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Symbols:

- caution or danger

- advice

- pay attention

- functionality limitation

PFC - power factor correction

PWM - power width modulation

PID-controller - proportional integral derivative controller

FC - frequency converter

1. SAFETY PRECAUTIONS

THIS OPERATING MANUAL DESCRIBES THE ORDER OF STORAGE, MOUNTING, ADJUSTMENT AND OPERATION OF THE FC

CAUTION!

Before performing any work with FC **necessarily** read manual.

DANGER!

- FC must be disconnected from AC (alternating current) mains before any types of maintenance related with removing (opening) protective covers, switching power or control circuits. FC maintenance must be performed by a qualified technician after learning current manual.
- After FC is disconnected from mains, capacitors in the intermediate DC (direct current) circuit stay under voltage for a while (up to 2 minutes) so do **NOT** open FC covers that protect you from elements under voltage. Visual sign of the dangerous voltage in capacitors is LED indicators glowing on the control panel. Under dangerous voltage are not only FC elements but also are cables of motor and mains!
- Do **NOT** connect mains to **U, V** and **W** terminals which are designed to connect motor. FC will be broken if it happens. In this case customer forfeits warranty obligations of provider and manufacturer!

WARNING!

- FC must be used with three-phase induction motors only and powered from single-phase AC mains.
- FC has electronic components sensitive to static electricity. To avoid damaging those components by electrostatic discharges do **NOT** touch those components or printed circuit boards (PCB) with electrically conductive tools or bare hands.
- FC must be necessarily grounded via appropriate terminal on its body. Ground loop impedance - no more than 4 ohm.
- The FC radiator can reach the temperature of more than 70ºC during operation. Do **NOT** touch the FC radiator in operation in order to avoid burn. Do not cover or block radiator with items that can barrier air convection.
- To measure the cables insulation resistance disconnect them from FC.
- Do **NOT** connect any capacitors to the motor terminals.

2. TECHNICAL DATA OF FREQUENCY CONVERTER CFM210

Table 1. Technical data

Input	Input voltage U_{in}	1phase x 220V(+10%, -15%, with PFC to -25%)
	Input voltage frequency	45...66 Hz
Output	Output voltage	3phase x 0... U_{in} (with PFC 0...275V)
	Output frequency	0; 1...800 Hz
	Frequency forming deviation	0.05 Hz
	PWM type	Voltage vector
	Motor connection	Standard three-phase 220V induction motor with delta connected windings «Δ»
Control system	Control mode	■ Scalar U / f with linear (proportional) characteristic. ■ Scalar U / f with quadratic characteristic. ■ Scalar U / f with forced characteristic. ■ Improved scalar U / f with automatic torque and slip compensation.

	Power module control frequency	3 – 6 – 9 – 12 kHz
	Rotation speed setting	■ Analog inputs ■ Digital inputs ■ Control panel ■ PID-controller ■ Communication interface RS485 ■ Programmable script Resolution: 0,1% analog input 0,1 Hz for control panel and digital inputs
	Braking modes	■ DC braking ■ Using braking resistor
	Cooling	Forced air cooling
Control inputs / outputs	Analog inputs	2 analog inputs AN.IN1 and AN.IN2: ■ in voltage mode: 0...10 V, Rin ≥ 50 kOhm ■ in current mode: 0(4)...20 mA, Rin = 220 Ohm
	Digital inputs	6 digital inputs galvanically isolated from mains with switchable polarity: NPN ■ active level: 0 V ■ inactive state: 20...24 V PNP ■ active level: 20...24 V ■ inactive state: 0 B Resistance Rin ≥ 4 kOhm.
	Analog output / output with an open collector (not in the same time)	1 analog output: ■ 0...10V 1 digital output with an open collector: ■ up to 1A /0...40V Fully programmable signal source.
	Relay outputs	2 relays with changeover contacts: ■ switching load: 250V / 10A (AC) Fully programmable signal source.
Communication	Hardware capabilities and a protocol	Support of communication module RS485 with galvanically isolated channel. Modbus RTU exchange protocol.
	Transmission speed	4800, 9600,19200, 38400, 56000 or 115200 bps
	Additional capabilities	Capability to change FC parameters. Implemented control from PC with capability to change configurations
Additional functions	Meter counter	Allows to use FC in conveyers and pulling mechanisms which require to control the length or the quantity of product in pieces.
	Integral PID-controller	Two modes of task signal formation, the ability to change the polarity of the control error signal and other PID parameters.
	Programmable script	Allows to configure up to 8 independent motor control steps according to a given tachogram.
	Configurations control	Capability to safe and upload user's configurations into FC non-volatile memory. Factory configuration for quick reset of the FC to the factory settings.

Protection		■ against FC current overloads ■ against DC bus overvoltage ■ against bus voltage reduction during operation ■ against motor operation powered from two phases ■ against motor overload ■ against motor underload (can be disabled) ■ against communication failure over RS485 ■ against FC or motor overheating ■ against interphase short circuit ■ against ground fault of any phase ■ against short circuit in brake resistor circuit ■ against system and the other errors

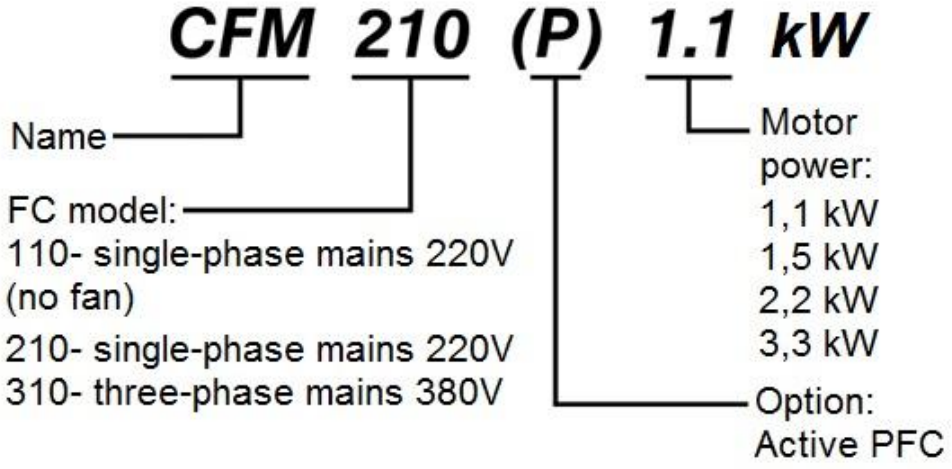
CFM210 series of frequency converters replenished with models (CFM210P) that have embedded active Power Factor Correction (PFC). These frequency converters can operate in input voltage range of 165-260V without power reduction on a motor shaft, they have input power factor near to one which reduces the load on mains supply and the other consumers. It allows to operate with output frequency 20% higher than rated without torque reduction.

Table 2. *Parameters summary table of CFM210 models*

FC POWER	SERIES	INPUT CURRENT, A		OUTPUT CURRENT, A		WEIGHT, KG
		NOMINAL	AUTOMATIC CIRCUIT BREAKER (cat.B)	NOMINAL	MAX.	
1.0 kW	CFM210	9.3	16	5.7	8.55	1.6
	CFM210P	7.2*	20			1.8
1.5 kW	CFM210	12.8	20	7.8	11.7	1.6
	CFM210P	9.8*	25			1.8
2.2 kW	CFM210	17.4	25	10.6	15.9	2.2
	CFM210P	13.4*	32			2.6
3.3 kW	CFM210	22.1	32	13.5	20.25	2.3
	CFM210P	17*	40			2.7

**The current is specified for nominal mains voltage of 220V and nominal load. With the input voltage of 165V current will be higher than specified one in about 1.4 times.*

Model designation



3. RECEIPT AND INSPECTION

Check the received kit which in the basic version should consists of:

- CFM210 frequency converter.....1 pcs.
- ground wire terminal.....1 pcs.
- manual with warranty card.....1 pcs.
- cardboard packing box.....1 pcs.

