TWERD ENERGO-PLUS

MFC710/AcR

Regenerative frequency converter enabling energy return to the mains

General description
Mechanical dimensions
Electrical connection diagram
Failure codes
List of parameters

MFC710 User's Manual supplement

Edition 4.5,0 en

www.twerd.pl

ATTENTION:

This description of MFC710 / AcR supplements the description of MFC710 and includes:

- general description of the MFC710 / AcR frequency converter,
- mechanical dimensions,
- electrical power circuit connection diagram,
- failure codes,
- list of additional parameters active only in the MFC710 / AcR converter.

- Other information, such as:
- nominal currents values,
- operating the control panel,
- description of individual frequency converter functions,
- list of all parameters

are the same as in the MFC710 frequency converter and are included in the "Frequency converter type MFC710" user's manual.

- **The information contained in this MFC710 / AcR description takes precedence over the information contained in the MFC710 manual.**

- Before mechanical and electrical installation and using the MFC710/AcR regenerative frequency converter, the user is obliged to read both this description of MFC710/AcR and the manual of the MFC710 frequency converter.

- The user bears the full consequences of not complying with the above recommendations.

- In case of any doubts, please contact us. Contact details can be found on the company website www.twerd.pl in the "contact" tab.

The terms "frequency converter", "converter" and "inverter" in this description are used interchangeably.

Contents

1. General description of the MFC710/AcR frequency converter

The MFC710/AcR frequency converter was developed by extending the MFC710 frequency converter with an AcR (Active Rectifier) reversible rectifier module replacing the conventional diode input circuit. This eliminates the problems arising from the use of diode rectifiers:

- power supply current and voltage distortions caused by the non-linear load,
- no possibility of returning electricity to the mains.

Fig. 1.1 shows block diagrams of both types of converters.

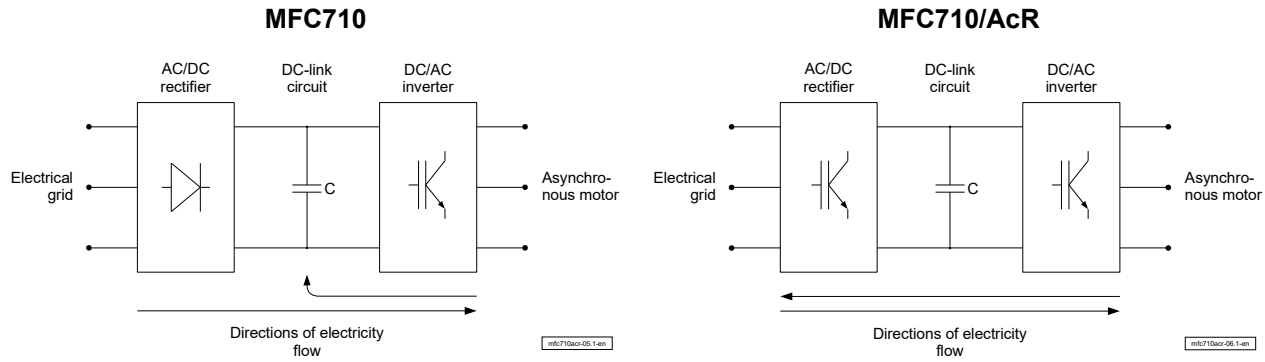


Fig. 1.1: Block diagrams of MFC710 and MFC710/AcR converters

Using the MFC710/AcR converter, we obtain:

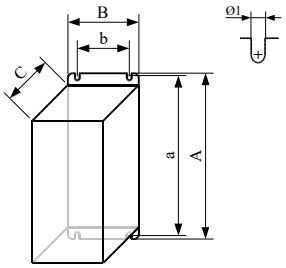
1. **FC power factor correction, limitation of THDi current distortion factor and THDu voltage.**
   The AcR module allows to obtain a sinusoidal waveform of the consumed current, eliminating the negative impact of higher harmonics introduced into the power supply network when using conventional power supply systems.
2. **Bidirectional power flow, four-quadrant operation.**
   In converter drives, there is often a situation in which the energy accumulated in the load must be transferred back to the source or lost in the form of heat on an additional resistor. If this process is intense or repeated often, the use of an additional braking resistor may be unprofitable or impossible. The AcR module allows bidirectional power flow, so that it can transfer the stored energy to the mains for recycling. Such a solution is justified not only from the point of view of the energy balance but also from the point of view of operating costs. The module is used, among others in drive applications for centrifuges, cranes and the processing of energy obtained from renewable sources.
3. **Voltage stabilization in the intermediate circuit.**
   The AcR module is a three phase AC / DC boost converter. This means that the voltage in the intermediate circuit of the inverter may be higher than the mains voltage. The use of the AcR module in the frequency converter allows for higher voltage than the supply voltage at the inverter output (e.g. 400VAC 50Hz input voltage, 0-500VAC 0-400Hz output voltage).

