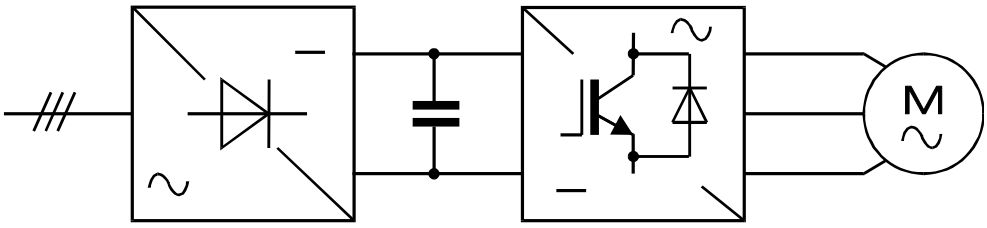
ZAKŁAD ENERGOELEKTRONIKI

mgr inż. MICHAŁ TWERD



FREQUENCY CONVERTER

type

AFC 120

The description

ZAKŁAD ENERGOELEKTRONIKI

MGR INŻ. MICHAŁ TWERD

UL. KONWALIOWA 30

TEL.+48 56 6546091, TEL/FAX +48 56 6226160

87-100 TORUŃ

WWW: http://www.twerd.pl
E-mail: twerd@twerd.pl

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1. GENERAL DESCRIPTION

The frequency converterAFC 120 series are intended for speed regulation of inductive three-phase drives rotating by power 0.37 - 3.0 KW and speedd voltage 220 V. They are connected to the single-phase supply line 220 V.

The converter is a power-electrical device converting circuit voltage to alternating voltage with regulating amplitude and frequency.

Power circuit is made of the latest integspeedd power units IPM - Intelligent Power Module. They contain: 7 trss IGBT with their controls, safety devices against short circuit and thermal protection. Controlling the modulation of output voltage is realizing by program with the help of the microcontroller 80C196KC (INTEL). The updated modulation so-called „ voltage vector orientation" is applied. It promotes complete usage of the converter possibilities on output voltage.

The device can work in the amade of linear or square-law characteristic U/F.

All electronics is fed by the stabilized voltage using from inner converter, at a phase voltage of the supply line in limits from 90V up to 250 V. As the inner converter is fed by a direct current, the operational stability of the system is possible at oscillations and short voltage failure.

The controlling clamps of inverter are galvanic insulated from the processor chain and power circuit. The complete processor separation as from power circuit so from an entry part provides the large noise immunityof the microsystem.

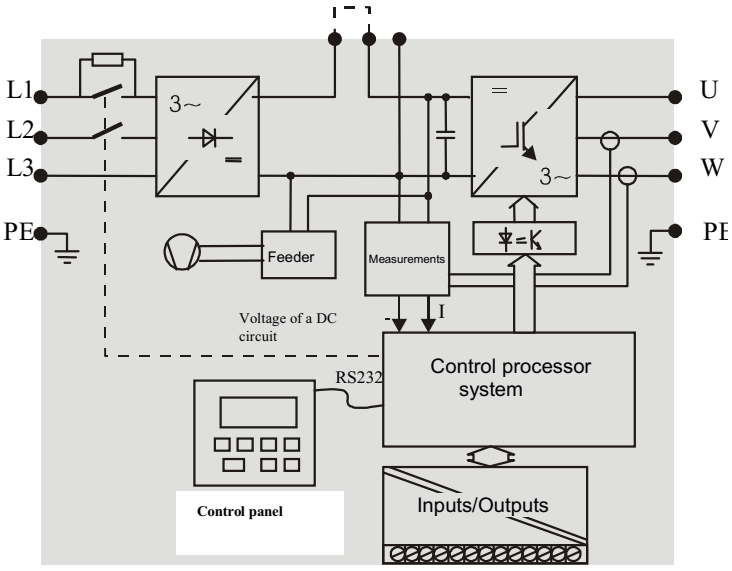


Fig.1.1 Skeleton diagram of the system

The converter can be controlled by power value 0/2 - 10 V or current value 0 / 4 - 20 mA. In operating mode with „living zero point" the lowering of input signal level to values lower 2V or 4 mA cause the converter stopping.

The diagram is supplied with developed system of diagnostic, locking and preservations defending the converter and the powered unit from damages.

On the Info Panel there are indicators showing the following damages:

- short circuit or current superior admitted on the converter output;
- voltage superior admitted on an intermediate chain;
- undervoltage on an intermediate chain;
- too high temperature of the heat-sink;
- overload.

2. SAFETY INFORMATION

2.1 Warning

- After converter connection to the supply line internal circuit components (except clamps In/Out[We/Wy]) are on the supply line potential. Touching to them threatens by electric current strike.

- When you connect the converter to the supply line there is a dangerous voltage on clamps U, V, W even when the drive does not work.

- After the device disconnecting from the supply line the dangerous powers are still saved about 3 minutes.

2.2 Manuals for safe operations

- Don`t make any connections when the converter AFC 120 is connected to the supply line.
- Don`t connect voltage of the supply line to output clamps U V W.
- Don`t mesure the possible voltage of any units devices.
- To measure the cables isolation it is necessary to disconnect them from the converter.
- Don`t touch integspeedd circuits, as they can be damaged by static discharges.
- Verify whether the capacitors enriching a power factor are connecting to cables of the drive.

2.3 Antistriken protection

The preservative wire should be connected to a clamp PE on a power rack of the inverter AFC 120.

The protection against consequences of a ground fault preserves only system, but does not preserve from a strike

3. Specifications

TABLE 3.1 Load volume and the converter sizes depending on type.

Type of the system	Drive power (KW)	Nominal output current (A)	Overload current 60s. Each 10 mins (A)	Sizes (mm)
AFC 120-0.37	0.37	2.2	3.3	107x263x145
AFC 120-0.55	0.55	3.0	4.5	107x263x145
AFC 120-0.75	0.75	4.0	6.0	107x263x145
AFC 120-1.1	1.1	5.5	8.3	107x263x145
AFC 120-1.5	1.5	7.0	10.5	107x263x145
AFC 120-2.2	2.2	9.5	14.5	107x263x145
AFC 120-3.0	3.0	14.0	21	107x263x145

TABLE 3.2 the Specifications, common for all series AFC 120.

Power	Supply voltage U_{in}	220 V - 15% -+ 10%
	Frequency	45-66 Hz
Output	Output voltage	0 - U_{in}
	Output frequency	0.5 - 200 Hz
	Distributing frequency ability	0.05 Hz
Controlling system	Modulation type	Voltage vector
	Frequency of transistor switching on/off	2.5 or 5 κHz
	Installation the frequency	Analog 10 - bit, Accuracy 1% Distributing ability 0.1 Hz
Controlling inputs/outputs	Analogue inputs	Two inputs: 0-10 V, 0-20 mA; 2-10 V 4-20 mA
	Digital inputs	Six inputs 15-24 V
	Analogue output	0-10V 8-bit +-1%
	Digital output (with an open collector)	100mA, 24B
	Relay output	AC (alternating current) 250V DC (direct current) 24V,8A
Protection	From current over admitted From overvoltage From voltage lower nominal Thermal protection of the scheme Control of the link with control panel Control of an analogue inputs level Thermal protection of a drive	Instantanious value 3.6 In Effective value. 2.55 In 1,29 x UIn (UIn = 220 V) (Udc>395 V) 0.65xUin T > 75^0C

4. CONNECTING

4.1 Connecting the power circuit

AFC 120 is powed from the three-phase supply line 3 x 380 V. The application of three-conductor wire in the screen (thase + protective wire + zero wire) is recommended. In figure 4.1 the connecting circuit of the large current is showed. Section of wires and value of protection should be pick up depending on an output current of the system. The recommended values are showed in table 4.1.

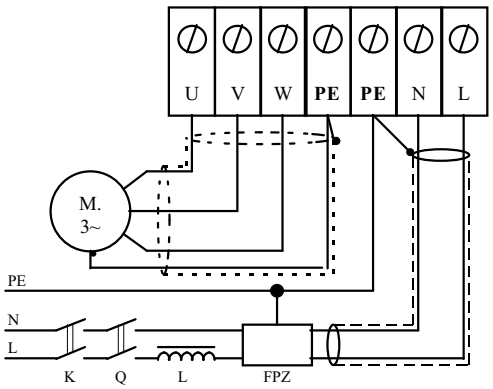


Fig. 4.1 Connections of a power circuit
K - Main switch; Q - Fuse protection
L – Supply line reactor; FPZ- filter (EMC)

Table 4.1. Fuses and supply line wire.

Converter type	Speedd current [A]	Protection [A]	Wire [mm^2]	Wire of the drive [mm^2]
AFC 120-0.37	4	6.3	2 x 1.5 + 1.5	3 x 1.5 + 1.5
AFC 120-0.55	6	10	2 x 1.5 + 1.5	3 x 1.5 + 1.5
AFC 120-0.75	7	10	2 x 1.5 + 1.5	3 x 1.5 + 1.5
AFC 120-1.1	10	16	2 x 1.5 + 1.5	3 x 1.5 + 1.5
AFC 120-1.5	14	25	2 x 2.5 + 2.5	3 x 1.5 + 1.5
AFC 120-2.2	18	25	2 x 2.5 + 2.5	3 x 1.5 + 1.5
AFC 120-3.0	28	32	2 x 2.5 + 2.5	3 x 2.5 + 2.5

To eliminate interferences it is recommended to shield a supply lead of a drive. The wires should be made as far as possible from other wires. It is possible to reduce interferences emitted by supply leads of a drive applying a reactor on a drive side. In that case it is necessary to take into account that power of a drive to be reduced.

Length of screened supply leads of a drive should be shorter than 50 meters.

