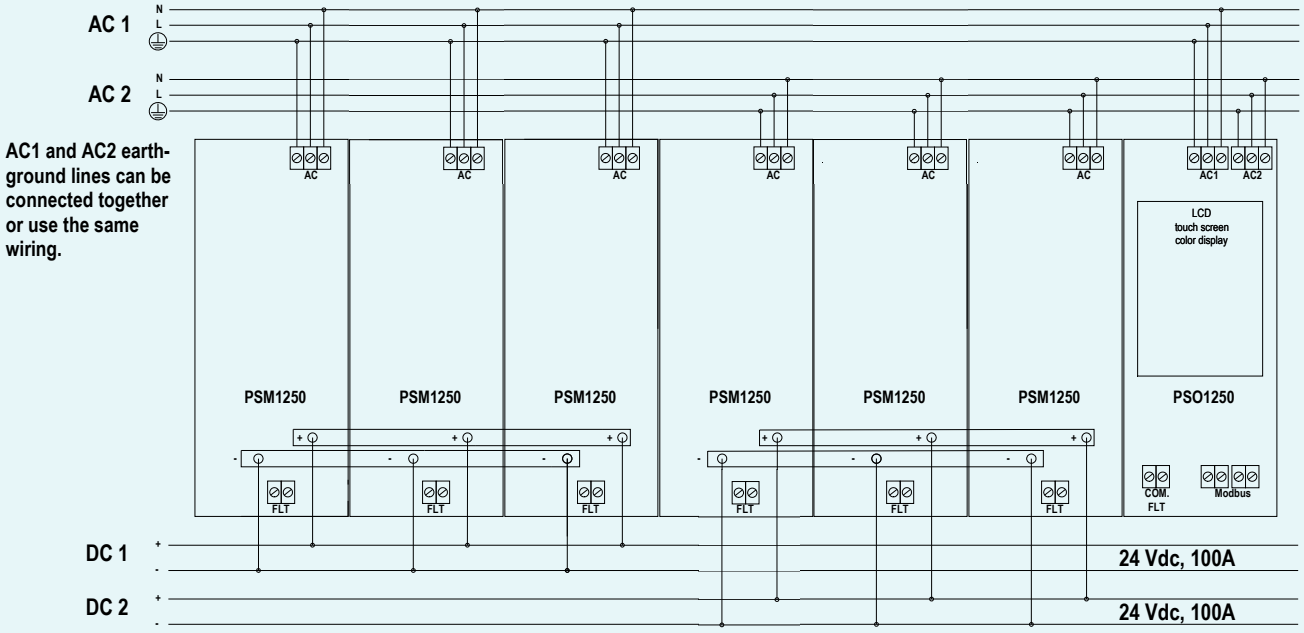
Back Panel PCB of PSS1250-7-3-D or PSS1250-7-8-D without Hot Swapping circuits:



Function Diagram Dual AC Supply wiring architecture for PSS1250-HS-7-4/9-D or PSS1250-7-4/9-D fully equipped:

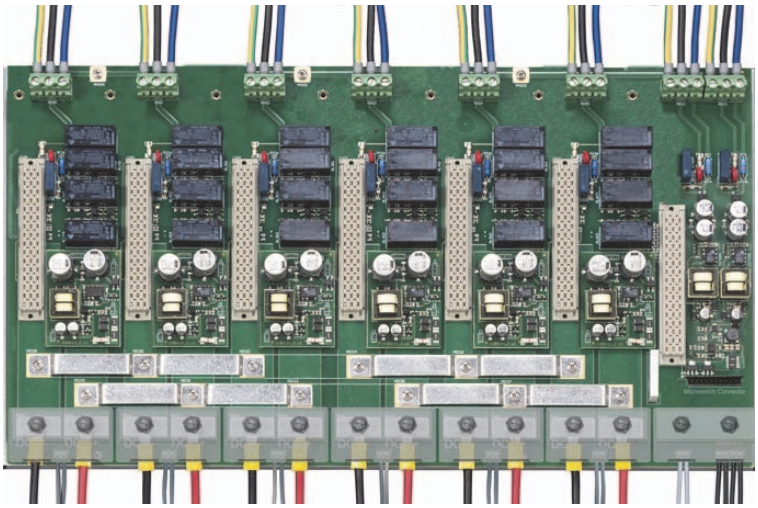
SAFE AREA / NON HAZARDOUS LOCATIONS or
ZONE 2 GROUP IIC T4 or CLASS I, DIVISION 2, GROUPS A, B, C, D T-Code T4

PSS1250-HS-7-4-D or PSS1250-HS-7-9-D or PSS1250-7-4-D or PSS1250-7-9-D, dual AC supply, 2 redundant 100 A Outputs, PSO1250 overview module
Two groups of three power modules connected in parallel. Each group provides 100 A redundant Output with redundance 2+1 (100 A + 50 A).

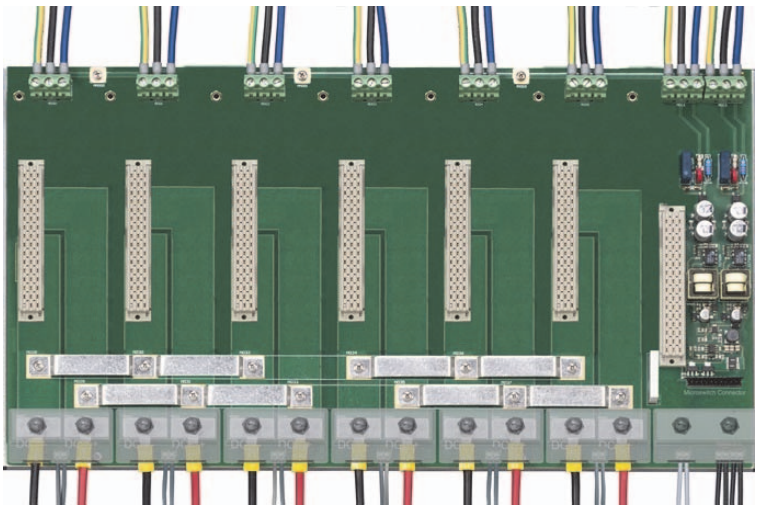


If electrical isolation between paralleled output groups is not required, DC 1 (-) and DC 2 (-) negative lines can be connected together or use the same wiring.

Back Panel PCB of PSS1250-HS-7-4-D or PSS1250-HS-7-9-D with Hot Swapping circuits:



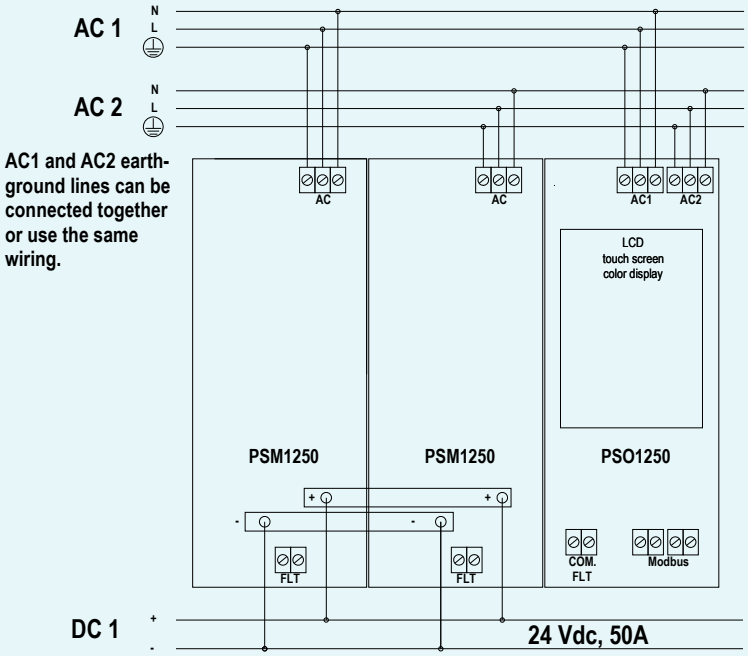
Back Panel PCB of PSS1250-7-4-D or PSS1250-7-9-D without Hot Swapping circuits:



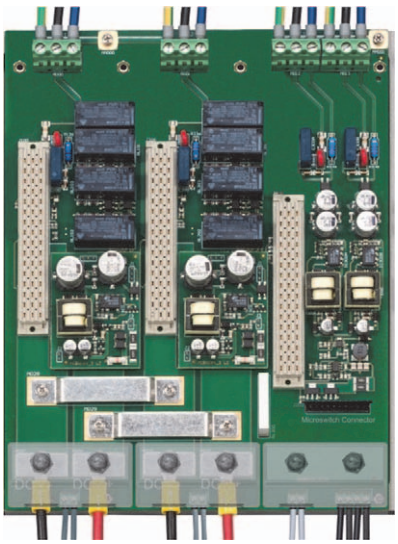
Function Diagram Dual AC Supply wiring architecture for PSS1250-HS-3-D or PSS1250-3-D fully equipped:

SAFE AREA / NON HAZARDOUS LOCATIONS or
ZONE 2 GROUP IIC T4 or CLASS I, DIVISION 2, GROUPS A, B, C, D T-Code T4

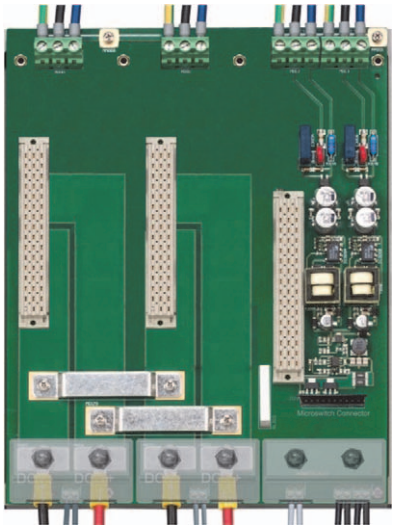
PSS1250-HS-3-D or PSS1250-3-D, dual AC supply, 1 redundant 50 A Output, PSO1250 overview module
two power modules connected in parallel to provide full redundancy on AC lines (AC1 and AC2) and one 50 A redundant output.



Back Panel PCB of PSS1250-HS-3-D with Hot Swapping circuits:



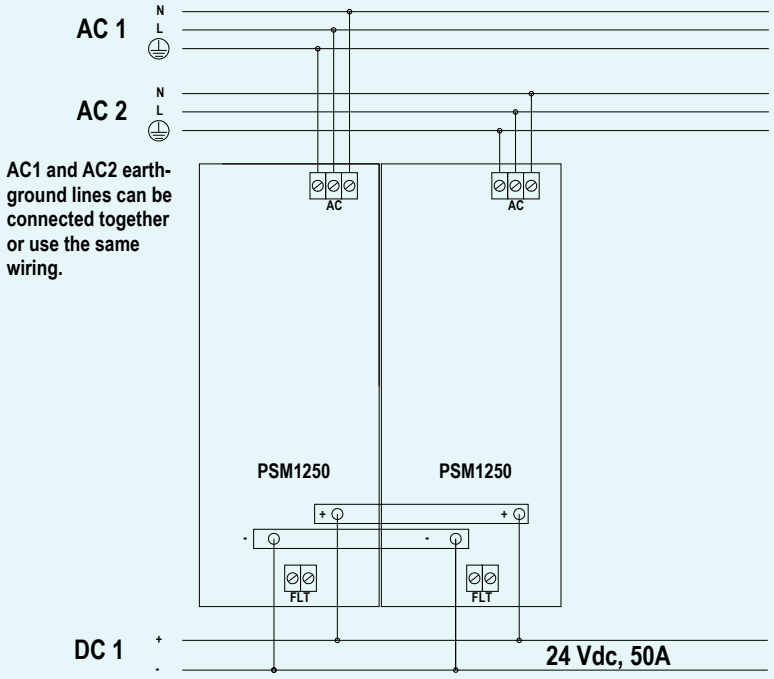
Back Panel PCB of PSS1250-3-D without Hot Swapping circuits:



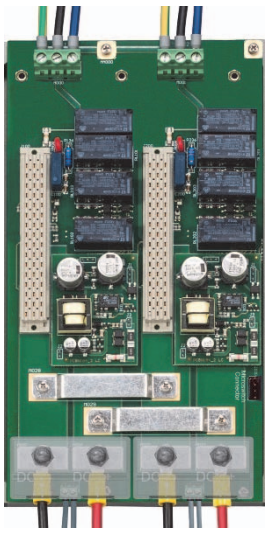
Function Diagram Dual AC Supply wiring architecture for PSS1250-HS-2 or PSS1250-2 fully equipped:

SAFE AREA / NON HAZARDOUS LOCATIONS or
ZONE 2 GROUP IIC T4 or CLASS I, DIVISION 2, GROUPS A, B, C, D T-Code T4

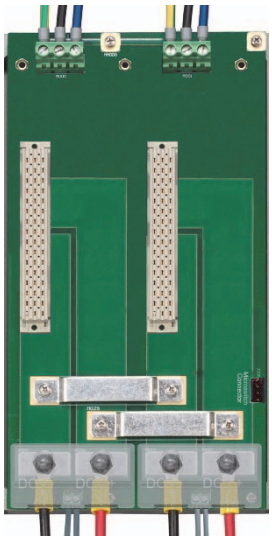
PSS1250-HS-2 or PSS1250-2, dual AC supply, 1 redundant 50 A Output.
two power modules connected in parallel to provide full redundancy on AC lines (AC1 and AC2) and one 50 A redundant output.



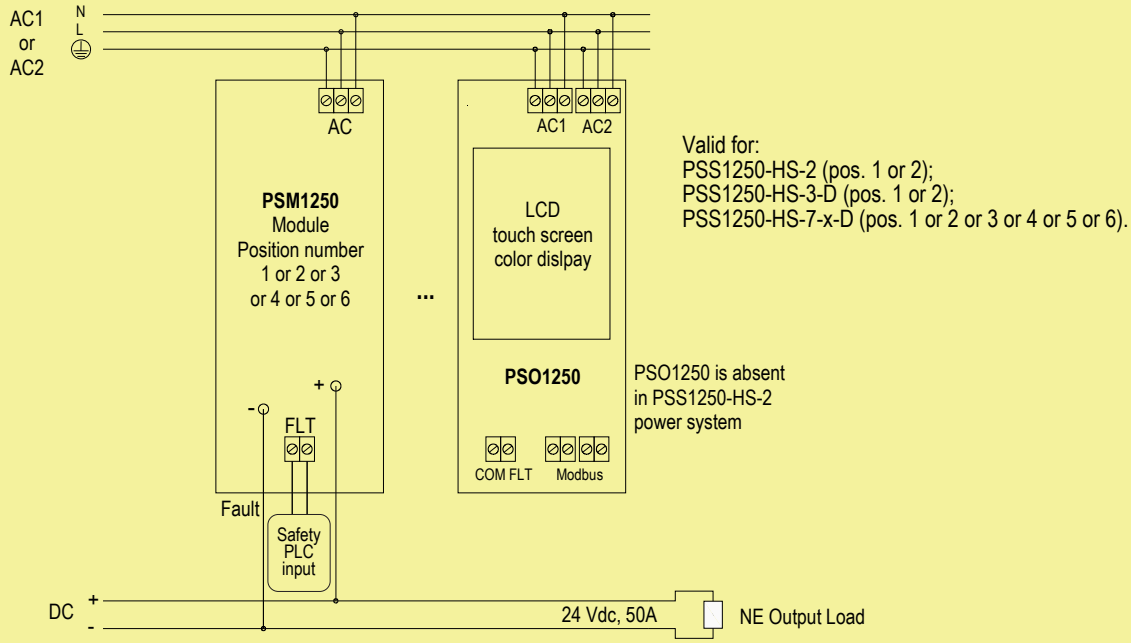
Back Panel PCB of PSS1250-HS-2 with Hot Swapping circuits:



Back Panel PCB of PSS1250-2 without Hot Swapping circuits:



1) Application of PSS1250 with HS and single PSM1250 module, for NE output load



Description:

In normal operation the PSM1250 module is powered by connecting AC input supply to related terminal blocks on the Back Panel PCB (see previous functional diagram for more information). The fault relay contact must be connected to Safety PLC or Safety logic solver because power supply internal diagnostic uses this contact to notify under/over voltage faults to logic solver, which can require to turn off power supply and to replace it with a new PSM1250 module. In absence of fault the relay contact is closed, while in presence of fault the relay contact is open.

The green Power ON LED of PSM1250 is lit in presence of AC input supply. In this condition the NE output load (connected to related output copper bars with screw terminals on the Back Panel PCB) is Normally Energized (NE).

In absence of AC input supply, the PSM1250 module is shutdown (its fault relay contact is open) and output load is de-energized (Safe State).

Safety Function and Failure behavior:

PSS1250 with HS and single PSM1250 module is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 0.

The failure behaviour of PSM1250 for NE load is described by the following definitions :

- □ Fail-Safe State: it is defined as the output going below 2 Vdc. Internal diagnostic detects and notifies Low/High (Under/Over voltage) fails (DD) to logic solver, which can operate to convert these fails to the fail-safe state, requiring to turn off power supply and to replace it with a new PSM1250 module.
- □ Fail Safe: failure mode that causes the module / (sub)system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the output voltage is blocked or oscillating between 2 and 20 Vdc or above 30 Vdc, and internal diagnostic cannot detect and notify faults to logic solver.
- □ Fail High - Overvoltage: failure mode that causes the output to go above 30 Vdc. Internal overvoltage protection tries to limit output voltage < 30 Vdc, otherwise internal crowbars trip to fail safe state for output ≥ 30 Vdc. Internal diagnostic detects and notifies High fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail Low - Undervoltage: failure mode that causes the output to go between 2 and 20 Vdc. Internal diagnostic detects and notifies Low fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail "No Effect": failure mode of a component that plays a part in implementing the safety function but that is neither a safe failure nor a dangerous failure, so that the output voltage is deviated between 20 and 30 Vdc. When calculating the SFF, this failure mode is not taken into account.
- □ Fail "Not part": failure mode of a component that is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF, this failure mode is not taken into account.

The PSO1250 diagnostic module **does not interfere** with the power system functional safety. The power system can perfectly work without the diagnostic module and any failure of the PSO1250 diagnostic module does not affect system performance, reliability and SIL level of this Functional Safety application.

Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	42.76
λ_{du} = Total Dangerous Undetected failures	12.34
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	1890.87
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**1945.97**
MTBF (safety function) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**58 years**
$\lambda_{no\ effect}$ = "No Effect" failures	1146.91
$\lambda_{not\ part}$ = "Not Part" failures	267.09
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{no\ effect} + \lambda_{not\ part}$	**3359.97**
MTBF (device) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**34 years**

Failure rates table according to IEC 61508:2010 Ed.2 :

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
0.00 FIT	1890.87 FIT	42.76 FIT	12.34 FIT	99.37%	0.00%	77.60%

PFDavg vs T[Proof] table (assuming Proof Test coverage of 90%), with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

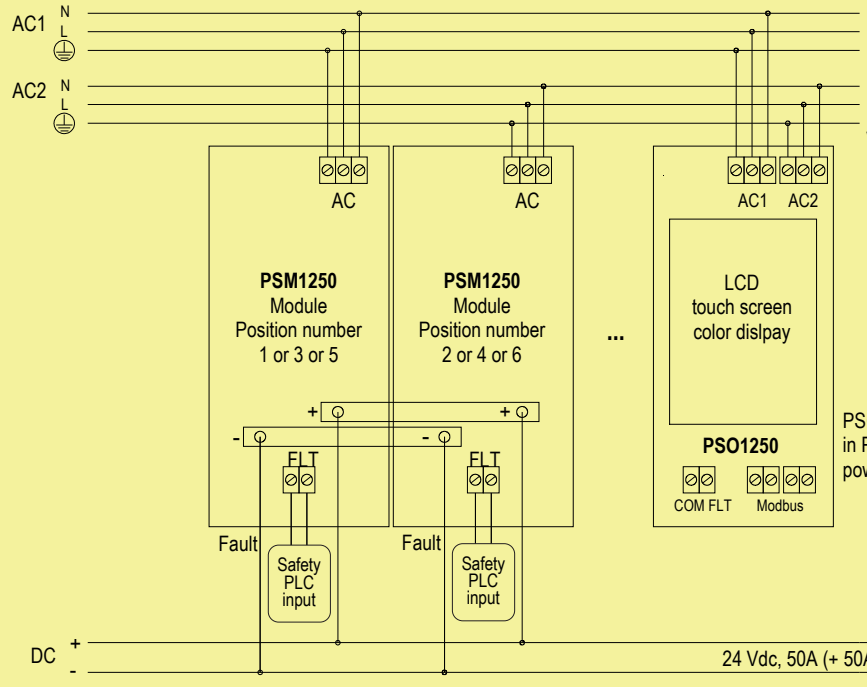
T[Proof] = 1 year	T[Proof] = 1.5 years	T[Proof] = 18 years
PFDavg = 5.449E-05 Valid for **SIL 3**	PFDavg = 8.17E-05 Valid for **SIL 3**	PFDavg = 9.81E-04 Valid for **SIL 2**

PFDavg vs T[Proof] table (assuming Proof Test coverage of 90%), with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 10 years	T[Proof] = 20 years
PFDavg = 5.45E-04 Valid for **SIL 3**	PFDavg = 1.09E-03 Valid for **SIL 2**

Systematic capability SIL 3.

2) Application of PSS1250 with HS and two paralleled PSM1250 modules, for NE output load



Valid for:
PSS1250-HS-2 ;
PSS1250-HS-3-D ;
PSS1250-HS-7-4-D (pos. 1&2 or 2&3 or 4&5 or 5&6);
PSS1250-HS-7-9-D (pos. 1&2 or 2&3 or 4&5 or 5&6);
PSS1250-HS-7-3-D (pos. 1&2 or 3&4 or 5&6);
PSS1250-HS-7-8-D (pos. 1&2 or 3&4 or 5&6);
PSS1250-HS-7-2-D (2 modules into position 1 to 4 or 5&6);
PSS1250-HS-7-7-D (2 modules into position 1 to 4 or 5&6);
PSS1250-HS-7-1-D (2 modules into position 1 to 6);
PSS1250-HS-7-6-D (2 modules into position 1 to 6).

PSO1250 is absent in PSS1250-HS-2 power system

Description: In normal operation two paralleled PSM1250 modules are powered by connecting AC1 input supply to one module and AC2 input supply to other one by means of related terminal blocks on the Back Panel PCB (see previous functional diagram for more information). For each PSM1250 module, its fault relay contact must be connected to Safety PLC or Safety logic solver because power supply internal diagnostic uses this contact to notify under/over voltage module faults to logic solver, which can require to turn off this power supply and to replace it with a new PSM1250 module. In absence of module fault the relay contact is closed, while in presence of module fault the relay contact is open.
The green Power ON LED of each PSM1250 is lit in presence of AC input supply.
The outputs of two PSM1250 modules are already paralleled on the Back Panel PCB by specific copper bars. Therefore, the NE output load is connected to outputs of both PSM1250 modules (by related output copper bars with screw terminals on the Back Panel PCB). In normal condition, NE output load is Normally Energized (NE).
In absence of one only AC input supply (AC1 or AC2), one PSM1250 module is shutdown (its fault relay contact is open) but the other one operates in normal condition, so that output load is normally energized. In absence of both AC input supplies (AC1 and AC2), both paralleled PSM1250 modules are shutdown (their fault relay contacts are open) and output load is de-energized (Safe State).

Safety Function and Failure behavior: PSS1250 with HS and two paralleled PSM1250 modules is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 1 or redundant config.1+1 on in/out. The failure behaviour of two paralleled PSM1250 modules for NE load is described by the following definitions:

- □ Fail-Safe State: it is defined as the paralleled outputs going below 2 Vdc. Internal diagnostics detect and notify Low/High (Under/Over voltage) fails (DD) to logic solver, which can operate to convert these fails to the fail-safe state, requiring to turn off all malfunctioning power supplies and to replace them with new PSM1250 modules.
- □ Fail Safe: failure mode that causes the system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the paralleled output voltage is blocked or oscillating between 2 and 20 Vdc or above 30 Vdc, and both internal diagnostics cannot detect and notify faults to logic solver.
- □ Fail High - Overvoltage: failure mode that causes the paralleled output to go above 30 Vdc. Internal overvoltage protections try to limit paralleled output voltage < 30 Vdc, otherwise internal crowbars trip to fail safe state for paralleled output ≥ 30 Vdc. Internal diagnostics detect and notify High fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail Low - Undervoltage: failure mode that causes the paralleled output to go between 2 and 20 Vdc. Internal diagnostics detect and notify Low fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail "No Effect": failure mode of a component that plays a part in implementing the safety function but that is neither a safe failure nor a dangerous failure, so that the paralleled output voltage is deviated between 20 and 30 Vdc. When calculating the SFF, this failure mode is not taken into account.
- □ Fail "Not part": failure mode of a component that is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF, this failure mode is not taken into account.

The PSO1250 diagnostic module **does not interfere** with the power system functional safety. The power system can perfectly work without the diagnostic module and any failure of the PSO1250 diagnostic module does not affect system performance, reliability and SIL level of this Functional Safety application.
Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	5.86
λ_{du} = Total Dangerous Undetected failures	2.83
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	94.54
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**103.23**
MTBF (safety function) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**1105 years**
$\lambda_{no\ effect}$ = "No Effect" failures	6082.53
$\lambda_{not\ part}$ = "Not Part" failures	534.18
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{no\ effect} + \lambda_{not\ part}$	**6719.94**
MTBF (device) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**17 years**

Failure rates table according to IEC 61508:2010 Ed.2 :

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
0.00 FIT	94.54 FIT	5.86 FIT	2.83 FIT	97.26%	0.00%	67.47%

PFDavg vs T[Proof] table (assuming Proof Test coverage of 90%), with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

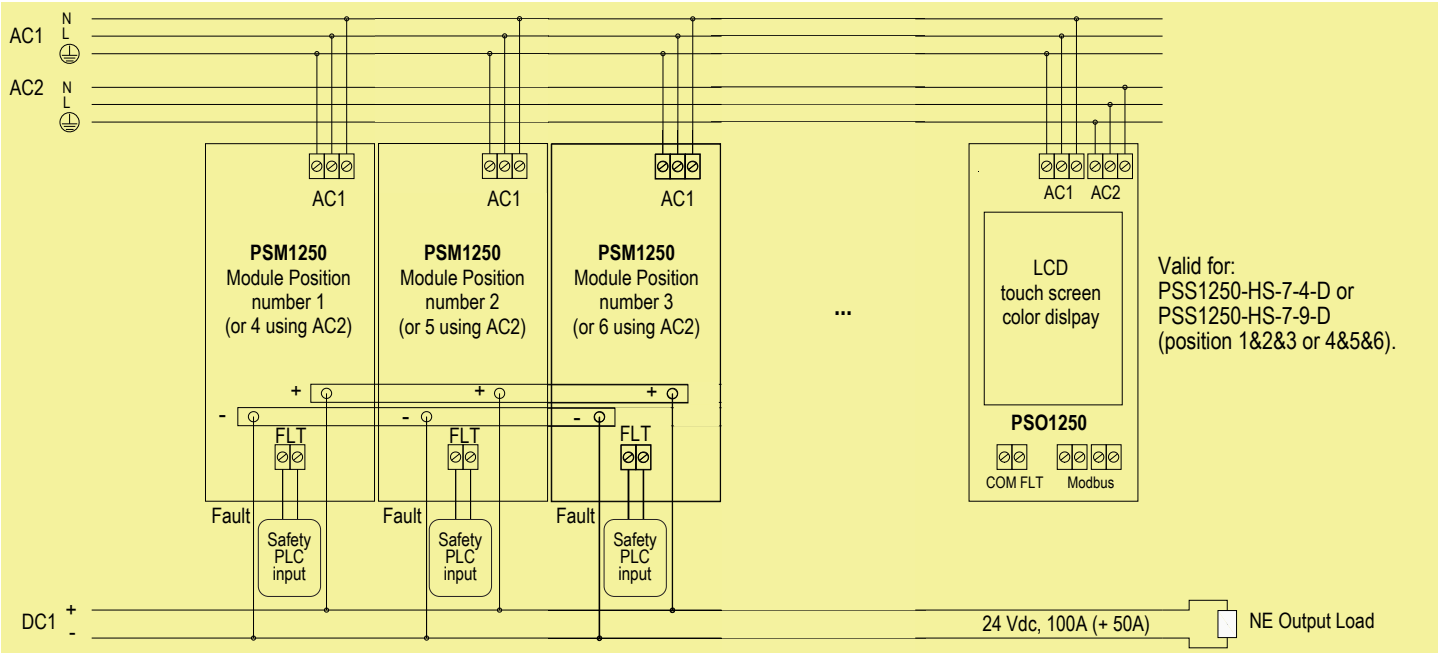
T[Proof] = 1 year	T[Proof] = 8 years
PFDavg = 1.246E-05 Valid for **SIL 3**	PFDavg = 9.97E-05 Valid for **SIL 3**

PFDavg vs T[Proof] table (assuming Proof Test coverage of 90%), with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 20 years
PFDavg = 2.49E-04 Valid for **SIL 3**

Systematic capability SIL 3.

17) Application of PSS1250 with HS and three paralleled PSM1250 modules, for NE output load



Description: In normal operation three paralleled PSM1250 modules (1st, 2nd and 3rd ones) are powered by connecting only AC1 input supply (for 4th, 5th and 6th modules connect to AC2 input supply) by means of related terminal blocks on the Back Panel PCB (see previous functional diagram for more information). For each PSM1250 module, its fault relay contact must be connected to Safety PLC or Safety logic solver because power supply internal diagnostic uses this contact to notify under/over voltage module faults to logic solver, which can require to turn off this power supply and to replace it with a new PSM1250 module. In absence of module fault the relay contact is closed, while in presence of module fault the relay contact is open.
The green Power ON LED of each PSM1250 is lit in presence of AC input supply.
The outputs of three PSM1250 modules are already paralleled on the Back Panel PCB by specific copper bars. Therefore, the NE output load is connected to outputs of three PSM1250 modules (by related output copper bars with screw terminals on the Back Panel PCB). In normal condition, NE output load is Normally Energized (NE).
In absence of AC1, three paralleled PSM1250 modules are shutdown (their fault relay contacts are open) and output load is de-energized (Safe State).

Safety Function and Failure behavior: PSS1250 with HS and three paralleled PSM1250 modules is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 1 or redundant config 2+1 on out. The failure behaviour of three paralleled PSM1250 modules for NE load is described by the following definitions:

- □ Fail-Safe State: it is defined as the paralleled outputs going below 2 Vdc. Internal diagnostics detect and notify Low/High (Under/Over voltage) fails (DD) to logic solver, which can operate to convert these fails to the fail-safe state, requiring to turn off all malfunctioning power supplies and to replace them with new PSM1250 modules.
- □ Fail Safe: failure mode that causes the system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the paralleled output voltage is blocked or oscillating between 2 and 20 Vdc or above 30 Vdc, and both internal diagnostics cannot detect and notify faults to logic solver.
- □ Fail High - Overvoltage: failure mode that causes the paralleled output to go above 30 Vdc. Internal overvoltage protections try to limit paralleled output voltage < 30 Vdc, otherwise internal crowbars trip to fail safe state for paralleled output ≥ 30 Vdc. Internal diagnostics detect and notify High fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail Low - Undervoltage: failure mode that causes the paralleled output to go between 2 and 20 Vdc. Internal diagnostics detect and notify Low fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail "No Effect": failure mode of a component that plays a part in implementing the safety function but that is neither a safe failure nor a dangerous failure, so that the paralleled output voltage is deviated between 20 and 30 Vdc. When calculating the SFF, this failure mode is not taken into account.
- □ Fail "Not part": failure mode of a component that is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF, this failure mode is not taken into account.

The PSO1250 diagnostic module **does not interfere** with the power system functional safety. The power system can perfectly work without the diagnostic module and any failure of the PSO1250 diagnostic module does not affect system performance, reliability and SIL level of this Functional Safety application.
Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	7.77
λ_{du} = Total Dangerous Undetected failures	3.96
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	94.54
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**106.28**
MTBF (safety function) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**1074 years**
$\lambda_{no\ effect}$ = "No Effect" failures	9172.36
$\lambda_{not\ part}$ = "Not Part" failures	801.27
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{no\ effect} + \lambda_{not\ part}$	**10079.91**
MTBF (device) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**11 years**

Failure rates table according to IEC 61508:2010 Ed.2 :

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
0.00 FIT	94.54 FIT	7.77 FIT	3.96 FIT	96.27%	0.00%	66.25%

PFDavg vs T[Proof] table (assuming Proof Test coverage of 90%), with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

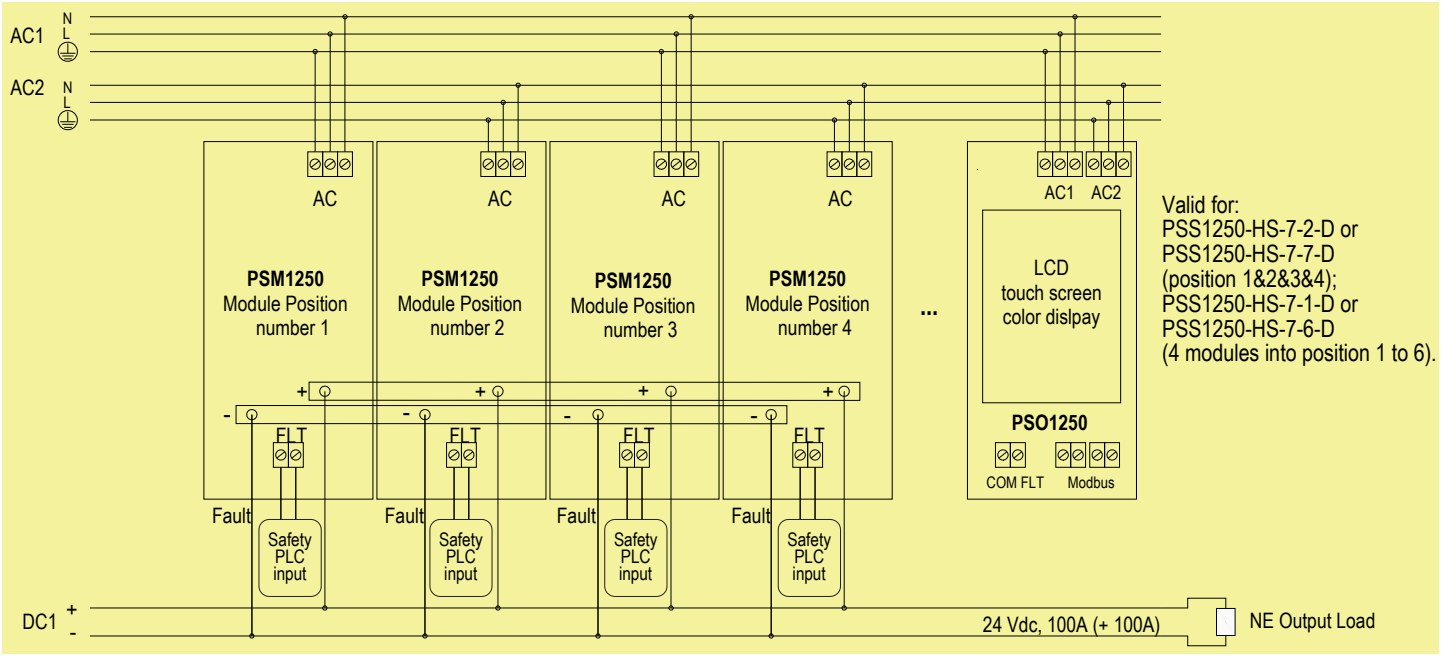
T[Proof] = 1 year	T[Proof] = 5 years
PFDavg = 1.744E-05 Valid for **SIL 3**	PFDavg = 8.72E-05 Valid for **SIL 3**

PFDavg vs T[Proof] table (assuming Proof Test coverage of 90%), with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 20 years
PFDavg = 3.49E-04 Valid for **SIL 3**

Systematic capability SIL 3.

3) Application of PSS1250 with HS and four paralleled PSM1250 modules, for NE output load



Description: In normal operation four paralleled PSM1250 modules are powered by connecting AC1 input supply to two modules and AC2 input supply to other ones by means of related terminal blocks on the Back Panel PCB (see previous functional diagram for more information). For each PSM1250 module, its fault relay contact must be connected to Safety PLC or Safety logic solver because power supply internal diagnostic uses this contact to notify under/over voltage module faults to logic solver, which can require to turn off this power supply and to replace it with a new PSM1250 module. In absence of module fault the relay contact is closed, while in presence of module fault the relay contact is open.
The green Power ON LED of each PSM1250 is lit in presence of AC input supply.
The outputs of four PSM1250 modules are already paralleled on the Back Panel PCB by specific copper bars. Therefore, the NE output load is connected to outputs of four PSM1250 modules (by related output copper bars with screw terminals on the Back Panel PCB). In normal condition, NE output load is Normally Energized (NE).
In absence of one only AC input supply (AC1 or AC2), two PSM1250 modules are shutdown (their fault relay contacts are open) but the other ones operate in normal condition, so that output load is normally energized.
In absence of both AC input supplies (AC1 and AC2), four paralleled PSM1250 modules are shutdown (their fault relay contacts are open) and output load is de-energized (Safe State).

