



Frequency converter type:

MFC 810

3 x 1140 V
2 x 250 kW

- Vector controlled
- Three level topology
- Liquid cooled heatsink

User Manual

Part I: Hardware
Instalation and technical data

Zakład Energoelektroniki TWERD Michał Twerd

ul. Aleksandrowska 28-30
87-100 Toruń, Poland

tel. +48 56 654-60-91
e-mail: twerd@twerd.pl



Table of Contents

- H.1. Safety principles..... 4
 - H.1.1. Principles of electromagnetic compatibility (EMC)..... 4
- H.2. TECHNICAL DATA..... 5
- H.3. FREQUENCY CONVERTER INSTALLATION..... 8
 - H.3.1. Electrical connections..... 8
 - H.3.2. Fiber-optic connections..... 9
 - H.3.2. Liquid cooling..... 10
 - H.3.3. The printed circuit board (PCB) 810/05..... 10
 - H.3.4. Connection of the control circuits..... 12
 - H.3.5. Expansion cards..... 13
 - H.3.6. Single module working mode..... 14

H.1. Safety principles

Leveling connections

Touch protection encompasses the automatic switching off of the power supply by means of the special short circuit (differential type) or limitation of voltages which may be touched if the insulation is damaged to a level not exceeding the permissible values.

Due to the intermediate circuit operation, a short to ground in the output circuit of the frequency converter may not be detected by the short circuit protection. The frequency converter provides protection against short circuits between the phases and the output, but this protection is based on putting the IGBT transistors in the blocking state, which does not meet the requirements of fire protection.

In this regard, in order to ensure the staff safety, it is necessary to make local leveling connections in a corresponding way.

The special, respectively designated and protected from corrosion points for connection of the leveling wires are provided in the frequency converter.

Protections

There are some protections provided in the frequency converter: against the motor overload, against the motor overheat, against too low or too high voltage in the intermediate circuit of the converter, against the short circuit at the output of the frequency converter (protecting only the converter!!).

The switching devices

To comply with the EU Directive, in accordance with PN-EN 60204-1: 2010, a device for switching off the power must be provided in the motor controller system, which consists of a frequency converter and an electric machine. This device must be one of the following:

- a disconnector (with or without fuses), an AC-23B category of use that meets the requirements EN 60947-3,
- a disconnector (with or without fuses), which ensures disconnection of the load circuit by opening the main contacts, complying with the requirements of EN 60947-3,
- circuit breaker complying with EN 60947-2.

Fulfilment of the requirements is the responsibility of the organization performing the installation.

Emergency stop

To comply with the EU Directive, in accordance with PN-EN 60204-1: 2010, on the basis of the staff and equipment safety, it is necessary to use an emergency stop switch, which has an advantage over other functions, regardless of the operation mode. The STOP key on the operator panel cannot be considered as an emergency stop switch, because pressing it does not turn off the frequency converter from the power supply.

Fulfilment of the requirements is the responsibility of the organization performing the installation.

Housing

The housing meets the requirements of IP00 degree of protection. The surface on which the operator panel of the frequency converter is located meets the requirements of IP00 degree of protection. The housing is designed in such a way that it cannot be removed without the use of tools.

Discharging capacitors

There is a battery of relatively large capacitors in the intermediate circuit of the frequency converter. After turning off the supply voltage of the frequency converter, dangerous voltage is held at its terminals for a certain time. It is necessary to wait 15 min. before switching at the terminals of the power terminal connections of the frequency converter. Information about the danger of such a voltage is on the panel, which closes the terminal connections of the supply voltage.

H.1.1. Principles of electromagnetic compatibility (EMC)

According to PN-EN 61800-3 (2008), part 3: "EMC requirements and special test methods", devices for which:

- voltage above 1000V and
- current above 400A,

belong to the C4 class. According to the requirements of the above norm, a user and a manufacturer agree on an EMC plan to fulfil the EMC requirements for the intended use. A user determines the characteristics of the EMC environment taking into account the entire installation and its environment.

H.2. TECHNICAL DATA

Table H.2.1 shows the technical data.