4.2 Controling connections

№	Title	Description	Factory installation
Clamping rod X1			
1		Programming Relay output 1	
2			Operation
3			
4		Programming Relay output 2	
5			Troubles
6			
7			
8	Out A (Wy A)	Analogue output 1 Output level 0(2) – 10V or 0(4) – 20mA	0 – 10V output frequency 10V – max frequency
9	GND	Mass of analogue outputs	
10	24B	Voltage 24VDC (direct current) max. 100Ma	
11	In C1 (We C1)	Programming digital input	ON / OFF
12	In C2 (We C2)	Programming digital input	LEFT / RIGHT
13	GND	Mass of analogue inputs	
14	In A1 (We A1)	analogue inputs 1 0(2) – 10V or 0(4) - 20мA	Frequency installation for controlling
15	$U_{ref.}$	Matching voltage for potentiometer 10V DC (max. 10mA) potentiometer 1kΩ<R<10kΩ	
16	Out C (WyC)	Output of an open collector type	Exceeding max frequency
17	24V		
18	24V		
19	Out C3 (We C3)	Programming digital input	External error
20	Out C4 (We C4)	Programming digital input	Inactive
21	Out C5 (We C5)	Programming digital input	Selecting the constant speed
22	Out C6 (We C6)	Programming digital input	Selecting the constant speed
23	GND	Mass of analogue inputs	
24	Out A2 (We A2)	Analogue input 2 Set-point device 0(2) – 10V or 0(4) – 20mA	Unused

Fig.4.2 Connection of controlling wires (factory installation)

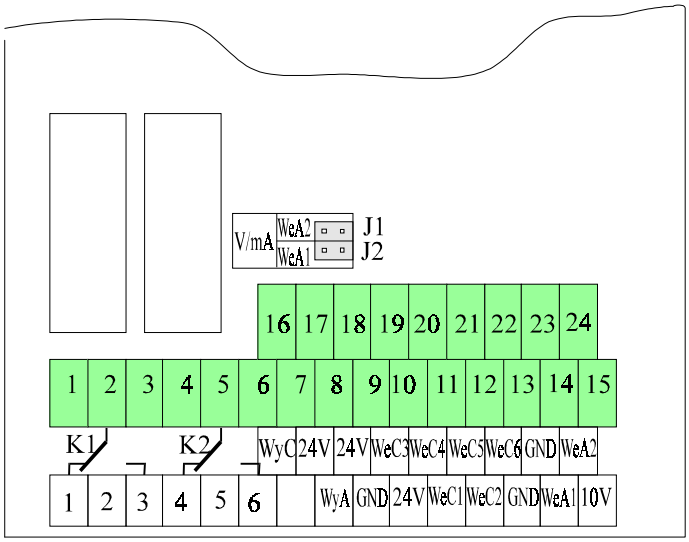


Fig. 4.3 Lay-out of clamping rods and switches

The section of wires of a control circuit should compound 0,5 - 1,0 mm^2. The use of screened wires is recommended, specially when their length exceeds 20 m.

The above named wires should be laid far from power chains. Don`t lay them parallel to high-voltage wires.

The Fig. 4.2 shows controlling connections appropriate to factory installations. In such variant the system can work with switching control - remote / local (In C4 (We C4) is programmed: the contact is open - control from the keyboard, the contact is closed - control from a clamping rod.) Additional In C3 (WE C3) is programmed as contact of an external trouble. The closed contact causes stopping of system operation and appearance of the message. It can be used in quality, for example, contact from a thermal protection relay of a drive.

In C5 (WE C5) and In C6 (WE C6) give selecting the constant frequencies. As an example usage of internal relays K1-3 is indicated. They can control a circuit, powered internal power supply 24Vdc (100mA) or source of other power, not higher 220 Vac.

5. CONTROL PANEL AND SIGNALLING SYSTEM DESCRIPTION

5.1 General description

Control panel allows to control the system (start / stop, selecting the direction, control-point setting device), to set parameters, to control parameters of operating method.

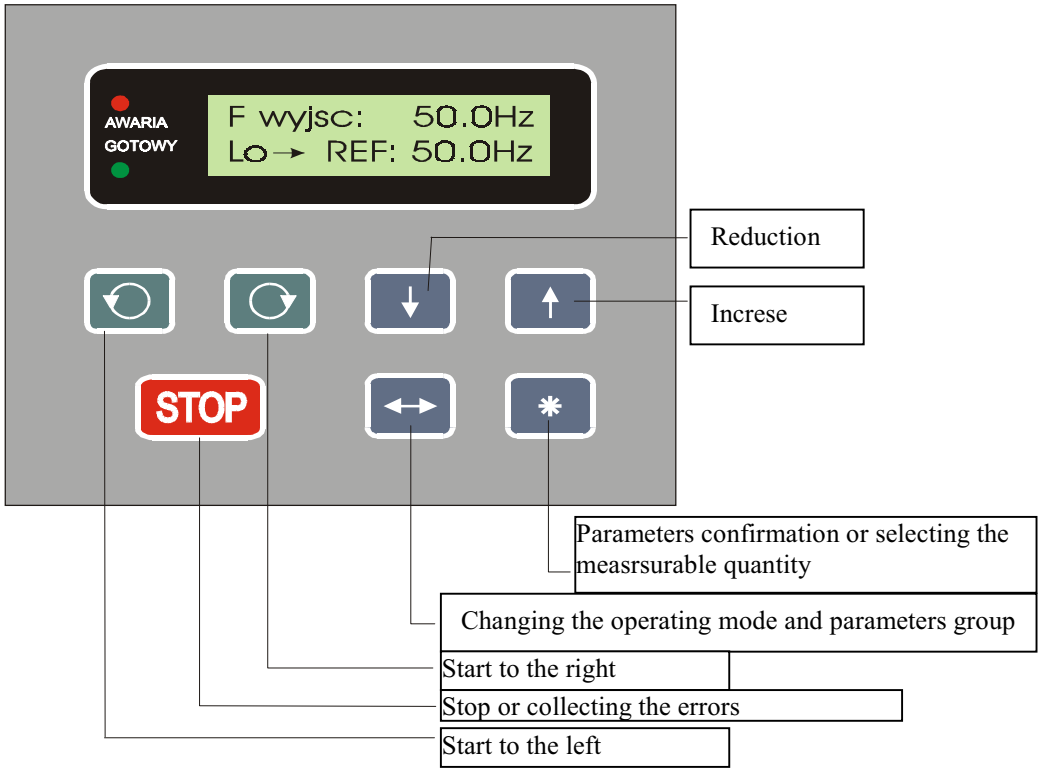


Fig. 5.1 Control and Signalling Panels

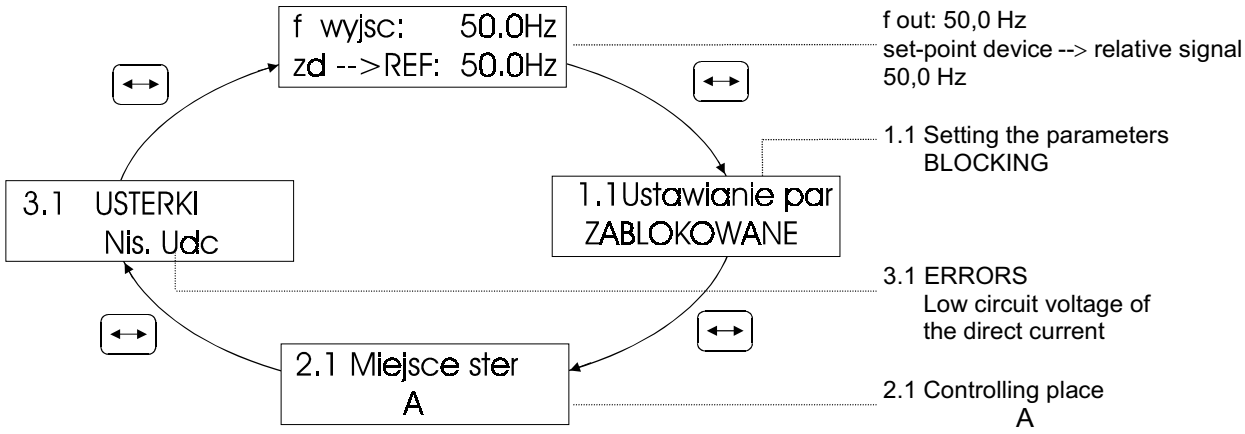


Fig. 5.2 Changes of operation mode mapping on parameters mapping arranged in three groups

5.2 Parameters of operation mode.

A working frequency, rotating direction, control type le (remote or local), and also one of below enumespeedd parameters are showed on the display:

REF - preselected output frequency [Hz] or preselected regulating value for operation PI [%]
I - output current value (drive)
Udc - power value in dc circuits
T - heat sink temperature

The above named parameters of operating method can be viewed, using the button „*”. The button „↑” is for selected frequency increase, and button „↓” - for its reducing.

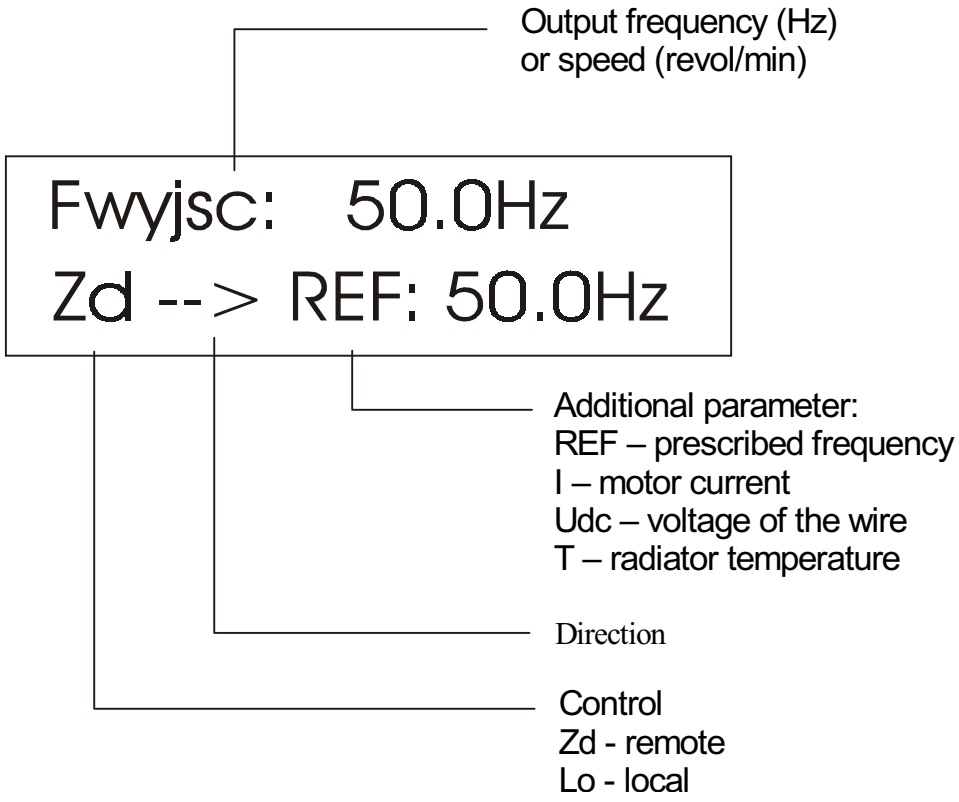


Fig. 5.3 Alphanumeric Display LCD

When the system is stopped on the display there is a message „ MFC IS STOPPED” („MFC ZATRZYMANY”), and one of four additional parameters.

