TWERD™
ENERGO-PLUS

Active Front End converter
with buli-in LCL filter
type:

# MFC1000AcR


## 30 kW, 37 kW
## 45 kW, 55 kW, 75 kW
## 90 kW, 110 kW

## 3 x 400 V
## 3 x 500 V
## 3 x 690 V

**User Manual**
*Part I: Hardware*

*Document version: 4.3,0*

## Table of Contents

# H.1. Conditions of safe operations

Before starting any work with the MFC1000 frequency converter read carefully this User manual.

This User manual contains notices intended to ensure personal safety, as well as to protect the MFC1000 frequency converter and connected equipment against damage.

**Ignorance or not knowing of the information contained in It can cause physical injury or death!**
It can also cause damage to the MFC1000 frequency converter and connected equipment!

*In the further part of this User manual, the MFC1000 frequency converter, to which this instruction applies, will be also referred to as the "drive" or "converter".*

## H.1.1. Warnings

**Incorrect installation, usage, and maintenance of the drive can cause physical injury or death, or damage to the drive and connected equipment!**

**R I S K O F E L E C T R I C**
**S H O C K!**

**The drive contains high voltage when connected to mains voltage!**
**Dangerous voltage present inside the device for at least 10 minutes**
**after disconnecting the power supply!**

- Installation, usage, and maintenance of the drive must be performed only by qualified personnel.
- Don't make any connections changes when the drive is connected to the power supply.
- Before switching on the main power supply and control circuit voltage make sure the drive has been correctly installed and all housing elements have been properly assembled.
- It is forbidden to touch the drive's voltage terminals if it is connected to the power supply.
- After connecting the drive to the supply voltage, its internal components (without the control terminals) are on the power supply potential. Touching these components can cause an electric shock.
- When the drive is connected to the supply voltage, dangerous voltage appears at its output terminals U, V, W even when the electric motor is not running.
- Externally supplied control circuits may carry dangerous voltage even when the input power of the drive is switched off.
- After disconnecting the drive from the supply voltage, dangerous voltages still remain inside the drive due to the energy stored in the power circuit capacitors (DC-link circuit). It can cause an electric shock! The time required for self-discharge of capacitors in an undamaged drive is usually between 5÷15 minutes (a higher power rating of the drive means the longer time).
  For this reason before starting any works on the drive, the electric motor or the electric motor cable always wait at least 10 minutes after disconnecting all power supplies sources and make sure that a voltage on a clamps is not present.
  **Attention! The lack of the voltage at the connection terminals does not ensure the lack of dangerous voltage in the internal DC-link circuit of the drive!**
- The drive is not adapted for use in flammable or explosive environment because it can cause fire or explosion. Use suitable flameproof enclosures.

### H.1.2. Basic rules

- Don’t connect mains voltage to output terminals U, V, W.
- Don’t measure the voltage endurance of any unit drives.
- To measure the cables insulation it is necessary to disconnect them from the drive.
- Do not try to repair the unit yourself. Any repairs must be performed only by authorized service.

  Any modifications or self-repairs of the drive can cause physical injury, death, or damage to the drive and the connected equipment. Any attempt at unauthorised repairs will void any warranty.
- Don’t touch integrated circuits and any other parts on the drive’s electronic board.
- Don't connect any capacitors to motor wires (e.g. intended for improvement of power factor).
- Don't measure output voltage of a converter using digital voltmeters without low-pass filter. The voltage can only be measured correctly with an electromagnetic voltmeter.
- The drive is not designed to operate with periodically switched on/off supply voltage.
- If the electric motor runs at low speed (below 25 Hz), additional cooling of the motor is necessary.

### H.1.3. Operation list

| ***The operations applied at installation and the first start-up of the drive*** | |
|---|---|
| 1. | After unpacking the converter, it is necessary to check up visually the presence of damages which could arise during transport. |
| 2. | Check whether the delivery is in accordance with the order - check the nameplate. |
| 3. | Check up the correspondence between the conditions in which the converter will be used and conditions of an environment for which it is designed (section H.1.4). |
| 4. | Installation of the frequency converter should be made due to the principles of safety and EMC rules. |
| 5. | Perform the configuration of the converter in accordance with the chapters of this manual. |

## H.1.4. Environmental conditions

**Degree of pollution**

The second degree of pollution has been assumed during the design, at which there are normally only non-conducting pollution. However, there is a probability of temporary conductivity caused by a condensation, when the converter is disconnected from the voltage source.
In case the environment in which the frequency converter will work contains pollution, which can influence its safety, it is necessary to apply appropriate counteraction, using, for example, additional cases, air channels, filters etc.

**Climatic conditions**

| | ***Installation site*** | ***During warehousing*** | ***During transport*** |
|---|---|---|---|
| Temperature | from -10°C to +50°C[1]) | -25°C to +55°C | -25°C to +70°C |
| | | Protective packing | |
| Relative humidity | from 5% to 95% | from 5% to 95% | to 95% |
| | Short-term, insignificant condensation on the external side of the converter case is permitted only when the converter is disconnected from the voltage source. | | |
| Air pressure | from 86 kPa to 106 kPa | from 86 kPa to 106 kPa | from 70 kPa to 106 kPa |

## H.1.5. Recycle

Equipment containing electrical and electronic components can not be removed into municipal waste containers. Such equipment must be separated from other wastes and attached to electrical and electronic waste in accordance with applicable local regulations.
This way you help to prevent uncontrolled waste disposal and promote the recycling of materials.

