TWERD ENERGO-PLUS

Frequency converter AFC200 type
0,37 - 3,0 kW

Single phase supply 230V

User manual

Edition 8.1

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AC 070 QMS

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Contents

Technical data of frequency converters AFC200

Table 0.1. Technical data, common for frequency converters of the AFC200 series

Power supply	Voltage U_{in}	1-phase: 230 V (-15%, +10%) / 45..66 Hz; other voltage levels are available on request
Output	Voltage	3-phase: 0..U_{in} [V]
	Frequency	0,00..320,00 Hz – scalar operation mode 0,00..90,00 Hz – vector operation mode
	Frequency resolution	0,01 Hz
Control system	Modulator	SVPWM
	Operation mode	Scalar: U/f (linear or quadratic), Vector without sensor
	Frequency-Shift Keying	4/8/16 kHz
	Rotation speed setting	Analogue inputs, control panel, motopotentiometer, PI controller, RS485 port. Resolution 0.1% for analog inputs or 0.01 Hz/1rpm for control panel and RS
Control: inputs / outputs	Analogue inputs	2 analogue inputs AI1 and AI2: AI1: voltage mode 0 (2) .. 10V, Rin ≥ 470kΩ; accuracy 0.5% of the full range AI2: current mode 0 (4) .. 20mA, Rin = 500Ω; accuracy 0.5% of the full range
	Digital inputs	6 digital inputs separated by 0/ (15..24) V, Rin ≥ 8kΩ
	Analogue outputs	1 current output AO1 : 0(4)..20mA - configuration by parameters, accuracy: 0.5% of the full range
	Digital outputs	2 relay outputs (K1, K2) - breaking capacity: 250V/ 1A AC
Communica-tion	Connectors	RS-485 with optoisolation
	Communication protocol	MODBUS RTU. Function 3 (Read Register); Function 6 (Write Register)
	Transmission speed	9600 or 19200 bit/s
	Application	Remote operation control and programming of all the frequency converter parameters.
Special functions	PI controller	Selection of referencing-unit signal source and feedback signal source, possibility of inverting polarity of control error signal, output erasing on STOP signal, limitation of an output value.
	Restoring factory parameters	Possibility of quick restoration of factory parameters of frequency converter

Protections	Short-circuit	Short-circuit at the system output
	Over-current	Instantaneous value 3,5 $I_{n;}$; effective value 2,5 I_n
	Thermal: converter	Heatsink temperature sensor
	Thermal: motor	I^2t limit
	Communication control via RS-485	Established permissible time of connection absence
	Control of analog inputs	Checking the absence of “living null” in modes 2..10V and 4..20mA

Table 0.2. Technical data of frequency converters of the AFC200 series, depending on a type

***Type of a frequency converter*: AFC200/...**	**Constant-torque load (permissible overload = 1.5 I_n)**		**Variable-torque load (permissible overload = 1.1 I_{n2})[1)]**		**I_p [A]**
	P_n [kW]	**I_n [A]**	**P_{n2} [kW]**	**I_{n2} [A]**	
0,37 kW	0,37	2,2	0,55	3,0	3,3
0,55 kW	0,55	3,0	0,75	4,0	4,5
0,75 kW	0,75	4,0	1,1	5,5	6,0
1,1 kW	1,1	5,5	1,5	7,0	8,3
1,5 kW	1,5	7,0	2,2	9,5	10,5
2,2 kW	2,2	9,5	3,0	13,0	14,5
3,0 kW	3,0*)	13,0*)	3,0	13,0	14,5

P_n – nominal power with permissible overload current I_p of ~1.5 I_n

I_n – nominal output current at P_n

P_{n2} – nominal power with permissible overload current I_p of ~1.1 I_{n2} (pumps, fans)

I_{n2} – nominal output current at P_{n2}

I_P – output over-current: for 60 seconds every 10 minutes

*) **Caution**: The AFC200/3.0 kW converter is intended for fan/pump applications and **cannot be loaded with a current greater than 1.1I_n.**

1) For ambient temperature <35^{0}C

1. Conditions of safe operation

Ignorance of these instructions can result in serious injury or death to personnel or damage to the frequency converter.

1.1. Threats and warnings

Incorrect installation or use of the AFC200 frequency converter may cause a risk to life, human health or irreparable damage to the device.

RISK OF ELECTRIC SHOCK

- Installation, operation, maintenance and repair of the device must be performed only by properly qualified and authorized personnel.
- Before switching on the power supply voltage, make sure that the frequency converter has been correctly installed and all housing elements have been properly assembled.
- It is forbidden to touch the voltage terminals of the frequency converter connected to the power supply voltage.
- After connecting the converter to the power supply voltage, its internal components (except for the control terminals) are on the power supply potential. Touching these components can cause an electric shock.
- When the converter is connected to the power supply voltage, dangerous voltage occurs at its output U, V, W terminals even when the motor is not running.
- Externally supplied control circuits may carry dangerous voltage even when the input power supply voltage of the frequency converter is switched off.
- After disconnecting the device from the power supply voltage, the dangerous voltage is still present for about 5 minutes.
- Don’t make any changes to the connections when the converter AFC200 is connected to the power supply voltage.
- Before working with the frequency converter, electric motor cable or electric motor, wait minimum 5 minutes after disconnecting the power supply voltage and make sure that there is no dangerous voltage at the connection terminals.
  Attention! The lack of the voltage at the connection terminals is not synonymous with the lack of dangerous voltage in the internal DC circuit of the frequency converter.
- The frequency converter is not designed to be installed in a flammable/explosive environment as it may cause a fire/explosion.

1.2. Basic rules

- Don’t connect the supply voltage to the U, V, W output terminals.
- Don’t measure the voltage endurance of any unit devices.
- It is necessary to disconnect cables from the frequency converter to measure their insulation.
- Don’t repair the frequency converter yourself. All repairs can only be carried out by the manufacturer's authorized service centre. Any attempt at unauthorised repairs will void your warranty.
- Don't connect any capacitor banks to the output (motor) cables to improve cos φ.
- The voltage at the output terminals U, V, W should be measured with an electromagnetic voltmeter (*measurement with a digital voltmeter without a low-pass filter is incorrect).*
- The frequency converter is not designed to operate with periodically switched on/off supply voltage. Don't turn on the power supply voltage more than once every 5 minutes because this will damage the frequency converter.

1.3. Operation list

The operations applied at installation and the first start-up of the frequency converter	
✔	After unpacking the frequency converter, it is necessary to check up visually presence of damages which could arise during transport.
✔	Check whether the delivery is in accordance with the order - check the nameplate.
✔	Check up the correspondence between the conditions in which the frequency converter will be used and conditions of an environment for which it is designed (section 1.5).
✔	Installation of the frequency converter should be made due to the principles of safety and EMC rules listed in section 2.
✔	Perform the configuration of frequency converter in accordance with sections 4 and 5.

1.4. Disposal considerations

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.

1.5. Environmental conditions

Degree of pollution

During design, the second degree of pollution has been assumed, at which there is normally only non-conducting pollution. However, there is a probability of temporary conductivity caused by a condensation when the converter is not running.

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

Table 1.1. Installation climatic conditions: requirements

	Installation site	***During warehousing***	***During transport***
Temperature	from -10°C to +50°C[1)]	-25°C to +55°C	-25°C to +70°C
		In protective packaging	
Relative humidity	from 5% to 95%	from 5% to 95%	Max 95%
	Short-term, insignificant condensation on the external side of the converter case is permitted only when converter isn't running.		
Air pressure	from 86 kPa to 106 kPa	from 86 kPa to 106 kPa	from 70 kPa to 106 kPa

1.6. Limits of responsibility

- The User is obliged to read the information contained in this Manual before using the device.
- Despite all the efforts and due diligence, TWERD ENERGO-PLUS Sp. z o.o. does not guarantee that the published data is error-free. All information is subject to change without any notice.
- The TWERD ENERGO-PLUS Sp. z o.o. logo is a registered trademark of TWERD ENERGO-PLUS Sp. z o.o.
- In case of any doubts or questions, please contact us.

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

2. Installation of the frequency converter

2.1. Safety rules

Protective earthing connections

The protection against indirect contact consists in the automatic shutdown of the power supply voltage by special short-circuit (or differential-current) protection or voltage limitation to a level not exceeding the permissible values in case of an insulation failure.

Due to the operation of the intermediate circuit, a ground fault at the frequency converter output cannot be detected by short-circuit protection. Although the protection against interpolar and ground faults at the frequency converter output is provided, it is based on IGBT transistors blocking which does not meet the requirements of electric shock protection. For these reasons, to ensure the safety of personnel, local protective connections must be made accordingly.

The frequency converter provides terminals, appropriately marked and protected against corrosion, for connecting protective conductors.

Protections

The frequency converter is equipped with protections: against electrical motor overload, thermal motor (I^2t limit), under- or over voltage in the converter intermediate circuit, short-circuit at the converter output (it only protects the converter!).

The usage of differential-current protection to prevent electric shock can appear unfavourable since it can trigger due to temporary or constant leakage current of the power drive system, operating under normal conditions. If a differential-current device is used, due to the different nature of the differential current, only circuit breakers of a B type are permitted.

Disconnecting device

In order to comply with EU directives, according to PN-EN 60204-1:2010, power drive, which consists of a frequency converter and electrical machine, should be supplied with a device for disconnecting power supply voltage. This device should be one of listed below:

- separator (with or without fuses), category of usage AC-23B fulfilling the requirements EN 60947-3,
- disconnector (with or without) fuses, disconnecting a load circuit before opening main contacts, conforming the EN 60947-3 requirements,
- circuit breaker, in accordance with EN 60947-2.

A user is obliged to fulfil these requirements.

Emergency stop

In order to comply with the European Union Directive, according to PN - EN 60204-1:2010, for the safety of personnel and equipment, it is necessary to use an emergency stop switch, the operation of which takes precedence over other functions, irrespective of operating mode. The key STOP on the operator panel cannot be treated as an emergency stop switch, because it doesn't disconnect a frequency converter from power supply voltage.
A user is obliged to fulfill this requirement.

Housing

The housing conforms to the requirements of an IP20 protection degree. The surface, on which the operator's control panel is located, meets the requirements of an IP40 protection degree. The housing has been designed so that it cannot be removed without the use of tools.

Capacitors discharging

There is a capacitor battery with relatively high capacity in a DC link circuit of the frequency converter. Despite switching off the power supply voltage of the converter, dangerous voltage may remain on the terminals for a specified period of time. It is necessary to wait 5 minutes before switching on the power strip of the frequency converter. The information about danger of such voltage is also placed on the terminal block cover.

2.2. Assembly of the frequency converter

To ensure appropriate air circulation, the converter must be mounted vertically with a free space around the device: 10 cm from the top and the bottom and 3 cm on both sides of the device.

The dimensions of the AFC200 frequency converters are presented in figure 2.1.

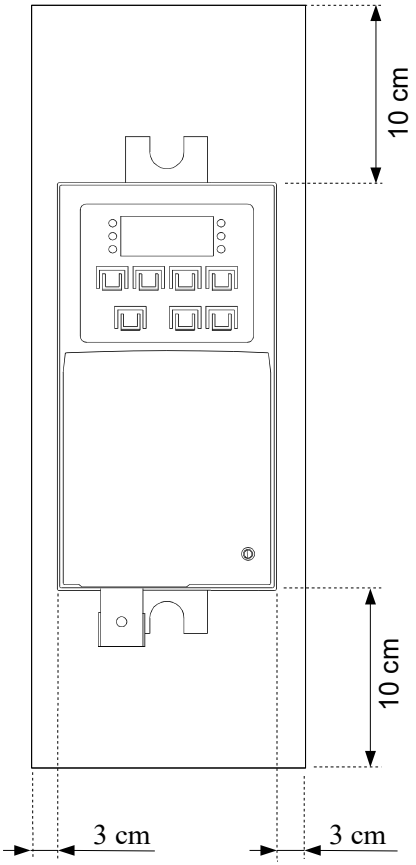


Fig. 2.1. The required free space around the device

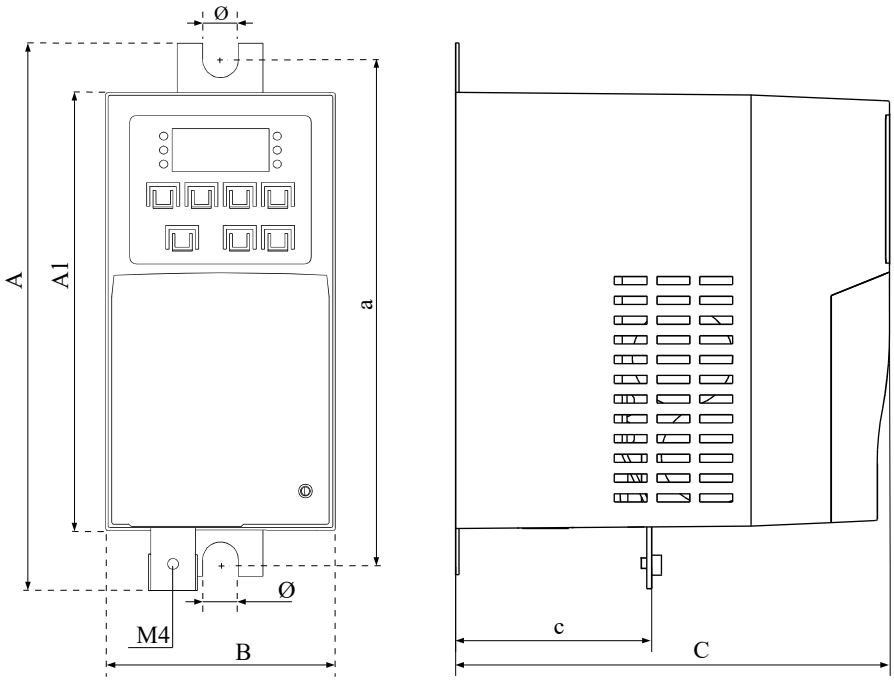


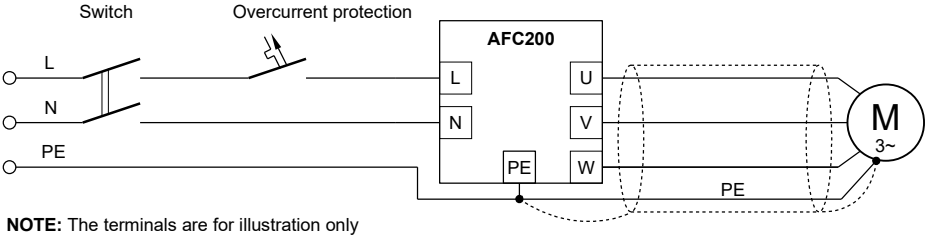
Fig. 2.2. The dimensions of the AFC200 frequency converters

Table 2.1. The dimensions of the AFC200 frequency converters

Type: AFC200/...	Size [mm]							Weight [kg]
	A	A1	a	B	C	c	Ø	
0,37 kW	168	134	151	70	133	60	7	0,80
0,55 kW								0,80
0,75 kW								0,80
1,1 kW								0,85
1,5 kW	195	162	174	73	169	74	7	1,30
2,2 kW								1,35
3,0 kW								1,40

2.3. Connecting the power circuit

- The AFC200 frequency converter is powered by a single phase voltage 230 VAC, 50 Hz.
- Connect the frequency converter to electric motor using the shortest possible symmetrical shielded cable.
- Do not use contactors and circuit breakers on the output side of the converter that would disconnect the system during operation - see section 2.5.
- Figure 2.3 shows the scheme of power circuits connections.