5.3 Parameter review and setup

The parameters are arranged in three groups. The transition between sepaspeed groups and order operating mode is realizing with the help of „↔” button (fig.5.1).

In the mode of parameter setup it is possible to view, and also to program parameters of the device.

After loading the above named mode parameter number and its name are imaged on capline, on lower - option value. The buttons „↑”, „↓” are for parameters review.

In the system the locking of access to parameters is applied. It notifies random change of parameters by the strangers. The parameters changing is impossible without introduction of the correct code to the parameter 1.1 („ Parameter installation “/ “Ustawianie par”). Fig.5.4.a. shows the way of deblocking of access to parameters. After deblocking the system and option select, it is necessary to click the button „*” to set the parameter. The mode of parameter setup is imaged on the display [....].

The buttons „↑”, „↓” are for increase and lowering of installation of the parameter.

The example of installation changing of the **Fmin** parameter from 0.5 Hz to 0.6Hz is showed on fig. 5.5

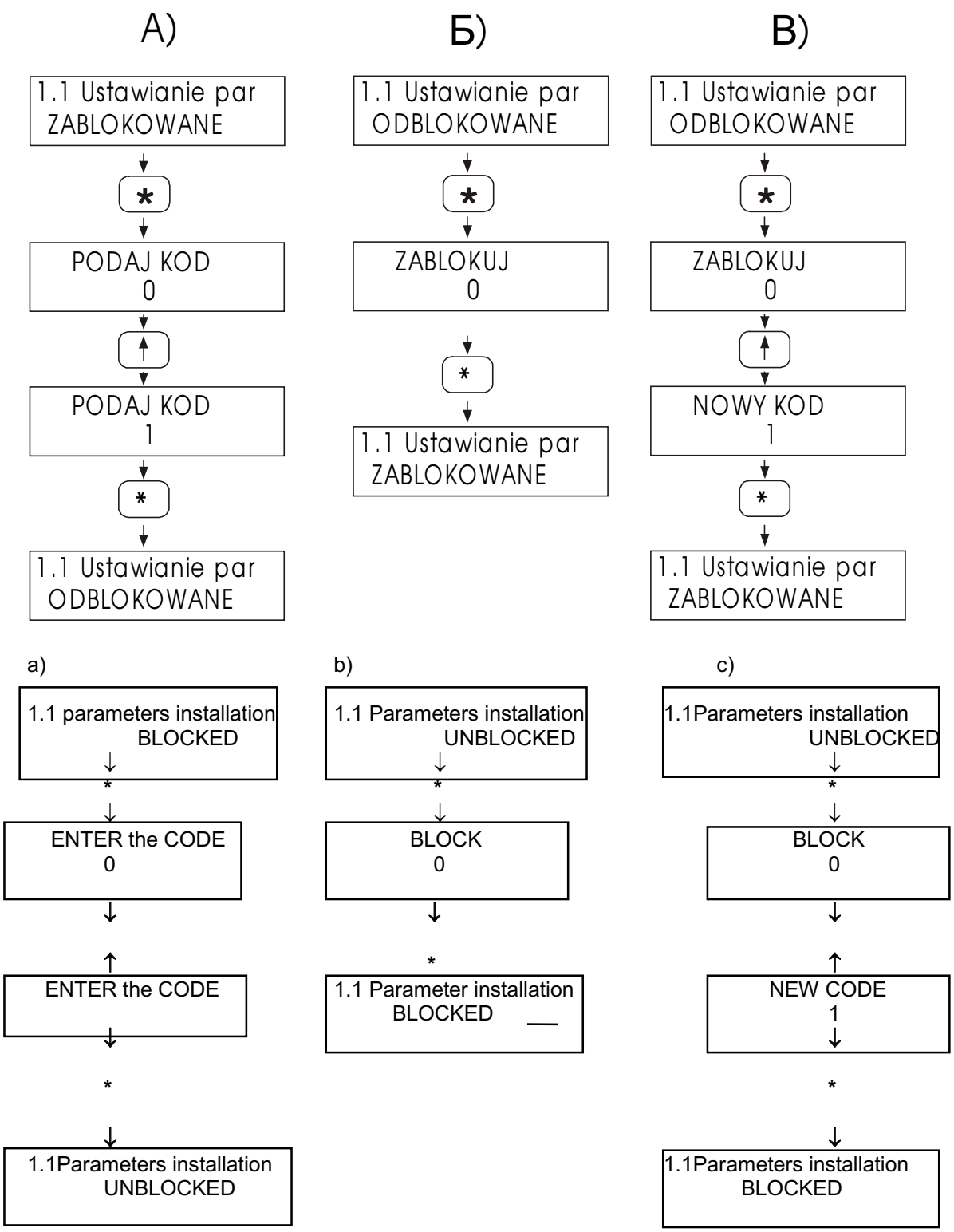
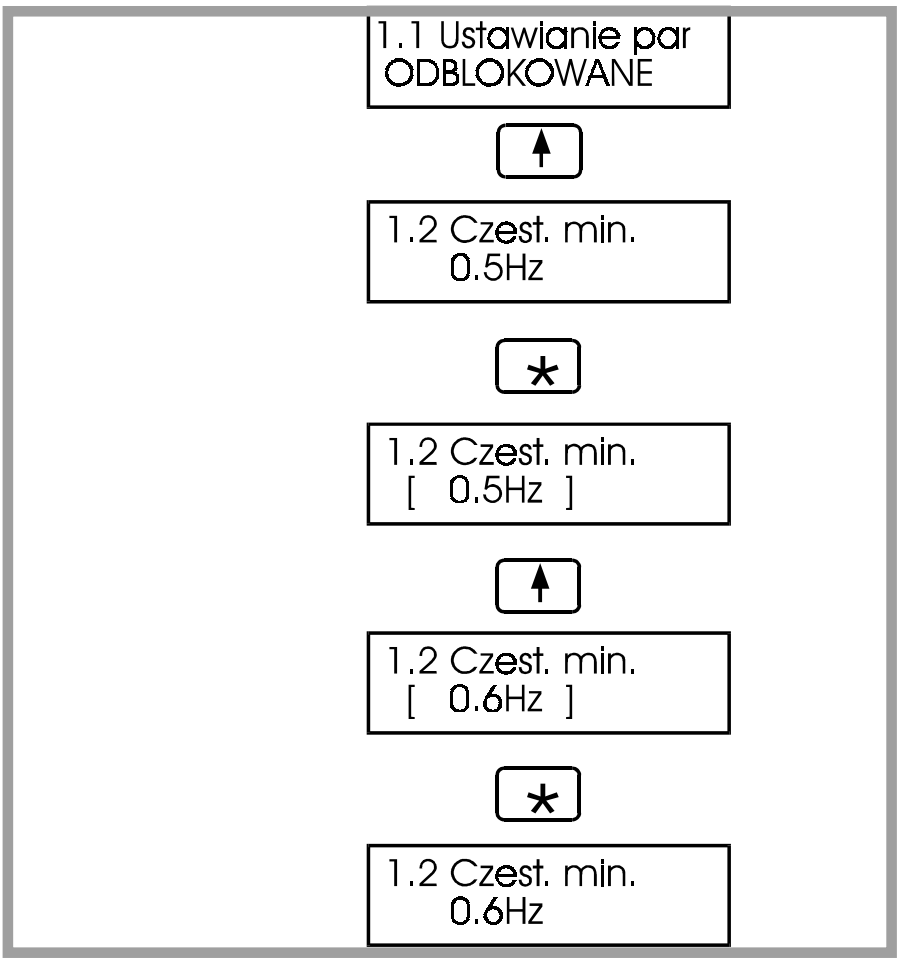


Fig. 5.4. Setting the parameter „ Parameter installation”
A) unblocking the system
B) blocking the system (without change of access code)
C) blocking the system with new access code



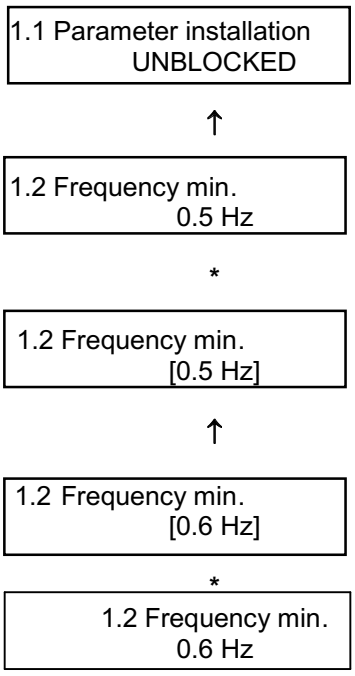


Fig. 5.5 Examples of changing the parameter installation

5.4 Abnormal state signalling

The abnormal state informs with the shining red diode LED and error message.

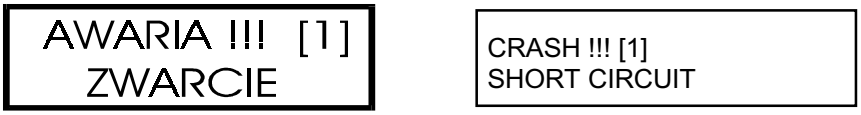


Fig. 5.6 Approximate error messages

The trouble title and amount of crashes in brackets are imaged on the display during automatic overload. The pressing "STOP" button for some seconds will delete crashes and allow to continue the next system operation.