## H.1.6. Limits of responsibility

Despite all the efforts and due diligence of TWERD ENERGO-PLUS sp. z o.o. does not guarantee that the published data is error-free.

The User is obliged to read the information contained in this Manual before using the device. The TWERD ENERGO-PLUS sp. z o.o. is not responsible for any consequences of incorrect use of information contained in this Manual or any infringement of patents or other rights of third parties that may arise from their use.

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For more information contact out technical support at: twerd@twerd.pl

1) For nominal load temperature 40°C was assumed; however, for lower loads higher temperatures are acceptable.

## H.1.7. CE marking

Frequency converters of MFC1000, MFC1000AcR fulfill the fundamental requirements of following instructions of the new approach:

- the Instruction low-voltage LVD 2014/35/EU,
- the Instruction EMC 2014/30/EU.

Mentioned above instructions are fulfilled only after installation of the frequency converter and configuration of the electric drive according to instructions of installation principles and the principles of safety resulted below. User is obliged to fulfill this requirements.

| **Safety** | |
|---|---|
| IEC/EN 50178:2003 | Electronic products which are used in installations of the high power. |
| IEC/EN 61800-5-1:2007 + A1:2017-07 + A11:2021-07 | Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy. |

| **Electromagnetic compatibility** | |
|---|---|
| IEC/EN 61800-3:2008 | Electric power drives with regulated speed. Electromagnetic compatibility (EMC) in consideration of special methods of research |
| | |
| **Conducted emission** | IEC/EN 61800-3:2008 second environment |
| | **Class C3** - with use of installation principles (section 2.1.2) and the equipment (section 2.1.2 without item “**f.4**” and “**f.5**”). |
| **Radiation emission** | IEC/EN 61800-3:2008 second environment |
| | **Class C3** - with use of installation principles (section 2.1.2) and the equipment (section 2.1.2 without item “f.4” and “f.5”). |
| **Resistance** | IIEC/EN 61800-3:2008 first and second environment |

In a frequency converter where to meet the emission requirements for Class C3 the RFI filter is not required, the possibility of radio interference may be expected.

**The inverters are not intended for use in the public low voltage network that supplies residential premises. Radio frequency interference is expected when used in such a network.**

In IT grids usage of asymmetric filters of high frequency (capacitors Y) to reduce emission of interference, ruins the concept of the distributive grid isolated from the ground. Additional grounded impedances can become threat of safety in such systems.

Before buying a drive for use in an IT grid, please contact us to set the individual design of the system.

For technical reasons in some applications (current higher than 400A) fulfilling requirements of EMC is not possible. In such cases user and manufacturer should decide on ways of satisfying EMC requirements in this particular application.

## H.2. Technical data

This User's manual refers to frequency converter MFC1000AcR. Table 2.1 shows the technical data.

**Table 2.1.** Technical data

| | | |
|---|---|---|
| **Power supply** | Voltage $U_{in}$ / freq. | Depending on the type:<br>• **3 x 400 V** (-15%, +10%), 45..66Hz<br>• **3 x 500 V** (-15%, +10%), 45..66Hz<br>• **3 x 690 V** (-15%, +10%), 45..66Hz<br>*Note: information contained the supply voltage is placed on the nameplate.* |
| **Output** | Output voltage | 0 ... $U_{in}$ [V] |
| | Frequency | 0,0 ... 400 Hz – U/f operation mode<br>0,0 ... 120 Hz – Vector operation mode |
| | Frequency resolution | 0.01 Hz |
| **Cooling system** | Cooling is made by a forced ventilation from down to up | |
| **Control system** | Modulator | SVPWM |
| | Operation mode | U/f (linear, exponential),<br>Vector DTC-SVM without sensor<br>Vector DTC-SVM with sensor of the rotor position |
| | Switching frequency | 1 ... 8 kHz<br>*Default: 2,5 kHz for nominal power when supply voltage is 3x400Vac and 2,0kHz for nominal power when supply voltage is 3x690V* |
| | Rotation speed setting | Analog inputs, control panel, motopotentiometer, PID controller, communication unit RS-485 and other possibilities.<br>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):<br>AI0: voltage mode 0(2) ... 10V, $R_{IN}$ ≥ 350 kΩ;<br>AI1, AI2, AI3, AI4:<br>voltage mode 0(2) ... 10V, $R_{IN}$ ≥ 100 kΩ;<br>current mode 0(4)...20mA, $R_{IN}$ = 250 Ω,<br>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, $R_{IN}$ ≥ 6 kΩ.<br>The possibility of obtaining up to 30 digital inputs on expansion cards. |
| | Analog outputs | 2 analog outputs (voltage-current mode)<br>AO1, AO2:<br>Voltage mode 0(2)...10 V, $R_L$ > 10 kΩ<br>Current mode 0(4)...20 mA, $R_L$ < 1 kΩ<br>Configured by parameters, accuracy: 0.5%.<br>The possibility of obtaining up to 10 digital inputs via expansion cards. |
| | Relay outputs | 6 relays output K1..K6 – breaking capacity: 250V/1A AC, 24V/1A DC.<br>Fully programmable signal source. The possibility of obtaining up to 25 relay outputs via expansion cards. |
| | Encoder interface | Possibility to connect HTTL 24V or TTL 5V/12V encoder via expansion cards. |
| | Temperature sensor | Pt100 |

