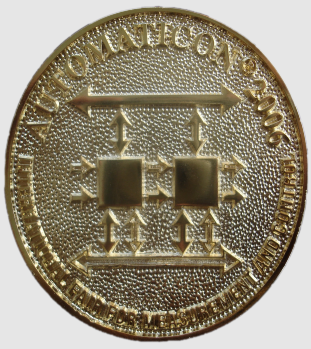
Power Electronics Company

TWERD

AFC150

User's manual



CONTENTS

Power	Voltage U_{in}	one-phase power : 230V -15% +10%, if ordered –other Voltage available
Output	Output voltage	0 ... U_{in} [V] / 0,0 … 320Hz
	Frequency resolution	0.01Hz
Control system	Modulator	SVPWM
	Operation mode	U/f linear / square-law scalar
	Switching frequency	4,8,16kHz
	Rotation speed setting	Analog inputs, control panel, motopotentiometer, PI-regulator, communication unit RS485 and other possibilities. Resolution of 0.1 % for analog inputs or 0.1Hz / 1 rpm for the control panel i RS
Control inputs/outputs	Analog inputs	2 analog inputs (AI0 I AI1): voltage mode 0(2) ... 10V, $R_{in} \geq 470k\Omega$; accuracy 0,5%
	Digital inputs	6 digital separated inputs 0/(15...24)V. $R_{in} \geq 8k\Omega$
	Analog outputs	1 output 0(4)....20mA – configuration with the help of parameters and switches, accuracy:0.5 %
	Digital outputs	2 relays (K1, K2) – breaking capacity: 250V/5A AC
Communication	Connectors	RS485 with optoisolation
	Communication protocol	MODBUS RTU. Function 3 (Read Register); Function 6 (Write Register).
	Transmission speed	9600 or 19200 bit/s
	Application	Remote control of unit operation and programming of all parameters of the frequency converter.
Special functions	PI-regulator	Choice of referencing-unit signal source and feedback signal source, possibility of inverting polarity of an control error signal , SLEEP function and output erasing on STOP signal, limitation of an output value.
	Set of Predefined (Factory) Parameters	There are 6 available set of predefined parameters: - Local: control from keyboard - Remote: control through digital or analog inputs - Local/Remote: choice between local and remote - PI: speed regulated by PI-regulator - Motopotentiometer: control with “increase/decrease” signals from digital inputs - Constant frequencies: operation with constant frequencies, switching through digital inputs
Protection	Short-circuit protection	Short-circuit on unit output.
	Overcurrent protection	Instantaneous value 3.5 $I_{n;}$; effective value 2.5 I_n
	Device thermal protection	Radiator's heat sensor, 85°C
	Motor thermal protection	I^2t limit, motor heat sensor.
	Supervision of communication through RS	Established permissible time of connection absence.
	Control of analog inputs	Check of absence of “living null” in modes 2... 10V and 4... 20mA

Table 0.2 - Specifications of frequency converters of the MFC710 series, depending on a type

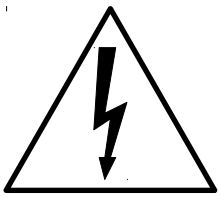
Type of frequency converter	**Constant-torque load Overload 1.5**		**Variable-torque load Overload 1.1**		**Ip [A]**
	P_{N1} [kW]	**I_{N1} [A]**	**P_{N2} [kW]**	**I_{N2} [A]**	
AFC150-0,37kW	0,37	2,2	0,55	3,0	3,3
AFC150-0,55kW	0,55	3,0	0,75	4,0	4,5
AFC150-0,75kW	0,75	4,0	1,1	5,5	6,0
AFC150-1,1kW	1,1	5,5	1,5	7,0	8,3
AFC150-1,5kW	1,5	7,0	2,2	9,5	10,5
AFC150-2,2kW	2,2	9,5	3,0	14	14,5
AFC150-3,0kW	3,0	14,0	4,0	19	21

P_{N1} – nominal power at overload 1.5 I_n
I_{N1} – nominal output current at overload 1.5 I_n
P_{N2} – nominal power at overload 1.1 I_n (pumps, ventilators)
I_{N2} – nominal output current at overload 1.1 I_n (pumps, ventilators)
I_P – overload current 60s every 10min

1. Conditions of safe operation

1.1 Warnings

- After connecting converter to the supply network, internal circuit components (except In/Out clamps) are on the supply network potential. Touching them can cause an electric shock..
- When you connect the converter to the supply network there is a dangerous voltage on clamps U, V, W, even when the motor does not work.
- After disconnecting the device from the supply network the dangerous voltage is still present for about 5 minutes.



1.2. Basic rules

- **Don’t make any connections when the converter AFC150 is connected to the mains.**
- **Don’t connect mains voltage to output clamps U, V, W.**
- **Don’t measure the voltage endurance of any unit devices.**
- **To measure the cables insulation it is necessary to disconnect them from the converter.**
- **Don’t touch integrated circuits and any other parts on the converter's electronic board, as they can be damaged by electrostatic discharge.**
- **Don't connect any capacitors to motor wires intended for improvement of power factor**
- **Don't measure output voltage of converter using digital voltmeters**

1.3 Operation list applied at first start-up of the system

The operations applied at installation and the first start-up of the electric drive	
✔	After unpacking the converter, it is necessary to check up visually presence of damages which could arise during transport.
✔	Check up the correspondence between the delivered frequency converter and the order - check up the ratings plate on the case. Delivery includes: • the frequency converter with the User's manual, • a ferrite ring or RFI filter - depending on the order.
✔	Check up the correspondence between conditions in which the converter will be used and conditions of an environment for which it is designed (section 1.4).
✔	Installation of the frequency converter should be made according to principles of safety and EMC rules, listed in section 2.
✔	Choose a configuration of the frequency converter and realize it according to sections 4 and 5.

Environmental conditions

Degree of pollution

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

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>
<tr><th></th><th>Installation site</th><th>During warehousing</th><th>During transport</th></tr>
<tr><td rowspan="2">Temperature</td><td rowspan="2">from -10°C to +55°C[1]</td><td>from -25°C to +55°C</td><td>from -25°C to +70°C</td></tr>
<tr><td colspan="2">Protective packing</td></tr>
<tr><td rowspan="2">Relative humidity</td><td>from 5% to 95%</td><td>from 5% to 95%</td><td>Max 95%</td></tr>
<tr><td colspan="3">Short-term, insignificant condensation on the external side of the converter case is permitted only when converter doesn't work.</td></tr>
<tr><td>Air pressure</td><td>from 86 kPa to 106 kPa</td><td>from 86 kPa to 106 kPa</td><td>from 70 kPa to 106 kPa</td></tr>
</table>

[1] For nominal load temperature 40ºC was assumed, however for lower loads higher temperatures are acceptable.

2. Installation of the frequency converter

2.1. Connection of a power circuits

The AFC150 converter is fed from the one-phase supply line 1x230V (AC, 50Hz). The application of a three-wire shielded cable is recommended (L1, N and PE). In the fig. 2.1 the scheme of power circuits connections is presented. Diameters of wires and protection values should be selected depending on output current of the unit.

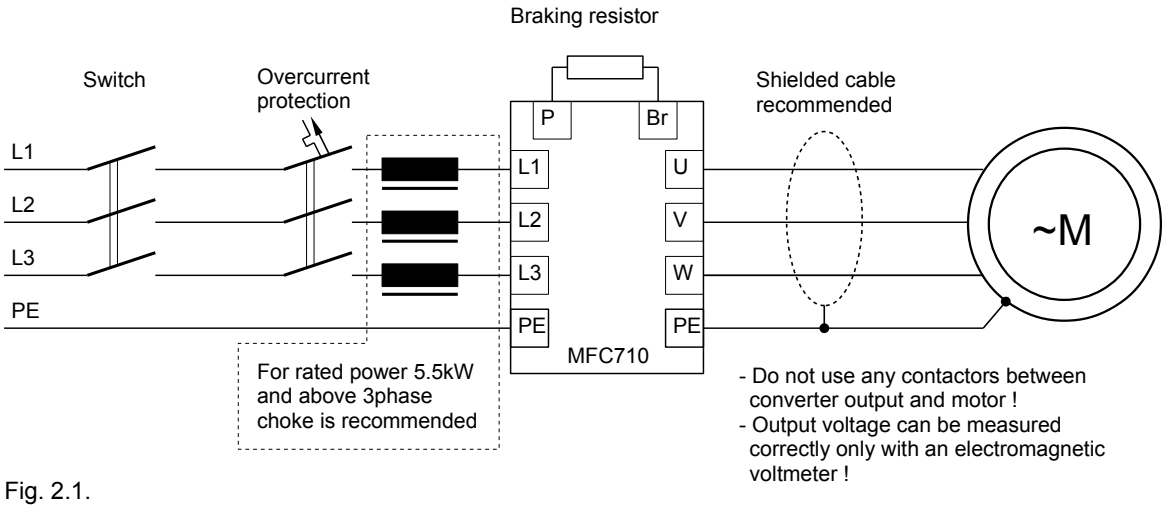


Fig. 2.1.

2.1.2 Safety rules

Equipotential connections

The protection against indirect touching live parts consists of automatic switching off by special short-circuit protection (or differential-current protection) or voltage limitation to a level not exceeding acceptable values, in case of an insulation failure.

The short circuit to ground at the frequency converter output can be not detected by short-circuit protection, devices due to DC link circuit. The protection against interpolar and ground short-circuit on the output of the converter is provided. However this protection is based on IGBT transistors blocking, what does not conform to the requirements of fire-prevention protection. Due to that, for safety of staff, it is necessary to make local equipotential connections.

In the frequency converter there are provided appropriate terminals, properly marked, protected from corrosion to make equipotential connections.

Protection

Use of gG or aM fuses is allowed in the circuits, however taking into account necessity of protection of the rectifier bridge of the frequency converter, the best solution is gR or aR fuses. You can use overcurrent protection, but the response time of such devices is longer than properly chosen fuse.

Frequency converter is protected from: drive overloading, motor overheating, under- and overvoltage in an DC link circuit of the converter, a short-circuit at the converter output (it protects converter only!!).

Usage of differential-current protection due to electrical shock prevention can appear unfavorable, since it can trigger due to temporary or constant leakage current of the power drive system, working in normal conditions. In case of usage of the differential-current protection devices you may use only cut-out switches of a B type, due to different nature of a differential current.

Disconnecting device

In order to comply with EU directives, according to PN-EN 60204-1:2001, power drive, which consists of a frequency converter and electrical machine should be supplied with a device for disconnecting power supply. 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 fuses or without), disconnecting a load circuit before opening main contacts, conforming the EN 60947-3 requirements,
- tripper conforming the EN 60947-2 requirements.

User is obliged to fulfil this requirement.

Emergency stop

In order to comply with EU directives and PN-EN 60204-1:2001 and for personnel safety and equipment, it is necessary to use an emergency stop switch, which has higher priority than other functions, irrespective of operating mode. The key STOP on operator panel cannot be treated as the switch of abnormal break, because it doesn't

disconnect a frequency converter from power supply. User is obliged to fulfill this requirement.

Casing

The casing conforms to the requirements of a IP20 protection degree. The surface, on which the control panel is situated fulfills the requirements of a IP40 protection degree. The casing was designed in such a manner that it cannot be removed without usage of tools.

Capacitors discharging

In a DC link circuit of a frequency converter there is a capacitor battery with relatively high capacity. After turning off of a supply voltage in its clamps dangerous voltage is present for a certain time. It is necessary to wait for 5 minutes before making connections on clamps of power terminal strip of a frequency converter. The information about danger of such voltage is placed also on terminal strip cover.

The AFC150 converter is fed from the one-phase supply line 1x230V. In the fig. 2.1 the scheme of power circuits connections is presented. Diameters of wires and the parameters of chokes should be selected depending on current of a load. 2.1. The frequency converter is supplied with appropriate resources, protected from corrosion, dedicated to make apropriate connections. Additional information about external connections can be found in section 2.1.1 under the "*Equipotential connections*" and in section 2.1.2. In order to comply with EU directives of electromagnetic compability (EMC) application of a four-wire shielded cable (three phases + earth wire) is recommended to fed the engine. Type of mains choke and protections is available at producer's representative. It is strogly recommended not to use any switches or contactors at the converter output that could disconnect system during the run.

2.2Connection of control circuits

On fig. 2.2 user terminal block of AFC150 are presented. In the table 2.1. are the descriptions and functions of clamping rods showed in the fig. 2.2.

