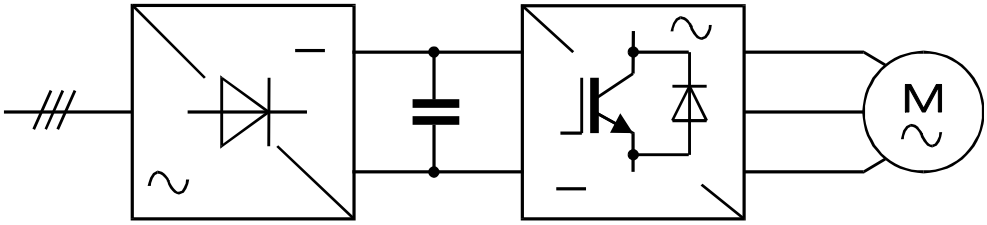
ZAKŁAD ENERGOELEKTRONIKI

mgr inż. MICHAŁ TWERD



FREQUENCY CONVERTER

type

MFC 310

The description

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1. GENERAL DESCRIPTION

The frequency converter MFC 310 series are intended for rate regulation of non-synchronic three-phase drives rotating by power from 18 to 110 kW and rated voltage 380 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 transistor IGBT-modules of FUJI Company. Controlling the modulation of output voltage is realising 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 stabilised 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 immunity of the microsystem.

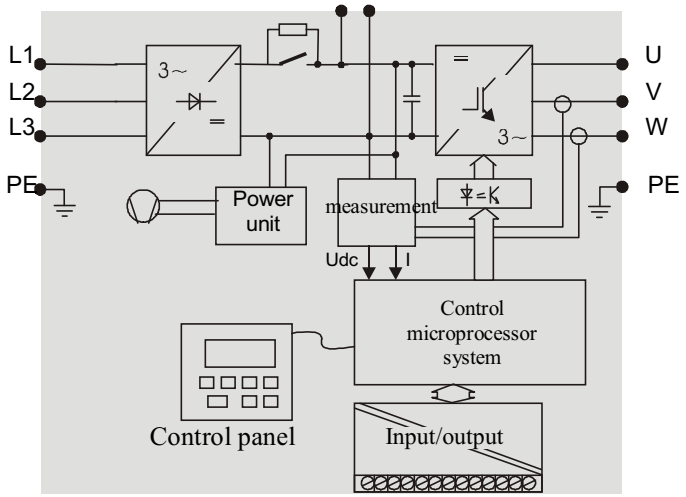


Fig.1.1 Structure diagram of the system

Power value -10 V 0/2 or current values 0 / 4 - 20 mA can control the converter. 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 computer 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 DC stage;
- undervoltage on an DC stage;
- 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 MFC 310is connected to the supply line.
- Don't connect voltage of the supply line to output clamps U V W.
- Don't measure the possible voltage of any units devices.
- To measure the cables isolation it is necessary to disconnect them from the converter.
- Don't touch integrated 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 Antistrike 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 Power and sizes of the converter.

Type of the frequency convector					Overload current 60s. each 10 min (A)	Sizes (mm) width x height x depth
	Drive power (kW)	Nominal output current (A)	Drive power (kW)	Nominal output current (A)		
MFC 310-18.5	18.5	39	22	45	60	220x450x227
MFC 310-22	22	45	30	60	68	220x450x227
MFC 310-30	30	60	37	75	90	225x600x250
MFC 310-37	37	75	45	90	112	225x600x250
MFC 310-45	45	90	55	105	135	225x600x250
MFC 310-55	55	110	75	150	165	360x680x270
MFC 310-75	70	150	90	170	225	360x860x270
MFC 310-90	90	180	110	210	270	360x860x270
MFC310-110	110	210	132	250	315	434x955x270
MFC310-132	132	250	160	310	375	575x1020x290
MFC310-160	160	310	180	385	465	575x1020x290
MFC310-200	200	380	250	460	570	700x1410x430
MFC310-250	250	460	315	570	690	700x1410x430
MFC310-315	315	570	355	680	850	700x1410x430

TABLE 3.2 Specification, common for all series MFC 310.

Power	Supply voltage U_{in}	380 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 кHz
	Installation the frequency	Analog 10 - bit, Accuracy 1% Distributing ability 0.1 Hz
Controlling inputs/outputs	Analogue inputs	Two inputs: 0(2)-10 V or 0(4)-20 mA
	Digital inputs	Six inputs 15-24 V
	Analogue output	0(2)-10V, 0(4)-20 mA 8-bit +-1%
	Digital output (with an open collector)	100мА, 24В
	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	Instantaneous value 3.6 In Effective value. 2.55 In 1,47 x UIn (UIn = 380 V) (Udc>750 V) 0.65xUin $T > 75^0C$

4. CONNECTING

4.1 Connecting the power circuit

MFC 310 is powered from the three-phase supply line 3 x 380 V. The application of four-conductor wire in the screen (3 phases + ground 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 picking up depending on an output current of the system. The recommended values are showed in table 4.1.

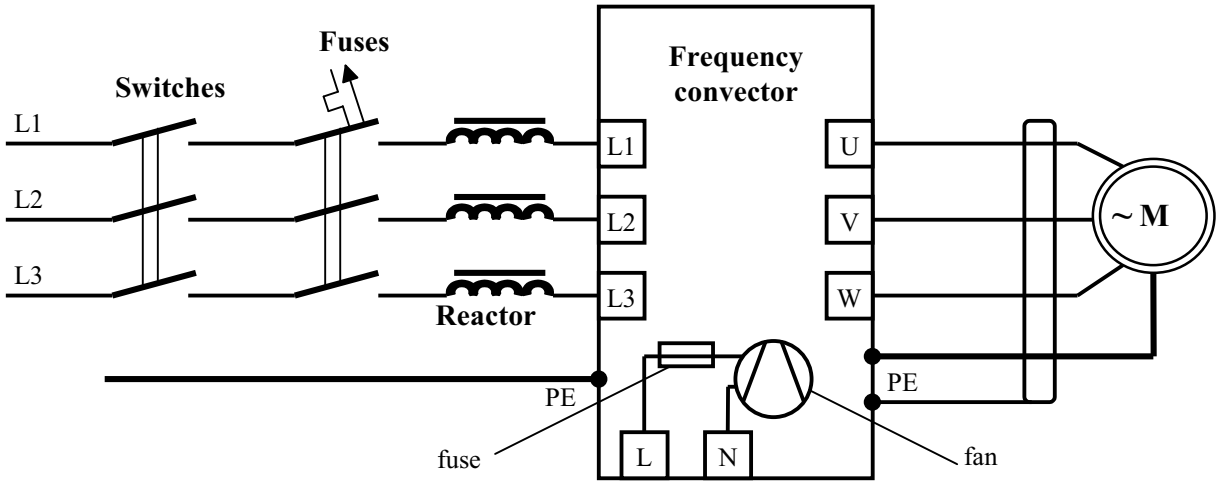


Fig. 4.1 Connections of a power circuit

NOTICE: Inner fan with power equal or greater than 30 kW is supplied with voltage 220 V from additional chassis connector L, N

Table 4.1. Fuses and network wire.

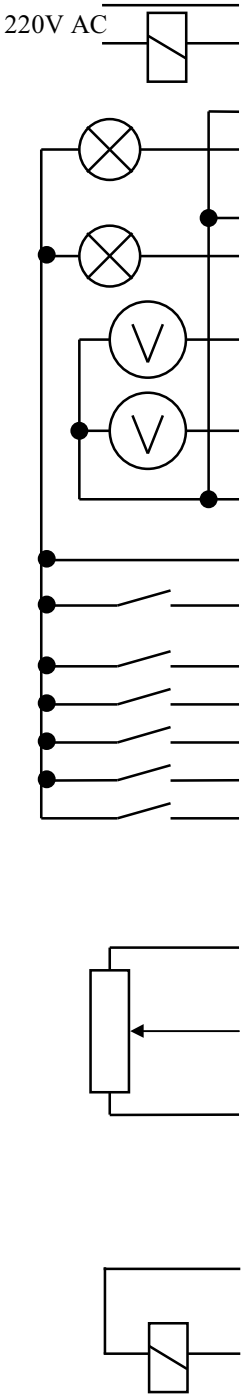
Converter type	Rated current [A]	Protection [A]	Wire [mm^2]	Reactor
MFC 310-18.5	39	50	3 x 10 + 10	3 x 45 A 3 x 0.7 mH
MFC 310-22	45	50	3 x 10 + 10	3 x 45 A 3 x 0.7 mH
MFC 310-30	60	63	3 x 16 + 16	3 x 80 A 3 x 0.4 mH
MFC 310-37	75	80	3 x 25 + 25	3 x 80 A 3 x 0.4 mH
MFC 310-45	90	100	3 x 25 + 25	3 x 100 A 3 x 0.2 mH
MFC 310-55	110	120	3 x 35 + 25	3 x 130 A 3 x 0.1 mH
MFC 310-75	150	180	3 x 50 + 35	3 x 150 A 3 x 0.1 mH
MFC 310-90	180	200	3 x 50 + 35	3 x 180 A 3 x 0.07 mH
MFC 310-110	210	250	3 x 75 + 50	3 x 220 A 3 x 0.06 mH
MFC 310-132	250	315	3 x 95 + 75	3 x 260 A 3 x 0.05 mH
MFC 310-160	310	350	3 x 120 + 95	3 x 320 A 3 x 0.04 mH
MFC 310-200	380	400	3 x 185 + 120	3 x 400 A 3 x 0.03 mH
MFC 310-250	460	500	3 x 240 + 185	3 x 500 A 3 x 0.025 mH
MFC 310-315	570	630	3 x 300 + 240	3 x 630 A 3 x 0.02 mH

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 Controlling connections

Fig.4.2 Connection of controlling wires (factory installation)