Table H.2.1 – Technical data

| | | |
|-------------------------------|--|---|
| Power supply | Voltage U_{in} / freq. | Three-phase power: 1100..1140 V (-15%, +5%), 45..66Hz |
| Output | Output voltage | $0..U_{in}$ [V] |
| | Frequency | 0,0..400 Hz - U/f operation mode 0,0..100 Hz – Vector operation mode |
| | Frequency resolution | 0.01Hz |
| Cooling system | Coolant | Water / glycol |
| | Inlet fluid temperature | 20 – 50 °C |
| | Coolant flow | 20 l / min |
| | Operating pressure | 2.5 bar |
| | Maximum pressure | 5 bar |
| | Internal diameter of the water/glycol supply wires | 19 mm |
| Control system | Modulator | SVPWM |
| | Operation mode | U/f (linear, exponential), Vector DTC-SVM without sensor Vector DTC-SVM with sensor of the rotor position |
| | Switching frequency | 2.5 kHz (2,5 kHz for nominal power) |
| | Rotation speed setting | Analog inputs, control panel, motopotentiometer, PID controller, communication unit RS-485 and other possibilities. Resolution of 0.1% for analog inputs or 0.1Hz / 1 rpm for the control panel and RS. |
| Control inputs/outputs | Analog inputs | 5 analog inputs (1 voltage mode, 4 voltage-current mode): AI0: voltage mode 0(2) ... 10V, $R_{in} \geq 200k\Omega$; AI1, AI2, AI3, AI4: voltage mode 0(2) ... 10V, $R_{in} \geq 100k\Omega$; current mode 0(4)...20mA, $R_{in} = 250\Omega$, Operation mode and polarity are chosen by parameters. Accuracy: 0.5 % of the full range. |
| | Digital inputs | 10 digital separated inputs 0/(15...24)V, $R_{in} \geq 3k\Omega$. The possibility of obtaining up to 30 digital inputs on expansion cards. |
| | Analog outputs | 2 analog outputs (voltage-current mode) AO1, AO2: Voltage mode 0(2)...10 V Current mode 0(4)...20 mA Configured by parameters, accuracy: 0.5%. The possibility of obtaining up to 10 digital inputs on expansion cards (2 inputs on one each expansion card). |
| | Digital outputs | 6 output relays K1 ... K6 – breaking capacity: 250V/1A AC, 24V/1A DC. Fully programmable signal source. The possibility of obtaining up to 5 digital inputs on expansion cards. |
| | Encoder interface | Possibility of direct connection of incremental encoder (A B Z optical connectors on the MFC810 / 05 board). Recommended pulse rate: 1024-2048. |
| | Temperature sensor | Pt100 |

| | | |
|---|---|---|
| Communication | Connectors | RS-485 x2, USB, Ethernet, CAN |
| | Communication protocol | MODBUS RTU. Function 3 (Read Register), function 6 (Write Register), function 16 (Write Multiple Registers). |
| | Baud-rate | 2400, 4800, 9600, 19200, 38400, 57600, 115200 bit/s |
| | Application | Remote control of unit operation and programming of all parameters of the frequency converter. |
| Special functions | PID controller | Build-in 4 PIC controllers. Choice of referencing-unit signal source and feedback signal source, possibility of inverting polarity of an control error signal, SLEEP function and output erasing on STOP signal, limitation of an output value. |
| | PLC controller | Possibility of taking control over converter's operation, START / STOP system, direction of rotation and frequency, possibility of controlling any external process without connection of external PLC controller. 100 universal functional blocks, 43 functions: simple logic and arithmetic blocks; block of 8-state sequencer, 2 multiplexers with 8 inputs, curve shaping unit, maximum execution time of the PLC program: 10ms. |
| | Additional functions of the panel | Definition of User's values for direct observation of the process variables- choice of measurement unit, scale and data source (e.g. from PLC controller). |
| | | Definition of User's referencing-device for direct changing of the process variables – choice of measurement unit and scale |
| Copying parameter settings between frequency converters | | |
| Protections | Short-circuit | Short-circuit on unit output |
| | Overcurrent | Instantaneous value $3.2 I_n$; effective value $2.25 I_n$ |
| | Overvoltage AC/DC | $1,46 U_{in}$ AC |
| | Undervoltage | $0.65 U_{in}$ |
| | Thermal: device | Heatsink's heat sensor |
| | Thermal: motor | I^2t limit, motor heat sensor |
| | Supervision of communication with control panel | Established permissible time of connection absence |
| | Supervision of communication through RS | Established permissible time of connection absence |
| | Control of analog inputs | Check of absence of "living null" in modes 2..10 V and 4..20mA |
| | Control of a load symmetry | E.g. break in one of the motor phases |
| | Underload | Protection from operating without any load |
| | Stall | Protection against stall of a motor |

Table H.2.2 – Technical data: nominal power and nominal current

| Type of frequency converter | P_n [kW] | I_n [A] | I_p [A] |
|-----------------------------|---------------|--------------|--------------|
| MFC810 / 2x250kW | 2x250 | 2x180 | 2x240 |