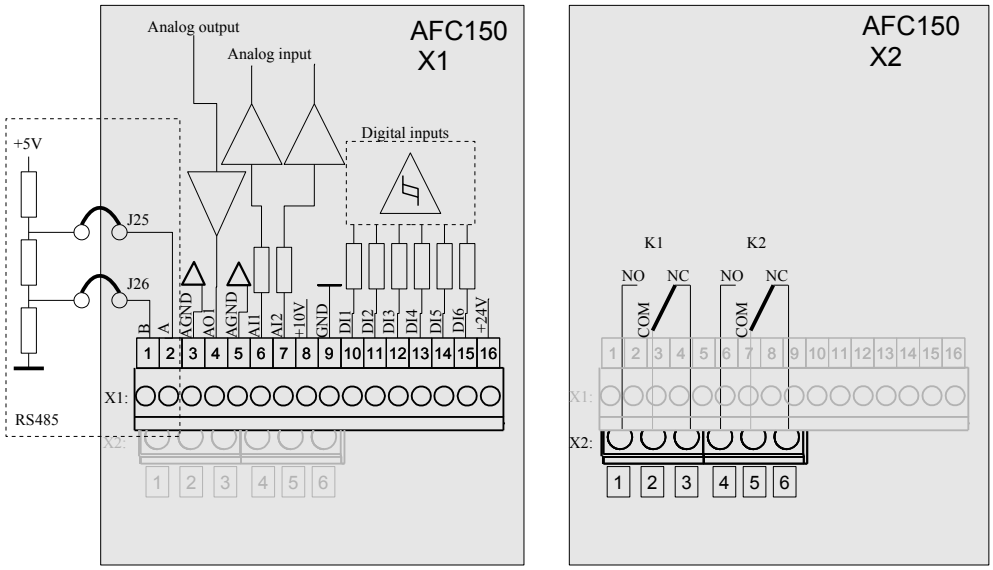


Fig. 2.2

Tab. 2.1. terminal block – evaluation of inputs and outputs on the X1 block

No	Name	Description	
X1-1	B	Interface RS-485, line B	Terminator/bias are connected with jumpers J25/J26
X 1-2	A	Interface RS-485, line A	The same
X1-3	AGND	Analog Ground	Use only for connecting analog inputs/ outputs signals
X1-4	Way	Analog output	
X1-5	AGND	Analog Ground	
X1-6	AI0	Analog input 1	Input impedance 500 Ohm
X1-7	AI1	Analog input 2	The same
X1-8	+10V	Supply of external systems, i.e. potentiometer of referencing-unit	Load capacity of the source: 100mA
X1-9	GND	General mass	
X1-10	WeC1	Digital input 1	Input impedance 7KOhm
X1-11	WeC2	Digital input 2	Input impedance 7KOhm
X1-12	WeC3	Digital input 3	Input impedance 7KOhm
X1-13	WeC4	Digital input 4	Input impedance 7KOhm
X1-14	WeC5	Digital input 5	Input impedance 7KOhm
X1-15	WeC6	Digital input 6	Input impedance 7KOhm
X1-16	+24V	Supply odf external systems	Load capacity of the source: 200 mA

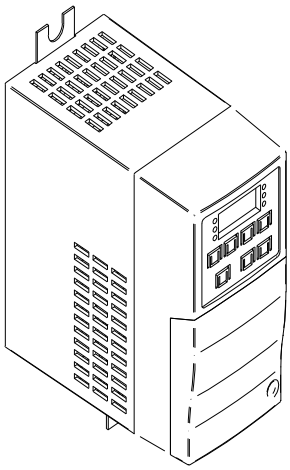
Tab.2.2 terminal block – evaluation of inputs and outputs on the X2 block

X2-1	K1 (NO)	Relay input K1, contact N.O. (normal open)	Load capacity of contacts 5A/250VAC
X2-2	K1 (COM)	Relay input K1, contact COM (common)	Load capacity of contacts 5A/250VAC
X2-3	K1 (NC)	Relay input K1, contact N.C. (normal closed)	Load capacity of contacts 5A/250VAC

X2-4	K2 (NO)	Relay input K2, contact NO (normal open)	Load capacity of contacts 5A/250VAC
X2-5	K2 (COM)	Relay input K2, contact COM (common)	Load capacity of contacts 5A/250VAC
X2-6	K2 (NC)	Relay input K2, contact N.C. (normal closed)	Load capacity of contacts 5A/250VAC

2.3. Assembly (mechanical) drawings

In the fig 2.3. an overall view of AFC150 is showed. On the fig 2.4. a drawing with detailed size is being presented. During the assembly it is essential to remember to leave a free space around the device to insure the right air circulation (10 cm from above and from the bottom side and 3 cm on both sides of the device)



2.3. View of AFC15

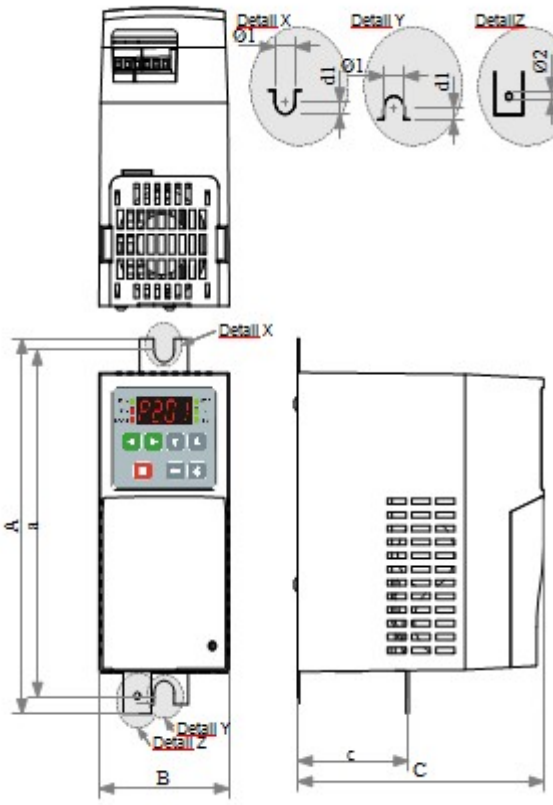


Fig.2.5. Overal dimensions and wiring draft

Table 2.3. Sizes of AFC150

Type	Size [mm]									kg
	a	A	B	c	C	D1	D2	ϕ1	ϕ2	
AFC150/0,37kW	151	168	70	60	133	5,0	8,0	10,5	6,0	0,8
AFC150/0,55kW										0,8
AFC150/0,75kW										1,0
AFC150/1,1kW										1,0
AFC150/1,5kW	175	187	73	74	166					1,0
AFC150/2,2kW										1,0
AFC150/3,0kW										1,2

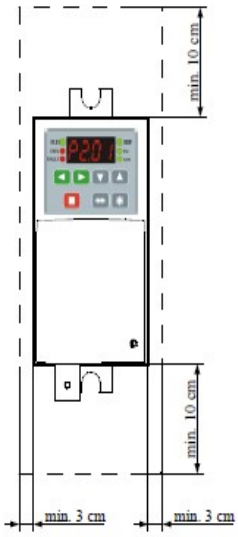
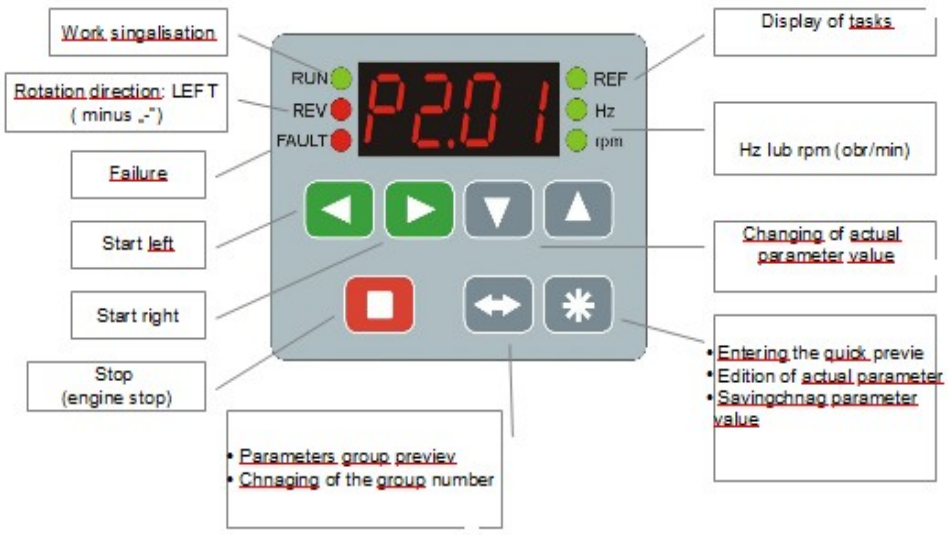


Fig.2.5. Required free space

3. *The control panel*

On fig. 3.1 is the control panel with all functions presented.



Control panel serves for constant review of the process parameters (rotational speed, current), the operating mode control (START / STOP, change of the referencing unit, cancelling fault message) and also for viewing and changing of converter's parameters. In the panel LED display.
After switching on the converter to mains, the control panel is switched on in the Base Mode.
On fig. 3.2 the main sequence of control panel service is presented.

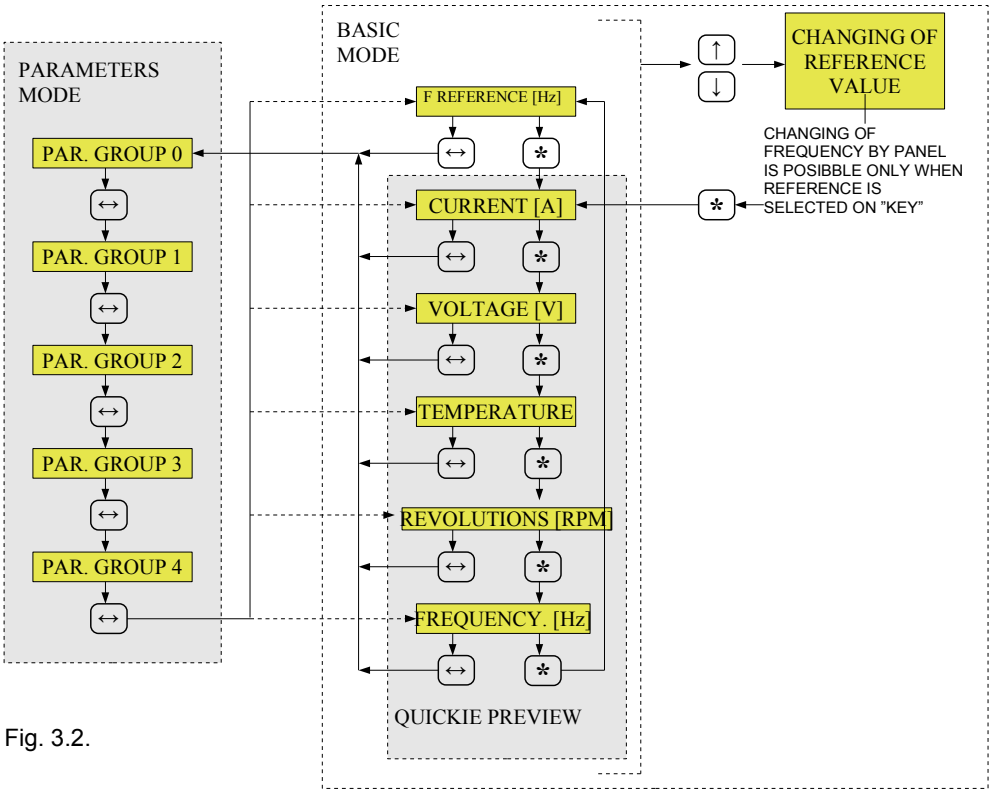


Fig. 3.2.