2. Mechanical dimensions

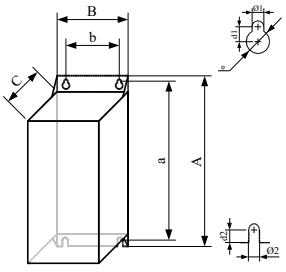
Assembly drawings

Dimensions of frequency converters MFC 710 / AcR type.

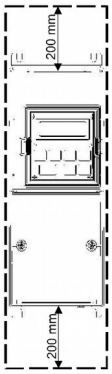
Enclosure type A



Enclosure type B



Free space around the converter



It is necessary to provide some free space around the converter for appropriate air circulation.

*Table 2.1: Dimensions of the **MFC710/AcR 400V** and **MFC710 500V** frequency converters*
(replaces the table 0.3a in the MFC710 user's manual)

Modification	***Type of a converter***	***Dimensions [mm]***										***Weight[1] [kg]***
		a	***A***	***b***	***B***	***C***	***d1***	***d2***	***Ø1***	***Ø2***	***φ***	
A	0,75kW	255	267	2x75 [4]	2x114 [4]	154	-	-	7	7	-	6,5
	1,1kW											
	1,5kW											
	2,2kW											
	3kW											
	4kW											
	5,5kW	322	337	2x90 [4]	2x130 [4]	188	-	-	7	7	-	12
	7,5kW											
	11kW	322	337	2x90 [4]	2x130 [4]	223	-	-	7	7	-	15
	15kW											
	18,5kW											
B	22kW	590	615	192	256	266	10	15	8,2	8,2	15	30
	30kW											
	37kW											
	45kW											
	55kW											
	75kW	838	865	190	283	400	12	15	8,5	8,5	18	60
	90kW											
	110kW	875	920	338	460	345	15	25	13	13	22	100
	132kW											
	160kW											
	200kW											
	250kW											
	315kW	875	920 940 [2]	420 558 [3]	640	345	15	25	13	13	22	130
	355kW											
	400kW	1045	1090 1127[2]	2x317	800	345	15	25	13	13	22	200
	450kW											
	500kW											

*Table 2.1: Dimensions of the **MFC710/AcR 690V** frequency converters*
(replaces the table 0.3b in the MFC710 user's manual)

Modification	***Type of a converter***	***Dimensions [mm]***										***Weight[1] [kg]***
		a	***A***	***b***	***B***	***C***	***d1***	***d2***	***Ø1***	***Ø2***	***φ***	
B	45	*Casings are chosen according to the individual requirements.*										
	55											
	75 kW	838	865	190	283	400	12	15	8,5	8,5	18	65
	90 kW											
	110 kW	875	920	338	460	345	15	25	13	13	22	100
	132 kW											
	160kW											
	200kW											
	250kW	875	920 940 [2]	420 558 [3]	640	345	15	25	13	13	22	130
	315kW											
	355kW											
	400kW	1045	1090 1127 [2]	2x317	800	345	15	25	13	13	22	200
	450kW											
	500kW											
	560kW	*Cabinet construction*										
	630kW											
	800kW											

1. Approximate weight of a frequency converter, may vary depending on its construction.
2. Height of a frequency converter increased due to due to protruding rails for power and load connection.
3. Bottom spacing of mounting holes.
4. In version A, we use two identical casings placed next to each other.

We also offer MFC710 / AcR converters in a cabinet version with a selected degree of IP protection according to individual customer requirements.