NOTE: The terminals are for illustration only and do not correspond to their actual location on the inverter.

* Do not use any contactors between converter output and motor!
* Output voltage can be measured correctly only with an electromagnetic voltmeter!

Figure 2.3. Connection of power circuits to AFC200 frequency converter

Table 2.2 can be used to select the cross-sections of power cables. **The final selection of cable cross-sections must comply with the applicable standards.**

Table 2.2. Conductor cross-sections selected for long-term load capacity in accordance with PN-IEC 60364-5-523:2001 for Cu PVC multicore cables laid in pipes or strips on walls, walls or floors; design ambient temperature: 25^0 C.

AFC200/...	I_{in} [A]	I_z [A]	L,N,PE [mm^2]	U,V,W,PE [mm^2]
0,37 kW	4,5	6	3 x 1,5	4 x 1,5
0,55 kW	6,9	10	3 x 1,5	4 x 1,5
0,75 kW	8,9	10	3 x 1,5	4 x 1,5
1,1 kW	13,5	16	3 x 1,5	4 x 1,5
1,5 kW	17,7	20	3 x 2,5	4 x 1,5
2,2 kW	28,8	32	3 x 4,0	4 x 2,5
3,0 kW	28,8	32	3 x 4,0	4 x 2,5

I_{in} – the highest RMS value of input current
I_z – the maximum permissible nominal protection current; the protection can be a gG fuse or a "B" type circuit breaker.

2.4. Connection of control systems

Fig. 2.4 shows a view of terminal blocks of the frequency converter control block together with a simplified internal block diagram. Tables 2.3 and 2.4 describe the functions of the individual terminals.

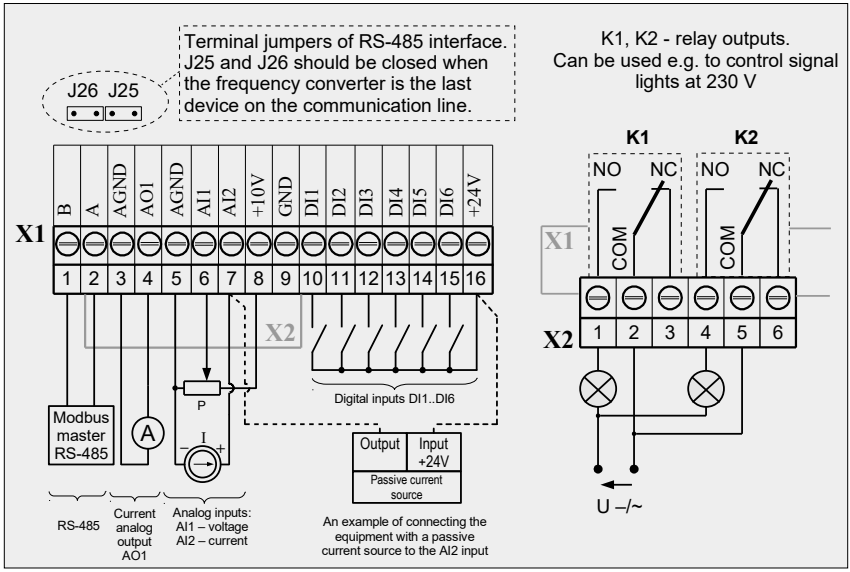


Figure 2.4. View of control system terminal blocks (X1, X2) and an exemplary connection configuration

Table 2.3. Control terminal block X1

No	Name	Description	Note
X1:1	B	Interface RS-485, line B	Terminator/bias are connected with J25/J26 jumpers
X1:2	A	Interface RS-485, line A	The same
X1:3	AGND	Analog Ground	Use only for connecting analog inputs/outputs signals
X1:4	AO1	Analog Output 1 (current mode)	
X1:5	AGND	Analog Ground	Use only for connecting analog inputs/outputs signals
X1:6	AI1	Analog input 1 (voltage mode)	Input impedance: $\geq$ 470 kOhm
X1:7	AI2	Analog input 2 (current mode)	Input impedance: = 500 Ohm

No	Name	Description	Note
X1:8	+10V	Power supply of external systems, i.e. potentiometer of a referencing-unit	**Load capacity of the source: 100 mA**
X1:9	GND	Digital Inputs Ground	
X1:10	DI1	Digital input 1	Input impedance: ≥8 kOhm
X1:11	DI2	Digital input 2	The same
X1:12	DI3	Digital input 3	The same
X1:13	DI4	Digital input 4	The same
X1:14	DI5	Digital input 5	The same
X1:15	DI6	Digital input 6	The same
X1:16	+24V	Power supply for digital inputs and external systems	**Load capacity of the source: 200 mA**

Table 2.4. Control terminal block X2

No	Name	Description	Note
X2:1	K1 (NO)	Relay output K1, contact NO (normally open)	Load capacity of contacts: 1A / 250V AC
X2:2	K1 (COM)	Relay output K1, contact COM (common)	The same
X2:3	K1 (NC)	Relay output K1, contact NC (normally closed)	The same
X2:4	K2 (NO)	Relay output K2, contact NO (normally open)	The same
X2:5	K2 (COM)	Relay output K2, contact COM (common)	The same
X2:6	K2 (NC)	Relay output K2, contact NC (normally closed)	The same

Note:
Control circuit cables should be routed separately from power circuit cables.

2.5. Using contactors and circuit breakers at the frequency converter output

If it is necessary to use contactors or circuit breakers between the frequency converter and the electric motor, the switching of the contactor (circuit breaker) must absolutely(!) be carried out in the voltageless state, when the converter is stopped (STOP state). Otherwise, there will be damage to the converter not covered by the warranty.

3. The control panel

Fig. 3.1 shows the view of the converter control panel with a description of each function of the keys and the display.

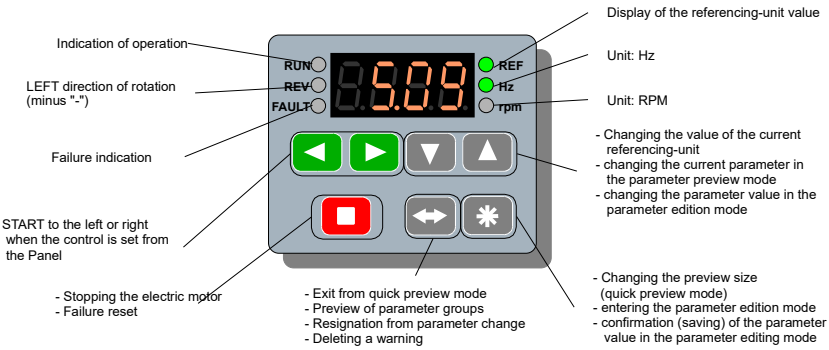


Fig. 3.1. The control panel, the basic functions of the keys and the display

The control panel is used for continuous monitoring of the process parameters (e. g. output frequency, electric motor current), system operation control (START/STOP, change of referencing-unit value, reset of failure report) and for reviewing and changing the frequency converter parameters. The panel is equipped with an LED display. When the system is connected to the mains, the control panel is activated in the Basic Mode.

The functions of the keys, changing the panel modes and the way of changing the values displayed on the panel are shown schematically in fig. 3.2, 3.3, 3.4, 3.5.

The parameters in group 0 (read only) allow to view the process variables, such as present output currents of the frequency converter, the heat sink temperature, input and output status and other important parameters of the converter.

The parameters placed in the following groups are responsible for:

- group 1: drive configuration,
- group 2: referencing-units and control,
- group 3: failures,
- group 4: access codes, settings of RS communication and the display.

Editing any parameter from groups 1 ... 4 takes place according to the scheme shown in fig. 3.3.