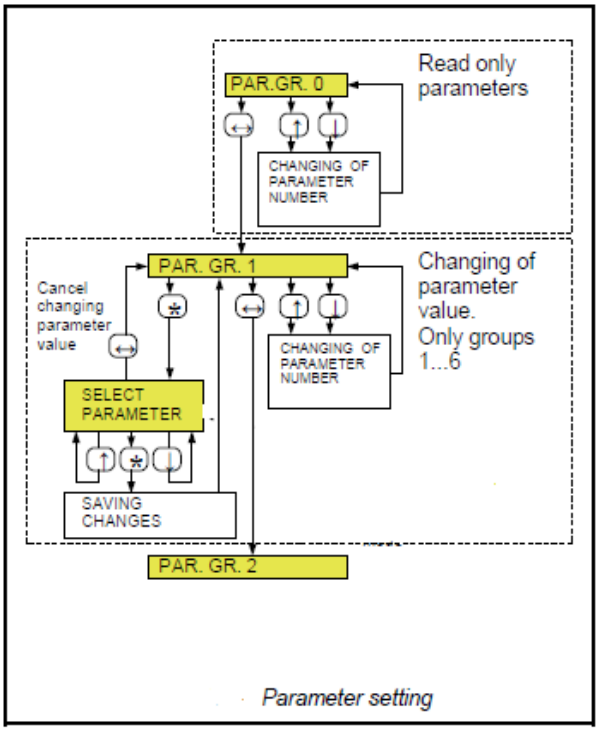


Fig 3.3

As attachment for fig. 3.2 see fig 3.4. pictures of displayer panel in the quick search mode

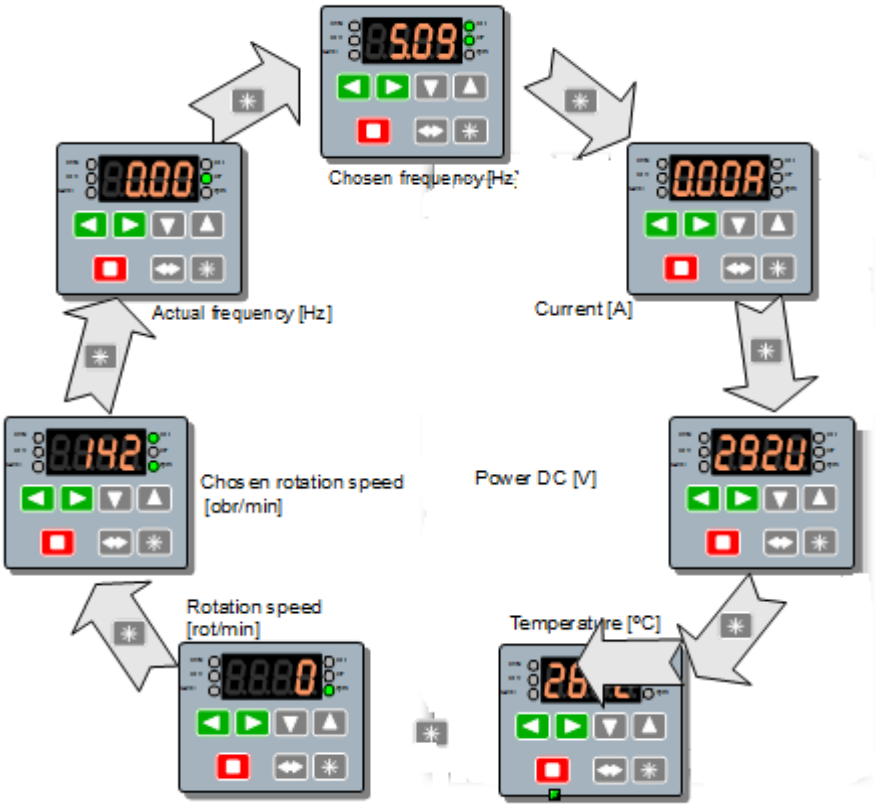


Fig 3.4.

Changing the value of parameters fig. 3.5.

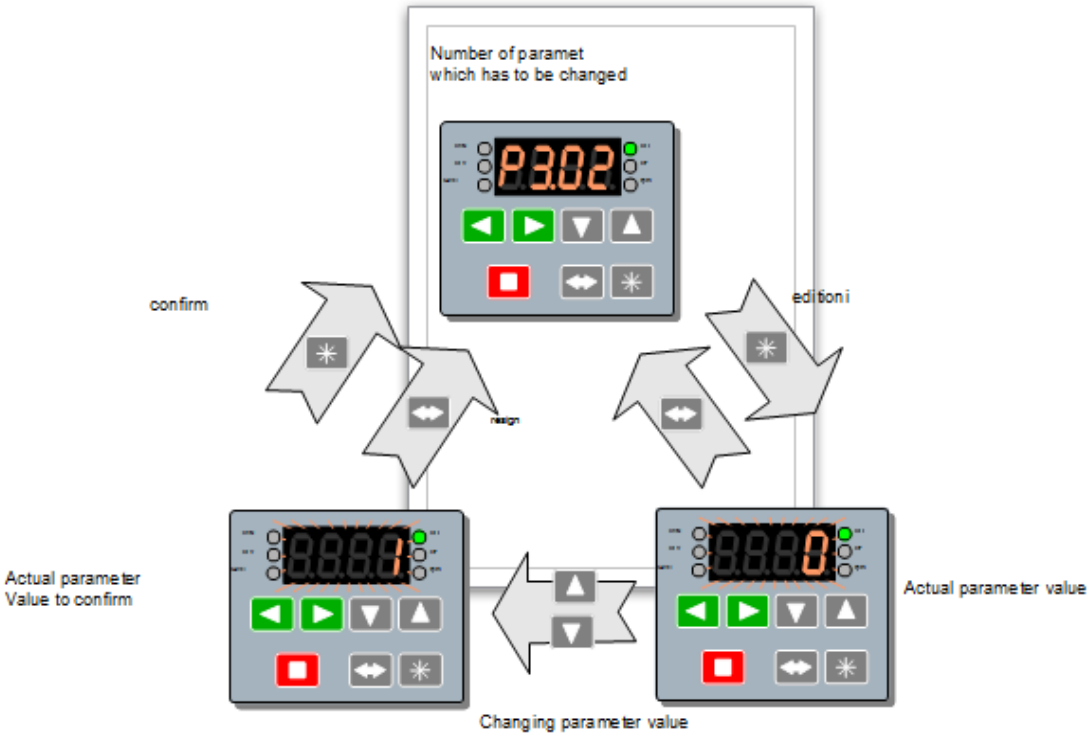

Number of paramet
which has to be changed
P3.02
confirm
editioni
Actual parameter
Value to confirm
Actual parameter value
Changing parameter value

Fig 3.5

4. *Configuration of the frequency converter*

Main possibilities of converter control – referencing output frequency (rotation rate) and configuration of control with a START / STOP signal - are described below with additional information about configuration of output relays of a converter. More detailed information is in „parameter list" – (Appendix). The control possibilities of the converter arise from the analysis of a structure of the control system - fig. 4.2/4.3.

In control system of the converter AFC150 there is a philosophy of 2 independent „control places" A and B, that allows to change whole structure of the converter control (sources of START and STOP signals and sources of frequency for electric drive operation) by changing only one parameter. In fig. 4.1 there is simple diagram and in fig. 4.2 and 4.3 there are developed diagrams of the converter control.

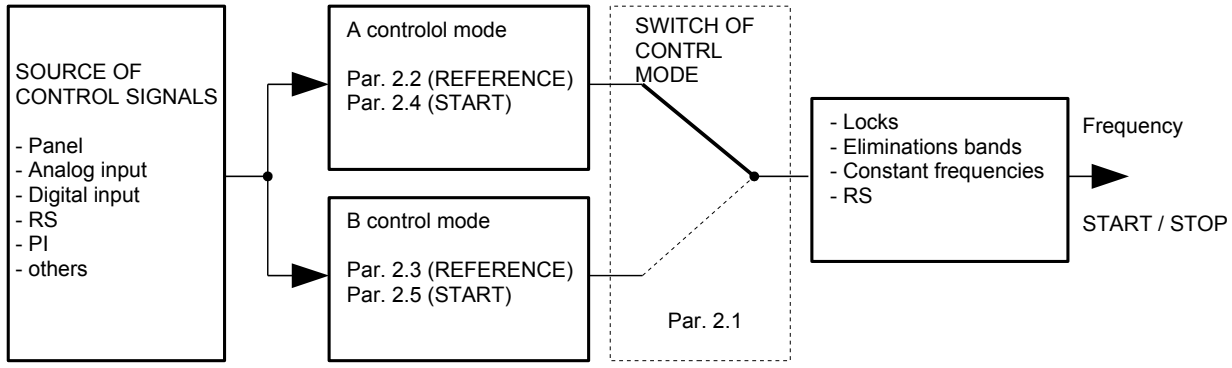
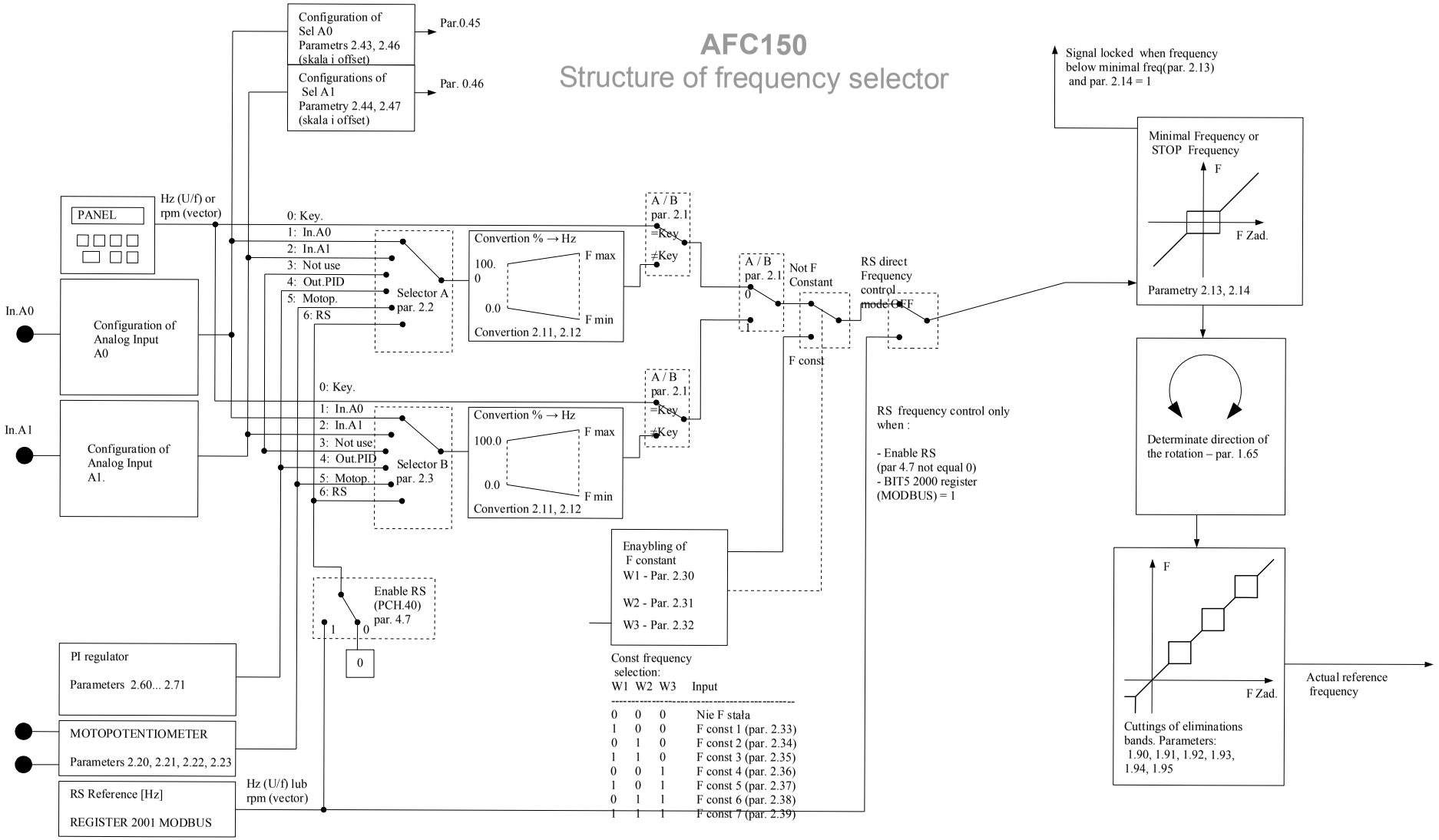