Safety Function and Failure behavior: PSS1250 with HS and four paralleled PSM1250 modules is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 1 or redundant config. 2+2 on in/out. The failure behaviour of four paralleled PSM1250 modules for NE load is described by the following definitions:

- □ Fail-Safe State: it is defined as the paralleled outputs going below 2 Vdc. Internal diagnostics detect and notify Low/High (Under/Over voltage) fails (DD) to logic solver, which can operate to convert these fails to the fail-safe state, requiring to turn off all malfunctioning power supplies and to replace them with new PSM1250 modules.
- □ Fail Safe: failure mode that causes the system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the paralleled output voltage is blocked or oscillating between 2 and 20 Vdc or above 30 Vdc, and both internal diagnostics cannot detect and notify faults to logic solver.
- □ Fail High - Overvoltage: failure mode that causes the paralleled output to go above 30 Vdc. Internal overvoltage protections try to limit paralleled output voltage < 30 Vdc, otherwise internal crowbars trip to fail safe state for paralleled output ≥ 30 Vdc. Internal diagnostics detect and notify High fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail Low - Undervoltage: failure mode that causes the paralleled output to go between 2 and 20 Vdc. Internal diagnostics detect and notify Low fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail "No Effect": failure mode of a component that plays a part in implementing the safety function but that is neither a safe failure nor a dangerous failure, so that the paralleled output voltage is deviated between 20 and 30 Vdc. When calculating the SFF, this failure mode is not taken into account.
- □ Fail "Not part": failure mode of a component that is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF, this failure mode is not taken into account.

The PSO1250 diagnostic module **does not interfere** with the power system functional safety. The power system can perfectly work without the diagnostic module and any failure of the PSO1250 diagnostic module does not affect system performance, reliability and SIL level of this Functional Safety application.
Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	9.68
λ_{du} = Total Dangerous Undetected failures	5.09
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	94.54
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**109.32**
MTBF (safety function) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**1044 years**
$\lambda_{no\ effect}$ = "No Effect" failures	12262.20
$\lambda_{not\ part}$ = "Not Part" failures	1068.36
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{no\ effect} + \lambda_{not\ part}$	**13439.88**
MTBF (device) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**8 years**

Failure rates table according to IEC 61508:2010 Ed.2 :

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
0.00 FIT	94.54 FIT	9.68 FIT	5.09 FIT	95.34%	0.00%	65.53%

PFDavg vs T[Proof] table (assuming Proof Test coverage of 90%), with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

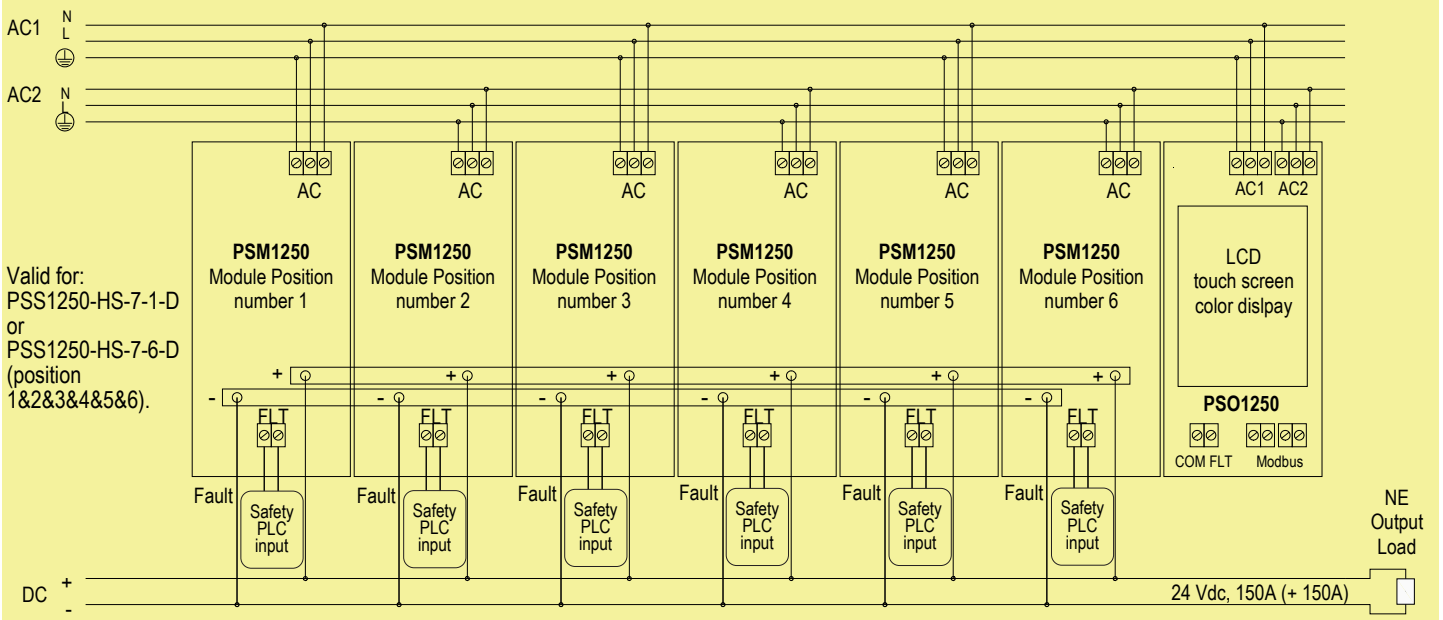
T[Proof] = 1 year	T[Proof] = 4 years
PFDavg = 2.241E-05 Valid for **SIL 3**	PFDavg = 8.96E-05 Valid for **SIL 3**

PFDavg vs T[Proof] table (assuming Proof Test coverage of 90%), with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 20 years
PFDavg = 4.48E-04 Valid for **SIL 3**

Systematic capability SIL 3.

4) Application of PSS1250 with HS and six paralleled PSM1250 modules, for NE output load



Description: In normal operation six paralleled PSM1250 modules are powered by connecting AC1 input supply to three modules and AC2 input supply to other ones by means of related terminal blocks on the Back Panel PCB (see previous functional diagram for more information). For each PSM1250 module, its fault relay contact must be connected to Safety PLC or Safety logic solver because power supply internal diagnostic uses this contact to notify under/over voltage module faults to logic solver, which can require to turn off this power supply and to replace it with a new PSM1250 module. In absence of module fault the relay contact is closed, while in presence of module fault the relay contact is open.
The green Power ON LED of each PSM1250 is lit in presence of AC input supply.
The outputs of six PSM1250 modules are already paralleled on the Back Panel PCB by specific copper bars. Therefore, the NE output load is connected to outputs of six PSM1250 modules (by related output copper bars with screw terminals on the Back Panel PCB). In normal condition, NE output load is Normally Energized (NE).
In absence of one only AC input supply (AC1 or AC2), three PSM1250 modules are shutdown (their fault relay contacts are open) but the other ones operate in normal condition, so that output load is normally energized.
In absence of both AC input supplies (AC1 and AC2), six paralleled PSM1250 modules are shutdown (their fault relay contacts are open) and output load is de-energized (Safe State).

Safety Function and Failure behavior:

PSS1250 with HS and six paralleled PSM1250 modules is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 1 or redundant configuration 3+3 on in/out. The failure behaviour of six paralleled PSM1250 modules for NE load is described by the following definitions:

- □ Fail-Safe State: it is defined as the paralleled outputs going below 2 Vdc. Internal diagnostics detect and notify Low/High (Under/Over voltage) fails (DD) to logic solver, which can operate to convert these fails to the fail-safe state, requiring to turn off all malfunctioning power supplies and to replace them with new PSM1250 modules.
- □ Fail Safe: failure mode that causes the system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the paralleled output voltage is blocked or oscillating between 2 and 20 Vdc or above 30 Vdc, and both internal diagnostics cannot detect and notify faults to logic solver.
- □ Fail High - Overvoltage: failure mode that causes the paralleled output to go above 30 Vdc. Internal overvoltage protections try to limit paralleled output voltage < 30 Vdc, otherwise internal crowbars trip to fail safe state for paralleled output ≥ 30 Vdc. Internal diagnostics detect and notify High fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail Low - Undervoltage: failure mode that causes the paralleled output to go between 2 and 20 Vdc. Internal diagnostics detect and notify Low fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail "No Effect": failure mode of a component that plays a part in implementing the safety function but that is neither a safe failure nor a dangerous failure, so that the paralleled output voltage is deviated between 20 and 30 Vdc. When calculating the SFF, this failure mode is not taken into account.
- □ Fail "Not part": failure mode of a component that is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF, this failure mode is not taken into account.

The PSO1250 diagnostic module **does not interfere** with the power system functional safety. The power system can perfectly work without the diagnostic module and any failure of the PSO1250 diagnostic module does not affect system performance, reliability and SIL level of this Functional Safety application.
Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	13.50
λ_{du} = Total Dangerous Undetected failures	7.36
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	94.54
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**115.41**
MTBF (safety function) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**989 years**
$\lambda_{no\ effect}$ = "No Effect" failures	18441.87
$\lambda_{not\ part}$ = "Not Part" failures	1602.54
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{no\ effect} + \lambda_{not\ part}$	**20159.82**
MTBF (device) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**6 years**

Failure rates table according to IEC 61508:2010 Ed.2 :

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
0.00 FIT	94.54 FIT	13.50 FIT	7.36 FIT	93.62%	0.00%	64.72%

PFDavg vs T[Proof] table (assuming Proof Test coverage of 90%), with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

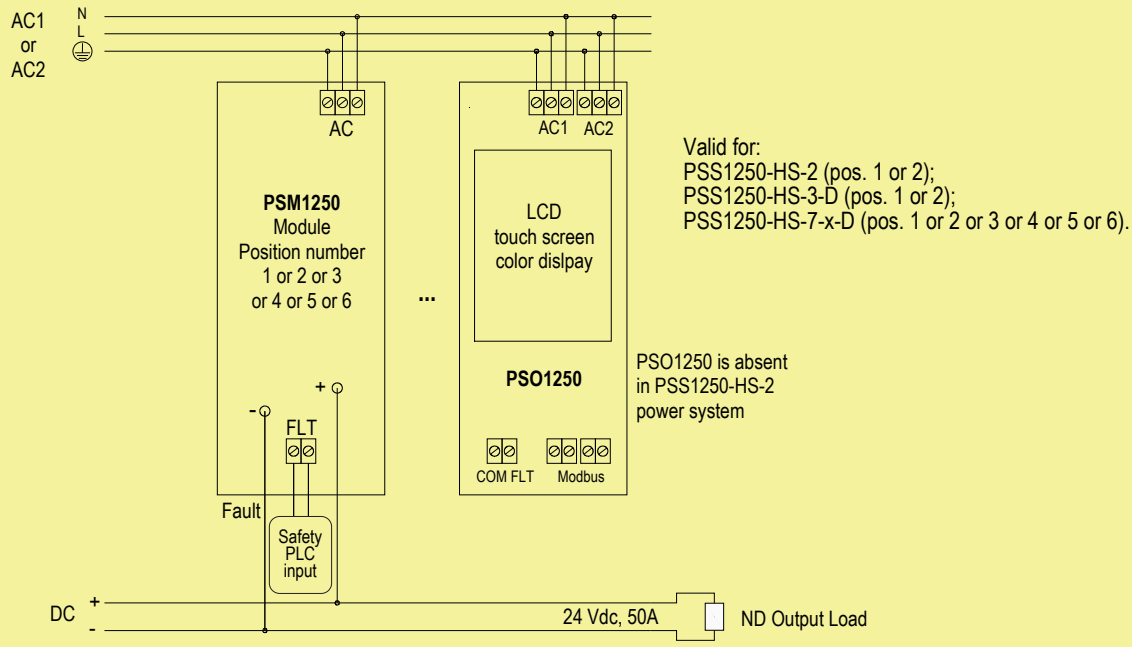
T[Proof] = 1 year	T[Proof] = 3 years	T[Proof] = 20 years
PFDavg = 3.24E-05 Valid for **SIL 3**	PFDavg = 9.72E-05 Valid for **SIL 3**	PFDavg = 6.48E-04 Valid for **SIL 2**

PFDavg vs T[Proof] table (assuming Proof Test coverage of 90%), with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 15 years
PFDavg = 4.86E-04 Valid for **SIL 3**

Systematic capability SIL 3.

5) Application of PSS1250 with HS and single PSM1250 module, for ND output load



Description:

In normal operation the PSM1250 module is unpowered because of absence of AC input supply, which is connected to related terminal blocks on the Back Panel PCB (see previous functional diagram for more information). The fault relay contact can be connected to Safety PLC or Safety logic solver because power supply internal diagnostic uses this contact to notify under/over voltage dangerous faults to logic solver, which can only require to turn off power supply and to replace it with a new PSM1250 module. In absence of fault the relay contact is closed, while in presence of fault the relay contact is open.

In normal condition, absence of AC input supply implies that the green Power ON LED of PSM1250 is turned off, fault relay contact is open and the ND output load (connected to related output copper bars with screw terminals on the Back Panel PCB) is Normally De-energized (ND).

In presence of AC input supply, the green Power ON LED of PSM1250 is lit, fault relay contact is closed (if fault is absent) and output load is energized (Safe State).

Safety Function and Failure behavior:

PSS1250 with HS and single PSM1250 module is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 0.

The failure behaviour of PSM1250 for ND load is described by the following definitions :

- □ Fail-Safe State: it is defined as the output going between 20 and 30 Vdc.
- □ Fail Safe: failure mode that causes the module / (sub)system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the output voltage is blocked or oscillating between 0 and 20 Vdc or above 30 Vdc, and internal diagnostic cannot detect and notify faults to logic solver.
- □ Fail High - Overvoltage: failure mode that causes the output to go above 30 Vdc. Internal overvoltage protection tries to limit output voltage < 30 Vdc, otherwise for output ≥ 30 Vdc internal crowbars trip, turning off the power supply. In any case, this failure mode is dangerous, but internal diagnostic notifies High fail to logic solver, which cannot convert this failure to the fail-safe state but it can only require to turn off power supply and to replace it with a new PSM1250 module.
- □ Fail Low - Undervoltage: failure mode that causes the output to go between 0 and 20 Vdc. This failure mode is dangerous, but internal diagnostic notifies Low fail to logic solver, which cannot convert this failure to the fail-safe state but it can only require to turn off power supply and to replace it with a new PSM1250 module.
- □ Fail "Not part": failure mode of a component that is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF, this failure mode is not taken into account.

The PSO1250 diagnostic module **does not interfere** with the power system functional safety. The power system can perfectly work without the diagnostic module and any failure of the PSO1250 diagnostic module does not affect system performance, reliability and SIL level of this Functional Safety application.

Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	0.00
λ_{du} = Total Dangerous Undetected failures	1945.97
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	1146.91
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**3092.88**
MTBF (safety function) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**36 years**
$\lambda_{not\ part}$ = "Not Part" failures	267.09
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{not\ part}$	**3359.97**
MTBF (device) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**34 years**

Failure rates table according to IEC 61508:2010 Ed.2 :

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
0.00 FIT	1146.91 FIT	0.00 FIT	1945.97 FIT	37.08%	0.00%	0.00%

PFDavg vs T[Proof] table, with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

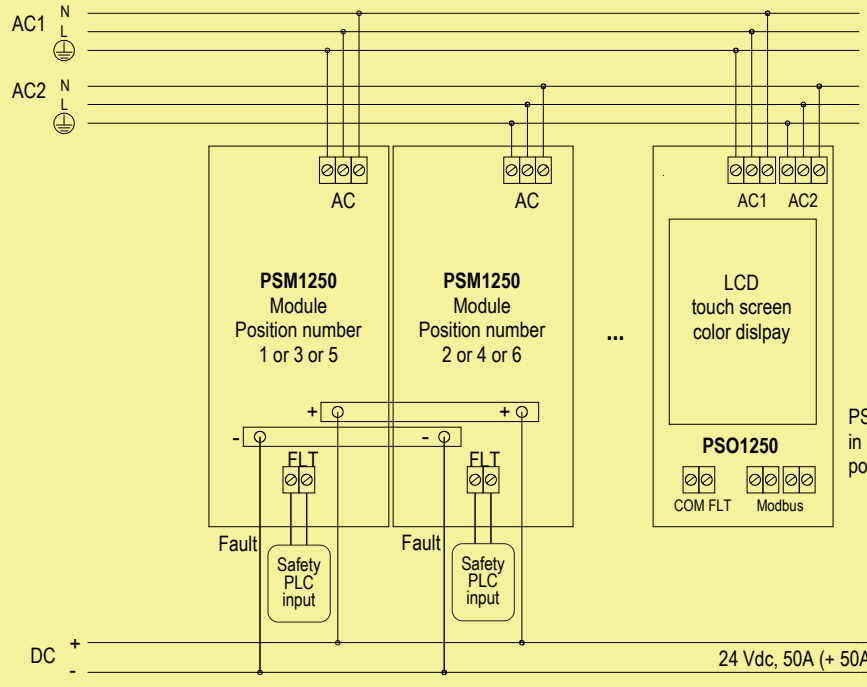
T[Proof] = 1 year
PFDavg = 8.54E-03 Valid for **SIL 1**

PFDavg vs T[Proof] table, with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 5 years
PFDavg = 4.27E-02 Valid for **SIL 1**

Systematic capability SIL 3.

6) Application of PSS1250 with HS and two paralleled PSM1250 modules, for ND output load



Valid for:
PSS1250-HS-2 ;
PSS1250-HS-3-D ;
PSS1250-HS-7-4-D (pos. 1&2 or 2&3 or 4&5 or 5&6);
PSS1250-HS-7-9-D (pos. 1&2 or 2&3 or 4&5 or 5&6);
PSS1250-HS-7-3-D (pos. 1&2 or 3&4 or 5&6);
PSS1250-HS-7-8-D (pos. 1&2 or 3&4 or 5&6);
PSS1250-HS-7-2-D (2 modules into position 1 to 4 or 5&6);
PSS1250-HS-7-7-D (2 modules into position 1 to 4 or 5&6);
PSS1250-HS-7-1-D (2 modules into position 1 to 6);
PSS1250-HS-7-6-D (2 modules into position 1 to 6).

PSO1250 is absent
in PSS1250-HS-2
power system

Description: In normal operation two paralleled PSM1250 modules are unpowered because of absence of both AC input supplies (AC1 and AC2), where AC1 is connected to one module and AC2 to other one by means of related terminal blocks on the Back Panel PCB (see previous functional diagram for more information). For each PSM1250 module, its fault relay contact must be connected to Safety PLC or Safety logic solver because power supply internal diagnostic uses this contact to notify over voltage module faults to logic solver, which can require to turn off this power supply and to replace it with a new PSM1250 module. In absence of module fault the relay contact is closed, while in presence of module fault the relay contact is open.

The outputs of two PSM1250 modules are already paralleled on the Back Panel PCB by specific copper bars. Therefore, the ND output load is connected to outputs of both PSM1250 modules (by related output copper bars with screw terminals on Back Panel PCB). In normal condition, absence of both AC input supplies (AC1 and AC2) implies that both green Power ON LEDs of PSM1250 modules are turned off, both fault relay contacts are open and the ND output load is Normally De-energized (ND).

In presence of one only AC input supply (AC1 or AC2), one PSM1250 module is shutdown (its fault relay contact is open) but the other one is correctly turned on, so that output load is energized (Safe State). In presence of both AC input supplies (AC1 and AC2), both paralleled PSM1250 modules are correctly turned on and output load is energized (Safe State).

Safety Function and Failure behavior:

PSS1250 with HS and two paralleled PSM1250 modules is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 1 or redundant config.1+1 on in/out. The failure behaviour of two paralleled PSM1250 modules for ND load is described by the following definitions :

- □ Fail-Safe State: it is defined as the the paralleled outputs going between 20 and 30 Vdc. Internal diagnostics detect and notify High (Over voltage) fails (DD) to logic solver, which can operate to convert these fails to the fail-safe state, requiring to turn off malfunctioning power supply and to replace it with new PSM1250 modules.
- □ Fail Safe: failure mode that causes the system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the paralleled output voltage is blocked or oscillating between 0 and 20 Vdc or above 30 Vdc, and internal diagnostic cannot detect and notify faults to logic solver.
- □ Fail High - Overvoltage: failure mode that causes the paralleled output to go above 30 Vdc. Internal overvoltage protection tries to limit output voltage < 30 Vdc, otherwise for output ≥ 30 Vdc internal crowbars trip, turning off malfunctioning power supply. Internal diagnostics detect and notify High fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail Low - Undervoltage: failure mode that causes the paralleled output to go between 0 and 20 Vdc. This failure mode is dangerous, but internal diagnostic notifies Low fail to logic solver, which cannot convert this failure to the fail-safe state but it can only require to turn off malfunctioning power supply and to replace it with a new PSM1250 module.
- □ Fail "Not part": failure mode of a component that is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF, this failure mode is not taken into account.

The PSO1250 diagnostic module **does not interfere** with the power system functional safety. The power system can perfectly work without the diagnostic module and any failure of the PSO1250 diagnostic module does not affect system performance, reliability and SIL level of this Functional Safety application.

Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	3.82
λ_{du} = Total Dangerous Undetected failures	99.41
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	6082.53
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**6185.76**
MTBF (safety function) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**18 years**
$\lambda_{not\ part}$ = "Not Part" failures	534.18
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{not\ part}$	**6719.94**
MTBF (device) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**17 years**

Failure rates table according to IEC 61508:2010 Ed.2 :

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
0.00 FIT	6082.53 FIT	3.82 FIT	99.41 FIT	98.39%	0.00%	3.70%

PFDavg vs T[Proof] table, with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

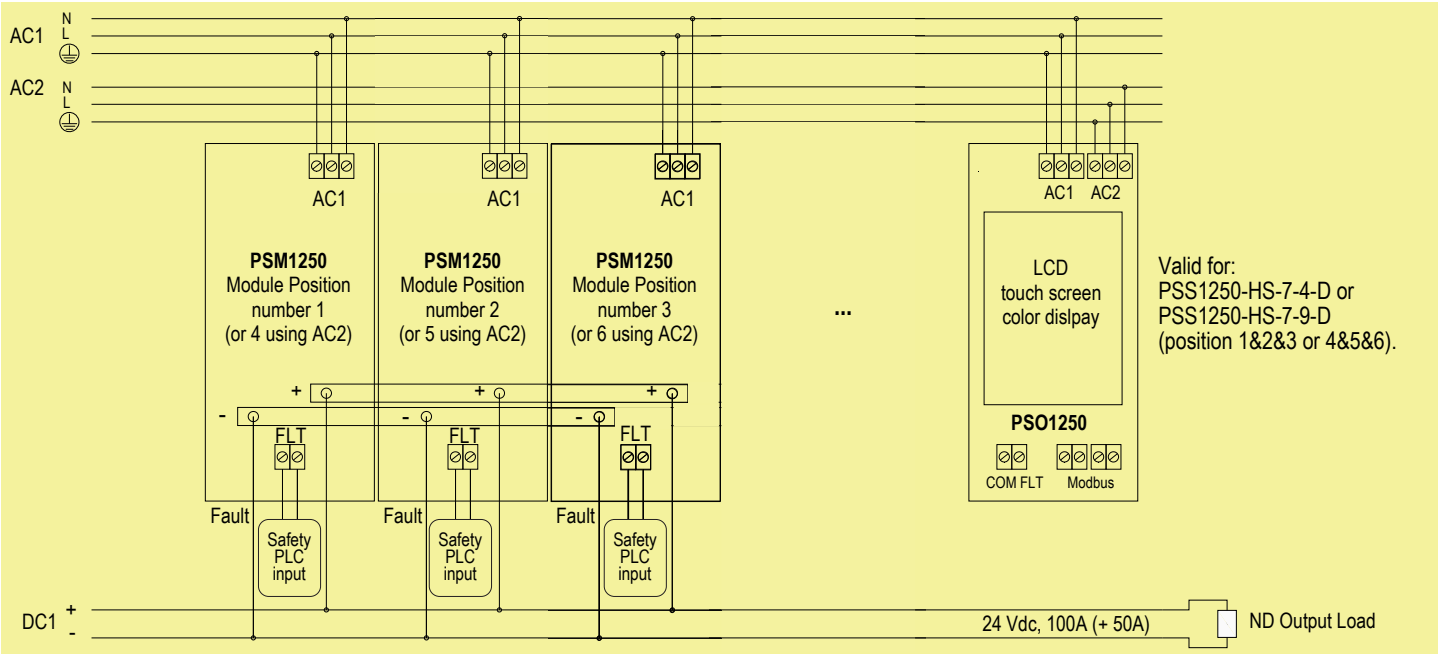
T[Proof] = 1 year	T[Proof] = 2 years	T[Proof] = 20 years
PFDavg = 4.36E-04 Valid for **SIL 2**	PFDavg = 8.72E-04 Valid for **SIL 2**	PFDavg = 8.72E-03 Valid for **SIL 1**

PFDavg vs T[Proof] table, with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 10 years
PFDavg = 4.36E-03 Valid for **SIL 2**

Systematic capability SIL 3.

18) Application of PSS1250 with HS and three paralleled PSM1250 modules, for ND output load



Description: In normal operation three paralleled PSM1250 modules (1st, 2nd and 3rd ones) are unpowered because of absence of only AC1 input supply (for 4th, 5th and 6th modules use AC2 input supply line), which is connected by means of related terminal blocks on the Back Panel PCB (see previous functional diagram for more information).
For each PSM1250 module, its fault relay contact must be connected to Safety PLC or Safety logic solver because power supply internal diagnostic uses this contact to notify over voltage module faults to logic solver, which can require to turn off this power supply and to replace it with a new PSM1250 module. In absence of module fault the relay contact is closed, while in presence of module fault the relay contact is open.
The outputs of three PSM1250 modules are already paralleled on the Back Panel PCB by specific copper bars. Therefore, the ND output load is connected to outputs of three PSM1250 modules (by related output copper bars with screw terminals on Back Panel PCB). In normal condition, absence of AC1 input supply implies that three green Power ON LEDs of PSM1250 modules are turned off, three fault relay contacts are open and the ND output load is Normally De-energized (ND).
In presence of AC1 input supply, three paralleled PSM1250 modules are correctly turned on and output load is energized (Safe State).

Safety Function and Failure behavior:
PSS1250 with HS and three paralleled PSM1250 modules is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 1 or redundant config 2+1 on out. The failure behaviour of three paralleled PSM1250 modules for ND load is described by the following definitions :

- □ Fail-Safe State: it is defined as the the paralleled outputs going between 20 and 30 Vdc. Internal diagnostics detect and notify High (Over voltage) fails (DD) to logic solver, which can operate to convert these fails to the fail-safe state, requiring to turn off malfunctioning power supply and to replace it with new PSM1250 modules.
- □ Fail Safe: failure mode that causes the system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the paralleled output voltage is blocked or oscillating between 0 and 20 Vdc or above 30 Vdc, and internal diagnostic cannot detect and notify faults to logic solver.
- □ Fail High - Overvoltage: failure mode that causes the paralleled output to go above 30 Vdc. Internal overvoltage protection tries to limit output voltage < 30 Vdc, otherwise for output ≥ 30 Vdc internal crowbars trip, turning off malfunctioning power supply. Internal diagnostics detect and notify High fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail Low - Undervoltage: failure mode that causes the paralleled output to go between 0 and 20 Vdc. This failure mode is dangerous, but internal diagnostic notifies Low fail to logic solver, which cannot convert this failure to the fail-safe state but it can only require to turn off malfunctioning power supply and to replace it with a new PSM1250 module.
- □ Fail "Not part": failure mode of a component that is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF, this failure mode is not taken into account.

The PSO1250 diagnostic module **does not interfere** with the power system functional safety. The power system can perfectly work without the diagnostic module and any failure of the PSO1250 diagnostic module does not affect system performance, reliability and SIL level of this Functional Safety application.
Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	5.73
λ_{du} = Total Dangerous Undetected failures	100.55
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	9172.36
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**9278.64**
MTBF (safety function) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**12 years**
$\lambda_{not\ part}$ = "Not Part" failures	801.27
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{not\ part}$	**10079.91**
MTBF (device) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**11 years**

Failure rates table according to IEC 61508:2010 Ed.2 :

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
0.00 FIT	9172.36 FIT	5.73 FIT	100.55 FIT	98.92%	0.00%	5.39%

PFDavg vs T[Proof] table, with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

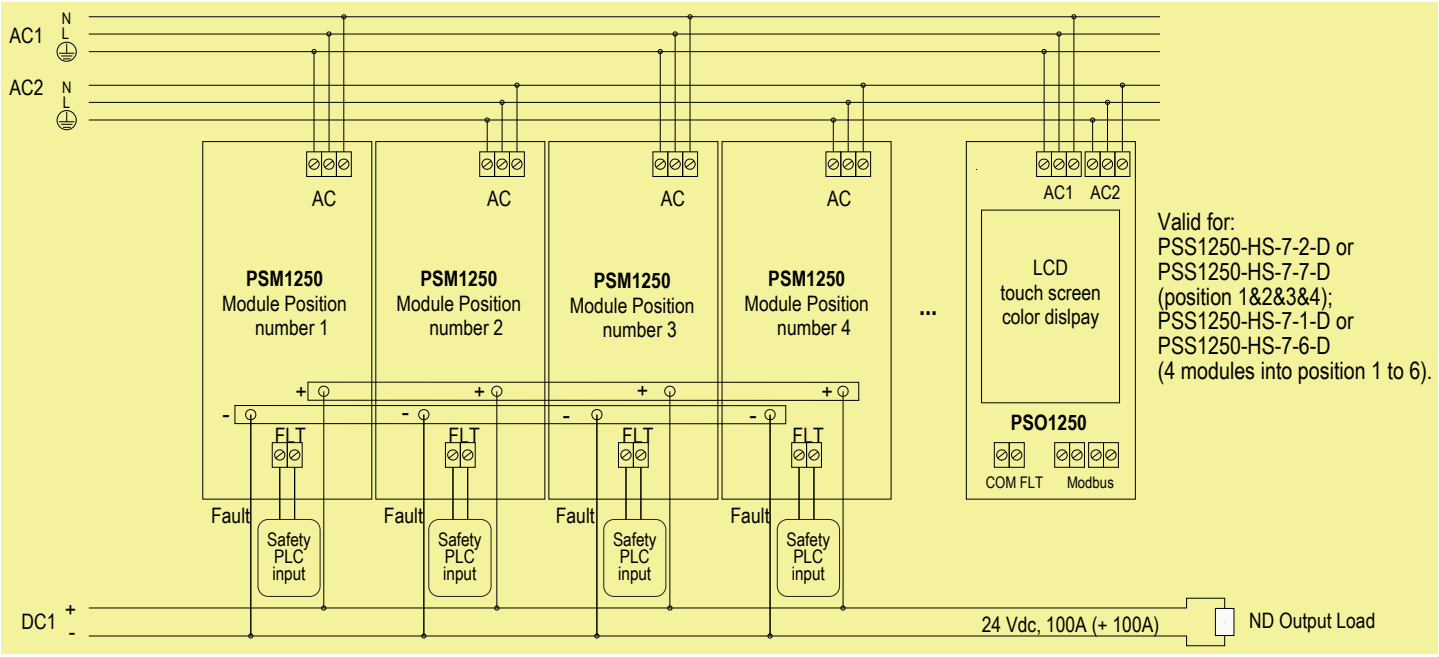
T[Proof] = 1 year	T[Proof] = 2 years	T[Proof] = 20 years
PFDavg = 4.41E-04 Valid for **SIL 2**	PFDavg = 8.82E-04 Valid for **SIL 2**	PFDavg = 8.82E-03 Valid for **SIL 1**

PFDavg vs T[Proof] table, with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 10 years
PFDavg = 4.41E-03 Valid for **SIL 2**

Systematic capability SIL 3.

7) Application of PSS1250 with HS and four paralleled PSM1250 modules, for ND output load



Description: In normal operation four paralleled PSM1250 modules are unpowered because of absence of both AC input supplies (AC1 and AC2), where AC1 is connected to two modules and AC2 to other ones by means of related terminal blocks on the Back Panel PCB (see previous functional diagram for more information). For each PSM1250 module, its fault relay contact must be connected to Safety PLC or Safety logic solver because power supply internal diagnostic uses this contact to notify over voltage module faults to logic solver, which can require to turn off this power supply and to replace it with a new PSM1250 module. In absence of module fault the relay contact is closed, while in presence of module fault the relay contact is open.

The outputs of four PSM1250 modules are already paralleled on the Back Panel PCB by specific copper bars. Therefore, the ND output load is connected to outputs of four PSM1250 modules (by related output copper bars with screw terminals on Back Panel PCB). In normal condition, absence of both AC input supplies (AC1 and AC2) implies that four green Power ON LEDs of PSM1250 modules are turned off, four fault relay contacts are open and the ND output load is Normally De-energized (ND).

In presence of one only AC input supply (AC1 or AC2), two PSM1250 module are shutdown (their fault relay contact are open) but the other ones are correctly turned on, so that output load is energized (Safe State). In presence of both AC input supplies (AC1 and AC2), four paralleled PSM1250 modules are correctly turned on and output load is energized (Safe State).

Safety Function and Failure behavior:

PSS1250 with HS and four paralleled PSM1250 modules is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 1 or redundant config. 2+2 on in/out. The failure behaviour of four paralleled PSM1250 modules for ND load is described by the following definitions :

- □ Fail-Safe State: it is defined as the the paralleled outputs going between 20 and 30 Vdc. Internal diagnostics detect and notify High (Over voltage) fails (DD) to logic solver, which can operate to convert these fails to the fail-safe state, requiring to turn off malfunctioning power supply and to replace it with new PSM1250 modules.
- □ Fail Safe: failure mode that causes the system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the paralleled output voltage is blocked or oscillating between 0 and 20 Vdc or above 30 Vdc, and internal diagnostic cannot detect and notify faults to logic solver.
- □ Fail High - Overvoltage: failure mode that causes the paralleled output to go above 30 Vdc. Internal overvoltage protection tries to limit output voltage < 30 Vdc, otherwise for output ≥ 30 Vdc internal crowbars trip, turning off malfunctioning power supply. Internal diagnostics detect and notify High fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail Low - Undervoltage: failure mode that causes the paralleled output to go between 0 and 20 Vdc. This failure mode is dangerous, but internal diagnostic notifies Low fail to logic solver, which cannot convert this failure to the fail-safe state but it can only require to turn off malfunctioning power supply and to replace it with a new PSM1250 module.
- □ Fail "Not part": failure mode of a component that is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF, this failure mode is not taken into account.

The PSO1250 diagnostic module **does not interfere** with the power system functional safety. The power system can perfectly work without the diagnostic module and any failure of the PSO1250 diagnostic module does not affect system performance, reliability and SIL level of this Functional Safety application.

Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	7.64
λ_{du} = Total Dangerous Undetected failures	101.68
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	12262.20
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**12371.52**
MTBF (safety function) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**9 years**
$\lambda_{not\ part}$ = "Not Part" failures	1068.36
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{not\ part}$	**13439.88**
MTBF (device) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**8 years**

Failure rates table according to IEC 61508:2010 Ed.2 :

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
0.00 FIT	12262.20 FIT	7.64 FIT	101.68 FIT	99.18%	0.00%	6.99%

PFDavg vs T[Proof] table, with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

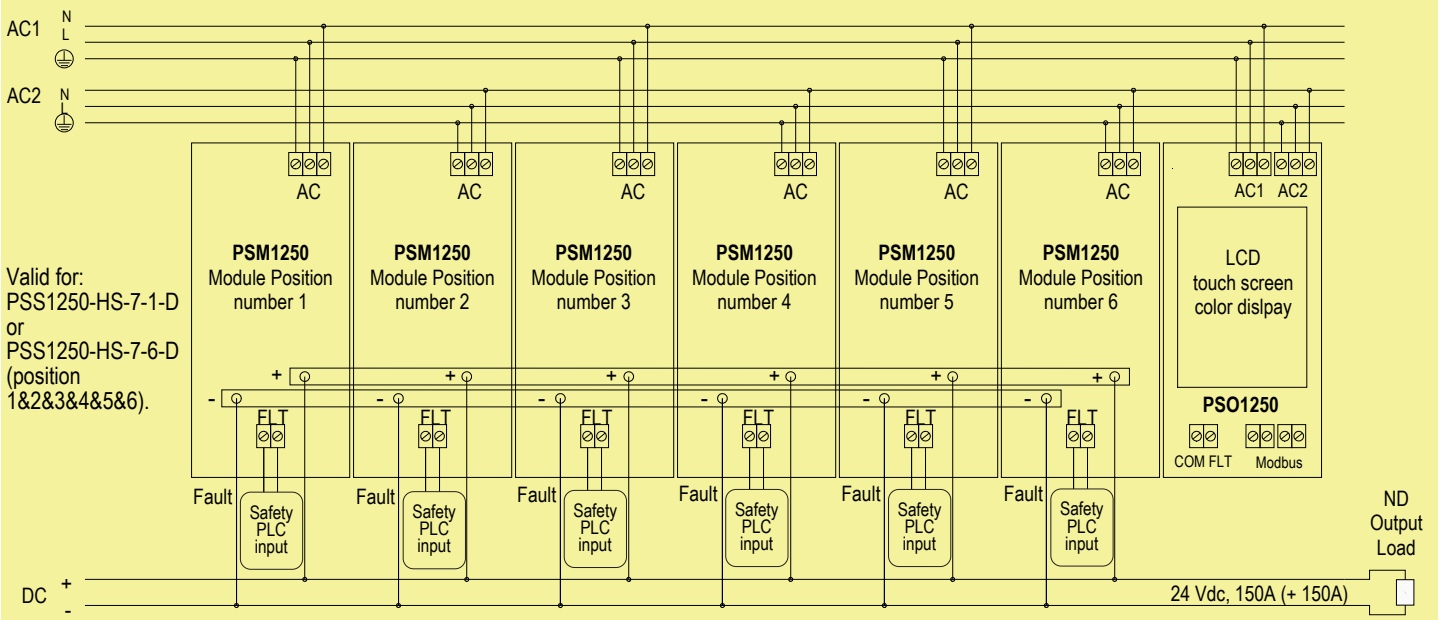
T[Proof] = 1 year	T[Proof] = 2 years	T[Proof] = 20 years
PFDavg = 4.46E-04 Valid for **SIL 2**	PFDavg = 8.92E-04 Valid for **SIL 2**	PFDavg = 8.92E-03 Valid for **SIL 1**

PFDavg vs T[Proof] table, with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 10 years
PFDavg = 4.46E-03 Valid for **SIL 2**

Systematic capability SIL 3.