Control panel operation diagram

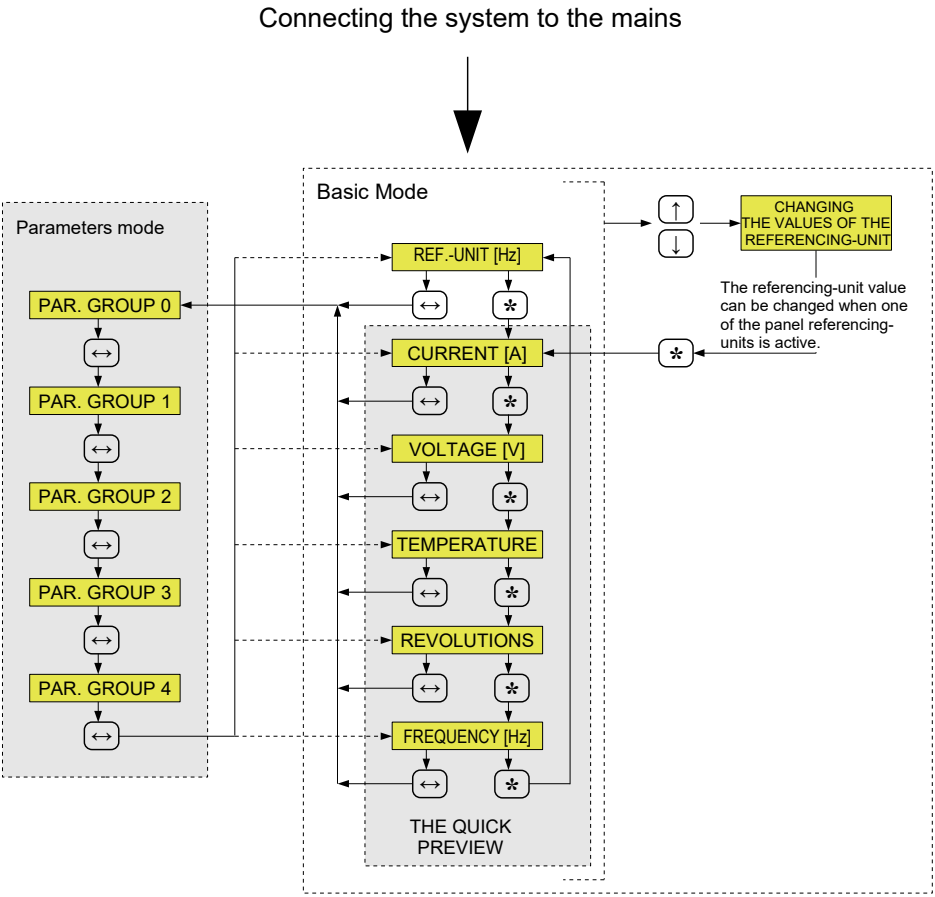


Fig. 3.2. Control panel operation diagram

An example of editing a parameter

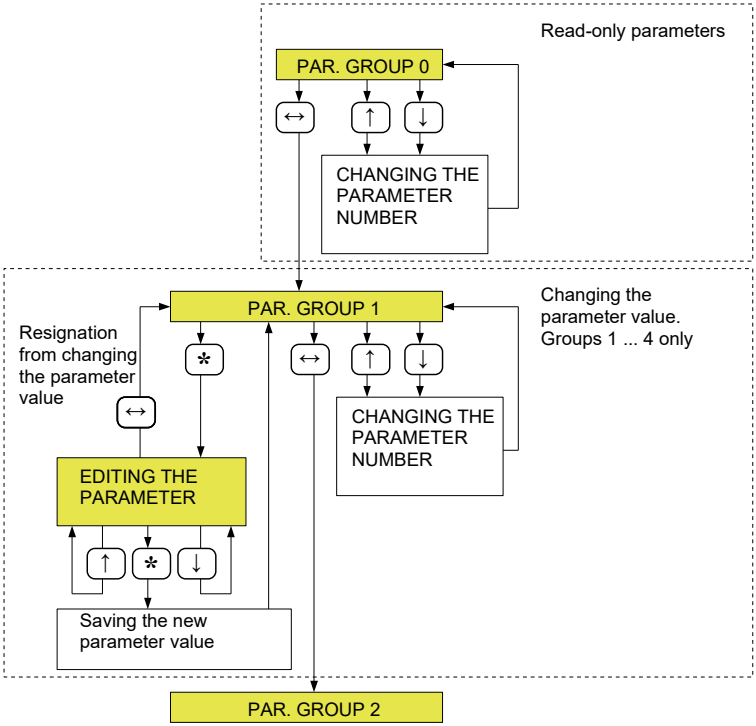


Fig. 3.3. An example of editing a parameter

Quick view mode - changes in the display status

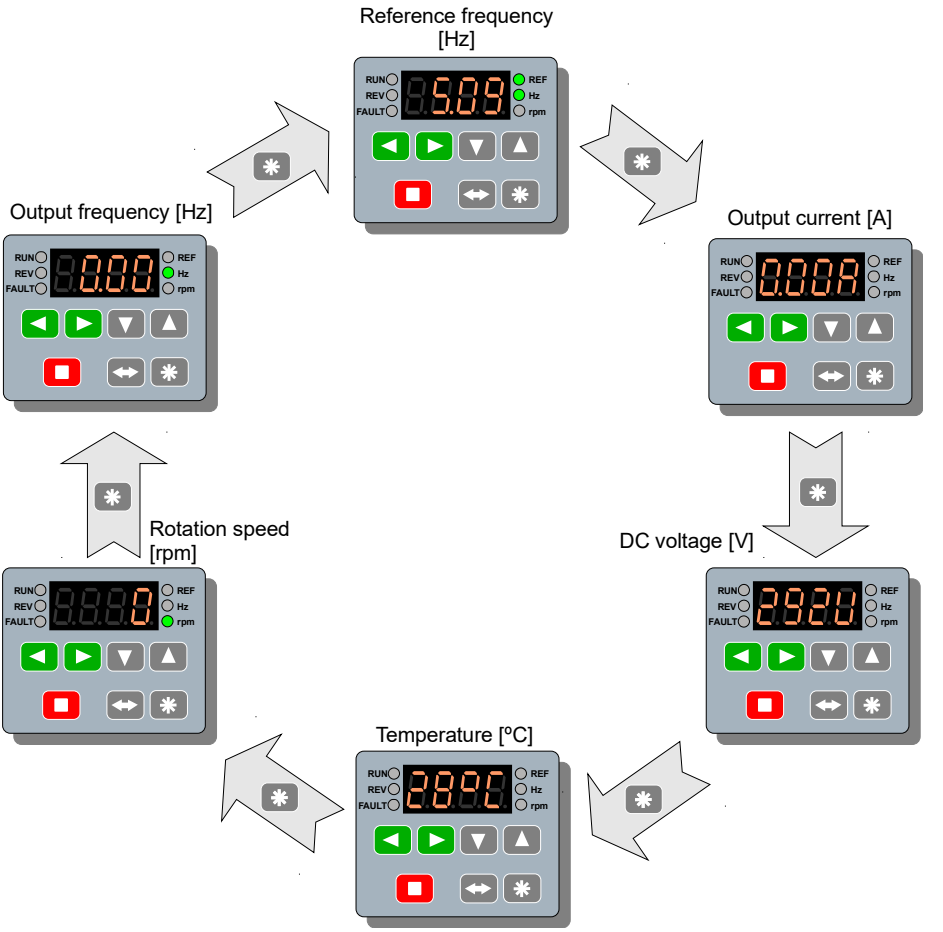


Fig. 3.4. Quick view mode: required user actions using the keyboard and views of the display status

Example: changing the value of the parameter 3.02

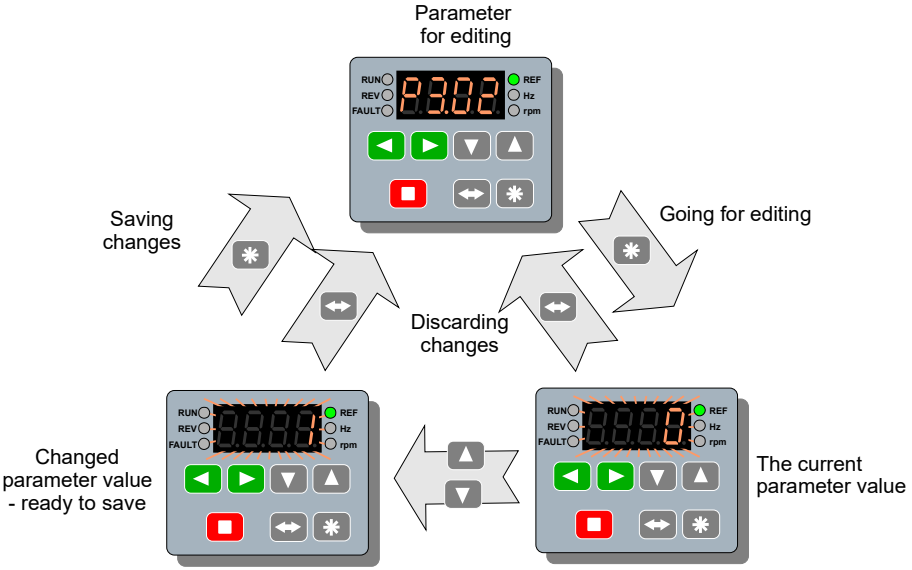


Fig. 3.5. Changing the parameter value 3.02 (group 3)

4. The first start

4.1. Power circuit connection

Caution:
All connections must be made in a voltageless state.

The connection should be made according to Fig. 2.3 on page 16:

- the L and N terminals should be connected to a single-phase power supply network 230V 50Hz, and the PE terminal should be connected to a PE protective conductor,
- to the U, V, W, PE terminals, a three-phase induction motor with a power corresponding to the converter power must be connected.

After applying voltage to the frequency converter input terminals (L, N), it will be initialized.

4.2. Entering nominal data

Enter the motor nominal parameters into the frequency converter.

- nominal motor power Pn ….....**<par. 1.01>**
- nominal motor speed Rn ….....……**<par. 1.02>**
- nominal motor current In ….....**<par. 1.03>**
- nominal motor voltage Un ….....…...**<par. 1.04>**
- nominal motor frequency fn …….….....**<par.1.05>**
- nominal motor cos φ ….....…...**<par. 1.06>**

After entering the above nominal motor data, the system is ready to operate in U/f scalar mode. The control takes place via the control panel (described in section 3).

5. Configuration of the frequency converter

The converter allows to define two independent "control places" **"A"** and **"B"**. The active "control place" is selected by parameter 2.01:

Value of par. 2.01	Function
0	Active "control places A" (default setting).
1 .. 6	Selection of A / B control place via any digital input: **1 = DI1 .. 6 = DI6**
7	Active "control places A".

The following functions are separately assigned to each "control place":

Function	Control place A	Control place B
Speed referencing-unit	par. 2.02	par. 2.03
Start/Stop signal source	par. 2.04	par. 2.05
Direction control signal source	par. 2.06	par. 2.07

By default, the control from the Control Panel is assigned to the "control place A" and control from the converter terminal block—to "control place B".

This solution allows to easily switch between control places "A" and "B" only by changing one parameter **2.01**.

Fig. 5.1 shows a simplified control structure of the system and in Appendices B and C - a developed one.

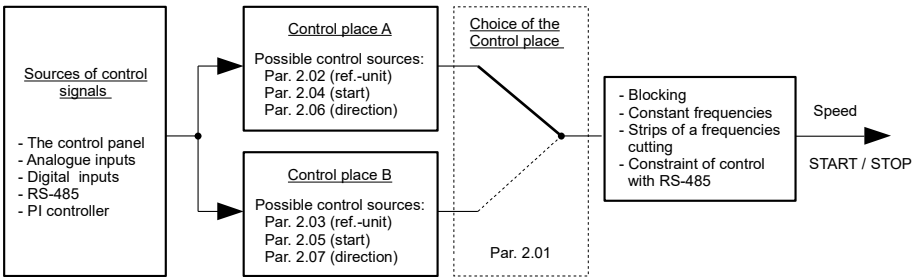


Fig. 5.1. AFC200 simplified control structure

5.1. Control from the control panel

Control from the control panel is assigned by default to "control place A". It is possible to assign control from the control panel to the "control place B" (or restore to the "control place A" when a change has been made). To do this:

- set parameter **2.02** (for A) or **2.03** (for B) to **"0" – KBD (keyboard)**;
- set parameter **2.04** (for A) or **2.05** (for B) to **"1" – Key**;
- set parameter **2.06** (for A) or **2.07** (for B) to **"1" – Key**;
- make sure that constant speed selection is not active: parameters **2.30, 2.31** and **2.32** should be set to **"0" – Off;**
- activate the desired control place with parameter **2.01**: **"0"** for A, **"7"** for B.

5.2. Control from the terminal block

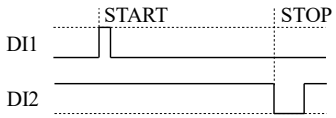
Control from the terminal block is the default setting of the "control place B". In order to control the frequency converter from the terminal block, it is recommended to activate the "control point B" **(par. 2.01 = "7" - On)** and, based on the factory settings, adjust the converter to your needs.

An example of control using the factory settings is described at the end of this section.

In order to control the system from the terminal strip (e.g. Start/Stop from digital inputs and speed control by means of a potentiometer):

- Select analogue input AI1 or AI2 as the speed referencing-unit.
  *The choice of the referencing-unit is made by the parameter **2.02** (for the "control place" A) or **2.03** (for the "control place" B). In each of these parameters:*
  ***"1" - AI1** means analog input 1 (voltage),*
  ***"2" - AI2** means analog input 2 (current).*
- Select digital inputs as the Start/Stop signal source - set parameter **2.04** (for A) or **2.05** (for B) to **"0" – DI.**
- Also select digital inputs as the signal for direction control - set parameter **2.06** (for A) or **2.07** (for B) to **"0" – DI**.
- Make sure that the constant speed selection is not active: par. **2.30**, **2.31** and **2.32** should be set to **"0" – Off.**
- Set parameter **2.08** - **Remote start**. It defines the functions of the control digital inputs according to the table 5.1.
- Activate the desired control place with the parameter **2.01.**

Table 5.1. The possible configuration variants of remote start

Value of par. 2.08	***Function***	***Description***
0	DI1 = START / STOP DI2 = DIRECTION	Applying voltage to digital input 1 results in start and voltage removal – in stopping the system. The state of digital input 2 determines the change of the direction of the electric motor rotation.
1	DI1 = START RIGHT DI2 = START LEFT	Applying voltage to digital input 1 will start the electric motor. Applying voltage to digital input 2 causes the motor to start in the opposite direction.
2	DI1 = PULSE START DI2 = PULSE STOP	The frequency converter will start after a pulse is fed to the DI1 input at a high DI2 state. The direction of rotation depends only on a sign of a referencing-unit. 
3	DI1 = PULSE START DI2 = PULSE STOP DI3 = DIRECTION	as above, additionally the DI3 digital input is responsible for changing the direction
4	DI1 = START / STOP	Applying voltage to digital input 1 results in start and voltage removal – in stopping the system. The direction of rotation depends only on a sign of a referencing-unit.
5	DI1 or DI2 = START / STOP	Applying voltage to the DI1 or DI2 digital inputs (according to the "or" logic gate) will cause the system to start.
6	DI1 and DI2 = START / STOP	Applying voltage to the DI1 and DI2 digital inputs (according to the "and" logic gate) will cause the system to start.

An example of control from the terminal block using the factory settings

After activating the "control place B" **(par. 2.01 = "7" - On)**, the converter is ready for operation with terminal block control, using the following factory settings:

- **parameter 2.03="1"** - speed referencing-unit: potentiometer connected to voltage input AI1,
- **parameter 2.05="0"** - Start/Stop: digital input DI1 (when par. 2.08=0),
- **parameter 2.07="0"** - direction control: digital input DI2 (when par. 2.08=0),
- **parameter 2.08="0"** - remote start configuration: according to the Table 5.1.

Applying +24V (16) voltage to the DI1 (10) digital input will cause the system to start. If the voltage is removed from the DI1 (10) digital input, the system will stop. The state of the digital input DI2 (11) determines the change of the electric motor rotation direction. The speed is set using a potentiometer connected between the analog input AI0 (6), voltage source +10V (8) and AGND ground (5).
Use a potentiometer with the resistance of1k..10k Ω , *5 k*Ω. recommended.

Figure 5.2 shows an example of the connection layout for controlling the frequency converter from the terminal block. The speed referencing-unit is a potentiometer P connected to the analog input AI1. Start / stop is done with the switch S1 and change of direction with the switch S2.

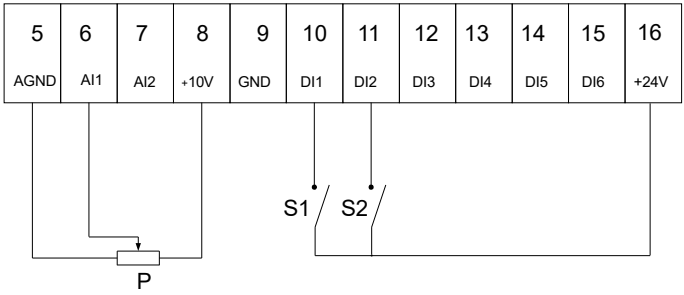


Fig. 5.2. Connections on the terminal block X1 for remote control of AFC200

5.3. Shaping the drive dynamics

Parameters related to dynamics determine the speed at which the motor speed changes: acceleration and deceleration (braking).

parameter 1.30 – Acceleration - preset acceleration time from 0Hz to 50Hz,
parameter 1.31 – Deceleration - preset deceleration time from 50Hz to 0Hz.

Caution:

1. Setting too short acceleration time can cause an E6 "Electric motor current too high" fault at start-up, especially when the motor is under heavy load.
2. Setting too short deceleration time can cause can cause an E3 "High DC circuit voltage" fault during ramp deceleration.