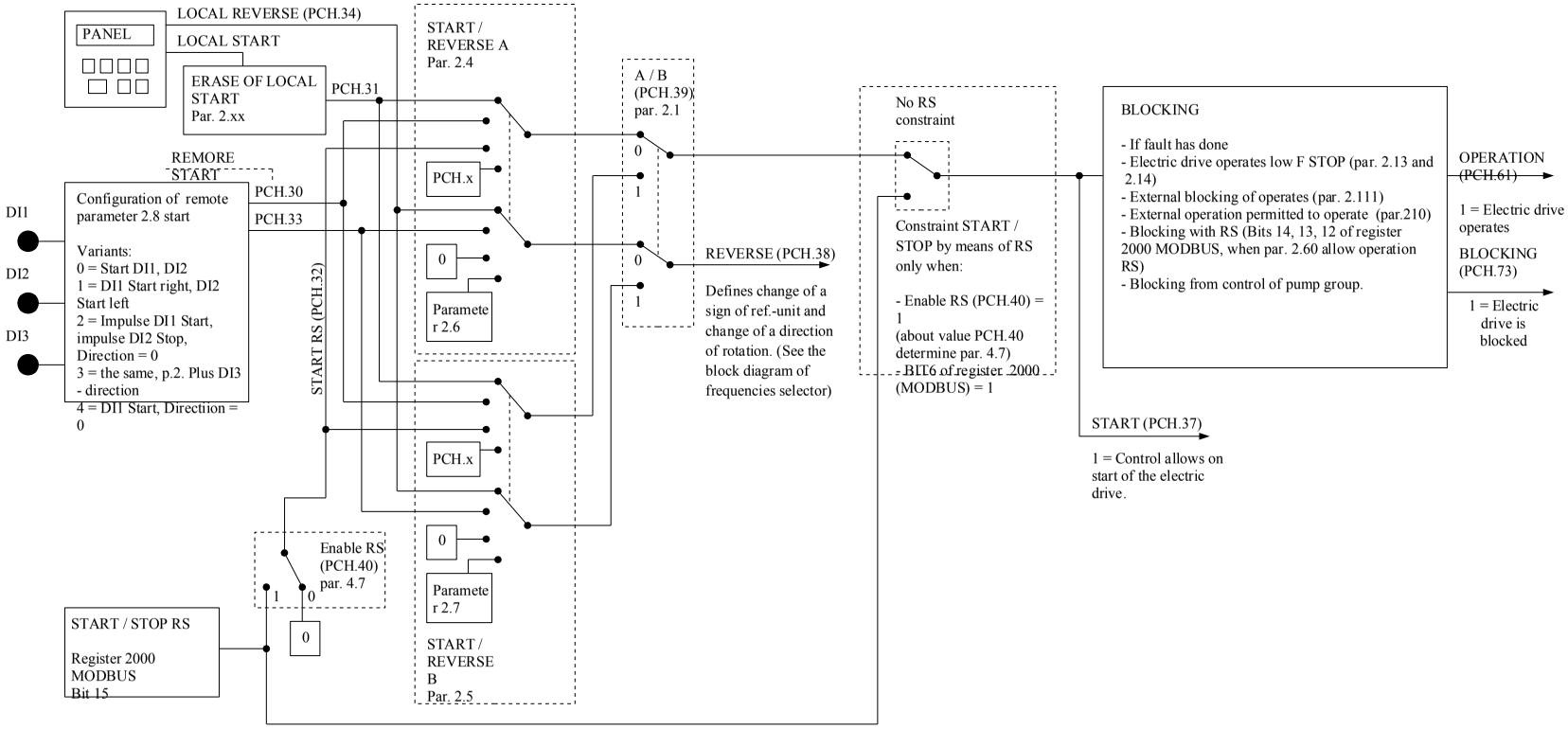
Fig. 4.1.

AFC150
Structure of frequency selector



AFC150

Structure of control START / STOP



4.1 Control from the control panel

In order to control the electric drive from the control panel it is necessary to:

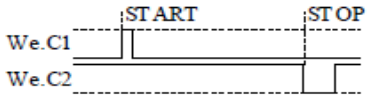
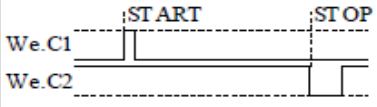
- choose „ control place ” **A or B** with the help of parameter 2.1
- establish parameter 2.2 (for A) or 2.3 (for B) to in position „**> 0 Keys** ”
- establish parameter 2.4 (for A) or 2.5 (for B) to in position „**> 1 Keys** ”
- make sure, that the constant speed mode isn't chosen: Par. 2.30, 2.31 and 2.32 should be established in position „**> 0 Switch off** ”

Control through terminal connections

To have an opportunity of control of the electric drive through terminal connections (e.g. **START / STOP through digital inputs and regulation of rotation speed with the help of a potentiometer**) it is necessary:

- To choose „ control place ” **A or B** with the help of parameter 2.1
- To set up value of parameter 2.2 (for A) or 2.3 (for B) in position:
  - „> **1 We.A0** ” for an analog input 0
  - ,,> **2 We.A1** ” for an analog input 1
- To set up value of parameter 2.4 (for A) or 2.5 (for B) in position „**> 0 We.Cyf**
- To set up value of parameter 2.6 (for A) or 2.7 (for B) in position 0 (switch on of the control of analog inputs directions)
- To be sure that the choice of a mode of constant speed is not made: values of parameters 2.30, 2.31 i 2.32 should be set up „**> 0 Wylacz”**
- To set up parameter 2.8" Remote start ”. It defines functions of control digital inputs as at the tab. 4.1

Table 4.1 - possible configuration variants of remote start (START)

Value of par. 2.8 „Remote start”	***Notation***	***Function***
0	We.C1 = START/STOP D We.C2 = DIRECTION	Voltage feeding to digital input 1 results in start and voltage removal - stopping of the electric drive. The condition of a digital input 2 defines change of a direction of drive rotation
1	We.C1 = START to the RIGHT We.C2 = START to the LIFT	Voltage feeding to digital input 1 results in a drive start. Voltage feeding to digital input 2 results to a drive start in opposite direction.
2	We.C1 =PULSE START We.C2 = PULSE STOP	 Direction of rotation depends only on sign of referencing-unit signal.
3	We.C1 =PULSE START We.C2 = PULSE STOP We.C3 = DIRECTION	
4	We.C1 = START/STOP	Voltage feeding to digital input 1 results in start and voltage removal - stopping of the electric drive. Direction of rotation is depends only on sign of referencing-unit signal..

Display in mode “control state” looks as in the fig. 4.4 – referencing-unit from analog input and START from digital

input. Regulation of output frequency of converter and rotation speed of drive is carried out through selected analog input (e.g. with a help of potentiometer).

4.2. *Work with constant speeds*

The system can work with one of seven constant speeds. The choice of constant speed is made by digital inputs determined by parameters 2.30, 2.31 and 2.32 - an example in table 4.2. Sizes of constant speeds are defined by parameters:

par. 2.33 – constant speed number 1 [Hz]
par. 2.34 – constant speed number 2 [Hz]
par. 2.35 – constant speed number 3 [Hz]
par. 2.36 – constant speed number 4 [Hz]
par. 2.37 – constant speed number 5 [Hz]
par. 2.38 – constant speed number 6 [Hz]
par. 2.39 – constant speed number 7 [Hz]

Table 4.2 – suggested configuration of constant speed control

Parameters	***Example***	***Notation***
2.30 W1	>3 We.C3	Signal of constant speed selection W1 comes from digital input 3 (W1 = DI3)
2.31 W2	>4 We.C4	Signal of constant speed selection W2 comes from digital input 4 (W2 = DI4)
2.32 W3	>0 SWITCH OFF.	W3 = 0
!!! ATTENTION!!! - see structural circuit of frequency referencing-unit - section 4.2.1		

As a result of choice of such parameter configuration it is possible to choice between 3 available constants through digital inputs 3 and 4:

State DI3	***State DI4***	***Effect***
0	0	Electric drive does not operate with constant speed. At this moment another referencing-unit is operating. (See structural circuit of frequency referencing-unit - section 4.2.1)
1	0	Constant speed no. 1 (Value as Par. 2.33)
0	1	Constant speed no. 2 (Value as Par. 2.34)
1	1	Constant speed no. 3 (Value as Par. 2.35)

CONTROL STATE display when constant speed referencing-unit is active looks like it is shown on fig. 4.5 – Referencing-unit: constant frequency (speed), START through digital input.

4.2.1. A motopotentimeter

Motopotentiometer is a simple “increase-reduce” device for speed control of drive rotation with help of two buttons. An example way of connecting “increase-reduce” buttons to the frequency converter is shown on fig. 4.6a. Fig. 4.6b. Illustrates action of the device

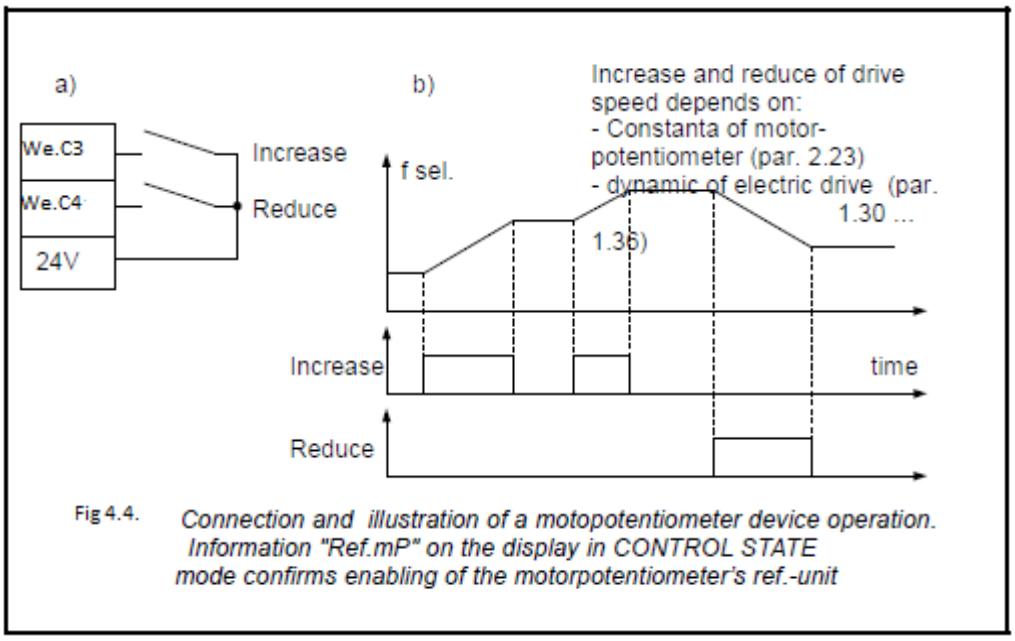


Fig 4.4. *Connection and illustration of a motopotentiometer device operation. Information "Ref.mP" on the display in CONTROL STATE mode confirms enabling of the motorpotentiometer's ref.-unit*

In order to set the output frequency of the converter with help of a motor-potentiometer par. 2.2 (for control A) or 2.3 (for control B) must be set on value "MotPot" (mP).

Attention: Fig. 4.6a corresponds to a situation when par. 2.20 = "DI3" and par. 2.21 = "DI4".

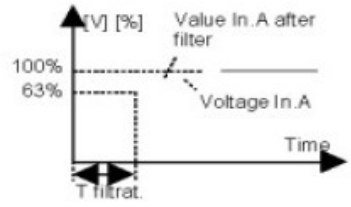
There are four available modes of motopotentiometer operation: 0, 1, 2 and 3. Modes 0, 1 and 2 should be used only when current referencing-unit (par 2.2/par. 2.3) is set on "MotPot". Mode 3 can be used regardless of setting of current referencing-unit.

Stopping the converter In mode **0** will cause reset of motopotentiometer settings. In mode **1** settings of motopotentiometer will be stored and there is no possibility of changing it while the drive is stopped. In mode **2** settings of current referencing-unit are traced by motopotentiometer so switching from current referencing-unit to motopotentiometer's referencing is made very easily. In mode **3** configuration of motopotentiometer is stored and there is possibility of changing it while the drive is stopped.