8) Application of PSS1250 with HS and six paralleled PSM1250 modules, for ND output load



Description:

In normal operation six paralleled PSM1250 modules are unpowered because of absence of both AC input supplies (AC1 and AC2), where AC1 is connected to three modules and AC2 to other ones by means of related terminal blocks on the Back Panel PCB (see previous functional diagram for more information). For each PSM1250 module, its fault relay contact must be connected to Safety PLC or Safety logic solver because power supply internal diagnostic uses this contact to notifies over voltage module faults to logic solver, which can require to turn off this power supply and to replace it with a new PSM1250 module. In absence of module fault the relay contact is closed, while in presence of module fault the relay contact is open.

The outputs of six PSM1250 modules are already paralleled on the Back Panel PCB by specific copper bars. Therefore, the ND output load is connected to outputs of six PSM1250 modules (by related output copper bars with screw terminals on Back Panel PCB). In normal condition, absence of both AC input supplies (AC1 and AC2) implies that six green Power ON LEDs of PSM1250 modules are turned off, six fault relay contacts are open and the ND output load is Normally De-energized (ND).

In presence of one only AC input supply (AC1 or AC2), three PSM1250 module are shutdown (their fault relay contact are open) but the other ones are correctly turned on, so that output load is energized (Safe State). In presence of both AC input supplies (AC1 and AC2), six paralleled PSM1250 modules are correctly turned on and output load is energized (Safe State).

Safety Function and Failure behavior:

PSS1250 with HS and six paralleled PSM1250 modules is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 1 or redundant configuration 3+3 on in/out. The failure behaviour of six paralleled PSM1250 modules for ND load is described by the following definitions :

- □ Fail-Safe State: it is defined as the the paralleled outputs going between 20 and 30 Vdc. Internal diagnostics detect and notify High (Over voltage) fails (DD) to logic solver, which can operate to convert these fails to the fail-safe state, requiring to turn off malfunctioning power supply and to replace it with new PSM1250 modules.
- □ Fail Safe: failure mode that causes the system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the paralleled output voltage is blocked or oscillating between 0 and 20 Vdc or above 30 Vdc, and internal diagnostic cannot detect and notify faults to logic solver.
- □ Fail High - Overvoltage: failure mode that causes the paralleled output to go above 30 Vdc. Internal overvoltage protection tries to limit output voltage < 30 Vdc, otherwise for output ≥ 30 Vdc internal crowbars trip, turning off malfunctioning power supply. Internal diagnostics detect and notify High fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail Low - Undervoltage: failure mode that causes the paralleled output to go between 0 and 20 Vdc. This failure mode is dangerous, but internal diagnostic notifies Low fail to logic solver, which cannot convert this failure to the fail-safe state but it can only require to turn off malfunctioning power supply and to replace it with a new PSM1250 module.
- □ Fail "Not part": failure mode of a component that is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF, this failure mode is not taken into account.

The PSO1250 diagnostic module **does not interfere** with the power system functional safety. The power system can perfectly work without the diagnostic module and any failure of the PSO1250 diagnostic module does not affect system performance, reliability and SIL level of this Functional Safety application.

Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	11.46
λ_{du} = Total Dangerous Undetected failures	103.95
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	18441.87
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**18557.28**
MTBF (safety function) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**6 years**
$\lambda_{not\ part}$ = "Not Part" failures	1602.54
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{not\ part}$	**20159.82**
MTBF (device) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**6 years**

Failure rates table according to IEC 61508:2010 Ed.2 :

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
0.00 FIT	18441.87 FIT	11.46 FIT	103.95 FIT	99.44%	0.00%	9.93%

PFDavg vs T[Proof] table, with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

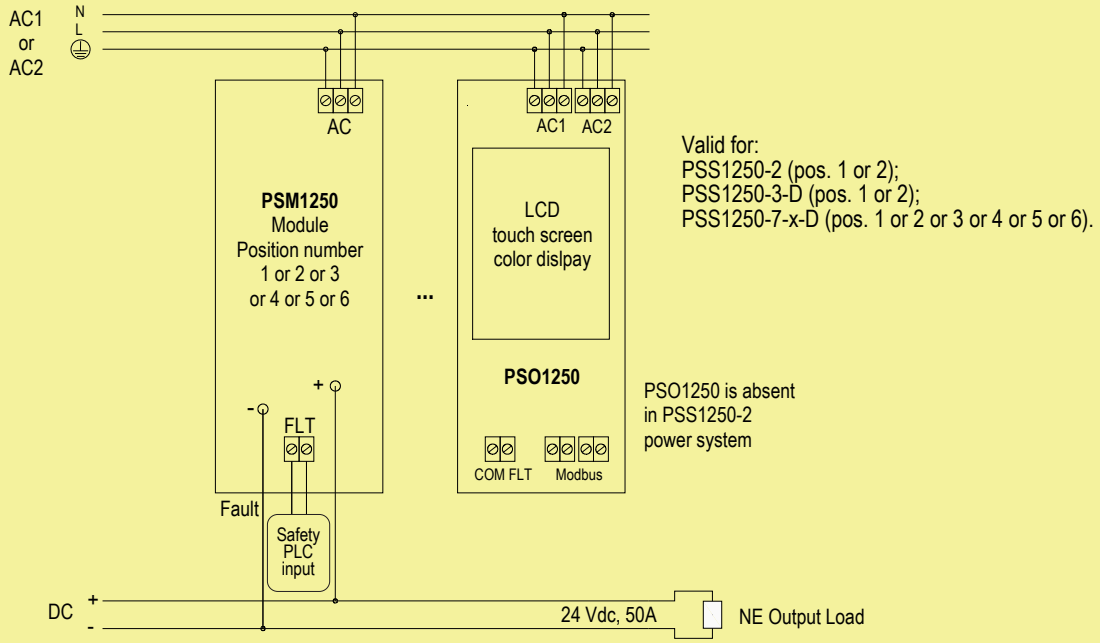
T[Proof] = 1 year	T[Proof] = 2 years	T[Proof] = 20 years
PFDavg = 4.56E-04 Valid for **SIL 2**	PFDavg = 9.12E-04 Valid for **SIL 2**	PFDavg = 9.12E-03 Valid for **SIL 1**

PFDavg vs T[Proof] table, with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 10 years
PFDavg = 4.56E-03 Valid for **SIL 2**

Systematic capability SIL 3.

9) Application of PSS1250 without HS and single PSM1250 module, for NE output load



Description:

In normal operation the PSM1250 module is powered by connecting AC input supply to related terminal blocks on the Back Panel PCB (see previous functional diagram for more information). The fault relay contact must be connected to Safety PLC or Safety logic solver because power supply internal diagnostic uses this contact to notify under/over voltage faults to logic solver, which can require to turn off power supply and to replace it with a new PSM1250 module. In absence of fault the relay contact is closed, while in presence of fault the relay contact is open. The green Power ON LED of PSM1250 is lit in presence of AC input supply. In this condition the NE output load (connected to related output copper bars with screw terminals on the Back Panel PCB) is Normally Energized (NE).

In absence of AC input supply, the PSM1250 module is shutdown (its fault relay contact is open) and output load is de-energized (Safe State).

Safety Function and Failure behavior:

PSS1250 without HS and single PSM1250 module is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 0.

The failure behaviour of PSM1250 for NE load is described by the following definitions :

- □ Fail-Safe State: it is defined as the output going below 2 Vdc. Internal diagnostic detects and notifies Low/High (Under/Over voltage) fails (DD) to logic solver, which can operate to convert these fails to the fail-safe state, requiring to turn off power supply and to replace it with a new PSM1250 module.
- □ Fail Safe: failure mode that causes the module / (sub)system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the output voltage is blocked or oscillating between 2 and 20 Vdc or above 30 Vdc, and internal diagnostic cannot detect and notify faults to logic solver.
- □ Fail High - Overvoltage: failure mode that causes the output to go above 30 Vdc. Internal overvoltage protection tries to limit output voltage < 30 Vdc, otherwise internal crowbars trip to fail safe state for output ≥ 30 Vdc. Internal diagnostic detects and notifies High fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail Low - Undervoltage: failure mode that causes the output to go between 2 and 20 Vdc. Internal diagnostic detects and notifies Low fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail "No Effect": failure mode of a component that plays a part in implementing the safety function but that is neither a safe failure nor a dangerous failure, so that the output voltage is deviated between 20 and 30 Vdc. When calculating the SFF, this failure mode is not taken into account.
- □ Fail "Not part": failure mode of a component that is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF, this failure mode is not taken into account.

The PSO1250 diagnostic module **does not interfere** with the power system functional safety. The power system can perfectly work without the diagnostic module and any failure of the PSO1250 diagnostic module does not affect system performance, reliability and SIL level of this Functional Safety application.

Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	42.51
λ_{du} = Total Dangerous Undetected failures	12.34
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	1635.27
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**1690.12**
MTBF (safety function) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**67 years**
$\lambda_{no\ effect}$ = "No Effect" failures	938.09
$\lambda_{not\ part}$ = "Not Part" failures	169.89
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{no\ effect} + \lambda_{not\ part}$	**2798.10**
MTBF (device) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**40 years**

Failure rates table according to IEC 61508:2010 Ed.2 :

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
0.00 FIT	1635.27 FIT	42.51 FIT	12.34 FIT	99.27%	0.00%	77.50%

PFDavg vs T[Proof] table (assuming Proof Test coverage of 90%), with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

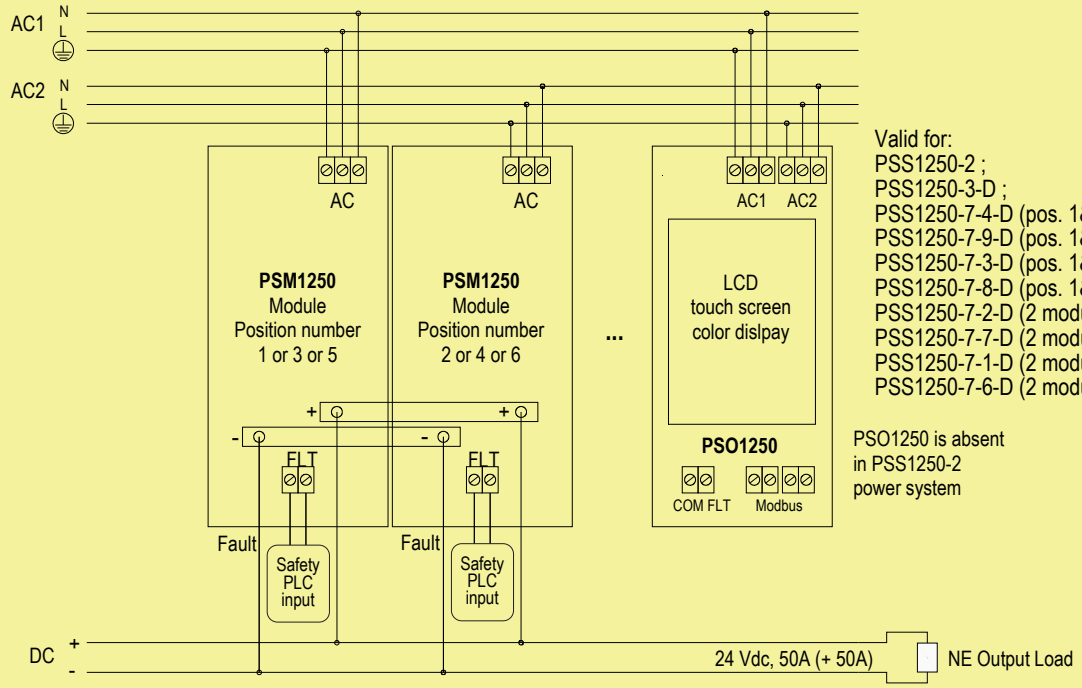
T[Proof] = 1 year	T[Proof] = 1.5 years	T[Proof] = 18 years
PFDavg = 5.449E-05 Valid for **SIL 3**	PFDavg = 8.17E-05 Valid for **SIL 3**	PFDavg = 9.81E-04 Valid for **SIL 2**

PFDavg vs T[Proof] table (assuming Proof Test coverage of 90%), with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 10 years	T[Proof] = 20 years
PFDavg = 5.45E-04 Valid for **SIL 3**	PFDavg = 1.09E-03 Valid for **SIL 2**

Systematic capability SIL 3.

10) Application of PSS1250 without HS and two paralleled PSM1250 modules, for NE output load



Valid for:
PSS1250-2 ;
PSS1250-3-D ;
PSS1250-7-4-D (pos. 1&2 or 2&3 or 4&5 or 5&6);
PSS1250-7-9-D (pos. 1&2 or 2&3 or 4&5 or 5&6);
PSS1250-7-3-D (pos. 1&2 or 3&4 or 5&6);
PSS1250-7-8-D (pos. 1&2 or 3&4 or 5&6);
PSS1250-7-2-D (2 modules into position 1 to 4 or 5&6);
PSS1250-7-7-D (2 modules into position 1 to 4 or 5&6);
PSS1250-7-1-D (2 modules into position 1 to 6);
PSS1250-7-6-D (2 modules into position 1 to 6).

PSO1250 is absent in PSS1250-2 power system

Description: In normal operation two paralleled PSM1250 modules are powered by connecting AC1 input supply to one module and AC2 input supply to other one by means of related terminal blocks on the Back Panel PCB (see previous functional diagram for more information). For each PSM1250 module, its fault relay contact must be connected to Safety PLC or Safety logic solver because power supply internal diagnostic uses this contact to notify under/over voltage module faults to logic solver, which can require to turn off this power supply and to replace it with a new PSM1250 module. In absence of module fault the relay contact is closed, while in presence of module fault the relay contact is open.
The green Power ON LED of each PSM1250 is lit in presence of AC input supply.
The outputs of two PSM1250 modules are already paralleled on the Back Panel PCB by specific copper bars. Therefore, the NE output load is connected to outputs of both PSM1250 modules (by related output copper bars with screw terminals on the Back Panel PCB). In normal condition, NE output load is Normally Energized (NE).
In absence of one only AC input supply (AC1 or AC2), one PSM1250 module is shutdown (its fault relay contact is open) but the other one operates in normal condition, so that output load is normally energized. In absence of both AC input supplies (AC1 and AC2), both paralleled PSM1250 modules are shutdown (their fault relay contacts are open) and output load is de-energized (Safe State).

Safety Function and Failure behavior: PSS1250 without HS and two paralleled PSM1250 modules is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 1 or redundant config.1+1 on in/out. The failure behaviour of two paralleled PSM1250 modules for NE load is described by the following definitions:

- □ Fail-Safe State: it is defined as the paralleled outputs going below 2 Vdc. Internal diagnostics detect and notify Low/High (Under/Over voltage) fails (DD) to logic solver, which can operate to convert these fails to the fail-safe state, requiring to turn off all malfunctioning power supplies and to replace them with new PSM1250 modules.
- □ Fail Safe: failure mode that causes the system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the paralleled output voltage is blocked or oscillating between 2 and 20 Vdc or above 30 Vdc, and both internal diagnostics cannot detect and notify faults to logic solver.
- □ Fail High - Overvoltage: failure mode that causes the paralleled output to go above 30 Vdc. Internal overvoltage protections try to limit paralleled output voltage < 30 Vdc, otherwise internal crowbars trip to fail safe state for paralleled output ≥ 30 Vdc. Internal diagnostics detect and notify High fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail Low - Undervoltage: failure mode that causes the paralleled output to go between 2 and 20 Vdc. Internal diagnostics detect and notify Low fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail "No Effect": failure mode of a component that plays a part in implementing the safety function but that is neither a safe failure nor a dangerous failure, so that the paralleled output voltage is deviated between 20 and 30 Vdc. When calculating the SFF, this failure mode is not taken into account.
- □ Fail "Not part": failure mode of a component that is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF, this failure mode is not taken into account.

The PSO1250 diagnostic module **does not interfere** with the power system functional safety. The power system can perfectly work without the diagnostic module and any failure of the PSO1250 diagnostic module does not affect system performance, reliability and SIL level of this Functional Safety application.
Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	5.85
λ_{du} = Total Dangerous Undetected failures	2.83
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	81.76
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = λ_{dd} + λ_{du} + λ_{sd} + λ_{su}	**90.44**
MTBF (safety function) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**1262 years**
$\lambda_{no\ effect}$ = "No Effect" failures	5165.98
$\lambda_{not\ part}$ = "Not Part" failures	339.78
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe}$ + $\lambda_{no\ effect}$ + $\lambda_{not\ part}$	**5596.20**
MTBF (device) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**20 years**

Failure rates table according to IEC 61508:2010 Ed.2 :

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
0.00 FIT	81.76 FIT	5.85 FIT	2.83 FIT	96.88%	0.00%	67.42%

PFDavg vs T[Proof] table (assuming Proof Test coverage of 90%), with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

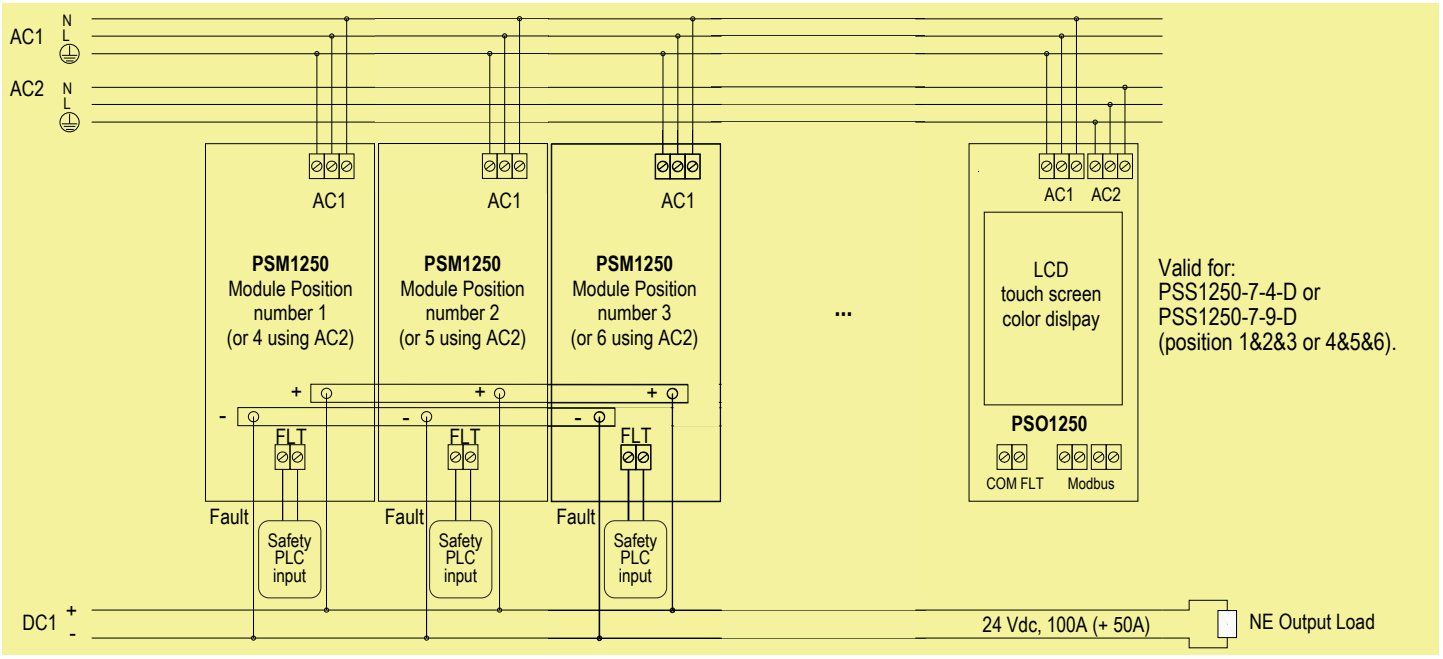
T[Proof] = 1 year	T[Proof] = 8 years
PFDavg = 1.246E-05 Valid for **SIL 3**	PFDavg = 9.97E-05 Valid for **SIL 3**

PFDavg vs T[Proof] table (assuming Proof Test coverage of 90%), with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 20 years
PFDavg = 2.49E-04 Valid for **SIL 3**

Systematic capability SIL 3.

19) Application of PSS1250 without HS and three paralleled PSM1250 modules, for NE output load



Description: In normal operation three paralleled PSM1250 modules (1st, 2nd and 3rd ones) are powered by connecting only AC1 input supply (for 4th, 5th and 6th modules connect to AC2 input supply) by means of related terminal blocks on the Back Panel PCB (see previous functional diagram for more information). For each PSM1250 module, its fault relay contact must be connected to Safety PLC or Safety logic solver because power supply internal diagnostic uses this contact to notify under/over voltage module faults to logic solver, which can require to turn off this power supply and to replace it with a new PSM1250 module. In absence of module fault the relay contact is closed, while in presence of module fault the relay contact is open.
The green Power ON LED of each PSM1250 is lit in presence of AC input supply.
The outputs of three PSM1250 modules are already paralleled on the Back Panel PCB by specific copper bars. Therefore, the NE output load is connected to outputs of three PSM1250 modules (by related output copper bars with screw terminals on the Back Panel PCB). In normal condition, NE output load is Normally Energized (NE).
In absence of AC1, three paralleled PSM1250 modules are shutdown (their fault relay contacts are open) and output load is de-energized (Safe State).

Safety Function and Failure behavior: PSS1250 with HS and three paralleled PSM1250 modules is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 1 or redundant config 2+1 on out. The failure behaviour of three paralleled PSM1250 modules for NE load is described by the following definitions:

- □ Fail-Safe State: it is defined as the paralleled outputs going below 2 Vdc. Internal diagnostics detect and notify Low/High (Under/Over voltage) fails (DD) to logic solver, which can operate to convert these fails to the fail-safe state, requiring to turn off all malfunctioning power supplies and to replace them with new PSM1250 modules.
- □ Fail Safe: failure mode that causes the system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the paralleled output voltage is blocked or oscillating between 2 and 20 Vdc or above 30 Vdc, and both internal diagnostics cannot detect and notify faults to logic solver.
- □ Fail High - Overvoltage: failure mode that causes the paralleled output to go above 30 Vdc. Internal overvoltage protections try to limit paralleled output voltage < 30 Vdc, otherwise internal crowbars trip to fail safe state for paralleled output ≥ 30 Vdc. Internal diagnostics detect and notify High fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail Low - Undervoltage: failure mode that causes the paralleled output to go between 2 and 20 Vdc. Internal diagnostics detect and notify Low fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail "No Effect": failure mode of a component that plays a part in implementing the safety function but that is neither a safe failure nor a dangerous failure, so that the paralleled output voltage is deviated between 20 and 30 Vdc. When calculating the SFF, this failure mode is not taken into account.
- □ Fail "Not part": failure mode of a component that is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF, this failure mode is not taken into account.

The PSO1250 diagnostic module **does not interfere** with the power system functional safety. The power system can perfectly work without the diagnostic module and any failure of the PSO1250 diagnostic module does not affect system performance, reliability and SIL level of this Functional Safety application.
Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	7.76
λ_{du} = Total Dangerous Undetected failures	3.96
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	81.76
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**93.48**
MTBF (safety function) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**1221 years**
$\lambda_{no\ effect}$ = "No Effect" failures	7791.15
$\lambda_{not\ part}$ = "Not Part" failures	509.67
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{no\ effect} + \lambda_{not\ part}$	**8394.30**
MTBF (device) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**13 years**

Failure rates table according to IEC 61508:2010 Ed.2 :

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
0.00 FIT	81.76 FIT	7.76 FIT	3.96 FIT	95.76%	0.00%	66.21%

PFDavg vs T[Proof] table (assuming Proof Test coverage of 90%), with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

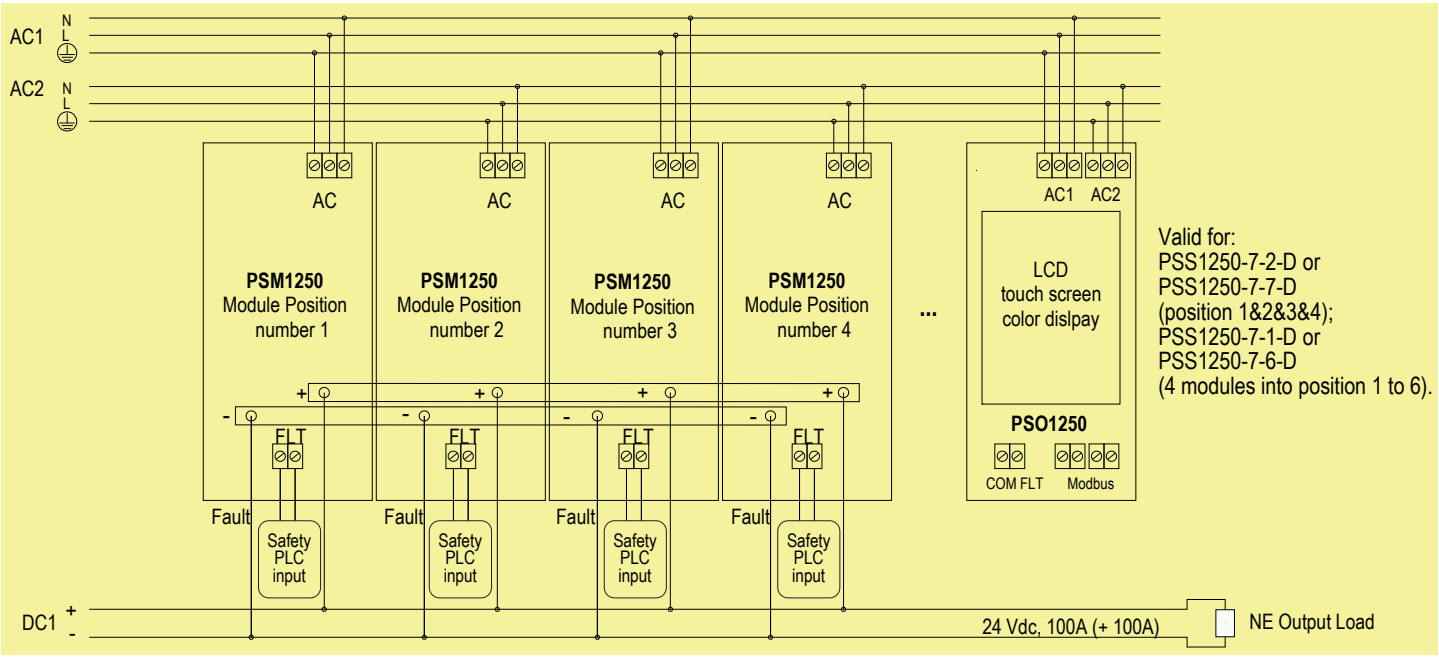
T[Proof] = 1 year	T[Proof] = 5 years
PFDavg = 1.744E-05 Valid for **SIL 3**	PFDavg = 8.72E-05 Valid for **SIL 3**

PFDavg vs T[Proof] table (assuming Proof Test coverage of 90%), with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 20 years
PFDavg = 3.49E-04 Valid for **SIL 3**

Systematic capability SIL 3.

11) Application of PSS1250 without HS and four paralleled PSM1250 modules, for NE output load



Description: In normal operation four paralleled PSM1250 modules are powered by connecting AC1 input supply to two modules and AC2 input supply to other ones by means of related terminal blocks on the Back Panel PCB (see previous functional diagram for more information). For each PSM1250 module, its fault relay contact must be connected to Safety PLC or Safety logic solver because power supply internal diagnostic uses this contact to notify under/over voltage module faults to logic solver, which can require to turn off this power supply and to replace it with a new PSM1250 module. In absence of module fault the relay contact is closed, while in presence of module fault the relay contact is open.
The green Power ON LED of each PSM1250 is lit in presence of AC input supply.
The outputs of four PSM1250 modules are already paralleled on the Back Panel PCB by specific copper bars. Therefore, the NE output load is connected to outputs of four PSM1250 modules (by related output copper bars with screw terminals on the Back Panel PCB). In normal condition, NE output load is Normally Energized (NE). In absence of one only AC input supply (AC1 or AC2), two PSM1250 modules are shutdown (their fault relay contacts are open) but the other ones operate in normal condition, so that output load is normally energized. In absence of both AC input supplies (AC1 and AC2), four paralleled PSM1250 modules are shutdown (their fault relay contacts are open) and output load is de-energized (Safe State).

Safety Function and Failure behavior: PSS1250 without HS and four paralleled PSM1250 modules is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 1 or redundant config. 2+2 on in/out. The failure behaviour of four paralleled PSM1250 modules for NE load is described by the following definitions:

- □ Fail-Safe State: it is defined as the paralleled outputs going below 2 Vdc. Internal diagnostics detect and notify Low/High (Under/Over voltage) fails (DD) to logic solver, which can operate to convert these fails to the fail-safe state, requiring to turn off all malfunctioning power supplies and to replace them with new PSM1250 modules.
- □ Fail Safe: failure mode that causes the system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the paralleled output voltage is blocked or oscillating between 2 and 20 Vdc or above 30 Vdc, and both internal diagnostics cannot detect and notify faults to logic solver.
- □ Fail High - Overvoltage: failure mode that causes the paralleled output to go above 30 Vdc. Internal overvoltage protections try to limit paralleled output voltage < 30 Vdc, otherwise internal crowbars trip to fail safe state for paralleled output ≥ 30 Vdc. Internal diagnostics detect and notify High fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail Low - Undervoltage: failure mode that causes the paralleled output to go between 2 and 20 Vdc. Internal diagnostics detect and notify Low fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail "No Effect": failure mode of a component that plays a part in implementing the safety function but that is neither a safe failure nor a dangerous failure, so that the paralleled output voltage is deviated between 20 and 30 Vdc. When calculating the SFF, this failure mode is not taken into account.
- □ Fail "Not part": failure mode of a component that is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF, this failure mode is not taken into account.

The PSO1250 diagnostic module **does not interfere** with the power system functional safety. The power system can perfectly work without the diagnostic module and any failure of the PSO1250 diagnostic module does not affect system performance, reliability and SIL level of this Functional Safety application.
Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	9.67
λ_{du} = Total Dangerous Undetected failures	5.09
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	81.76
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**96.53**
MTBF (safety function) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**1182 years**
$\lambda_{no\ effect}$ = "No Effect" failures	10416.31
$\lambda_{not\ part}$ = "Not Part" failures	679.56
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{no\ effect} + \lambda_{not\ part}$	**11192.40**
MTBF (device) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**10 years**

Failure rates table according to IEC 61508:2010 Ed.2 :

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
0.00 FIT	81.76 FIT	9.67 FIT	5.09 FIT	94.72%	0.00%	65.50%

PFDavg vs T[Proof] table (assuming Proof Test coverage of 90%), with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

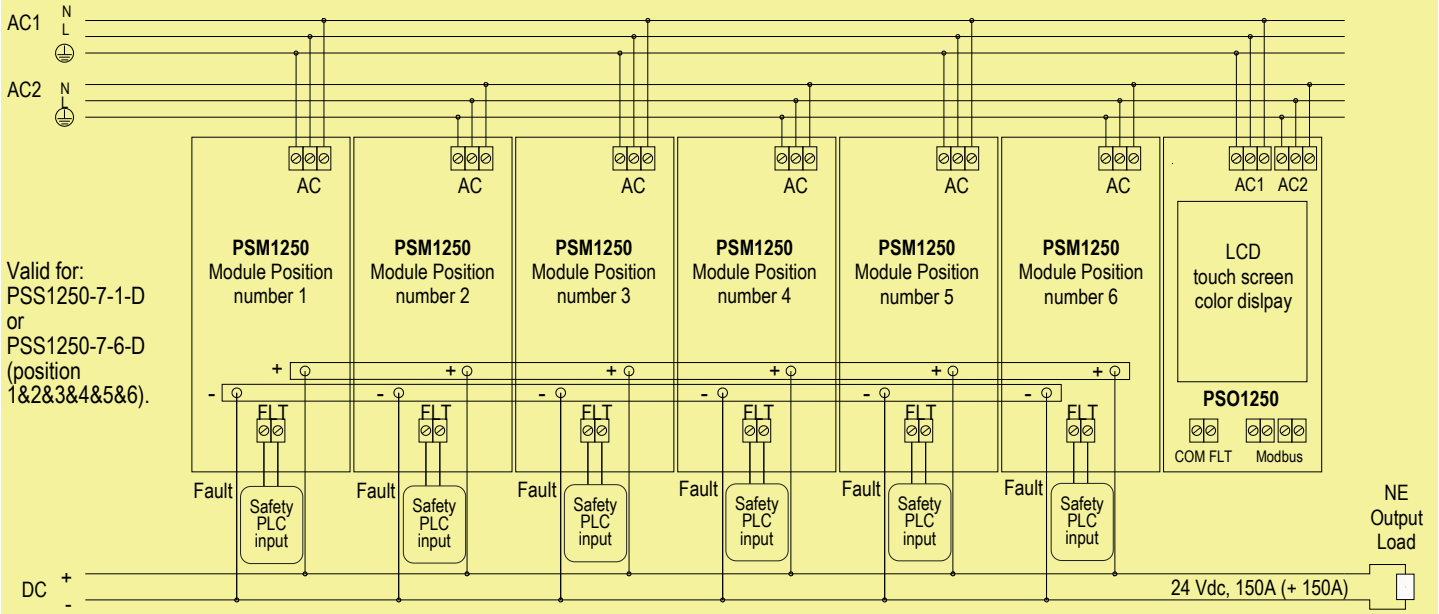
T[Proof] = 1 year	T[Proof] = 4 years
PFDavg = 2.241E-05 Valid for **SIL 3**	PFDavg = 8.96E-05 Valid for **SIL 3**

PFDavg vs T[Proof] table (assuming Proof Test coverage of 90%), with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 20 years
PFDavg = 4.48E-04 Valid for **SIL 2**

Systematic capability SIL 3.

12) Application of PSS1250 without HS and six paralleled PSM1250 modules, for NE output load



Description: In normal operation six paralleled PSM1250 modules are powered by connecting AC1 input supply to three modules and AC2 input supply to other ones by means of related terminal blocks on the Back Panel PCB (see previous functional diagram for more information). For each PSM1250 module, its fault relay contact must be connected to Safety PLC or Safety logic solver because power supply internal diagnostic uses this contact to notify under/over voltage module faults to logic solver, which can require to turn off this power supply and to replace it with a new PSM1250 module. In absence of module fault the relay contact is closed, while in presence of module fault the relay contact is open.
The green Power ON LED of each PSM1250 is lit in presence of AC input supply.
The outputs of six PSM1250 modules are already paralleled on the Back Panel PCB by specific copper bars. Therefore, the NE output load is connected to outputs of six PSM1250 modules (by related output copper bars with screw terminals on the Back Panel PCB). In normal condition, NE output load is Normally Energized (NE).
In absence of one only AC input supply (AC1 or AC2), three PSM1250 modules are shutdown (their fault relay contacts are open) but the other ones operate in normal condition, so that output load is normally energized. In absence of both AC input supplies (AC1 and AC2), six paralleled PSM1250 modules are shutdown (their fault relay contacts are open) and output load is de-energized (Safe State).

Safety Function and Failure behavior: PSS1250 without HS and six paralleled PSM1250 modules is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 1 or redundant config. 3+3 on in/out.The failure behaviour of six paralleled PSM1250 modules for NE load is described by the following definitions:

- □ Fail-Safe State: it is defined as the paralleled outputs going below 2 Vdc. Internal diagnostics detect and notify Low/High (Under/Over voltage) fails (DD) to logic solver, which can operate to convert these fails to the fail-safe state, requiring to turn off all malfunctioning power supplies and to replace them with new PSM1250 modules.
- □ Fail Safe: failure mode that causes the system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the paralleled output voltage is blocked or oscillating between 2 and 20 Vdc or above 30 Vdc, and both internal diagnostics cannot detect and notify faults to logic solver.
- □ Fail High - Overvoltage: failure mode that causes the paralleled output to go above 30 Vdc. Internal overvoltage protections try to limit paralleled output voltage < 30 Vdc, otherwise internal crowbars trip to fail safe state for paralleled output ≥ 30 Vdc. Internal diagnostics detect and notify High fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail Low - Undervoltage: failure mode that causes the paralleled output to go between 2 and 20 Vdc. Internal diagnostics detect and notify Low fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail "No Effect": failure mode of a component that plays a part in implementing the safety function but that is neither a safe failure nor a dangerous failure, so that the paralleled output voltage is deviated between 20 and 30 Vdc. When calculating the SFF, this failure mode is not taken into account.
- □ Fail "Not part": failure mode of a component that is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF, this failure mode is not taken into account.