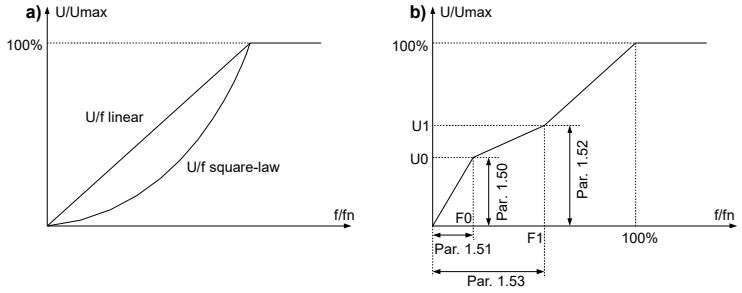
5.4. Operation in U/f scalar modes

After entering the correct nominal data of the electric motor, described in section 4.2, the frequency converter is ready for operation in one of two scalar operating modes: U / f linear or U / f square-law. The operating mode is selected using parameter 1.20:

Value of par. 1.20	Function
0	**U/f linear mode-** (factory setting): It is applicable where there is a constant load torque which does not depend on speed.
1	**U/f square-law mode-**: It is applicable if the load torque grows under the square-law speed (e.g. the electric drive of the fan). The usage of U/f square-law characteristic causes reduction of noise and motor losses.

It is possible to shape the U / f characteristic by specifying two points: initial U0 (par. 1.50), f0 (par. 1.51) and intermediate U1 (par. 1.52), f1 (par. 1.53).

Fig. 5.3a shows the characteristics for linear and square-law U/f mode, and Fig. 5.3b shows how to shape the U/f characteristic using intermediate points U0, f0 and U1, f1.



Pic. 5.3. Linear and square-law characteristics (a), shaping the U/f characteristic (b)

In the "U/f square-law" operating mode, the characteristics are limited to the initial points U0, f0.

5.5. Operation in vector mode

Vector sensorless operation mode is available on the AFC200 frequency converter. In order for the converter to operate in this mode, it is necessary to run an identification run beforehand.

Caution!
Incorrect entry of the nominal motor data described in section 4.2 may destroy the motor during the identification run.

In order to start the identification run procedure, set par. 1.10 "ID run" to "1", confirm with the button and wait a few seconds - the duration of the identification run is signaled by the green "RUN" LED. After its termination, par. 1.20 "Operating mode" should be set to "3" -vector. After each motor change, the identification procedure must be repeated.

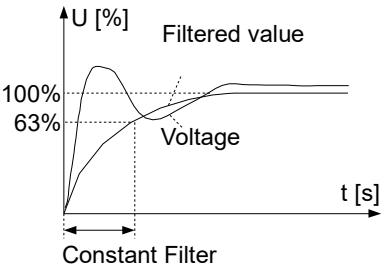
Caution:
1. In vector mode, the U/f characteristics shaping parameters described in section 5.4 are inactive.
2. The frequency converter must be in scalar mode when performing "ID Run" (par. 1.20 = 0).

5.6. Analogue inputs

The system has two analogue inputs AI1 and AI2. The AI1 input works in voltage mode and the AI2 input works in current mode. The potentiometer or voltage source can be connected directly to the AI1 analog input. A device with active or passive current referencing-unit can be connected to the AI2 analog input- fig. 2.4 on page 17.

Table 5.2 lists the parameters configuring the operation of analog inputs. As with digital inputs, analog inputs do not have parameters that define their function in the system, but are "selected" to perform a specific function by the control configuration parameters.

Table 5.2. Parameters configuring the analog inputs of the system

Parameter	***Function***	***Description***
2.40	Configuration of the AI1 analog input range (voltage input)	Input range selection: **0**: 0..10V (0V=0%, 10V=100%), **1**: 10..0V (10V=0%, 0V=100%), **2**: 2..10V (2V=0%, 10V=100%), **3**: 10..2V (10V=0%, 2V=100%).
2.41	Configuration of the AI2 analog input range (current input)	Input range selection: **0**: 0..20mA (0mA=0%, 20mA=100%), **1**: 20..0mA (20mA=0%, 0mA=100%), **2**: 4..20mA (4mA=0%, 20mA=100%), **3**: 20..4mA (20mA=0%, 4mA=100%).
2.49	AI1 low pass filter time constant	
2.50	AI2 low pass filter time constant	Similarly as above
0.40	AI1 input value [%]	*Read-only.* *E.g. for the 0..10V range, 5V corresponds to 50.0%*
0.41	AI2 input value [%]	*Read-only.* *E.g. for the 0..20mA range, 10mA corresponds to 50.0%*

Parameter	*Function*	*Description*
3.23	Reaction to the lack of signal at the Analog Input	In modes of operation: 2...10V, 10...2V and 4mA...20mA, 20mA...4mA it is possible to define the system behaviour when the voltage value drops below 2V or the current value drops below 4mA. See Appendix A— parameter 3. 23. Caution The system has a set deadband in the range 1.0..2.0V for voltage input and 2..4mA for current input. The reaction to the lack of signal at the analog input will only occur after the voltage or current drops below the deadband.

Analog referencing-units

The structure of the system also includes analogue referencing-units. Analog referencing-units are closely related to analog inputs, from which they differ in that they have parameters that define the value of offset and scale.

Table 5.3 gives the configuration parameters for Analog Inputs and the dependence of the output value of the Analog Ref.-units **A1** and **A2** on the value of the analog inputs AI1 and AI2.

Tabel 5.3. Analog referencing-units

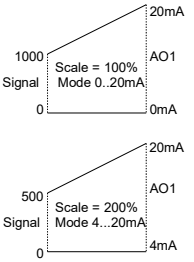
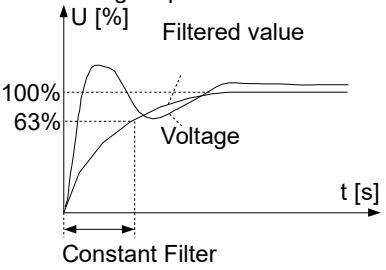
Parameter	*Function*	*Description*
2.43	A1 referencing-unit scale	Value in [%] : -500.0 ... 500.0 %
2.44	A2 referencing-unit scale	Value in [%] : -500.0 ... 500.0 %
2.46	A1 referencing-unit offset	Value in [%] : -500.0 ... 500.0 %
2.47	A2 referencing-unit offset	Value in [%] : -500.0 ... 500.0 %

Parameter	*Function*	*Description*
0.45	A1 referencing-unit value [%]	*Read-only.* *A1 referencing-unit = par. 2.46 + par. 2.43 * AI1 / 100.0%* *e.g. if par. 2.46 = 20.0%, par. 2.43 = 50.0% and AI1= 30.0%,* *then A1 referencing-unit = 20.0% + 50.0% * 30.0% / 100.0% = 35.0%*
0.46	A2 referencing-unit value [%]	*Read-only.* A2 referencing-unit = par. 2.47 + par. 2.44 * AI2 / 100.0%

5.7. Analog output

Table 5.4 lists the parameters configuring the AO1 analog output. The output operates in 0-20mA (4-20mA) current mode.

Table 5.4. AO1 analog output configuration parameters

Parameter	***Function***	***Description***
0.43	The value of the analog output AO1	*Range: 0..100.0%* ***AO1 = Absolute value (signal * scaleAO1 / 1000)*** Read-only
2.80	Signal selection for the output AO1	Details in Appendix A
2.82	Configuration of AO1 output range (current output)	**1**: 0..20mA, **2**: 20..0mA, **3**: 4...20mA, **4**: 20...4mA.
2.84	AO1 scale examples:  	Range: 0...500.0%. Standard 100.0% For a 0..20mA configuration, the 20mA current value corresponds to a 1000 signal value with the scale set at 100.0%. For the scale set at 50.0% to get 20mA output voltage, the signal value must be 2000. Similarly for the scale set to 200.0%, in order to get 20mA output voltage, the signal value must be 500. **The signal value corresponds to the value of the selected quantity without a decimal place, e.g.** **12.5% = 125 2.43 A = 243 375 V = 375** **e.g. when the signal (current value) is 11.7 A, which corresponds to 117, then:** **current = scale * signal / 1000** **current = 100.0% * 117/1000 = 11.7% (0 ... 10V) = 1.17 V**
2.86	AO1 low pass filter time constant	AO1 analog output filter. Details in Appendix A. 

5.8. Constant speeds operation

The frequency converter can currently operate at one of 7 constant speeds. The constant speed is selected by a combination of three input signals: W1, W2 and W3. The input signals W1, W2 and W3 use the digital inputs specified in the parameters respectively: 2.30 for W1, 2.31 for W2 and 2.32 for W3.

The setting of each of these parameters can be:

- **"0" -Off —** the given input signal is inactive.
- **"1" -DI1**..."6" -DI6 — assigns the appropriate digital input as the source for the given input signal.

Constant speeds 1..7 are stored in parameters 2.33..2.39.

The method of selecting a constant speed depending on the combination of W1, W2, W3 inputs is presented in the table below:

Table 5.5. Constant speed control configuration for 3 input signals W1, W2 and W3

W1	W2	W3	Constant speed no.
0	0	0	The system does not work with any of the defined constant speeds; referencing-unit A (par. 2.2) or B (par. 2.3) is active, depending on the par. 2.1.
1	0	0	Constant speed No. 1, by default 10 Hz (par. 2.33)
0	1	0	Constant speed No. 2,by default20 Hz (par. 2.34)
1	1	0	Constant speed No. 3,by default25 Hz (par. 2.35)
0	0	1	Constant speed No. 4, by default 30 Hz (par. 2.36)
1	0	1	Constant speed No. 5, by default40 Hz (par. 2.37)
0	1	1	Constant speed No. 6, by default 45 Hz (par. 2.38)
1	1	1	Constant speed No. 7, by default 50 Hz (par. 2.39)

Only two inputs W1 and W2 can be used. Then par. 2.32 defining W3 should be set to **"0" -Off**, and parameters 2.30 (W1) and 2.31 (W2) should be assigned any two input signals, e.g. **"5" -DI5** and **"6" -DI6**.

The method of selecting a constant speed depending on the combination of W1 and W2 inputs is presented in the table below:

Table 5.6. Constant speed control configuration for 2 input signals W1 and W2

W1	W2	Constant speed no.
0	0	The system does not work with any of the defined constant speeds; referencing-unit A (par. 2.2) or B (par. 2.3) is active, depending on the par. 2.1.
1	0	Constant speed No. 1, by default 10 Hz (para. 2.33)
0	1	Constant speed No. 2, by default 20 Hz (para. 2.34)
1	1	Constant speed No. 3, by default 25 Hz (para. 2.35)

Note:
The digital input DI4 is set by default as the external reset source, therefore before using it to set the constant speeds, parameter 3.70 should be changed to **"0" - Disable.**

An example of operation at constant speeds

Using DI5 and DI6 digital inputs, we want to achieve 3 constant speeds: 10, 25 and 50Hz. The Start/Stop signal is given via the digital input DI1 and the direction change is done via the input DI2.

In order to do so, it is necessary to:

- switch on the control place B: par. 2.01 set to **"7" - On**;
- check if par. 2.05 and 2.08 have factory settings:
  - par. 2.05 Start B: **"0" -DI**,
  - par. 2.08 Remote Start: **"0"**.
- Assign digital inputs DI5 and DI6 as constant speed input signals W1 and W2, respectively:
  - par. 2.30 (input W1): **"5" -DI5**,
  - par. 2.31 (input W2): **"6" -DI6**.
- Define 10, 25 and 50 Hz constant speeds:
  - par. 2.33 (constant speed 1) set to 10 Hz,
  - par. 2.34 (constant speed no. 2) set to 25 Hz,
  - par. 2.35 (constant speed no. 3) set to 50 Hz.

Fig. 5.4 shows the arrangement of electrical connections for above-mentioned example.

- START/STOP: applying 24Vdc voltage to the DI1 digital input.
- Changing the direction of rotation: applying 24Vdc voltage to the DI2 digital input.
- Speed selection: applying 24Vdc voltage to digital inputs DI5 and/or DI6 according to table 5.6.

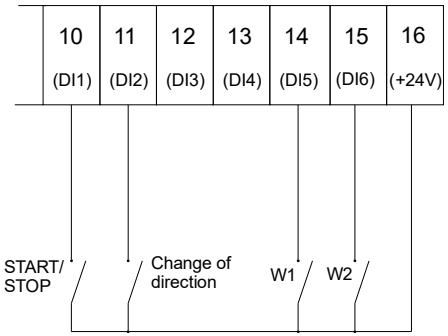


Fig. 5.4. Connection system on terminal block X1 for three constant speeds

5.9. Motopotentiometer

The motopotentiometer is an "increase-decrease" system designed to control the electric motor speed by means of two monostable switches connected to the digital inputs. To use the motopotentiometer function:

- connect two monostable switches to any two digital inputs, e.g. DI5 and DI6.
  The use of other digital inputs is possible after making sure that they do not perform other functions:
  - *DI4 input is by default used as external fault reset (par. 3.70)*
  - *DI1, DI2, DI3 inputs can be used as Start / Stop signal sources and direction changes (par. 2.08) when the frequency converter is controlled from the control terminal block, i.e. for control from the place A: par. 2.04 and 2.06 = "0"-DI, and for control from the place B: par. 2.05 and 2.07 = "0" -DI;*
- set the motopotentiometer as a speed referencing-unit; depending on the control place selected in parameter 2.01 (by default, it is control A: par. 2.01 = "0" – Disable), set **par. 2.02** (for control A) or **2.03** (for control B) to the value **"5" - MotPot;**
- set as the signal source "increase" (**par. 2.20**) and "decrease" (**par. 2.21**) digital inputs DI, to which monostable switches have been connected. The possible settings of par. 2.20 and 2.21:
  "0" - off, "1" - DI1, "2" - DI2.."6" - DI6.