4.3.Analog inputs

Frequency converter has two analog inputs (We.A0, In,A1 and We.A2), which cooperate in voltage mode 0-10V .It is possible to connect directly a potentiometer or a voltage (current) source to analog inputs - see fig. xxx Table xxx compares the parameters responsible for a configuration of the analog inputs. By analogy to digital inputs, analog inputs have no parameters which define their function in the system. Inputs are selected by control configuration parameters to perform certain actions. Xxx

Table 4.3 - parameters which define a configuration of analog inputs

Parameter	***Function***	***Description***
2.40	Configuration of We.A0 range	Choice of range for input value 0...10V, 2...10V, 10...0V (inversion), 10...2V.
2.41	Configuration of We.A1 range	0-10V, 10-0V, 2-10V, 10-2V (voltage mode)
2.42	Configuration of We.A2 range	0-10V, 10-0V, 2-10V, 10-2V (voltage mode)
2.49	Constant of time for lowpass filter We.A2	

Parameter	***Function***	***Description***
2.50	Constant of time for lowpass filter We.A1	As par.2.49
0.40	Value We.A0 [%]	READ ONLY. Value We.A0 in [%]. e.g. for range 0... 10V voltage 5V corresponds par. 0.40=50.0 %
0.41	Value We.A1 [%]	READ ONLY Value We.A1 in [%]. e.g. for range 0... 10V voltage 5V corresponds par. 0.41 =50.0%
3.23	Reaction to signal absence at the Analog Input	In operating modes 2... 10V, 10... 2V it is possible to define behavior of the electric drive when value of voltage falls below 1V or value of a current falls below 2mA. (See. Appendix C - par. 3.23).

In structure of the electric drive **Analog Referencing-units** are also provided. Analog referencing-units are strictly connected to Analog Inputs, from which they differ, that they have parameters carrying the information on value of their offset and scale. Usually analog referencing-units are used only as inputs for the PI-regulator. As control signals in any point of the structural diagram of control (e.g. fig. 4.9b). In the table 4.4 there are parameters which define a configuration of Analog Referencing-units and dependence of value Ref.A from AI.

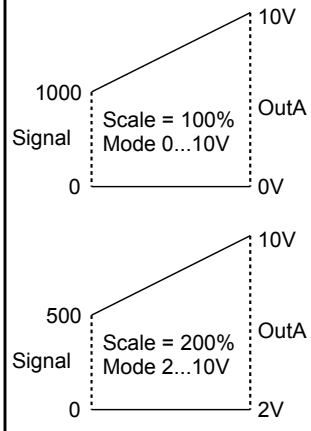
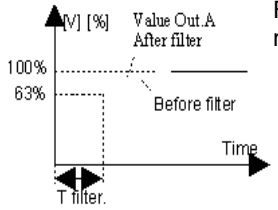
Table 4.4 – Analog Referencing-units

Parameter	***Function***	***Description***
2.43	Ref.A0 scale	Value in [%] : -500.0 ... 500.0 %
2.44	Ref.A1 scale	Value in [%] : -500.0 ... 500.0 %
2.45	Ref.A2 scale	Value in [%] : -500.0 ... 500.0 %
2.46	Ref.A0 offset	Value in [%] : -500.0 ... 500.0 %
2.47	Ref.A0 offset	Value in [%] : -500.0 ... 500.0 %
2.48	Ref.A0 offset	Value in [%] : -500.0 ... 500.0 %
0.45	Ref.A0 value [%]	READ ONLY. Value Ref.A0 in [%]. Ref.A0 = (par. 2.46 + par. 2.43 * We.A0 / 100.0%) E.g: if par. 2.46 = 20.0%, par. 2.43 = 50.% and Ref.A0 = 30.0% Ref.A0 = 20.0% + 50.0% * 30.0% / 100.0% = 35.0%
0.46	Ref.A1 value [%]	READ ONLY. Value Ref.A1 in [%]. Ref.A1 = (par. 2.47 + par. 2.44 * AI1 / 100.0%)

4.4.Analog outputs

Table 4.5 presents parameters which concern configuration of analog output WyA0. It operates in a current mode 0-20mA (4-20mA).

Table 4.5 – Parameters which define configuration of analog outputs

Parameter	*Function*	*Description*
0.43	Wy.A1 Value of analog output 1	0...100.0% READ ONLY **Wy.A1 = Absolute value (signal * scale Wy.A1 / 1000)**
2.80	Choice of signal for Wy.A1	Details in Appendix C
2.82	Configuration of range Wy.A1	0...20mA, 20...0mA, 4...20mA, 20...4mA (current mode)
2.84	Out.A1 scale Examples: 	0 ... 500.0 %. Typically 100.0 % For a configuration 0-10V signal value 1000 at a scale established on 100.0 % corresponds to voltage value 10V. For a scale established on 50.0 % to receive 10V of output voltage the signal value should be 2000. Similarly for a scale established on 200.0 % to receive 10V of output voltage the signal value should be 500. Value of a signal corresponds to value of the selected size without a decimal point, e.g.: 12.5 % = 125 2.43 A = 243 375 B = 375 e.g., if signal (value of current) is 11.7 A it corresponds to 117 number. In this case: voltage = scale * signal / 1000 voltage = 100.0% * 117 /1000 = 11.7 %(0...10V) = 1.17 V
2.86	Constant of time for the lowpass filter of AO1	 Filter of analog output AO1 – see Appendix C for more details

Formation of U/f characteristic

In modes of scalar control U/f there is an possibility of influence on type of the characteristic. **In modes of vector control (Vector 1 and Vector 2) parameters of U/f characteristic formation are not relevant.**

The main parameter which influences on form of the electric drive characteristic is par. **1.20 "Operating mode":**

- **Mode U/f linear.** It is used if there exists a constant moment of loading which does not depend on speed (see fig. 4.11).
- **Mode U/f square-law.** It is used if the moment of loading grows under the square-law from speed (e.g. the electric drive of the fan). Use of square-law characteristic U/f cause reduction of noise and decrease of losses in the motor (see fig. 4.11).

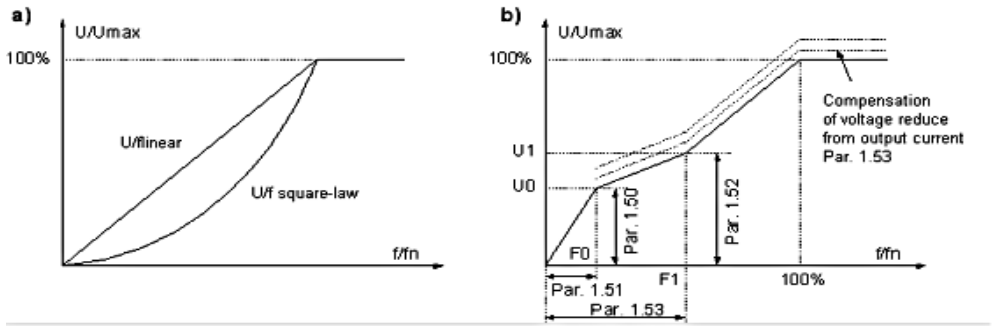


Fig. 4.5 - Linear and square-law characteristic(a), formation of U/f characteristic (b)

4.6.*Elimination of frequencies*

With purpose of elimination of undesirable output frequencies which can result in the resonant phenomena of the drive, it is possible to determine 3 ranges called "ranges of elimination". Their options can be set up by parameters:

- Par. 1.90 - bottom frequency of elimination range 1 [Hz]
- Par. 1.91 - top frequency of elimination range 1 [Hz]
- Par. 1.92 - bottom frequency of elimination range 2 [Hz]
- Par. 1.93 - top frequency of elimination range 2 [Hz]
- Par. 1.94 - bottom frequency of elimination range 3 [Hz]
- Par. 1.95 - top frequency of elimination range 3 [Hz]

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

Fig. 4.6 shows influence of range elimination procedure on output frequency of referencing-unit.

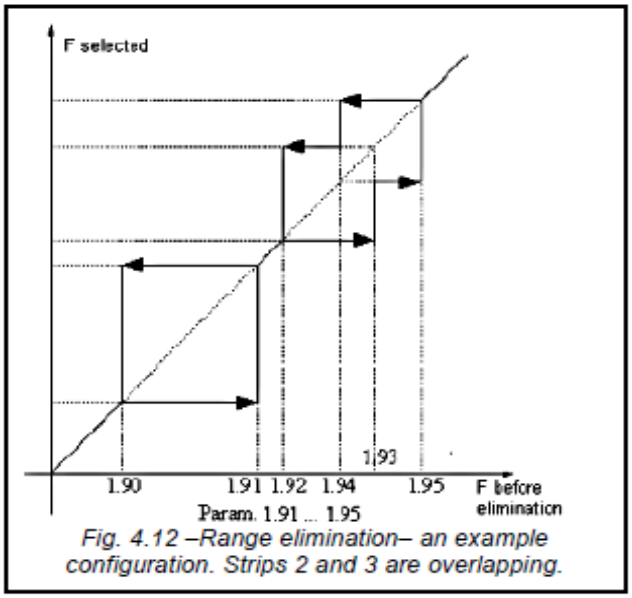


Fig. 4.12 –Range elimination– an example configuration. Strips 2 and 3 are overlapping.

4.6.Blocking a direction of drive rotation

There is a possibility of partial blocking of the electric drive with permission of operation only in one direction. In this case irrespective of control signals the frequency converter will rotate the drive only in one direction. Parameter 1.65 allows to define this option:

"Reverser" - operation in two directions (option relative)
"To the left" - operation in one direction
"To the right" - operation in one direction

4.7.Thermal protection of the drive

Protection limit I^2t

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

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

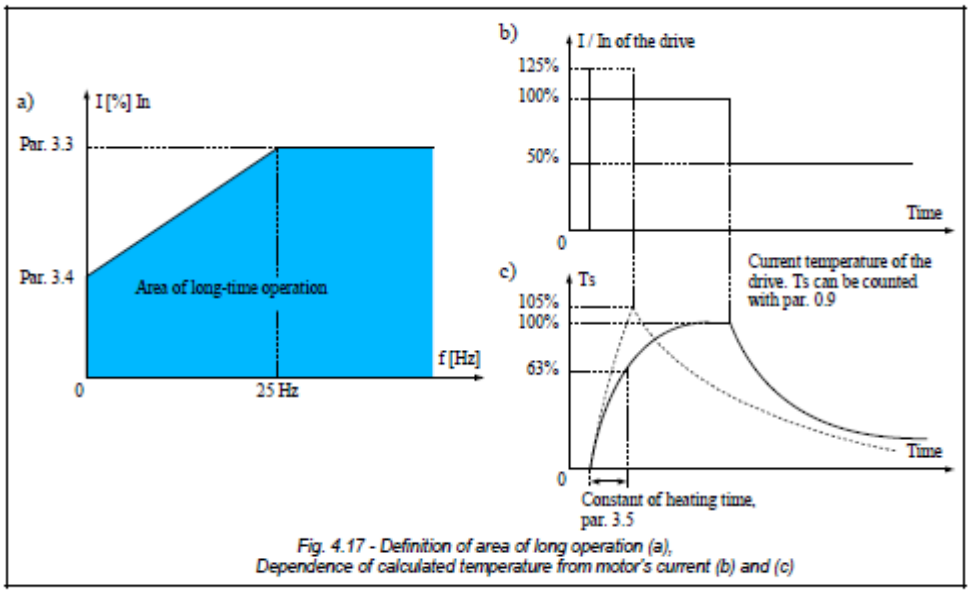


Fig. 4.17 - Definition of area of long operation (a), Dependence of calculated temperature from motor's current (b) and (c)

Relative **long-term motor current** value for frequency higher then 25 Hz is determined by **parameter 3.3**. For frequency lower then 25 Hz long-term current is lower (smaller efficiency of the cooling fan which is placed on a drive shaft) and it is determined by **parameter 3.4**. These parameters are determined in comparison with rating value of a drive current (for 100.0 % = In). Thus the **area of long-term work** (fig. 4.17a) is defined.

When cooling the motor without additional ventilation (only with the internal fan) par. 3.4 is necessary to set up on value of 35 % of rated motor current. If additional ventilation of the drive is used value of par. 3.4 can be set up to 75 %. If the motor current is outside of defined area of long-term operation the calculated temperature will increase above 100 %. **When the calculated temperature achieves value of 105 % electric drive will stop** (the message of failure will appear (fig. 4.18)). Such situation is represented on fig. 4.17c for a increase in temperature marked by a dotted line.

Speed of increase in calculated temperature is determined by **parameter 3.5** - a constant of time of motor heating. It equals time after which the temperature of the drive will achieve 63 % from value of a final gain. In practice it is possible to accept option:

Par. 3.5 = 120*t_6 [min], where t_6 [s] is provided by motor manufacterer

Demonstration values of constants of time are resulted in table 4.7.