№	Title	Description	Factory installation
		Plug X1	
1		Programming	
2		Relay output 1	Operation
3			
4		Programming	
5		Relay output 2	Ready
6			
7		Programming	
8		Relay output 3	Troubles
9			
10	OutputA2 [WyA2]	Analogue output 2 Output level 0(2) – 10V or 0(4) – 20mA	0 – 10V output current with 10V max current of convector is 2x Inominal
11	OutputA1 [WyA1]	Analogue output 1 Output level 0(2) – 10V or 0(4) – 20mA	0 – 10V output frequency with 10V max frequency is at the convector's output
12	GND	Mass of analogue outputs	
13	24 V	Voltage 24V DC (direct current) max. 100 mA	
14	InC6 [WeC6]	Programming digital inputs	Choice of the selected frequency
15	InC5 [WeC5]		Choice of the selected frequency
16	InC4 [WeC4]		Unused
17	InC3 [WeC3]		Inside fault
18	InC2 [WeC2]		LEFT / RIGHT
19	InC1 [WeC1]		START/STOP
20	InA2 [WeA2]	Analogue Input 2 Input level 0(2) – 10V or 0(4) – 20mA	Unused
21	GND	Mass of analogue inputs	
22	InA1 [WeA1]	Analogue Input 1 Input level 0(2) – 10V or 0(4) – 20mA	Installation of frequency for controlling through channel B
23	Uref	Matching voltage for potentiometer 10V DC (max. 10мА) potentiometer 1kΩ<R<10kΩ	
		Plug X1A	
1	24 V		
2	OutC1 [WyC1]	Programming output (open collector type)	Exceeding of the selected frequency

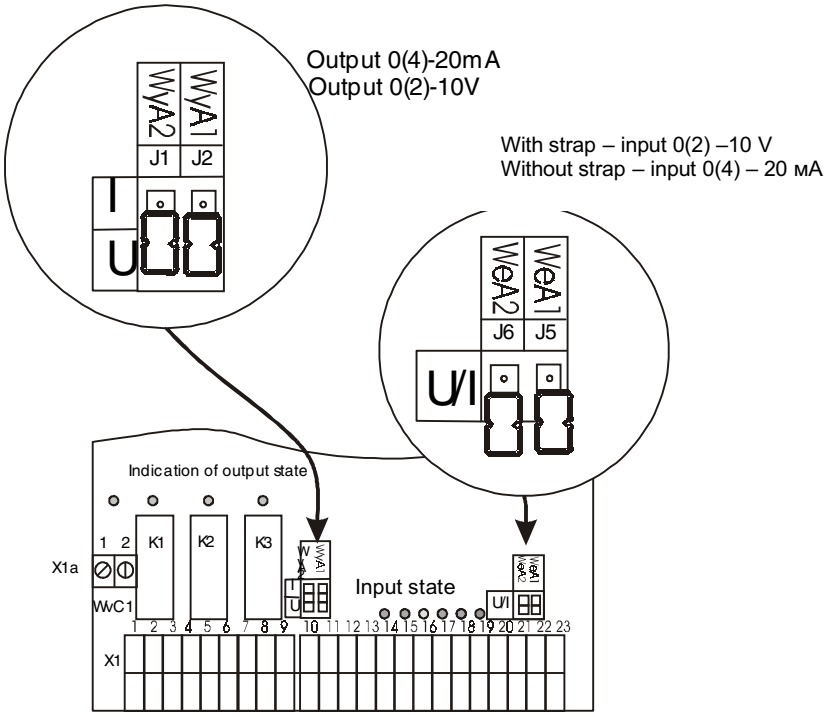


Fig. 4.3 Layout of plugs and switches

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.

The Table 4.2 shows controlling connections and established parameters appropriating to factory installations.

The input C3 [WeC3] is programmed under contact of an external fault. The closed contact is caused a stop with a IF and appearance of the message about an external crash. It can be utilized, for example, as contact from a relay thermal protection of a drive.

The inputs C5 [WeC5] and C6 [WeC6] enable of choice of the selected constant frequencies.

As an example usage of internal relays K1-K3 is indicated. They can control a chain fed from the internal power supply 24 V DC (100 mA) or from other source with power no more then 220 V AC.

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.

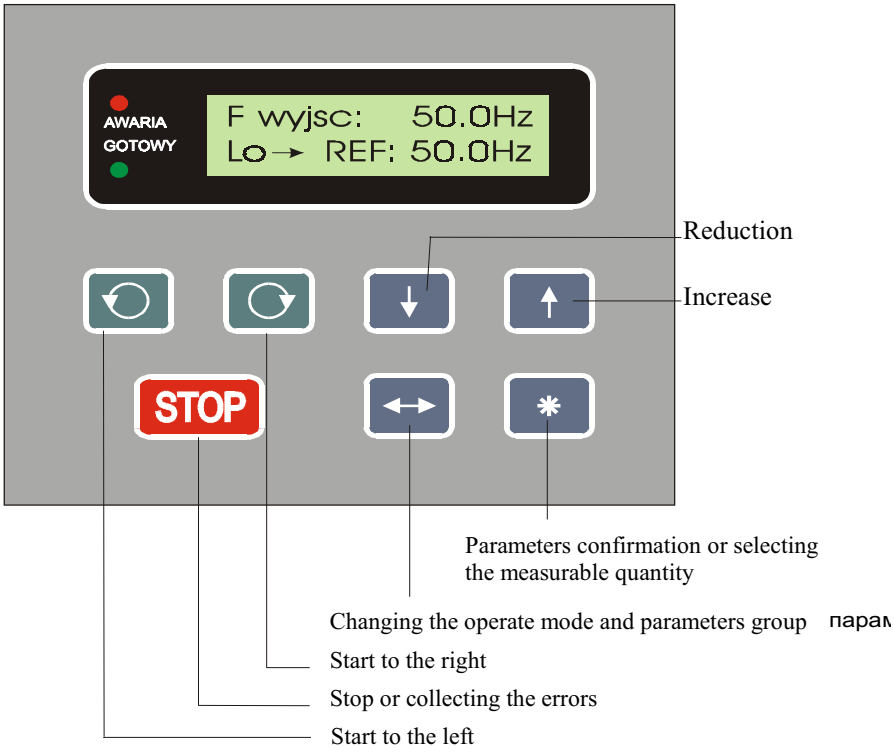


Fig. 5.1 Control and Signalling Panels

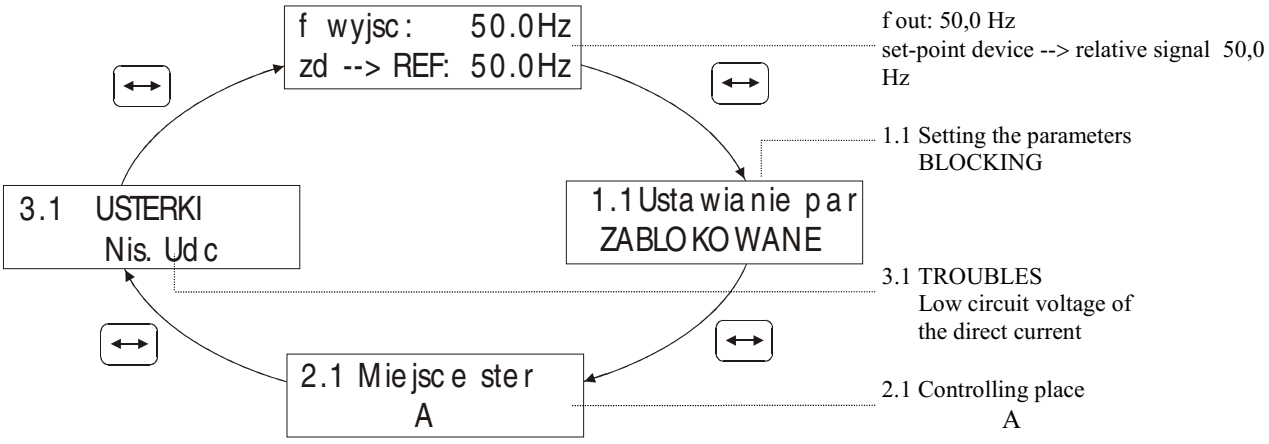


Fig. 5.2 Changes of operation mode mapping on mapping of three parameter groups

5.2 Parameters of operation mode.

A working frequency, rotating direction, control type (remote [zdalne] or local [lokalne]), and also one of below enumerated parameters are showed on the display:

REF - selected output frequency
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.

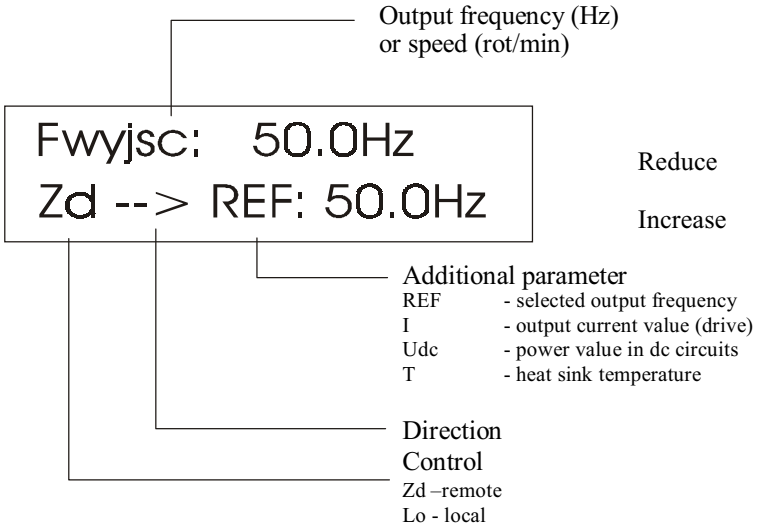


Fig. 5.3 Alphanumeric LCD Display

When the system is stopped the message „ MFC IS STOPPED», („MFC ZATRZYMANY») and also one of four additional parameters will appear on the display.