The PSO1250 diagnostic module **does not interfere** with the power system functional safety. The power system can perfectly work without the diagnostic module and any failure of the PSO1250 diagnostic module does not affect system performance, reliability and SIL level of this Functional Safety application.
Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	13.49
λ_{du} = Total Dangerous Undetected failures	7.36
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	81.76
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**102.61**
MTBF (safety function) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**1112 years**
$\lambda_{no\ effect}$ = "No Effect" failures	15666.65
$\lambda_{not\ part}$ = "Not Part" failures	1019.34
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{no\ effect} + \lambda_{not\ part}$	**16788.60**
MTBF (device) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**7 years**

Failure rates table according to IEC 61508:2010 Ed.2 :

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
0.00 FIT	81.76 FIT	13.49 FIT	7.36 FIT	92.83%	0.00%	64.70%

PFDavg vs T[Proof] table (assuming Proof Test coverage of 90%), with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

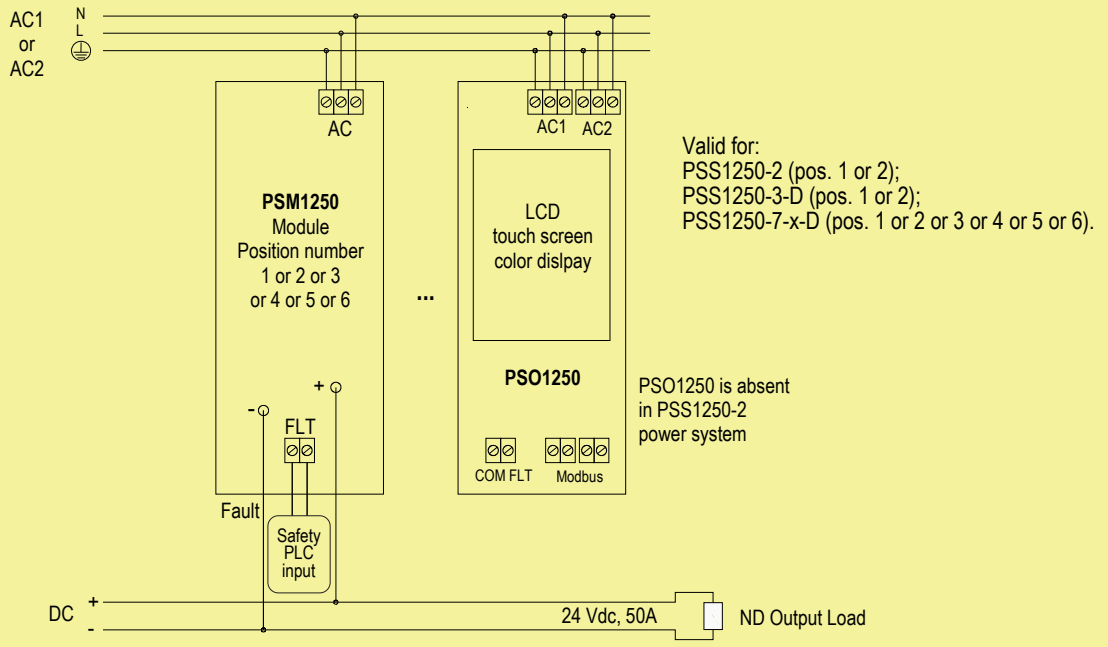
T[Proof] = 1 year	T[Proof] = 3 years	T[Proof] = 20 years
PFDavg = 3.24E-05 Valid for **SIL 3**	PFDavg = 9.72E-05 Valid for **SIL 3**	PFDavg = 6.48E-04 Valid for **SIL 2**

PFDavg vs T[Proof] table (assuming Proof Test coverage of 90%), with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 15 years
PFDavg = 4.86E-04 Valid for **SIL 3**

Systematic capability SIL 3.

13) Application of PSS1250 without HS and single PSM1250 module, for ND output load



Description:

In normal operation the PSM1250 module is unpowered because of absence of AC input supply, which is connected to related terminal blocks on the Back Panel PCB (see previous functional diagram for more information). The fault relay contact can be connected to Safety PLC or Safety logic solver because power supply internal diagnostic uses this contact to notify under/over voltage dangerous faults to logic solver, which can only require to turn off power supply and to replace it with a new PSM1250 module. In absence of fault the relay contact is closed, while in presence of fault the relay contact is open.

Absence of AC input supply implies that the green Power ON LED of PSM1250 is turned off, fault relay contact is open and the ND output load (connected to related output copper bars with screw terminals on the Back Panel PCB) is Normally De-energized (ND).

In presence of AC input supply, the green Power ON LED of PSM1250 is lit, fault relay contact is closed (if fault is absent) and output load is energized (Safe State).

Safety Function and Failure behavior:

PSS1250 without HS and single PSM1250 module is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 0.

The failure behaviour of PSM1250 for ND load is described by the following definitions :

- □ Fail-Safe State: it is defined as the output going between 20 and 30 Vdc.
- □ Fail Safe: failure mode that causes the module / (sub)system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the output voltage is blocked or oscillating between 0 and 20 Vdc or above 30 Vdc, and internal diagnostic cannot detect and notify faults to logic solver.
- □ Fail High - Overvoltage: failure mode that causes the output to go above 30 Vdc. Internal overvoltage protection tries to limit output voltage < 30 Vdc, otherwise for output ≥ 30 Vdc internal crowbars trip, turning off the power supply. In any case, this failure mode is dangerous, but internal diagnostic notifies High fail to logic solver, which cannot convert this failure to the fail-safe state but it can only require to turn off power supply and to replace it with a new PSM1250 module.
- □ Fail Low - Undervoltage: failure mode that causes the output to go between 0 and 20 Vdc. This failure mode is dangerous, but internal diagnostic notifies Low fail to logic solver, which cannot convert this failure to the fail-safe state but it can only require to turn off power supply and to replace it with a new PSM1250 module.
- □ Fail "Not part": failure mode of a component that is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF, this failure mode is not taken into account.

The PSO1250 diagnostic module **does not interfere** with the power system functional safety. The power system can perfectly work without the diagnostic module and any failure of the PSO1250 diagnostic module does not affect system performance, reliability and SIL level of this Functional Safety application.

Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	0.00
λ_{du} = Total Dangerous Undetected failures	1690.12
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	938.09
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**2628.21**
MTBF (safety function) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**43 years**
$\lambda_{not\ part}$ = "Not Part" failures	169.89
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{not\ part}$	**2798.10**
MTBF (device) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**40 years**

Failure rates table according to IEC 61508:2010 Ed.2 :

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
0.00 FIT	938.09 FIT	0.00 FIT	1690.12 FIT	35.69%	0.00%	0.00%

PFDavg vs T[Proof] table, with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

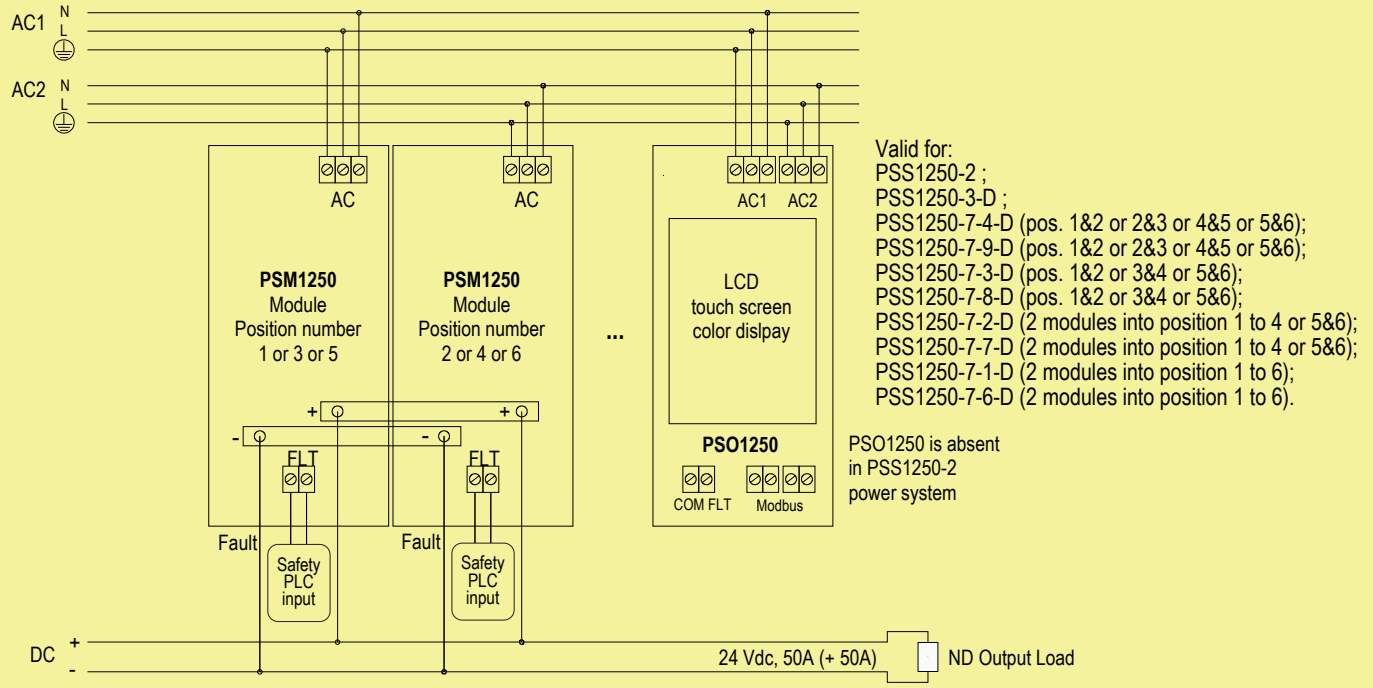
T[Proof] = 1 year
PFDavg = 7.42E-03 Valid for **SIL 1**

PFDavg vs T[Proof] table, with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 5 years
PFDavg = 3.71E-02 Valid for **SIL 1**

Systematic capability SIL 3.

14) Application of PSS1250 without HS and two paralleled PSM1250 modules, for ND output load



Description: In normal operation two paralleled PSM1250 modules are unpowered because of absence of both AC input supplies (AC1 and AC2), where AC1 is connected to one module and AC2 to other one by means of related terminal blocks on the Back Panel PCB (see previous functional diagram for more information). For each PSM1250 module, its fault relay contact must be connected to Safety PLC or Safety logic solver because power supply internal diagnostic uses this contact to notify over voltage module faults to logic solver, which can require to turn off this power supply and to replace it with a new PSM1250 module. In absence of module fault the relay contact is closed, while in presence of module fault the relay contact is open.

The outputs of two PSM1250 modules are already paralleled on the Back Panel PCB by specific copper bars. Therefore, the ND output load is connected to outputs of both PSM1250 modules (by related output copper bars with screw terminals on Back Panel PCB). In normal condition, absence of both AC input supplies (AC1 and AC2) implies that both green Power ON LEDs of PSM1250 modules are turned off, both fault relay contacts are open and the ND output load is Normally De-energized (ND).

In presence of one only AC input supply (AC1 or AC2), one PSM1250 module is shutdown (its fault relay contact is open) but the other one is correctly turned on, so that output load is energized (Safe State). In presence of both AC input supplies (AC1 and AC2), both paralleled PSM1250 modules are correctly turned on and output load is energized (Safe State).

Safety Function and Failure behavior:

PSS1250 without HS and two paralleled PSM1250 modules is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 1 or redundant config.1+1 on in/out. The failure behaviour of two paralleled PSM1250 modules for ND load is described by the following definitions:

- □ Fail-Safe State: it is defined as the the paralleled outputs going between 20 and 30 Vdc. Internal diagnostics detect and notify High (Over voltage) fails (DD) to logic solver, which can operate to convert these fails to the fail-safe state, requiring to turn off malfunctioning power supply and to replace it with new PSM1250 modules.
- □ Fail Safe: failure mode that causes the system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the paralleled output voltage is blocked or oscillating between 0 and 20 Vdc or above 30 Vdc, and internal diagnostic cannot detect and notify faults to logic solver.
- □ Fail High - Overvoltage: failure mode that causes the paralleled output to go above 30 Vdc. Internal overvoltage protection tries to limit output voltage < 30 Vdc, otherwise for output ≥ 30 Vdc internal crowbars trip, turning off malfunctioning power supply. Internal diagnostics detect and notify High fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail Low - Undervoltage: failure mode that causes the paralleled output to go between 0 and 20 Vdc. This failure mode is dangerous, but internal diagnostic notifies Low fail to logic solver, which cannot convert this failure to the fail-safe state but it can only require to turn off malfunctioning power supply and to replace it with a new PSM1250 module.
- □ Fail "Not part": failure mode of a component that is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF, this failure mode is not taken into account.

The PSO1250 diagnostic module **does not interfere** with the power system functional safety. The power system can perfectly work without the diagnostic module and any failure of the PSO1250 diagnostic module does not affect system performance, reliability and SIL level of this Functional Safety application.

Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	3.82
λ_{du} = Total Dangerous Undetected failures	86.62
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	5165.98
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**5256.42**
MTBF (safety function) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**21 years**
$\lambda_{not\ part}$ = "Not Part" failures	339.78
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{not\ part}$	**5596.20**
MTBF (device) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**20 years**

Failure rates table according to IEC 61508:2010 Ed.2 :

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
0.00 FIT	5165.98 FIT	3.82 FIT	86.62 FIT	98.35%	0.00%	4.22%

PFDavg vs T[Proof] table, with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

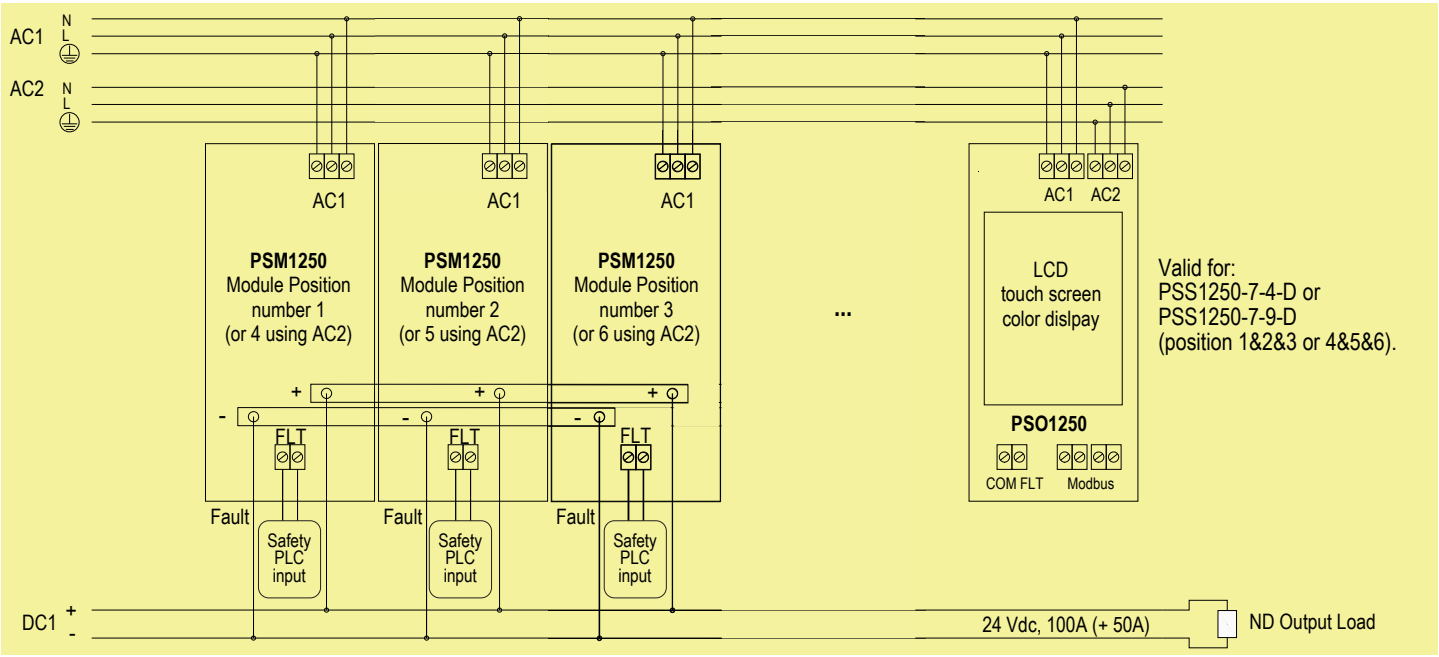
T[Proof] = 1 year	T[Proof] = 2 years	T[Proof] = 20 years
PFDavg = 3.80E-04 Valid for **SIL 2**	PFDavg = 7.60E-04 Valid for **SIL 2**	PFDavg = 7.60E-03 Valid for **SIL 1**

PFDavg vs T[Proof] table, with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 10 years
PFDavg = 3.80E-03 Valid for **SIL 2**

Systematic capability SIL 3.

20) Application of PSS1250 without HS and three paralleled PSM1250 modules, for ND output load



Description: In normal operation three paralleled PSM1250 modules (1st, 2nd and 3rd ones) are unpowered because of absence of only AC1 input supply (for 4th, 5th and 6th modules use AC2 input supply line), which is connected by means of related terminal blocks on the Back Panel PCB (see previous functional diagram for more information).
For each PSM1250 module, its fault relay contact must be connected to Safety PLC or Safety logic solver because power supply internal diagnostic uses this contact to notify over voltage module faults to logic solver, which can require to turn off this power supply and to replace it with a new PSM1250 module. In absence of module fault the relay contact is closed, while in presence of module fault the relay contact is open.
The outputs of three PSM1250 modules are already paralleled on the Back Panel PCB by specific copper bars. Therefore, the ND output load is connected to outputs of three PSM1250 modules (by related output copper bars with screw terminals on Back Panel PCB). In normal condition, absence of AC1 input supply implies that three green Power ON LEDs of PSM1250 modules are turned off, three fault relay contacts are open and the ND output load is Normally De-energized (ND).
In presence of AC1 input supply, three paralleled PSM1250 modules are correctly turned on and output load is energized (Safe State).

Safety Function and Failure behavior:

PSS1250 with HS and three paralleled PSM1250 modules is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 1 or redundant config 2+1 on out. The failure behaviour of three paralleled PSM1250 modules for ND load is described by the following definitions:

- □ Fail-Safe State: it is defined as the the paralleled outputs going between 20 and 30 Vdc. Internal diagnostics detect and notify High (Over voltage) fails (DD) to logic solver, which can operate to convert these fails to the fail-safe state, requiring to turn off malfunctioning power supply and to replace it with new PSM1250 modules.
- □ Fail Safe: failure mode that causes the system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the paralleled output voltage is blocked or oscillating between 0 and 20 Vdc or above 30 Vdc, and internal diagnostic cannot detect and notify faults to logic solver.
- □ Fail High - Overvoltage: failure mode that causes the paralleled output to go above 30 Vdc. Internal overvoltage protection tries to limit output voltage < 30 Vdc, otherwise for output ≥ 30 Vdc internal crowbars trip, turning off malfunctioning power supply. Internal diagnostics detect and notify High fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail Low - Undervoltage: failure mode that causes the paralleled output to go between 0 and 20 Vdc. This failure mode is dangerous, but internal diagnostic notifies Low fail to logic solver, which cannot convert this failure to the fail-safe state but it can only require to turn off malfunctioning power supply and to replace it with a new PSM1250 module.
- □ Fail "Not part": failure mode of a component that is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF, this failure mode is not taken into account.

The PSO1250 diagnostic module **does not interfere** with the power system functional safety. The power system can perfectly work without the diagnostic module and any failure of the PSO1250 diagnostic module does not affect system performance, reliability and SIL level of this Functional Safety application.
Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	5.73
λ_{du} = Total Dangerous Undetected failures	87.75
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	7791.15
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**7884.63**
MTBF (safety function) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**14 years**
$\lambda_{not\ part}$ = "Not Part" failures	509.67
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{not\ part}$	**8394.30**
MTBF (device) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**13 years**

Failure rates table according to IEC 61508:2010 Ed.2 :

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
0.00 FIT	7791.15 FIT	5.73 FIT	87.75 FIT	98.89%	0.00%	6.13%

PFDavg vs T[Proof] table, with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

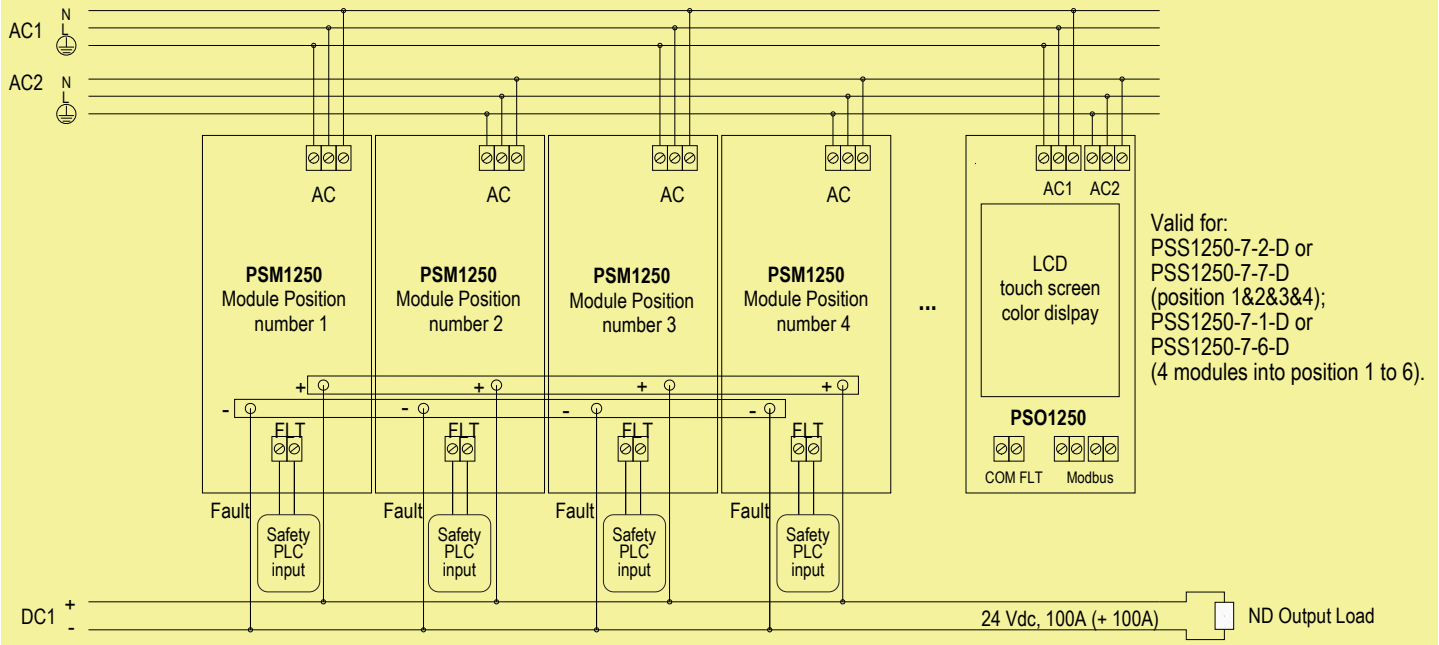
T[Proof] = 1 year	T[Proof] = 2 years	T[Proof] = 20 years
PFDavg = 3.85E-04 Valid for **SIL 2**	PFDavg = 7.70E-04 Valid for **SIL 2**	PFDavg = 7.70E-03 Valid for **SIL 1**

PFDavg vs T[Proof] table, with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 10 years
PFDavg = 3.85E-03 Valid for **SIL 2**

Systematic capability SIL 3.

15) Application of PSS1250 without HS and four paralleled PSM1250 modules, for ND output load



Description:

In normal operation four paralleled PSM1250 modules are unpowered because of absence of both AC input supplies (AC1 and AC2), where AC1 is connected to two modules and AC2 to other ones by means of related terminal blocks on the Back Panel PCB (see previous functional diagram for more information). For each PSM1250 module, its fault relay contact must be connected to Safety PLC or Safety logic solver because power supply internal diagnostic uses this contact to notify over voltage module faults to logic solver, which can require to turn off this power supply and to replace it with a new PSM1250 module. In absence of module fault the relay contact is closed, while in presence of module fault the relay contact is open.

The outputs of four PSM1250 modules are already paralleled on the Back Panel PCB by specific copper bars. Therefore, the ND output load is connected to outputs of four PSM1250 modules (by related output copper bars with screw terminals on Back Panel PCB). In normal condition, absence of both AC input supplies (AC1 and AC2) implies that four green Power ON LEDs of PSM1250 modules are turned off, four fault relay contacts are open and the ND output load is Normally De-energized (ND).

In presence of one only AC input supply (AC1 or AC2), two PSM1250 module are shutdown (their fault relay contact are open) but the other ones are correctly turned on, so that output load is energized (Safe State). In presence of both AC input supplies (AC1 and AC2), four paralleled PSM1250 modules are correctly turned on and output load is energized (Safe State).

Safety Function and Failure behavior:

PSS1250 without HS and four paralleled PSM1250 modules is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 1 or redundant config. 2+2 on in/out. The failure behaviour of four paralleled PSM1250 modules for ND load is described by the following definitions:

- □ Fail-Safe State: it is defined as the the paralleled outputs going between 20 and 30 Vdc. Internal diagnostics detect and notify High (Over voltage) fails (DD) to logic solver, which can operate to convert these fails to the fail-safe state, requiring to turn off malfunctioning power supply and to replace it with new PSM1250 modules.
- □ Fail Safe: failure mode that causes the system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the paralleled output voltage is blocked or oscillating between 0 and 20 Vdc or above 30 Vdc, and internal diagnostic cannot detect and notify faults to logic solver.
- □ Fail High - Overvoltage: failure mode that causes the paralleled output to go above 30 Vdc. Internal overvoltage protection tries to limit output voltage < 30 Vdc, otherwise for output ≥ 30 Vdc internal crowbars trip, turning off malfunctioning power supply. Internal diagnostics detect and notify High fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail Low - Undervoltage: failure mode that causes the paralleled output to go between 0 and 20 Vdc. This failure mode is dangerous, but internal diagnostic notifies Low fail to logic solver, which cannot convert this failure to the fail-safe state but it can only require to turn off malfunctioning power supply and to replace it with a new PSM1250 module.
- □ Fail "Not part": failure mode of a component that is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF, this failure mode is not taken into account.

The PSO1250 diagnostic module **does not interfere** with the power system functional safety. The power system can perfectly work without the diagnostic module and any failure of the PSO1250 diagnostic module does not affect system performance, reliability and SIL level of this Functional Safety application.

Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	7.64
λ_{du} = Total Dangerous Undetected failures	88.89
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	10416.31
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**10512.84**
MTBF (safety function) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**11 years**
$\lambda_{not\ part}$ = "Not Part" failures	679.56
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{not\ part}$	**11192.40**
MTBF (device) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**10 years**

Failure rates table according to IEC 61508:2010 Ed.2 :

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
0.00 FIT	10416.31 FIT	7.64 FIT	88.89 FIT	99.15%	0.00%	7.91%

PFDavg vs T[Proof] table, with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

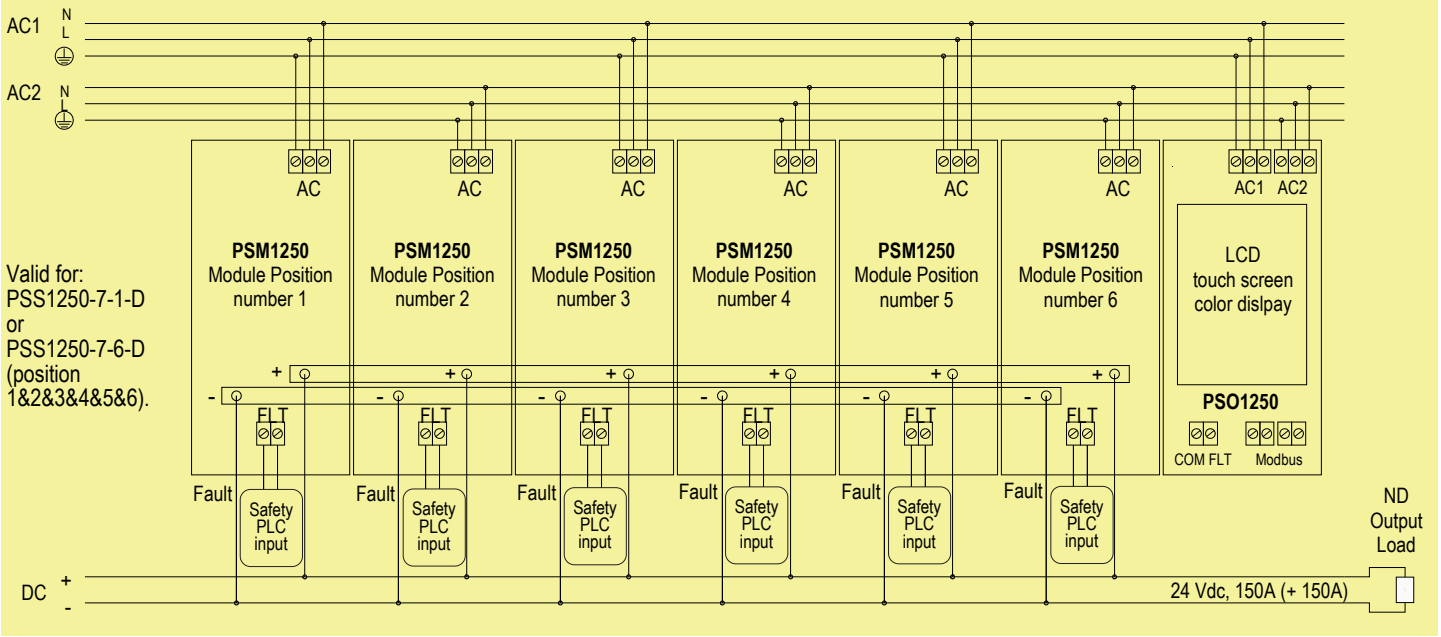
T[Proof] = 1 year	T[Proof] = 2 years	T[Proof] = 20 years
PFDavg = 3.90E-04 Valid for **SIL 2**	PFDavg = 7.80E-04 Valid for **SIL 2**	PFDavg = 7.80E-03 Valid for **SIL 1**

PFDavg vs T[Proof] table, with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 10 years
PFDavg = 3.90E-03 Valid for **SIL 2**

Systematic capability SIL 3.

16) Application of PSS1250 without HS and six paralleled PSM1250 modules, for ND output load



Description:

In normal operation six paralleled PSM1250 modules are unpowered because of absence of both AC input supplies (AC1 and AC2), where AC1 is connected to three modules and AC2 to other ones by means of related terminal blocks on the Back Panel PCB (see previous functional diagram for more information). For each PSM1250 module, its fault relay contact must be connected to Safety PLC or Safety logic solver because power supply internal diagnostic uses this contact to notify over voltage module faults to logic solver, which can require to turn off this power supply and to replace it with a new PSM1250 module. In absence of module fault the relay contact is closed, while in presence of module fault the relay contact is open.

The outputs of six PSM1250 modules are already paralleled on the Back Panel PCB by specific copper bars. Therefore, the ND output load is connected to outputs of six PSM1250 modules (by related output copper bars with screw terminals on Back Panel PCB). In normal condition, absence of both AC input supplies (AC1 and AC2) implies that six green Power ON LEDs of PSM1250 modules are turned off, six fault relay contacts are open and the ND output load is Normally De-energized (ND). In presence of one only AC input supply (AC1 or AC2), three PSM1250 module are shutdown (their fault relay contact are open) but the other ones are correctly turned on, so that output load is energized (Safe State). In presence of both AC input supplies (AC1 and AC2), six paralleled PSM1250 modules are correctly turned on and output load is energized (Safe State).

Safety Function and Failure behavior:

PSS1250 without HS and six paralleled PSM1250 modules is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 1 or redundant configuration 3+3 on in/out. The failure behaviour of six paralleled PSM1250 modules for ND load is described by the following definitions :

- □ Fail-Safe State: it is defined as the the paralleled outputs going between 20 and 30 Vdc. Internal diagnostics detect and notify High (Over voltage) fails (DD) to logic solver, which can operate to convert these fails to the fail-safe state, requiring to turn off malfunctioning power supply and to replace it with new PSM1250 modules.
- □ Fail Safe: failure mode that causes the system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the paralleled output voltage is blocked or oscillating between 0 and 20 Vdc or above 30 Vdc, and internal diagnostic cannot detect and notify faults to logic solver.
- □ Fail High - Overvoltage: failure mode that causes the paralleled output to go above 30 Vdc. Internal overvoltage protection tries to limit output voltage < 30 Vdc, otherwise for output ≥ 30 Vdc internal crowbars trip, turning off malfunctioning power supply. Internal diagnostics detect and notify High fail to logic solver, which does not automatically trip on this failure, classified as Dangerous Detected (DD).
- □ Fail Low - Undervoltage: failure mode that causes the paralleled output to go between 0 and 20 Vdc. This failure mode is dangerous, but internal diagnostic notifies Low fail to logic solver, which cannot convert this failure to the fail-safe state but it can only require to turn off malfunctioning power supply and to replace it with a new PSM1250 module.
- □ Fail "Not part": failure mode of a component that is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF, this failure mode is not taken into account.

The PSO1250 diagnostic module **does not interfere** with the power system functional safety. The power system can perfectly work without the diagnostic module and any failure of the PSO1250 diagnostic module does not affect system performance, reliability and SIL level of this Functional Safety application.

Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	11.46
λ_{du} = Total Dangerous Undetected failures	91.15
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	15666.65
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**15769.26**
MTBF (safety function) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**7 years**
$\lambda_{not\ part}$ = "Not Part" failures	1019.34
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{not\ part}$	**16788.60**
MTBF (device) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**7 years**

Failure rates table according to IEC 61508:2010 Ed.2 :

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
0.00 FIT	15666.65 FIT	11.46 FIT	91.15 FIT	99.42%	0.00%	11.17%

PFDavg vs T[Proof] table, with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

T[Proof] = 1 year	T[Proof] = 2 years	T[Proof] = 20 years
PFDavg = 4.00E-04 Valid for **SIL 2**	PFDavg = 8.00E-04 Valid for **SIL 2**	PFDavg = 8.00E-03 Valid for **SIL 1**

PFDavg vs T[Proof] table, with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 10 years
PFDavg = 4.00E-03 Valid for **SIL 2**

Systematic capability SIL 3.

Testing procedure at T-proof

According to IEC 61508-2, the proof test will be performed to reveal dangerous faults which cannot be otherwise detected. This means that it is necessary to specify how dangerous undetected faults, which have been noted during the FMEDA analysis, can be revealed during the proof test.
For **Functional Safety applications with two or more paralleled power supply modules in redundant configuration for NE output load**, the following **Proof Test** must be executed **for each PSM1250** composing the Functional Safety used application. It consists of the following steps:

Steps	Action
1	In order to control correct operating of the fault contact (FLT), necessary to give information about dangerous failures, take appropriate action on the safety-related PLC to acquire presence of fault but to not take any action because fault condition is intentionally provoked.
2	Shutdown the tested power supply module by unplugging: at least one of two top screws that fix PSM1250 into PSS1250 rack with HS capability; two top and two bottom screws that fix PSM1250 into PSS1250 rack without HS capability and disconnecting the module from the rack unit. This action does not affect output load operating, which holds normally energized because of fully redundant configuration on input (two independent AC lines) and output (paralleling connection implies high availability) of the Functional Safety application. The power supply module turn off time lasts some seconds (typically 5 to 10 sec). During this time, the power supply module output voltage goes below 19.5 Vdc (undervoltage UV condition), therefore the fault relay contact must be open and the green Power ON LED must blink. The safety-related PLC must acquire presence of fault, which proves that power supply internal diagnostic operates correctly. If the safety-related PLC does not acquire any fault, this means that fault relay contact is blocked in closed position (for welding) or power supply internal diagnostic is wrongly operating. Therefore this power supply module must be replaced with new one.
3	Turn on the tested power supply module by plugging: both two top screws that fix PSM1250 into PSS1250 rack with HS capability; two top and two bottom screws that fix PSM1250 into PSS1250 rack without HS capability and connecting the module into the rack unit. After about 3 seconds the power supply module operates correctly in current sharing mode with other paralleled power supply modules. This can be seen on the TFT display of PSO1250 overview module.
4	Restore normal operation of the safety-related PLC, so that it can take any action if fault is acquired.
5	Unplug two M6 nylon-capped lock nuts, to unfix IP20 polycarbonate cover from the DC (+ / -) couple screw output terminals of the tested power supply module.
6	Use an AC true rms voltmeter and connect its probes to DC (+ / -) couple screw output terminals in order to measure AC rms voltage. In normal operation conditions, the output supply voltage should have no AC component, that is its rms value should be ideally null. But little ripple is allowed, therefore this value must be less than 100 mVrms. If higher rms value (as some volts) is measured, a dangerous failure which has produced an oscillation of the output voltage regulator is detected. Therefore this power supply module must be replaced with new one.
7	Plug two M6 nylon-capped lock nuts, to fix IP20 polycarbonate cover on the DC (+ / -) couple screw output terminals of the tested power supply module.

This test reveals 90% of all possible Dangerous Undetected failures in the PSM1250 power supply module and therefore in the PSS1250 system, when the output load is NE type.