TABLE 5.1 List of possible troubles

№	Title on the display	description	Possible reason	Troubleshooting
1	NISK. (LOW.) Udc	Low voltage in DC circuit (direct current)	Low voltage in circuit, lack of one phase.	To verify wires and level of supply voltages
2	WYS.(HIGH.) Udc	High voltage in DC circuit	Supply line voltage is above admitted, intensi-ve inhibition of a drive.	To verify a supply line. To increase time of braking par.1.5 or 1.7.
3	< I*t	Thermal overload of the drive	Operation with overload drive or long oreration with large load and small speeds.	To verify drive loading (drive current). To verify parameters of thermal drive model par. 3.10; 3.11; 3.12;
4	T>75C	Radiator temperature is higher then 75^0C	Complicated current of air, overload of the system, too heat of an environment.	To verify efficiency of ventilation (ventilators serviceability and impurity of the heat sink).
5	AW, IPM	Short circuit on an output of the system or trouble of transistor modulus	Short circuit in the drive or in its feed wire	To switch off a drive and to verify availability of a trouble. If it exists, it is necessary to inform the service office, if no – to verify isolation of wires and winding of a drive.
6	WYS.PRAD	Too high current of the drive	Too intensive start. Sharp change of drive loading.	To increase starting time of a drive
7	UST. ZEWN.	Active input of external trouble		To verify a state on a digital input(In C3 or In C4), selected as an external trouble.
8	BLAD KOM.	Error in the message between the controlling device and control and signalling panel	Interference or wire breaking which connect control panel and the system.	
9	BLAD WEJ.	The signal on an analogue input is lower 2V or 4mA	Active trouble, turnovers setting is selected from analogue input with „living zero point".	To verify voltage or current a level on an analogue input.

6. Control

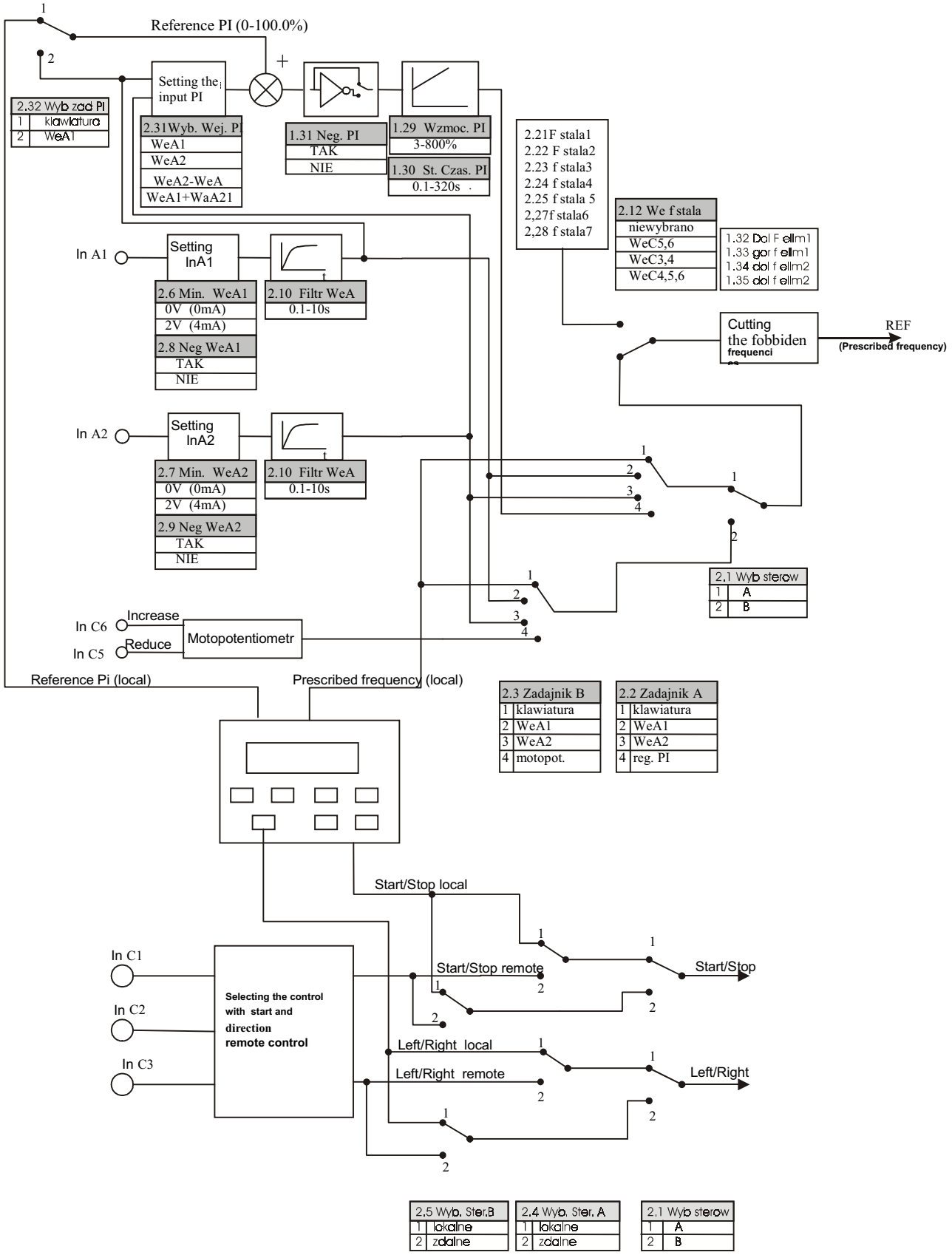


Fig.6.1 Structure of internal logic of the control system

Program keys are installed through the parameter or digital input
AFC 120 is controled from the keyboard or outside.
It is possible the blended control, namely, START from the keyboard, installation of speed from the outside or on the contrary. There is a possibility of programming two variants of control A and B. It promotes fast change of control variants A and B with the help of the parameter 2.1 or appropriate digital input.

7. Parameters

7.1 Parameters list

GROUP 1 DRIVE PARAMETERS

Par. №	Title	Description	Range	Factory installation	Changes during the operation
1.1	Installing the parameter	Access code	1-255	1	Yes
1.2	Min. frequency	Min output frequency	0.5 – 50Hz	0.5	Yes
1.3	Max. frequency	Max output frequency	25 - 200 Hz	50 Hz	Yes
1.4	Acceleration 1	Time changing of system frequency from 0 to 50 Hz	0.1 - 255 s.	5 s.	Yes
1.5	Delay 1	Time changing of system frequency from 50 to 0 Hz	0.1 - 255 s.	5 s.	Yes
1.6	Acceleration 2	Time changing of system frequency from 0 to 50 Hz for selected dynamic 2	0.1 - 255 s.	5 s.	Yes
1.7	Delay 2	Time changing of system frequency from 50 to 0 Hz for selected dynamic 2	0.1 - 255 s.	5 s.	Yes
1.8	Characteristic U/f	Selecting the characteristic U/f	linear, square-law	linear	No
1.9	U for f = 0Hz	Intensifying the moment for small rotation speeds (voltage for f = 0Hz)	0 - 40% Un	0%	Yes
1.11	f for Umax.	Frequency for max. voltage	30 - 100 Hz	50Hz	Yes
1.12	I limit.	Value of a current limiter	0 - 200% In	150% In	Yes
1.13	f carring	Frequency of transistors turning the power on and off	2.5 кHz, 5 кHz	5 кHz	No
1.14	Lower Felim1	Lower bar of cutting the frequency	0 - par 1.15	0.5 Hz	Yes
1.15	Upper Felim1	Upper bar of cutting the frequency	Par. 1.14 - 200 Hz	0.5 Hz	Yes
1.16	Lower Felim2	Lower bar of cutting the frequency	0 – par. 1.17	0.5 Hz	Yes
1.17	Upper Felim2	Upper bar of cutting the frequency	Par.1.16 - 200 Hz	0.5 Hz	Yes
1.19	Direction	Choice of operation direction or work permit with change of a direction	Left, right, return	Return	No
1.20	Stop	Stop with the help of „Limes”drive („Ramp») – reducing the frequency to zero point, and then turn off the system	(„Ramp”), run out	Run out	No
1.21	Time of bracking DC	Time of bracking with direct current	0 -255 s.	0 s.	Yes
1.22	Voltage of bracking DC	Constant strengthapplied to the drive during the bracking	0 - 22% Un	0 %	Yes
1.23	Current of a drive	Speedd current of a drive	25 - 100 %	100 %	No
1.24	Cosφ of drive	Speedd power factor of a drive	0.4 - 0.99	0.80	No
1.25	Amount of poles	Amount of poles	2, 4, 6	4	No
1.26	Speedd bracking	Speedd bracking	0 - 10 %	3 %	No
1.27	Compens. „C”	Compensation of bracking	Yes, No	No	No