5.3 Parameters review and set-up

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

In the mode of parameter set-up 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 setting for the **Fmin** parameter from 0.5 Hz to 0.6Hz is showed on fig. 5.5

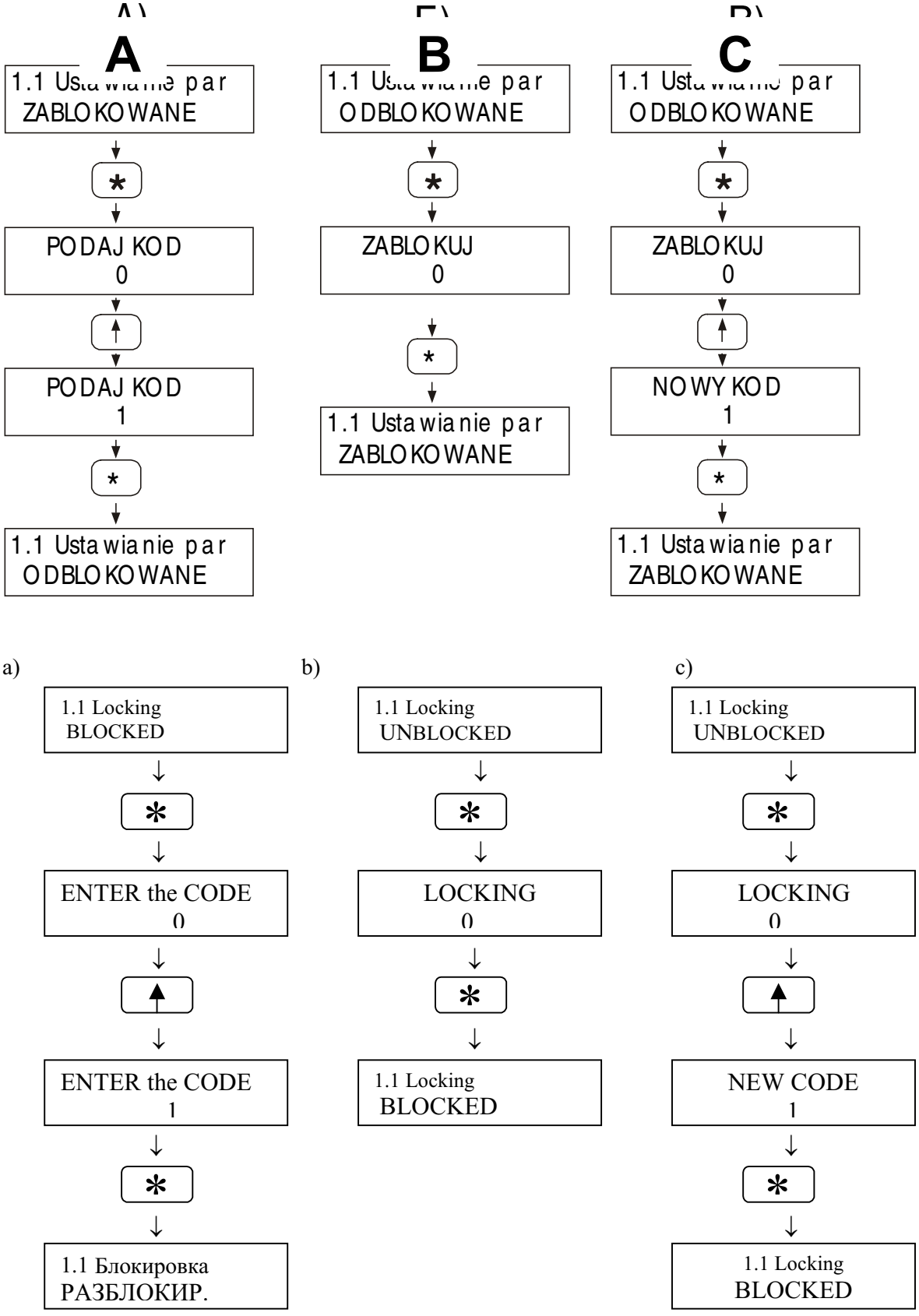
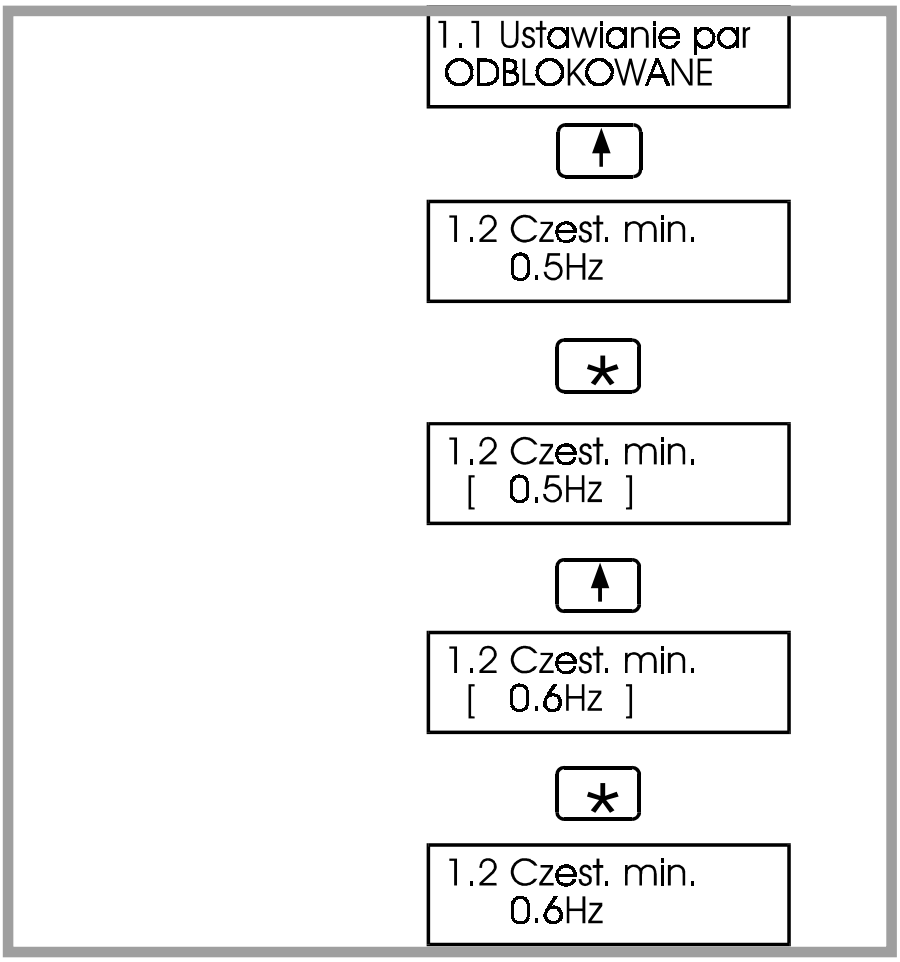


Fig. 5.4. Access unlocking to parameters
A) unlocking of the system
B) the system's locking (without change of access code)
C) the system's locking with new access code



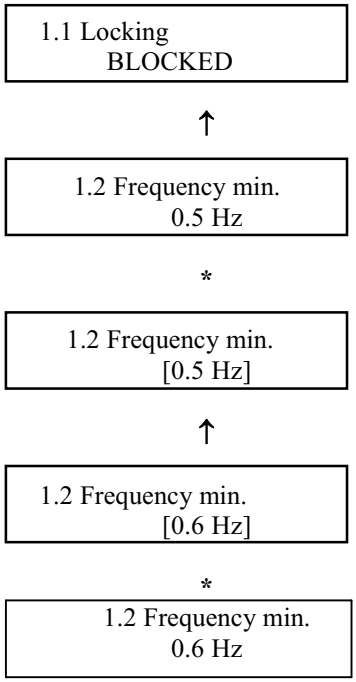


Fig. 5.5 Example of changing the parameter installation

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.

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.)U dc	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	Short curcuit 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(InC3 or InC4), sele-cted 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.
12	Error of communication1 [BLAD KOM 1]	Connecting error between processor and link module	Trouble of communicating module or connection	To check communications between CPU and module
13	Time of RS [Czas dop. RS]	Max. time of RS signal waiting		To check exterior connections and parameters settings