Warning

PSS1250 series are isolated Switching Power Supply units located in Safe Area or Zone 2 Gas Group IIC, Temperature T4 or Class I, Division 2, Group A, B, C, D, T4 Hazardous Area (valid for all configurations except for PSS1250(-HS)-7-0 & -7-5) within the specified operating temperature limits -40°C ≤ Tamb ≤ +70°C and mounting conditions.
For UL compliance, PSS1250 series are suitable for use in Class I, Division 2, Groups A, B, C and D Hazardous Locations (valid for all configurations except for PSS1250(-HS)-7-0 & -7-5), or Nonhazardous Locations only. Read installation manual before operating the unit.
PSS1250 series must be installed, wired, operated and maintained only by qualified personnel, in accordance to the relevant national/international installation standards (e.g. IEC/EN60079-14 Explosive atmospheres - Part 14: Electrical installations design, selection and erection), following established installation rules.
De-energize power source (turn off power supply voltage) before plug or unplug the terminal blocks when installed in Hazardous Area or unless area is known to be nonhazardous.
Warning - explosion hazard - substitution of components may impair suitability for Zone 2 / Class I, Division 2. Avertissement - danger d'explosion - la substitution des composants peut nuire à l'aptitude à la Zone 2 / Class I, Division 2.
Warning - explosion hazard - do not disconnect equipment while the circuit is live or unless the area is known to be free of ignitable concentrations. Avertissement - danger d'explosion - débranchez pas l'appareil lorsque le circuit est sous tension ou à moins que région est connue pour être exempte de concentrations inflammables.
Explosion Hazard: to prevent ignition of flammable atmospheres, disconnect power and wait that power-on LED is OFF before servicing or unless area is known to be nonhazardous. Danger d'Explosion: pour éviter l'inflammation d'atmosphères inflammables, débrancher l'alimentation et attendre que le LED de mise sous tension soit éteint avant l'entretien ou à moins que région est connue pour être non dangereuse.
Warning: de-energize main power source (turn off power supply voltage) before opening the enclosure to avoid electrical shock. Avertissement: débrancher l'alimentation (couper la tension d'alimentation) avant d'ouvrir le boîtier pour éviter les chocs électriques.
Green Power ON LED of PSM1250 power module: check that green LED is OFF before screwing out PSM1250 module front panel. **Red LED (one for each PSM1250 slot position) on wall mounting panel board:** connect a PSM1250 power module to the rack unit only if corresponding red LED on back panel board is in OFF state.
This equipment is an open-type device and is meant to be installed in an enclosure suitable for the environment such that the equipment is only accessible with the use of a tool.
The enclosure provides, according to EN60529, an IP20 minimum degree of protection (or similar to NEMA Standard 250 type 1). The equipment shall only be used in an area of at least pollution degree 2, as defined in IEC 60664-1. When installed in EU Zone 2 (valid for all configurations except for PSS1250(-HS)-7-0 & -7-5), the unit shall be installed in an enclosure that provides a minimum ingress protection of IP54 in accordance with IEC 60079-0. When installed in a Class I, Zone 2 Hazardous Location (valid for all configurations except for PSS1250(-HS)-7-0 & -7-5), the unit shall be mounted in a supplemental AEx or Ex enclosure that provides a degree of protection not less than IP54 in accordance with UL/CSA 60079-0. When installed in a Class I, Division 2 Hazardous Location (valid for all configurations except for PSS1250(-HS)-7-0 & -7-5), the unit shall be mounted in a supplemental enclosure that provides a degree of protection not less than IP54. The enclosure must have a door or cover accessible only by the use of a tool. The end user is responsible to ensure that the operating temperature of the module is not exceeded in the end use application.
Units must be protected against dirt, dust, extreme mechanical (e.g. vibration, impact and shock) and thermal stress, and casual contacts.
All circuits connected to PSS1250 series must comply with the overvoltage category II (or better) according to EN/IEC60664-1.
Electrostatic Hazard: to avoid electrostatic hazard, the enclosure of PSS1250 series must be cleaned only with a damp or antistatic cloth.
Any penetration of cleaning liquid must be avoided to prevent damage to the unit. Failure to properly installation or use of the equipment may risk to damage the unit or severe personal injury. The unit cannot be repaired by the end user and must be returned to the manufacturer or his authorized representative. Any unauthorized modification must be avoided.

Storage

If after an incoming inspection the unit is not installed directly on a system (parts for spare or expansion with long storage periods) it must be conveniently stocked.
Stocking area characteristics must comply with the following parameters. Temperature -40 to +70 °C, the -45 to +80 °C is meant for limited periods, -10 to +30 °C is preferred. Humidity 0 to 95 %, 0 to 60 % humidity is preferred. **Vibration:** no prolonged vibration should be perceivable in the stocking area to avoid loosening of parts or fatigue ruptures of components terminals. **Pollution:** presence of pollutant or corrosive gases or vapors must be avoided to prevent corrosion of conductors and degradation of insulating surfaces.

Disposal

The product should not be disposed with other wastes at the end of its working life. It may content hazardous substances for the health and the environment, to prevent possible harm from uncontrolled waste disposal, please separate this equipment from other types of wastes and recycle it responsibly to promote the sustainable reuse of material resources.
This product should not be mixed with other commercial wastes for disposal.

System composition

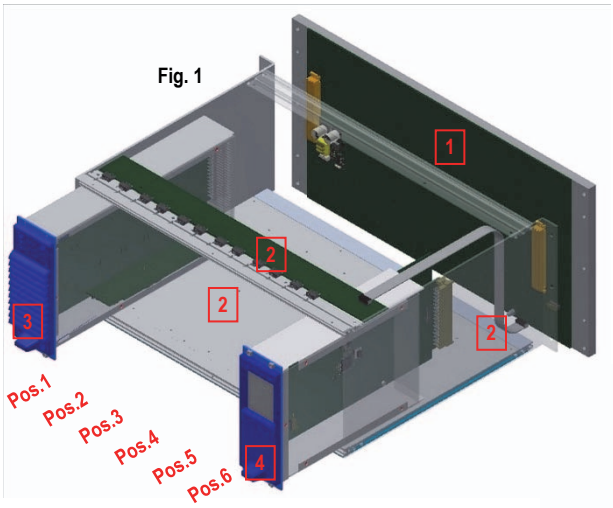


Fig. 1 shows **PSS1250-HS-7-0/1/2/3/4-D system** (for wall mounting into a cabinet), which includes the following parts:

1. Back Panel and its PCB with connections for power and diagnostic modules and hot swapping control circuits;
2. 19" Rack unit, enclosure with guides for inserting modules and microswitches board connected (by flat cable) to the hot swapping control on Back Panel PCB;
3. 6 Power Supply Modules (PSM1250), for each inserting position (Pos.1, Pos.2, Pos.3, Pos.4, Pos.5, Pos.6)
4. Diagnostic module (PSO1250) with TFT color screen for diagnostic information about each power module.

This **Fig.1** can be also used for **PSS1250-HS-7-5/6/7/8/9-D system** (for frontal rack mounting into a cabinet) because this system differs to the previous one only for the rack unit mechanical structure and not for the connections between compo- 1 2 3 4

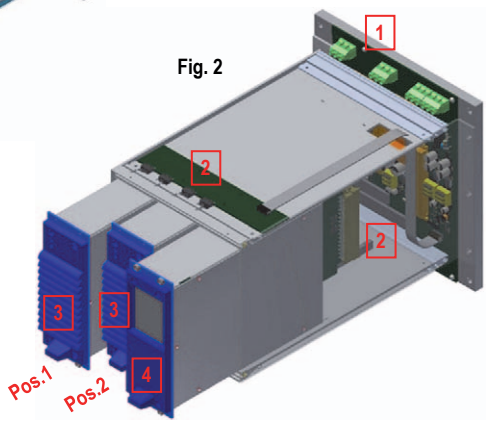


Fig. 2 shows **PSS1250-HS-3-D system**, which includes the following parts:

1. Back Panel and its PCB with connections for power and diagnostic modules and hot swapping control circuits;
2. 9" Rack unit, enclosure with guides for inserting modules and microswitches board connected (by flat cable) to the hot swapping control on Back Panel PCB;
3. 2 Power Supply Modules (PSM1250), for each inserting position (Pos.1, Pos.2)
4. Diagnostic module (PSO1250) with TFT color screen for diagnostic information about each power module.

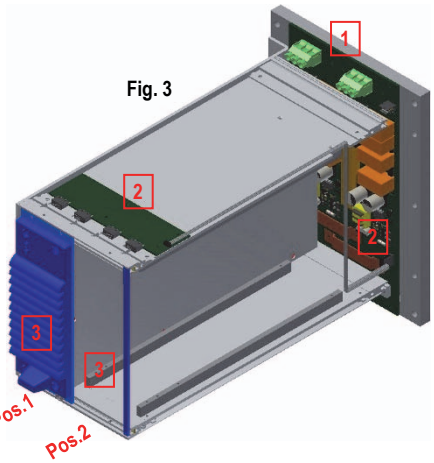
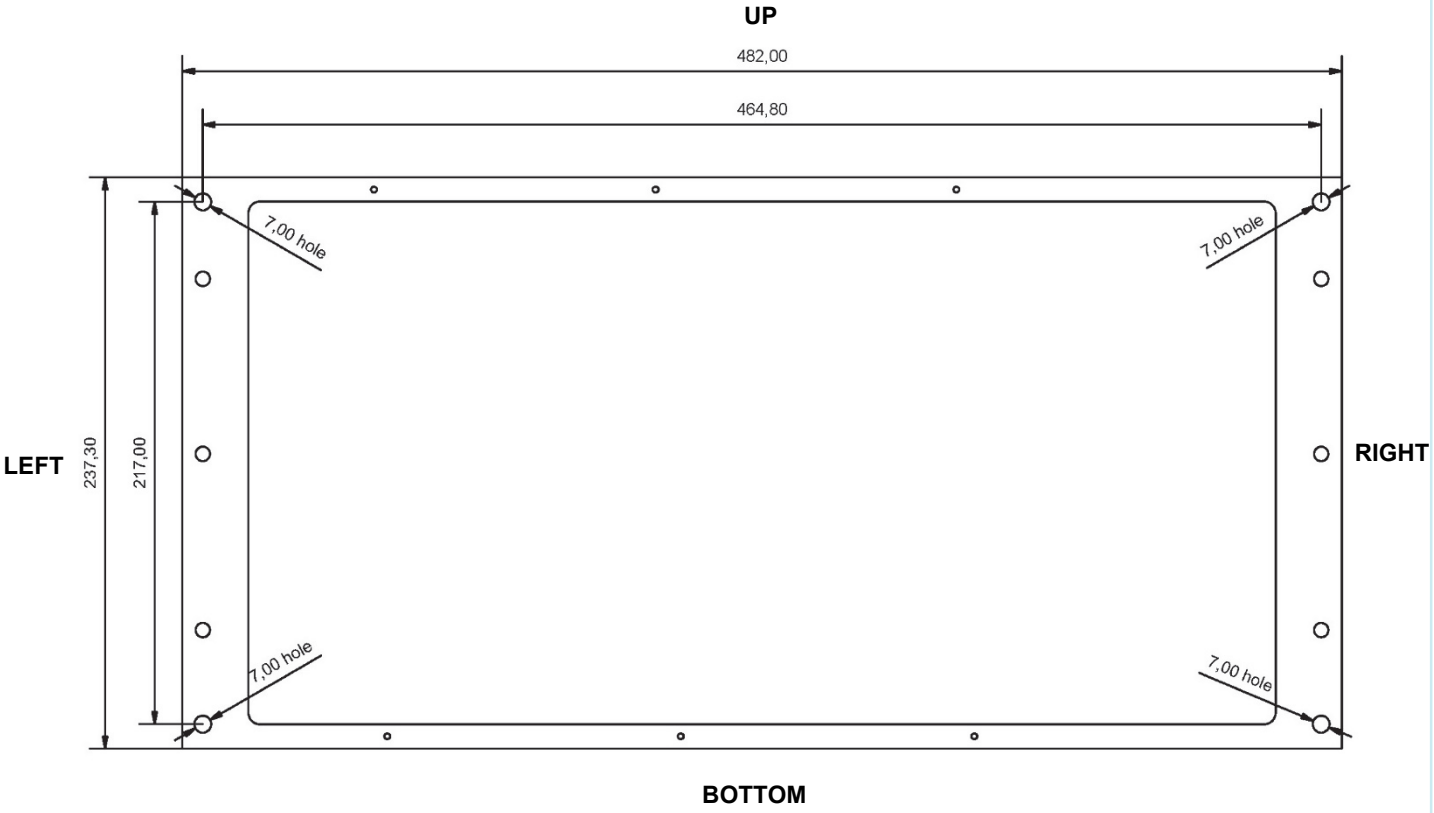


Fig. 3 shows **PSS1250-HS-2 system**, which includes the following parts:

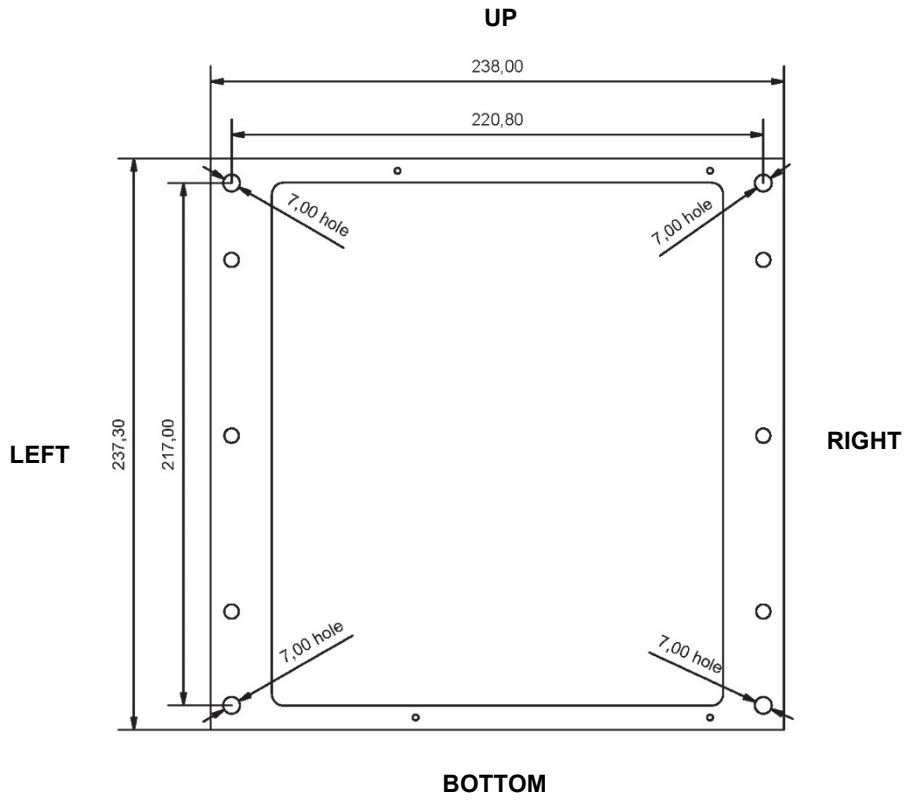
1. Back Panel and its PCB with connections for power and diagnostic modules andhot swapping control circuits;
2. 7" Rack unit, enclosure with guides for inserting modules and microswitches board connected (by flat cable) to the hot swapping control on Back Panel PCB;
3. 2 Power Supply Modules (PSM1250), for each inserting position (Pos.1, Pos.2)

Installation Procedure - 1st step: Back Panel installation for PSS1250-xx-7-0/1/2/3/4-D (for wall mounting into a cabinet)

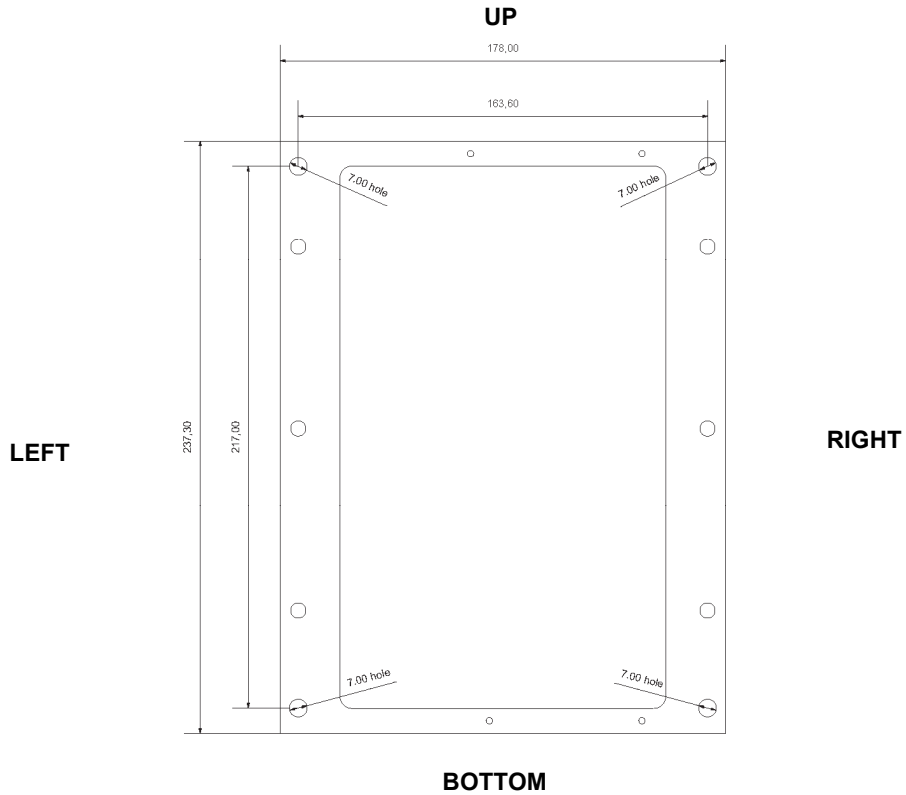
The following drawing with overall dimensions (mm) is only applicable to types: PSS1250-HS-7-0/1/2/3/4-D and PSS1250-7-0/1/2/3/4-D.
The back panel is fixed to a vertical wall into a cabinet by means of four screws through four 7.00 mm diameter holes shown in the drawing.
The back panel must only be installed as oriented in the following drawing. On the back panel is fixed the back panel PCB by means of six screws.



The following drawing with overall dimensions (mm) is only applicable to types: PSS1250-HS-3-D and PSS1250-3-D.
The back panel is fixed to a vertical wall into a cabinet by means of four screws through four 7.00 mm diameter holes shown in the drawing.
The back panel must only be installed as oriented in the following drawing. On the back panel is fixed the back panel PCB by means of six screws.

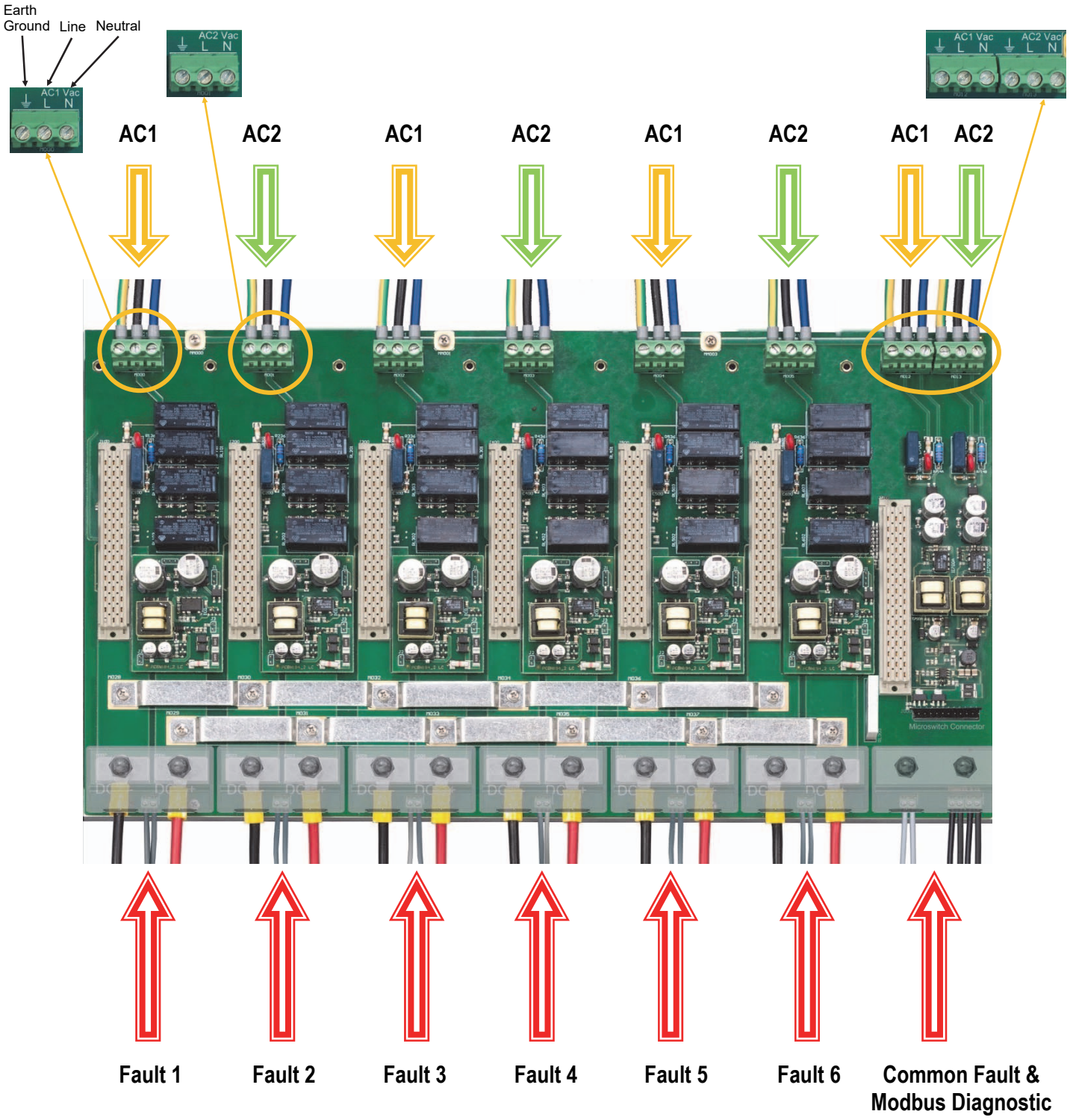


The following drawing with overall dimensions (mm) is only applicable to types: PSS1250-HS-2 and PSS1250-2.
The back panel is fixed to a vertical wall into a cabinet by means of four screws through four 7.00 mm diameter holes shown in the drawing.
The back panel must only be installed as oriented in the following drawing. On the back panel is fixed the back panel PCB by means of six screws.



Installation Procedure - 2nd step: Wiring of AC input lines, faults and modbus terminal blocks on Back Panel PCB of PSS1250-xx-7-x-D

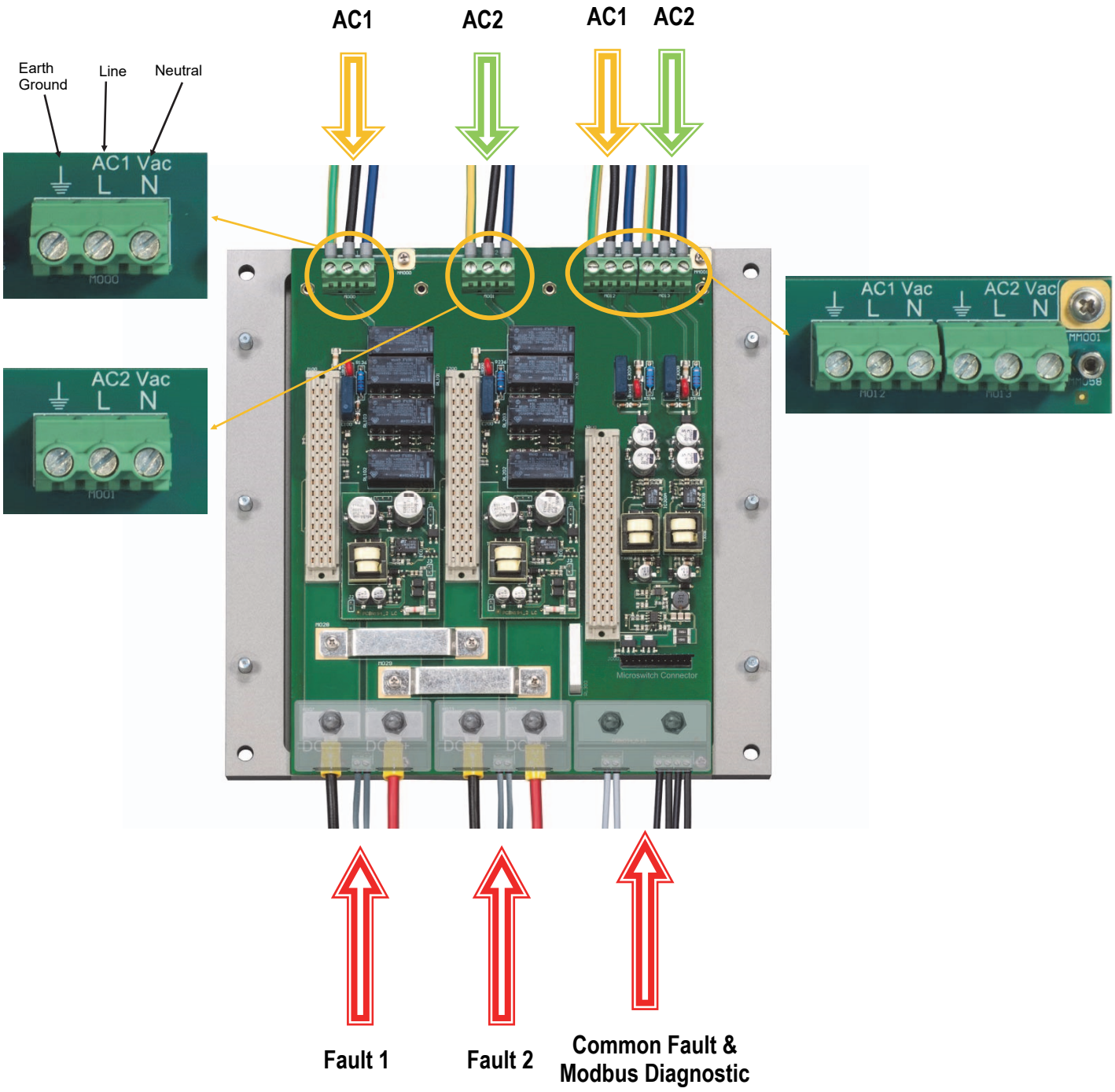
The following picture shows for example the terminal block wiring of PSS1250-HS-7-x-D Back Panel PCB. For PSS1250-7-x-D Back Panel PCB, the terminal block wiring is the same.



The PSS1250 redundant system requires to use two AC input power lines (AC1 and AC2) with different lines and neutrals but the same Earth Ground connection, in order to guarantee fully redundant configuration from the input to the output of power system. For PSS1250(-HS)-7-0 & -7-5 not redundant system, it is not required two AC input power lines.
Each PSM1250 unit slot must receive AC mains by means of a circuit breaker or switch with the following features:
B or C characteristic 20 Amps when nominal low input voltage 110÷120 Vac (±10%) is used;
B or C characteristic 10 Amps when nominal high input voltage 220÷240 Vac (±10%) is used.
Connect AC1 input power line to input terminal blocks of positions N.1, 3, 5 (odd positions) and connect AC2 input power line to input terminal blocks of positions N.2, 4, 6 (even positions). See functional diagrams at pages 8-9-10-11-12 for more information about wiring connection.
The last position on the right is used for PSO1250 diagnostic module, connect both AC1 and AC2 input power lines to related terminal blocks in order to guarantee continuous operation of diagnostic module even after shutdown of one AC input line. The PSO1250 unit slot must receive AC1 and AC2 mains by means of a circuit breaker or switch with the following features: B or C characteristic 0.5 Amps when input voltage nominal range 110÷240 Vac (±10%) is used.
For AC input terminal blocks, use a cable section range from 14AWG (or 2 mm^2) to 11AWG (or 4 mm^2) and tighten terminal block screws with maximum 0.6 Nm torque.
For all configurations except PSS1250(-HS)-7-0 & -7-5, fault contact output (of each PSM1250 or common of PSO1250) and Modbus terminal blocks, use a cable section range from 20AWG (or 0.5 mm^2) to 15AWG (or 1.5 mm^2) and tighten terminal block screws with maximum 0.25 Nm torque. Only for PSS1250(-HS)-7-0 & -7-5, for fault contact output (of each PSM1250 or common of PSO1250) use a cable section range from 30AWG (or 0.05 mm^2) to 16AWG (or 1.3 mm^2) on push-in spring connection terminal blocks. For Modbus terminal blocks, use a cable section range from 20AWG (or 0.5 mm^2) to 15AWG (or 1.5 mm^2) and tighten terminal block screws with maximum 0.25 Nm torque.

AC line internal fuses are not user replaceable. The unit cannot be repaired by the end user and must be returned to the manufacturer or his authorized representative.

The following picture shows for example the terminal block wiring of PSS1250-HS-3-D Back Panel PCB. For PSS1250-3-D Back Panel PCB, the terminal block wiring is the same.



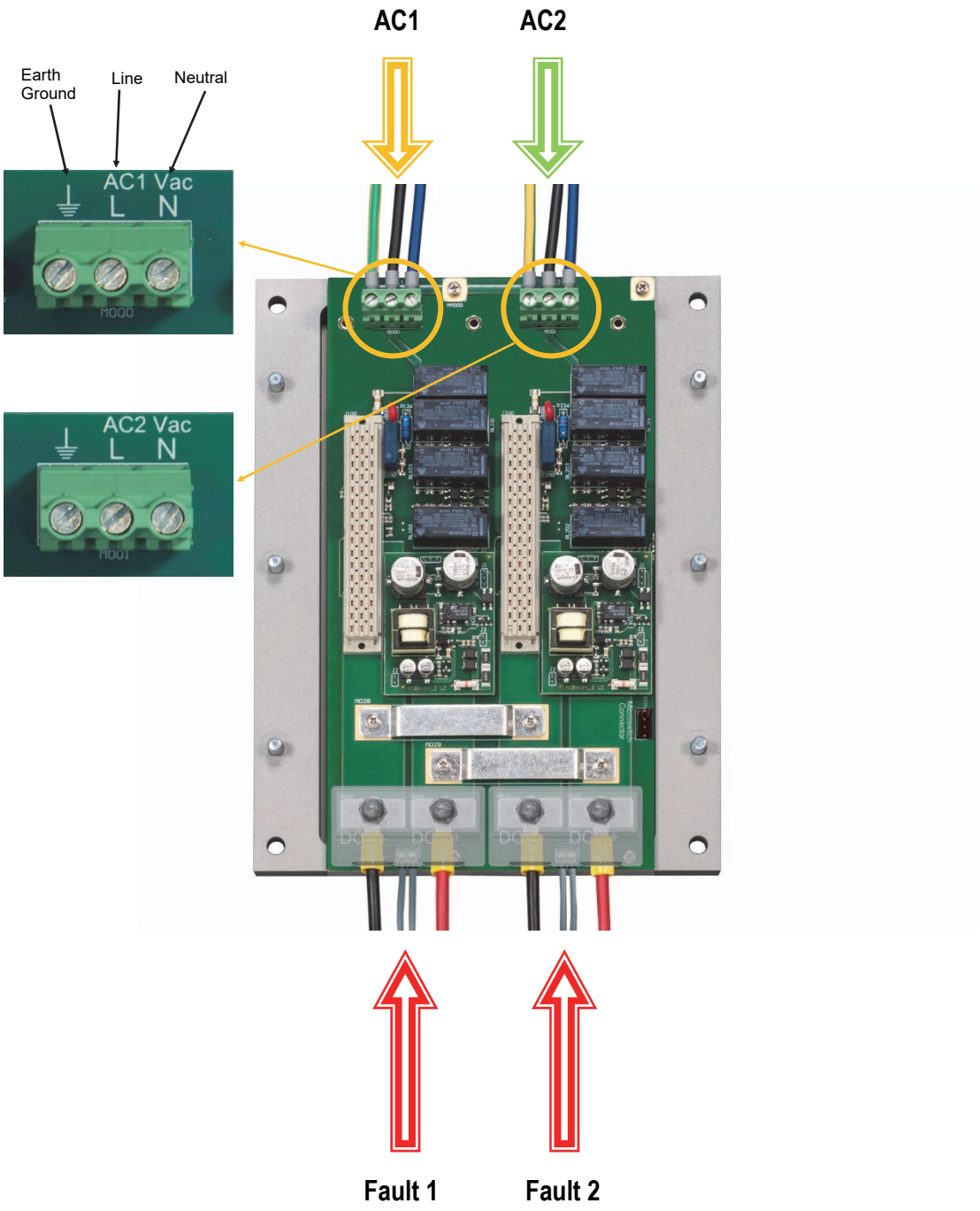
The PSS1250 redundant system requires to use two AC input power lines (AC1 and AC2) with different lines and neutrals but the same Earth Ground connection, in order to guarantee fully redundant configuration from the input to the output of power system.

Each PSM1250 unit slot must receive AC mains by means of a circuit breaker or switch with the following features:
B or C characteristic 20 Amps when nominal low input voltage 110÷120 Vac (±10%) is used;
B or C characteristic 10 Amps when nominal high input voltage 220÷240 Vac (±10%) is used.
Connect AC1 input power line to input terminal blocks of positions N.1 (odd position) and connect AC2 input power line to input terminal blocks of position N.2 (even position).
See functional diagrams at page 13 for more information about wiring connection.
The last position on the right is used for PSO1250 diagnostic module, connect both AC1 and AC2 input power lines to related terminal blocks in order to guarantee continuous operation of diagnostic module even after shutdown of one AC input line. The PSO1250 unit slot must receive AC1 and AC2 mains by means of a circuit breaker or switch with the following features: B or C characteristic 0.5 Amps when input voltage nominal range 110÷240 Vac (±10%) is used.

For AC input terminal blocks, use a cable section range from 14AWG (or 2 mm^2) to 11AWG (or 4 mm^2) and tighten terminal block screws with maximum 0.6 Nm torque.
For fault contact output (of each PSM1250 or common of PSO1250) and Modbus terminal blocks, use a cable section range from 20AWG (or 0.5 mm^2) to 16AWG (or 1.5 mm^2) and tighten terminal block screws with maximum 0.25 Nm torque.

AC line internal fuses are not user replaceable. The unit cannot be repaired by the end user and must be returned to the manufacturer or his authorized representative.

The following picture shows for example the terminal block wiring of PSS1250-HS-2 Back Panel PCB. For PSS1250-2 Back Panel PCB, the terminal block wiring is the same.



The PSS1250 redundant system requires to use two AC input power lines (AC1 and AC2) with different lines and neutrals but the same Earth Ground connection, in order to guarantee fully redundant configuration from the input to the output of power system.

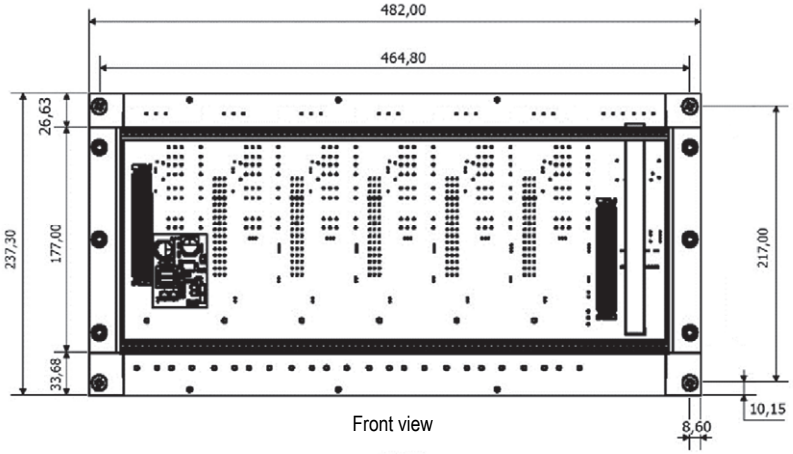
Each PSM1250 unit slot must receive AC mains by means of a circuit breaker or switch with the following features:
B or C characteristic 20 Amps when nominal low input voltage 110÷120 Vac (±10%) is used;
B or C characteristic 10 Amps when nominal high input voltage 220÷240 Vac (±10%) is used.
Connect AC1 input power line to input terminal blocks of positions N.1 (odd position) and connect AC2 input power line to input terminal blocks of position N.2 (even position).
See functional diagrams at page 14 for more information about wiring connection.

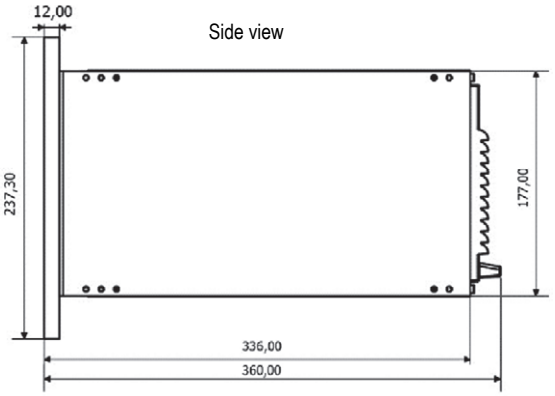
For AC input terminal blocks, use a cable section range from 14AWG (or 2 mm^2) to 11AWG (or 4 mm^2) and tighten terminal block screws with maximum 0.6 Nm torque.
For fault contact output (of each PSM1250), use a cable section range from 20AWG (or 0.5 mm^2) to 16AWG (or 1.5 mm^2) and tighten terminal block screws with maximum 0.25 Nm torque.