P_n – nominal output power

I_n – nominal output current

I_p – overload current: 60 seconds every 10 minutes

MECHANICAL DIMENSIONS

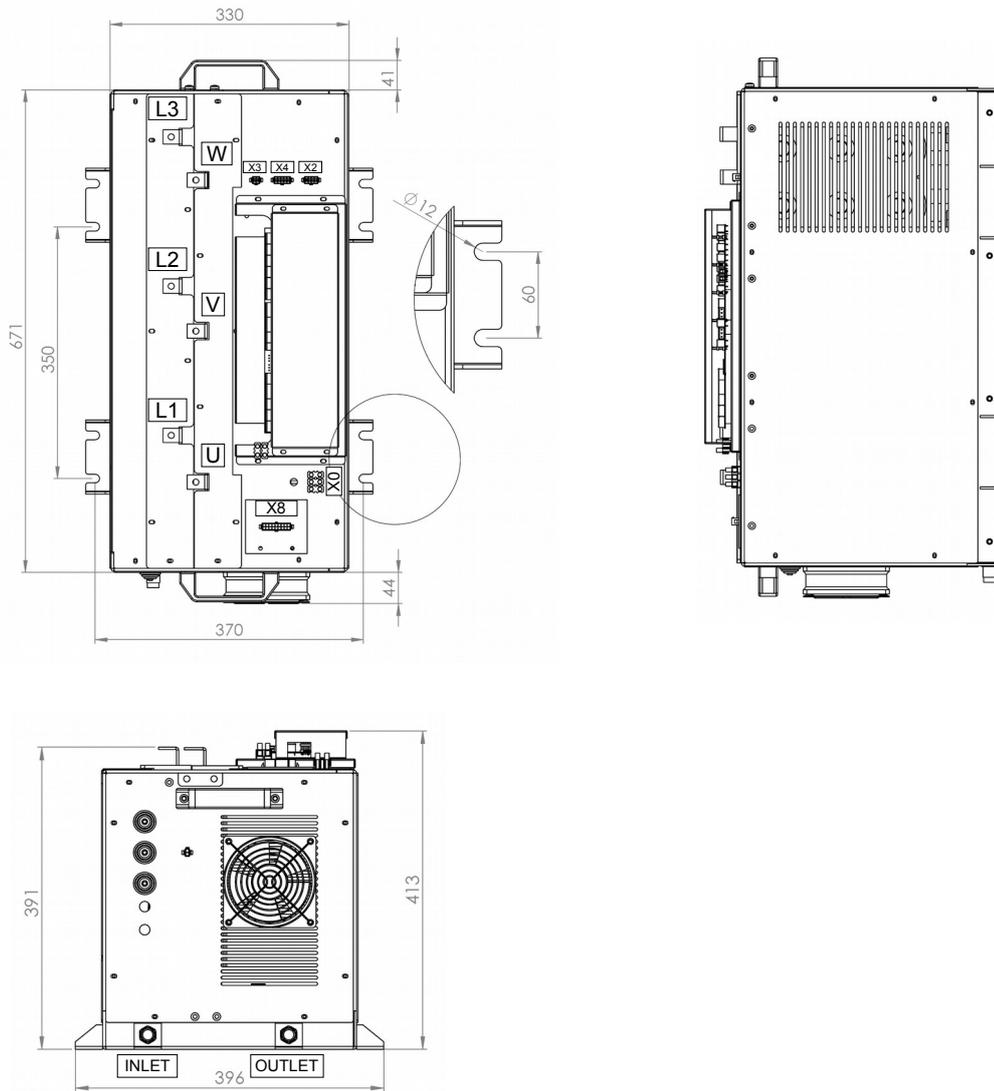


Fig . H.2.1. Mechanical dimensions of MFC810 1140V 200 kW converter

Weight: approximately 70 kg of each unit.

H.3. FREQUENCY CONVERTER INSTALLATION

H.3.1. Electrical connections

The MFC810 converter is powered by a three-phase power supply of 3 x 1100..1140 V (L1, L2, L3). Auxiliary power (circuits) supply: 230 V (L, N) on X0 connection terminal X0.