6. Control

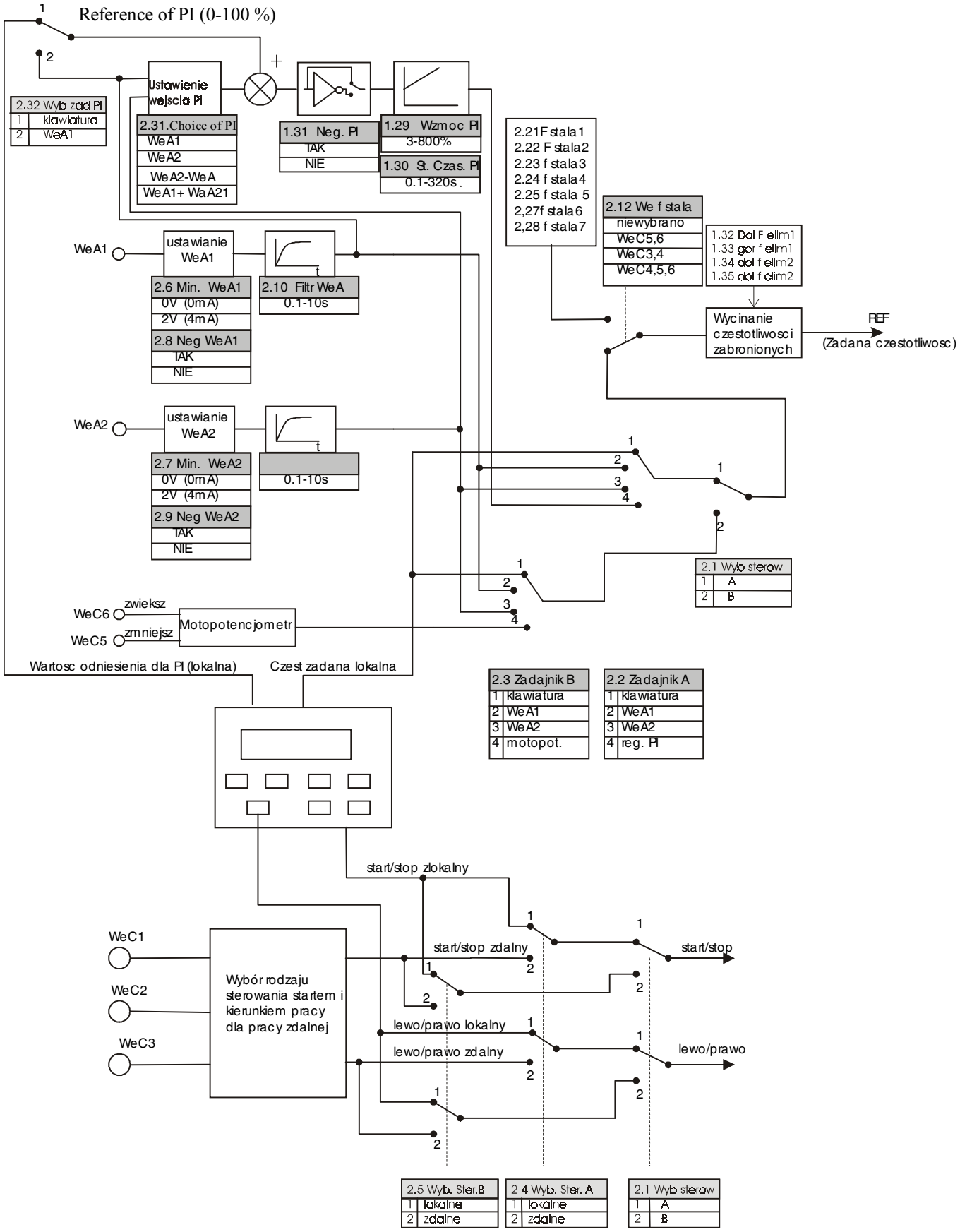


Fig.6.1 Structure of internal logic of the control system

Program keys are installed through the parameter or digital input. MFC 310 is controlled from the keyboard or outside. The mixed control is possible, 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 List of parameters

Par. №	Title	Description	Range	Factory installation	Changes during the operation
GROUP 1 (COMMON PARAMETERS)					
1.1	Blocking	Access code for parameters changing	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	Rate of dispersal 1	Time when convector will change output frequency from 0 to 50 Hz	0.1 - 255 s.	5 s.	Yes
1.5	Rate of stop 1	Time when convector will change output frequency from 50 to 0 Hz	0.1 - 250 s.	5 s.	Yes
1.6	Rate of dispersal 2	Time when convector will change output frequency from 0 to 50 Hz for selected dynamic 2	0.1 - 250 s.	20 s.	Yes
1.7	Delay 2	Time changing of system frequency from 50 to 0 Hz for selected dynamic 2	0.1 - 255 c.	5 c.	Yes
1.8	Characteristic U/f	Selecting the characteristic U/f	Linear [liniowa], square-law [kwadratowa]	Linear [liniowa]	No
1.9	U for f = 0Hz	Intensifying the moment for small speeds of drive's rotation (voltage for f = 0Hz)	0 - 40% Un	10%	Yes
1.11	f for Umax.	Frequency for max. output voltage	25 - 200 Hz	50Hz	Yes
1.12	I limit.	Value of limitation for drive's current	25 - 150% In	150% In	Yes
1.13	f carrier	Frequency of transistors turning the power on and off	2.5 кHz, 5 кHz	5 кHz	No
1.14	Lower frequency 1	Lower frequency of the first bar of cutting frequency	0,5 - par 1.15	0.5 Hz	Yes
1.15	Upper frequency 1	Upper frequency of the first bar of cutting frequency	Par. 1.14 - 200 Hz	0.5 Hz	Yes
1.16	Lower frequency 2	Lower frequency of the second bar of cutting frequency	0,5 – par. 1.17	0.5 Hz	Yes
1.17	Upper frequency 2	Upper frequency of the second bar of cutting frequency	Par.1.16 - 200 Hz	0.5 Hz	Yes
1.19	Direction	Choice of direction for drive's rotation or work permit with change of a direction	Left [Lewo], right [Prawo], Left/ right [Nawrót]	Left/ right [Nawrót]	No
1.20	Stop	Stop with help of drive («Ramp») – reducing the frequency to zero point, and then turn off the system	„Ramp"[ramp], run out [wybieg]	Run out [wybieg]	No
1.21	Time of braking DC	Time of braking with direct current	0 -250 s.	0 s.	Yes
1.22	Voltage of braking DC	Constant voltage applied to the drive during the braking	0 - 22% Un	0 %	Yes
1.23	Current of the drive	Rated current of the drive	25 - 100 %	100 %	No
1.24	Cos ϕ of the drive	Cos ϕ of the drive	0.4 - 0.99	0.8	No
1.25	Amount of poles	Amount of drive poles	2, 4, 6	4	No
1.26	Slip	Rated slip of the drive	0 - 10 %	3 %	No
1.27	Compensation of slip	Compensation of drive slip	Yes [TAK], No [NIE]	No [NIE]	No
1.28	Indexing of turnovers n.	Indexing of drive turnovers	Yes [TAK], No [NIE]	No [NIE]	No

1.29	Increasing of PI	Intensifying of proportional value of PI-regulator	0 - 800 %	100 %	Yes
1.30	Stoppage of PI	Stoppage of integral value of PI-regulator	0.1 - 320 sec	10 sec	Yes
1.31	Inversion PI	Inversion of PI-regulator	Yes [TAK], No [NIE]	No [NIE]	Yes
GROUP 2 (CONTROL PARAMETERS)					
2.1	Control channel	Selecting the control channel A or B	A, B	A	No
2.2	Selecting the set-point device A	Selecting the set-point device for control of channel A	InA1,InA2, [WeA1][WeA2] keyboard [klawiature], PI-regulator [reg. PI]	keyboard [klawiature]	No
2.3	Selecting the set-point device B	Selecting the set-point device for control of channel B	InA1[WeA1], InA2 [WeA2], keyboard [klawiature], potentiometer [motopot]	InA1 (WeA1)	No
2.4	Control place A	Choice of stop control of the converter and sense of rotation of a drive	Remote [zdalne], local [lokalne]	Local [lokalne]	No
2.5	Control place B	Choice of stop control of the converter and sense of rotation of a drive	Remote [zdalne], local [lokalne]	Local [lokalne]	No
2.6	Min. InA1	Min level of analogue input 1 [WeA1]	0V (0mA) 2V (4mA)	0V (0mA)	No
2.7	Min. InA2	Min level of analogue input 2 [WeA2]	0V (0mA) 2V (4mA)	0V (0mA)	No
2.8	Inversion InA1	Inversion of InA1 [WeA1]	Yes [TAK], No [NIE]	No [NIE]	No
2.9	Inversion InA2	Inversion of InA2 [WeA2]	Yes [TAK], No [NIE]	No [NIE]	No
2.10	Filter InA	Constant of time of filter for control signal (inertial element to both analogue inputs)	0.00 s. – 9.00 s.	0.1 s.	
2.11	START/STOP	Selecting the control type for system`s start and stop with a remote control	START/STOP LR; [ST/STOP LP] START_L START_R [ST_L ST_P]. START-Im STOP [ST-Im STOP] START-Im L/R [ST-Im L/P]	ST/ST LR [ST/STOP LP]	No
2.12	Selecting of digital inputs	Selecting of digital inputs according to constant speed selecting	Shut down [Nieaktywne] InC5,6 [WeC5,6]; In C3,4 [WeC3,4]; In C4,5,6 [WeC4,5,6]	In C5,6 [WeC5,6]s	No
2.13	Configuration InC3 [WeC3]	Definition of function for Input3 [WeC3]	Shut down [Nieaktywne] stop crash [Stop awar.] Permis to work [Zezwolenie. Pr] Contr. A/B [ster. A/B] reset crash [kasow ust.] dynam.1/2 [Dynam ½] outside troubles [usterka zew.]	Outside troubles [usterka zew.]	No
2.14	Configuration InC4	Definition of function for Input 4 [WeC4]	As in param. 2.13	Shut down [Nieaktywne]	No
2.16	Configuration K1	Definition of function for relay K1	Shut down	OPERATIO	Yes

			[Nieaktywne], READY [gotowy], TROUBLE [usterka], T > 65C, OPERATION MODE [praca], F > F control [f >f nadzoru] I>Ilim. f = f prescribed [f=f zad]	N MODE [praca]	
2.17	Configuration K2	Definition of function for relay K2	As par. 2.16	READY [gotowy]	Yes
2.18	Configuration K3	Definition of function for relay K3	As par. 2.16	TROUBLE [usterka]	Yes
2.19	Configuration OutC4 [WyC4]	Definition of function for digital output C4 [WyC4]	As par. 2.16	F > F control [f > f nadzoru]	Yes
2.24	F control	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	10 Hz	Yes
2.29	Constant frequency 5		0.5 - 200 Hz	20 Hz	Yes
2.30	Constant frequency 6		0.5 - 200 Hz	30 Hz	Yes
2.31	Constant frequency 7		0.5 - 200 Hz	30 Hz	Yes
2.32	Selecting of .PI control	Selecting the source of set-point device for regulator PI	Keyboard [Klawiatura] In A1 [WeA1]	Keyboard [Klawiatura]	No
2.33	Selecting of PI Input	Selecting the regulated value for PI regulator	In A1 [WeA1] In A2 [WeA2] InA1-InA2 [WeA1-WeA2] InA1+InA2/2 [(WeA1+WeA2)/2]	In A1 [WeA1]	No
2.34	RS resolution	Activation of the link unit	YES [TAK] NO [NIE]	NO [NIE]	Yes
2.35	RS speed	Speed of link	1200,2400,4800, 9600	9600	No
2.36	Number of FC	Number a FC	1-255	1	No
2.37	Time out	Not used MODBUS	-	-	-
2.38	RS time	Valid time between two signals of a distance control RS	0-120 s	0	No
GROUP 3 (TROUBLES AND PROTECTION)					
3.1	TROUBLES	List of last four troubles	where: 1-last trouble		Yes