Inspect the frequency converter for damages.

Make sure that FC nominal shown on the sticker of the received sample corresponds to ordered model.

4. STORAGE AND INSTALLATION

FC must be kept in their original packaging. To avoid loss of warranty for FC which are going to be stored for a long period of time ensure the storage conditions in accordance with the following recommendations:

- keep in dry and clean storage;
- at ambient temperature of 0°C up to +60 ºC;
- at related humidity up to 90% (non-condensing);
- at atmospheric pressure of 86 up to 106 kPa;
- do NOT store in conditions conducive to corrosion;
- do NOT store on unstable surfaces.

To provide normal FC heat regime it should be installed in vertical position providing an air passage: sides and front - at least 50 mm, above and below - at least 150 mm.

FC must be installed in the places with the following conditions:

- lack of direct splashes hit and moisture condensation;
- lack of the direct sun rays and the other heat sources;
- lack of aggressive gases and corrosion influence;
- lack of dust and metal particles;
- lack of vibrations and hits;
- lack of strong electromagnetic fields radiated by the other equipment;
- operating temperature of +10°C up to +40°C;
- related humidity up to 90% (non-condensing);
- atmospheric pressure: 86 - 106 kPa.

5. WIRING AND CONNECTIONS

5.1 CONSTRUCTION DESCRIPTION AND ORDER OF MOUNTING

FC physical configurations and overall dimensions of CFM210 series represented at figure 1.

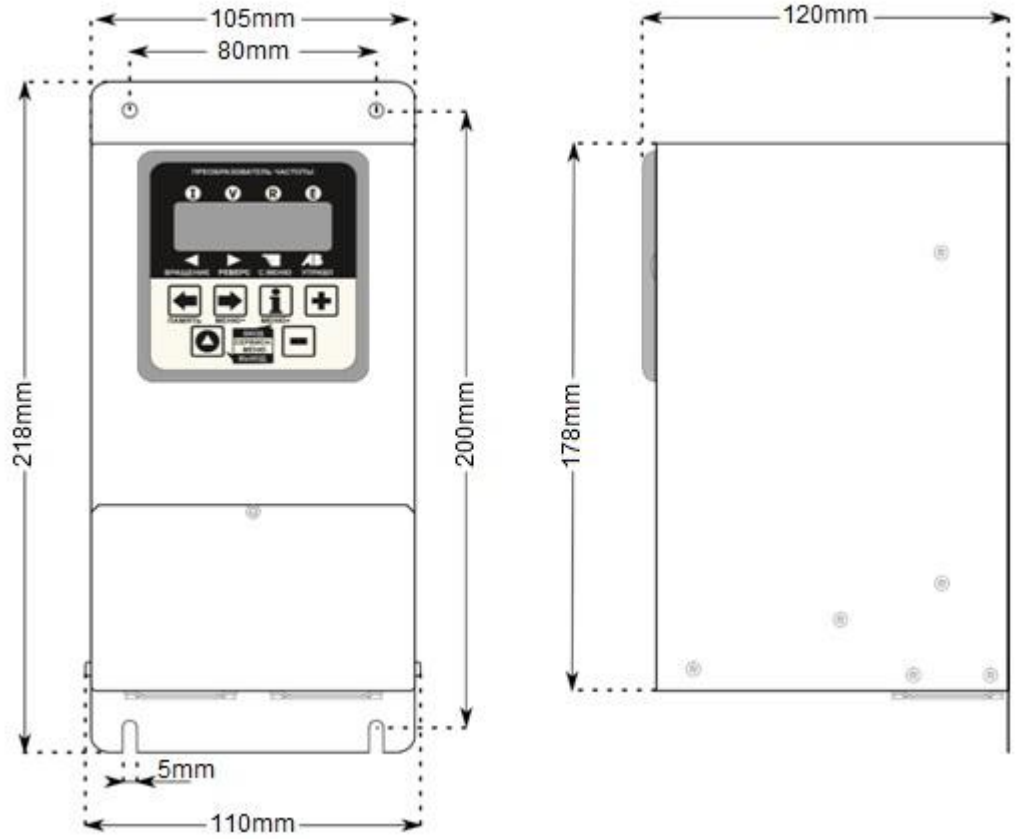


Figure1a. *Overall dimensions of CFM210 1.1 and 1.5 kW FC*

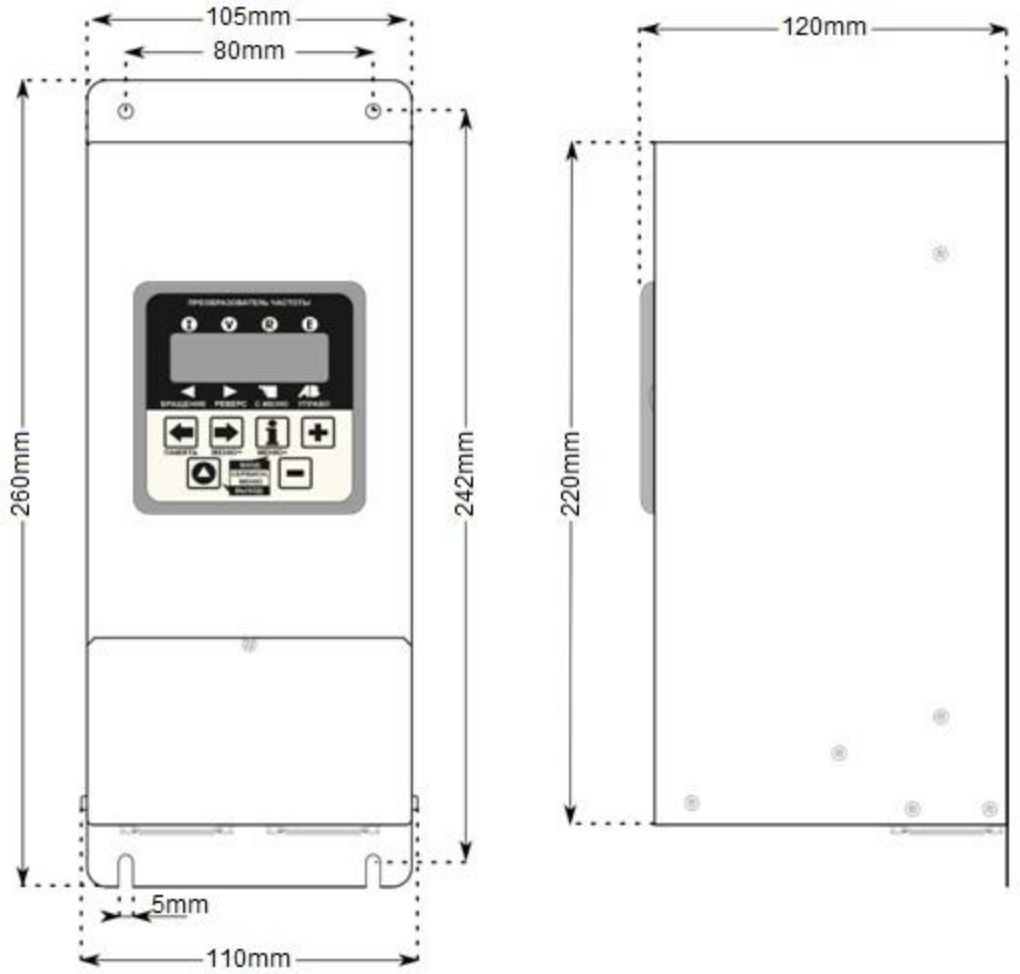


Figure 1b. *Overall dimensions of CFM210 2.2 and 3.3 kW FC*

- Install the FC on the mounting surface by screw connection using special holes located along the FC radiator contour.
- Connect the mains wires (~220V terminals) and the motor (UVW terminals).