Table 4.7 – Constants of time of heating

Nominal power of the motor Pn [kW]	***Quantity of poles***		
	2	4	6
	Constant of time of motor heating [min] (par. 3.5)		
2.2	11	17	24
3.0	12	18	26
4.0	13	19	29
5.5	15	21	29
7.5	16	23	31
11	19	26	34
15	20	29	39

5. The first start

Before first start of the converter AFC150 it is necessary to check section 4 "Configuration of frequency converter".The structural circuit of control AFC150 and Appendix – table of parameters of AFC150 are also very important

Main options:

	Description	
1.	nominal parameters of the drive	See section 4
2.	"control place" A or B	"Switch off" = Control A "Wy.C1" = Choice A/B with help of digital input 1 ... "Wy.C6" = Choice A/B with help of digital input 6 "Switch on" = Control B
3.	Source of signal START/STOP (local from control panel, remote from digital inputs, remote from RS or others)	parameter 2.4 "START A" - source of signal START for control A parameter 2.5 "START B" - source of signal START for control B
4.	method of referencing frequency or rotation speed of the motor (local from control panel, remote from analog input, through link RS, motopotentiometer, from PID-regulator or others)	parameter 2.2 "START A" - source of referencing-unit for control A parameter 2.3 "START B" - source of referencing-unit for control B

6. Failures and warnings

6.1 Messages on failures and warnings on the control panel

The luminescence of a red light-emitting diode LED (with a “FAULT” description) and messages (fig. 6.1) signals about **failure state.**
Thus the frequency converter passes to STOP mode. To make the next START it is necessary to deal with a failure and to erase the message of failure. In case of some failures the automatic restart (deleting of the message) is possible after disappearance of the failure reason.
Warning state is signaled by the appropriate message on the display **without stopping** the frequency converter, and also by a blinking red light-emitting diode LED (fig. 6.2). Warning is automatically erased after a drive stop.
In both cases functioning of a control panel is not blocked. It is possible to look through and change all parameters of the converter without obstructions.
Tab. 6.1. Failures codes

Code	Displayed name	description	Possible cause/ reason	***Counteraction***
E.1		Radiator temperature higher then 85^{O}C	The air course through the converter is complicated, unit overload, to high environment temperature	Check efficiency of ventilation (efficiency of the ventilating fan and pollution of a radiator)
E.3		High voltage in circuit DC	Too high voltage in the circuit, intensive braking of the drive	Test the mains Increase a time of braking Par 1.31
E.4		Low voltage in circuit DC	Low voltage in circuit, absence of one phase of a supply voltage	Check connecting cables and a level of a feeding voltage
E.5		Short circuit on output of the converter or failure of power module	Short circuit in the drive or in the wires feeding the drive	Disconnect the drive and test presence of a short circuit, if present call service to repair drives, and if is not present test isolation of wires and windings of the drive
E.6		The current of the drive is to high	Too high intensity of acceleration, a sudden change of drive loading	Increase acceleration time of the drive
E.7		Overheating of the drive	Overheating of the motor or operation with high loading at small speeds	Check loading of the motor (current of the motor); check parameters of thermal drive model
E.8		Damage of the analog input	At input option with „living zero” (2-10V or 4-20mA) value of a signal is lower than 1V	Check a configuration of analog inputs, test system of connection (damage of a cable, etc.)
E. 13		Temperature of radiator is lower than 10ºC	Temperature of converter's environment is to low.	Check efficiency of heating
E.21		The signal of external failure is active		Check a signal at digital input which is chosen as an external failure
E.27		Waiting time on a signal from RS is exceeded	Failure of a cable, parameters of the transmission are incorrectly set up	Check external connections and validity of RS parameters

6.2 Deleting failure message. Automatic restarts.

6.2.6 Manual deleting

To delete the failure message 

Push for at least 2 seconds

6.2.6 Deleting through a digital input of the converter

The parameter 3.70 allows to choose a digital input which will serve for deleting message of failure.

6.2.7 Remote deleting through RS link

If parameter 4.7 allows to operate with RS control mode, sequence of 2 next records in the register 2000 (MODBUS) deletes failure message. The detailed description of separate bits and methods of deleting can be found in the description of the register 2000.

6.3. Failure log

Parameters 3.80...3.111 form the Failures Log allows to display a history of last 16 failures.
Each record in the failure log consists of two parameters. First informs about failure code , and second - about time of its occurrence. Parameters 3.80 and 3.81 are the newest records of failure, and parameters 3.110 and 3.111 are the oldest records of failure.
In a time of one hour of the converter operation the same failure can take place many times. In order to prevent overflow of the failure log, only the quantity of failures which occurred in last operating hour is increased. Thanks to this the real quantity of failures which the failure log can remember increases.

7. *Sets of factory parameters*

There is 1 set of factory parameters (table 7.1) intended for loading standard, most used control programs. It is to find in parameter table attached.
Frequently in the beginning it is better to load one of the instanced standard sets of parameters, than manually change a lot of parameters of the frequency converter.
To carry out drive identification (see section 4.4).

8. PI – regulator

Frequency converter has a PI- regulator (Proportional – Integral). The regulator can be used for stabilization of any parameters at fixed level (fig. 8.1).

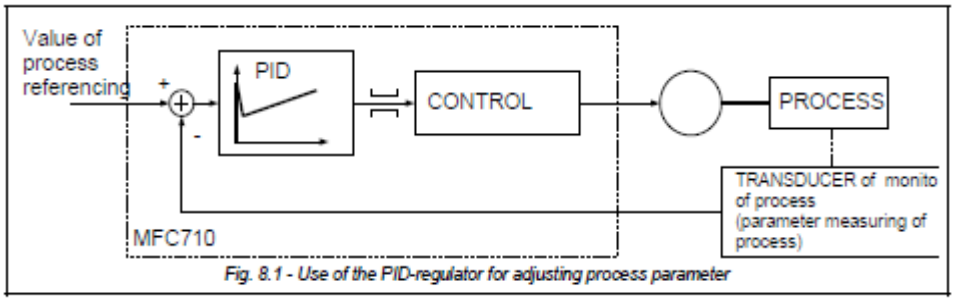


Fig. 8.1 - Use of the PID-regulator for adjusting process parameter

8.1. Turning on and a configuration of the PI-regulator

To enable PI – regulator as a source of referenced frequency it is necessary to set up par. 2.2 (for control A) or 2.3 (for control B) on value “Wy.PI” (fig. 8.2).

Table 8.1 - Control and information parameters of the PID-REGULATOR

Parameter	***Name***	***Description***
2.60	Ref.PI choice	Source of ref.-unit for PI-regulator. It serves for setting process referenced value. Possible values: **0-Keyboard**- referencing PI from control board **1- Ref.A0** **2- Ref.A1** **RS** –analog referencing-units from communication module RS232/485 (Modbus)
2.61	InPI choice	Signal source of feedback od PI-regulator. **0-Ref.A0** **1-Ref.A1**
2.62	Error inversion	Error inversion (difference between tasked value and feedback signal) **NO / YES**
2.63	P amplification (Kp)	Amplification of proportional component of PI-regulator. The bigger amplification, the faster reaction to speed error
2.64	I Const (Ki)	**0.01 ... 320.00s**
2.66	Max OutPI	Max value which output signal of PID-regulator can achieve (restriction of saturation) **0.0 .... 3000.0 %**
2.67	Min OutPI	Min value which output signal of PID-regulator can achieve (restriction of saturation) **0.0 .... 3000.0 %**
2.68	PI reset	
0.30	RefPI	Value of current PI referencing-unit**. READ ONLY.**
0.31	InPI	Current value of PI-regulator input. **READ ONLY**
0.32	PI error	Value of current regulator error par 0.32 = par 0.30 – par 0.31 **READ ONLY**

Parameter	*Name*	*Description*
0.33	OutPI	Current value of PI-regulator output. **READ ONLY**

9.Control of the frequency converter by means of connection RS

Frequency converter AFC150 is equipped with RS485 communication link. It enables to control work of device with help of a computer or an external controller. The basic characteristics and possibilities of the RS link of the frequency converter:

- operation with speed 9600 or 19200 bits per second,
- a format of a character: 8 data bits, lack of parity control, 2 stop bits,
- transfer protocol: MODBUS mode RTU,
- check of transfer validity with use of CRC sum,
- unit number (converter) set up with help of parameter (typically 12),
- support of MODBUS commands: command 3 - “read the register” - allows to read individual registers from the converter. Command 6 - “register write” - write to individual register in the converter,
- possibility of reading of an operating mode, control start/stop, reading and writing of referencing-units,
- possibility of reading and writing of all parameters of the converter just as by means of a control panel,

All operations are based on two basic commands of MODBUS RTU protocol - 3 and 6 which are described in publications concerning MODBUS.

9.1. Parameters which concern communication through RS

Table 13.1 - Parameters which refer to communication

Parameter	Description
2.2	Referencing-unit A - it is possible to set up a source "RS"
2.3	Referencing-unit B - it is possible to set up a source "RS"
2.4	Start A - it is possible to set up a source "RS"
2.5	Start B - it is possible to set up a source "RS"
4.7	RS permission – it is possible to enable permanent permission to control from RS, disable permanent permission or, for example, set enabling/disabling RS permission from a digital input. The permission concerns referencing frequency through RS, RS PID referencing-unit, and a START / STOP/BLOCKING signal from RS (see table 13.2 - registers 2000, 2001 and 2002).
4.8	RS speed - possible options is 1200, 2400, 9600 or 19200 bits per second.
4.9	Number of device (converter) in MODBUS protocol (possibility of connecting several converters through one communication channel RS 485).

CAUTION: If control RS blocked (par. 4.7), and parameters 2.2, 2.3, 2.4 or 2.5 define control as "RS" in this case the frequency converter remains in STOP mode or the referencing-unit of frequency will assume value 0.

9.2. Map of registers accessible through RS link

All registers are 16-bit numbers. Addresses which are omitted in the table are not supported.

Table 13.2 - Registers

The address of the registers (decimal)	***Description (meaning)***	***Mode***
REGISTERS OF OPERATING MODES		
2000	The register RS CONTROL. The data is valuable only when the parameter 4.7 (RS permission) allows control of the device with RS. Bits meaning: bits 0 - not used bits 1 - the sequence 0 → 1 → 0 erases the message on failure bits 2,3 - not used	Read / write

	bits 4 - 1 = force referencing PI from RS (the register 2002) bits 5 - 1 = force referencing frequency from RS (the register 2001) bits 6 - 1 = force START/STOP Control from RS bits 7,8,9,10,11 - not used bits 12 - 1 = BLOCKING of OPERATION shut down according to Parameter bits 13 - 1 = BLOCKING of OPERATION shut down RAMP bits 14 - 1 = BLOCKING of OPERATION shut down RUN OUT bits 15 - 1 = START 0 = STOP Bits 4,5,6 allow to force control of the drive through communication channel RS even if referencing-units or source of START / STOP signal is set up on value which differs from RS. If, for example, the referencing-units A is set up on value "RS" , to set frequency with RS, there is no necessity 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 drive irrespective of the established type of control (also when, for example, there is control through RS and bits 15 = 1).	The last value written down in this register cab be read.
2001	The RS frequency referencing-unit operates only if the parameter 4,7 (RS permission) allows operation with RS. Resolution 0,1Hz (see. CAUTION), a range - 5000....5000. e.g. 250 = 25.0 Hz clockwise rotation e.g.-122 = 12.2 Hz anti-clockwise rotation CAUTION. For a mode of vector control (the Vector 1 and Vector2) value is in rotations per one minute (rpm) instead of in Hz.	Read / write
2002	The referencing-unit of the PID-regulator operates only if the parameter 4.7 (RS permission) allows operation with RS. Resolution 0,1 %, a range 0....1000. e.g. 445 = 44,5 %	Read / write
2004	STATE OF CONTROL The register which informs from where current START/STOP signal and current frequency referencing-unit is coming. bits 0 - 1 = control A active bits 1 - 1 = control B active bits 2 - 1 = the referencing-unit from an analog input 0 bits 3 - 1 = the referencing-unit from an analog input 1 bits 4 - 1 = the referencing-unit from an analog input 2 bits 5 - 1 = the referencing-unit from a motor-potentiometer bits 6 - 1 = the referencing-unit from an output of the PID-regulator bits 7 - 1 = the referencing-unit from a control panel bits 8 - 1 = the referencing-unit with another PCH (advanced) bits 9 - 1 = START / STOP from digital inputs (remote) bits 10 - 1 = START / STOP from a control panel (local) bits 11 - 1 = START / STOP with another PCH (advanced) bits 12 - 1 = START / STOP set through RS connection bits 13 - 1 = the referencing-unit of frequency from communication channel RS bits 14 - 1 = active frequency is CONSTANT (f c) its 15 - 1 = the emergency referencing-unit is switched on (can be connected to other bits determining a source of the referencing-unit)	Read only
2005	Not used	Read only
2006	OPERATION STATE Value of this register serves for identification of the device's state: bits 0 - 1 = the drive operates bits 1 - 1 = one of referencing-units of a control panel (frequency, the PID-regulator or the user's referencing-unit) is switched on bits 2 - 1 = device is blocked bits 3 - 1 = ready to restart (failure message was erased, but reason has not disappeared) bits 4,5,6 - number of automatic restart/number of a stage of identification bits 7 - CRC error in EEPROM	Read only