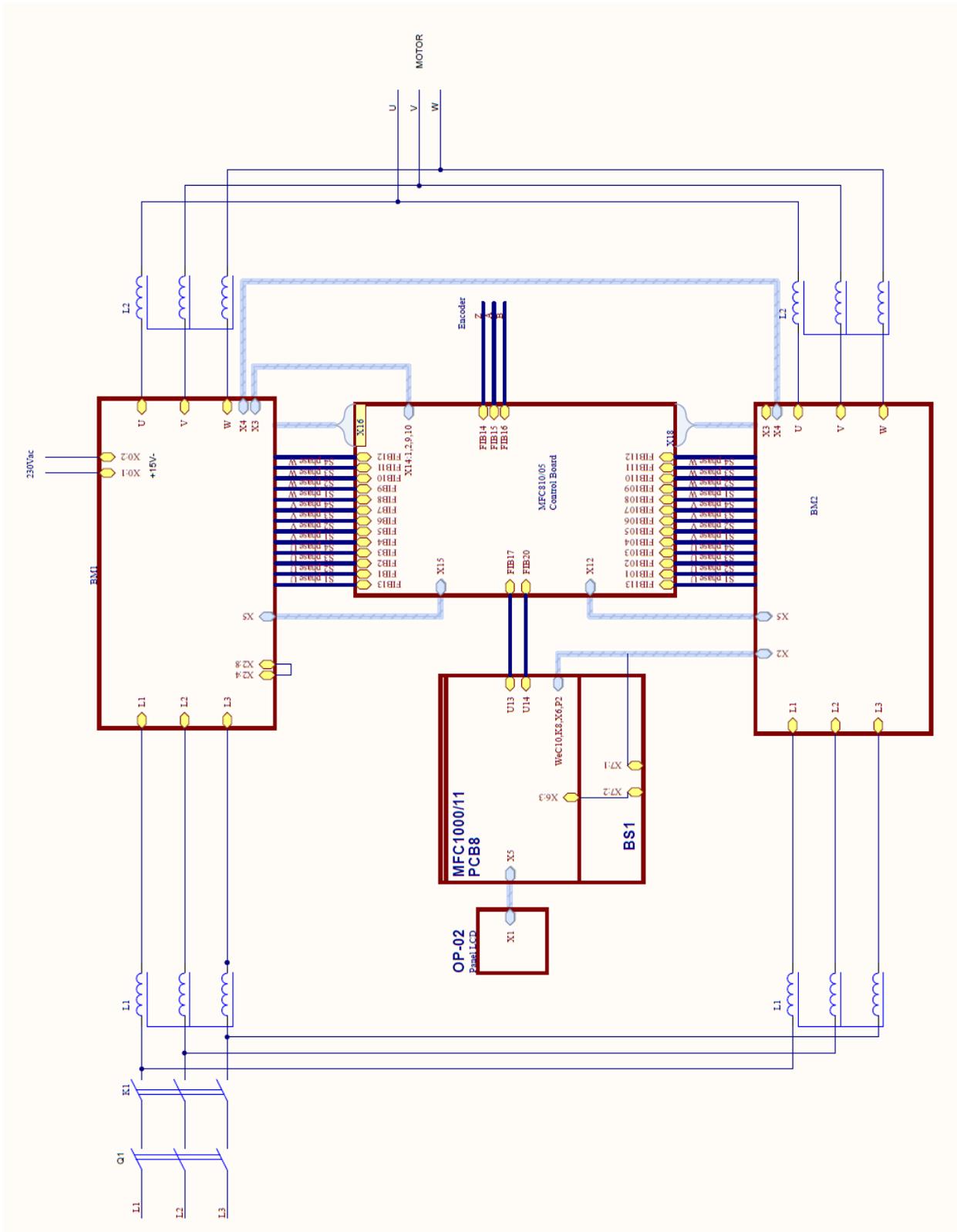
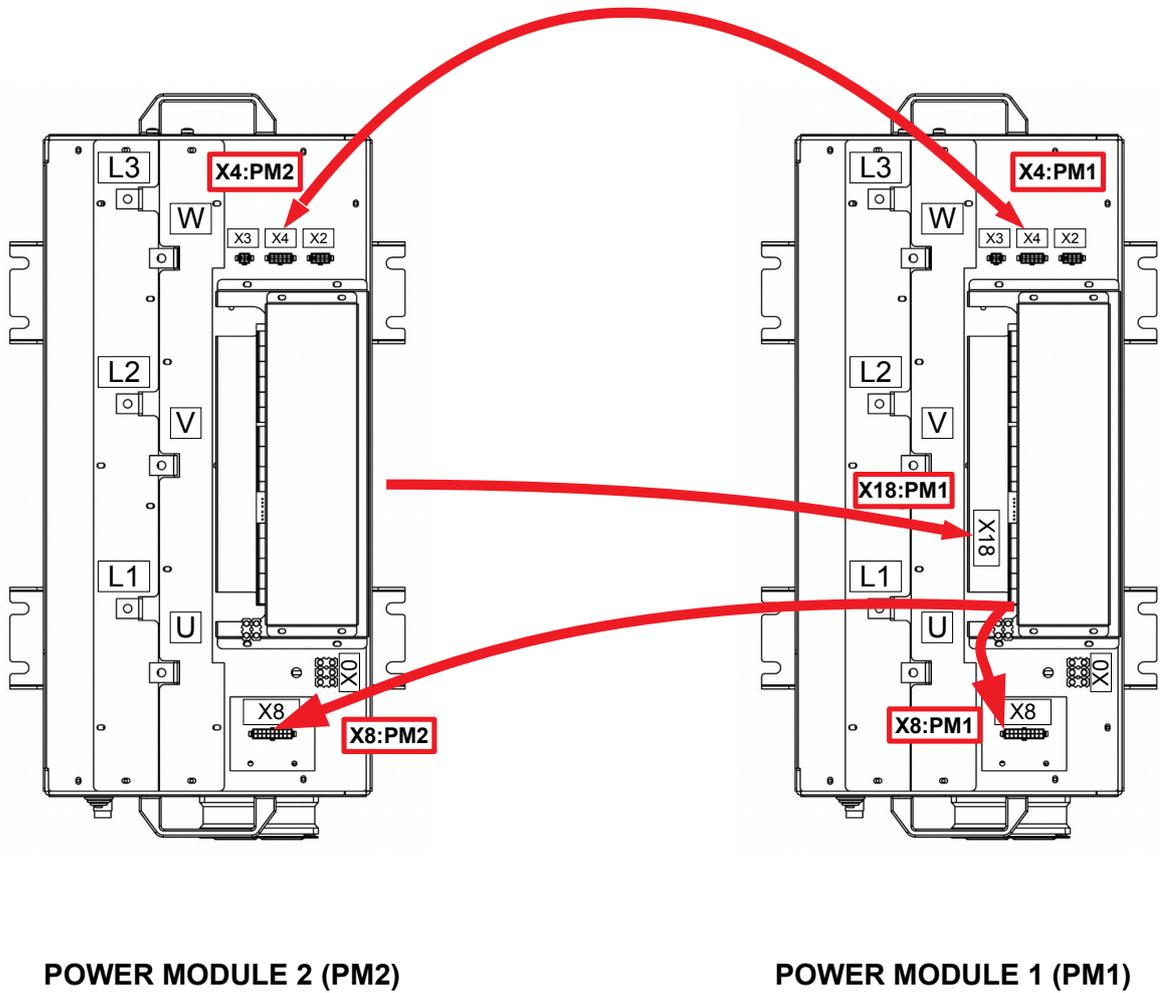


Fig. H.3.1. Electrical connections



POWER MODULE 2 (PM2)

POWER MODULE 1 (PM1)