Do *NOT* mix them up! The clamping screws tightening torque of the power terminals - 12 kg x cm.

5.2 BASIC SCHEME OF CONNECTIONS

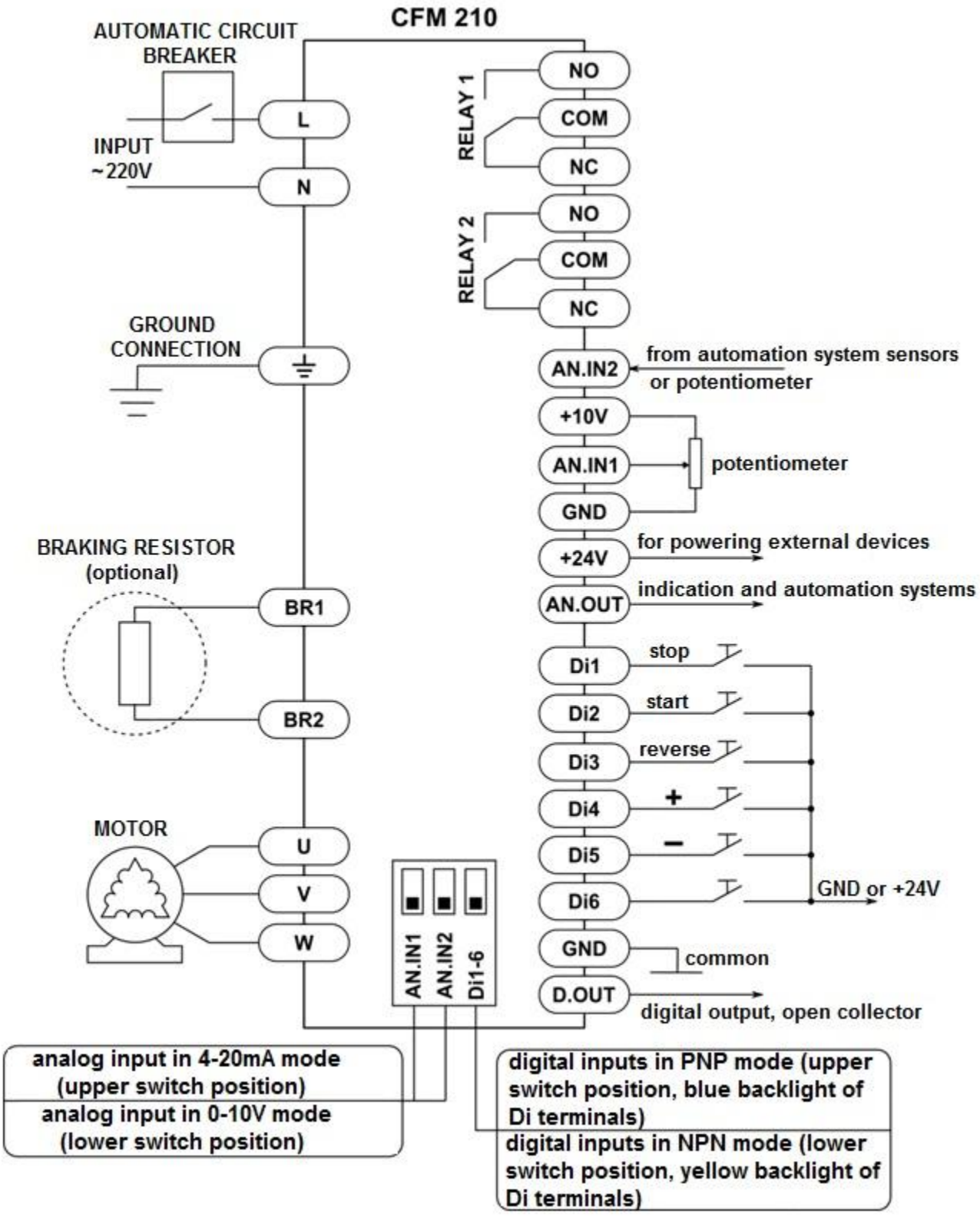


Figure 2. *Basic scheme of the FC external connections*

5.3 WIRING INSTRUCTIONS

WARNING!
Do **NOT** connect mains to U, V and W terminals which are designed to connect motor.

ATTENTION!
Tighten the wires clamping screws with the force recommended by this manual.

Given FC are designed to operate with standard delta connected «Δ» three-phase induction motors. This connection method is illustrated on the figure 3 on the right, star winding connection «Y» is illustrated on the left at which the same motor can work but with less torque on the shaft. Star connection **is NOT recommended.**

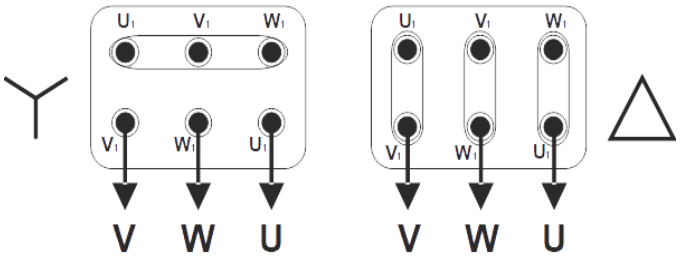


Figure 3. *Motor windings connection methods*

Follow the electrical device operation regulations and safety standards during FC installation and connection.

- Make sure that the protective device is installed between mains and the FC.
- Make sure that the FC is grounded and the grounding circuit impedance does NOT exceed 4 ohm.
- Do the FC and motor grounding in accordance with the requirements of current regulations.
- When using several FCs installed alongside, their ground terminals can be connected in parallel, but so that no loops form from the ground wires.
- To change the motor shaft rotation direction swap two wires that connect motor with FC.
- Make sure that the mains is able to provide the required voltage on FC terminals at full motor load.
- Do NOT connect or disconnect the FC wires when the mains voltage is supplied.
- Do NOT monitor (measure) signals on printed circuit boards while the drive is running.
- Use two ~ 220V terminals to connect a single-phase network. Do NOT try to connect a single-phase motor to the FC.
- To reduce the FC caused interference, it is possible to use an electromagnetic interference filter (optional).
- Use an inductive filter to reduce capacitive leakage currents when working on a long cable (option), which is connected directly to the FC output. Do not use filters that have installed capacitors on its inlets.
- When using a residual current protective device (RCD), it is recommended to choose a protective device with a tripping current of at least 20 mA and a tripping time of at least 0.1 s, since false tripping is possible with a more sensitive RCD.

ATTENTION!
It is forbidden to connect the FC directly to the mains without protective device (automatic circuit breaker).

To restore the FC operation after the external protection has been activated it is necessary to first eliminate the cause of the overload and then to start the FC again.