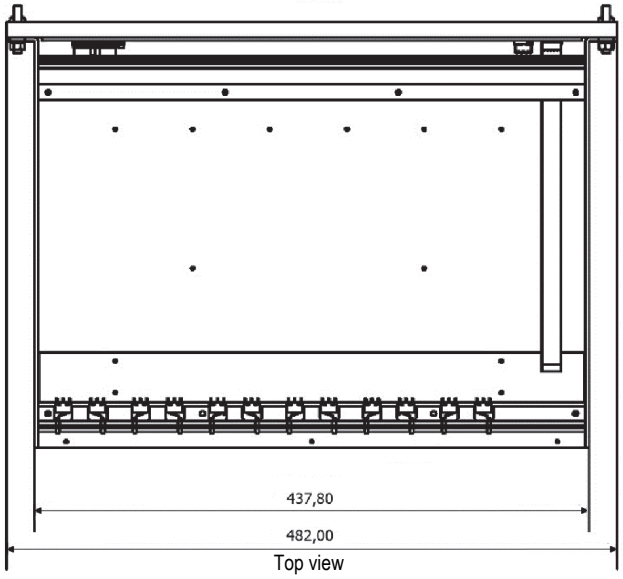
AC line internal fuses are not user replaceable. The unit cannot be repaired by the end user and must be returned to the manufacturer or his authorized representative.

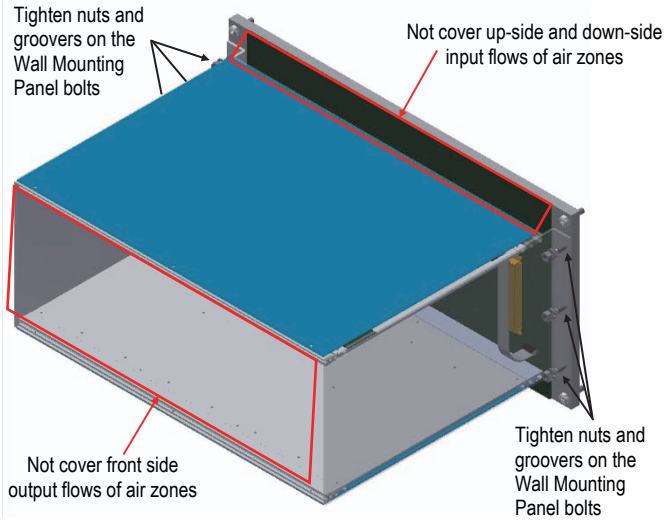
Installation Procedure - 3rd step: Rack unit installation on Back Plane for PSS1250-xx-7-0/1/2/3/4-D (for wall mounting into a cabinet)

The following drawing shows overall dimensions (mm) of PSS1250-xx-7-0/1/2/3/4-D, with Rack unit mounted on related Back Plane with its PCB.
Fix the Rack unit to 6 wall mounting panel bolts (3 on the right side and 3 on the left side) by means of 6 M6 nuts and groovers.



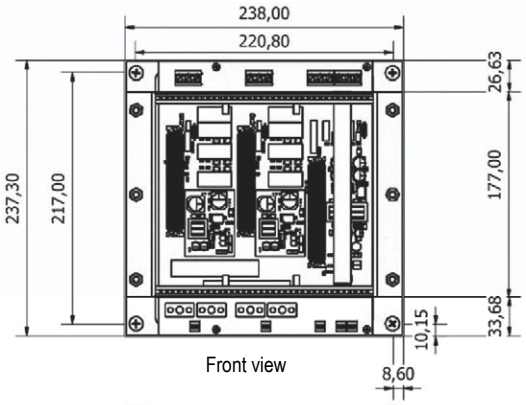


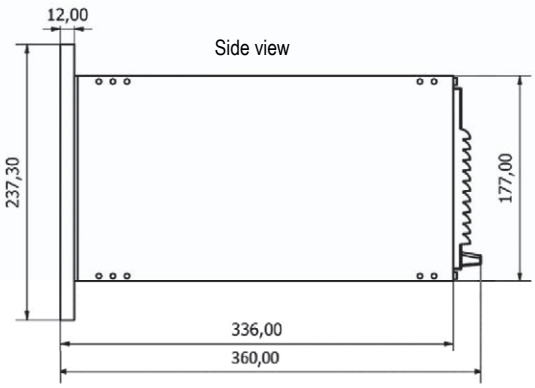


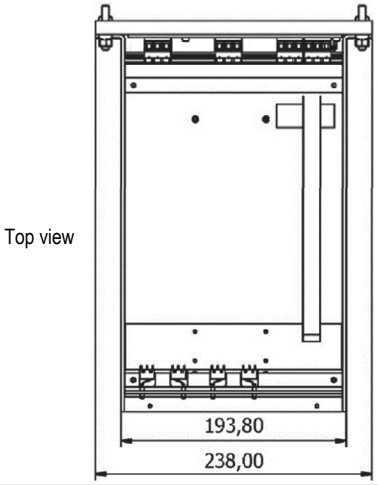


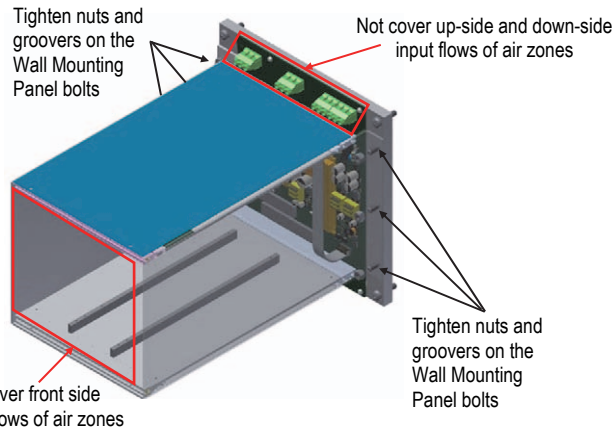
Installation Procedure - 3rd step: Rack unit installation on Back Plane for PSS1250-xx-3-D (for wall mounting into a cabinet)

The following drawing shows overall dimensions (mm) of PSS1250-xx-3-D, with Rack unit mounted on related Back Plane with its PCB.
Fix the Rack unit to 6 wall mounting panel bolts (3 on the right side and 3 on the left side) by means of 6 M6 nuts and groovers.



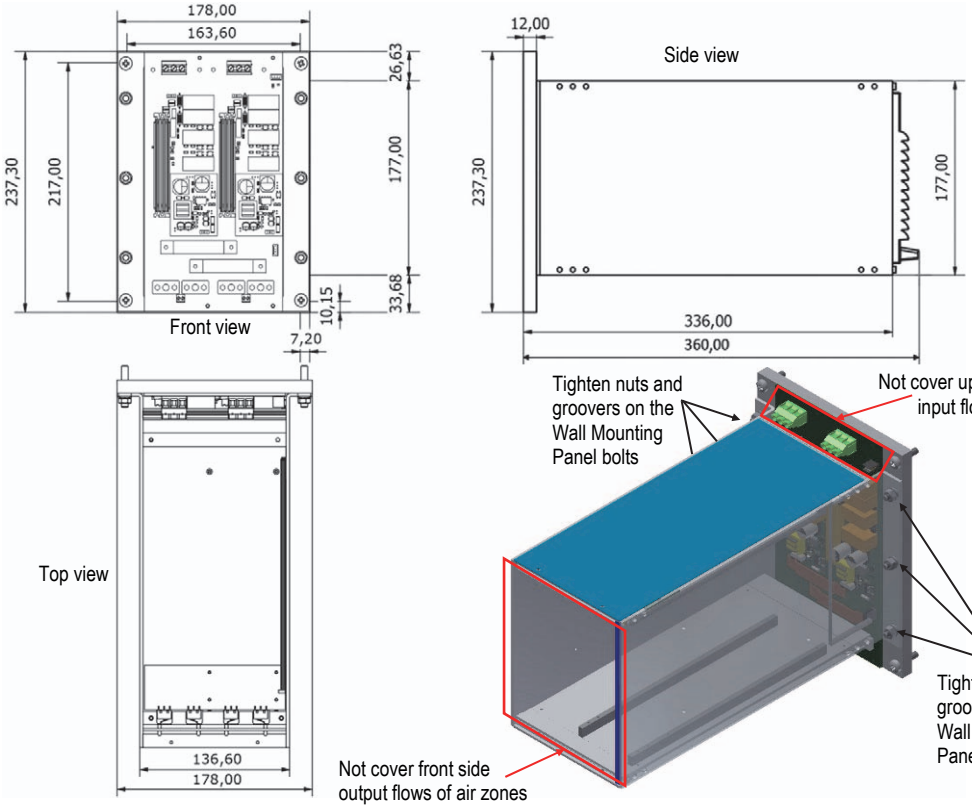






Installation Procedure - 3rd step: Rack unit installation on Back Plane for PSS1250-xx-2 (for wall mounting into a cabinet)

The following drawing shows overall dimensions (mm) of PSS1250-xx-2, with Rack unit mounted on related Back Plane with its PCB.
Fix the Rack unit to 6 wall mounting panel bolts (3 on the right side and 3 on the left side) by means of 6 M6 nuts and groovers.



Installation Procedure - 3rd step: Installation of PSS1250-xx-7-5/6/7/8/9-D (for frontal rack mounting into a cabinet)

The following drawing shows overall dimensions (mm) of PSS1250-xx-7-5/6/7/8/9-D, where Rack unit and Back Plane with its PCB are already fixed together.
Fix the PSS1250 to the rack rails of a cabinet, as frontal rack mounting, matching 4 holes of Rack unit lugs (2 on the right side lug and 2 on the left side lug) with rail holes and fixing with 4 screws and related nuts.

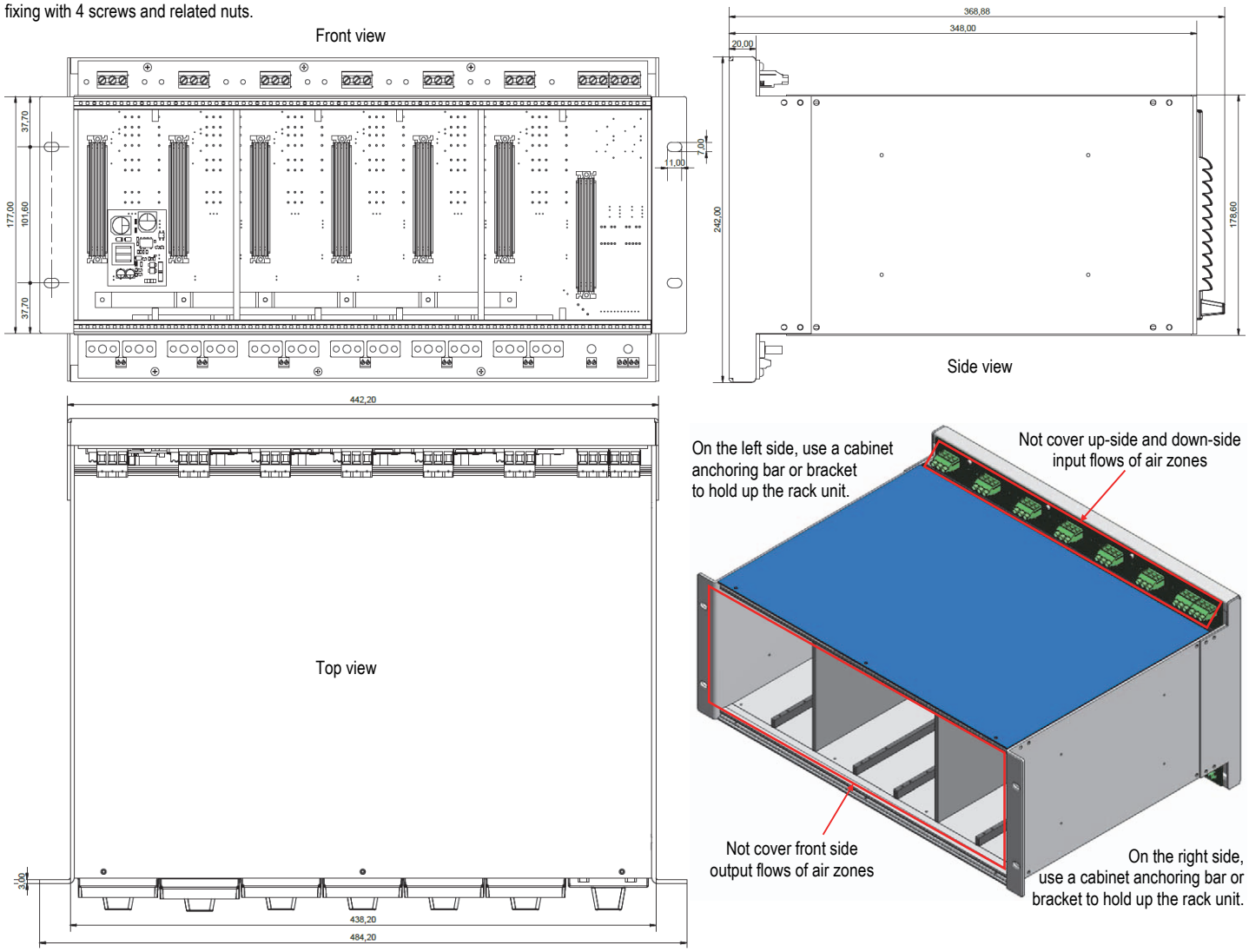


Fig. 7 shows PSS1250-HS-7-x-D or PSS1250-HS-3-D Back Panel PCB with a 12 poles male connector, which must be connected with the flat cable coming from the microswitches PCB of the Rack unit. In the **Fig. 4-5-6-7** is shown how to connect this flat cable for PSS1250-HS-7-x-D or PSS1250-HS-3-D system.

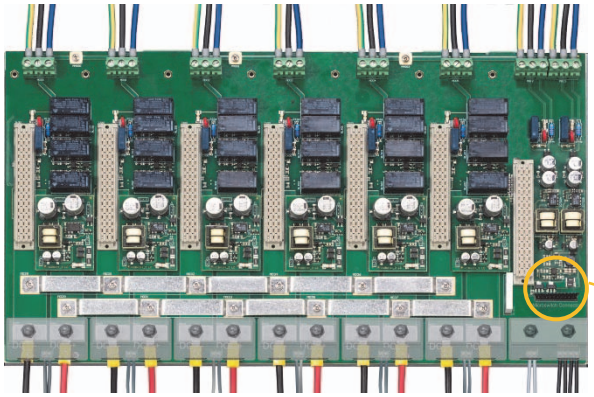
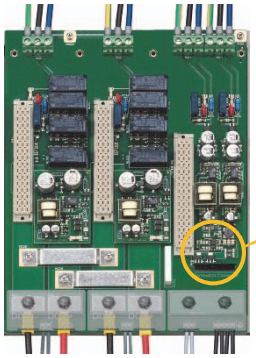


Fig. 4



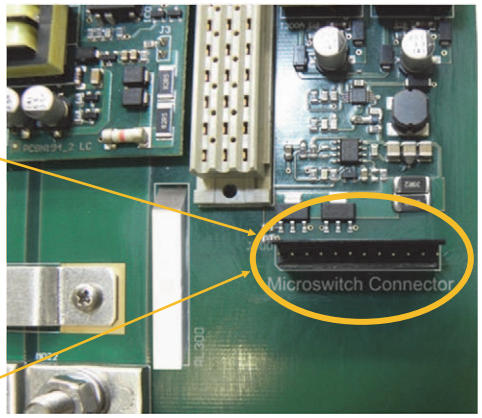


Fig. 5

During installation of the PSS1250-HS-7-x-D or PSS1250-HS-3-D, connect the flat cable, coming from the microswitches PCB of the Rack unit, to the 12 poles male connector on Back Panel PCB, as shown in **Fig. 6-7**.

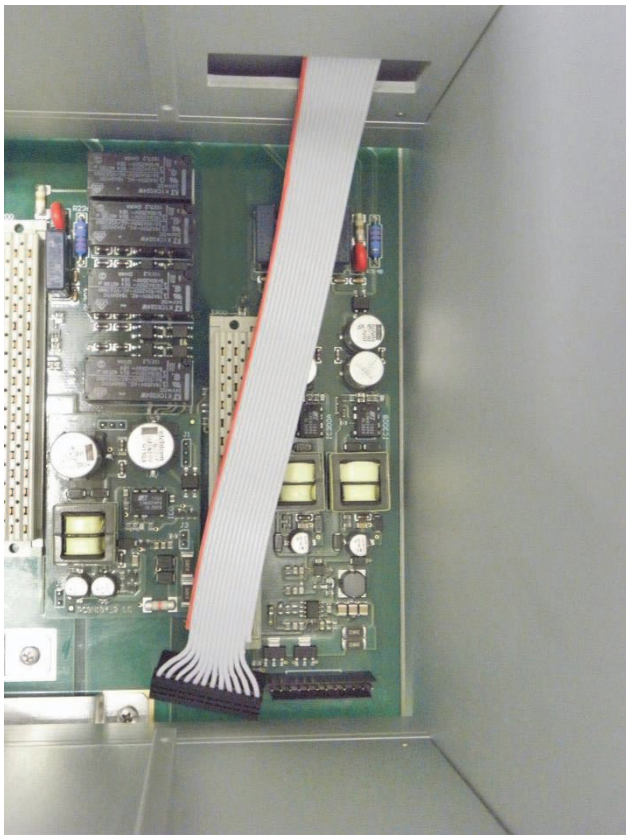


Fig. 6

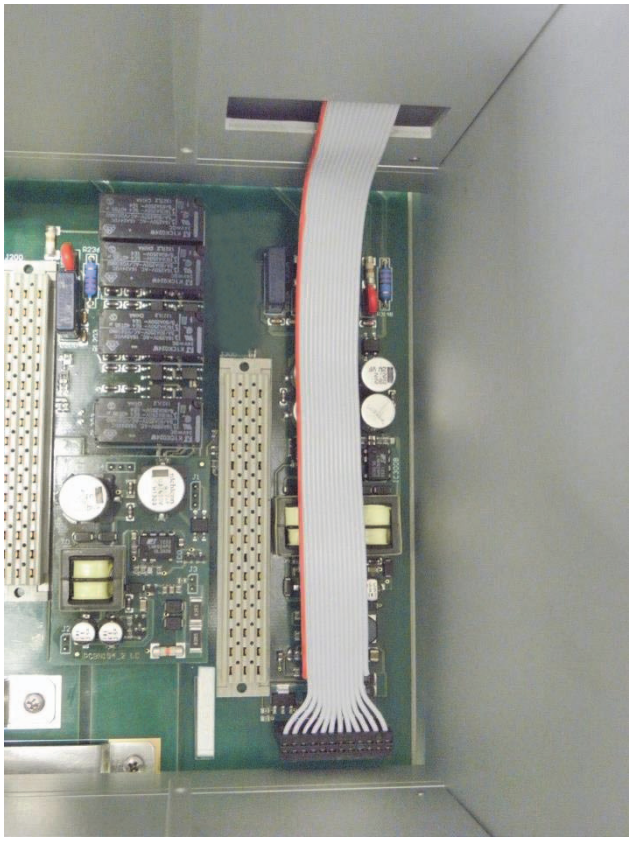


Fig. 7

Fig. 11 shows PSS1250-HS-2 Back Panel PCB with a 4 poles male connector, which must be connected with the flat cable coming from the microswitches PCB of the Rack unit.
In the **Fig. 8-9-10-11** is shown how to connect this flat cable for PSS1250-HS-2 system.

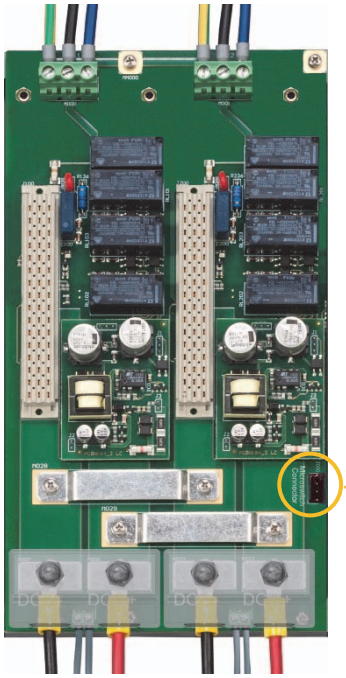


Fig. 8

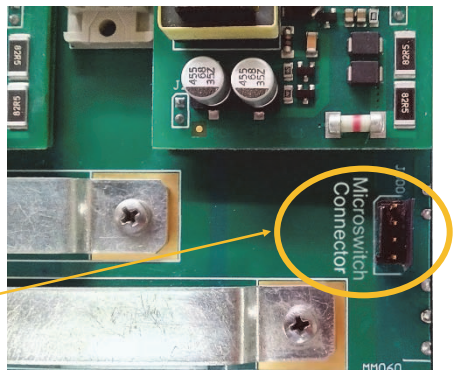


Fig. 9

During installation of the PSS1250-HS-2, connect the flat cable, coming from the microswitches PCB of the Rack unit, to the 4 poles male connector on Back Panel PCB, as shown in **Fig. 10-11**.

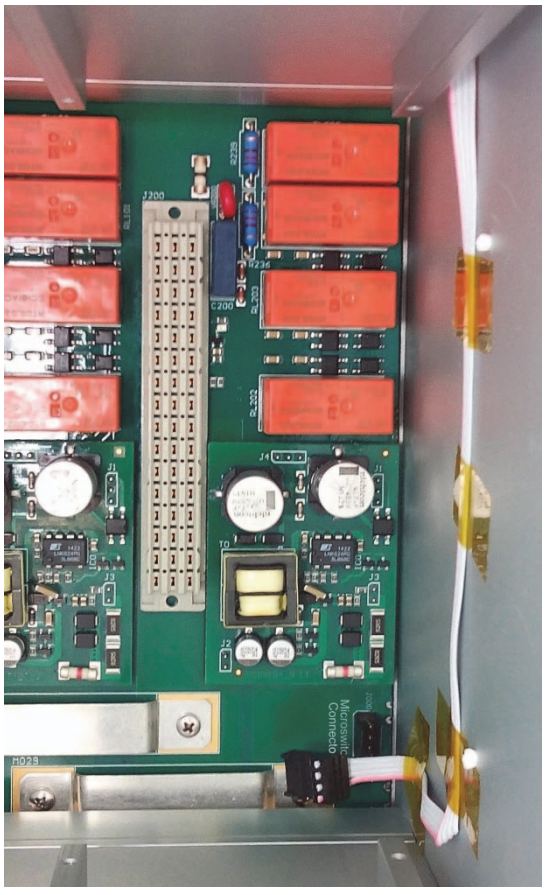


Fig. 10

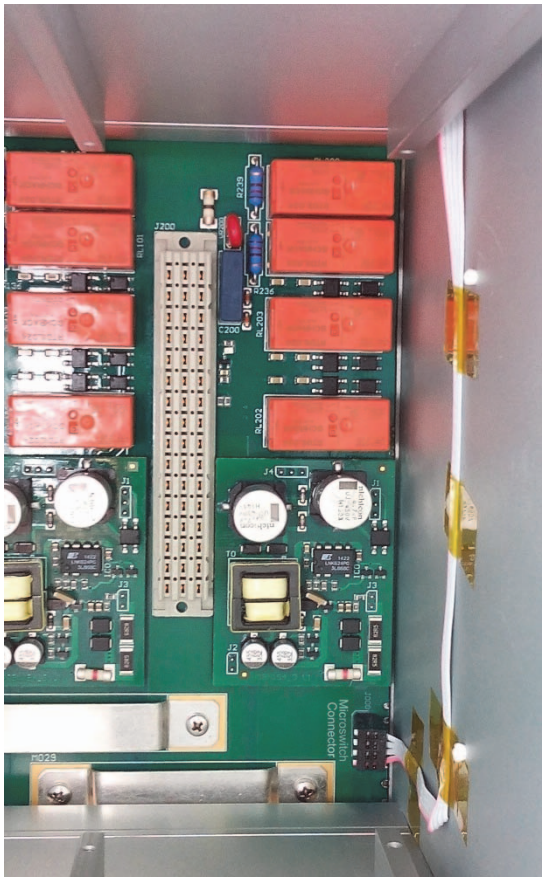
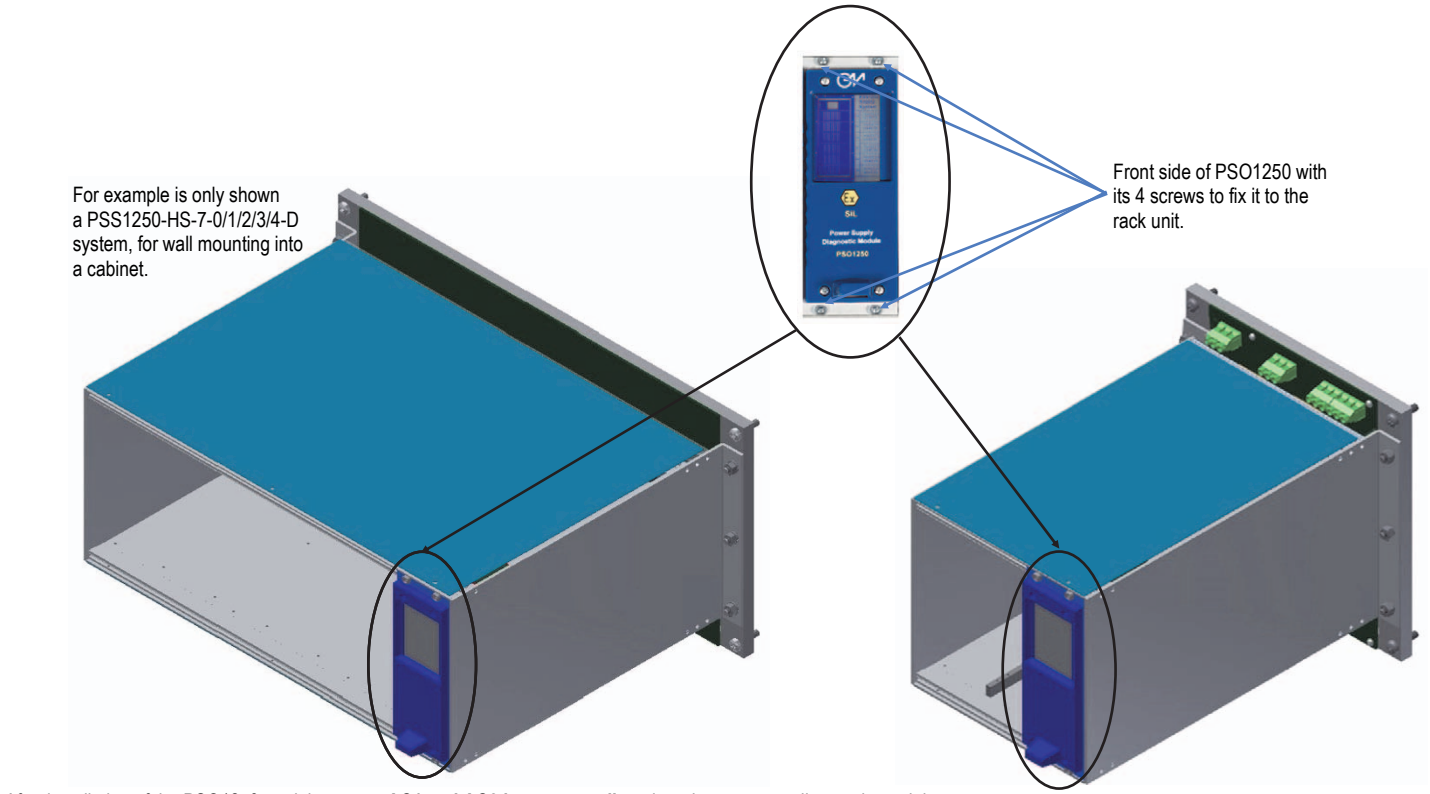


Fig. 11

Installation Procedure - 4th step (for models with HS) - Section B: Installation and start up of PSO1250 Diagnostic Module (only for PSS1250-HS-7-x-D or PSS1250-HS-3-D)

Only for 19" and 9" Rack unit (PSS1250-HS-7-x-D and PSS1250-HS-3-D), insert the PSO1250 diagnostic module in the last postion on the right of the Rack unit and fix the module to the Rack unit by means of its 4 screws on its front side.



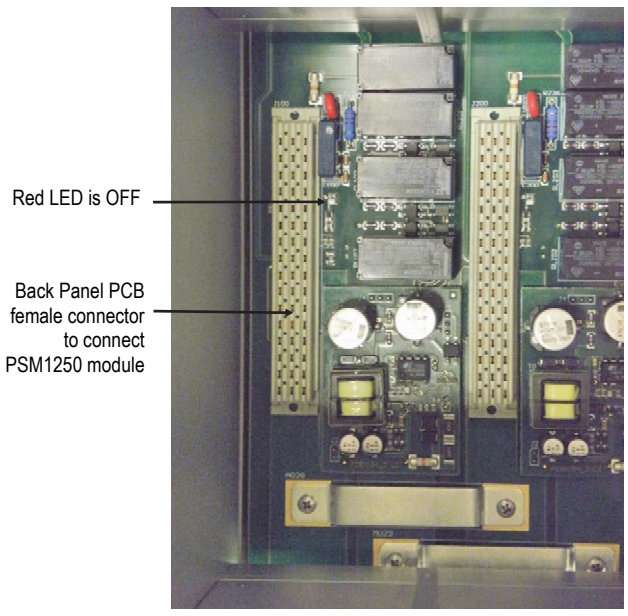
After installation of the PSO1250 module, **power AC1 and AC2 input power lines** in order to turn on diagnostic module.
For more information about diagnostic module features and its set up, please see description from page 52.

Installation Procedure - 4th step (for models with HS) - Section C: HSC red LED signalling test (for all PSS1250-HS systems)

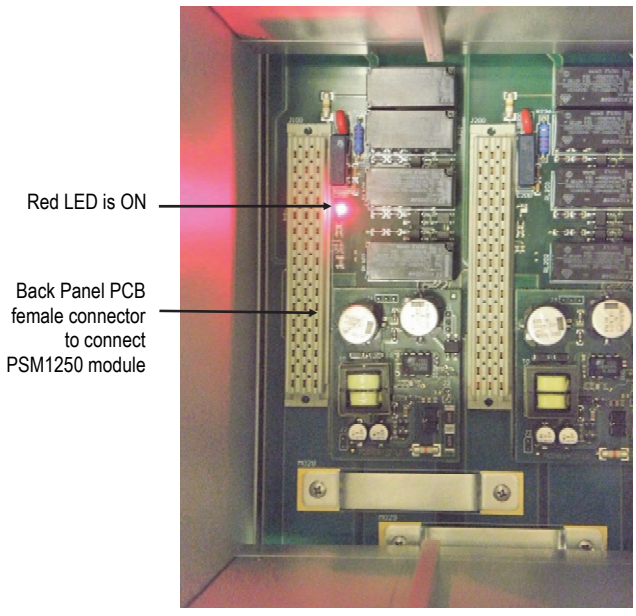
Independently from installation or not of the PSO1250 module, for PSS1250-HS-7-x-D or PSS1250-HS-3-D or PSS1250-HS-2 system, **power AC1 and AC2 input power lines** anyway.

Each Hot Swapping Control (HSC) circuit (one for each PSM1250 position) is supplied from AC1 or AC2 input line.
The Hot Swapping Control circuit controls if PSM1250 can be installed and fixed to the Rack unit.
If no PSM1250 module is installed and fixed into the Rack unit, no Hot Swapping Control circuit can give input power lines to the Back Panel PCB female connector. In this condition, each red LED must be OFF.
If a red LED is ON, it means that related Hot Swapping Control circuit is not correctly operating and therefore no PSM1250 module shall be insert and fixed into its Rack position.

PSM1250 module can be installed and fixed into the Rack unit only if corresponding Back Panel PCB red LED is OFF.



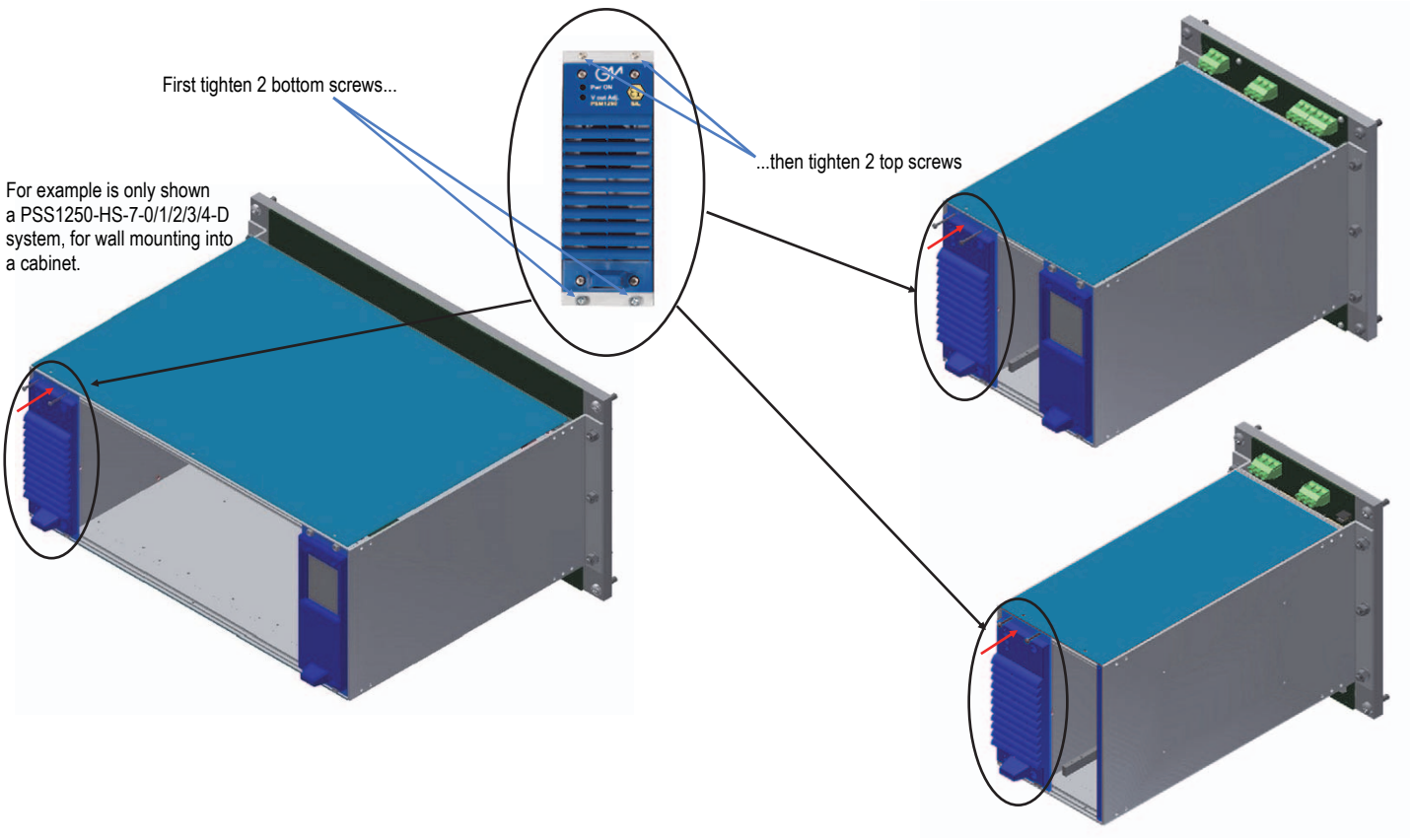
Normal condition: the red LED is OFF.
The PSM1250 module can be installed and fixed into the Rack unit position.

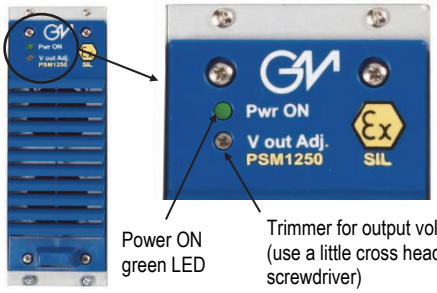


Dangerous condition: the red LED is ON.
The PSM1250 module must not be installed.

AC1 and AC2 input power lines are powered. Therefore PSM1250 module can be installed and fixed into the Rack unit only if corresponding back panel red LED is OFF.
The following procedure is split in **3 sub-steps** and it is the same for each PSM1250, independently from its position in the Rack unit.
Starting from position 1 to position 6 (for PSS1250-HS-7-x-D) or 2 (for PSS1250-HS-3-D and PSS1250-HS-2), execute pre-start up of each PSM1250 module.

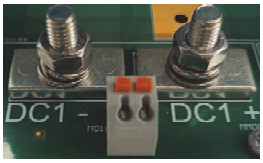
1st sub-step: insert and fix the PSM1250 module into the Rack unit by means of its 4 screws on its front side. Two of them in the bottom part are only used for mechanical purpose; the other two, in the top part, when completely tightened, close the microswitches and enable the hot swap control circuit to provide input power lines to PSM1250 module by Back Panel PCB female connector. First of all, tighten 2 bottom screws and then tighten 2 top ones.