Fig. H.3.2. Electrical connections between power modules PM1 and PM2

H.3.2. Fiber-optic connections

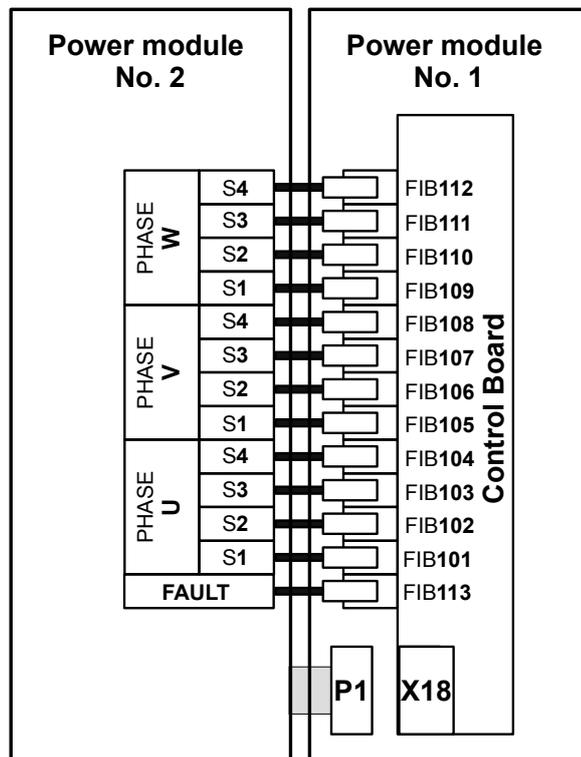


Fig. H.3.3. Fiber-optic connections (FIB101-FIB113) between power modules PM1 and PM2

H.3.2. Liquid cooling

It is necessary to connect hoses and to provide a stream of cooling liquid to every power block (fig. H.2.1 - inlet/outlet), according to the data from the table H.2.1.

H.3.3. The printed circuit board (PCB) 810/05

The printed circuit board 810/05 controls the switching of the IGBT transistors in the Power Modules. This occurs through fiber optic connectors. One MFC810/05 board serves up to two power modules. The fiber optic connectors FIB1 ÷ FIB13 control the operation of the power module 1 (Power Module No. 1). In turn, the fiber optic connectors FIB101 ÷ FIB113 control the operation of the power module 2 (Power Module No. 2).

SW100 switch

The SW100 switch (fig. 3.4) allows you to configure the converter's operation by turning on / off the individual power modules: Power Module No. 1 and Power Module No. 2. This can be useful if one of the modules fails — then you can turn it off with the SW100 switch and continue to work only with another working module.

Caution:

Before changing the SW100 position, it is necessary to disconnect all voltage sources from the converter:

1. The main circuit of 1100..1400 V
2. Auxiliary 230 V.

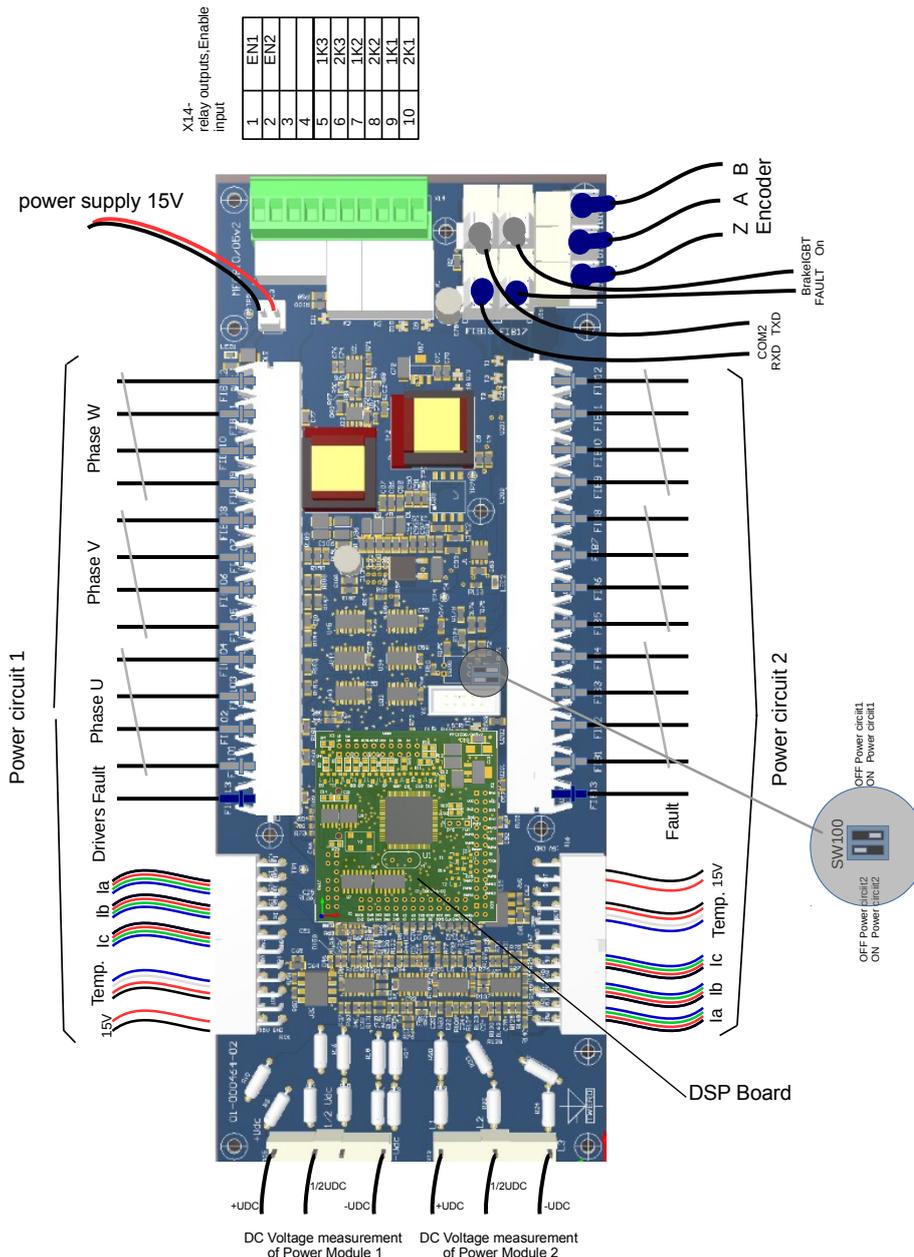


Fig. H.3.4. PCB MFC 810/05: SW100 switch

Power Module 2

Power Module 1

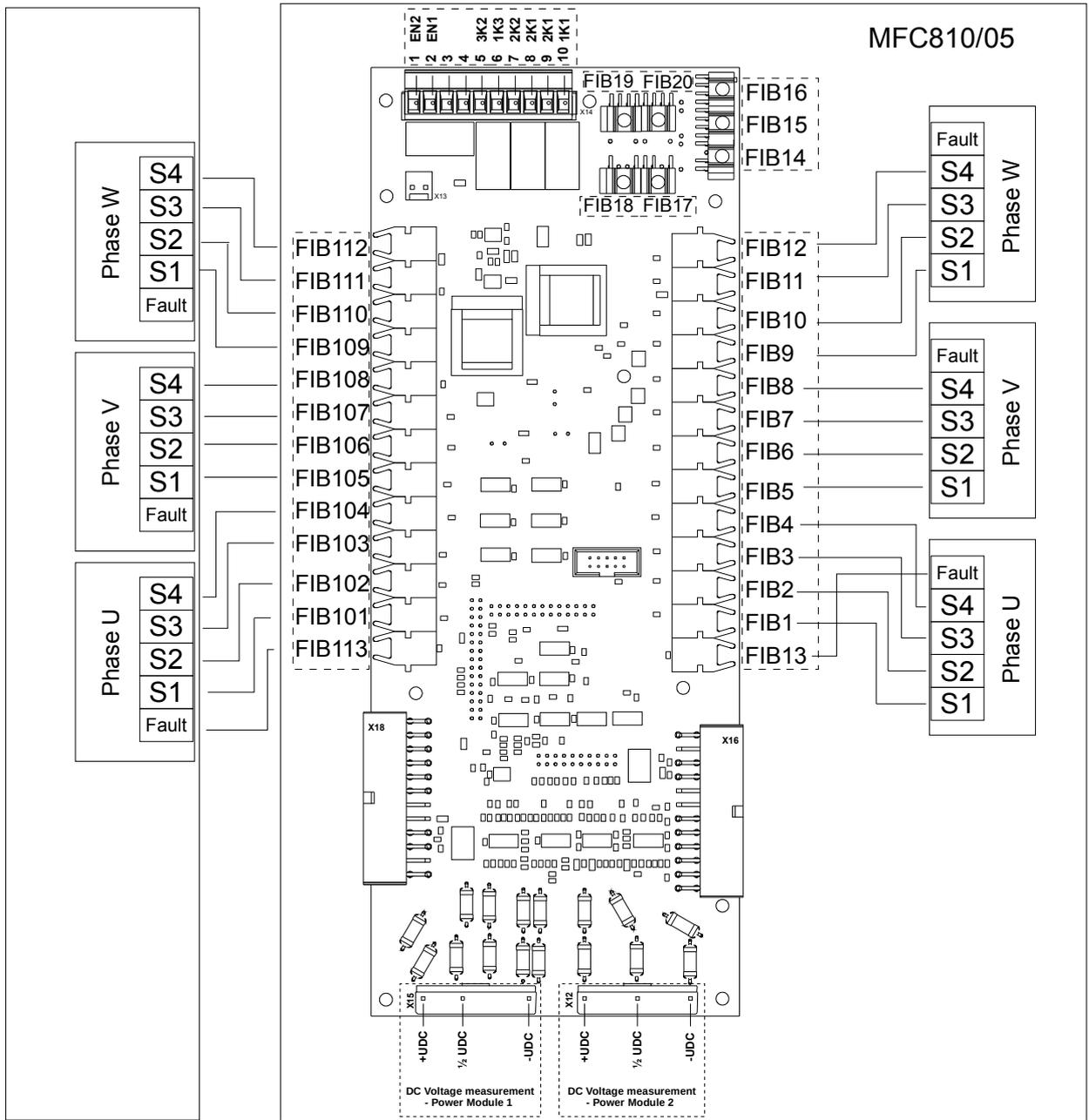


Fig. H.3.5. PCB MFC 810/05: Fiber-optic connections between Control Board MFC810/05 and Power Module 1 and Power Module 2

H.3.4. Connection of the control circuits

Figure H. 3.6. shows the control electronics board used in the converter.