5.4 OPERATION SPECIFICS OF STANDARD INDUCTION MOTORS WITH FREQUENCY CONVERTERS

1. The losses in the motor are less when a three-phase induction motor is powered from a FC than when powered from the mains. Depending on the set acceleration time, the starting current consumed by the electric drive from the mains may not exceed the rated current or exceed it by only 1.5 - 2 times. When starting the induction motor with a squirrel-cage rotor

directly, the starting current is 5-7 times higher than the rated current, which is extremely negative for the mains and its consumers.

2. During long-term operation of a standard induction motor at low speed with a rated torque it may overheat because of reduced blowing by its own fan.
3. A standard (self-ventilated) induction motor can provide maximum torque for a long time only at the nominal rotation speed, therefore, if the rotation speed is reduced, it is necessary to reduce the average load on the motor shaft.
4. To achieve high torque at low rotational speed, use special motors (with cooling independent from rotation speed) or overpowered motors.
5. When using a standard motor (for instance, powered by a 50Hz mains) at high frequencies provided by the FC, take into account the limitations related with the bearing life and increased vibration due to residual rotor disbalance, as well as torque reduction compared to the nominal.
6. With a long cable connected the FC to the motor, peak voltage surges on the motor windings are possible, which can cause a motor windings insulation breakdown. There are a few methods to solve this problem:
    - the use of a motor filter that reduces the peak surge voltage;
    - the use of a motor with high breakdown voltage isolation, specifically designed to work with semiconductor FCs;
    - use of a cable no longer than 10 - 30 m.

6. CONTROL AND ADJUSTMENT OF FREQUENCY CONVERTER

6.1 CONTROL PANEL

The FC can be in one of two modes: operation or programming (service mode chapter 6.4). In the operating mode only the basic parameters of the FC are available for viewing (Fig. 5).

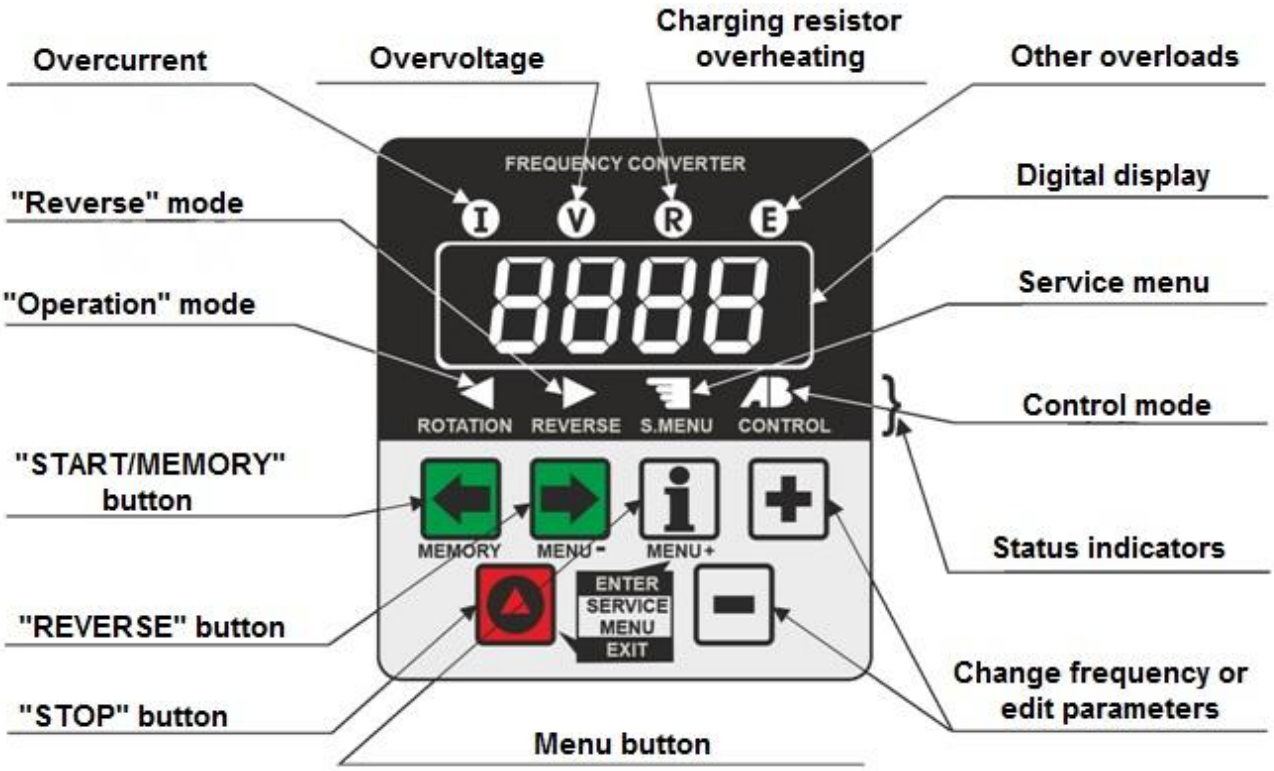


Figure 4. *Control panel physical configurations*

The FC control panel has two functional parts: a digital LED display and buttons for the drive operating modes control.

The digital display is divided into three zones:

- overload indicators (marked red LEDs) - at the top,
- a digital display for the FC parameters displaying - in the middle,

- FC status indicators (yellow LEDs) - on the bottom.

The lower yellow indicators indicate the status of the FC (from the left to the right):

- constant glow - motor rotation (regardless of direction),
  low frequency flashing - the motor rotates and acceleration or braking is in progress,
  flashing with high frequency - voltage is supplied to the motor, auxiliary procedures are performed.
- rotation direction (regardless of the rotation),
- FC operation in the tuning menu (service menu),
- automatic or manual control.

Automatic control means FC operation from a programmable script.

The panel can be removed from the FC and placed on the door of the control cabinet or operator's panel or replaced by RS485 communication interface panel. To remove the control panel, on its sides slots are provided in which it is necessary to insert the spine of a flat screwdriver and raise it with a slight movement.