| | | |
|---|---|---|
| **Connectors and communication channels** | Modbus RTU | RS-485 – two build-in connectors, third connector is available via expansion cards.<br>Functions: 3 (Read Register), 6 (Write Register), 16 (Write Multiple Registers).<br>Baud-rate: 2400, 4800,9600, 19200, 38400, 57600, 115200 bit/s<br>Application: remote control of operation and programming of all parameters of the frequency converter.<br>Note: the second build-in RS-485 connector port uses a common communication channel with the Ethernet port (Modbus TCP protocol) and only one of them can be used. |
| | Modbus TCP | Build-in Ethernet connector.<br>Application: remote control of operation and programming of all parameters of the frequency converter. |
| | CAN, Ethernet IP, Profinet | Via optional expansion cards.<br>Application: remote control of operation and programming of all parameters of the frequency converter. |
| | USB | Only for service purpose: backup of parameters settings, firmware updating. |
| **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.<br>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 | MFC1000 400 V: 1,43 $U_{in}$ AC, 750 Vdc<br>MFC1000 500 V: 1,43 $U_{in}$ AC, 900 Vdc<br>MFC1000 690 V: 1,28 $U_{in}$ AC, 1200 Vdc |
| | 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 ... 10V 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 2.2.** Technical data of frequency converters of the **MFC1000AcR 400V** series, depending on a type

| Type of frequency converter | $P_n$ [kW] | $I_n$ [A] | $I_p$ [A] |
|---|---|---|---|
| MFC1000AcR/30kW | 30 | 60 | 90 |
| MFC1000AcR/37kW | 37 | 75 | 112 |
| MFC1000AcR/45kW | 45 | 90 | 135 |
| MFC1000AcR/55kW | 55 | 110 | 165 |
| MFC1000AcR/75kW | 75 | 150 | 225 |
| MFC1000AcR/90kW | 90 | 180 | 270 |
| MFC1000AcR/110kW | 110 | 210 | 215 |

**Table 2.3.** Technical data of frequency converters of the **MFC1000AcR 500V** series, depending on a type

| Type of frequency converter | $P_n$ [kW] | $I_n$ [A] | $I_p$ [A] |
|---|---|---|---|
| MFC1000AcR/30kW 500V | 30 | 50 | 75 |
| MFC1000AcR/37kW 500V | 37 | 60 | 90 |
| MFC1000AcR/45kW 500V | 45 | 72 | 108 |
| MFC1000AcR/55kW 500V | 55 | 90 | 135 |
| MFC1000AcR/75kW 500V | 75 | 120 | 180 |
| MFC1000AcR/90kW 500V | 90 | 150 | 225 |
| MFC1000AcR/110kW 500V | 110 | 180 | 270 |

**Table 2.4.** Technical data of frequency converters of the **MFC1000AcR 690V** series, depending on a type

| Type of frequency converter | $P_n$ [kW] | $I_n$ [A] | $I_p$ [A] |
|---|---|---|---|
| MFC1000AcR/30kW 690V | 30 | 36 | 52 |
| MFC1000AcR/37kW 690V | 37 | 43 | 65 |
| MFC1000AcR/45kW 690V | 45 | 52 | 78 |
| MFC1000AcR/55kW 690V | 55 | 64 | 95 |
| MFC1000AcR/75kW 690V | 75 | 87 | 130 |
| MFC1000AcR/90kW 690V | 90 | 104 | 156 |
| MFC1000AcR/110kW 690V | 110 | 121 | 182 |

$P_n$ – nominal output power
$I_n$ – nominal output current
$I_p$ – overload current: for 60 seconds every 10 minutes