Four modes of operation are possible (**0, 1, 2, 3**):

0: stopping the frequency converter operation (STOP) causes resetting of the motopotentiometer setting;
1: after stopping the frequency converter operation (STOP), the value of the motopotentiometer setting will be stored and it is not possible to change the motopotentiometer setting during standstill.
2: the value of the current referencing-unit setting is monitored by the motopotentiometer, which enables a gentle switching from the current referencing-unit to the referencing-unit from the motopotentiometer.
3: after stopping the frequency converter operation, the motopotentiometer setting value will be saved, it is possible to change the motopotentiometer setting during standstill.

An example of how to connect the "increase" and "decrease" buttons is shown in Fig. 5.5a. The operation of the system is illustrated in Fig. 5.5b.

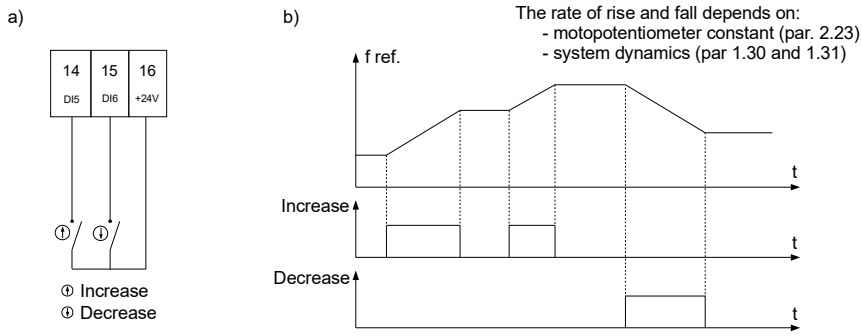


Fig. 5.5. a) - connections on terminal block X1, b) - illustration of the motopotentiometer system operation

In the above-mentioned example, the digital inputs DI5 and DI6 were used, which corresponds to the settings: par. 2.20 = **"5"**, par. = 2.21 **"6"**.

The change of the rise/fall time of the motopotentiometer referencing-unit in the range of 0.1..320.0 s. is made by par. 2.23.

5.10. Elimination of frequencies

In order to eliminate undesirable output frequencies that can cause drive resonances, 3 ranges called "ranges of elimination" can be defined. They are defined by parameters:

par 1.90 – bottom frequency of the elimination band 1 [Hz]
par 1.91 – top frequency of the elimination band 1 [Hz]
par 1.92 – bottom frequency of the elimination band 2 [Hz]
par 1.93 – top frequency of the elimination band 2 [Hz]
par 1.94 – bottom frequency of the elimination band 3 [Hz]
par 1.95 – top frequency of the elimination band 3 [Hz]

Referencing-unit of the electric drive will "bypass" frequencies which are chosen by the above-mentioned parameters.

Fig.5.6 shows the influence of elimination ranges on the output frequency of the referencing-unit.

Note:
During acceleration and deceleration, the frequency range elimination function is inactive.

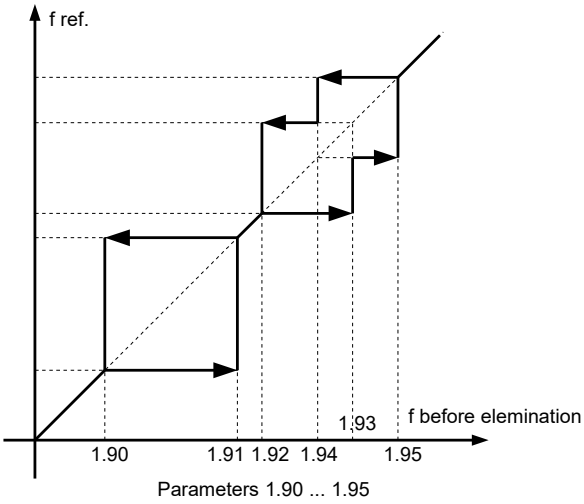


Fig. 5.6.Elimination bands - sample configuration. Bands 2 and 3 overlap

5.11. Electric motor rotation direction lock

It is possible to block the system to work only in one direction. Then, regardless of the control signals, the system will rotate the motor only one way. Parameter **1.65** allows you to specify this setting:

„0" - Two-way operation (default setting)
„1" - One-way operation
„2" - One-way operation (rotation direction is opposite to setting "1")
„3" - DI4/DI5 - selecting the locking direction by digital inputs
DI4 → "1" and DI5 → "2"

5.12. Thermal protections of the motor - protection by I^2t limit

The built-in thermal model of the motor enables to calculate the motor temperature in the theoretical way. The model is developed on the basis of the following assumptions:

- the temperature of windings changes according to the exponential law,
- the electric motor achieves the maximal temperature for continuous work at a nominal current,
- the temperature rise depends on the ratio $(I/In)^2$,
- the cooling time constant for the stopped motor is four times higher than the heating time constant during operation.

Relative **long-term motor current** for frequencies above 25Hz is determined by **parameter 3.03**. For frequencies below 25Hz, the long-term current is lower (lower efficiency of the cooling fan placed on the motor shaft) and determined by **parameter 3.04**. These parameters are determined in relation to the nominal motor current for 100. 0% = In. This is how the **long-term work area** is determined (Fig. 5.7a).

When cooling the motor without additional ventilation (only internal fan), set par. 3.04 to 35% of the nominal motor current. If additional engine ventilation is used, the value of par. 3.04 can be increased up to 75%. If the motor current is not within the defined long-term operating range, the calculated temperature will increase above 100%. **When the calculated temperature reaches 105%, the system will be switched off** (a failure message will be displayed). This situation takes place in Fig. 5.7c for the increase in temperature marked with a dashed line.

The rate of increase of the calculated temperature is specified by **parameter 3.05** - time constant of motor heating. This is the time after which the motor temperature reaches 63% of the final temperature increase value. In practice, it is possible to set par. 3.05 = 120 * t6 [min], where t6 [s] is given by the motor manufacturer.

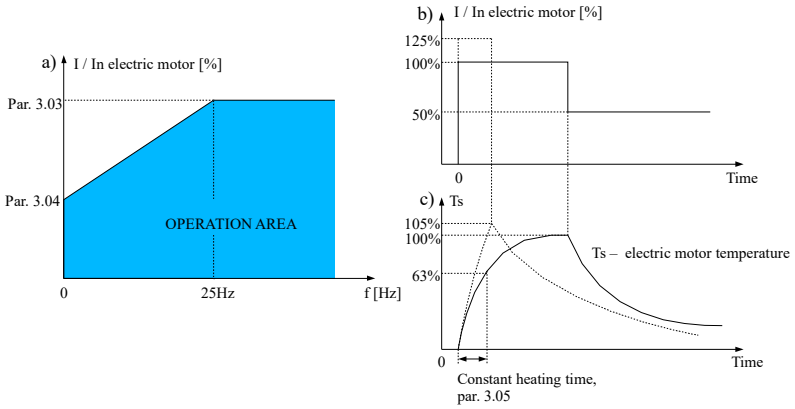


Fig. 5.7. Defining long-term operation area (a), dependence of calculated motor temperature on current (b) and (c)

5.13. Operating at frequencies exceeding 50 Hz

The use of a frequency converter enables an output frequency higher than 50 Hz. For typical electric motors with f_n = 50 Hz, this means operating at a higher speed than the nominal speed.

Note:

1. Make sure that the motor manufacturer allows its operation with a frequency above 50 Hz.
2. Operating at speeds above the nominal speed may result in, among other things, shortening of motor life due to faster bearing wear.
3. Above nominal speed the electric motor operates with constant power. This means that as the speed increases above nn, the motor shaft moment will decrease.

Two parameters are responsible for working with a frequency above 50 Hz: 2.12 and 1.40.

Par. no.	**Name**	**Description**
par. 2.12	Ref. max.	The maximum value of the reference frequency (corresponding to 100% of the referencing-unit value)
par. 1.40	F max.	Maximum output frequency F max > Ref. max *usually Fmax = Ref. max + 5 Hz*

Example settings of par. 2.12 and 1.40 for operation at 70 Hz
par. 2.12 = 70 Hz
par. 1.40 = 75 Hz

6. PI controller

The system is equipped with a PI (Proportional-Integral) controller. The controller is used to stabilize any process parameter at a specific level (fig. 6.1).

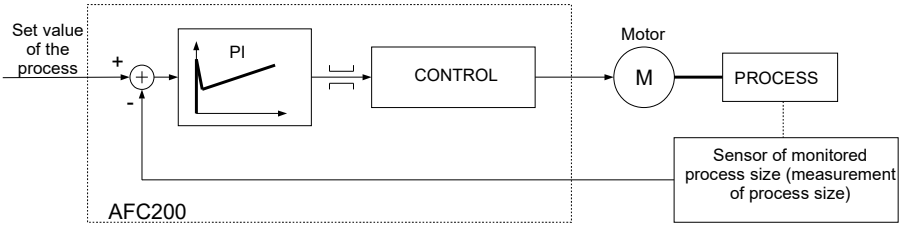


Fig. 6.1. Using the PI controller to regulate the monitored process size

6.1. Turning on and configuration of the PI controller

The PI controller is switched on by means of par. 2.02 (for control A) or 2.03 (for control B) by selecting the value **"4" - Out. PI.**

Changing the process setpoint of the PI controller when the keyboard reference mode is set (par. 2.60 = 0) is done in the Quick view mode using the "up"/"down" arrows. For editing to be possible, the current referencing-unit (par. 2.02 for control place A, or par. 2.03 for control place B) must be set to PI controller ("4" - OUT.PI). The referencing-unit value can be changed in the range from 0.0% to 100.0%.

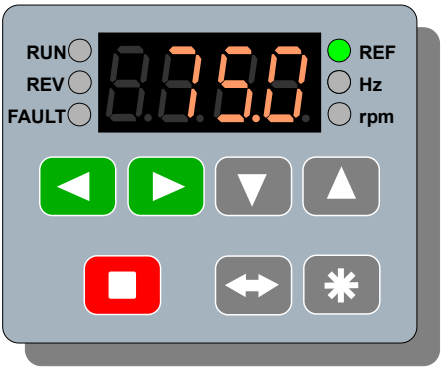


Fig. 6.2. Changing the PI controller ref.-unit value (keyboard ref.-unit: par 2.60 = 0)

Table 6.1. Control and information parameters of the PI controller

Par.	***Name***	***Description***
0.30	PI reference	The value of the currently selected PI controller referencing-unit [%]. Read-only.
0.31	PI input	The value of the currently selected PI feedback signal input [%]. Read-only.
0.32	PI error	The value of the current controller error. Par. 0.32 [%] = par. 0.30 - par. 0.31. Read-only.
0.33	PI output	The current value of the PI controller output [%]. Read-only
2.60	The choice of PI ref.-unit	The referencing-unit source for the PI controller is used to set the process reference value. Possible values: **0 - KBD:** PI referencing-unit from the control panel **1- Ref.-unit A1** **2- Ref.-unit A2** **3:** not used **4-RS:** reference via 485 interface (Modbus)
2.61	The choice of PI input	The source of the PI controller feedback signal **0: Ref.-unit A1** **1: Ref.-unit A2**
2.62	Error negation	Error negation (difference between reference value and feedback signal) **0: NO** **1: YES**
2.63	P amplification (Kp)	Amplification of the proportional part of the PI controller. The greater the amplification , the faster the controller will react to a speed error. Range: **1 ... 3000%**
2.64	Constant I (Ki)	Time constant of the PI controller. Range: **0.01 ... 320.00s**
2.66	Max.Out.PI	Maximum value that the PI controller output can reach (saturation limitation) Range: **0.0 ... 3000.0 %**
2.67	Min.Out.PI	The minimum value that the PI controller output can reach (saturation limitation) Range: **-3000.0 ... 0.0 %**
2.68	PI reset	Resetting the PI output when the system is stopped: **0:** reset to STOP **1:** the controller is always active

7. Frequency converter control via RS-485 communication link

The AFC200 frequency converter is equipped with an RS-485 communication link. This allows you to control the system from a computer or external controller. The basic features and capabilities of the converter RS link are:

- operation at 9600 or 19200 bits per second,
- character format: 8 data bits, no parity check, 2 stop bits,
- supported transmission protocol: MODBUS RTU mode,
- checking the correctness of the transmission through the CRC sum,
- unit number set by means of the parameter (standard 12),
- supported MODBUS protocol commands: command 3 – "register reading" - enables reading a single register from the drive. Command 6 - "register writing" - write a single register to the converter,
- possibility of reading the operating status, start/stop control, reading nd writing referencing-units,
- possibility of reading and writing all parameters of the converter as on the control panel.

The operations are based on MODBUS RTU protocol commands - No. 3 and 6 described in publications on MODBUS.

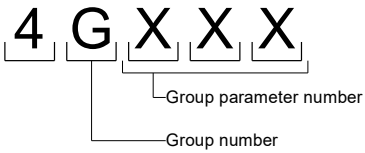


Fig. 7.1. Addressing parameters for the MODBUS protocol

The figure above shows how to address parameters in the AFC200 frequency converter in the case of the MODBUS protocol. For example, parameter **1.01** corresponds to address **(41001)d**, parameter **2.12** corresponds to address **(42012)d** etc.