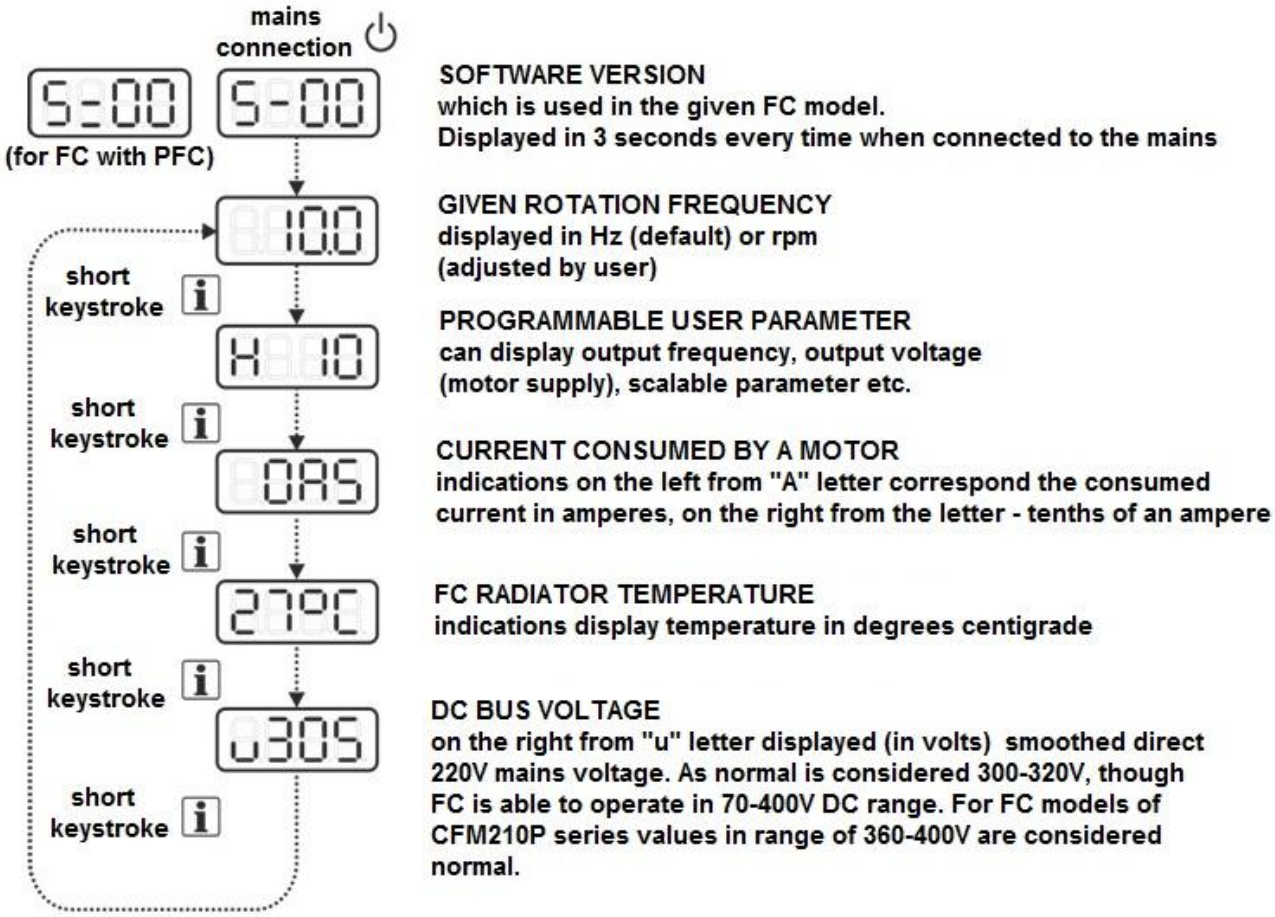


Figure 5. *FC operating menu*

Factory settings, installed at the sale, allow you to control the rotation speed using the ⊞ and ⊟ buttons, start, reverse and stop using the corresponding ⬅, ➡ and ⏏ buttons.

Navigation through the service menu is described in chapter 6.4.

6.2 OPERATION SPECIFICS OF ALARM AND WARNING SYSTEM

In CFM frequency converters an alarm and warning system is realized, which is able to attract the attention of service personnel.

In case of an accident in the FC operation the output voltage is completely turned off, followed by the device setting to the emergency standby mode. In this mode the drive restart is completely blocked until measures are taken to eliminate the emergency and until the FC alarms memory is cleared using the button ⏏ ("STOP / EXIT") or until automatic restart initiation when using it. At the same time, in emergency standby mode, a special light indication is performed on the FC control panel display in the form of a blinking inscription with a frequency of 0.7 sec, switching sequentially the codes of all errors recorded in the drive (Fig.6a) "Error NN", the emergency LED also blinks, which reports that this code belongs to one of the error categories, which will allow you to make a quick decision on troubleshooting or find a description and recommendations in the summary list of error codes. In cases where a critical accident is occurred on a drive in operation - alongside with the error code flashes on the display a continuous audible alarm is performed.

The warning system was created to inform service personnel about incorrectly entered settings of individual drive operation modes or in cases when the FC goes into the critical operation mode area and you should pay attention to its operation parameters to prevent an emergency.

Warnings are displayed only on the front panel indicator ("Attention NN"), and are not recorded in the error log memory. In concurrence with this a sequential switching performed with a frequency of 0.7 sec for each of the warning codes and the FC operation parameter from the main menu (Fig. 6b).

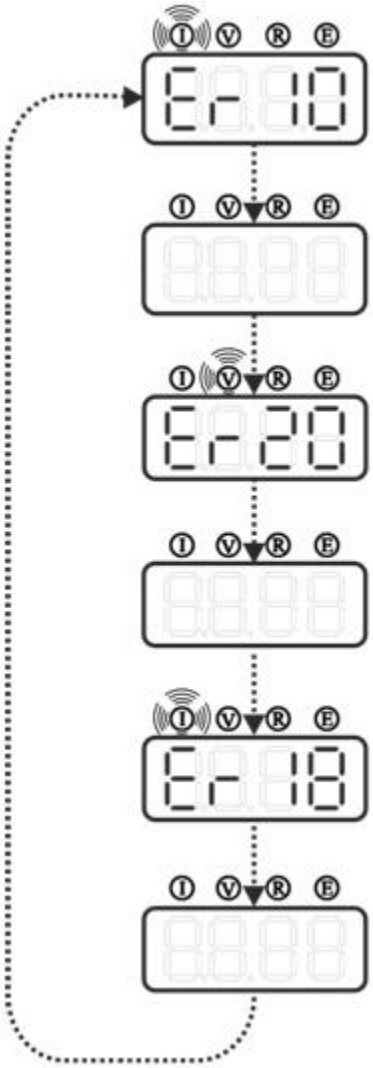


Figure 6. a) *The FC operation error display format "Error NN"*

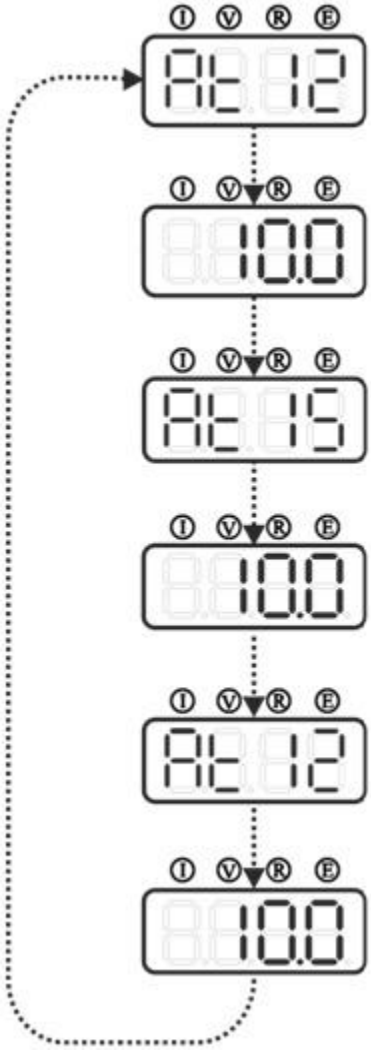


Figure 6. b) *The FC warnings display format "Attention NN"*

6.3 EXTERNAL CONTROL TERMINALS

The converter control signals do not have galvanic communication with the mains ~220V.

CAUTION!

To avoid false reports of external control signals, it is recommended to use a shielded cable with a length of not more than 30 m. The shielding braid must be connected to the common wire of the control terminals **or** to be grounded.

In addition to the front panel control, the FC provides remote control of the motor operation connected to the FC using external control terminals (Fig. 7). The terminals support discrete and analog input signals.

Digital inputs can be connected to external buttons, switches, sensors and other switching elements with the outputs of "NPN" or "PNP" types. The input mode selection corresponds to the active state of the corresponding switch (see Fig. 2).