**MECHANICAL DIMENSIONS**

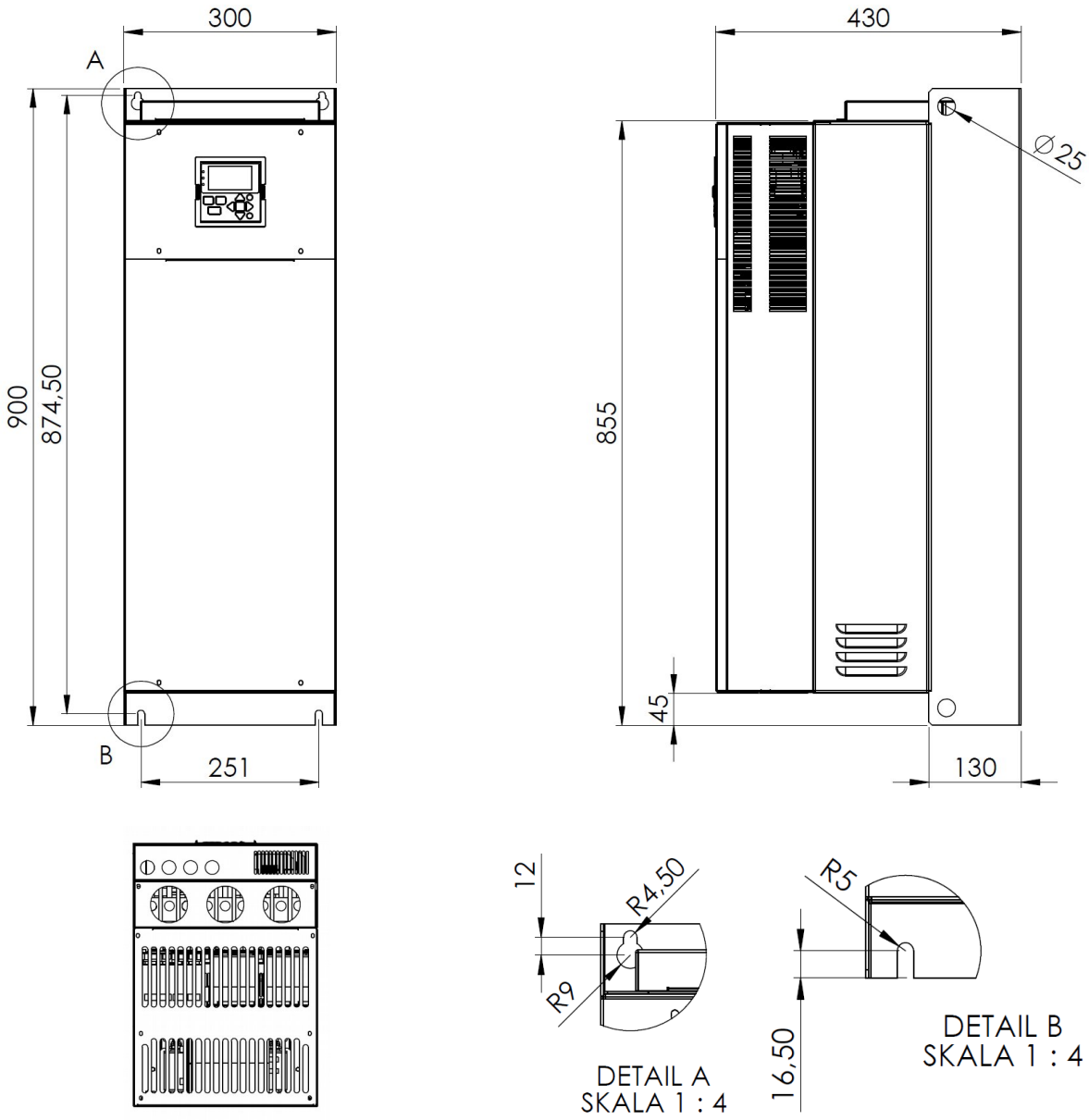


**Fig. 2.1.** Mechanical dimensions MFC1000AcR converters

Weight: approximately 102 kg ±10 kg – depending on the nominal power and custom modifications.

# H.3. Installation

## H.3.1. Safety principles

**a. 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 levelling connections in a corresponding way.

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

**b. Protections**

Usage of gG or aM fuses is allowed in the circuits, however taking into account necessity of protection of the rectifier bridge of the frequency converter, the best solution is gR or aR fuses.
Frequency converter is protected from: drive overloading, motor overheating, under- and overvoltage in an DC link circuit of the converter, a short-circuit at the converter output - it protects converter only!

**c. 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.**

**d. 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.**

**e. Housing**

The housing 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.

**f. 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 10 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.3.2. Electromagnetic Compatibility (EMC)

The installation principles reducing EMC problems are divided into four groups. To achieve full success it is necessary to apply all principles listed below. Not applying to one of principles ruins the effect of others.

- separation,
- equalizer connections,
- shielding,
- filtration.

**a. Separation**
Power cables (supplying, motor's) must be separated from signal wires. It is necessary to avoid parallel leading of power and signal wires in the common wire channels, and especially in group of cables. The crossing of power cables and signal cables under a right angle is allowed.

**b. Equipotential connections**
The frequency converter and the filter should be mounted as close as possible, preferably on a common metal plate which act as a ground. For this purpose you can use, a mounting plate or a back wall of a case for example. The casing of the frequency converter, the filter and the metal plate shouldn't be coated with any insulation materials. It is necessary to pay attention to an opportunity of oxidation of a surface that results in deterioration of contact. For limitation of asymmetric disturbance level, it is necessary to apply many connections of the cable shielding to ground.

**c. Shielding**
Wires between the mains filter and the frequency converter are not necessary for shielding, if their length doesn't exceed 300mm. In case the length of conductors exceeds 300mm it is necessary to use the shielded wires. Completely shielded cable is a cable which fully complies with requirements of interference radiation according to EN 55011 norms. Such cable should have the screen consisting of spiral metallized aluminium foil and tinned copper plait with a puls-duty factor of not less than 85 %, not separated galvanically.

Connection of the cable ends to ground is obligatory. It is necessary to use grounding of the cable shielding on whole section of a cable, on both ends. For this purpose a special EMC grommets are used. They provide valid contact of cable shielding to the case of the equipment. In addition it is necessary to use special cable clips to connect it to back wall of a case for example. It is necessary to pay attention that the unshielded cables, are as short as possible. Junctions of the shielding with a ground should be free from insulating coat on a whole section. Be careful not to damage the shielding. It is not recommended to weave the copper plait in one point (without using EMC grommet) in order to realize grounding.
In case of need control signal wires should also be shielded using the same principles.