7.1. Parameters regarding communication via RS-485

Table 7.1. Communication parameters

Parameter	***Description***
2.02	Ref.-unit A: **"6" - RS** - frequency reference via the "RS-485" connection
2.03	Ref.-unit B: **„6"- RS** – frequency reference via the "RS-485" connection
2.04	Start A: **„2"- RS** – START / STOP control via "RS-458" link
2.05	Start B: **„2"- RS** – START / STOP control via "RS-458" link
4.07	RS permission - it is possible to set the RS permission for permanent control (**par. 4.07="7"**), to disable the permission for permanent control (**par. 4.07="0"**) or to control the RS permission from the digital input (**par. 4.07="1" for DI1 ... par. 4.07="6" for DI6**). The permission applies to the frequency referencing-unit from RS, RS PI referencing-unit and the signal START/STOP/BLOCKING from RS (see table 7. 2 - registers 2000, 2001 and 2002).
4.08	RS speed - the possible options are 9600 or 19200 bits per second.
4.09	Unit number in MODBUS protocol (possibility of connecting several converters through one communication link RS-485)

CAUTION:
If the RS control is blocked (par. 4.07) and the parameters 2.02, 2.03, 2.04 or 2.05 define the control as "RS", then the system remains in STOP mode or the referencing-unit of frequency will assume value 0.

7.2. Map of registers accessible through RS-485 link

All registers are 16-bit numbers. Register addresses (decimal) that are omitted are not supported.

Table 7.2. Registers

The address of the registers	***Description (meaning)***	***Mode***
REGISTERS OF OPERATING MODES		
2000	The register RS CONTROL. The data is only valid when parameter 4.07 (RS permission) allows the system to work with RS. The meaning of bits: bit 0 – *not used* bit 1 – the sequence 0 → 1 → 0 erases the message on failure bity 2,3 – *not used* bit 4 - 1 = force PI reference from RS (register 2002) bit 5 - 1 = force frequency reference from RS (register 2001) bit 6-1 = Force START / STOP control from RS bits 7,8,9,10,11,12,13,14 – *not used* bit 15 – 1 = START 0 = STOP Bits 4,5,6 allow to force control of the converter through RS communication links even if referencing-units or source of START / STOP signal are set up on value which differs from RS. If, for example, the referencing-unit A is set up on value "RS", then in oder to set frequency with RS, it is not necessary to set up bit 5. Forcing of control with RS by means of bits 4,5,6 results in switching off a source of the control established with parameters. Bits 12,13,14 block operation of the system irrespective of the established type of control (also when, for example, there is control through RS and bits 15 = 1).	Read/ write The last value written down in this register cab be read.
2001	The RS frequency referencing-unit operates only if the parameter 4,07 (RS permission) allows operation with RS. Resolution 0,1Hz *), a range - 32000...32000 e.g. 2500 = 25.0 Hz clockwise rotation e.g.-1220 = 12.20 Hz anti-clockwise rotation *)CAUTION: in Vector mode, the value is expressed in revolutions per minute (rpm).	Read/ write

The address of the registers	***Description (meaning)***	***Mode***
2002	The referencing-unit of the PI-controller operates only if the parameter 4.07 (RS permission) allows operation with RS. Resolution 0,1 %, range 0....1000. e.g. 445 = 44,5 %	Read / write
2004	STATE OF CONTROL The register which informs where the current START/STOP signal source and frequency referencing-unit come from. bit 0 – 1 = active control A bit 1 – 1 = active control B bit 2 – 1 = the referencing-unit from an analog input 1 bit 3 – 1 = the referencing-unit from an analog input 2 bit 4 – *not used* bit 5 – 1 = the referencing-unit from a motor-potentiometer bit 6 – 1 = the referencing-unit from an output of the PI-controller bit 7 – 1 = the referencing-unit from the control panel bit 8 – *not used* bit 9 – 1 = START / STOP from digital inputs (remote) bit 10 – 1 = START / STOP from the control panel (local) bit 11 – *not used* bit 12 – 1 = START / STOP set through RS link bit 13 – 1 = he referencing-unit of frequency comes from communication link RS bit 14 – 1 = CONSTANT active frequency (f const) bit 15 – *not used*	Read only
2005	*Not used*	Read only

The address of the registers	*Description (meaning)*	*Mode*
2006	OPERATION STATE The value of this register serves for identification of the device state: bit 0 - 1 = the drive operates bit 1 - 1 = one of the referencing-units of the control panel (the frequency, the PI-controller or the user's referencing-unit) is active bit 2 - 1 = device is blocked bit 3 - 1 = ready for restart (failure signal deleted but its cause has not disappeared) bits 4,5,6 – *not used* bit 7 - CRC error in EEPROM bits 8,9,10,11,12 - the failure code or warning (0= absence of failure) bit 13 - failure code meaning: 0 = failure, 1 = warning bit 14 - a direction of operation (0 = to the right, 1 = to the left). bit 15 - 1 = identification run (started by par. 1.10)	Read only
THE REGISTERS CONNECTED TO PARAMETERS		
40xxx	Parameters from group 0. they are similar to parameters on the control panel. e.g. register 40003 corresponds to parameter 0.3	Read only
41xxx	Parameters from group 1. They are similar to parameters on the control panel. e.g. register 41020 corresponds to parameter 1.20 CAUTION: Changing parameters is subject to the same rules as when operating from the control panel. It may be necessary to disable the blocking of parameters change (parameter 4.01 = register 44001) or enter the appropriate access code (parameter 4.02 = register 44002). Some system parameters can only be changed when the system does not operate - see Appendix A.	Read / write
42xxx	Parameters from group 2. They are similar to parameters on the control panel. e.g. register 42001 corresponds to parameter 2.01. REMARKS as above	Read / write
43xxx	Parameters from group 3. REMARKS as above	Read / write
44xxx	Parameters from group 4. REMARKS as above	Read / write

7.3. Handling communication errors

In case of transmission errors or sending a command with improper parameters, the system responds in the manner provided for by the MODBUS standard. Possible return error codes are:

Error №	Description
1	Unknown command - when a command other than 3 or 6 has been sent.
2	Wrong address - the register address is not supported by the system (there is no such register).
3	Wrong value - an attempt was made to send a register value outside the allowable range using the command 6.

In case of wrong transfer (e.g. CRC error) device does not send answers to commands.

8. Failures and warnings

8.1. Messages on failures and warnings on the control panel

The luminescence of a red light-emitting diode LED (with a “FAULT” description) and the display of appropriate messages signal about failure state.
Thus, the frequency converter passes to STOP mode. To make the next START, it is necessary to remove the cause and delete the fault report - see section 8.2.

Warning state is signalled by the appropriate message on the display without stopping the frequency converter. The removal of the warning notification is done by removing its cause and pressing .

Table 8.1. Failures and warnings codes

Code	*Display view*	*Description*	*Possible cause*	*Counteraction*
E. 1		Heat sink temperature higher than 80ºC.	Difficult airflow, system overload, ambient temperature too high.	Check ventilation efficiency (fan efficiency and heat sink contamination).
E. 3		High voltage in DC circuit	Too high voltage in the circuit, intensive braking of the electric motor.	Check mains supply. Increase the braking time (deceleration) in par. 1.31.

Code	Display view	Description	Possible cause	Counteraction
E. 4		Low voltage in DC circuit	Low voltage in circuit, absence of one supply phase.	Check wires and supply voltage level.
E. 5		Short circuit at the system output or power module fault.	Short circuit in electric motor or motor power cable.	Disconnect the motor and check if the fault persists; if it is present, contact the service centre, if not —check insulation of motor wires and windings.
E. 6		Electric motor current is too high.	Too intensive start-up. A rapid change in motor load.	Increase motor acceleration time in par. 1.30.
E. 7		Electric motor thermal overload.	Operation with a loaded motor or long operation with high loading at low speeds	Check motor load (motor current). Check the parameters of the motor thermal model
U. 8		No signal at the analog input.	When setting the input with "living null" (2-10V or 4-20mA - par. 2.40) the signal is below 1V or 2mA. Depending on the setting of par. 3.23, the warning (U.8) or failure (E.8) occurs.	Check the configuration of the analog inputs, check the connection system (broken wires etc.)
E. 8				
E. 13		Heatsink temperature is lower than -10ºC.	The ambient temperature of the converter is too low.	Check heating efficiency.
E. 21		The signal of external failure is active	Depending on the User's configuration,	Check the status at the digital input selected as an external fault.
E. 27		Waiting time for RS signal is exceeded.	Cable damage, parameters of the transmission are incorrectly set up.	Check external connection and correctness of RS parameters.

8.2. Deleting failure message.

Manual deleting

To delete the failure message press the stop button ( ) for at least 2 seconds.

Deleting through a digital input of the freqency converter
Parameter 3.70 allows to select a digital input which will be used to clear the failure message.

Remote deleting through RS link
If the permission for operation of the system with RS control, selected by parameter 4.07, is active, then the sequence of 2 successive entries to the 2000 register (MODBUS) enables the failure notification to be cleared. A detailed description of the meaning of bits and the method of resetting faults is in the description of the register 2000.

8.3. Failure log

Parameters 3.80 ... 3.111 contain the Failure Log, which allows you to retrieve the history of the last 16 failures.

Each entry in the failure log contains two parameters. The first one gives the failure code together with the number of occurrences in a given hour - Fig. 8.1a. The second - time it occurs - Fig.8.1b.

The failure time is counted in the converter operating hours from the moment it is first connected to the network.

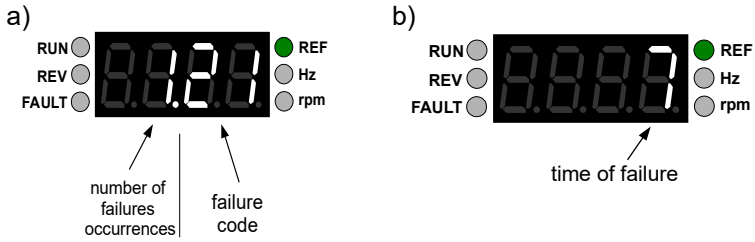


Fig. 8.1. An example of a failure read from par. 3.80 (Fig. A) with the time of occurrence read from par. 3.81 (fig. B)

Parameters 3.80 and 3.81 refer to the most recent failure record, and parameters 3.110 and 3.111 apply to the oldest failure record.
In one hour of converter operation time, the same failure can occur many times. In order not to overfill the failure log in such a case, only the number of failures in a given hour is increased. Thanks to this, the real number of failures that can be stored increases.

9. Restore factory parameters

To restore factory parameters set parameter 4.4 to **"1"**. PD2 access level is required (par. 4.02).

10. Periodic service

If the frequency converter is installed and used in accordance with its specification, the frequent periodic service is not required. It is necessary to ensure the cleanliness of the heatsink and the fan as well as the condition of electric wires connections, in particular the PE protective conductor. The frequency converter service schedule is shown in the table 10.1.

Heatsink
A large amount of dirt on the heatsink weakens heat dissipation and can trigger protection against an overheat of the converter. Cleaning the heatsink can be made by means of compressed, clean and dry air using a vacuum cleaner for gathering dirt.

Fan
The increased noise emitted by the internal fan of the converter indicates the need to replace it. It that case, please contact the service department.

Before performing any maintenance work, disconnect the converter from the power supply and wait at least 10 minutes due to the time required to discharge the internal DC circuit capacitors and to cool the converter.

Table 10.1. The frequency converter service schedule

The place	Aim	Frequency
The heatsink and the fan	Checking the pollution level of the heat sink and the fan.	**At least every 12 months** [1)]
The condition of electric wires connections	Checking the connection status, tightening the terminals.	

[1)] The service should be carried out regularly depending on the frequency of the frequency converter operation and environmental conditions (e. g. dust, vibrations).

Warranty conditions
The system is covered by the warranty in accordance with the information contained in the warranty card. The manufacturer is not responsible for any defects resulting from transport, misuse, faulty installation, inadequate environmental conditions (e. g. temperature, humidity, presence of caustic agents) and as a result of exceeding the nominal parameters.

Appendix A – AFC200 frequency converter parameters table

The parameters numbers given in the appendix refer to the display on the control panel. When reading the record via the RS link, each parameter is read/written by a different register. For example, parameter 2.02 corresponds to register 42002, parameter 4.30 corresponds to register 44030, etc.

The parameters of GROUP 0. Read-only process variables.