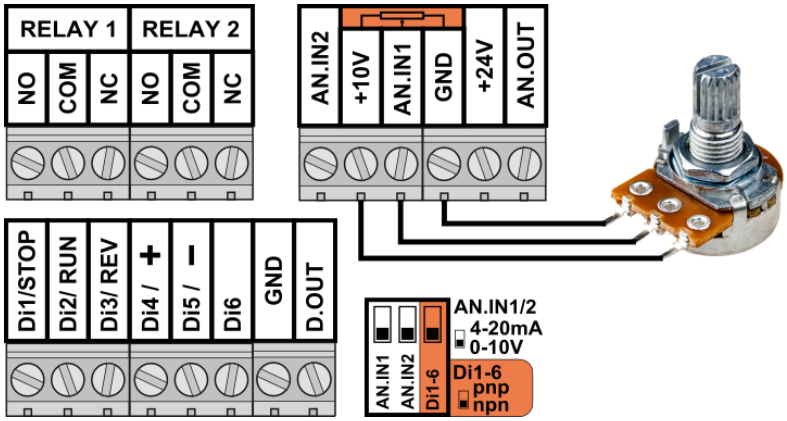


***Figure 7**. FC Remote Control Terminals*

The analog inputs are used to control the motor speed, as well as to formulate a task for the PID controller integrated into the converter.

To control using a variable resistor (potentiometer), it is necessary to connect it to the terminals “+ 10V”, “AN.IN1” and “GND” (Fig. 7). The nominal of the variable resistor should be in the range from 1 to 47 kOhm (typical value is 4.7 kOhm), preferably with a linear (A) resistance characteristic. After connecting the potentiometer to the terminals, it is necessary to configure the inverter to work with the first analog input in menu item **3-02 = 1**. In case you need to work with current analog signals 0 (4) ... 20mA, you should activate this input mode using appropriate switch (see Fig. 2).

The carrying abilities of the reference voltage output "+10V" is not more than 30mA.

If another reference voltage is used, it is necessary to scale the analog input taking into account the real voltage level in the corresponding FC settings.

The “D.OUT” output is a transistor “NPN” output, the characteristics of which are shown in table 1.

“AN.OUT” output is an analog output with programmable output voltage up to 10V.

To power the signal sensors, a “+ 24V” PSU is integrated into the FC, consumers with a total current of not more than 200mA can be connected.

6.4 SERVICE MENU PARAMETERS SETTING

The FCs have factory settings installed for sale which allow you to perform a test run and in the absence of special requirements operate the FC without any additional settings. The FC with the factory settings is designed to operate with a conventional three-phase induction motor with a supply voltage of 220V and a frequency of 50Hz. In case of using the motor with other parameters, additional adjustment must be made.

You should enter the service menu to configure the FC. You can enter the service menu in two ways:

- when turning on the power, simultaneously hold two buttons [i] and [→] on the FC front panel for 2 seconds.
- hold one [i] button from the work menu for 2 seconds.

Scrolling through the menu items is performed by the button [i] (up - named "MENU+") and button (down - named "MENU-"). The number of the menu item is displayed in the format **X-XX**, where the number before dash indicates the menu group and after the dash the sub-item number of the specified menu group. The value of its parameter will appear in 1 second after the needed item has been selected which can then be changed using the [+] and [−] buttons. To save a new parameter value, briefly press the [←] button (named “MEMORY"), upon that the digital display should turn off for 0.5 seconds confirming the storage. When viewing the inverters serial number or the error log that are available for reading only, the "MEMORY" button displays the rest values of the selected menu item (Fig. 28 and Fig. 29).

In order to exit the service menu to normal operation briefly pressing the [⏏] button (“EXIT”). All saved parameters will take effect immediately upon exiting the service menu.

The navigation principles through the service menu are shown in Figure 8.

To reset the FC to the factory settings, do the following: when turning on the FC power, simultaneously hold down the [i], [→] and [−] buttons for 2 seconds, after that the FC will go into service mode and display item 7-03 with the value of 0. To confirm the reset press the [←] "MEMORY" button.

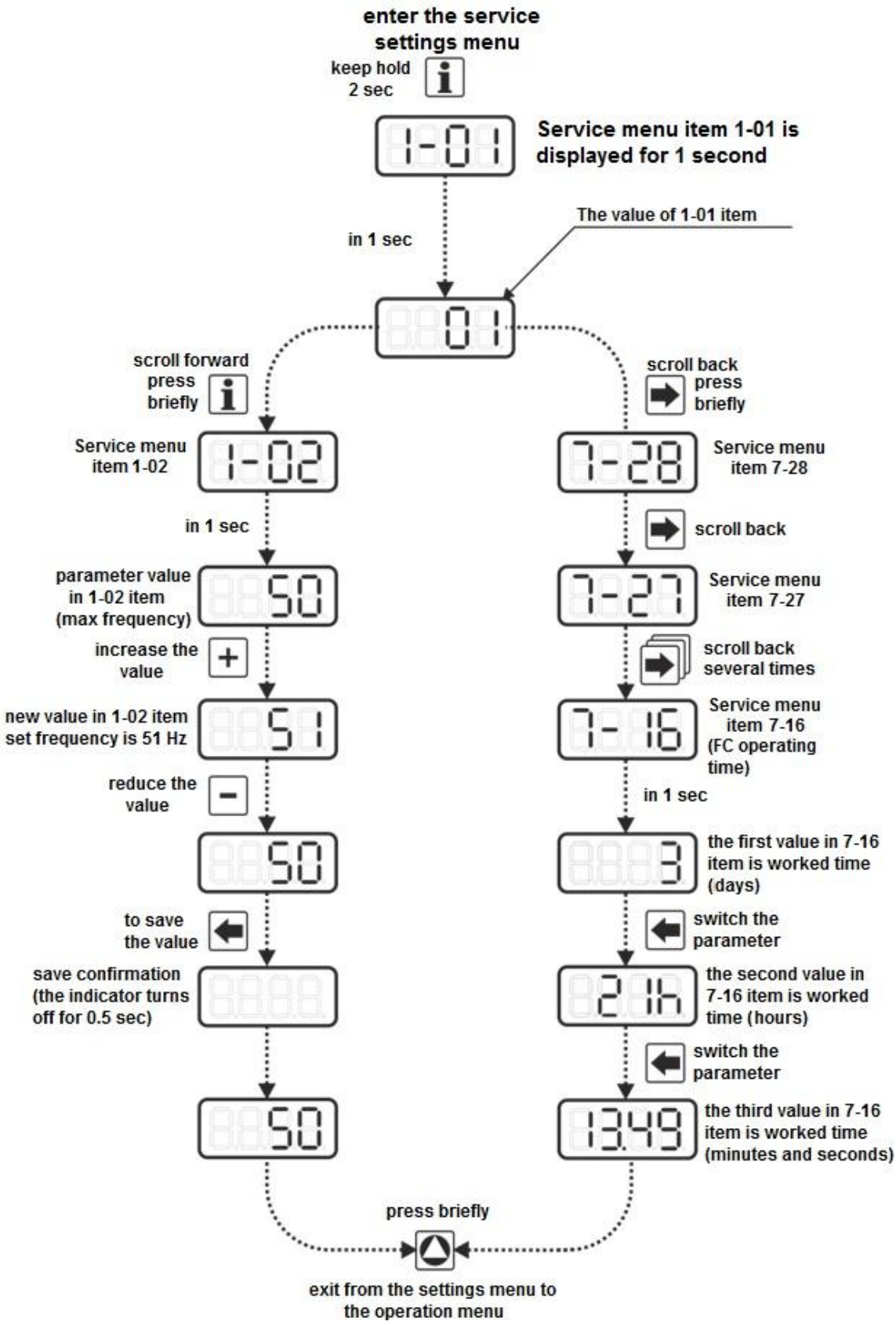


Figure 8. *Navigation through the FC service menu.*

To avoid accidental incorrect FC settings, starting from software version 5-00, access to changing the parameters of some menu items was partially 🔓 or completely limited 🔒. The corresponding mark can be found in table No. 3.