3.2	Amount of overloads	Amount of automatic system start after trouble during time in parameter 3.3	0-3	0	No
3.3	Time of restart	Time during which restart is possible	10-250 s.	10	Yes
3.4	Restart < Udc	Permission for restart with low voltage Udc	YES [TAK] NO [NIE]	NO [NIE]	No
3.5	Restart > Udc	Permission for restart with high voltage Udc	YES [TAK] NO [NIE]	NO [NIE]	No
3.6	Restart > I	Restart with exceeding of prescribed current	YES [TAK] NO [NIE]	NO [NIE]	No
3.7	Restart >T	Restart with exceeding of radiator temperature	YES [TAK] NO [NIE]	NO [NIE]	No
3.8	Restart > InA	Restart with input signal range lower 2V (4mA)	YES [TAK] NO [NIE]	NO [NIE]	No
3.9	Protection I 2*T	Blocking activation with drive protection	YES [TAK] NO [NIE]	Yes [TAK]	No
3.10	I therm. lim.	The current is higher than which one load is actively calculated	25 – 100 %	100 %	Yes
3.11	I therm. f = 0	Valid thermal current for the stopped drive	0 - 150 %	50 %	Yes
3.12	t therm. drive.	Constant of time for drive heat	0 - 200 min	18 min	Yes
3.13	Factory parameters	The activation of the given parameter loads factory parameters	YES [TAK] NO [NIE]	NO [NIE]	
3.14	Absence of a signal on input	Absence of a signal on an analogue input	Trouble F constant f	F constant	Yes

7.2 Description of parameters GROUP 1 (COMMON PARAMETERS)

7.2.1 Minimum and maximum frequency

The parameter 1.2 enables installations of a minimum working frequency. After start the drive starts to work with frequency not below Fmin.

The parameter 1.3 is a high bound of output frequency.

7.2.2 Parameters defining the system dynamics

The parameter 1.4 (Acceleration 1) and 1.6 (Acceleration 2) defines a slope of frequency changes during increase of speed.

The parameter 1.5 (Delay 1) and 1.7 (Delay 2) concerns decrease of frequency. The called parameters define time (in sec.) of frequency change on 50 Hz.

In the system it is possible to change acceleration and delay with the help of InC3 [WeC3] or InC4 [WeC4]. For this purpose it is necessary to install parameters 2.13 or 2.14 on “Dynamics1/2” [DYNAMIKA ½]. If on a selected digital input the signal will be fed, the device will work during time, preselected by parameters 1.6 and 1.7

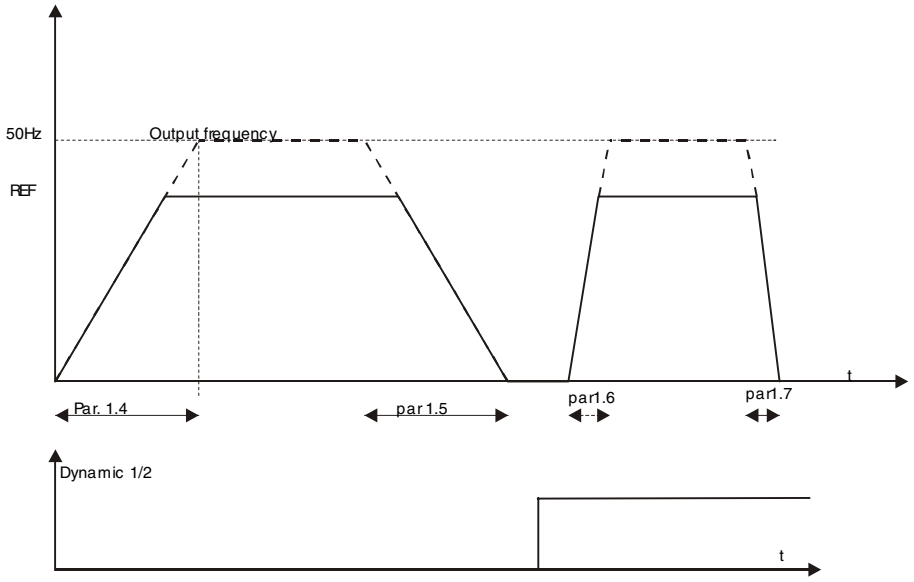


Fig.7.1 Time of accelerations and delays

7.2.3 Parameters shaping the characteristic U/f

The parameter 1.8 allows to select sort of the characteristic U/f (linear, square-law).
The straight-line characteristic is applied where is a constant moment of load depending on speed.
In case of load of a ventilator type (the moment increases proportionally to quadrate of speed) it is useful to apply the „square-law» characteristic to reduce hums and losses in a drive.
The parameter 1.9 is so-called overcoming of power for low frequencies. It allows to indemnify a voltage drop on a resistance of a winding and, therefore, to augment the moment for low speeds.

- For small drives the voltage of compensation can be more, than for the large drives, as for them the resistance of a winding is higher. If it is necessary to install the moment of load high, power of compensation so high to switch on the drive. As too high tension of compensation can overheat a drive or make overload, it is necessary to install it, as far as possible, low.

The parameter 1.11 is a point of weakening of a field. It, predominantly, nominal frequency of a drive. For frequencies that are higher then parameter 1.11 the drive works with the diminished moment. It works only with constant power.

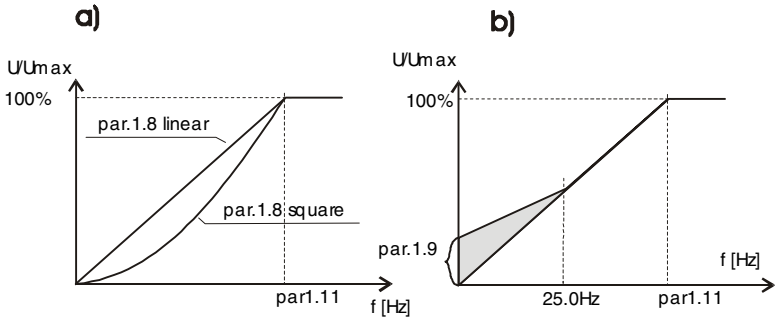


Fig. 7.2 Characteristics U/f
a) Linear and square-law characteristic
b) Voltage variation of compensation

7.2.4 Limitation of a current

The parameter 1.12 - sets limitation of a current. The value of the parameter is underlined in percentage of rated current of a converter. The factory installation is set on 150 % of rated current of the system.

NOTICE:

1. Rated current of the system is not rated current of a drive. In case drive usage of smaller power, it is necessary to diminish installation of limitation of a current.

2. Operation time of limitation of a current is not controlled and during durable overloads can be a disconnect of the system owing to exceeding temperature of the heat sink.

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

7.2.5 Carrier frequency

The parameter 1.13 allows to change the frequency of power transistors control. It is possible to install one of the two carrier frequencies: 2.5 κHz and 5 κHz.

For 5kHz the hum of a drive is lower, but the losses increase. In trouble case caused by exceeding of temperature of the heat sink, it is necessary to diminish a carrier frequency.

7.2.6 Frequency of exceptions

In some systems there can be a necessity of avoiding of operation on some output frequencies concerning with problems of a resonance.

In systems it is possible to avoid two ranges of frequencies.

For this purpose it is necessary to set lower and upper values of frequencies for each range. For the preselected frequencies, the output frequency were between lower and upper boundaries, compounds a low bound in case of increase of a working frequency or high bound in case of decrease (fig.7.3).

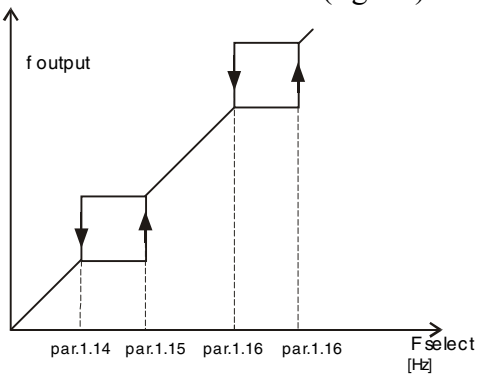


Fig. 7.3 Implementations of a clipping of a bar of frequency

7.2.7 Locking of a reversing method of operating.

The parameter 1.19 can lock a reversing method of operating. For this purpose the parameter should be installed depending on necessity, on „left" [Lewo] or „ the right" [Prawo]. In this case, irrespective of handle, the FC will work only in the preselected direction.

That the FC worked in two directions, the parameter should be installed on „l/r [Nawrot]. The direction of operation of the FC will be preselected remotely or with a selected button on control panel (local method of operating).

7.2.8 Way of a stop.

The parameter 1.20 determines a way of a stop the FC. For value „running out› [wybieg], after the command STOP [STOP] the FC will switch off power, and the drive will stop through a running out.