Parameter	Name	Description
GROUP 0: PROCESS VARIABLES – READ-ONLY PARAMETERS		
0.02	Motor n	Current rotation speed of the motor in rotations per one minute [rpm] - when working in vector mode
0.04	F out.	Current output frequency of the converter [Hz] – only in scalar U/f mode
0.05	F ref,	Referenced frequency [Hz]
0.06	Motor torque	Motor torque %
0.07	Motor current	Average value of current in windings of the motor [A]
0.08	Motor voltage	An output voltage AC of the converter [V] (voltage of the motor)
0.10	DC voltage	Voltage of the DC intermediaries circuit of the converter [V]
0.14	Ia	Current of a phase A of the motor [A]
0.15	Ib	Current of a phase B of the motor [A]
0.16	Ic	Current of a phase C of the motor [A]
0.23	Heatsink temperature	Heatsink temperature [ºC]
0.30	PI ref.	Value of the current referencing-unit of the PI controller [%]
0.31	PI in.	Current input value of the PI controller [%]
0.32	PI error	Error of the PI controller [%]
0.33	PI out.	Current output value of the PI controller [%]
0.35	ON time	Number of operating hours of the converter [h]
0.40	AI1	Value of an analog input 1 [%]
0.41	AI2	Value of an analog input 2 [%]
0.43	AO1	Value of an analog output 1 [%]
0.45	A1 ref.	Value of the analog referencing-unit 1 [%]
0.46	A2 ref.	Value of the analog referencing-unit 2 [%]
0.48	DI state	State of all six digital inputs (for RS six youngest bits of the register)

Parameter	Name	Description
0.50	RS1 state	It corresponds to the value written into the register 2000 through RS connection
0.51	Version	Version of the keyboard software
0.52	RS ref.	RS referencing-unit, which corresponds to the value written into the register 2001 through RS [Hz] or [rpm]
0.53	PI RS ref.	PI RS ref.-unit, which corresponds to the value written into the register 2002 through RS [%]

Group parameters: 1 - 4

Parameter / Name	Function	Available options / measurement unit / comments	Factory setting	Change during operation
GROUP 1: CONFIGURATION OF THE DRIVE				
1.01 Power Pn	Nominal power of the electric motor	0.0 ... 3.0 kW	Nominal power of the frequency converter	NO
1.02 Rotations Rn	Nominal motor speed	0 ... 9999 rpm	1450 rpm	NO
1.03 Current In	Nominal motor current	0.00 ...30.0 A Nominal power of the frequency converter	Nominal current of the frequency converter	NO
1.04 Voltage Un	Nominal motor voltage	0 ... 999 V	230 V	NO
1.05 Częst. fn	Nominal motor frequency	0.0 ... 320.0 Hz	50.0 Hz	NO
1.06 cos n	Nominal cos φn of the motor	0.50 ... 1.00	0.80	NO
1.10 ID run	Identification of the motor parameters	**0:** without identification **1:** identification of parameters of the motor replacement scheme (necessary for operation in vector mode)	0	NO
1.11 Rs	Resistance stator windings Rs	0 ... 300.0 Ohm		NO

Parameter / Name	Function	Available options / measurement unit / comments	Factory setting	Change during operation
1.20 Operating mode	Frequency converter operating mode	**0-U/f lin.:** operation in scalar mode (linear characteristic) **1-U/f sq.:** as above (square-law characteristic) **2:** not used **3-Vector:** operation in vector mode	0	NO
1.21 F carrier	Switching frequency	**0:** 4kHz **1:** 8kHz **2:** 16kHz	0	NO
1.30 Acceleration	Acceleration time from 0 Hz to 50 Hz	0.0 ... 320.0 s	5.0 s	YES
1.31 Deceleration	Deceleration time from 50Hz to 0Hz	0.0 ... 320.0 s	5.0 s	YES
1.37 Initiation time	Time after which it will be possible to start the frequency converter from the moment of supplying power	0...200 s	0 s	YES
1.38 Stop delay	The start time of stopping when the STOP signal has been given	0...200 s	0 s	YES
1.40 F max	Maximum output frequency	0.0 ... 320.0 Hz *Note: See also par. 2.12*	55.0 Hz	YES
1.41 I limit S	Current restriction at electric motor operation	0.0 ... 200.0 % motor In	150.0 %	YES
1.43 M limit S	Torque restriction at motor operation	0.0...200.0 % motor Mn	150.0%	YES
1.50 U0	Voltage for output frequency F0 (par. 1.51)	0.0 ... 40.0 % motor Un	2.0 %	YES
1.51 F0	F0 frequency	0.0 ... 20.0 %	0.0 %	YES
1.52 U1	Voltage for output frequency F1 (par 1.53)	0.0 ... 40.0 %	20.0 %	YES

Parameter / Name	Function	Available options / measurement unit / comments	Factory setting	Change during operation
1.53 F1	F1 frequency	0.0 ... 25.0 %	25,0 %	YES
1.60 Slip comp.	Slip compensation	**0-NO:** disabled **1-YES:** enabled	0	YES
1.64 Stop mode	Stopping by coast or according to characteristic	**0-Coast:** stopping by running out after STOP command (voltage taken off immediately) **1-Ramp:** deceleration to 0 Hz at first, then shutting down	0	YES
1.65 Direction Lock	Operation direction lock	**0:** Two-way motor operation **1:** One-way motor operation **2:** One-way operation (rotation direction is opposite to setting "1") **3-DI4/DI5** – selecting the locking direction by digital inputs DI4 → “1” and DI5 → “2”	0	YES
1.70 Amp. reg. n	Speed regulator gain	0..5000	60	NO
1.71 Ki of reg.n	Integration time of speed regulator	0..5000	40	NO
1.72 Amp. reg.T	Torque regulator gain	0..5000	30	NO
1.73 Ki of reg.T	Integration time of Torque regulator	0..5000	130	NO
1.74 Amp. reg.S	Motor stream regulator gain	0..5000	60	NO
1.75 Ki of reg.S	Integration time of motor stream regulator	Service parameter	100	NO
1.90 F elim1 min	Minimum frequency of frequency elimination range number 1	0.00 ... 320.0 Hz	0.00 Hz	YES
1.91 F elim1 max	Maximum frequency of frequency elimination range number 1	0.00 ... 320.0 Hz	0.00 Hz	YES

Parameter / Name	Function	Available options / measurement unit / comments	Factory setting	Change during operation
1.92 F elim2 min	Minimum frequency of frequency elimination range number 2	0.00 ... 320.0 Hz	0.00 Hz	YES
1.93 F elim2 max	Maximum frequency of frequency elimination range number 2	0.00 ... 320.0 Hz	0.00 Hz	YES
1.94 F elim3 min	Minimum frequency of frequency elimination range number 3	0.00 ... 320.0 Hz	0.00 Hz	YES
1.95 F elim3 max	Maximum frequency of frequency elimination range number 3	0.00 ... 320.0 Hz	0.00 Hz	YES
GROUP 2: REFERENCING-UNITS AND CONTROL				
2.01 Control B	Switching on variant A or B of control	**0-Off:** active ‘control place A’ **1-DI1 .. 6-DI6:**A / B control place selection via digital input (0V→A, 24V→B) **7-On:** active ‘control place B’ ***Note:*** *software version: 12 and lower* **0-Off:** Control A **1-On:** Control B	0 (Active ‘control place A’)	YES

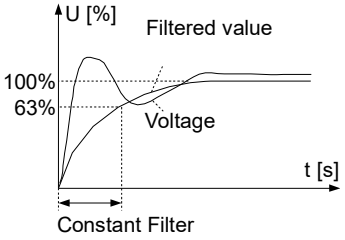
Parameter / Name	Function	Available options / measurement unit / comments	Factory setting	Change during operation
2.02 Ref. A	Choice of a referencing-unit for Control A	**0-Keyb .:** frequency ref.-unit from the panel **1-AI1:** referencing frequency by signal from analog input 1 **2-AI2:** referencing frequency by signal from analog input 2 **3:** not used **4-Out.PI:** referencing frequency from PI-regulator **5-MotPot:** referencing by increase/decrease signals from motopotentiometer **6-RS:** referencing through RS485 connection (Modbus) **7-Ref.A1:** frequency reference with signal from analog referencing-unitA1 **8-Ref.A2:** frequency reference with signal from analog referencing-unit A2	0	YES
2.03 Ref. B	Choice of a referencing-unit for Control B	As above	1	YES
2.04 Start A	Choice of a source of START / STOP signal for Control A	**0-DI:** remote START/STOP control (from device's digital inputs – see par 2.8) **1-Keyb.:** local START/STOP control from the panel **2-RS:** START/STOP control through RS485 (Modbus)	1	YES
2.05 Start B	Choice of a source of START / STOP signal for Control B	As above	0	YES
2.06 A Direction	Choice of signal of direction control for Control A	As above	1	YES
2.07 B Direction	Choice of signal of direction control for Control B	As above	0	YES

Parameter / Name	Function	Available options / measurement unit / comments	Factory setting	Change during operation
2.08 Remote Start	Variant of START/STOP remote contro	**0:** DI1 = START/STOP, DI2 =direction **1:** DI1 = START RIGHT, DI2 = START LEFT **2:** impulse DI1 = START, impulse DI2 = STOP **3:** as above + DI3 = direction **4:** DI1 = START/STOP **5:** DI1 or DI2 = START/STOP **6:** DI1 and DI2 = START/STOP	0	YES
2.11 Ref. min	Referenced frequency corresponding to 0% of the referencing-unit	-320.0 ... 320.0 Hz	0.00 Hz	YES
2.12 Ref. max	Referenced frequency corresponding to 100 % of the referencing-unit	-320.0 ... 320.0 Hz *Note: see also par. 1.40*	50.00 Hz	YES
2.13 F Stop	The absolute minimum value of the frequency reference	0.00 ... 55.00 Hz	0.00 Hz	YES
2.14 Use F Stop	Stopping when f < par 2.13	Software from version 15.0 **0:** the drive will limit the output frequency to value set in par. 2.13. **1**: the drive will stop when ref.F is lower than the minimum specified in par. 2.13 *Note: in lower versions of the software, the functions are reversed.*	0	YES
2.20 Motopot.up	Signal source "increase" for the referencing-unit by the motopotentiometer	**0-off: lack** **1-DI1 .. 6-DI6:** increase the referencing-unit when voltage is applied to digital input 1 ... 6	0	YES
2.21 Motopot.down	Signal source "decrease" for the referencing-unit by the motopotentiometer	**0-Off:** lack **1-DI1 .. 6-DI6:** decrease the referencing-unit when voltage is applied to digital input 1 ... 6	0	YES

Parameter / Name	Function	Available options / measurement unit / comments	Factory setting	Change during operation
2.22 Motopot. mode	Motopotentiometer mode	**0:** sending STOP signal by pushing STOP button causes resetting of motopotentiometer settings **1:** value of motopotentiometer setting is stored in memory. There is no possibility of changing this setting during stoppage. **2:** value of current referencing-unit setting is traced by motopotentiometer. It is applied for gentle transmission from current ref.-unit to motopotentiometer **3:** value of motopotentiometer setting is stored in memory. There is a possibility of changing this setting during stoppage.	0	YES
2.23 Motopot. time	Time of increase/decrease of motopotentiometer ref.-unit	0.0 ... 320.0 s	10.0 s	YES
2.24	Logic of DI1	**0:** no negation of digital input DI1 **1:** negation of digital input DI1	0	YES
2.25	Logic of DI2	**0:** no negation of digital input DI2 **1:** negation of digital input DI2	0	YES
2.26	Logic of DI3	**0:** no negation of digital input DI3 **1:** negation of digital input DI3	0	YES
2.27	Logic of DI4	**0:** no negation of digital input DI4 **1:** negation of digital input DI4	0	YES
2.28	Logic of DI5	**0:** no negation of digital input DI5 **1:** negation of digital input DI5	0	YES
2.29	Logic of DI6	**0:** no negation of digital input DI6 **1:** negation of digital input DI6	0	YES
2.30 FConst0 src	Source of W1 signal for referencing constant speeds	**0-OFF:** W1 = 0 **1-DI1 .. 6-DI6:** W1=1 when voltage is applied to digital input 1 ... 6	0	YES
2.31 FConst1 src	Source of W2 signal for referencing constant speeds	as above	0	YES

Parameter / Name	Function	Available options / measurement unit / comments	Factory setting	Change during operation
2.32 FConst2 src	Source of W3 signal for referencing constant speeds	as above	0	YES
2.33 F constant 1	Constant frequency 1	0.00 ... 320.0 Hz	10.00 Hz	YES
2.34 F constant 2	Constant frequency 2	0.00 ... 320.0 Hz	20.00 Hz	YES
2.35 F constant 3	Constant frequency 3	0.00 ... 320.0 Hz	25.00 Hz	YES
2.36 F constant 4	Constant frequency 4	0.00 ... 320.0 Hz	30.00 Hz	YES
2.37 F constant 5	Constant frequency 5	0.00 ... 320.0 Hz	40.00 Hz	YES
2.38 F constant 6	Constant frequency 6	0.00 ... 320.0 Hz	45.00 Hz	YES
2.39 F constant 7	Constant frequency 7	0.00 ... 320.0 Hz	50.00 Hz	YES
2.40 Cfg. AI1	Configuration of analog input AI1 (voltage mode)	**0: 0-10 V** 0 V = 0.0 % 10 V = 100.0% **1: 10-0 V** 10 V = 0.0 % 0 V = 100.0% **2: 2-10 V** 2 V = 0.0 % 10 V = 100.0% **3: 10-2 V** 10 V = 0.0 % 2 V = 100.0%	0	YES
2.41 Cfg. AI2	Configuration of analog input AI1 (current mode)	**0: 0-20 mA** 0 mA = 0.0 % 20 mA = 100.0%) **1: 20-0 mA** 20 mA = 0.0 % 0 mA = 100.0% **2: 4-20 mA** 4 mA = 0.0 % 20 mA = 100.0% **3: 20-4 mA** 20 mA = 0.0 % 4 mA = 100.0%)	0	YES
2.43 AI1 scale	Scale of analog referencing-unit RefA1	-500.0 ... 500.0 %	100.0 %	YES
2.44 AI2 scale	Scale of analog referencing-unit RefA2	-500.0 ... 500.0 %	100.0 %	YES

Parameter / Name	Function	Available options / measurement unit / comments	Factory setting	Change during operation
2.46 AI1 Offs.	Offset of analog referencing-unit RefA1	-500.0 ... 500.0 %	0.0 %	YES
2.47 AI2 Offs.	Offset of analog referencing-unit RefA2	-500.0 ... 500.0 %	0.0 %	YES
2.49 Filter AI1	Low-pass filter time constant	0.00 ... 50.00 s	0.10 s	YES
2.50 Filtr AI2	Low-pass filter time constant	0.00 ... 50.00 s	0.10s	YES
2.60 PI Ref.Src	Choice of PI controller referencing-unit	**0-Keyb.:** referencing frequency from panel **1-AI1:** referencing frequency by signal from analog input AI1 **2-AI2:** referencing frequency by signal from analog input AI2 **3:** not used **4-RS:** referencing through RS-485 link	0	YES
2.61 PI Inp.Src	Choice of regulated value of PI controller	**0-Ref.A1:** referencing regulated value from analog referencing-unit Ref.A1 **1-Ref.A2:** referencing regulated value from analog referencing-unit Ref.A1	0	YES
2.62 Negation of error	Negation of controller error	**0:** NO **1:** YES	0	YES
2.63 P Amp.	Amplification of proportional element of PI controller	0 ... 3000 %	100 %	YES
2.64 I constant	Time constant of PI controller	0.00 ... 320.0 s	0.10 s	YES
2.66 max.Out. PI	Upper limitation of PI controller output value	0,0 ... 300,0 %	100.0 %	YES
2.67 min.Out. PI	Lower limitation of PI controller output value	-300,0 ... 0,0 %	0.0 %	YES