For more information on removing restrictions see paragraph 7-02.

Table 3. *Summary list of parameters*

Menu №	Access	Menu item assignment	Units	Min. value	Max. value	Factory setting
1. Acceleration and Braking Parameters						
1-01		Minimum motor speed	Hz	1	800	1
1-02		Maximum motor speed	Hz	1	800	50
1-03		Acceleration Time A	sec	0,1	999,9	3,0
1-04		Braking time A	sec	0,1	999,9	3,0
1-05	🔓	Starting frequency	Hz	1	800	1
1-06		Release frequency	Hz	1	800	10
1-09		Acceleration Time B	sec	0,1	999,9	3,0
1-10		Braking time B	sec	0,1	999,9	3,0
1-14	🔓	Drive start mode		0	3	0
1-15	🔓	Drive Stop Mode		0	3	1
1-16		Magnetization voltage level before starting		1	100	10
1-17		DC braking time	sec	0,0	30,0	0,0
1-18		DC braking force		0	100	10
2. Control Mode Parameters						
2-01	🔓	Control Command Source A		0	6	2
2-02		Control mode A		0	4	2
2-03		Reverse rotation ban A		0	1	0
2-04		Control Command Source B		0	2	1
2-05		Control mode B		0	4	1
2-06		Reverse rotation ban B		0	1	0
2-07		Digital input mode Di1		0	38	1
2-08		Digital input mode Di2		0	38	3
2-09		Digital input mode Di3		0	38	5
2-10		Digital input mode Di4		0	40	7
2-11		Digital input mode Di5		0	40	9
2-12		Digital input mode Di6		0	40	39
2-13		Display of the digital inputs status	Read only			
2-14	🔓	FC response to the external control terminals operation error		0	1	0
3. Frequency setter parameters						
3-01	🔓	Frequency reference source A		0	4	2
3-02	🔓	Frequency setting mode A		0	7	0
3-03		Frequency reference source B		0	2	1
3-04	🔓	Frequency setting mode B		0	7	1

Menu №	Access	Menu item assignment	Units	Min. value	Max. value	Factory setting
3-05		Min task signal level AN.IN1	V / mA	0,00	10/20	0,00
3-06		Max task signal level AN.IN1	V / mA	0,01	10/20	10,00
3-07		Characteristic AN.IN1		0	3	0
3-09		Min task signal level AN.IN2	V / mA	0,00	10/20	0,00
3-10		Max task signal level AN.IN2	V / mA	0,01	10/20	10,00
3-11		Characteristic AN.IN2		0	3	0
3-12		Preset Step Time 1	sec	0,1	999,9	0,1
3-13		Preset Step Time 2	sec	0,1	999,9	0
3-14		Preset Step Time 3	sec	0,1	999,9	0
3-15		Preset Step Time 4	sec	0,1	999,9	0
3-16		Preset Step Time 5	sec	0,1	999,9	0
3-17		Preset Step Time 6	sec	0,1	999,9	0
3-18		Preset Step Time 7	sec	0,1	999,9	0
3-19		Preset Step Time 8	sec	0,1	999,9	0
3-20		Preset frequency 1*	Hz	0	800	5
3-21		Preset frequency 2*	Hz	0	800	10
3-22		Preset frequency 3*	Hz	0	800	15
3-23		Preset frequency 4*	Hz	0	800	20
3-24		Preset frequency 5*	Hz	0	800	25
3-25		Preset frequency 6*	Hz	0	800	30
3-26		Preset frequency 7*	Hz	0	800	35
3-27		Preset frequency 8*	Hz	0	800	40
3-28		PID-controller period	ms	1	100	10
3-29		PID-controller proportional coefficient		1	1000	100
3-30		PID-controller integral coefficient		1	1000	0
3-31		PID-controller differential coefficient		1	1000	0
3-32		PID-controller output restriction	%	5,0	100,0	100,0
3-33		PID-controller deadband	%	0,0	15,0	0,0
4. Motor Control Parameters						
4-01	🔓	Motor control mode		1	4	1
4-05		PWM frequency	kHz	3	12	6
4-06		Programmable maximum motor current**	A	0,1	20,0	20,0
4-07		Overcurrent trip delay	sec	0,1	999,9	120
4-08		Programmable minimum motor current**	A	0,0	20,0	0
4-09		Undercurrent trip delay	sec	0,1	999,9	2,0

Menu №	Access	Menu item assignment	Units	Min. value	Max. value	Factory setting
4-10	🔒	FC response to mains undervoltage		0	3	0
4-11	🔒	FC response to mains overvoltage		0	3	0
4-12	🔒	FC response to overcurrent		0	3	0
4-13	🔒	Maximum number of auto restart attempts		1	10	3
4-14	🔒	Auto Restart Delay	sec	1	60	1,0
4-17		Torque compensation level below corner frequency	%	0	150	25
4-18		corner frequency	Hz	5	30	20
4-19	🔒	Torque compensation level above corner frequency	%	0	150	0
4-20	🔒	Torque Compensation Time Constant	sec	0,05	99,99	0,5
4-21	🔒	Slip Compensation Level	%	0	150	0
4-22	🔒	Slip Compensation Time Constant	sec	0,05	99,99	0,5
5. Motor Parameters						
5-01		Rated motor speed	rpm	200	3000	3000
5-02		Rated motor voltage frequency	Hz	40	800	50
5-03		Rated motor voltage	V	36	660	220
5-04		Rated motor current***	A	0,2	30,0	13,5
5-05	🔒	Active resistance of phase motor winding	Ohm	0,02	99,99	10
5-07	🔒	Motor stator windings connection diagram		0	1	0
5-08	🔒	Motor identification start		0	1	
5-11	🔒	Start threshold of motor current limit	%	60	300	100
5-12	🔒	Current limit intensity	%	0	100	0
5-14	🔒	Current Limit Response Delay	sec	0,01	20	0,01
5-16	🔒	Durable motor thermal current	%	0,0	200,0	0,0
5-17		Motor heating time constant	sec	1	9999	40
6. Parameters of peripherals						
6-01		Control mode RELAY1		0	20	2
6-02		Response timer RELAY1	sec	0,1	999,9	0,3
6-03		Control mode RELAY2		0	20	17
6-04		Response timer RELAY2	sec	0,1	999,9	0,3
6-05		Control mode D.OUT/AN.OUT		0	28	22
6-06		D.OUT-IN.OUT amplification factor in analog mode		1	5000	1500
6-07		Timer D.OUT-AN.OUT	sec	1	9999	1
6-08		Meterage Mode		0	4	0
6-09		Pulse transducer step	mm	0,01	199,99	50,00
6-10		Brake start distance	m	0,0	10,0	0,0