**d. Filtration**
Use of the EMC filter limits noises spreading from electric drive system to mains. Principles of filter installation are described at the description of equipotential connections and shielding.

**e. Ferrite rings**
The reduction of interference emission can be obtained by using ferrite rings located on the input wires (power supply wires) and output wires (to an electric motor).

**f. The list of the equipment reducing EMC problems**
The list contains the equipment which can be additionally established in the electric drive system to increase its noise stability and to reduce emission of interferences in the certain environment of operation.

1. completely shielded cables - we recommend cables TOPFLEX EMV and TOPFLEX EMV 3 PLUS (HELUKABEL),
2. EMC grommets (throttles),
3. Ferrite rings,
4. RFI filter (REO, SCHAFFNER),
5. EMC case - an option, which is not necessary for fulfillment of the EMC instructions.

## H.3.3. Connecting the power circuit

The frequency converter is powered by a three-phase power line through terminals L1, L2, L3. Information about the supply voltage is also placed on the nameplate. Figure 3.1 shows the electric scheme of the power circuit connections.

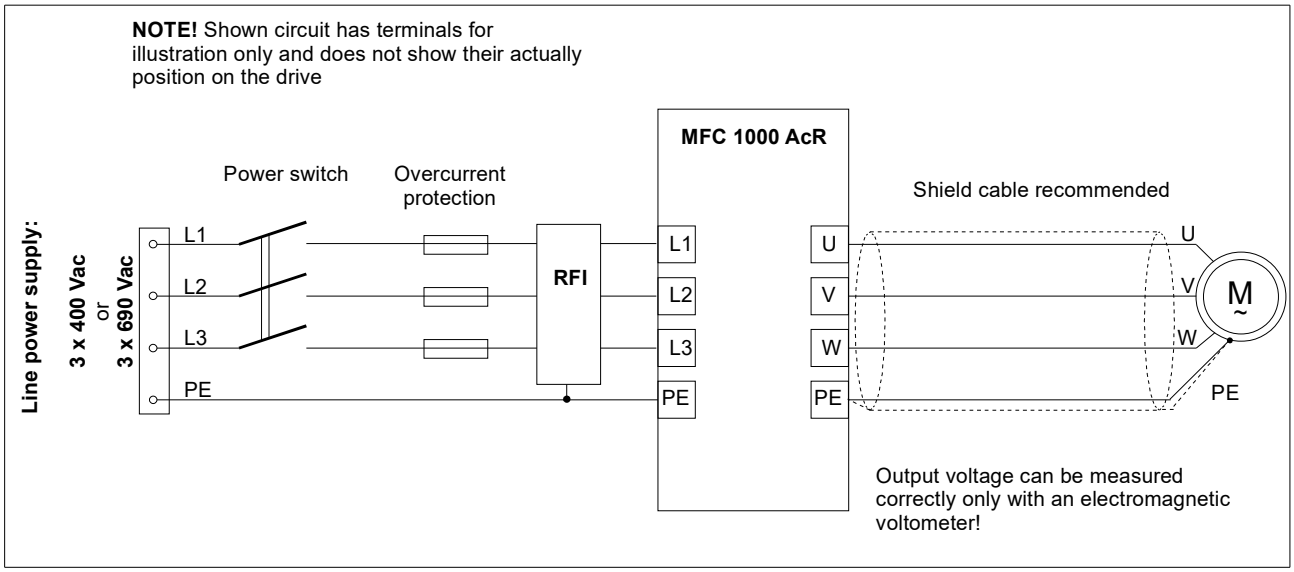


**Fig. 3.1.** Example connections of the power circuit

## H.3.4. Using contactors between the frequency converter and the motor

If it is necessary to use contactors between the drive and the motor, make sure to switch the contactor when there is no voltage on the output terminals and the drive is stopped (STOP status). Otherwise, there is a high probability of damage to the drive.

CAUTION: just issuing the STOP command is not enough, because there is a possibility of programmatic delay of the reaction to the STOP command (par. 13.20) and the possibility of setting the ramp stop (par. 11.20). For this reason, in order to avoid damage, it is necessary to check the operation status of the converter (PCH514), e.g. by using one of the relays output K.

## H.3.5. Connection of control circuits

Figure 3.2 shows the MFC1000/11 control electronic board used in the converter. The communication channels description can be found in the second part of the user manual "Software".