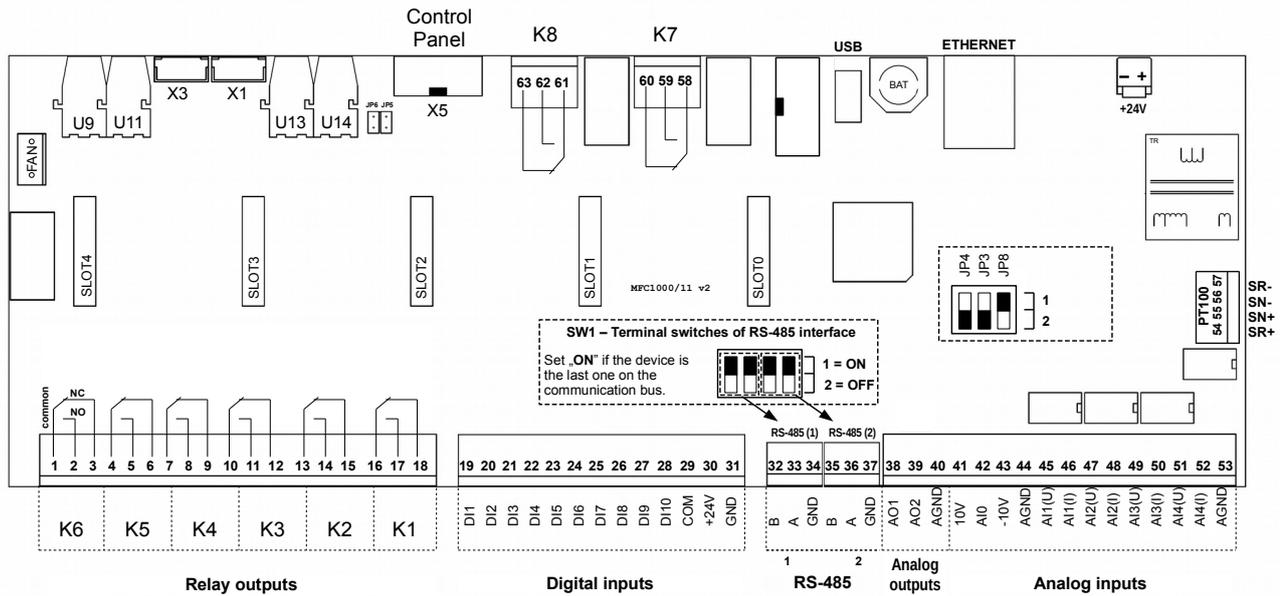


Fig. H.3.6. MFC1000/11 board - the placement of the main elements: analog / digital inputs / outputs, configuration jumpers and fiber optic connections

Note: The JP8 micro switch is used only for device diagnostics. During normal operation should be set to position 1.

Table H.3.1 – Description of the connections used by a user

| | |
|----------------------------|--|
| K1[16-18] - K6[1-3] | Digital relay outputs |
| DI1[19] - DI10[28] | To trigger the digital inputs, use the output voltage of 24V DC [30] or external voltage |
| +24 V [30] | Internal power supply for digital inputs (max. 200mA) |
| GND [31] | The GND potential for digital inputs |
| B[32], A[33], B[35], A[36] | RS-485 communication |
| GND [34], [37] | The GND potential for RS-485 |
| AO1[38], AO2[39] | Analog outputs |
| +10V [41], -10V [43] | +/- 10V DC voltage (max. 20mA) |
| AGND [40], [44], [53] | The GND potential for analogue inputs / outputs |
| AI1(U)[45] - AI4(I)[52] | Analog inputs |

Digital inputs can work in two variants: common ground or common + 24V. The choice of the variant is made by shortening the clamps on the terminal block:

- variant 1 - common mass: COM - GND terminals
- variant 2 - common + 24V: COM terminals - + 24V