	bits 8,9,10,11,12 - a failure code or warning (0 - absence of failure) bits 13 - value of a failure code: 0 = failure, 1 – warning) bits 14 - a direction of operation (0 = to the right, 1 = to the left). bits 15 - 1 = identification (it is started by par. 1.10)	
THE REGISTERS CONNECTED TO PARAMETERS		
40xxx	Parameters from group 0. They are analogous with parameters on the control panel, e.g. the register 40003 corresponds to parameter 0.3	Read only
41xxx	Parameters from group 1. They are similar with parameters on the control panel, e.g. the register 41020 corresponds to parameter 1.20. CAUTION: Changes of parameters are subjected to the same rules, as in case of operating from a control panel. There can be necessary to disable blocking of parameters change (parameter 4.1 = the register 44001) or entering of the corresponding code of access (parameter 4.2 = the register 44002). Some parameters of the device can be changed only in a case when it does not operate. Details: section 3.2 and following.	Read / write
42xxx	Parameters from group 2. They are similar with parameters on the control panel, e.g. the register 42001 corresponds to parameter 2.1. CAUTION: the same as item 41xxx.	Read / write
43xxx	Parameters from group 3. CAUTION: the same as item 41xxx	Read / write
44xxx	Parameters from group 4. CAUTION: the same as item 41xxx	Read / write
45xxx	Parameters from group 5. CAUTION: the same as item 41xxx	Read / write
46xxx	Parameters from group 6. CAUTION: the same as item 41xxx	Read / write

9.3. Handling of connection errors

If connection errors appear or if the command with Improper parameter is sent, response of the device is described by MODBUS standard. Possible return error codes are:

1 = unknown command - when the command other than 3 or 6 is sent,
2 = wrong address - the address of the register is not supported by the electric drive (there is no such register),
3 = wrong value - command 6 tried to send value which is out of range of specified register

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

10. Information from the manufacturer

Help from PWC "TWERD"

The Manufacturer provides the full help during guarantee and postguarantee service, updates of software and equipment.

Periodic service

In case of installation and use of the converter according to its specification, there is no necessity of its frequent periodic service. It is necessary to pay attention to cleanliness of a radiator and the fan.

Radiator	A plenty of a dirt which covers a radiator at operation worsens removing heat from device and can trigger protection against an overheat of the converter. Cleaning of a radiator can be made by means of pure and dry air under pressure using in addition a vacuum cleaner for gathering a dirt.
Fan	In case of strengthening noise at fan operation and reduction of its productivity, it is necessary to replace the fan. To replace the fan it is necessary to disconnect a cable feeding the fan, and to unscrew the fan. New fan should be ordered in TWERD.

Appendix – Table of AFC150 frequency converter's parameters

Numbers of parameters which are instanced in the appendix are numbers presented on the display of the control panel. In case of reading/writing by means of RS connection, each parameter is read/written with the help of specified register. For example the register 42002 corresponds to parameter 2.2 there, the register 44030 corresponds to parameter 4.30, etc.

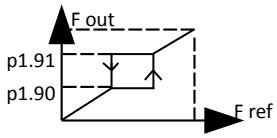
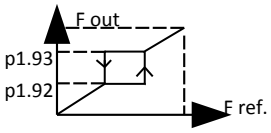
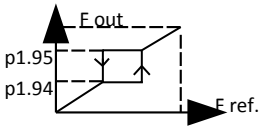
Parameters of GROUP 0. Variables of process - only for reading. It is possible to program the control panel to display value of any of these parameters without need to enter mode of parameters viewing (section 3).

Parameter in group 0	***Name***	***The description***
0.2	Motor n	Current rotation speed of the drive in rotations per one minute [rpm]
0.4	f out	Current output frequency of the converter [Hz]
0.5	f Ref.	Referenced frequency [Hz].
0.6	Mot torque	The moment of the drive compared to the nominal moment [%]
0.7	Mot. cur.	Average value of current in windings of the drive [A]
0.8	Mot. volt.	An output voltage AC of the converter [V] (voltage of the drive)
0.10	DC volt.	Voltage of the DC intermediaries circuit of the converter [V]
0.14	Ia cur.	Current of a phase A of the drive [A]
0.15	Ib cur.	Current of a phase B of the drive [A]
0.16	Ic cur.	Current of a phase C of the drive [A]
0.23	Hts. temp.	Maximum of parameters 0.20, 0.21, 0.22 [°C]
0.30	PI Ref.	Value of current referencing-unit of the PI-regulator [%]
0.31	PI In.	Current input value of the PI-regulator [%]
0.32	PI error	Error of the PI-REGULATOR [%]
0.33	PI Out.	Current output value of the PI-REGULATOR [%]
0.35	ON time	Quantity of hours of converter's operation [h].
0.40	We.A0	Value of an analog input 0 [%]
0.41	We.A1	Value of an analog input 1 [%]
0.43	Wy.A1	Value of an analog output 1 [%]
0.45	Ref.A0	Value of the analog referencing-unit 0 [%]
0.46	Ref. A1	Value of the analog referencing-unit 1 [%]
0.48	We.C state	State of all six digital inputs (for RS six youngest bits of the register)
0.50	RS1 state	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. Corresponds to the value written into the register 2001 through RS [Hz] or [rpm].

Parameter in group 0	*Name*	*The description*
0.53	RS PI Ref.	RS PI Ref.-unit. Corresponds to the value written into the register 2002 through RS [%]

Parameter / Name	*Function*	*Available options / measurement unit*	*Factory setting*	*Change during operating time*
GROUP 1 – CONFIGURATION OF THE DRIVE				
1.1 Pn	Nominal power of the drive	0.2 ... 3 kW	Nominal power of the frequency converter	NO
1.2 Rn	Nominal engine speed	0 ... 9000 rpm	1450 rpm	NO
1.3 In	Nominal engine current	0.00 ... 30 A	Nominal current of the frequency converter	NO
1.4 Un	Nominal engine voltage	0 ... 1000 V	380 V	NO
1.5 fn	Nominal engine frequency	0.0 ... 320.0 Hz	50.0 Hz	NO
1.6 PF nom.	Nominal cos φn of the engine	0.50 ... 1.00	0.80	NO
1.10 ID run	Identification of engine's equivalent circuit parameters	**NO** – without identification **Don't run** – only for stopped drive	NO	NO
1.11 Rs	Resistance stator windings	0 ... 32.000 Ohm	0.000 Ohm	NO
1.20 Oper. mode	Device operating mode	**U/f lin.** – operation in scalar mode (linear characteristic) **U/f sq.** – as above. (square-law characteristic) **1** – not used **2** – not used	U/f lin.	NO
1.21 f carr	Frequency of keying	4,8,15 kHz	5.0 kHz	NO
1.30 Accel. 1	Acceleration DYNAMICS 1	0.0 ... 320.0 s	5.0 s	YES

Parameter / Name	***Function***	***Available options / measurement unit***	***Factory setting***	***Change during operating time***
1.31 Decel. 1	Delay DYNAMICS 1	0.0 ... 320.0 s	5.0 s	YES
1.40 f max	Maximum output frequency	0.0 ... 600.0 Hz	55.0 Hz	YES
1.41 I limit M	Current restriction at motor operation	0.0 ... 200.0 % engine In	150.0 %	YES
1.43 T limit M	Torque restriction at motor operation	0.0 ... 200.0 % engine Mn	150.0 %	YES
1.50 U0	Voltage for output frequency F0 (par 1.51)	0.0 ... 40.0 % engine 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 ... 25.0 %	25.0 %	YES
1.53 f1	F1 frequency	0.0 ... 25.0 %	20.0 %	YES
1.55 f Start	Minimal output frequency for U/f operation modes	0.0 ... 40.0 Hz	0.0 Hz	
1.60 Slip comp.	Slip compensation	**YES** – slip compensation enabled **NO** - disabled	NO	YES
1.64 Stop mode	Stopping by coast or according to characteristic	**Coast** – stopping by running out after STOP command (voltage taken off immediately) **Ramp** – deceleration to 0 Hz at first, then shutting down	Coast	YES
1.65 Dir. Block	Blocking direction of rotation	**0-Reversal** – bidirectional, 1- **LEFT/RIGHT**	Reversal	YES
1.66 U DC br.	Voltage of DC braking	0.1 ... 40.0 % engine's Un, direct current braking	0.1 %	YES
1.67 DC br. time	Braking time	On units up to 2KW	0.0 s	
1.70 Amp. reg.n	Speed regulator gain	Service parameter for Vector modes		
1.71 Ki of reg.n	Integration time of speed regulator	Service parameter for Vector modes		

Parameter / Name	*Function*	*Available options / measurement unit*	*Factory setting*	*Change during operating time*
1.72 Amp. reg.T	Torque regulator gain	Service parameter for Vector modes		
1.73 Ki of reg.T	Integration time of Torque regulator	Service parameter for Vector modes		
1.74 Amp. reg.S	Engine stream regulator gain	Service parameter for Vector modes		
1.75 Ki of reg.S	Integration time of engine stream regulator	Service parameter for Vector modes		
1.90 f elim1 min	Minimum frequency of frequency elimination range number 1.	0.0 ... 320 Hz 	0.0 Hz	YES
1.91 f elim1 max	Maximum frequency of frequency elimination range number 1.	0.0 ... 320.0 Hz	0.0 Hz	YES
1.92 f elim2 min	Minimum frequency of frequency elimination range number 2.	0.0 ... 320.0 Hz 	0.0 Hz	YES
1.93 f elim2 max	Maximum frequency of frequency elimination range number 1.	0.0 ... 320.0 Hz	0.0 Hz	YES
1.94 f elim3 min	Minimum frequency of frequency elimination range number 3.	0.0 ... 320.0 Hz 	0.0 Hz	YES
1.95 f elim3 max	Maximum frequency of frequency elimination range number 3.	0.0 ... 320.0 Hz	0.0 Hz	YES
GROUP 2 – REFERENCING-UNITS AND CONTROL				
2.01 B Ctrl.unit	Switching on variant A or B of control	**1-** **Sw.off** – Control A **2-** **Sw.on** – Control B	Sw.off (Control A enabled)	YES
2.02 Ref.unit A	Choice of a referencing-unit for Control A	**0-Keyb.** – frequency ref.-unit from the panel **1-AI0** – referencing frequency by signal from analog input 1 **2-AI1** - referencing frequency by signal from analog input 2	Keyb..	YES