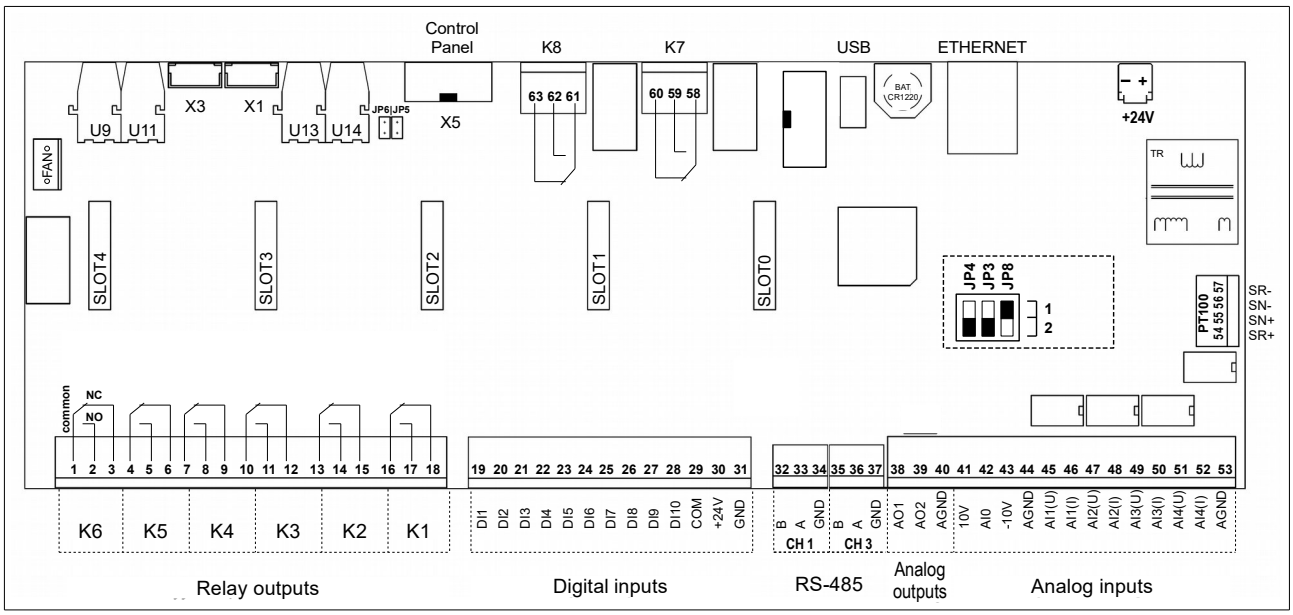


**Fig. 3.2.** MFC1000/11 board - the placement of the main elements

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

**Table 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 |

### H.3.5.1. Relay outputs

The MFC1000/11 control board has built-in 6 relay outputs K1-K6: 250V/1A AC, 24V/1A DC. The expansion cards allow you to increase the number of relay outputs by 25. Fig. 3.3 shows an example of connection.

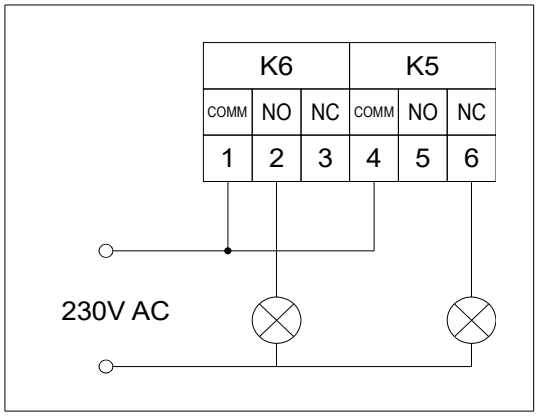


**Fig. 3.3.** An example of K5 and K6 relays outputs connection

Operating mode configuration is done by parameters in group 27 and 28.

### H.3.5.2. Digital inputs

The MFC1000/11 control board has built-in 10 separated digital inputs DI1÷DI10 0÷15..24V; internal resistance $R_{IN}$ ≥ 6 kΩ. The expansion cards allow you to increase the number of digital inputs by 30. Digital inputs can be connected in two variants:

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

Fig 3.4 shows an example of connection.

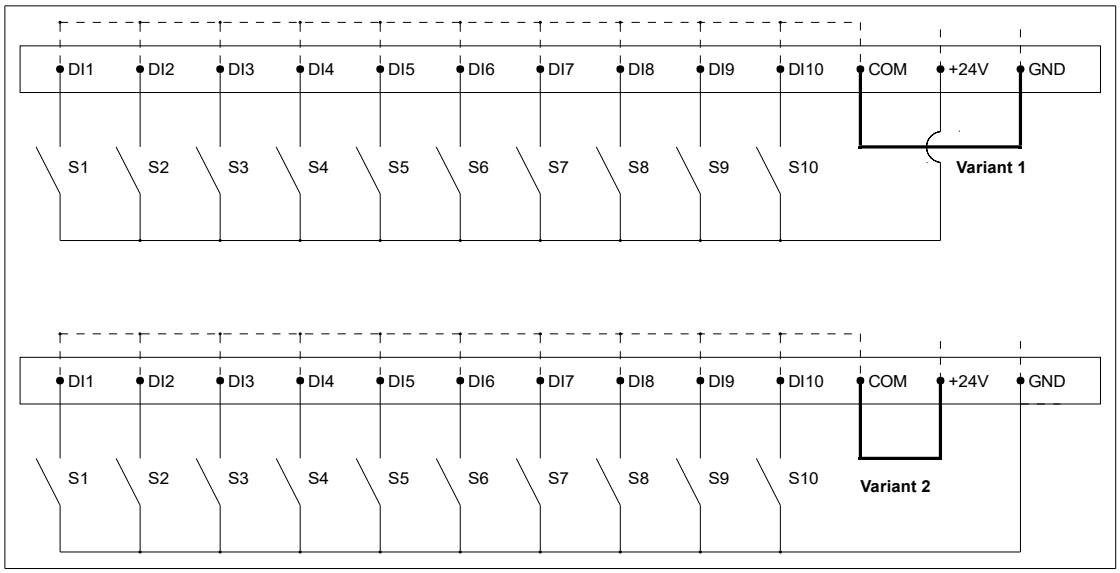


**Fig. 3.4.** Two variants of using the digital inputs: variant 1 and variant 2.
The internal connections of the board are marked by a dashed line.
S1 ÷ S10: exemplary connectors to switch on/off the digital inputs

Operating mode configuration is done by parameters in group 26.