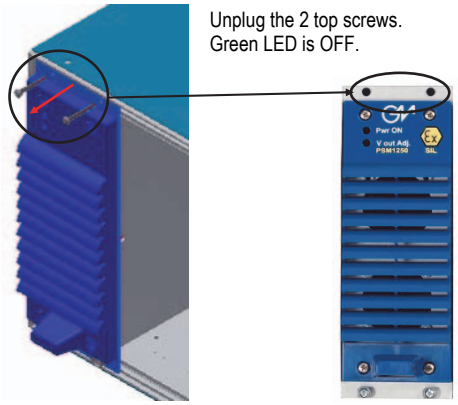
2nd sub-step: with PSM1250 module powered, its front panel Power ON green LED is ON and 24 Vdc (factory setting) output voltage is present on PSM1250 screw output terminals DC- and DC+ (see page 7 for more information about Power ON green LED signalling).
Only for 19" and 9" rack (PSS1250-HS-7-x-D and PSS1250-HS-3-D), on the TFT color screen of PSO1250 diagnostic module it is possible to monitor the PSM1250 module status and to collect information about the power supply: for example output voltage value (see description from page 52). If no PSO1250 diagnostic module is present or for PSS1250-HS-2 system, the output voltage can be measured on PSM1250 screw output terminals by means of a multimeter.
If it is required to set an output voltage value different from factory setting (24 Vdc), use the trimmer for output voltage adjusting. Turn the trimmer clockwise (to the right) to increase output voltage (max. 28 Vdc) or turn the trimmer counterclockwise (to the left) to decrease output voltage (min. 21 Vdc).
Warning: for correct current sharing operation (not applicable on PSS1250(-HS)-7-0 & -7-5), power supply modules must have output voltages calibrated within ± 0.5 V.

For all configurations except PSS1250(-HS)-7-0 & -7-5
PSM1250 screw output terminals on copper bars:
DC- is negative out pole,
DC+ is positive out pole.
(in the figure it's shown DC1- and DC1+ which are related to PSM1250 in position 1 of PSS1250 system).



Only for PSS1250(-HS)-7-0 & -7-5
PSM1250 screw output terminals on copper bars:
DC- is negative out pole,
DC+ is positive out pole.
(in the figure it's shown DC1- and DC1+ which are related to PSM1250 in position 1 of PSS1250 system).

3rd sub-step: after having adjusted PSM1250 output voltage, shut down the power module unplugging the 2 top screws in order to repeat **sub-steps 1 to 3** procedure for other modules and complete the setting for all PSM1250 of PSS1250 power system.



At this step, only for 19" and 9" rack (PSS1250-HS-7-x-D and PSS1250-HS-3-D) PSO1250 diagnostic module is installed and fixed to rack unit with 4 screws, while each PSM1250 power module is installed and fixed to rack unit with **2 bottom screws only** (2 top screws are unplugged to keep PSM1250 shutdown).
Unpower AC1 and AC2 input power lines (also PSO1250 will turn off) before starting the wiring of bottom screw output terminals on copper bars (DC output lines) of Back Panel PCB.

To wire bottom screw output terminals on copper bars (DC output lines: DC- is negative out pole, DC+ is positive out pole), see **Fig. 12-13-14-15-16**, where DC1- and DC1+ are shown, related to PSM1250 in position 1 of PSS1250 system.
For PSS1250-HS-7-x-D, see functional diagrams at pages 8-9-10-11-12 for more information about wiring connection.
For PSS1250-HS-3-D, see functional diagrams at page 13 for more information about wiring connection.
For PSS1250-HS-2, see functional diagrams at page 14 for more information about wiring connection.

For all configurations except PSS1250(-HS)-7-0 & -7-5

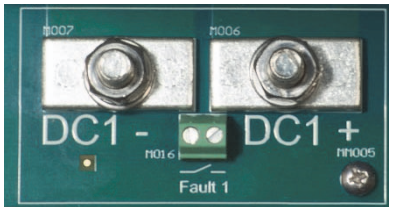


Fig. 12

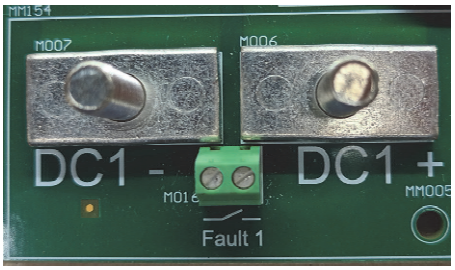


Fig. 13

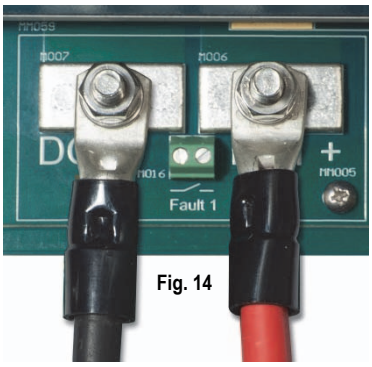
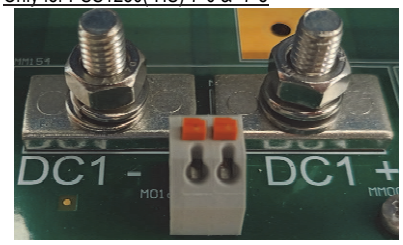


Fig. 14

Only for PSS1250(-HS)-7-0 & -7-5



Unplug M6 nuts, groovers and washers. Then insert a cable lug (at least 6.5 mm hole diameter) with wire, washer and groover on each screw output terminal. Finally tighten nut to fix wire.

For DC screw output terminals, use a cable section range from 6AWG (or 13 mm^2) to 5AWG (or 16 mm^2) and tighten M6 nut+groover+washer on screw with maximum 4 Nm torque.

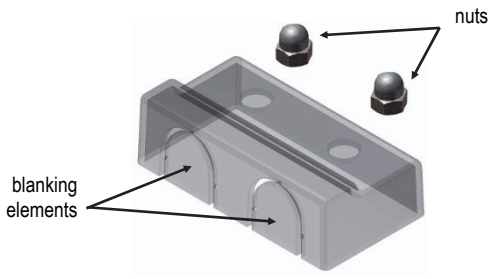


Fig. 15

A polycarbonate cover is used for IP20 to protect each couple of screw output terminals. Break two preformed blanking elements to allow cable passage. Then insert and fix the cover on couple of screw output terminals by means of M6 nylon-capped lock nut.

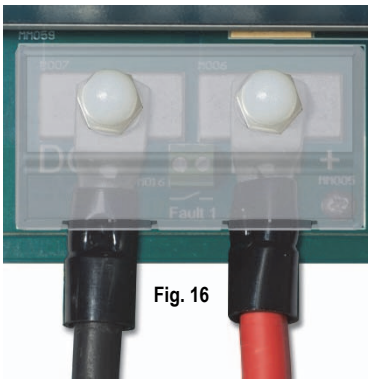


Fig. 16

After having wired all DC output lines, starting from position 1 to position 6 (for PSS1250-HS-7-x-D) or 2 (for PSS1250-HS-3-D and PSS1250-HS-2), tighten 2 top screws as shown in **Fig. 17**.

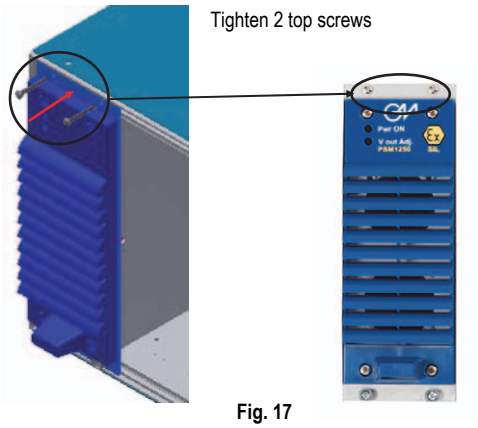
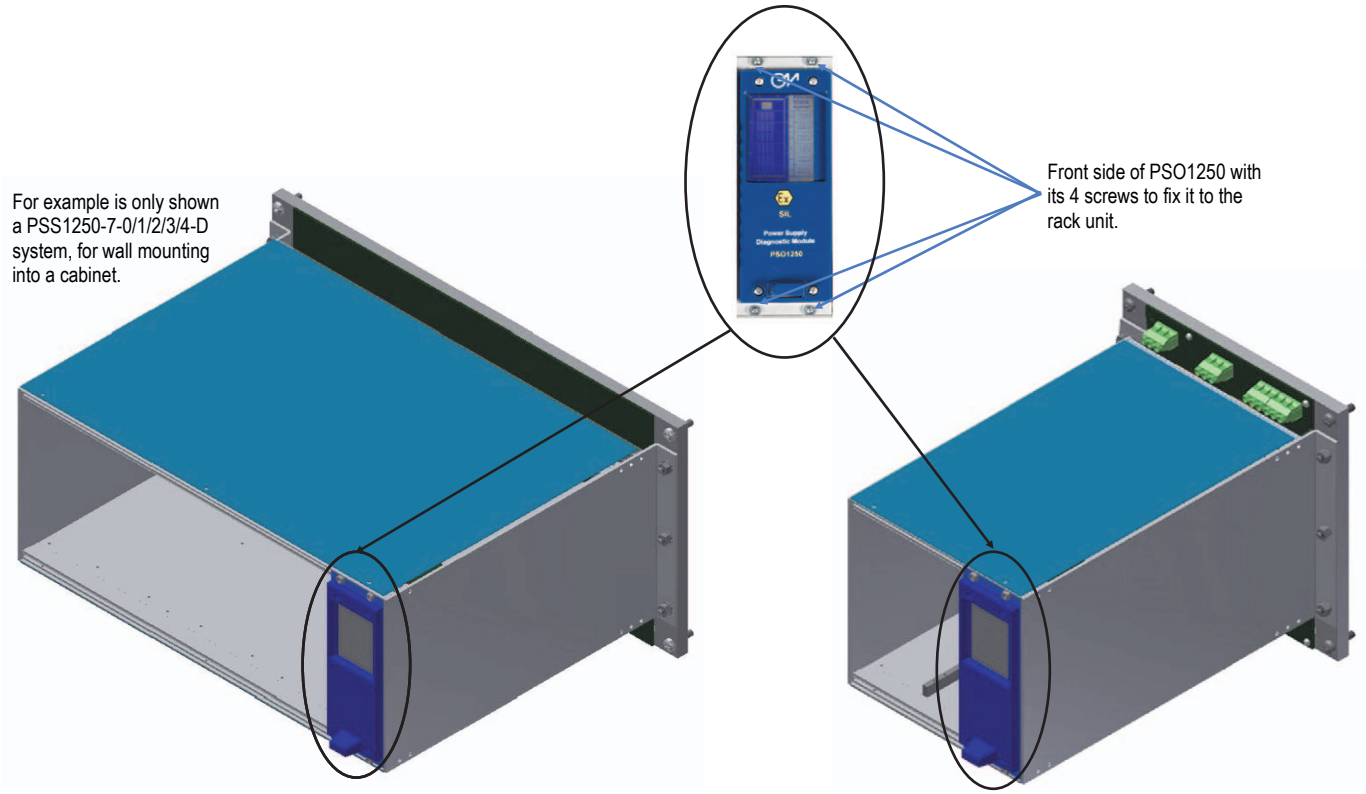


Fig. 17

Now **power AC1 and AC2 input power lines**. PSO1250 diagnostic module (if it's present) and each PSM1250 power module turn on and the DC output lines power the load.

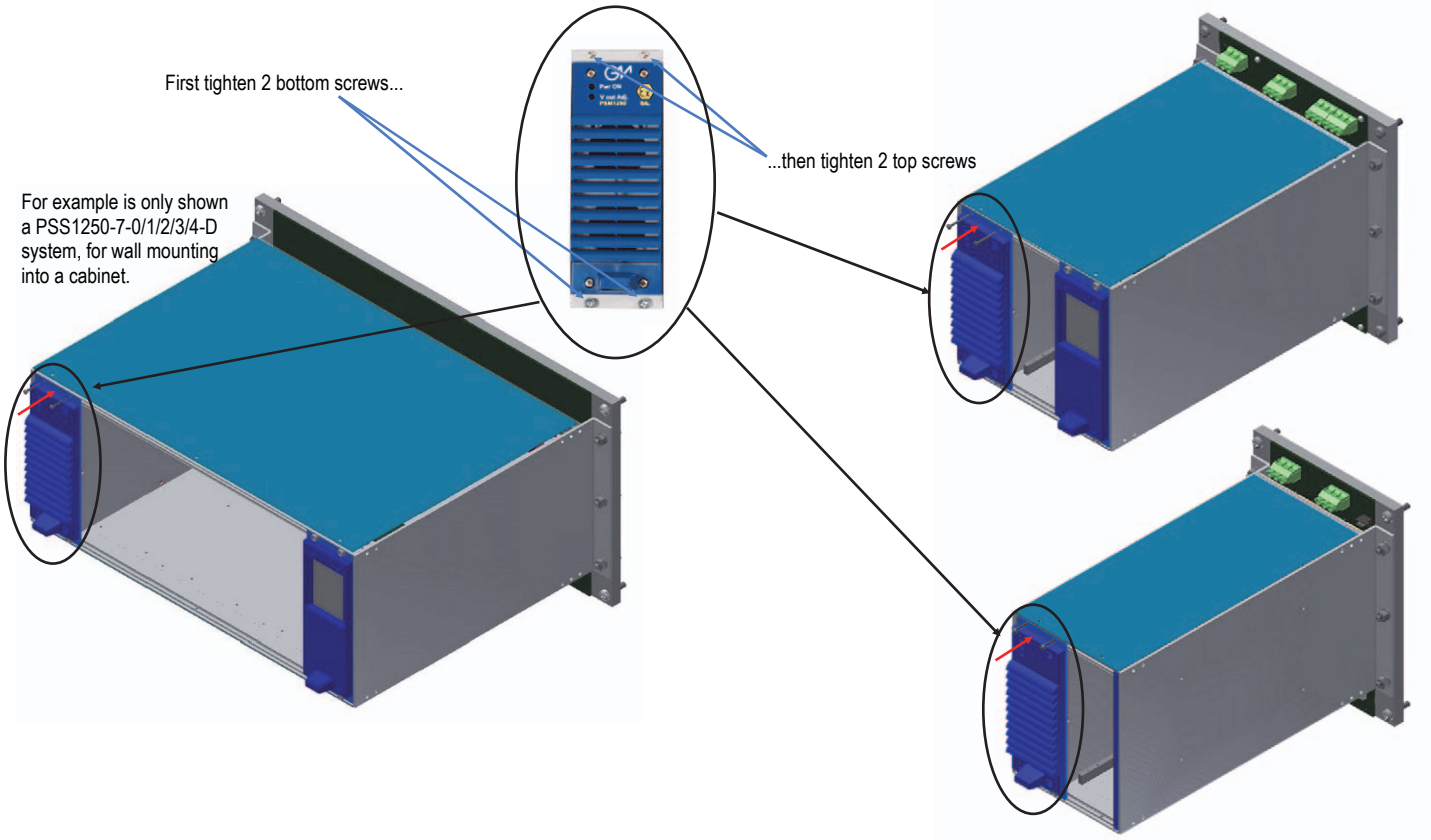
Only for 19" and 9" Rack unit (PSS1250-7-x-D and PSS1250-3-D), insert the PSO1250 diagnostic module in the last postion on the right of the Rack unit and fix the module to the Rack unit by means of its 4 screws on its front side.

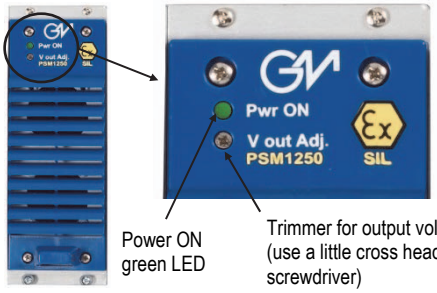


After installation of the PSO1250 module, **power AC1 and AC2 input power lines** in order to turn on the diagnostic module.
For more information about diagnostic module features and its set up, please see description from page 52.
After setting up the PSO1250 module, **unpower AC1 and AC2 input power lines**.

AC1 and AC2 input power lines are unpowered.
The following procedure is split in **3 sub-steps** and it is the same for each PSM1250, independently from its position in the Rack unit.
Starting from position 1 to position 6 (for PSS1250-7-x-D) or 2 (for PSS1250-3-D and PSS1250-2), execute pre-start up of each PSM1250 module.

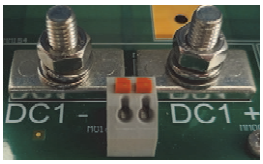
1st sub-step: insert and fix the PSM1250 module into the Rack unit by means of its 4 screws on its front side.





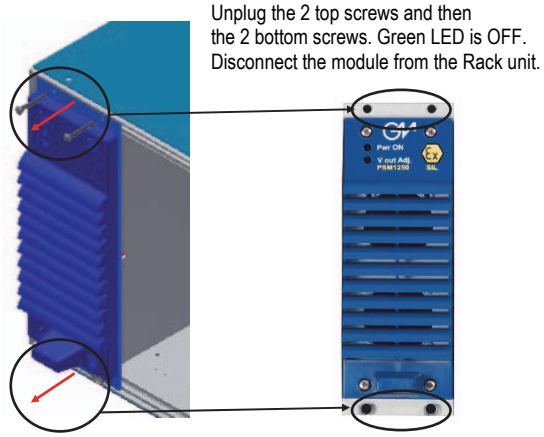
2nd sub-step: **powering AC1 and AC2 input power lines**, PSM1250 module is turned on, its front panel Power ON green LED is ON and 24 Vdc (factory setting) output voltage is present on PSM1250 screw output terminals DC- and DC+ (see page 7 for more information about Power ON green LED signalling).
Only for 19" and 9" rack (PSS1250-7-x-D and PSS1250-3-D), on the TFT color screen of PSO1250 diagnostic module it is possible to monitor the PSM1250 module status and to collect information about the power supply: for example output voltage value (see description from page 52). If no PSO1250 diagnostic module is present or for PSS1250-2 system, the output voltage can be measured on PSM1250 screw output terminals by means of a multimeter.
If it is required to set an output voltage value different from factory setting (24 Vdc), use the trimmer for output voltage adjusting. Turn the trimmer clockwise (to the right) to increase output voltage (max. 28 Vdc) or turn the trimmer counterclockwise (to the left) to decrease output voltage (min. 21 Vdc).
Warning: for correct current sharing operation (not applicable on PSS1250(-HS)-7-0 & -7-5), power supply modules must have output voltages calibrated within ± 0.5 V.

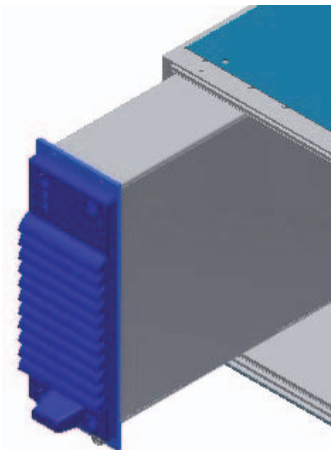
For all configurations except PSS1250(-HS)-7-0 & -7-5
PSM1250 screw output terminals on copper bars:
DC- is negative out pole,
DC+ is positive out pole.
(in the figure it's shown DC1- and DC1+ which are related to PSM1250 in position 1 of PSS1250 system).



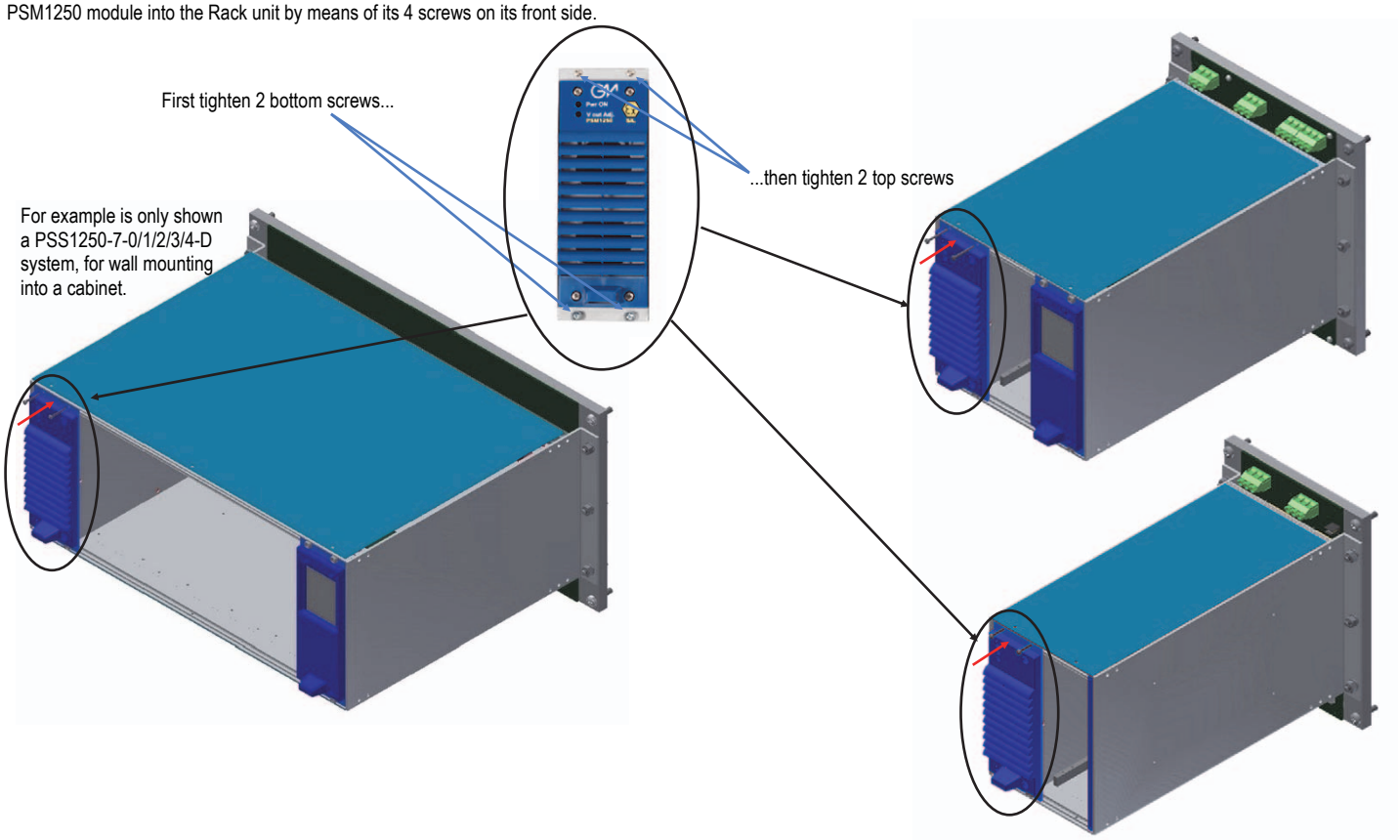
Only for PSS1250(-HS)-7-0 & -7-5
PSM1250 screw output terminals on copper bars:
DC- is negative out pole,
DC+ is positive out pole.
(in the figure it's shown DC1- and DC1+ which are related to PSM1250 in position 1 of PSS1250 system).

3rd sub-step: after having adjusted the PSM1250 output voltage, **unpower AC1 and AC2 input power lines** to turn off the power module. Then release 4 screws on its front side and disconnect the module from the Rack unit in order to repeat **sub-steps 1 to 3** procedure for other modules and complete the setting for all PSM1250 of PSS1250 power system.



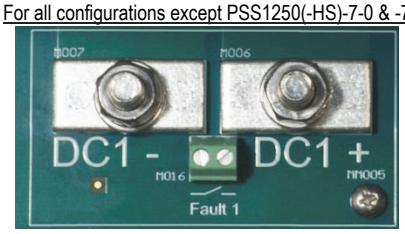


At this step **AC1 and AC2 input power lines are unpowered**, only for 19" and 9" rack (PSS1250-7-x-D and PSS1250-3-D) PSO1250 diagnostic module is installed and fixed to Rack unit with 4 screws, while all PSM1250 modules are disconnected. Starting from position 1 to position 6 (for PSS1250-7-x-D) or 2 (for PSS1250-3-D and PSS1250-2), insert and fix each PSM1250 module into the Rack unit by means of its 4 screws on its front side.



To wire bottom screw output terminals on copper bars (DC output lines: DC- is negative out pole, DC+ is positive out pole), see **Fig. 18-19-20-21-22**, where it's shown DC1- and DC1+, related to PSM1250 in position 1 of PSS1250 system.
For PSS1250-7-x-D, see functional diagrams at pages 8-9-10-11-12 for more information about wiring connection.
For PSS1250-3-D, see functional diagrams at page 13 for more information about wiring connection.
For PSS1250-2, see functional diagrams at page 14 for more information about wiring connection.

For all configurations except PSS1250(-HS)-7-0 & -7-5



Only for PSS1250(-HS)-7-0 & -7-5 **Fig. 18**

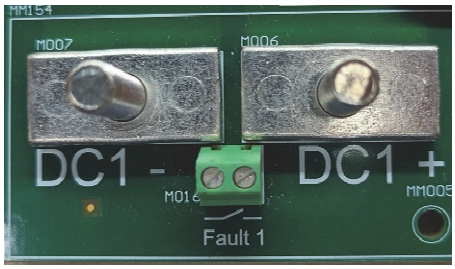


Fig. 19

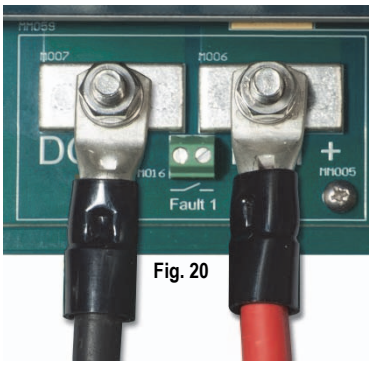


Fig. 20

Unplug M6 nuts, groovers and washers. Then insert a cable lug (at least 6.5 mm hole diameter) with wire, washer and groover on each screw output terminal. Finally tighten nut to fix wire.

For DC screw output terminals, use a cable section range from 6AWG (or 13 mm^2) to 5AWG (or 16 mm^2) and tighten M6 nut+groover+washer on screw with maximum 4 Nm torque.

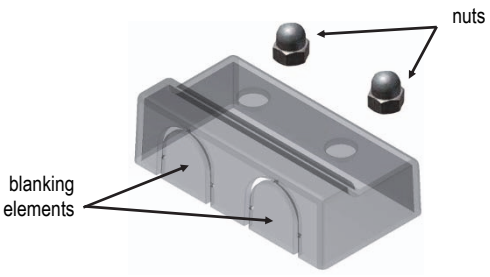


Fig. 21

A polycarbonate cover is used for IP20 to protect each couple of screw output terminals. Break two preformed blanking elements to allow cable passage. Then insert and fix the cover on couple of screw output terminals by means of M6 nylon-capped lock nut.

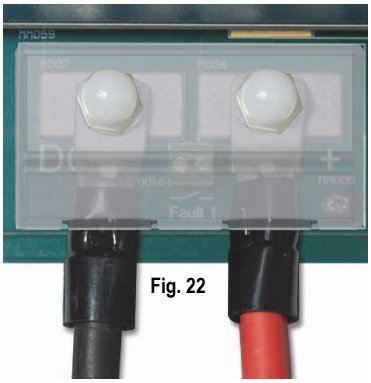


Fig. 22

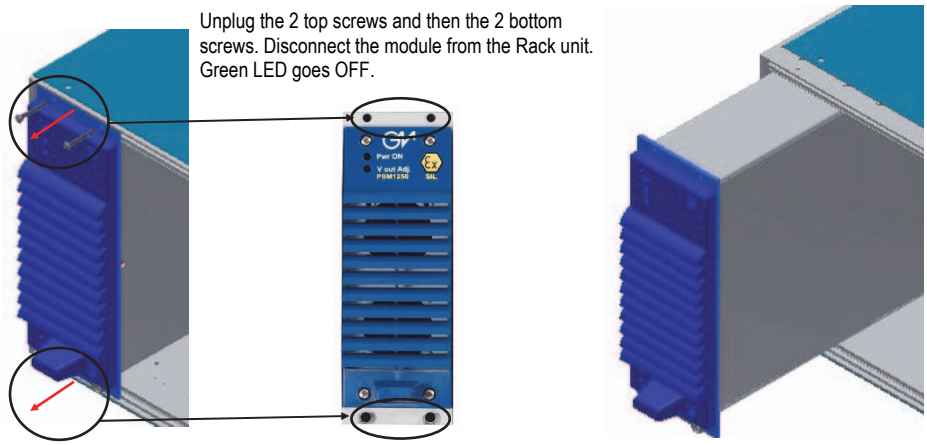
After having wired all DC output lines and tighten front panel screws, **power AC1 and AC2 input power lines**. PSO1250 diagnostic module and each PSM1250 power module turn on and the DC output lines power the load.

Shutdown and Disconnecting Procedure of PSM1250 power module from the Rack unit : - for models with HS

Disconnection of PSM1250 module from the Rack unit, can be done without switching off the power from AC1 and AC2 lines, because of the fully redundant configuration from the input to the output of the power system.
To remove a PSM1250 power module unplug the 2 top screws and then release the other 2 bottom screws.
Check that Power ON LED is OFF before disconnecting the module from the rack unit.

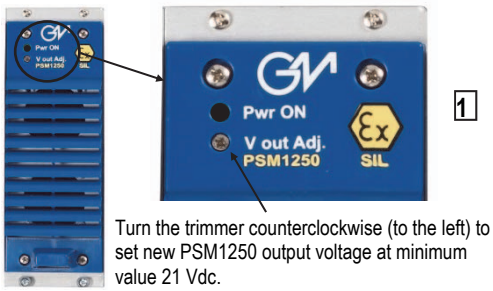
Shutdown and Disconnecting Procedure of PSM1250 power module from the Rack unit : - for models without HS

Disconnection of PSM1250 module from the Rack unit, can be done without switching off the power from AC1 and AC2 lines, because of the fully redundant configuration from the input to the output of the power system.
To remove a PSM1250 power module release 4 screws on its front side and disconnect the module from the Rack unit.

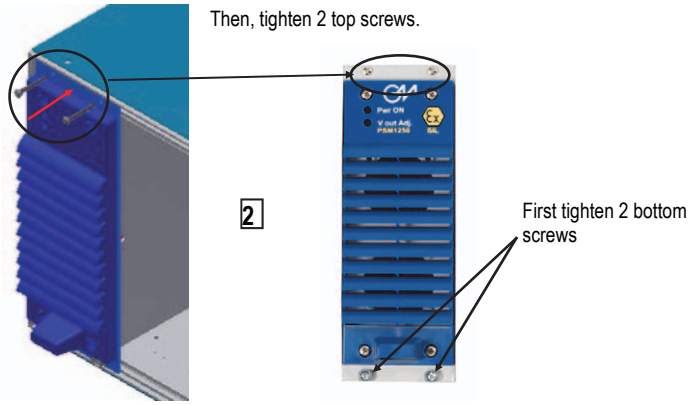


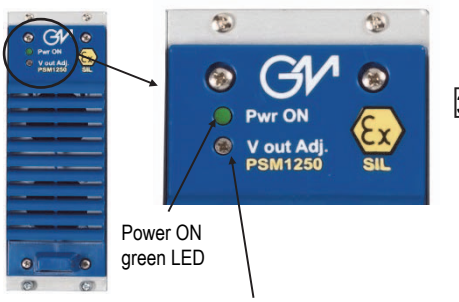
Replacement Procedure of PSM1250 power module from the Rack unit (for models with or without HS)

To disconnect a PSM1250 module from the Rack unit, follow the previous procedure "**Shutdown and disconnecting procedure of PSM1250 power module from the rack unit (for models with or without HS)**" to unplug the PSM1250 module.
Then, take a new PSM1250 power module and follow this procedure: 1 2 3



Then insert and fix the new PSM1250 module into the Rack unit by means of its 4 screws on front side. First tighten 2 bottom screws and then tighten 2 top ones.



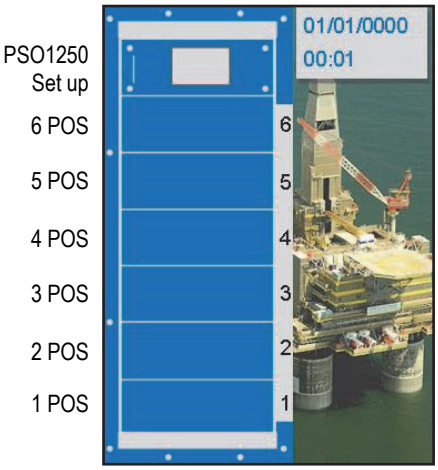


The new PSM1250 module is powered and its green LED is ON, but the module is not operating in current sharing with other PSM1250 modules paralleled with it, because its output voltage is too low (21 Vdc).
For correct current sharing operation (not applicable on PSS1250(-HS)-7-0 & -7-5), all power supply modules in parallel/redundant configuration, must have output voltages calibrated within ± 0.5 V.
For 19" and 9" rack (PSS1250-xx-7-x-D and PSS1250-xx-3-D) read the output voltage of the new PSM1250 on TFT color screen of PSO1250 diagnostic module, while if no PSO1250 diagnostic module is present or for PSS1250-xx-2, the output voltage can be measured on PSM1250 screw output terminals by means of a multimeter.
Then slowly increase output voltage with the trimmer to reach the output voltage (within ± 0.5 V) of all other PSM1250 modules paralleled with it, to guarantee a correct current sharing operation (not applicable on PSS1250(-HS)-7-0 & -7-5).

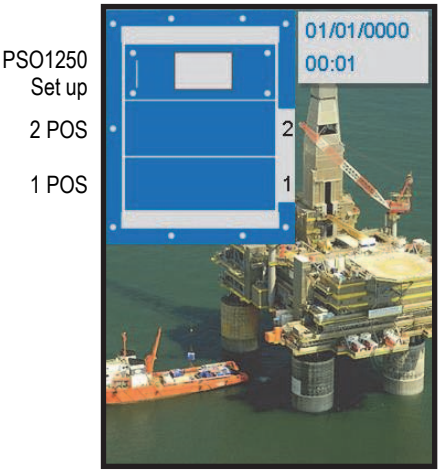
PSO1250 Diagnostic Module: features and set up

Communication with six (for PSS1250-xx-7-x-D) or two (for PSS1250-xx-3-D) power modules is achieved via PSO1250 diagnostic module, which incorporates a front panel color touch screen. The diagnostic module is able to query each power modules (using an internal proprietary bus) and read data such as: Input/Output Voltage, Current and Power; Input Line Frequency; Output current sharing percentage; Current sharing group; Internal Temperature; alarm status (under/over out voltage, AC line absence, internal PFC or PWM stage in OFF state, internal high temperature, fans malfunction). These information are available via front panel LCD and externally via Modbus RTU on related wall mounting terminal block.
The following figures are screenshots of TFT LCD and show the setting up of the PSO1250 diagnostic module and reading data from each power module.

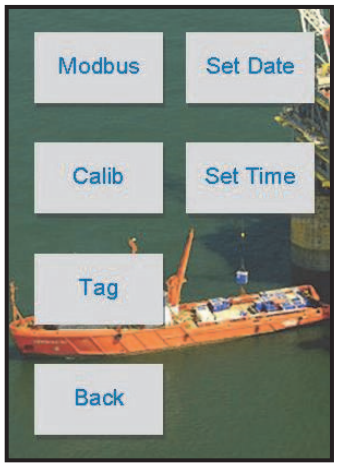
At start up of PSO1250 diagnostic module, this image is shown for some seconds.



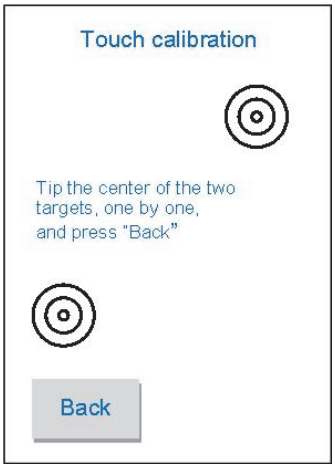
This image is PSS1250-xx-7-x-D main menu, when no PSM1250 module is operating in power system.



This image is PSS1250-xx-3-D main menu, when no PSM1250 module is operating in power system.

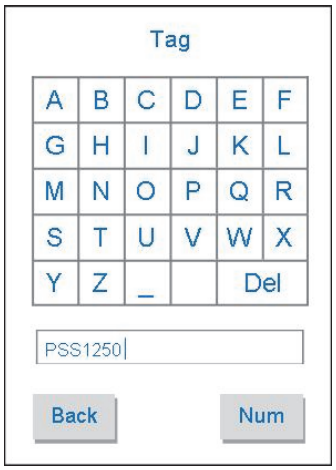


This set up menu image is shown when touching the "PSO1250 set up" cell in the main menu screen.

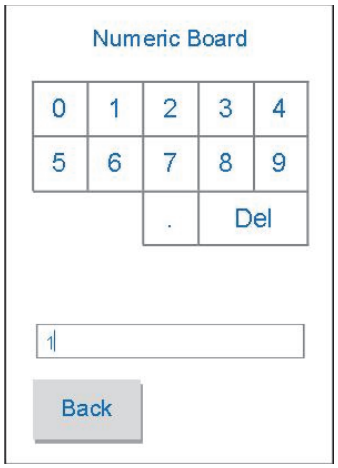


This image is shown when touching the "Calib" cell in the set up menu screen.
Tip the center of the two targets, one by one, and press back, for calibration of touch screen.