3. Installation of the frequency converter

3.1. Connecting the power circuit

The MFC710 / AcR drive is typically powered by a 3x400V 50Hz three-phase network. We also offer versions for other voltages (e.g. 3x500V, 3x690V). It should be noted that all parameters resulting from load currents are given for the 3x400V power supply network. Fig.3.1, 3.2 and 3.3 show variants of high-current connections - depending on the converter design. These diagrams replace the diagram in fig. 2.1 in the MFC710 manual. The cable cross-sections and the type of line reactor should be selected depending on the load current. To meet the requirements of the European Union Directive in the field of EMC electromagnetic compatibility, a four-wire cable should be used in the screen, supplying the motor (three phases + protective conductor).The type of line chokes and protections is available from the manufacturer's representative.

If there is a need to use contactors between the converter and the motor, care should be taken to switch the contactor off in a voltage free state when the converter is stopped (STOP state). Otherwise, there is a risk of damaging the converter. For more information, refer to chapter 2.3 of the MFC710 user's manual.

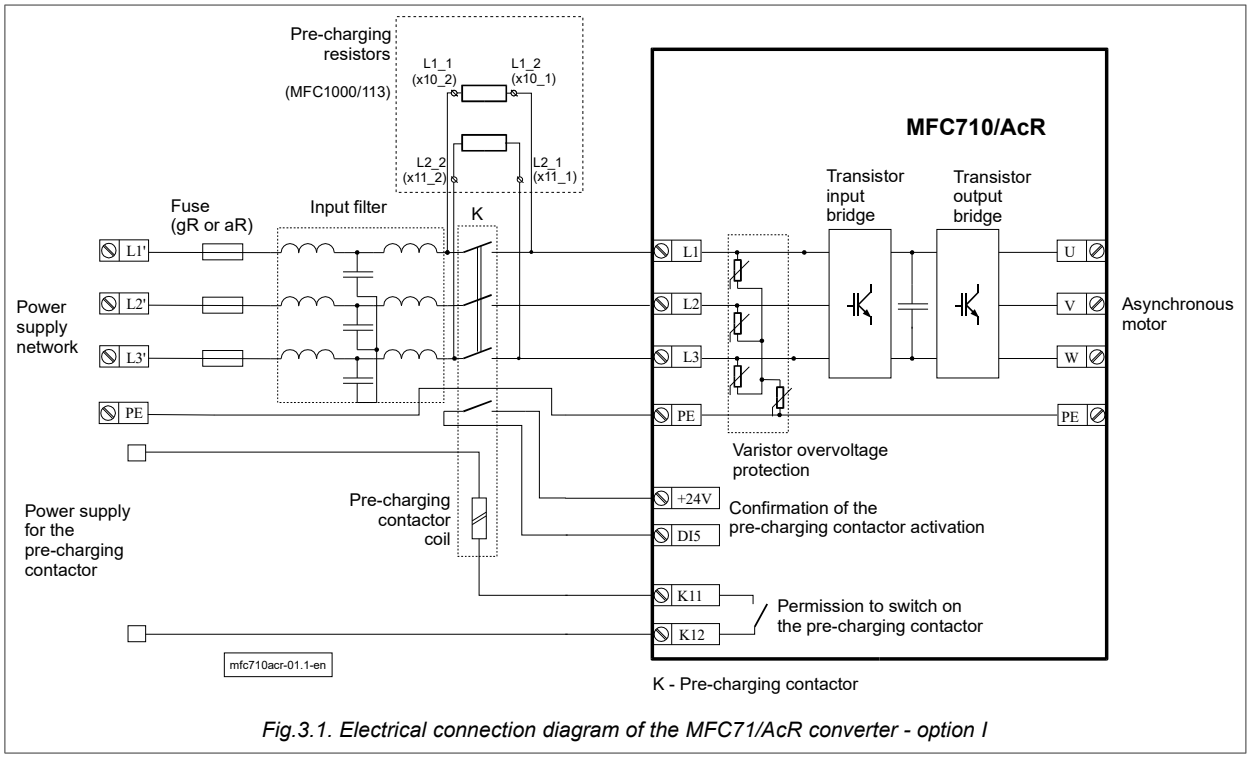


Fig.3.1. Electrical connection diagram of the MFC71/AcR converter - option I

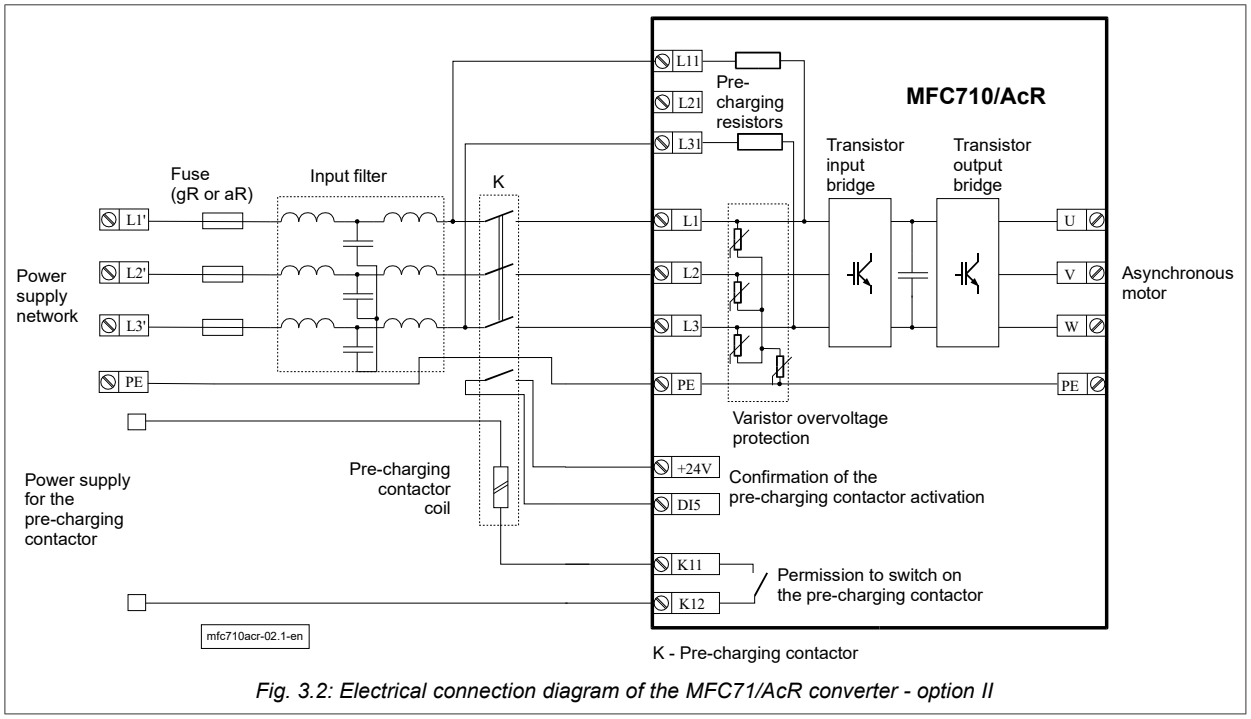


Fig. 3.2: Electrical connection diagram of the MFC71/AcR converter - option II

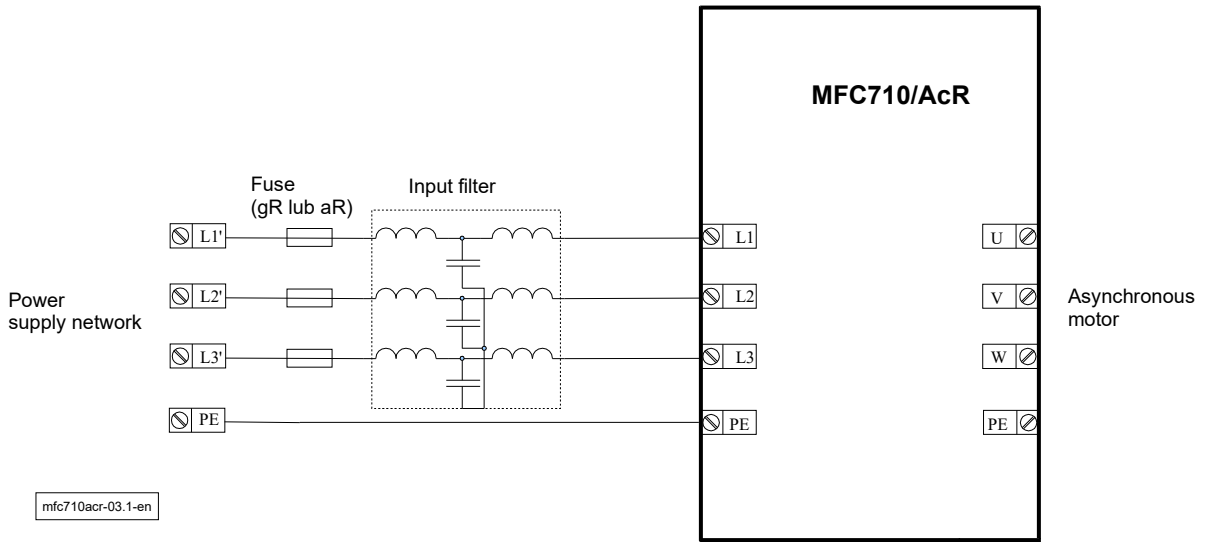


Fig. 3.3: Electrical connection diagram of the MFC71/AcR converter – option III

4. First run

The first run should be preformed according to the MFC710 frequency converter User Manual with the following differences:

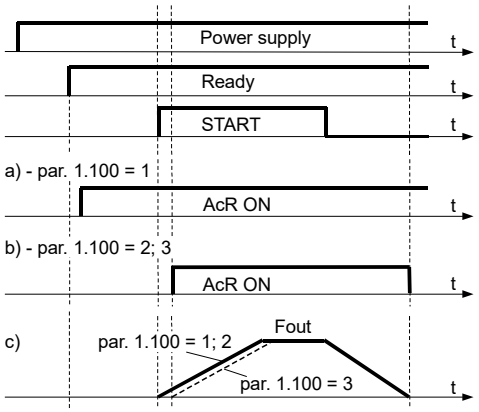
1. Parameter **1.62 Reg.Hi** Udc should be set to **000 NO**.
2. Parameter **3.57 AcR fail.Re** should be set to **001 Warning** or **002 Fault**.
3. In parameter **1.104** enter the inductances of the LC or LCL filter chokes used on power grid side (line side.
   Note: When using the LCL filter, sum up the values of both inductances.

5. Table of MFC710/AcR frequency converter parameters

1. Group 0: Read-only parameters

Parameter	*Name*	*Description*
0.70	AcR I L1	Line current in phase L1 [A]
0.71	AcR I L2	Line current in phase L2 [A]
0.72	AcR I L3	Line current in phase L3 [A]
0.73	AcR Ip	Active component of line current [A]
0.74	AcR Iq	Reactive component of line current [A]
0.75	AcR UL	Interfacial AC voltage of the supply grid powering the converter [V]
0.76	AcR Temp1	IGBT modules temperature of AcR rectifier [^{0}C]
0.77	AcR Temp2	IGBT modules temperature of AcR rectifier [^{0}C]
0.78	AcR f.code	Failure code reported by AcR (IGBT rectifier module)
0.79	AcR version	AcR software version