### H.3.5.3. Analog outputs

The MFC1000/11 control board has built-in 2 analog outputs AO1 and AO2. These outputs can work in current mode 0(4)..20mA or voltage mode 0(2)..10V. Signal inversion is possible: 20..0(4)mA lub 10..0(2)V. The expansion cards allow you to increase the number of analog outputs by 30. Fig. 3.5 and 3.6 shows an examples of connections.

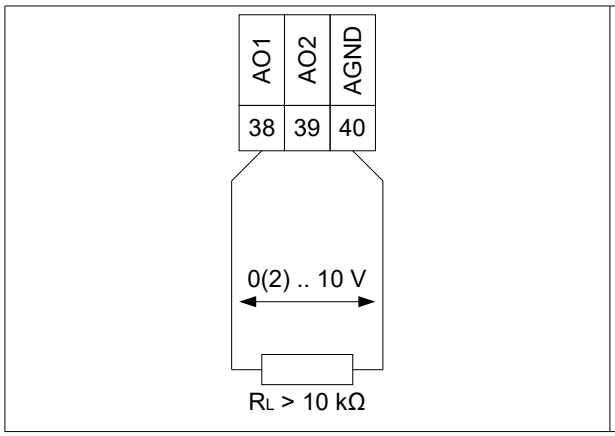


**Fig. 3.5.** AO1 output in voltage mode

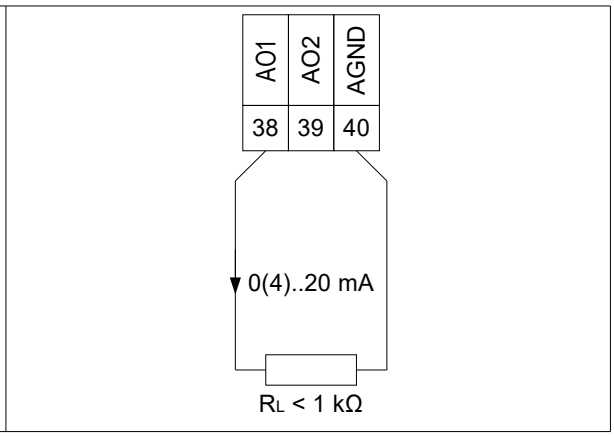


**Fig. 3.6.** AO1 output in current mode

$R_L$ – resistance of the connected circuit.
Operating mode configuration is done by parameters in group 25.

### H.3.5.4. Analog inputs

The MFC1000/11 control board has built-in 5 analog inputs AI0÷AI4.

AI0: voltage mode 0(2)..10 V, internal resistance $R_{IN}$ ≥ 350 kΩ;
AI1, AI2, AI3, AI4:

- voltage mode 0(2)..10 V, internal resistance $R_{IN}$ ≥ 100 kΩ
- current mode 0(4)..20 mA, internal resistance $R_{IN}$ = 250 Ω,

Operating mode configuration is done by parameters in group 24 i 32.
Fig. 3.7 shows an example of connection.