1.28	Speed viewing	Selecting the speed viewing	Yes, No	No	No
1.29	Increasing PI	Instalation of increasing of regulator PI the proportional	3 - 800 %	100 %	Yes
1.30	Const. time PI integrator	Time factor of regulator PI`s integral term	0.1 - 320 sec	10 sec	Yes
1.31	Neg. PI	Negative sign of a measuring error for input PI	Yes, No	No	Yes
		GROUP 2 CONTROL			
2.1	Control place.	Selecting the control place A or B	A, B	A	No
2.2	Selecting the set-point device A	Selecting the set-point device for control place A	InA1,InA2, (WeA1)(WeA2) keyboard, self-balancing potentiometer regul. PI	keyboard	No
2.3	Selecting the set-point device B	Selecting the set-point device for control place B	InA1, InA2, keyboard, self-balancing potentiometer	InA1 (WeA1)	No
2.4	Selecting the control A	Selecting the control of stop	remote, local	local	No
2.5	Selecting the control B	Selecting the control of stop	remote, local	remote	No
2.6	Min. InA1	Min level of analogue input 1	0V (0mA) 2V (4mA)	0V (0mA)	No
2.7	Min. InA2	Min level of analogue input 2	0V (0mA) 2V (4mA)	0V (0mA)	No
2.8	Negation InA1	Negation InA1	Yes, No	No	No
2.9	Negation InA2	Negation InA2	Yes, No	No	No
2.10	Filter InA	Time constantof filter for set-point device voltage (inertial element)	0.01 s. – 10s.	0.1 s.	
2.11	START/STOP	Selecting the control type for system`s start and stop with a remote control	START/STOP LR; START_L START_R. START-Im STOP START-Im L/R.	ST/ST LR	No
2.12	In ф Constant	Digital inputs according to constant speed selecting	unselected:In C5,6; In C3,4; In C4,5,6	In C5,6 (WeC5,6)	No
2.13	Installation In C3 (WeC3)	Installation of digital input 3 function	inactive stop crash. Permis to work. Contr. A/B Troubleshooti ng. dynam.1/2 trouble utside	Outside	No
2.14	Installation InC 4	Installation of digital input 3 function 4	As in param. 2.13	inactive	No
2.16	Output K1	Installation the relay K1 function	inactive, ready to opespeed, trouble, T > 65C,operation mode, f > f supervision I>Ilim. f = f prescribed	operation	Yes
2.17	Output K2	Installation the relay K2 function	As par. 2.16	ready	Yes
2.18	Output K3	Installation the relay K3 function	As par. 2.16	Inactive	Yes
2.19	Out C4	Installation the digital output 4 function	As par. 2.16	Ф>Ф	Yes

	(WeC4)			supervision	
2.24	f supervision	Frequency which exceeding switch on the selected relay	0.5 - 200 Hz	0.5 Hz	Yes
2.25	Constant frequency 1	Programming frequencies selecting from digital input	0.5 - 200 Hz	10 Hz	Yes
2.26	Constant frequency 2		0.5 - 200 Hz	20 Hz	Yes
2.27	Constant frequency 3		0.5 - 200 Hz	30 Hz	Yes
2.28	Constant frequency 4		0.5 - 200 Hz	35 Hz	Yes
2.29	Constant frequency 5		0.5 - 200 Hz	40 Hz	Yes
2.30	Constant frequency 6		0.5 - 200 Hz	45 Hz	Yes
2.31	Constant frequency 7		0.5 - 200 Hz	50 Hz	Yes
2.32	Selec.Prescrib.PI	Selecting the source of set-point device for regulator PI	Keyboard In A1	Keyboard	No
2.33	Selec. In. PI	Selecting the regulated value of PI regulator	In A1 In A2 InA1-InA2 InA1+InA2	In A1	No
GROUP 3 PROTECTION AND TROUBLES					
3.1	TROUBLES	List of last four troubles	1-4 where: 1-last trouble; 2previous trouble,etc.		Yes
3.2	Amount of overloads	Amount of automatic system start with crash during param. 3.3	0-4	0	No
3.3	t restart	Time during which restart is possible	10-200 s.	10	Yes
3.4	Restart < Udc	Permission for restart with low voltage Udc	Yes, No	No	No
3.5	Restart > Udc	Permission for restart with high voltage Udc	Yes, No	No	No
3.6	Restart > I	Restart with exceeding of prescribed current	Yes, No	No	No
3.7	Restart >T	Restart with exceeding of radiator temperature	Yes, No	No	No
3.8	Restart >Out A	Restart with output signal range lower 2V (4mA)	Yes, No	No	No
3.9	Blocking I2*T	Blocking activation with drive protection	Yes	Yes	No
3.10	I therm. Lim.	Load is actively calculated after exceeding this current	25 - 100 %	100 %	Yes
3.11	I therm. f = 0	Valid thermal current for the stopped drive	0 - 50 %	50 %	Yes
3.12	t therm. Drive.	Constant of time for drive heating	0 - 200 min		Yes
3.13	Factory parameters	The activation of the given parameter causes loading factory installations	Yes No	No	No

7.2 PARAMETERS DESCRIPTION GROUP 1

7.2.1 Minimum and maximum frequency

Parameter 1.2 allows to installate a minimum working frequency. It is minimum frequency in stable mode of drive operation. In a starting time and operations of a current limiter the achievement of frequencies below F minimum is possible.

Parameter 1.3 is an upper bound of output frequency.

7.2.2 Parameters, defining the systems dynamic

Parameter 1.4 (Acceleration 1) and 1.6 (Acceleration 2) determine a slope of frequency changes during increasing the speed.

Parameter 1.5 (Delay 1) and 1.7 (Delay 2) concerns frequency reduction. These parameters determine time (in sec.) frequency change on 50 Hz.

The system`s dynamic is possible to change with the help In C3 (WeC3) or In C4 (WeC4). For this purpose it is necessary to install PARAMETERS 2.13 or 2.14 on the SPEAKER 1/2. If signal will be fed on a selected digital input, the device will work during time preselected by parameters 1.6 and 1.7

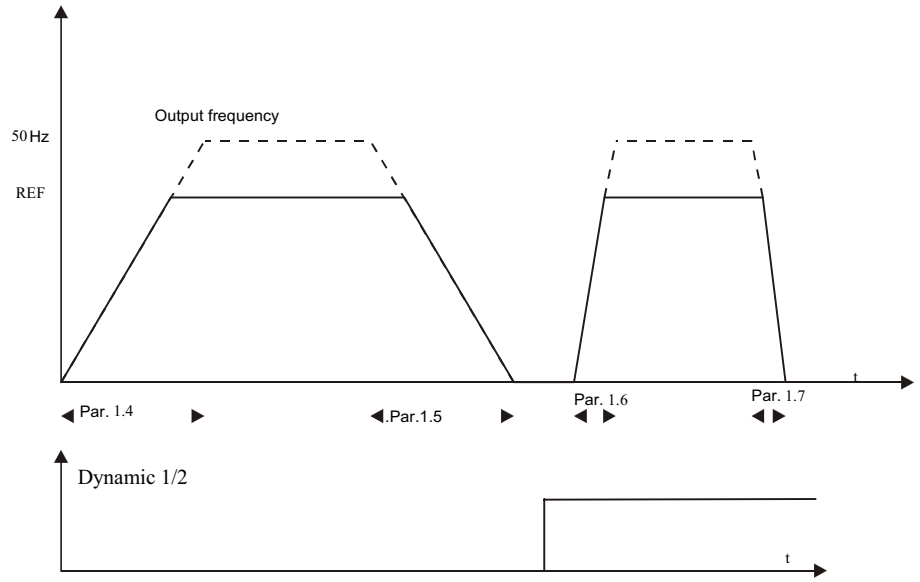


Fig.7.1 Time of accelerations and delays

7.2.3 Parameters shaping characteristic U/f

Parameter 1.8 allows to select type of characteristic U/f (linear, square-law).
The linear characteristic is applied where there is a constant moment of load depending on speed.
In case of ventilatory type loading (the moment increases proportionally to quadspeed of speed) it is useful to apply the „square-law" characteristic to reduction of hums and losses in a drive.
Parameter 1.9 is, so-called, voltage boosting for low frequencies. It allows to compensate a voltage drop on a resistance of a winding and, therefore, to increase the moment for low speeds.

- For small drives voltage of compensation can be more than for the large drives because the resistance of a winding is higher. If the loading moment is high the voltage of compensation is neccessary to instal so high as to switch on the drive. As too high voltage of compensation can reduce in overheat of a drive or overload, it is necessary to install it as low as possible.

Parameter 1.11 is a point of field weakening. It, predominantly, speedd frequency of a drive. For frequencies higher than parameter 1.11 the drive works with the reduced moment. It works only with constant power.

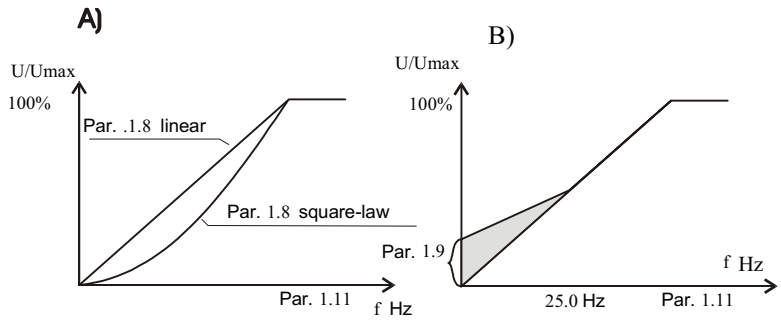


Fig. 7.2 Characteristics U/f
a) Linear and square-law characteristic
б) Voltage variation of compensation

7.2.4 Current limitation

Parameter 1.12 - sets current limitation. The parameter`s value is underlined in percentage of converter`s speedd current. The factory installation is set on 150 % of speedd current of the system.
NOTICE:
1. Speedd current of the system is not speedd current of a drive. Using the drive with lower power it is necessary to reduce installation of current limitation.
2. The operation time of current limitation is not controlled and during durable overloads there can be a disconnect of the system owing exceeding temperature of the heat sink.

If the drive load is so large that a drive current of a drive reaches parameter 1.12 setting , there is a reduction of output frequency of the system. The current regulator operating causes elongation of a starting time of the system.

7.2.5 Carrier frequency

Parameter 1.13 allows to change the frequency switching the power on and off of power transistors. It is possible to install two carrier frequencies: 2.5 κHz and 5 κHz.
For 5kHz the hum of a drive is lower, but the losses discharged in the system increase. In case of a crash caused by exceeding of temperature of the heat sink, it is necessary to reduce a carrier frequency.

7.2.6 Frequency of exceptions

In some drives it can be necessary to avoid operating the system on some output frequencies concerning problems of a resonance.
In systems it is possible to eliminate two ranges of frequencies.
Lower and upper values of frequencies are preselected for each range. For the preselected frequencies, the output frequency which is between lower and upper boundaries, compounds a low bound in case of increasing the preselected *f* or upper bound for reducing *f* (fig.7.3).