2. Other groups

Parameter / Name	*Function*	*Setting range / unit*	*Factory setting*	*Change during operation*
GROUP 1 – CONFIGURATION OF THE DRIVE				
1.62 Reg.Hi.Udc	DC-link voltage regulation	**000 NO** **001 YES** In a MFC710/AcR frequency converter this parameter must be set to **000 NO**.	001 YES	YES
1.100 AcR mode	Active Rectifier mode	**0** - AcR OFF **1** - AcR ON when "ready"- a) **2** - AcR ON when "run" mode - b) **3** - AcR ON when "run" mode is set b) and a motor starts after the AcR started - c) 	3	NO
1.101 Udc ref.	Reference voltage Udc	500..744 V for MFC710/AcR 3x 400V 500..894 V for MFC710/AcR 3x 500V 500..1418 V for MFC710/AcR 3 x 690V	620V 750V 1025	YES
1.102 Iq ref.	Reference reactive current %	-30.0...30.0% (100.0% = In)	0.0%	YES
1.103 Limit AcR	Line current limit (drawn current and fed back current)	1.0-150.0% (100.0% = In)	150.0%	YES
1.104 L mains	Inductance of the chokes used in the LCL filter from the power grid side.	0.000-32.767mH *The values read from the nameplate of the chokes on the power grid side should be summed up.*	*depends on the converter power*	YES
1.105 kp Udc	Kp and ki coefficients of the PI voltage controller Udc	0-32767	185	YES
1.106 ki Udc		0-32767	105	YES
1.107 kp Id	Kp and ki coefficients of the PI active current controller	0-32767	100	YES
1.108 ki Id		0-32767	115	YES
1.109 kp Iq	Kp and ki coefficients of the PI reactive current controller	0-32767	100	YES
1.110 ki Iq		0-32767	115	YES
1.112 df carr.AcR	*Service parameter*	0...10	0 Hz	YES

Parameter / Name	*Function*	*Setting range / unit*	*Factory setting*	*Change during operation*
1.113 SYNC mode	*Service parameter*	0,1,2,3	0	YES
GROUP 2 – REFERENCING-UNITS AND CONTROL				
2.113 Enable AcR	Enable active rectifier AcR	**Sw. Off** – operation impossible **In.C1**...**In.C6** – enabled when there is voltage supplied on digital input DI1...DI6 **Sw.On** – operation possible	Sw.On	YES
GROUP 3 – FAILURES				
3.57 AcR fail.Re	Reaction to lack of communication with AcR module or failure AcR device	**000 None** – ignore **001 Warning** - a warning will be displayed, device keeps working with set frequency **002 Fault** - device will stop and message will be displayed (type of failure is stored in par. 0.78) In a MFC710/AcR frequency converters this parameter should be set to **001 Warning** or **002 Fault**.	000 None	YES

6. Failure codes

AcR rectifier module failure codes are shown in parameter 0.78 (group 0).

Table 6.1 – List of failure codes

Failure codes	*Displayed name*	*Description*	*Possible cause*	*Counteraction*
1	High temperature	Too high temperature of one of the IGBT modules of the AcR active rectifier.	1. Hindered airflow. 2. System overload. 3. Ambient temperature is too high.	1. Check ventilation efficiency (fan efficiency and heat sink pollution). 2. Reduce system load. 3. Ensure proper temperature at the place of installation.
3	High voltage Udc	High voltage in DC circuit.	1. The voltage on the mains side is too high. 2. Intensive motor braking. 3. Too low current limit – par. 1.103. 4. Incorrect PI Udc controller settings – par. 1.105, 1.106.	1. Check the mains. 2. Increase the braking time (deceleration) of par. 1.31 or 1.33. 3. Increase the current limit – par. 1.103 (max. 150.0%) 4. Increase the kp Udc coefficient – par. 1.105 (max. 400) and/or decrease ki Udc coefficient at parameter 1.106.
4	Low voltage Udc	Low voltage in DC circuit.	1. Lack of one phase of the mains voltage. 2. Mains voltage too low. 3. Precharge circuit is defective.	1. Check the cables from the mains side. 2. Check the supply voltage level. 3. Check the precharge circuit wires.
5	Short circuit	A short circuit at the system input (from the AcR active rectifier side) or an IGBT module fault.	1. Incorrect connection of measuring and/or power wires. 2. Lack of, damaged or incorrectly connected input choke. 3. Damage to the AcR active rectifier IGBT module.	1. Check the correctness of the connections and the condition of the measuring and power wires. 2. Check the choke and the correctness of its connection. 3. Contact the Service.
10	DC charging	Pre-charging DC-link error.	1. Damage to the pre-charging contactor or the pre-charging control system.	1. Check the connections (wires, plugs) of the precharge circuit.
11	Absence of temp. sensor	Lack of signal from the IGBT module temperature sensor.	1. Unplugged sensor plug. 2. Damage to the sensor or connecting wires.	1. Check the connections (wire, plugs) of the temperature measuring circuit. 2. Contact the Service.
12	Short circuit of temperature sensor	Incorrect signal from the IGBT module temperature sensor.	1. Damage to the sensor or connecting wires.	1. Check the connections (wire, plugs) of the temperature measuring circuit.
13	Low temperature	The temperature is too low (below -10^{0}C) of one of the AcR active rectifier IGBT modules.	1. The ambient temperature is too low.	1. Ensure proper temperature at the place of installation.
14	Mains fault	Incorrect mains parameters.	1. The value of the supply voltage (RMS) or its frequency is outside the permissible range.	1a. Check the mains parameters. 1b. If the mains is unstable, wait until the parameters return to the correct values. 1c. If possible, connect the system to another power supply.
16	High current (software)	Exceeding the permissible current value (3 x In) from the mains side - software protection.	1. Incorrect setting of parameter 1.104 (due to e. g. changing the choke without entering in the par. 1.104 new value of its inductance). 2. Incorrect settings of the Id or Iq current regulator (parameters: 1.107 ÷ 1.110). 3. Too intensive starting of the motor or rapid change of its load. 4. Sudden voltage drop in the mains. 5. Damaged capacitor in the LCL input filter or incorrect connection of the LCL filter.	1. Check the setting of par. 1.104 with inductance of the chokes from the mains side. 2. Change the current regulator Id or Iq setting in par. 1.107 ÷ 1.110 (default value = 115%) 3. Increase motor start time. 4. Wait until the mains parameters return to the correct values. When possible, connect the system to another power supply. 5. Check that the capacitors have no leaks or are not swollen. Check the correctness of LCL filter connections.
17	Phase missing	One or two phases are missing from the mains side.	1. One or two phases are missing from the mains side. 2. Incorrect connection of the frequency converter to the mains.	1. Ensure correct mains supply values. 2. Check the correctness of connections from the mains side.