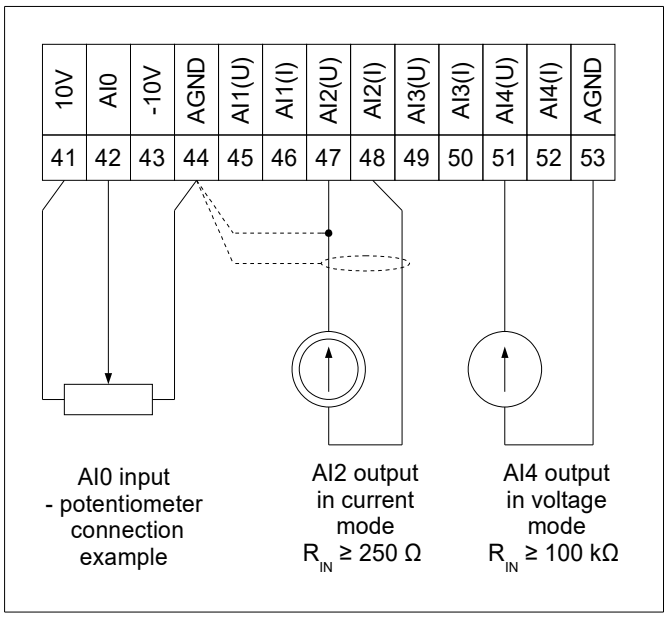


**Fig. 3.7.** An example of analog inputs connection;
$R_{IN}$ – internal resistance

## H.3.6. 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. Table 3.2 lists the available expansion cards.

**Table 3.2.** Available expansion cards

| Expansion card symbol | Description | Slot |
|---|---|---|
| MFC1000/512 | CAN communication card | SLOT 0 |
| MFC1000_ANYBUS_01 | Anybus communication card (Ethernet IP, Profinet) | SLOT 0 (the card has to be placed in slot 0, but the width of the card prevents the use of slots 1 and 2) |
| MFC1000/520 | 6 digital inputs card | SLOT 0, 1, 2, 3, 4 |
| MFC1000/521 | 3 relay outputs card | SLOT 0, 1, 2, 3, 4 |
| MFC1000/524 | 5 relay outputs card | SLOT 0, 1, 2, 3, 4 |
| MFC1000/502 | HTTL 24V encoder card | SLOT 0, 1, 2, 3, 4 |
| MFC1000/503 | TTL 5V/12V encoder card | SLOT 0, 1, 2, 3, 4 |
| MFC1000/523 | 6 digital OC outputs card | SLOT 0, 1, 2, 3, 4 |
| MFC1000/530 | 2 analog outputs card | SLOT 0, 1, 2, 3, 4 |

Note: Communication cards should only be placed in **slot 0**.

Examples of the use of extension cards are shown in Fig. 3.8.

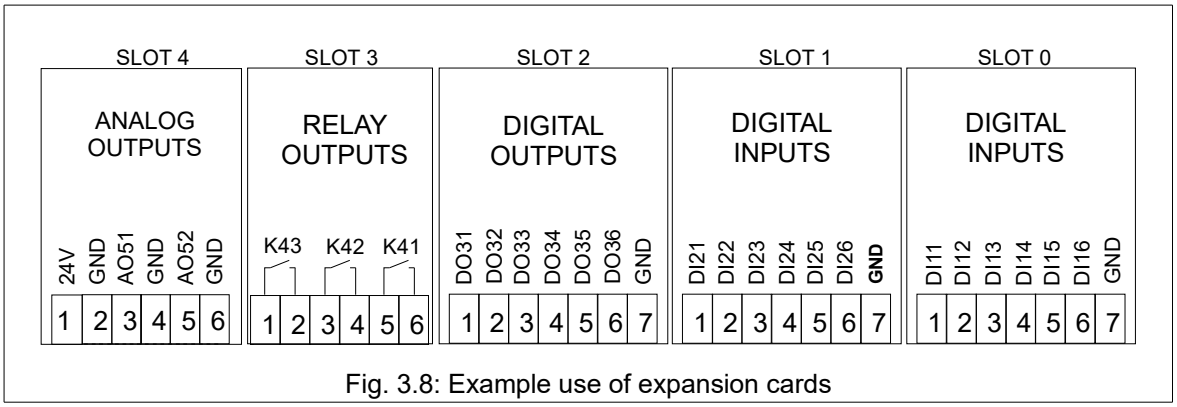


Fig. 3.8: Example use of expansion cards

| SLOT0 | | | |
|---|---|---|---|
| Digital Inputs expansion card | Digital Outputs expansion card | Relays expansion card | Analog Outputs expansion card |
| DI11 | DO11 | K13 | AO11 |
| DI12 | DO12 | K12 | AO12 |
| DI13 | DO13 | K11 | xxx |
| DI14 | DO14 | xxx | xxx |
| DI15 | DO15 | xxx | xxx |
| DI16 | DO16 | xxx | xxx |

| SLOT1 | | | |
|---|---|---|---|
| Digital Inputs expansion card | Digital Outputs expansion card | Relays expansion card | Analog Outputs expansion card |
| DI21 | DO21 | K23 | AO21 |
| DI22 | DO22 | K22 | AO22 |
| DI23 | DO23 | K21 | xxx |
| DI24 | DO24 | xxx | xxx |
| DI25 | DO25 | xxx | xxx |
| DI26 | DO26 | xxx | xxx |

| SLOT2 | | | |
|---|---|---|---|
| Digital Inputs expansion card | Digital Outputs expansion card | Relays expansion card | Analog Outputs expansion card |
| DI31 | DO31 | K33 | AO31 |
| DI32 | DO32 | K32 | AO32 |
| DI33 | DO33 | K31 | xxx |
| DI34 | DO34 | xxx | xxx |
| DI35 | DO35 | xxx | xxx |
| DI36 | DO36 | xxx | xxx |

| SLOT3 | | | |
|---|---|---|---|
| Digital Inputs expansion card | Digital Outputs expansion card | Relays expansion card | Analog Outputs expansion card |
| DI41 | DO41 | K43 | AO41 |
| DI42 | DO42 | K42 | AO42 |
| DI43 | DO43 | K41 | xxx |
| DI44 | DO44 | xxx | xxx |
| DI45 | DO45 | xxx | xxx |
| DI46 | DO46 | xxx | xxx |

| SLOT4 | | | |
|---|---|---|---|
| Digital Inputs expansion card | Digital Outputs expansion card | Relays expansion card | Analog Outputs expansion card |
| DI51 | DO51 | K53 | AO51 |
| DI52 | DO52 | K52 | AO52 |
| DI53 | DO53 | K51 | xxx |
| DI54 | DO54 | xxx | xxx |
| DI55 | DO55 | xxx | xxx |
| DI56 | DO56 | xxx | xxx |

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