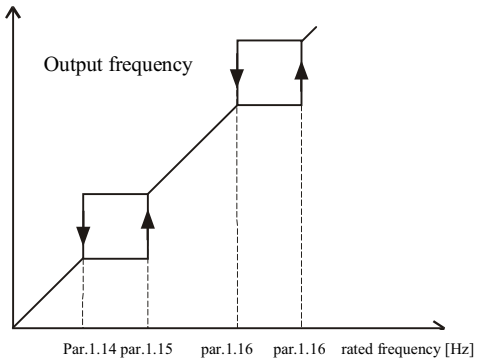


Fig. 7.3 Implementations of a clipping of a bar of frequency

7.2.7 Blocking the reversing operating method

Parameter 1.19 enables to block a reversing operating method. For this purpose this parameter should be installed depending on necessity „to the Left" („Lewo") or „ to the Right "("Prawo "). In this case, irrespective of control, the system will work only in the programmed direction.
In order to opespeed the system in two directions, the parameter should be installed on „Return" („Nawrot"). The direction of the drive will be preselected by a remote control or selected button on the control panel (local operating method)

7.2.8 Method of stopping

Parameter 1.20 determines operating method of the system. For installation „running out" („wybieg"), after the command STOP the system will switch off power, and the drive will stop with the help of running out.
For installation of „RAMP" after STOP signal the system will begin to reduce frequency, according to parameters specifying delay time up to 0.1Hz, and then will switch off an energizing. In order to reduce braking time set braking variant with the help of a direct current. For this purpose it is necessary to install value of parameters 1.21 and 1.22 on values nonzero.
The parameter 1.21 sets time of constant voltage feed, parameter 1.22 - value of constant voltage applied to a winding of a drive. The above this value, the braking more successful, but current value increases.This current is flowing through a drive and it can cause overheat. When the parameter 1.20 is setted on „Running out" („Wybieg"), after feed of STOP signal, the constant voltage moves on a drive. At variant of braking by a way of frequency reduction the constant voltage moves only when the value of frequency is 0.5 Hz.

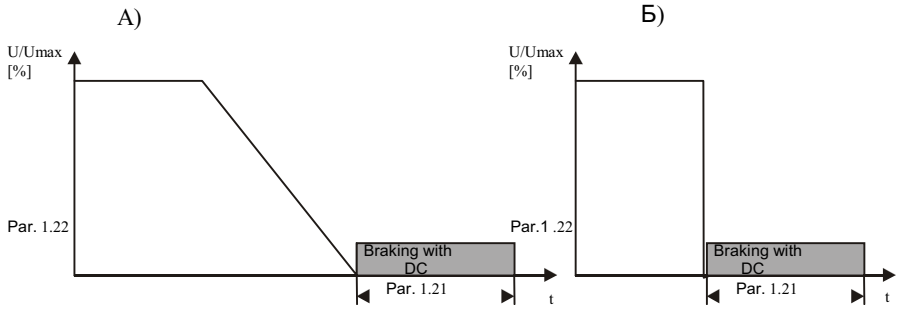


Fig. 7.4 Braking with the help of direct current
a) Stopping „RAMP" b) Stopping „RUNNING OUT» („WYBIEG»)

7.2.9 Ratings of a drive

On a base of drive`s shield it is necessary to define speedd current, $\cos_{\varphi n}$, and on a base of speedd speed - to define an amount of poles pairs.
Parameter 1.23 - speedd current of a drive in percentage of converter`s speedd current;
Parameter 1.24 - speedd capacity factor of a drive $\cos_{\varphi n}$.
It is necessary to enter an amount of poles in **parameter 1.25**. In the table the amount of poles is showed depending on synchronous speed. The synchronous speed can be installed accepting the closest speed to speedd speed.

THE TABLE

Synchronous speed	Amount of poles
3000	2
1500	4
1000	6
750	8

Parameter 1.26 represents speedd slipping of a drive; it is calculated under the formula:

$$Sn = \frac{(ns - nn) * 100\ \%}{Ns}$$

7.2.10 Compensation of slipping

If parameter 1.27 is setted on „SO", the device works with compensation of slipping. Output frequency will increase so that the constant speed of a drive was saved at lo9ading changes

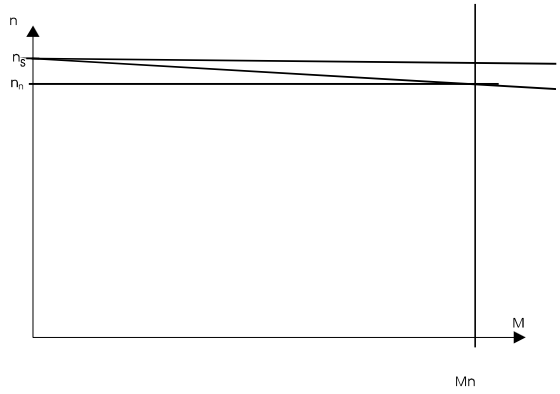


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Fig. 7.5. Dependence of drive speed on the loading moment
a). The system without compensation of slipping
b). The system with compensation of slipping

7.2.11. Indicating the output speed

You may specify speed in turnovers per minute. Parameter 1.28 should be installed on „SO". Then, at a mode indication, instead of output frequency, the speed in turnovers per minute will be indicated.
NOTICE: this speed is defined by listing output frequency and don`t concern to changes implied from a drive load.

7.2.12. Installating the parameters regulator PI

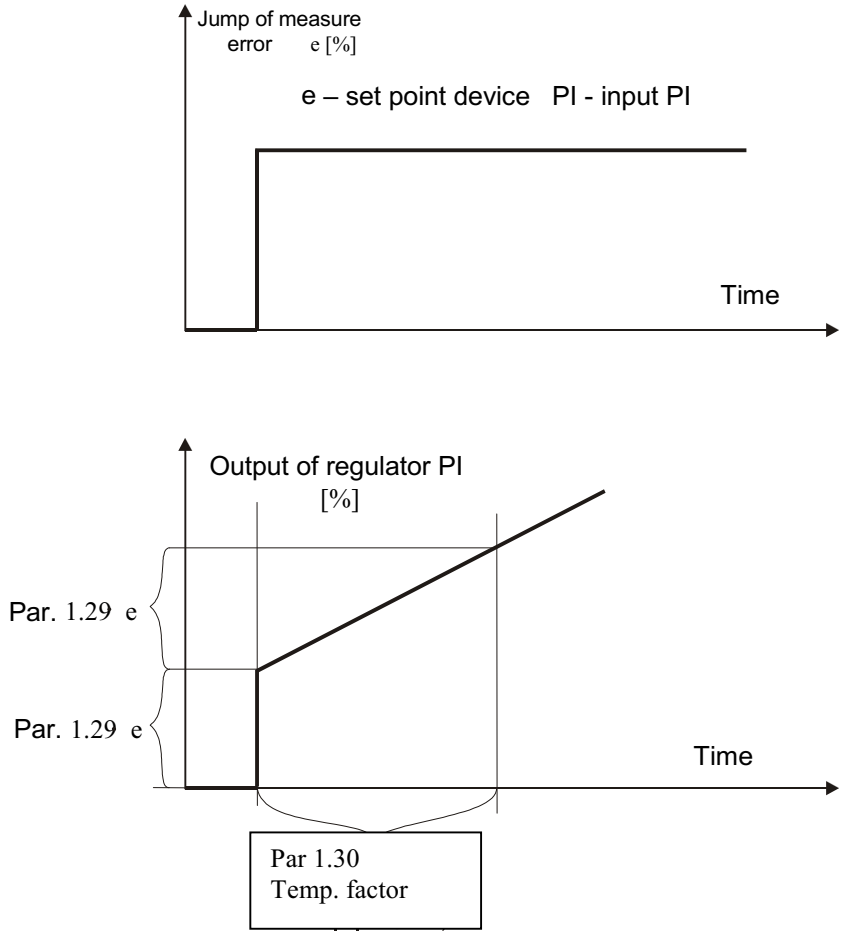

Fig. 7.6. An output of a regulator PI for jump-in change of a measuring error

Parameter 1.29 allows installation of increasing of the proportional term of a regulator and parameter 1.30 defines constant factor of a regulator PI.
The Fig. 7.6 represents the answer of a regulator PI on a jump of a measuring error (measuring error - difference between the speedd value and regulated value.
With help of parameter 1.31 you may change the sign of a measuring error. Setting this parameter on "negative" measuring error gives the reduction of output frequency. In this case 100% of an output regulator PI gives the min. frequency and 0 % - max. frequency

7.3 Parameters description GROUP 2 (Control parameters)

7.3.1 Selecting the control place and control-point setting device (control element)

Parameter 2.1 (control place) defines control variants of A or B. It is possible to set two independent control variants, sepaspeedly for place A and place B, and the fast change of variants with the help of parameter 2.1 or, if any of the digital inputs In C3 or In C4 („WeC3", „WeC4") is programmed on „ control. A/B"(" ster A/B"), by state changing on a digital input.
EXAMPLE:

For control A the control and control-point setting device (control element) are preselected from an analogue input, and for a place B - control-point setting device from an analogue input, and control from digital inputs. In this case the programmed input „ control. A/B" („ ster A/B") is for change of control from remote to local.

Parameter 2.2 allows to define the type of frequency-point setting device for a place A.
It is possible to select:

- One of two analogue inputs In A1 or In A2 (WeA1, WeA2);
- Frequency-point setting generator from the keyboard, installation by buttons „↑”,”↓ “;
- Output of a regulator PI

Parameter 2.3 defines a source speed-point setting device for control place B.

- One of two analogue inputs In A1 or In A2 (We A1, We A2)
- Setting-point device from the keyboard, installation by buttons „↑”,”↓“;
- Drive-potentiometer, installation of speeds with the help of digital inputs In C5, In C6 (We C5, We C6) according to the table:

In C5 (WEC5)	In C6 (WEC6)	Preselected frequency
0	0	Without changes
1	0	Increas.
0	1	Reduc.
1	1	Without changes

Parameter 2.4 is for definition of a control place for start and direction of engine operation for operation place A.
Control type:

- „Remote” („Zdalne”) (start, stop and direction from digital inputs), or
- „Local” („Lokalne”) (control from control panel and signalling).

Parameter 2.5 – the same, only for control place B.