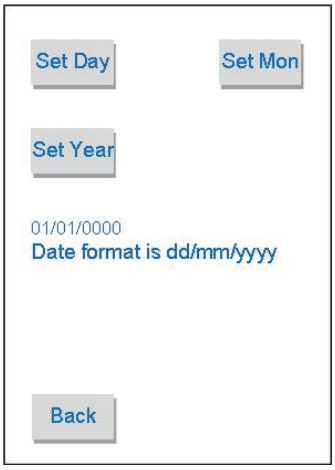
This image is shown when touching the "Modbus" cell in the set up menu screen.
Here is possible to set Modbus communication parameters as baudrate, parity, terminal resistance, endianness and address, touching related cells.
<u>These parameters are saved in PSO1250 memory and also held after AC1 and AC2 supply shutdown</u>.



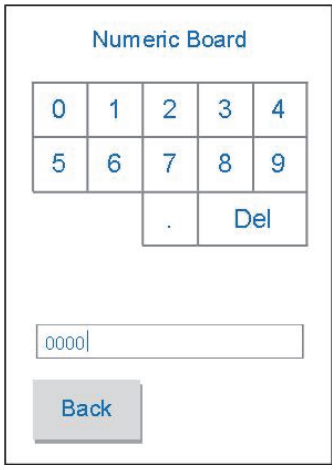
This image is shown when touching the "Tag" cell in the set up menu screen. Alphabetical board to introduce a tag to identify PSS1250.
<u>The Tag is saved in PSO1250 memory and also held after AC1 and AC2 supply shutdown</u>.



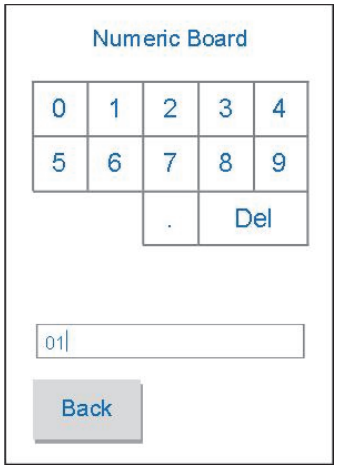
This image (numeric board) is shown when touching the "Addr" cell in Modbus menu or "Num" cell in Tag menu screen.
Modbus Address value must be included in the 1 to 247 range.



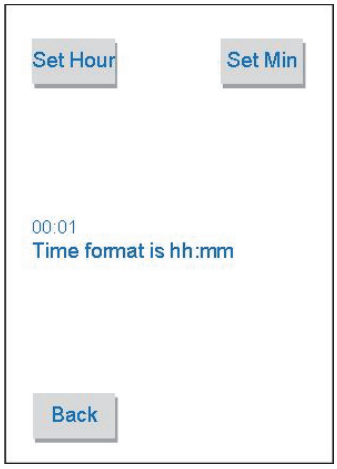
This image is shown when touching the "Set Date" cell in the set up menu screen. Here is possible to set Day, Month and Year touching related cells.
Date format is day/month/year (as dd/mm/yyyy).
Current setting is shown in numeric format.
<u>Date is not kept after AC1 and AC2 supply shutdown</u>.



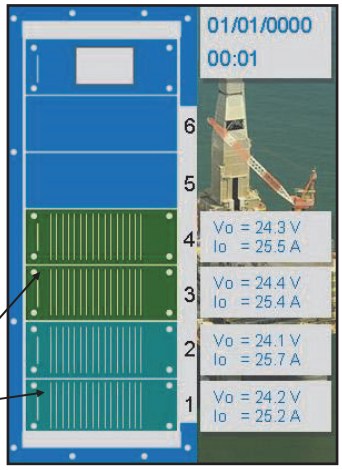
This image (numeric board) is shown when touching the "Set Year" cell in the Date menu screen. Year value must be expressed by 4 digits.



This image (numeric board) is shown when touching the "Set Day" - "Set Mon" cell in the Date menu screen or the "Set Hour" - "Set Min" cell in the Time menu screen. This value must be expressed by 2 digits.

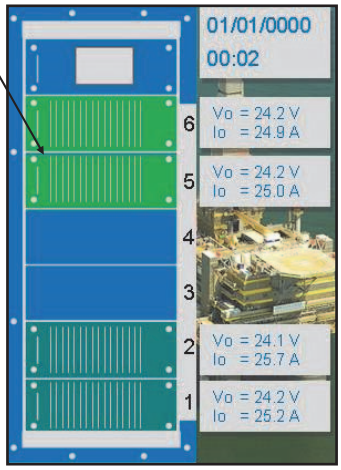


This image is shown when touching the "Set Time" cell in the set up menu screen. Here is possible to set Hour and Minute touching related cells.
24 hours Time format is hour:minute (as hh:mm).
Current setting is shown in numeric format.
Time is not kept after AC1 and AC2 supply shutdown.

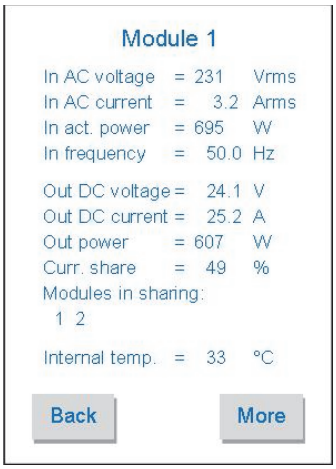


Different green colors for each current sharing group.

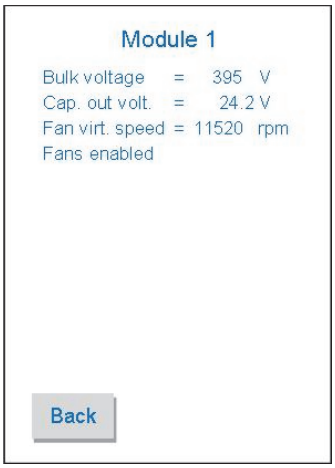
Not applicable for PSS1250 (-HS)-7-0 & -7-5 because of absence of any redundant group, therefore each "x POS" has got blue color when correctly enabled



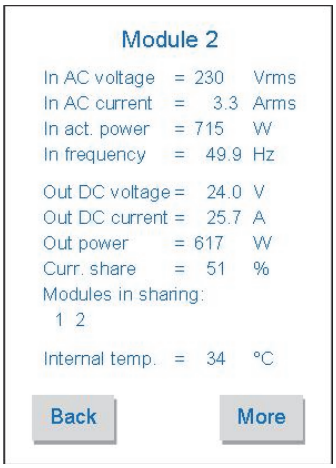
All PSM1250 modules are normally operating (their pos. cells are all green).
This image is related to PSS1250-xx-7-3-D because there are 3 current sharing groups:
1 & 2 ; 3 & 4 ; 5 & 6 .
For each operating PSM1250 module, on the right of its "x POS" cell, there is a label that shown:
- Vo , its out voltage before active ideal diode (which is different from out DC or out group voltage);
- Io , its out current or out DC current.



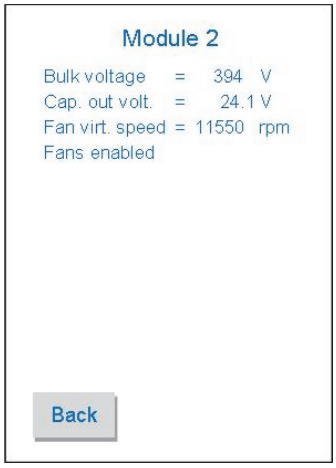
Touching "1 POS" cell on the main menu screen, PSM1250 module 1 (Pos.1) first page data are shown: Input AC Voltage and Current, Input Active Power, Input Line Frequency, Output DC or out group Voltage (after active ideal diode), Output DC Current, Output Power, Output current sharing percentage, Current sharing group (modules 1 and 2 are in sharing), Internal Temperature.
Touch "Back" cell to return on the main menu or touch "More" cell to go on the module second page data.



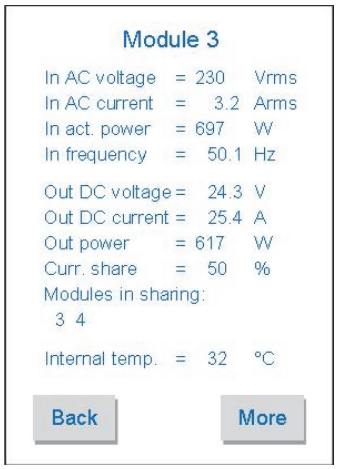
This is PSM1250 module 1 (Pos.1) second page where other data are shown: Bulk Voltage or internal PFC capacitor voltage, Capacitor out voltage or out voltage before active ideal diode, Fan virtual (or set) speed, indication if fans are enabled or disabile.
In addition, this page is used to show fault alarm as: under/over out voltage, AC line absence, internal PFC or PWM stage in OFF state, internal high temperature, fans malfunction).
Touch "Back" cell to return on the module first page.



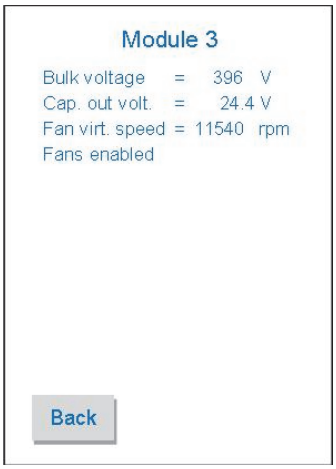
Touching "2 POS" cell on the main menu screen, PSM1250 module 2 (Pos.2) first page data are shown. Modules 1 and 2 are in sharing.
Touch "Back" cell to return on the main menu or touch "More" cell to go on the module second page data.



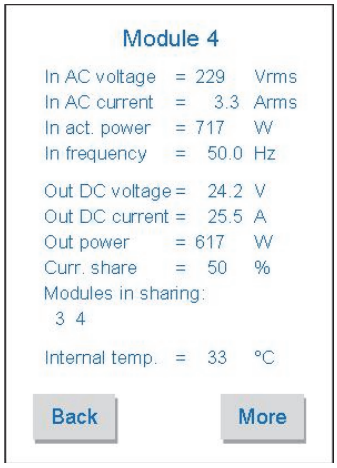
This is PSM1250 module 2 (Pos.2) second page where other data are shown. Touch "Back" cell to return on the module first page.



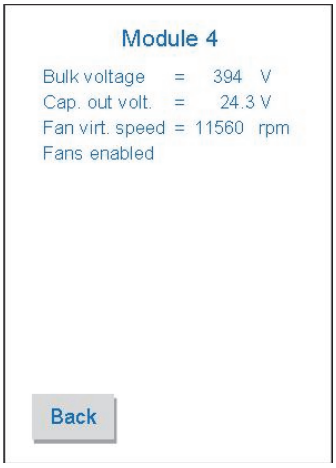
Touching "3 POS" cell on the main menu screen, PSM1250 module 3 (Pos.3) first page data are shown. Modules 3 and 4 are in sharing.
Touch "Back" cell to return on the main menu or touch "More" cell to go on the module second page data.



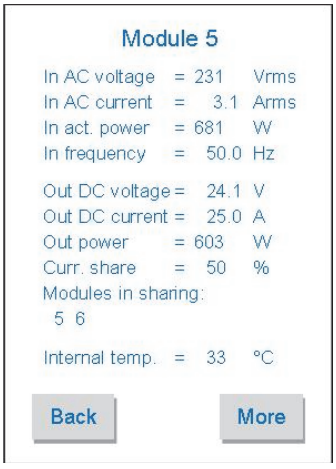
This is PSM1250 module 3 (Pos.3) second page where other data are shown. Touch "Back" cell to return on the module first page.



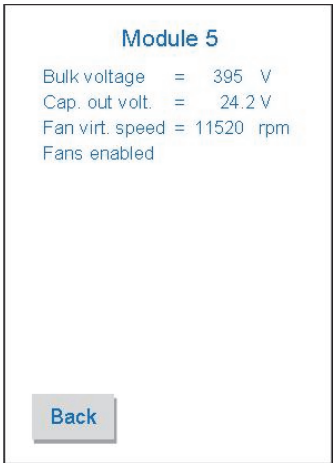
Touching "4 POS" cell on the main menu screen, PSM1250 module 4 (Pos.4) first page data are shown. Modules 3 and 4 are in sharing.
Touch "Back" cell to return on the main menu or touch "More" cell to go on the module second page data.



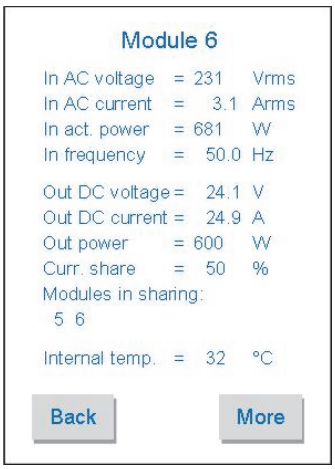
This is PSM1250 module 4 (Pos.4) second page where other data are shown. Touch "Back" cell to return on the module first page.



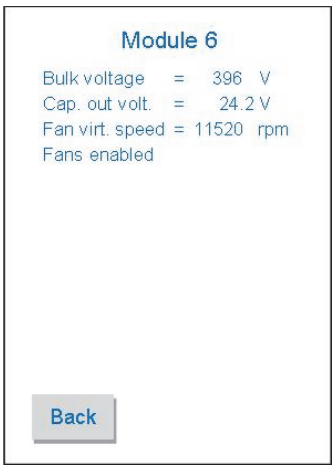
Touching "5 POS" cell on the main menu screen, PSM1250 module 5 (Pos.5) first page data are shown. Modules 5 and 6 are in sharing.
Touch "Back" cell to return on the main menu or touch "More" cell to go on the module second page data.



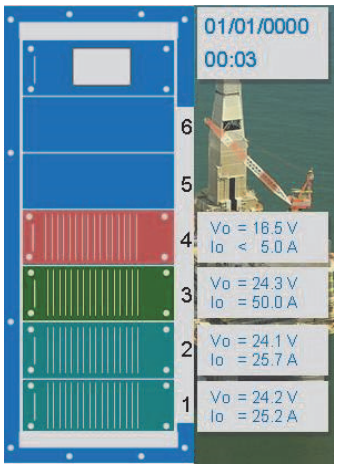
This is PSM1250 module 5 (Pos.5) second page where other data are shown. Touch "Back" cell to return on the module first page.



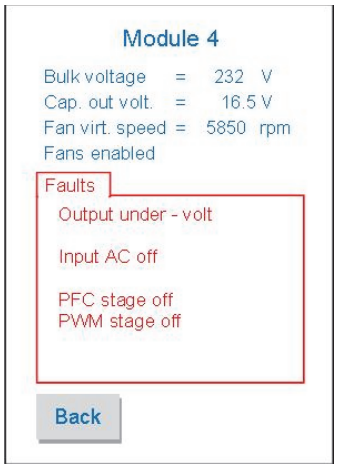
Touching "6 POS" cell on the main menu screen, PSM1250 module 6 (Pos.6) first page data are shown. Modules 5 and 6 are in sharing.
Touch "Back" cell to return on the main menu or touch "More" cell to go on the module second page data.



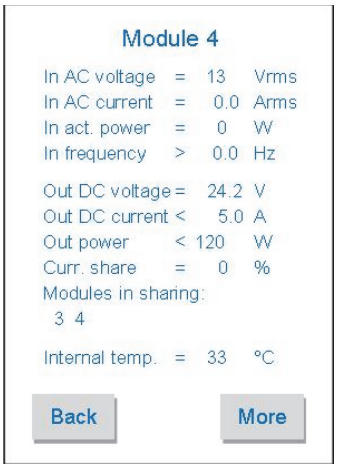
This is PSM1250 module 6 (Pos.6) second page where other data are shown. Touch "Back" cell to return on the module first page.



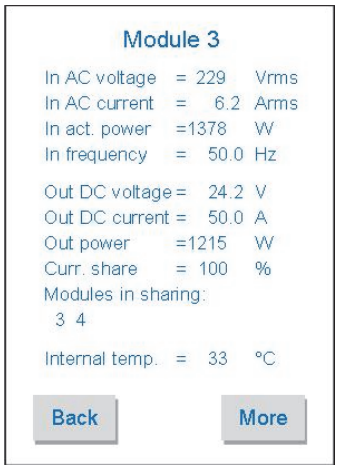
The PSM1250 module 4 (Pos.4) is in fault condition because its “4 POS” cell on the main menu screen is red. Its Vo out voltage before active ideal diode is 16.5 V < 24.3 V and its Io out current is < 5 A < 25.5 A . Therefore module 4 does not contribute to supply the 3 & 4 group load. Now, only module 3 (Pos.3) drives the 3 & 4 group load because its Io out current is increased from 25.4 to 50.0 A.



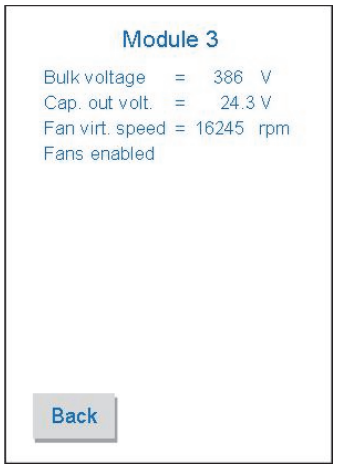
The PSM1250 module 4 (Pos.4) is in fault condition because of: AC line absence which implies internal PFC and PWM stages in OFF state and output under-voltage (16.5 V < 20 V bottom limit).



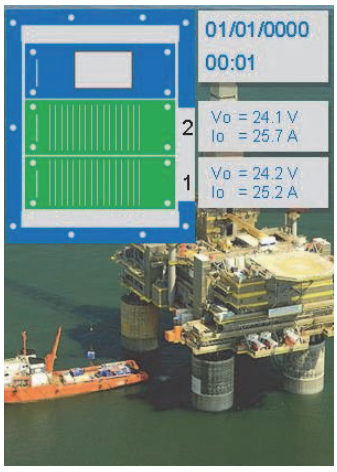
Capacitor out voltage or out voltage before active ideal diode is 16.5 V but out DC or out group voltage (after active ideal diode) is 24.2 V. Module 4 does not contribute to supply the 3 & 4 group load and its out current sharing percentage is 0%. Out current and power measure at low load (< 5 A) is not accurate so that: Out DC current < 5 A and Out power < 120W.



The PSM1250 module 3 (Pos.3) drives the 3 & 4 group load because its Io out current is increased from 25.4 to 50.0 A and its out current sharing percentage is 100%.

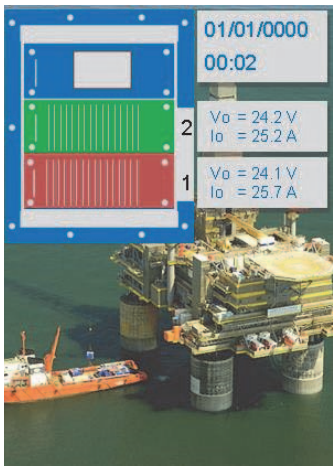


Now, Fan virtual (or set) speed is increased from 11540 to 16245 rpm because of out power increment. Indeed, fan speed control depending on output power and ambient temperature.

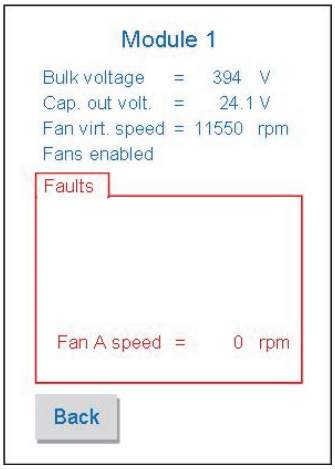


Both PSM1250 modules are normally operating (their pos. cells are all green).
This image is related to PSS1250-xx-3-D with 1 & 2 current sharing group.
For each operating PSM1250 module, on the right of its “x POS” cell, there is a label that shown:
- Vo , its out voltage before active ideal diode (which is different from out DC or out group voltage);
- Io , its out current or out DC current.

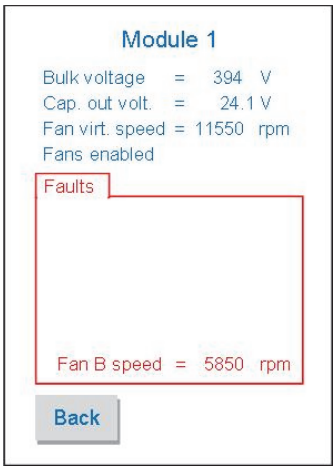
Touching “x POS” cell on the main menu screen, PSM1250 module x (Pos.x) first page data are shown (see previous page for more information about each module first or second page).



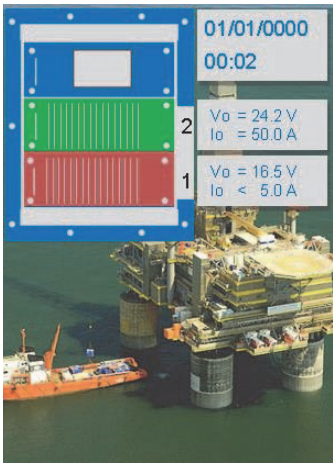
The PSM1250 module 1 (Pos.1) is in fault condition because its "1 POS" cell on the main menu screen is red. Its Vo out voltage before active ideal diode and its Io out current are seemingly correct.
The answer is shown in the module second page, which resumes fault alarms.



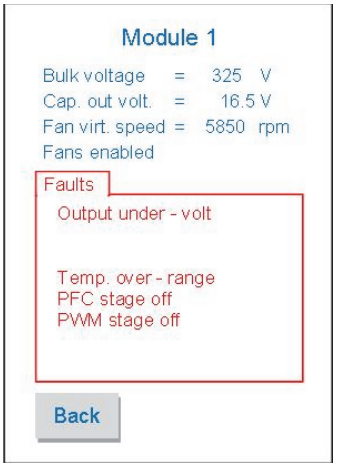
The fault is due to Fan A malfuction, because its speed is 0 < 11550 rpm setting, that is Fan A does not work.



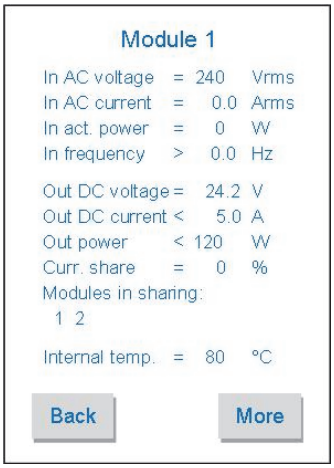
The fault is due to Fan B malfuction, because its speed is 5850 < 11550 rpm setting, that is Fan B works but not correctly. When speed difference between setting speed value and read speed value is more in absolute to 5000 rpm a fan fault is shown, specifing speed reading.



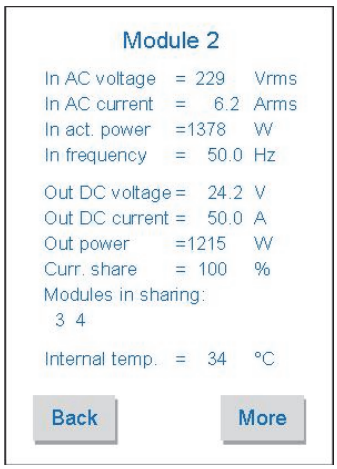
The PSM1250 module 1 (Pos.1) is in fault condition because its "1 POS" cell on the main menu screen is red. Its Vo out voltage before active ideal diode is 16.5 V < 24.3 V and its Io out current is < 5 A < 25.2 A . Therefore module 1 does not contribute to supply the 1 & 2 group load. Now, only module 2 (Pos.2) drives the 1 & 2 group load because its Io out current is increased from 25.7 to 50.0 A.



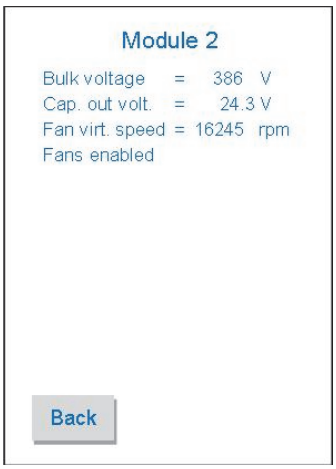
The PSM1250 module 1 (Pos.1) is in fault condition because of: internal temperature over-range, which imposes thermal shutdown of internal PFC and PWM stages, implying output under-voltage (16.5 V < 20 V bottom limit). Note that AC line is present and fans go on to work at low speed in order to cool whole module.



Indeed, module 1 internal temperature is 80°C, higher than 75°C. The module has thermal hysteresis and it removes internal temperature over-range fault when its internal temperature is reduce under 70°C.
AC line is present and its voltage is 240 Vrms.
Module 1 does not contribute to supply the 1 & 2 group load and its out current sharing percentage is 0%.



The PSM1250 module 2 (Pos.2) drives the 1 & 2 group load because its Io out current is increased from 25.7 to 50.0 A and its out current sharing percentage is 100%.



Now, Fan virtual (or set) speed is increased from 11550 to 16245 rpm because of out power increment. Indeed, fan speed control depending on output power and ambient temperature.

Supported Modbus parameters: functions and details

Only for PSS1250-xx-7-x-D and PSS1250-xx-3-D can communicate via Modbus RTU RS-485 protocol. Below is a list of all available registers.

Addr.	Description	Notes	Type (15)
0	G.M. Factory Code	Identification Data	R
1	Instrument Code		
2	Option Code		
3	Hardware Release		
4	Software Release		
16	Modbus Address	Communication Data	R/W
17	Modbus Baudrate (1)		
18	Modbus Format (1)		
71	PSM1250 Internal temperature (2)	1st position PSM1250 Module Data	R
72	Input active power (3)		
73	Output power (3)		
74	Power efficiency (4)		
75	Bulk electrolytic capacitor voltage (5)		
76	AC input voltage (6)		
77	AC input current (7)		
78	AC input frequency (8)		
79	Primary side fault information (1)		
81	Output electrolytic capacitor voltage (9)		
82	Output voltage (9)		
83	Output current (10)		
84	Fan driver enable (1)		
85	Fan driver inverted duty cycle (13)		
86	Fan driver speed (11)		
87	Fan A read frequency (12)		
88	Fan A read speed (11)		
89	Fan B read frequency (12)		
90	Fan B read speed (11)		
91	Secondary side fault information (1)		
92	Secondary side extra fault information (1)		
93	PSM1250 Internal temperature (2)	2nd position PSM1250 Module Data	R
94	Input active power (3)		
95	Output power (3)		
96	Power efficiency (4)		
97	Bulk electrolytic capacitor voltage (5)		
98	AC input voltage (6)		
99	AC input current (7)		
100	AC input frequency (8)		
101	Primary side fault information (1)		
103	Output electrolytic capacitor voltage (9)		
104	Output voltage (9)		
105	Output current (10)		
106	Fan driver enable (1)		
107	Fan driver inverted duty cycle (13)		
108	Fan driver speed (11)		
109	Fan A read frequency (12)		
110	Fan A read speed (11)		
111	Fan B read frequency (12)		
112	Fan B read speed (11)		
113	Secondary side fault information (1)		
114	Secondary side extra fault information (1)		
115	PSM1250 Internal temperature (2)	3rd position PSM1250 Module Data	R
116	Input active power (3)		
117	Output power (3)		
118	Power efficiency (4)		
119	Bulk electrolytic capacitor voltage (5)		
120	AC input voltage (6)		
121	AC input current (7)		
122	AC input frequency (8)		
123	Primary side fault information (1)		
125	Output electrolytic capacitor voltage (9)		
126	Output voltage (9)		
127	Output current (10)		
128	Fan driver enable (1)		
129	Fan driver inverted duty cycle (13)		
130	Fan driver speed (11)		
131	Fan A read frequency (12)		
132	Fan A read speed (11)		
133	Fan B read frequency (12)		
134	Fan B read speed (11)		
135	Secondary side fault information (1)		
136	Secondary side extra fault information (1)		
137	PSM1250 Internal temperature (2)	4th position PSM1250 Module Data	R
138	Input active power (3)		
139	Output power (3)		
140	Power efficiency (4)		
141	Bulk electrolytic capacitor voltage (5)		
142	AC input voltage (6)		
143	AC input current (7)		
144	AC input frequency (8)		
145	Primary side fault information (1)		
147	Output electrolytic capacitor voltage (9)		
148	Output voltage (9)		
149	Output current (10)		
150	Fan driver enable (1)		
151	Fan driver inverted duty cycle (13)		
152	Fan driver speed (11)		
153	Fan A read frequency (12)		
154	Fan A read speed (11)		
155	Fan B read frequency (12)		
156	Fan B read speed (11)		
157	Secondary side fault information (1)		
158	Secondary side extra fault information (1)		
159	PSM1250 Internal temperature (2)	5th position PSM1250 Module Data	R
160	Input active power (3)		
161	Output power (3)		
162	Power efficiency (4)		
163	Bulk electrolytic capacitor voltage (5)		
164	AC input voltage (6)		
165	AC input current (7)		
166	AC input frequency (8)		
167	Primary side fault information (1)		
169	Output electrolytic capacitor voltage (9)		
170	Output voltage (9)		
171	Output current (10)		
172	Fan driver enable (1)		
173	Fan driver inverted duty cycle (13)		
174	Fan driver speed (11)		
175	Fan A read frequency (12)		
176	Fan A read speed (11)		
177	Fan B read frequency (12)		
178	Fan B read speed (11)		
179	Secondary side fault information (1)		
180	Secondary side extra fault information (1)		
181	PSM1250 Internal temperature (2)	6th position PSM1250 Module Data	R
182	Input active power (3)		
183	Output power (3)		
184	Power efficiency (4)		
185	Bulk electrolytic capacitor voltage (5)		
186	AC input voltage (6)		
187	AC input current (7)		
188	AC input frequency (8)		
189	Primary side fault information (1)		
191	Output electrolytic capacitor voltage (9)		
192	Output voltage (9)		
193	Output current (10)		
194	Fan driver enable (1)		
195	Fan driver inverted duty cycle (13)		
196	Fan driver speed (11)		
197	Fan A read frequency (12)		
198	Fan A read speed (11)		
199	Fan B read frequency (12)		
200	Fan B read speed (11)		
201	Secondary side fault information (1)		
202	Secondary side extra fault information (1)		
203	Current sharing value (4)	1st pos. PSM1250 Data	R
204	Current sharing value (4)	2nd pos. PSM1250 Data	R
205	Current sharing value (4)	3rd pos. PSM1250 Data	R
206	Current sharing value (4)	4th pos. PSM1250 Data	R
207	Current sharing value (4)	5th pos. PSM1250 Data	R
208	Current sharing value (4)	6th pos. PSM1250 Data	R
209	Current sharing group with 1st PSM (1)	1st pos. PSM1250 Data	R
210	Current sharing group with 2nd PSM (1)	2nd pos. PSM1250 Data	R
211	Current sharing group with 3rd PSM (1)	3rd pos. PSM1250 Data	R
212	Current sharing group with 4th PSM (1)	4th pos. PSM1250 Data	R
213	Current sharing group with 5th PSM (1)	5th pos. PSM1250 Data	R
214	Current sharing group with 6th PSM (1)	6th pos. PSM1250 Data	R
464	Command execution (14)	Command	W
516	Inter-modules communic. error counter	Inter-modules protocol	R
517	Inter-modules missed communication (1)	Inter-modules protocol	R
518	Modbus error counter	Modbus protocol	R
533	Common fault status (1)	Common fault data	R

(To be continued on next page)

Supported Modbus parameters:

Addr.	Description	Notes	Type(14)
556	Chars 0, 1	PSS1250 Tag	R/W
557	Chars 2, 3		
558	Chars 4, 5		
559	Chars 6, 7		
560	Chars 8, 9		
561	Chars 10, 11		
562	Chars 12, 13		
563	Chars 14, 15		

Supported modbus functions:

Code	Name	Notes
03	read holding registers	reads a stream of words from memory
04	read input registers	reads a stream of words from memory
08	diagnostics: subcode 0	returns query data
06	write single register	writes a word in memory
16	write multiple registers	writes a stream of words in memory

Notes:

Each Modbus parameter is described by one 16-bit word.

(1) See command details on this page.
(2) Expressed in °C.
(3) Expressed in W.
(4) Expressed in %.
(5) Expressed in V.
(6) Expressed in Vrms.
(7) Expressed in 100 mArms.
(8) Expressed in 100 mHz.
(9) Expressed in 100 mV.
(10) Expressed in 100 mA.
(11) Expressed in Round Per Minute (RPM).
(12) Expressed in Hz.
(13) Expressed in %: inverted duty cycle (%) = 100% - duty cycle (%).
(14) All configurations must be confirmed via Addr. 464, see details on this page.
(15) Parameter Type: R = read only; W = write only; R/W = read and write.

Modbus parameters details:

Address 17: Supported Modbus Baudrates

Index	Baudrate
0	4800
1	9600
2	19200
3	38400
4	57600
5	115200

Address 18: Supported Modbus Formats

High Byte								Low Byte							
Bit position															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

- Bit 3: Endianness 32 bit Data (0 = Little; 1 = Big)
- Bit 2: Termination resistance (1 = enabled)
- Bits 1-0: Supported Modbus Parity:
  - 0 8 data bit, no parity, 1 stop bit
  - 1 8 data bit, even parity, 1 stop bit
  - 2 8 data bit, odd parity, 1 stop bit

Address 79: (1st PSM1250)
Address 101: (2nd PSM1250)
Address 123: (3rd PSM1250)
Address 145: (4th PSM1250)
Address 167: (5th PSM1250)
Address 189: (6th PSM1250)

Primary side fault information

High Byte								Low Byte							
Bit position															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

- Bit 2: PFC stage status (1 = operative ; 0 = shutdown and fault)
- Bit 1: High temperature status (1 = presence and fault ; 0 = absence)
- Bit 0: AC line status (1 = absence and fault ; 0 = presence)

Address 91: (1st PSM1250)
Address 113: (2nd PSM1250)
Address 135: (3rd PSM1250)
Address 157: (4th PSM1250)
Address 179: (5th PSM1250)
Address 201: (6th PSM1250)

Secondary side fault information

High Byte								Low Byte							
Bit position															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

- Bit 2: Over Voltage fault (1 = presence ; 0 = absence)
- Bit 1: Under Voltage fault (1 = presence ; 0 = absence)
- Bit 0: PWM stage status (1 = operative ; 0 = shutdown and fault)

Address 92: (1st PSM1250)
Address 114: (2nd PSM1250)
Address 136: (3rd PSM1250)
Address 158: (4th PSM1250)
Address 180: (5th PSM1250)
Address 202: (6th PSM1250)

Secondary side extra fault information

High Byte								Low Byte							
Bit position															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

- Bit 3: Inter-modules protocol comm. fault from PSO1250 (1=fault; 0=ok)
- Bit 2: Intra-module protocol communication fault (1=fault ; 0=ok)
- Bit 1: Fan B fault (1=fault, change > 5000 rpm on driver speed; 0=ok)
- Bit 0: Fan A fault (1=fault, change > 5000 rpm on driver speed; 0=ok)

Address 209: (1st PSM1250)
Address 210: (2nd PSM1250)
Address 211: (3rd PSM1250)
Address 212: (4th PSM1250)
Address 213: (5th PSM1250)
Address 214: (6th PSM1250)

Current Sharing group (CSg) with x pos. PSM1250

High Byte								Low Byte							
Bit position															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

- Bits 15-6: All bits '0'
- Bit 5: 6th PSM1250 (1 = belong ; 0 = not belong to CSg of x pos. PSM1250)
- Bit 4: 5th PSM1250 (1 = belong ; 0 = not belong to CSg of x pos. PSM1250)
- Bit 3: 4th PSM1250 (1 = belong ; 0 = not belong to CSg of x pos. PSM1250)
- Bit 2: 3rd PSM1250 (1 = belong ; 0 = not belong to CSg of x pos. PSM1250)
- Bit 1: 2nd PSM1250 (1 = belong ; 0 = not belong to CSg of x pos. PSM1250)
- Bit 0: 1st PSM1250 (1 = belong ; 0 = not belong to CSg of x pos. PSM1250)

Address 464: Various commands

High Byte								Low Byte							
Bit position															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

- 1 Save Input/Output Configuration
- 2 Save Modbus configuration
- 8 Save Tags
- 9 Lock Alarms
- 10 Analog Output Sink/Source Switch

Address 517: Inter-modules missed communication

High Byte								Low Byte							
Bit position															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

- Bits 15-6: All bits '0'
- Bit 5: 6th position PSM1250 module (1=missed; 0=present)
- Bit 4: 5th position PSM1250 module (1=missed; 0=present)
- Bit 3: 4th position PSM1250 module (1=missed; 0=present)
- Bit 2: 3rd position PSM1250 module (1=missed; 0=present)
- Bit 1: 2nd position PSM1250 module (1=missed; 0=present)
- Bit 0: 1st position PSM1250 module (1=missed; 0=present)

Address 533: Common fault status

High Byte								Low Byte							
Bit position															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

- Bits 15-6: All bits '0'
- Bit 5: 6th position PSM1250 module (1=fault ; 0=ok)
- Bit 4: 5th position PSM1250 module (1=fault ; 0=ok)
- Bit 3: 4th position PSM1250 module (1=fault ; 0=ok)
- Bit 2: 3rd position PSM1250 module (1=fault ; 0=ok)
- Bit 1: 2nd position PSM1250 module (1=fault ; 0=ok)
- Bit 0: 1st position PSM1250 module (1=fault ; 0=ok)