Failure codes	*Displayed name*	*Description*	*Possible cause*	*Counteraction*
18	Udc error in three-level topology	Too high Udc voltage imbalance ½ in the intermediate circuit.	1. Break in the gate signal circuit. 2. Damaged IGBT transistor. 3. Damaged Udc intermediate circuit capacitors.	1. Make sure all plugs are firmly seated in the sockets. 2. Contact with service. 3. Contact with service.
19	Saturation of the current controller	The current controller has reached the limit	1. The mains voltage is disconnected. 2. Incorrect mains power supply values. 3. In parameter 1.101 the Udc intermediate circuit voltage is set too low.	1. Check the voltage at the terminals from the mains side. 2. Check the voltage value at the terminals from the mains side. 3. Increase the value of parameter 1.101 "Udc ref." incrementally by 10 V until the failure is eliminated. *Note: Do not exceed 700V (for 3x400V supply voltage).*
22	External fault	External fault input active.		Check the status at the digital input selected as an external fault.
26	High current (hardware)	Exceeding the permissible current value (3 x In) from the mains side – hardware protection.	1. Incorrect setting of parameter 1.104 (due to e. g. changing the choke without entering in the par. 1.104 new value of its inductance). 2. Incorrect settings of the Id or Iq current regulator (parameters: 1.107 ÷ 1.110). 3. Too intensive starting of the motor or rapid change of its load. 4. Sudden voltage drop in the mains. 5. Damaged capacitor in the LCL input filter or incorrect connection of the LCL filter.	1. Check the setting of par. 1.104 with inductance of the chokes from the mains side. 2. Change the current regulator Id or Iq setting in par. 1.107 ÷ 1.110 (default value = 115%) 3. Increase motor start time. 4. . Wait until the mains parameters return to the correct values. When possible, connect the system to another power supply. 5. Check that the capacitors have no leaks or are not swollen. Check the correctness of LCL filter connections.
27	Time out	Communication error between internal converter control boards.	1. External interference. 2. Damaged wire connecting control boards. 3. Damage to one of the control boards.	Contact Service.
28	Sync Error	The system cannot synchronize with the mains.	1. Lack of one phase of the power supply network. 2. Precharge circuit is defective. 3. Incorrect mains frequency.	1. Check the correctness of connections from the mains side. 2. Check the precharge circuit. 3. Ensure that the mains frequency is correct.

If the fault cannot be removed, please contact the service centre. The phone number can be found at www.twerd.pl.

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