Parameter / Name	Function	Available options / measurement unit / comments	Factory setting	Change during operation
2.68 PI Out. reset	Resetting PI output when the device is stopped	**0:** reset on STOP **1:** controller is continuously active	0	YES
2.80 AO1 src.	Choice of signal for analog output AO1	**0-Obr:** speed with a sign 0.0 % = -Nn, 50.0 % = 0, 100.0 % = Nn **1-|rpm|:** speed without a sign 0 % = 0, 100 % = Nn **2-F out..:** output frequency 100.0 % = Fn **3-Current: output current** 100.0 % = In **4-|load.|:** load without a sign 100.0 % = 2Mn **5-load.:** load with a sign 100 % = 2Mn, 50 % = 0, 0 % = -2Mn **6-U.mot: output voltage** 100.0 % = Un	2	YES
2.82 AO1 Cfg.	Configuration of analog output AO1	**0: 0-20 mA** 0 mA = 0.0 % 20 mA = 100.0%) **1: 20-0 mA** 20 mA = 0.0 % 0 mA = 100.0% **2: 4-20 mA** 4 mA = 0.0 % 20 mA = 100.0% **3: 20-4 mA** 20 mA = 0.0 % 4 mA = 100.0%)	0	YES
2.84 AO1 scale	Scale of analog output AO1	0.0 ... 500.0%	100.0 %	YES
2.86 Filter AO1	Low-pass filter time constant	0.01 ... 50.00 s  	0.10 s	YES

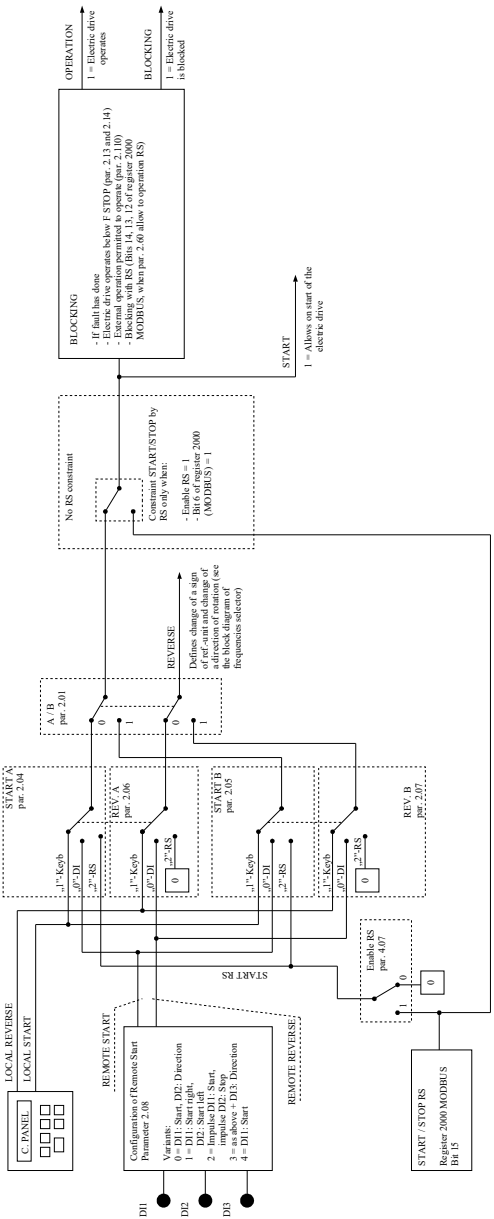
Parameter / Name	Function	Available options / measurement unit / comments	Factory setting	Change during operation
2.90 K1 funct. 1	Function 1 of the K1 relay	**0-Not active:** relay inactive **1-Operation:** active when there is voltage supplied to motor **2-Ready:** the device is ready for work **3-Fail.:** a failure has occurred **4-n.Flr.:** no failure **5:** not used **6:** not used **7-Fthr1:** F threshold 1 exceeded **8-Fthr2:** F threshold 2 exceeded **9-F.ref.:** referenced frequency reached **10-Thrs.T:** warning of exceeding programmed threshold of heatsink temperature **11-Warn.A: warning: error of analog signal (lack of** "living null" signal lower than 2V or 4mA); (the system has a dead band in the range of 2..1V and 4..2mA - a warning will appear only after exceeding it) **12-Act.DI1:**digital input DI1 is active **13-Act.DI1-2:** digital input DI1 or DI2 is active **14-Act.DI1-3:** digital input DI1, DI2 or DI3 is active	2	YES
2.91 K1 funct. 2	Function 2 of K1 relay	As above	0	YES
2.92 K2 funct. 1	Function 1 of K2 relay	As above	0	YES
2.92 K2 funct. 2	Function 2 of K2 relay	As above	0	YES
2.98 F thresh. 1	Threshold frequency 1	0.00 ... 320.0 Hz	25.00 Hz	YES
2.99 F thresh. 2	Threshold frequency 2	0.00 ... 320.0 Hz	45.00 Hz	YES
2.100 Temp.Warn.	Threshold of controller overheat warning	0 ... 80 °C	70 °C	YES
2.110 Operat. Perm.	External operation permission	**0-Off:** operation is not allowed **1-DI1 .. 6-DI6:** operation is allowed, when there is a voltage supplied on digital input DI1...DI6 **7-On.:** operation is allowed	7	YES

Parameter / Name	Function	Available options / measurement unit / comments	Factory setting	Change during operation
2.112 Emergency Stop	Emergency stop from digital inputs	**0-Off:** the emergency stop function from digital inputs is disabled **1-DI1 .. 6-DI6:** emergency stop, when voltage is applied to digital input 1 ... 6	0	NO
GROUP 3: FAILURES				
3.02 i^2t blockade	Switching on blocking from thermal overload	**0-NO:** disabled **1-YES:** enabled	0	NO
3.03 I therm.	Setting of electric motor thermal protection current	0.0 ... 200.0 %	100.0 %	NO
3.04 I therm. 0	Setting of thermorelay for stopped drive	0.0 ... 200.0 %	50.0 %	NO
3.05 Therm. Const.	Constant of electric motor heating	0 ... 320 min.	3 min	NO
3.10 Ext. fail.	Choice of external failure source	**0-Off:** disabled **1-DI1 .. 6-DI6:** reporting external failure, when there is voltage supplied on digital input DI1..DI6	0	YES
3.23 Re.4mA lack	Response to lack of analog signal (level <2V (4mA))	**0-No:** no response **1-Warn.:** a warning will be displayed, device will keep working with last referenced frequency **2-Fail.:** the device will stop and the indication of failure will be displayed *Note: the system has a deadband from 2.0V and 4..2mA*	0	YES
3.60 Re. RS lack	Response to lack of communication through RS link	**0-No:** no response **1-Failure:** the device will stop and the indicator of failure will be displayed	0	YES
3.61 Rs lack time	Acceptable time of lack of communication through RS link	1 ... 600 s	30 s	YES

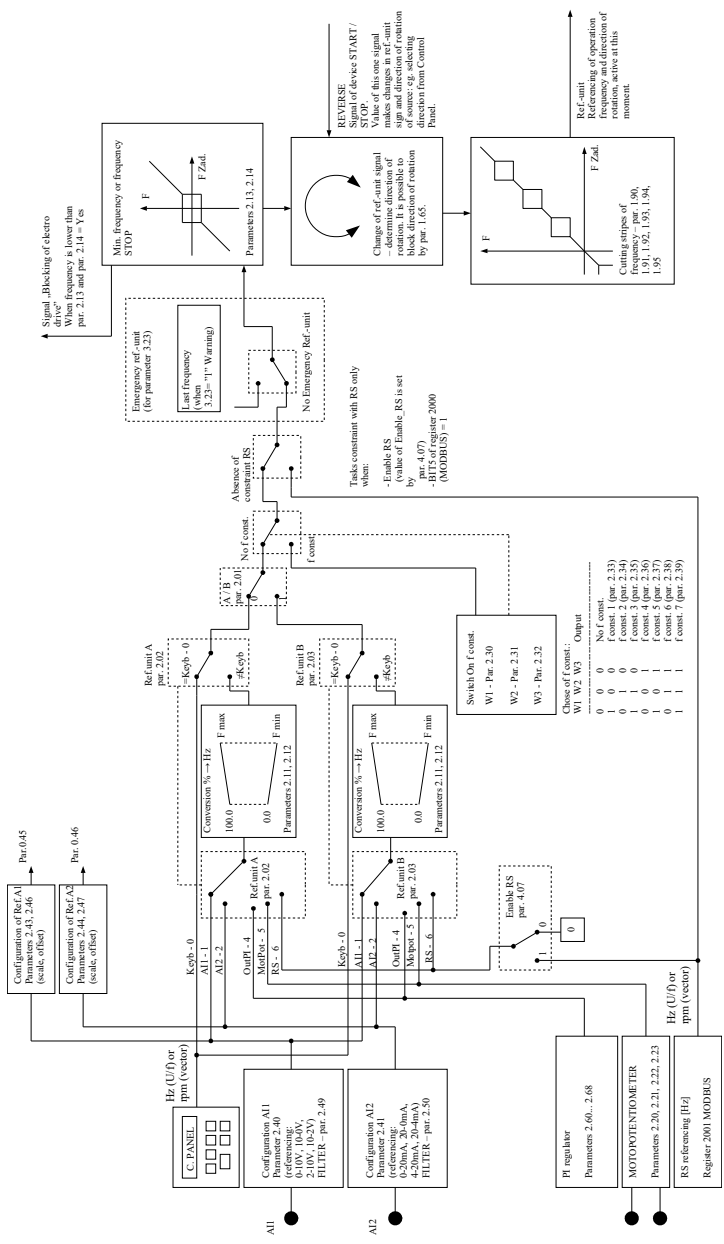
Parameter / Name	Function	Available options / measurement unit / comments	Factory setting	Change during operation
3.70 Ext. reset	Source of external reset	**0-Off:** no possibility of external erasing of a failure **1-DI1 .. 6-DI6:** erasing a failure by digital input	4	YES
3.80 Failure1	Failure Register 1 (the most current record)	**Failure number** (read only)		Read only
3.81 Time of failure 1	Register of time of occurrence of failure from Failure Register 1	**Time [h]** (read only)		Read only
...	...	...		...
3.110 Failure16	Failure Register 16 (the most current record)	**Failure number** (read only)		Read only
3.111 Time of failure 16	Register of time of occurrence of failure from Failure Register 16	**time [h]** (read only)		Read only
GROUP 4: ACCESS CODES, RS AND DISPLAY SETTINGS				
4.02 Level/CODE	Access level (reading) Access code (writing)	Access level **PD0 ... PD2** Access code 0 ... 5000 *Default access code for PD1 = 14* *Default access code forPD2 = 15*	2	YES
4.03 New CODE	Changing the access code to the current access level	New access code 0 ... 5000	0	YES
4.04 Fact. set.	Restoring factory settings	**0:** not active **1:** restoring factory settings of the frequency converter (access level PD2 is required)	0	NO
4.07 RS perm.	Permission to work through RS	**0-Off:** operation through RS is prohibited **1-DI1 .. 6-DI6:** enabling RS permission by digital input **7-On:** operation through RS is permitted	0	YES
4.08 RS baudrate	Transmission speed	**0**: 9600 bits/s **1**: 19200 bits/s **2**: 38400 bits/s	0	YES

Parameter / Name	Function	Available options / measurement unit / comments	Factory setting	Change during operation
4.09 Unit no.	Identification number of Modbus device	0 ... 247	12	YES
4.10 L1 at STOP	Value displayed when device is not working	**2:** parameter 0.02 … **48:** parameter 0.48	5	YES
4.11 L1 at START	Value displayed when device is not working	**2:** parameter 0.02 ... **48:** parameter 0.48	5	YES

Appendix B – Start / Stop control structure



Appendix C – Frequency referencing-unit structure



Appendix D – EU Declaration of Conformity

EU DECLARATION OF CONFORMITY CE

We:

Manufacturer's name:	**TWERD ENERGO-PLUS Sp. z o.o.**
Manufacturer's address:	**Aleksandrowska 28-30, 87-100 Toruń, Poland**
Phone:	**+48 56 654-60-91**
WWW, e-mail:	**www.twerd.pl twerd@twerd.pl**

declare at our own responsibility, that product:

Product name:	**Frequency converter**
Type:	**AFC200**
Power range:	**0,37 kW ÷ 3.0 kW**

installed and used according to the User manual is conformity with the following directives and standards:

Directive 2014/35/UE: Low Voltage Directive (LVD)
- **PN-EN 61800-5-1:2007+A1:2017-07+A11:2021-07**

Directive 2014/30/UE: Electromagnetic Compatibility (EMC) Directive
- **PN-EN 61800-3:2008+A1:2012**

Directive 2011/65/EU: Restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)
- **PN-EN IEC 63000:2019-01**

Standard **PN-EN 50178:2003**.

TWERD ENERGO-PLUS Sp. z o.o.
Oleksandr Skliar
Dyrektor ds. rozwoju i stosunków międzynarodowych
Prokurent

Oleksandr Skliar
Director of Development and International Relations / Commercial Proxy

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Date: 2025-05-20

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