Parameter / Name	*Function*	*Available options / measurement unit*	*Factory setting*	*Change during operating time*
		3-unused **4-OutPI** – referencing frequency by PI-regulator **5-MotPot** – referencing by increase/decrease signals from motopotentiometer **6-RS** – referencing through RS232 or RS485 connection (Modbus)		
2.03 Ref.unit B	Choice of a referencing-unit for Control B	as above	AI0	YES
2.04 Start A	Choice of a source of START / STOP signal for Control A	**0-InDig** – 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 RS232 or RS485 (Modbus)	Keyb..	YES
2.05 Start B	Choice of a source of START / STOP signal for Control B	as above	InDig	YES
2.06 Dir. A	Choice of signal of direction control for Control A	as above	Keyb..	YES
2.07 Dir. B	Choice of signal of direction control for Control B	as above	InDig	YES
2.08 Remote Start	Variant of START/STOP remote control	0 – WeC1 = START/STOP, DI2 = direction 1 – WeC1 = START RIGHT, DI2 = START LEFT 2 – impulse WeC1 = START, impulse DI2 = STOP 3 – as above plus WeC3 = direction 4 – WeC1 = START/STOP	0	YES
2.11 Ref. min	Referenced frequency which corresponds to 0 % of the referencing-unit	0.00 ... 320.0 Hz	0.0 Hz	YES
2.12 Ref. max	Referenced frequency which corresponds to 100 % of the referencing-unit	0 ... 320.0 Hz	50.0 Hz	YES
2.13 f stop	Minimal absolute value of referenced frequency	0.0 ... 320.0 Hz	0.5 Hz	YES
2.14 Use f stop	Stopping when f < par 2.13	0 – device will stop, if referenced F is lower than minimum determined by par 2.13 1 – device will only limit frequency to par 2.13	NO	YES
2.20 Motopot.up	Source of “increase” signal for motopotentiometer referencing-unit	0-Sw.off – lack (1-We.C1)...(6-We.C6) – increase ref.-unit, when there is a voltage supplied on digital input 1...6	Sw.off	YES
2.21 Motopot.dwn	Source of “decrease” signal for motopotentiometer ref.-unit	0-Sw.off – lack (1-We.C1)...(6-We.C6 – decrease ref.-unit, when there is a voltage supplied on digital input 1...6	Sw.off	YES

Parameter / Name	*Function*	*Available options / measurement unit*	*Factory setting*	*Change during operating time*
2.22 Motop.mode	Motopotentiometer mode	0 – 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 traced by motopotentiometer. Applied for gentle transmission from current ref.-unit to motopotentiometer 3 – value of motopotentiometer setting stored in the memory. There is a possibility of changing this setting during stoppage. 0, 1, 2: modes applied when current ref.-unit (par2.2/par2.3) is set on MotPot 3: mode independent of current ref.-unit choice	0	YES
2.23 Motop. time	Time of increase/decrease of motopotentiometer ref.-unit	1.1 ... 320.0 s up to 320s	10.0 s	YES
2.30 fConst0 src	Source of W1 signal for referencing constant speeds	0-Sw.off – W1 = 0 (1-We.C1)…(6-We.C6) – W1 = 1 when there is voltage supplied on digital input 1..6	Sw.off	YES
2.31 fConst1 src	Source of W2 signal for referencing constant speeds	as above	Sw.off	YES
2.32 fConst2 src	Source of W3 signal for referencing constant speeds	as above	Sw.off	YES
2.33 f Const 1	Constant frequency 1	0.00 ... 320.0 Hz	10.0 Hz	YES
2.34 f Const 2	Constant frequency 2	0.00 ... 320.0 Hz	20.0 Hz	YES
2.35 f Const 3	Constant frequency 3	0.00 ... 320.0 Hz	25.0 Hz	YES
2.36 f Const 4	Constant frequency 4	0.00 ... 320.0 Hz	30.0 Hz	YES
2.37 f Const 5	Constant frequency 5	0.00 ... 320.0 Hz	40.0 Hz	YES
2.38 f Const 6	Constant frequency 6	0.00 ... 320.0 Hz	45.0 Hz	YES
2.39 f Const 7	Constant frequency 7	0.00 ... 320.0 Hz	50.0 Hz	YES
2.40 Cfg. AI0	Configuration of analog input AI0	0-0-10 V - 0V = 0.0 % 10 V (20 mA)=100.0% 1-10-0 V - 0 V = 100.0 % 10 V (20 mA) = 0.0 % 2-2-10 V - 2 V = 0.0 % 10 V (20 mA) = 100.0 % 3-10-2 V – 2 V = 100.0 % 10 V = 0.0 % AI0 operates only in voltage mode.	0-10 V	YES
2.41 Cfg. We.A1	Configuration of analog input We.A1	as above.	0-10 V	YES
2.43 We.A0 Scale	Scale of analog	-500.0 ... 500.0 %	100.0 %	YES

Parameter / Name	*Function*	*Available options / measurement unit*	*Factory setting*	*Change during operating time*
	referencing-unit RefWe.A0			
2.44 We.A1 Scale	Scale of analog referencing-unit Ref We.A1	-500.0 ... 500.0 %	100.0 %	YES
2.46 We.A0 Offs.	Offset of analog referencing-unit Ref We.A0	-500.0 ... 500.0 %	0.0 %	YES
2.47 We.A1 Offs.	Offset of analog referencing-unit Ref We.A1	-500.0 ... 500.0 %	0.0 %	YES
2.49 We.A0 Fltr.	Constant of time of lowpass filter	0.01 ... 50.00 s	0.10 s	YES
2.50 We.A1 Fltr.	Constant of time of lowpass filter	0.01 ... 50.00 s	0.10s	YES
2.60 PI Ref.Src	Choice of PI1-regulator referencing-unit	0-Keyb. – referencing frequency from panel 1-AI0 – referencing frequency by signal from analog input AI0 2-AI1 – referencing frequency by signal from analog input AI1 3-unused RS – referencing through RS485 link	Keyb.	YES
2.61 PID Inp.Src	Choice of regulated value of PID-regulator	RefA0 – referencing regulated value from analog referencing-unit RefA0 RefA1 – referencing regulated value from analog referencing-unit RefA0 RefA2 – referencing regulated value from analog referencing-unit RefA0	RefA1	YES
2.62 Error inv.	Negation of regulator's error	0-NO 1- YES	NO	YES
2.63 P Amp.	Amplification of proportional element of PI regulator	1 ... 3000 %	100 %	YES
2.64 I Const.	Constant of time I of the PI regulator	0.01 ... 320.00 s	1.00 s	YES
2.66 max.Out.PI	Upper limitation of PI-regulator output value	0 ... 3000.0 %	100.0 %	YES
2.67 min.Out.PI	Lower limitation of PI-regulator output value	-3000.0 ... 0 %	0.0 %	YES
2.68 PI Out.res	Resetting PI output when device is stopped	0 – reset on STOP 1 – regulator continuously active		YES
2.80 Wy.A1 Src.	Choice of signal for analog output	0-rpm – 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-Cur. – 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	F out.	YES

Parameter / Name	***Function***	***Available options / measurement unit***	***Factory setting***	***Change during operating time***
		6-U mot. – output voltage 100.0 % = Un		
2.82 Wy.A1 Cfg.	Configuration of analog output	0-0-10 V – 0 V (0 mA) = 0.0 % 10 V (20 mA) = 100.0 % 1-10-0 V – 0 V (0 mA) = 100.0 % 10 V (20 mA) = 0.0 % 2-2-10 V – 2V (4 mA) = 0.0 % 10 V (20 mA) = 100.0 % 3-10-2 V – 2V (4mA) = 100.0 % 10 V (20 mA) = 0.0 % Current mode	0-20mA	YES
2.84 Wy.A1 Scal	Scale of analog output	0 ... 500.0%	100.0 %	YES
2.86 AO1 Fltr	Constant of time of lowpass filter	0.01 ... 50.00 s	0.10 s	YES
2.90 K1 funct. 1	Function 1 of K1 relay	0-NotAct – relay not active 1-Work – active when there is voltage supplied to motor 2-Ready – device is ready to work 3-Fail. – a failure has occurred 4-n.Flr. – not failure 5-unused 6-unused 7-Fthr1 – F threshold 1 exceeded 8-Fthr2 – F threshold 2 exceeded 9-Fref – referenced frequency reached 10-Temp.Wr – warning of exceeding programmed threshold of radiator temperature 11-An.Wrn. – warning: error of analog signal (lack of “living null” signal lower than 2V or 4mA)	Ready	YES
2.91 K1 funct. 2	Function 2 of K1 relay	as above	NotAct	YES
2.92 K2 funct. 1	Function 1 of K2 relay	as above		
2.93 K2 funct. 2	Function 2 of K2 relay	as above		
2.98 f thresh. 1	Threshold frequency 1	0.00 ... 320.0 Hz	25.0 Hz	YES
2.99 f thresh. 2	Threshold frequency 2	0.00 ... 320.0 Hz	45.0 Hz	YES
2.100 Temp.Warn	Threshold of radiator overheat warning	0 ... 80 °C	70 °C	YES
2.110 Op. Perm.	External operation permission.	(1-We.C1)…(6-We.C6) – operation allowed, when there is voltage supplied on digital input 1...6 Sw.on. - operation allowed	Sw.on.	YES

Parameter / Name	*Function*	*Available options / measurement unit*	*Factory setting*	*Change during operating time*
2.111 Op. Block.	External operation blocking.	0-Sw.off – without operation blocking (1-We.C1)…(6-We.C6) –blocking active, when there is voltage supplied on digital input 1...6	Sw.off.	YES
2.112 Em. Stop	Emergency Stop	0-Sw.off – no possibility of emergency stopping (1-We.C1)…(6-We.C6) – emergency stop by means of one of digital inputs	Sw.off.	YES
GROUP 3 – FAILURES				
3.02 i2t Block.	Switching on blocking from thermal overload	**0-NO –disabled** **1-YES –** enabled	YES	YES
3.03 I therm.	Setting of drive thermal protection current	0.0 ... 200.0 %	100.0 %	YES
3.04 I therm.0	Setting of thermorelay for stopped drive	0.0 ... 200.0 %	50.0 %	YES
3.05 therm. Const..	Constant of drive heating	0 ... 320 min.	3 min	YES
3.10 Ext. fail.1	Choice of external failure source 1	**0-Sw.off –** disabled **(1-We.C1)…(6-We.C6) –** reporting external failure 1, when there is voltage supplied on digital input 1..6	We.C3	YES
3.20 Sw.on We.A	Reporting failure of lack of signal (<2V) when AI doesn't serve as referencing-unit	**0-Sw.off –** don't report failures **(1-We.C1)…(6-We.C6) –** reporting failures, when there is voltage supplied on digital input 1..6 **7-Sw.on –** always report failures		
3.23 Re.4mA lack	Response to lack of analog signal (level <2V (4mA))	**0** – no response **1-Warn. -** a warning will be displayed, device keeps working with referenced frequency f const. 7 **2-Fail. –** device will stop and message will be displayed	No	YES
3.45 Spd. err Re.	Response to error of output speed	**0 –** no response **1-Warn. -** a warning will be displayed, device keeps working with referenced frequency f const. 7 **2-Fail. –** device will stop and message will be displayed	No	YES
3.60 Re. RS lack	Response to lack of communication through RS link	**0 –** no response **1-Warn. -** a warning will be displayed, device will keep working with referenced frequency **2-Fail.** – the electric drive will stop and the message will be displayed	No	YES
3.61 RSlack time	Acceptable time of lack of communication through RS link	0 ... 600 s	30 s	YES

Parameter / Name	*Function*	*Available options / measurement unit*	*Factory setting*	*Change during operating time*
3.70 Ext. reset	Source of external reset	**0-Sw.off –** no possibility of external erasing a failure message **(1-We.C1)…(6-We.C6) –** erasing a failure by digital input 1...6	We.C4	YES
3.80 Failure 1	Failure Register 1 (the most current record)	**Failure name** (read only)		Read only
3.81 Fa.1 time	Register of time of occurrence of failure from Failure Register 1	**Time [h]** (read only)		Read only
3.110 Failure 16	Failure Register 16 (the oldest record)	**Failure name** (read only)		Read only
3.111 Fa.16 time	Register of time of occurrence of failure from Failure Register 16	**Time [h]** (read only)		Read only
GROUP 4 – PARAMETERS BLOCKING, CONFIGURATION OF: RS, DISPLAYING AND USER REFERENCING-UNITS				
4.02 Level/CODE	Access level (reading) Access code (writing)	Access level **Pd0 ... Pd2** **Access** code 0 ... 9999	Do not apply	YES
4.03 New CODE	Change of access code to current access level	New access code 0 ... 9999	Do not apply	YES
4.04 Fact. set.	Loading factory settings	(access level AL2 required)	Do not apply	NO
4.07 RS perm.	Permission to work through RS	**0-Sw.off** – operation through RS prohibited **(1-We.C1)…(6-We.C6)** – enabling RS permission by digital input **7-Sw.on** – operation through RS permitted	Sw.off	YES
4.08 RS baudrate	Transmission speed	1- 9600 bs/s 2- 19200 bp/s	9600	YES
4.09 Unit no.	Identification number of Modbus device	1 ... 247	12	YES
4.10 L1 at STOP	Value displayed in upper line when device is not working (see section 3.3)	par 0.1 ... par 0.57		YES
4.11 L2 at STOP	Value displayed in lower line when device is not working (see section 3.3)	par 0.1 ... par 0.57		YES