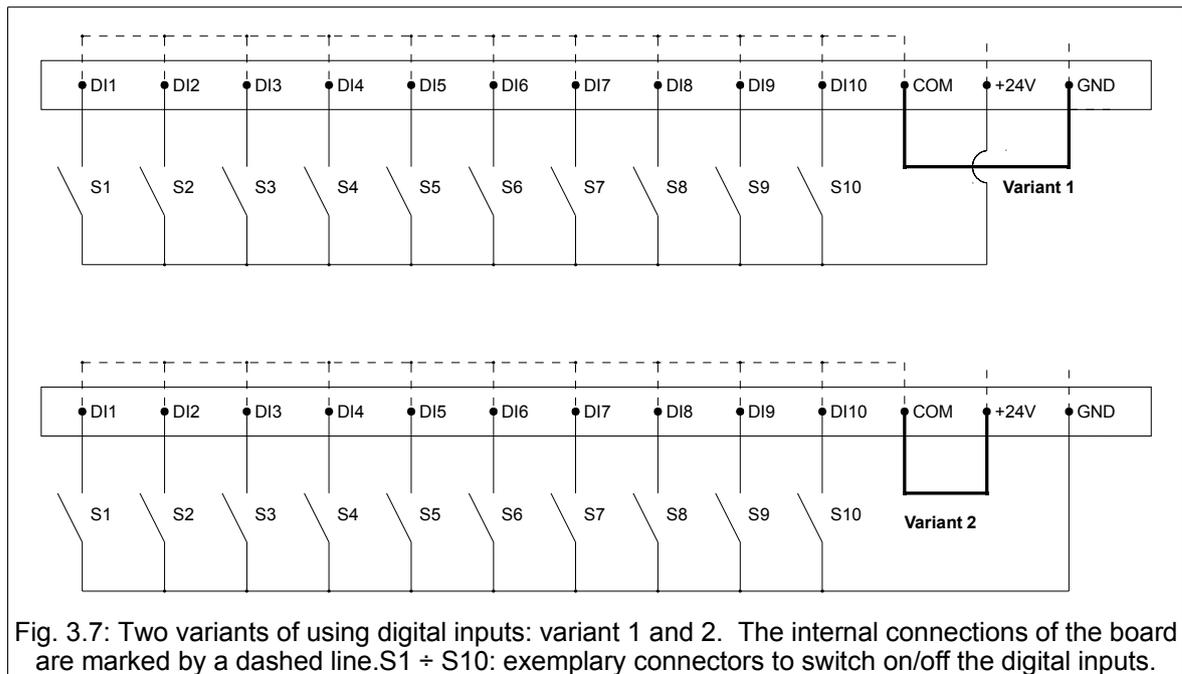


Fig. 3.7: Two variants of using digital inputs: variant 1 and 2. The internal connections of the board are marked by a dashed line. S1 ÷ S10: exemplary connectors to switch on/off the digital inputs.

H.3.5. Expansion cards

Expansion cards enable extending the drive with additional inputs / outputs. There are 5 slots available: 0 ÷ 4. In each of them, one expansion card can be installed. Expansion boards are available:

- 6 digital inputs,
- 6 digital outputs,
- 3 relay outputs,
- 2 analog outputs.

H.3.6. Single module working mode

Each power module has a possibility to work as single power module. When Power module 1 (PM1) and Power module 2 (PM2) work together than one PCB MFC810/05 (placed on top of the PM1) controls both power modules. Also both power modules have one common inputs/outputs board PCB MFC1000/11 – placed on top of the PM2.

In single working mode each power module needs separated PCB'S MFC810/05 and PCB MFC1000/11.

Power module 1 (PM1)

PCB MFC810/05 placed on the top of the PM1 should be moved inside the PM1 to the prepared place – Fig. 3.8. On the top of PM1 the PCB MFC1000/11 should be placed.

Power module21 (PM2)

Power module21 (PM2)

The PCB MFC1000/11 is already placed on the top of PM2, so there it is only necessary to mount the PCB MFC810/05 inside the PM2 – Fig. 3.8

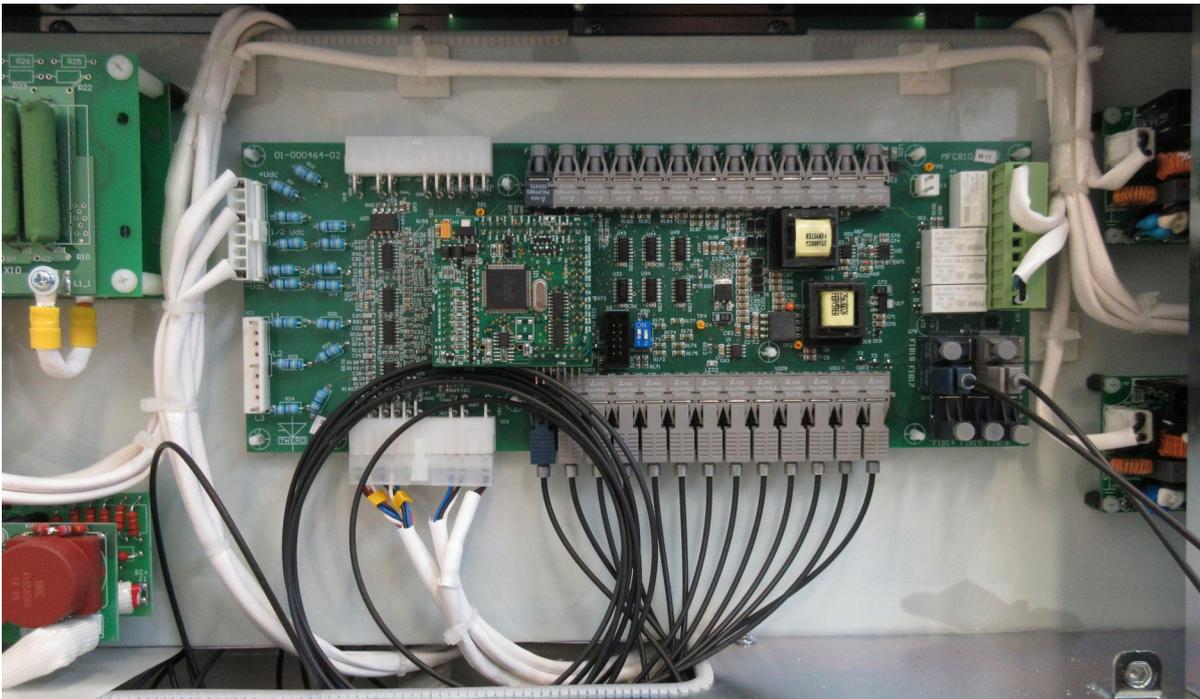


Fig. 3.8: Single module working mode – PCB MFC810/05 placed inside the power module.

(dtr_MFC810-1100V-2x250kW__hrdw_en_v1.2, 2020/05/28)