For value of „RAMP" [ramp] after the command „ STOP" [STOP] the FC will begin to diminish frequency, according to parameters specifying rate of a stop, up to 0.1 Hz, and then will switch off power. With the purpose of cutting deceleration time it is possible to set the parameter of inhibition by 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 feed of constant power, parameter 1.22 - value of constant power applied on a winding of a drive. Inhibition is more successful then higher this value, but a current magnitude which is flowing past through a drive increases, that can cause its overheat. When the parameter 1.20 is established on „running out" [wybieg], after the command „STOP" [STOP] the constant power moves on a drive. For variant of inhibition by a way of reduction of frequency, the constant power moves only then, when the value of frequency compounds 0.5 Hz.

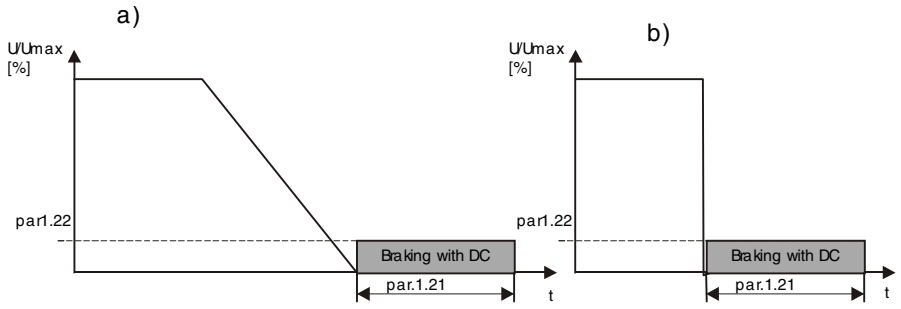


Fig. 7.4 Inhibitions with the help of a direct current
a) stop "ramp" [ramp]
b) stop „running out" [wybieg]

7.2.9 Ratings of a drive.

It is ground of datas on a drive it is necessary to define rated current, $\cos\varphi_n$ and on rated speed to define an amount of pairs of poles for the drive.

The parameter 1.23 - rated current of a drive in percentage of rated current a FC.

The parameter 1.24 - nominal capacity factor of a drive $\cos\varphi_n$.

In the parameter 1.25 it is necessary to set an amount of poles of a drive. In the table the amount of poles is underlined depending on synchronous speed.

- The synchronous speed can be installed accepting closest to rated speed.

TABLE 7.2

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

The parameter 1.25 represents nominal slip of a drive; it calculate under the formula:

$$S_n = \frac{(n_s - n_n) * 100\%}{n_s}$$

7.2.10 Compensation of slip

If the parameter 1.27 is established on YES [TAK], the device works with compensation of slip. Output frequency to be augmented so that the constant speed of a drive will be saved at changes of load.

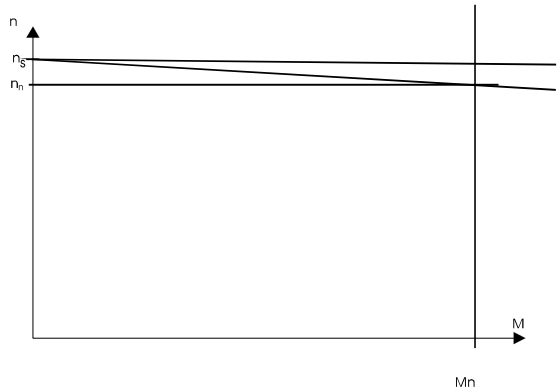


Fig. 7.5. Dependence of speed of a drive from the moment of load:
A). The system without compensation of slip
B). The system with compensation of slip

7.2.11. Indication of output speed

It is possible to specify speed definite in turnovers per minute. The parameter 1.28 should be installed on Yes [TAK] . 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 leave outs of changes implied from a drive load.

7.2.12. Installation of the PI- regulator parameters

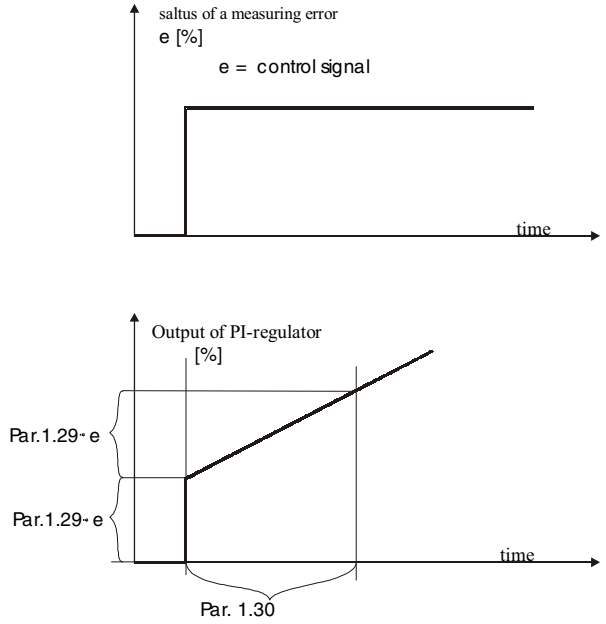


Fig. 7.6. An output of a PI-regulator at saltatory
of a measuring error

The parameter 1.29 installs intensifying the proportional member of a PI-regulator, and the parameter 1.30 defines coefficient of a PI-regulator.
The Fig. 7.6 shows response of a PI-regulator to a saltus of a measuring error (measuring error - difference between a specified value and value of handle).

With the help of the parameter 1.31 it is possible to change the sign of a measuring error. At installation of this parameter on YES [TAK] the increase of a specified value influences gain of PI output.

100 % of an outputs of a PI-regulator correspond to maximum frequency established in the parameter 1.3, and 0 % of an outputs of a PI-regulator correspond to frequency established by the parameter 1.2.

7.3. Description of parameters: the SECOND GROUP (PARAMETERS of CONTROL).

7.3.1. Choice of a control place and control device.

The parameter 2.1 defines variants of control through the channel A or the channel B. It is possible to set two independent variants of control, separately for the channel A and channel B, and also fast change of the channel by the parameter 2.1, or any of programmed digital inputs InC3 [WeC3] or InC4 [WeC4], programmed on „ control A/B" [ster A/B] by a state transition on an appropriate digital input.

The parameter 2.2 allows defining control of frequency for the channel A.
It is possible to select:

- One of two analogue inputs InA1 [WeA1] or InA2 [WeA2];
- Control from the keyboard (buttons „↑„ , „↓„);
- Control from a potentiometer;
- Installation of speeds through digital inputs InC5 [WeC5], InC6 [WeC6] according to the table:

TABLE 7.3

InC5 (WeC5)	InC6 (WeC6)	Preselected frequency
0	0	Without changes
1	0	Increase
0	1	Reduce
1	1	Without changes

The parameter 2.3 is the same as par. 2.2., only for channel B

The parameter 2.4 defines a control place of start and direction of drive operation for channel A.
Types of control:

- Remote [Zdalne] (start, stop and direction from digital inputs),
- Local [Lokalne] (control from control panel).

The parameter 2.5 is the same as par. 2.4., only for channel B

7.3.2 Choice of control from analogue inputs.

The parameter 2.6 defines a low level of a pilot signal 0 V (0 mA) or 2 V (4 mA) on an analogue input InA1 [WeA1] at which one the frequency is minimum (par. 1.2) if the parameter 2.8 is established on NO [NIE]; or maximum (per. 1.3) if the parameter 2.8 is established on YES [TAK].

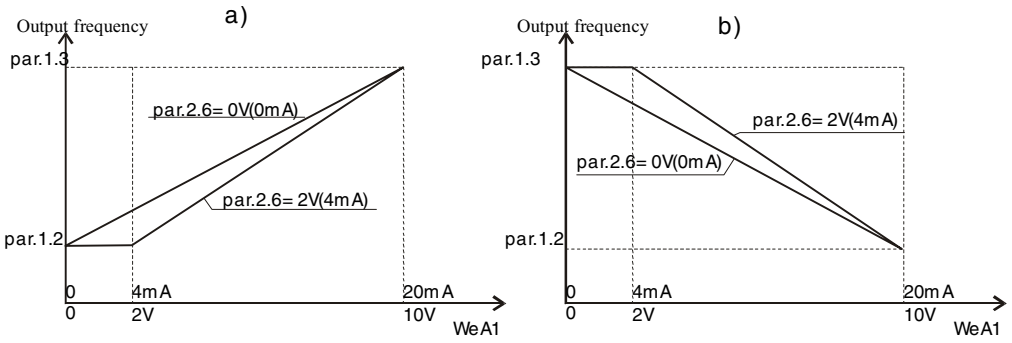


Fig. 7.7 Control characteristics
a) Parameter 2.8 InA1 (WeA1): NO [NIE]
b) Parameter 2.8 InA1 (WeA1): YES [TAK]

Parameters 2.7 and 2.9 - is the same as parameters 2.6 and 2.8 only for InA2 [WeA2].
The parameter 2.10 is for installation of a constant of time for a filter of analogue inputs that can filter interferences of an input signal.

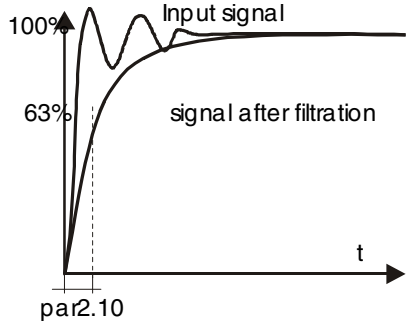


Fig. 7.8 Filter of a signal from an analogue input

7.3.3 Choice of a system control for a remote method of operating

The parameter 2.11 allows to program functions of digital inputs for start realization and choice of a direction of drive operation.