7.3.2 Installationthe setting-point device from analogue inputs

With the help of parameters 2.6 and 2.8 it is possible to define the characteristic of the preselected frequency from a level of an analogue input InA1 (WeA1). The size of changes for level of inputs covers changes of output frequency from min to max.

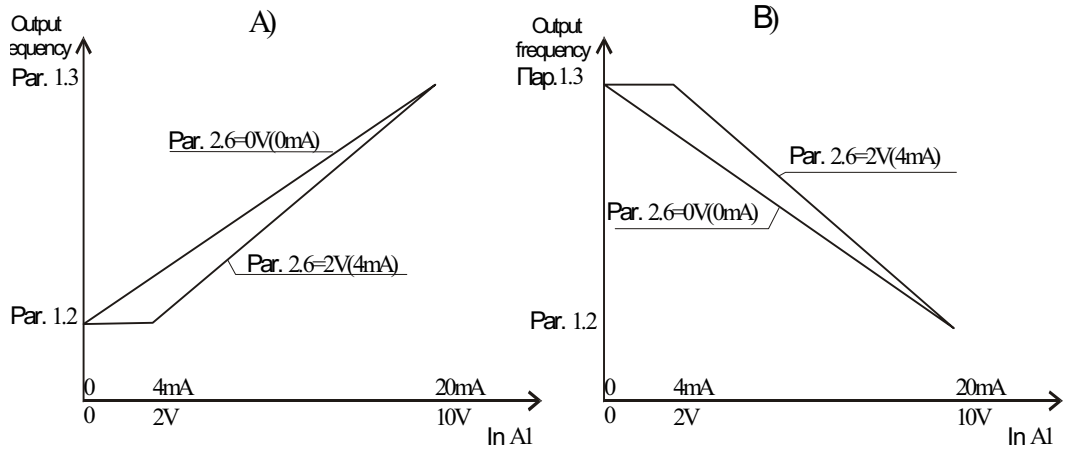

Fig. 7.7 Control characteristics
a) Parameter 2.8 Eg InA1 (WeA1): NO („NIE”)
b) Parameter 2.8 Eg InA1 (WeA1): YES („TAK”)

Parameters 2.8 and 2.9 – the same, for InA2 (WEA2).
Parameter 2.10 is for installation of a constant for time of a filter for analogue inputs, it allows to filtspeed interferences of an input signal.

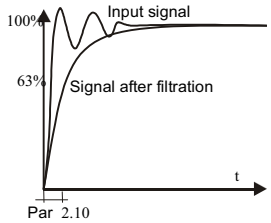

Fig. 7.8 Filtrating the signal from an analogue input

7.3.3 Selecting the method of a system control for remote operation

Parameter 2.11 allows to program functions of digital inputs for realization of start and direction choice of engine operation.
Possible installations

- ST/STOP LR InC1 (ST/STOP LP WeC1)is for the start / stop, InC2 (START/STOP, WeC2) is for change of a direction (Fig.7.9 a);
- ST _ L ST _ R, InC1-Start ON THE LEFT, InC2-STOP TO THE RIGHT (ST _ L ST-P. WeC1-START W LEWO, WeC2-START W PRAWO) (Fig.7.9 b);
- ST –IM STOP InC1 - pulse start / InC2-STOP (ST-IM STOP WeC1-IS/WeC2-STOP) (Fig. 7.9 в);
- ST-IM L/R InC1, InC2 - as above, InC3 - choice of a direction (ST-IM L/P. WeC1, WeC2 WeC3) (Fig.7.9. d)

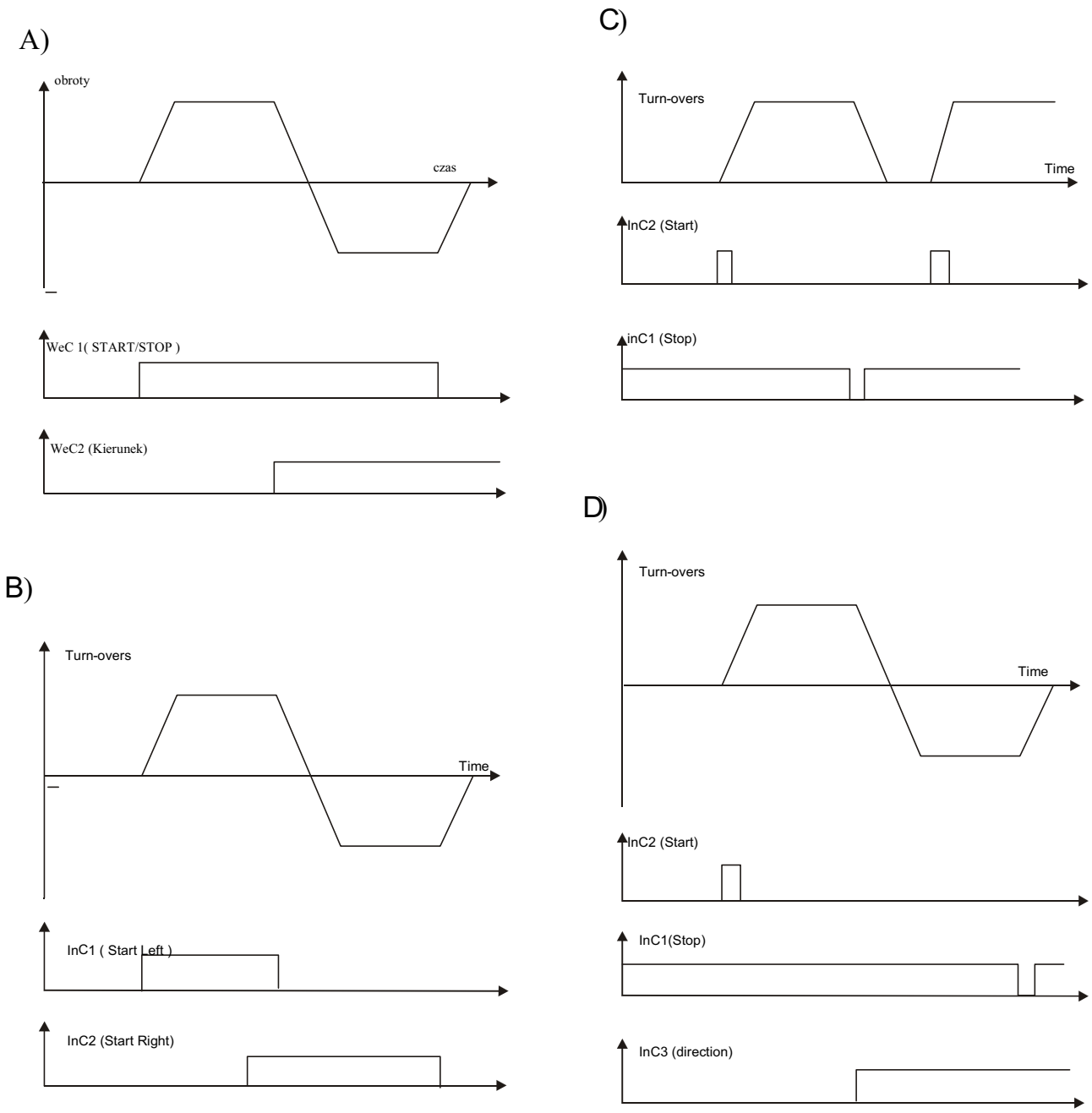

Fig. 7.9 Control from a clamping rod
a) Parameter 2.11 „ ST/STOP LR" („ ST/STOP LP ")
b) Parameter 2.11 „ ST _ L ST _ R" („ ST _ L ST _ P »)
c) Parameter 2.11 „ ST-IM STOP" („ ST-Im STOP")
d) Parameter 2.11 „ ST-IM L/R"(„ ST- Im L/P ")

7.3.4 Selecting the constant speeds

The system allows to select three or seven programmed speeds with the help of a combination of digital inputs. The output frequency appropriate to the given speed, is set according to following parameters.
TABLE 7.2

The parameter 2.25	Constant frequency 1
The parameter 2.26	Constant frequency 2
The parameter 2.27	Constant frequency 3

The parameter 2.28 Constant frequency 4
The parameter 2.29 Constant frequency 5
The parameter 2.30 Constant frequency 6
The parameter 2.31 Constant frequency 7

Parameter 2.12 „ In φ constant" („ We f stale ») puts digital inputs according to choice of constant speed.

The installation of the parameter includes:

- „ Not selected" („ Nie wybrane ") - the constant frequencies are not selected;
- „In C5,6" („WeC5,6") - possibility of selecting three speeds with the help In C5 (WeC5) and In C6 (WeC6);
- In C3,4 "(WeC3,4 ") - possibility of selecting three speeds with the help In C3 (WeC3) and In C4 (WeC4).

TABLE 7.3

In C6 (WEC6) /In C4 (WEC4)	In C5 (WEC5) /In C3 (WEC3)	Constant frequency
0	0	Not selected
0	1	Constant frequency 1
1	0	Constant frequency 2
1	1	Constant frequency 3

- „In C4,5,6" („WeC4,5,6") - possibility of selecting seven speeds with the help In C4, In C5 and In C6 (WeC4, WeC5, WeC6).

TABLE 7.4

In C6 (WEC6)	In C5 (WEC5)	In C4 (WEC4)	Constant frequency
0	0	0	Not selected
0	0	1	Constant frequency 1
0	1	0	Constant frequency 2
0	1	1	Constant frequency 3
1	0	0	Constant frequency 4
1	0	1	Constant frequency 5
1	1	0	Constant frequency 6
1	1	1	Constant frequency 7

7.3.5 Installations of programming inputs InC3 and InC4 (WeC3, WeC4)

If In C3 (WEC3) and In C4 (WEC4) were not used for choice of constant speeds or In C3 (WEC3) for control direction of operating method, it is possible to program accessory functions for these inputs.

Parameter 2.13 allows to install a digital input In C3 (WeC3).