Possible installations

- START/STOP LR [ST/STOP LP] InC1 [WeC1] is for command “START/STOP” [START/STOP], InC2 [WeC2] for change of a direction (Fig.7.8 a)
- ST_L ST_R [“ST_L ST_R”], InC1 [WeC1] - START ON THE LEFT, InC2[WeC2] - START TO THE RIGHT (Fig.7.8 б);
- ST-IM STOP [“ST-IM STOP”] InC1 [WeC1] START WITH IMPULSE / InC2 [WeC2] – STOP (Fig. 7.8 в);
- ST-IM L/R [“ST-IM L/R“] InC1 [WeC1] START WITH IMPULSE / InC3 [WeC3] – choice of direction (Fig. 7.8 г);

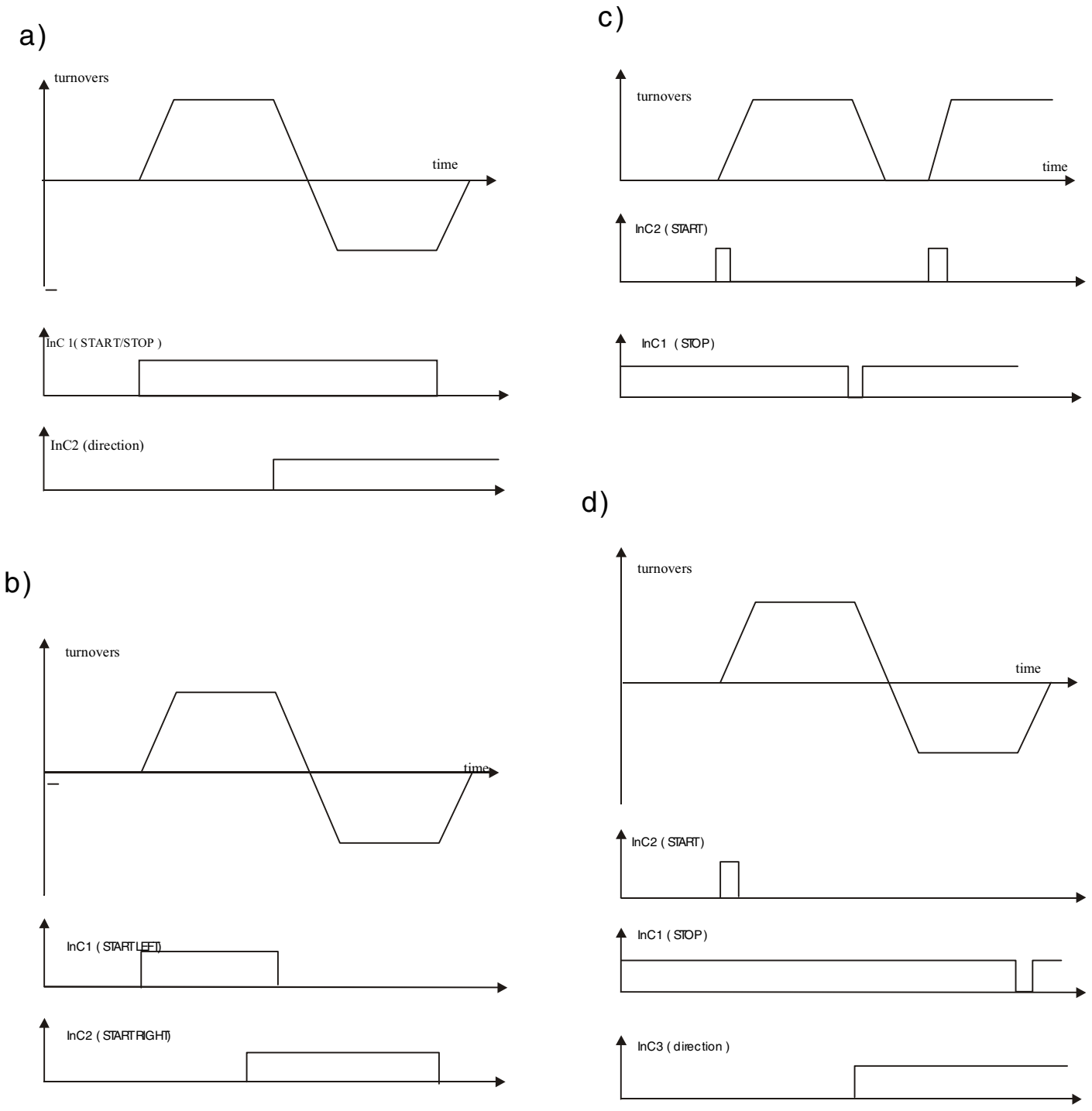


Fig. 7.9 Control with using digital inputs.
a) Parameter 2.11 ST/STOP LR.
b) Parameter 2.11 ST _ L ST _ R.
c) Parameter 2.11 ST-Im STOP.
d) Parameter 2.11 ST- Im L/R.

7.3.4 Choice of constant speeds

The system allows selecting of three or seven programmed speeds with the help of a combination of digital inputs. The output frequency appropriate to the given speed is set in correspondence to following parameters.

TABLE 7.4

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

The parameter 2.12 allow selecting of digital inputs for choice of constant speeds.

Possible variants:

- Power off [Nie wybrane] - the constant frequencies are not selected;
- InC5,6 [WeC5,6] - possibility of choice of three constant speeds with the help InC5 (WeC5) and InC6 (WeC6);
- InC3,4 [WeC3,4] - possibility of choice of three constant speeds with the help InC3 (WeC3) and InC4 (WeC4).

TABLE 7.5

InC4 [WeC4] /InC6 [WeC6]	InC5 [WeC5] /InC3 [WeC3]	Constant frequency
0	0	Not selected
0	1	Constant frequency 1
1	0	Constant frequency 2
1	1	Constant frequency 3

- InC4,5,6 [WeC4,5,6] - possibility of choice of seven frequencies from InC4, InC5 and InC6 [WeC4, WeC5, WeC6].

TABLE 7.6

InC4 [WeC4]	InC5 [WeC5]	InC6 [WeC6]	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 Installation of programmed inputs InC3 [WeC3] and InC4 [WeC4].

If InC3 [WeC3] and InC4 [WeC4] were not utilised for choice of constant speeds or InC3 [WeC3] for control of a direction of operating method, for these inputs it is possible to program additional functions.

The parameter 2.13 allows function of a digital input InC3 [WeC3].

TABLE 7.7

Value of par. 2.13	Description
Power off [Nieaktywne]	Digital input inactive
Stop, trouble [Stop awar.]	1 - stop of FC (running out)
Permission to operate [Zezwolenie Pr.]	Permission to operate 0 - the operation is impossible
Control A/B [ster. A/B]	Change of a control channel (0 - A; 1 - B)
Reset trouble [kasow.ust.]	Reset of a trouble (change from 0 to 1 throws off the message about a trouble and allows to restore operation of FC)
Dynamics 1/2 [dynam. 1/2]	Change of dynamics 0- choices of dispersal rate 1 and rate of a stop 1 1- choices of dispersal rate 2 and rate of a stop 2

0 - Means low tension on a digital input (is not on-line);
1 - Means high tension on a digital input (InC3 [WeC3]. It is on-line to 24 B)

The parameter 2.14 - is the same as 2.13 only for InC4 (WeC4)

7.3.6 Installation of relay outputs and digital output

The parameter 2.16 defines correspondence to a relay K1 (Table)

TABLE 7.6

Value of parameter 2.16	Description
Inactive [Nieaktywny]	The relay is not utilised
Ready [Gotowy]	In a switched on status it signals about availability of FC to operate
Error [usterka]	In a switched on status signals about a crash
Operate [praca]	In a switched on status signals about an energizing on a drive
T> 650C [T> 650C]	In a switched on status signals about heightened temperature of the heat sink
I> Ilim [I> Ilim]	In a switched on status signals about a operating method with limitation of a current
F = F select [f = F zad]	In a switched on status signals about achievement of the preselected frequency
F > Fcontrol [f>f Nadzoru]	In a switched on status signals about achievement of control frequency preselected in the parameter 2.24 (symmetric hystereses + - 0.5 Hz)

The 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 OutputC1 [WyC1] (output with an open header).

7.3.7. Configuration of a PI-regulator

The parameter 2.32 defines a source of a signal for a PI-regulator. The installation of a specified value is possible from the keyboard or from an analogue input In A1 [WeA1]. The specifying value can vary in limits from 0 up to 100%. Assignment of a PI-regulator - deduction of the entry value at a level specifying. The entry value is configurated by the parameter 2.3. The entry value can be:

- InA1 [WeA1] - signal is given on an analogue input In A1 [WeA1] in view of parameters defining the input In A1 [WeA1] (par. 2.6, par. 2.8 and par. 2.10);
- InA2 [WeA2] - signal is given on an analogue input In A2 [WeA2] in view of parameters defining the input In A2 [WeA2] (par. 2.7, par. 2.9 and par. 2.10);
- InA1-InA2 [WeA1-WeA2] - regulated value - difference of analogue inputs;
- (InA1 + InA2) /2 [(WeA1 + WeA2) /2] - regulated value - average value of two inputs.

7.3.8 Configuration of the communication parameters

The parameter 2.34 intensifies FC control through a serial communication. The change of this parameter is possible during a drive operating. If the parameter 2.34 is established on NO [NIE] those all command signals coming from RS will be ignored.

With the help of the parameter 2.36 the speed of link is installed. Possible values: 1200, 2400, 4800 and 9600 bps.

The parameter 2.36 corresponds to number of FC. In given net only one device with this number can work .

The installation of valid time between the signals, obtained through a serial communication, is defined with the parameter 2.38. When the FC will not receive correct sending in time preselected in this parameter, it will switch off a drive and will give out a crash Time RS [Czas RS]. It is possible only at an intensified method of operating with RS.

7.4. DESCRIPTION OF PARAMETERS: THE THIRD GROUP (ERRORS AND PROTECTION).

7.4.1 List of errors.

In the parameter 3.1 four last errors are automatically brought. The index 1 means last fault, 2 - penultimate etc.

7.4.2 Automatic reset.

If the FC will stop because of an error, there is a possibility of automatic restoration of operation after disappearance of an error reason. The parameter 3.2 defines a valid amount of starts (amount of resets) in time preselected by the parameter 3.3.

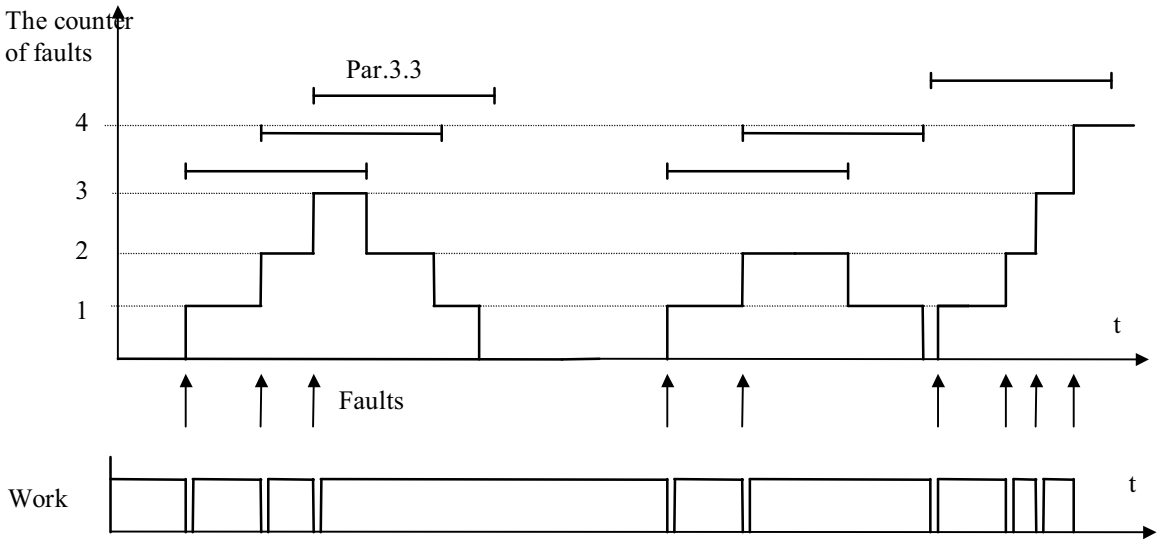


Fig.7.10 Automatic restoration of operating method at an amount of resets - 3

If in time preselected by the parameter 3.3, the amount of troubles exceeds the established amount of resets, the FC automatically will not restore an operating method. For restoration of operation it is necessary to click the STOP button [„STOP"] on control panel or to give a signal on a digital input programmed for reset of errors, or to switch off and to switch on a FC.

The parameter 3.4 permissions on reset of FC after an error „ low tension in dc circuits".

The parameter 3.5 permissions on reset of FC after an error: „ high tension in dc circuits".

The parameter 3.6 permissions on reset of FC after an error: „ a high output current".

The parameter 3.7 permissions on reset of FC after an error: „ exceeding of valid temperature of the heat sink".

The parameter 3.8 permissions on reset of FC after an error " signal level at analogue input InA [WeA] is low then 2 V (4mA)".

7.4.3 Thermal protection of a drive

The built-in math model allows theoretically to calculate temperature of a drive.

The model is developed with the following suppositions:

- Ex-potential increase of temperature of a winding;
- Availability of maximum temperature for a permanent operation 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 quarter 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.

The drive load can be shaped under the characteristic, introduced in a fig. 7.11. In a cooling-off period of a drive without accessory cooling it is necessary to set the Parameter 3.11 on 35 % of a drive current. At application of a drive with accessory cooling, this parameter can be inscreased, for example, up to 75 % of a drive current.

The essential parameter is the parameter 3.12, specifying a constant of heat of a drive. This parameter defines time, during which one the increase of temperature of a drive reaches 63 % of final increase of temperature.

In practice it is possible to accept, what is it time compounds:

Par. 3.12 = $2*t_6$ [min]. (t_6 [s.] is indicated by the manufacturer of drives

TABLE 7.9

Power of a drive, кW	Amount of poles		
	2	4	6
	Constant of drive heating, min		
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
18.5	21	31	39
22	23	34	45
30	28	37	49
37	31	41	53
45	34	44	57

The parameters 3.10, 3.11 are set in percentage of rated current of a FC. If rated current of a drive differs from a current of a FC, it is necessary to make adjustment of setpoint values of parameters.

EXAMPLE:

The frequency converter of 15 kW feeds a drive with rated current 27,5 A. Rated current of a FC - 30A. The parameter 3.10 should be setup on 27.5 A (27.5/30*100 %), i.e., 92 % of rated current of a FC.

a) For a drive without a padding ventilator, the parameter 3.11 should be set on 35 % of a current of a drive

The parameter 3.11 = 35 % / 100* par.3 10
The parameter 3.11 = 35 % / 100* 92 % = 32 %
The parameter 3.11 = 32 % In

b) For a drive with a padding ventilator suspected current for the stopped drive - 70 % of a current of a drive.

The parameter 3.11 = 0.7 * par.3 10
The parameter 3.11 = 0.7 * 92 %
The parameter 3.11 = 64 %

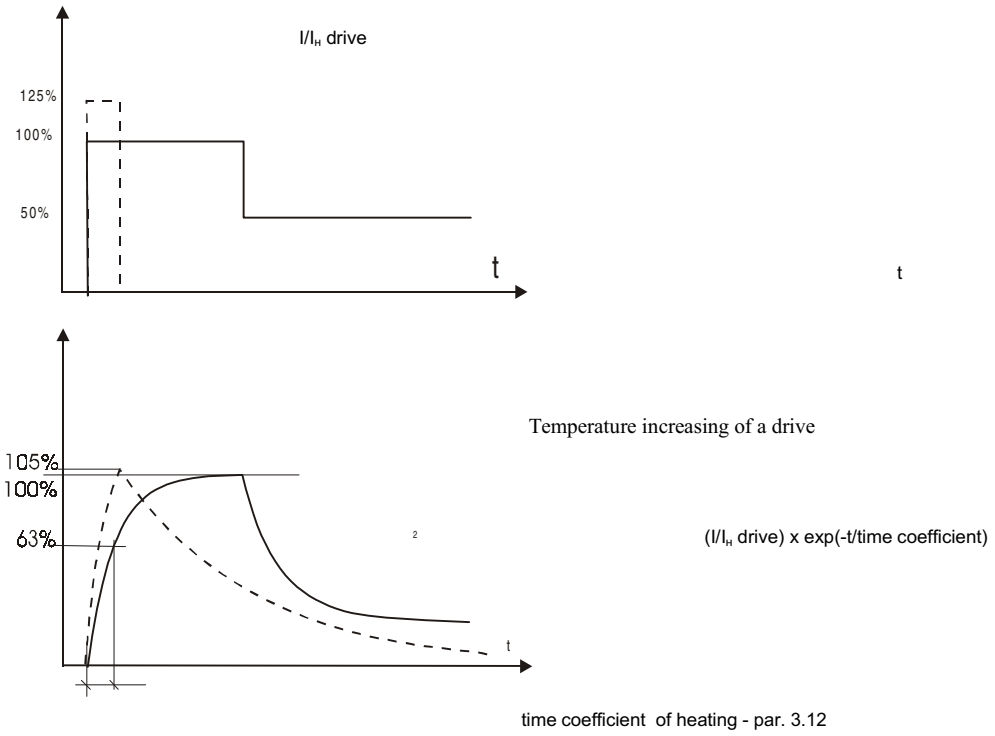


Fig. 7.11 Heating of a drive (model, used in the system)
Dashed line – the system turns off with current higher I = 1,25 In of a drive

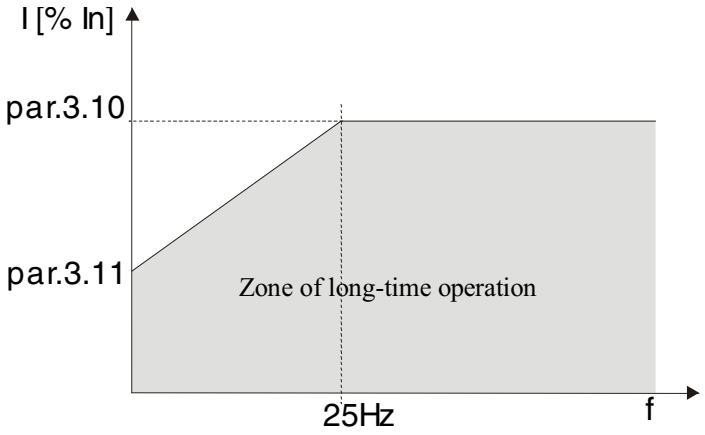


Fig. 7.12 Characteristics of a drive load

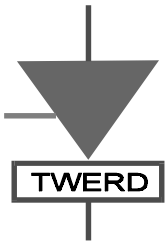
For operation with an external ventilator the par 3.11 is necessary to set on 70 % In, without a ventilator - on 35 % In.

7.4.4 Installation of factory parameters

After start of the parameter 3.13 „ Yes" [TAK] the factory parameters of a converter will boot on.

7.4.5 Operation of a FC with absence of an input signal on an input In A1 [WeA1] and InA2 [WeA2].

For operation of a FC with usage of analog signals for control and operating method with floating zero point the parameter 3.14 defines response to miss of an input signal (from 2 up to 10 V or 4-20 mA). It is possible to select a stop and output of an error or prolongation of operation with constant speed f 7 which is definited from the parameter 2.31.



ZAKŁAD ENERGOELEKTRONIKI

mgr inż. MICHAŁ TWERD

WARRANTY

12 months warranty is afforded for the article: ……

Serial number of the article: ……..…

Date of sale: ……

Place for seal and signature ……

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