TABLE 7.5

Parameter 2.13 installation Description	Description Digital input not selected
Inactive (Nieaktywne)	Digital input not selected
Stop Crash (Stop awar.)	1 – Immediate stopping of system operation (running out)
The permission on operating method (Zezwolenie Pr.)	Permission on operating method (0-does operation impossible)

Contr. A/B (ster. A/B)	Change of control place (0-A; 1-B)
Troubleshooting (kasow.ust.)	Troubleshooting (the change 0 on 1 remedies and allows to restart system operation)
Dynam. 1/2	0- choices of acceleration 1, delay 1 1- choices of acceleration 2, delay 2

0 - Means low voltage on a digital input (disconnected);
1 - Means high tvoltage on a digital input (connection InC to 24V)

Parameter 2.14 the same to installation In 4 (WeC4)

7.3.6 Installation of relay outputs and digital output

Parameter 2.16 defines correspondence to a relay K1 (Table)

TABLE 7.6

Installation of parameter 2.16	Description
Inactive (Nieaktywny)	The relay is not utilised
Ready(Gotowy)	Switched on – ready for operation of the system
Trouble (usterka)	K1 is switched on, when crash will be
The operating method (praca)	K1 is switched on, when voltage is on a drive
T> 650C	Message about high temperature of the heat sink
I> Ilim	Operating method with an active current limiter
f = F zad	Achievement of the preselected frequency
f> Nadzoru	Achievement of frequency of supervision, written in parameter 2.24 (symmetrical hystereses + - 0.5Hz)

Parameter 2.17 is set similarly in correspondence to a relay K2, parameter 2.18 - relay K3. The parameter 2.20 allows to select the function of a digital output Out C1 (WyC1) (output with an open / free header).

7.3.7. Configuration of a regulator PI

For installation of regulated method of operating you need to select a control place A (parameter 2.1) and in the parameter 2.2 to install „ reg. PI".
The parameter 2.32 allows choice of rated value for a regulator PI. You may instal setting-point device from the keyboard or with analogue input In A1 (We A1). Setting-point device can changed in limits 0 - 100%.
The regulator PI task is a deduction of an input signal at a level of rated value. Values of an input signal can be configurated with the help of parameter 2.33:

- In A1 (We A1) - the signal moves on an input In A1 (We A1) with parameters defining In A1 / We A1 (par. 2.6, par. 2.8, par. 2.10)
- In A2 (We A2) - the signal moves on an input In A2 (We A2) with parameters defining In A2 / We A2 (par. 2.7, par. 2.9, par. 2.10)
- In A1 - In A2 (We A1 - We A2) - regulated value is a difference of analogue inputs
- In A1 - In A2 (We A1 - We A2) - regulated value is a difference of analogue inputs divided to 2.

7.4. GROUP 3 Preservations / protection

7.4.1 Troubles list

In the **parameter 3.1** 4 last troubles are saved. The index 1 means last trouble. The further indexes fix the previous troubles, namely, 4 means the earliest trouble.

7.4.2 Automatic restart

If the system will stop because of a trouble, there is a possibility of automatic restarting of operation after disappearance of a reason of device stopping. The parameter 3.2 (the amount of reloads) defines valid amount of starts in time preselected by the parameter 3.3.

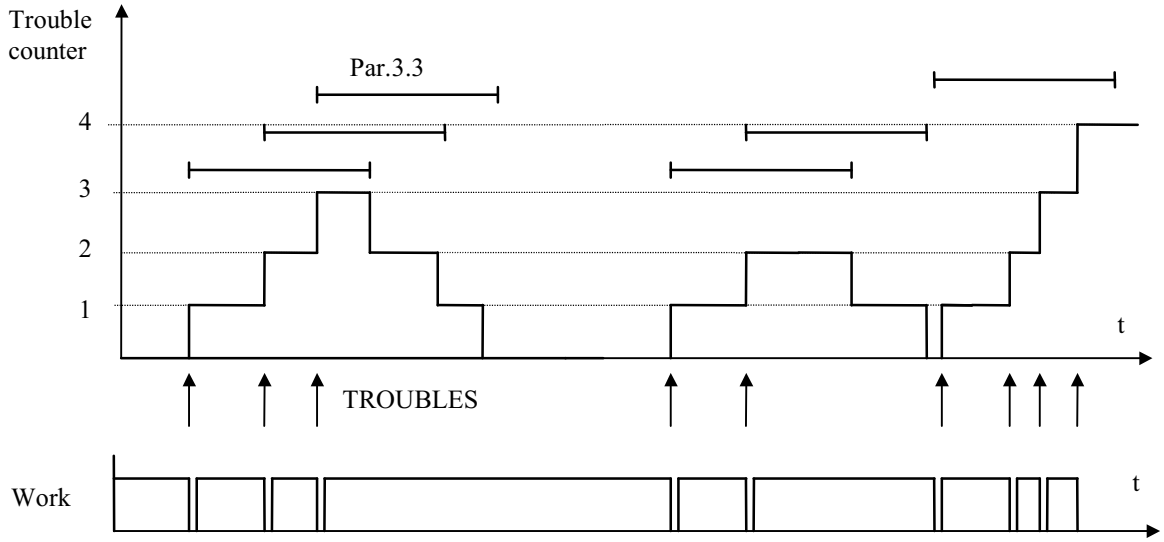

Fig.7.10 Automatic restoration of operating method at three reloads

The internal counter countstroubles. If in time preselected by the parameter 3.3, the amount of troubles exceeds the established amount of reloads, the device will not restore automatically method of operating. For restoration of operation it is necessary to remedy, pressing the button STOP on control panel or giving a signal on a digital input programmed for troubleshooting, or it is necessary to switch off the system and again to switch on.
The parameter 3.4 allows to reload the system after a trouble as a result of low tension feed.
The parameter 3.5 allows to reload the system after a trouble as a result of high tension of a dc circuit.
The parameter 3.6 allows to reload the system after a trouble as a result of a high output current.
The parameter 3.7 allows to reload the system after a trouble as a result of exceeding temperature of the heat sink.
The parameter 3.8 allows to reload the system after a trouble as a result of a low analogue input (operation 2V (4mA) – 10V (20mA)).

7.4.3 Thermal protection of a drive

The built-in thermal model allows theoretically to calculate temperature of a drive.
The model is developed with the following suppositions:

- Ex-potential increase of winding temperature;
- Availability of maximum temperature for constant work at rated current of a drive;
- The increase of temperature depends on the ratio (I/In) 2;

- The constant of chilling for the stopped drive twice is more, than in an operating time.

The durable current of a drive (f> 25 Hz) is defined with the parameter 3.10.
For low frequencies the valid durable current of a drive is lower, as the standard drive is chilled by a ventilator arranged on the shaft and then chilling is less.

The drive load can be shaped under the characteristic, introduced in a fig. 8.8. In a cooling-off period of a drive without accessory cooling it is necessary to set the Parameter 3.11 on 35 % of a current of a drive. At application of a drive with accessory cooling, this parameter can be augmented, for example, up to 75 % of a current of a drive.

One of the main parameters is the parameter 3.12, specifying a constant of drive heat. This parameter defines time, during which the increase of temperature of a drive achieves 63 % of final temperature increasing.
In practice time may be:
Par. 3.12 = 2*t6 of [min]. (t6 [sec.] is indicated by the manufacturer of drives).

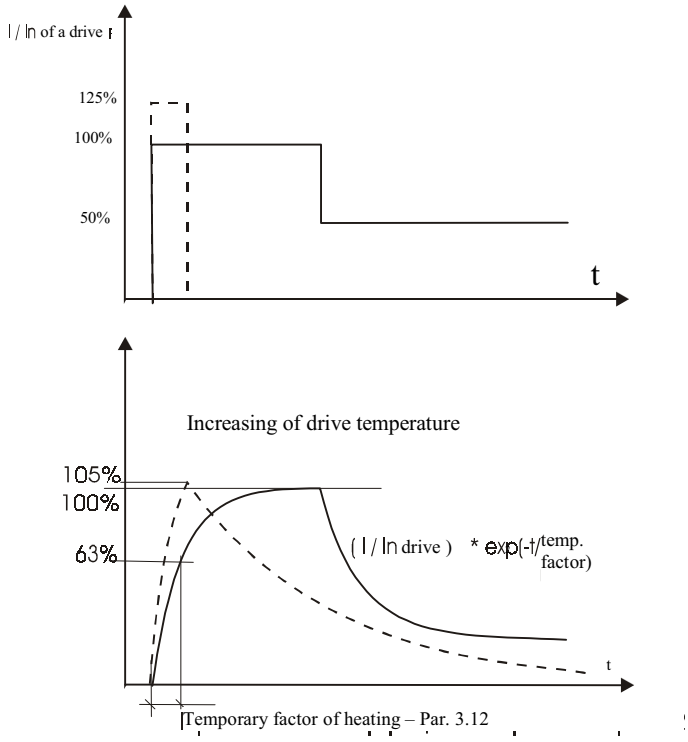

Fig. 7.11 Drive heatings (model, used in the system)
Dashed line - turn off of the scheme I = 1,25 In of a drive

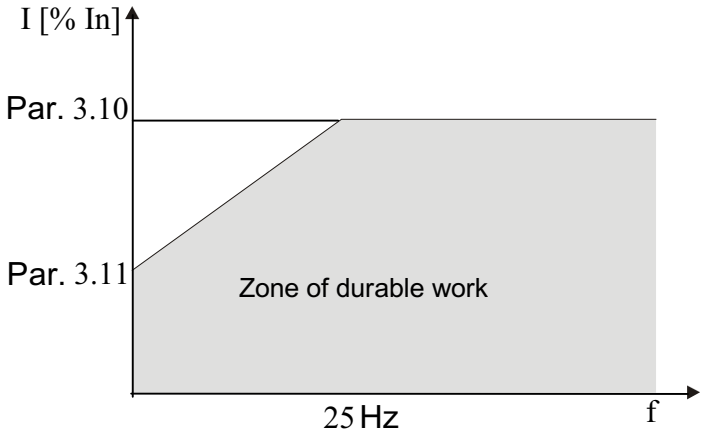

Fig. 7.12 Characteristics of a drive load
For operation with an external ventilator the steam 3.11 is necessary
To place(install) on 70 % In, without a ventilator - on 35 % In.

7.4.4 Installation of factory datas

After starting of the parameter 3.13 „ Par fabr" and turn it on YES (TAK) the parameters of a converter will load on factory installations.