Menu №	Access	Menu item assignment	Units	Min. value	Max. value	Factory setting
6-12		RS-485 baud rate		1	6	3
6-13		FC network address		1	247	81
6-14		Parity / Stop Bits		0	5	0
6-15		Watchdog RS-485	sec	0,0	30,0	5,0
6-16		Communication Error Response		0	1	0
6-17		FC response delay via RS-485	ms	0	2000	0
7. User's options						
7-01		Frequency reference display: rpm - Hz		0	1	0
7-02		Password to enter the service menu		0	9999	-
7-03		Configuration upload		0	2	0
7-04		Configurations storage		1	2	-
7-05		User Parameter Display Mode		0	7	0
7-06		User parameter scaling factor		0,1	199,9	1,0
7-07		User parameter decimal location		0	3	0
7-08		Prohibition of sound indication (buzzer)		0	1	0
7-09		Indicator brightness	%	5	115	80
7-10		The parameter shown on the display when the FC is turned on		0	2	1
7-11		Programmable Script Operation Mode		0	1	0
7-12		Programmable Script Reset Mode		0	3	1
7-14		Firmware version		Read only		
7-15		FC serial number		Read only		
7-16		FC Runtime		Read only		
7-17		Last recorded error in the FC operation		Read only		
7-18		Penultimate error recorded		Read only		
7-19…7-28		Earlier Errors Reported		Read only		

**** - these parameters have a special installation principle (in more detail in the items description).***
***** - the upper threshold for the FC is limited by the value: 1.1kW - 8.5A; 1.5kw - 12A; 2.2kW - 16A.***
****** - factory setting for FC: 1.1kW - 5.7A; 1.5kw - 7.8A; 2.2kW - 10.6A.***

ACCELERATION AND BRAKING PARAMETERS

Parameter 1-01. The minimum shaft speed (in Hertz) required when working with the drive.

When using the motor at low speeds, one should not forget that self-ventilated motors will not be able to provide a nominal air flow for their cooling, as a result long-term operation at low speeds is not recommended.

Valid value range: 1 ÷ 800 Hz.

Parameter 1-02. The maximum motor shaft rotation frequency (in Hertz) required when working with the drive.

The FC output frequency can rise above this value only when slip compensation by the value of the current motor slip is activated. When setting this parameter should be taken in an account that not all motors are designed to operate at high speeds. When operating at speeds above nominal, the motor shaft torque decreases due to the limited FC voltage supply, also wear and tear of the machine's mechanical components increases.

Valid value range: 1 ÷ 800 Hz.

Parameter 1-03 and 1-09. Acceleration time A / B (accuracy 0.1 seconds).

This value shows how long the output frequency changes from zero to nominal (nominal frequency - menu item 5-02). For example, at a task frequency of 25 Hz and a nominal frequency of 50 Hz and an acceleration time of 3.0 sec the actual acceleration time will be:
25 Hz / 50 Hz * 3.0 sec = 1.5 sec.

Valid value range: 0.1 ÷ 999.9 sec.

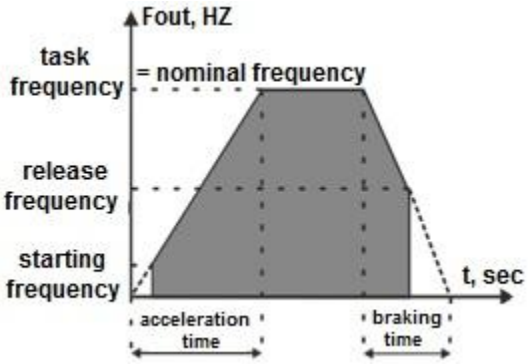


Figure 9. *Dynamic drive parameters*

Parameter 1-04 and 1-10. A / B braking time (setting accuracy 0.1 second).

This value shows how long the output frequency changes from the nominal to zero (nominal frequency - menu item 5-02). For example, the total braking time at a release frequency of 10 Hz, a task frequency of 40 Hz, a nominal frequency of 50 Hz and a braking time of 3.0 sec will be 3.0 sec * (40 Hz - 10 Hz) / 50 Hz = 1.8 sec.

Valid value range: 0.1 ÷ 999.9 sec.

Parameter 1-05. Motor shaft spin starting frequency (in Hertz).

Determines the three-phase voltage frequency supplied to the motor at start (Fig. 9). At high starting frequencies and maximum motor power at start, the FC current overload protection can be triggered.

Valid value range: 1 ÷ 800 Hz.

Parameter 1-06. The motor shaft "release" frequency at stop (in Hertz).

It determines the FC output frequency at which stops the three-phase voltage supply to the motor (Fig. 9), if a command for a controlled stop is given. This parameter is effective only when stop, i.e. if menu item 1.01 allows, the FC output frequency during motor rotation can be set less than the frequency of "release".

Valid value range: 1 ÷ 800 Hz.

Parameter 1-14. Drive start mode.

Sets the sequence for drive start.

Start mode 0 - simple start with the FC output phases check. Before applying a three-phase voltage to the motor stator, the machine windings are tested with direct current. This procedure eliminates the possibility for FC to turn on in two phases or on a short circuit in the motor windings or connecting wires.

Start mode 1 - start with preliminary stator magnetization during 0.5 sec and the FC output phases check. After testing the output phases, a fixed voltage vector with a given angular position and adjustable amplitude is supplied to the motor stator. This mode can be used to reduce starting currents during the drive dynamic acceleration or heavy starts.

Start mode 2 - start with the FC output phases check and preliminary direct current braking. It can be used in drives which working body can rotate in the desired motor shaft rotation direction as well as in the opposite direction during stop. This mode allows you to stop the working body and start the drive in safe mode with a stopped mechanism.

Start mode 3 - start with the FC output phases check and frequency scanning with next soft motor catch-up. In this mode, before starting, the electric motor frequency scan is performed to detect the actual rotor speed. After successful detection, the FC makes a soft motor catch-up at this frequency and then accelerates the motor to the given speed with the intensity defined in the FC menu. This mode can be used in mechanisms where it is necessary to turn on the FC on-go without a forced stop or in cases where the kinetic energy accumulated by the working body cannot be extinguished using DC braking before start.

Valid value range: 0 ÷ 3.

Scanning time for an induction motor with a nominal frequency of 50 Hz is up to 7 sec. The higher the actual shaft speed the faster the procedure. Frequency search is performed only in a given rotation direction. If the frequency is NOT found or the actual rotation direction does not match the

set one, the FC starts the motor from the starting frequency in the set direction.

Parameter 1-15. Drive stop mode

Specifies the drive actions when it receives a stop command.

Stop mode 0 - Motor coasts to a stop (free run).

Stop mode 1 - Frequency stop with a predetermined automatically corrected intensity and low threshold for fading in DC voltage when the motor enters the regenerative mode. If during the stator voltage frequency reduction process the motor enters the regenerative mode, accompanied by the DC link voltage increase, the drive “freezes”. It stops the frequency decrease and waits until the voltage drops to normal. As soon as the voltage drops into the valid range the frequency reduction process is resumed.

Stop mode 2 - Frequency stop with a predetermined intensity without limits and an increased threshold for fading in DC voltage when switching to regenerative mode.

This mode does not limit the set frequency reduction intensity and can only be used with a braking resistor if the drive has a high inertia (circular saws, fans, flywheels, etc.). The drive freezes when the frequency decreases only if the power of the used braking resistor is not enough to dissipate all the generated power. In this case, the voltage may rise above the safe FC operation level.

Stop mode 3 - Frequency stop with DC braking while releasing.

Until the release frequency, the drive stops at a given, automatically adjusted intensity; upon reaching the given value a fixed voltage vector with an adjustable amplitude and exposure duration is applied to the stator.

Valid value range: 0 ÷ 3

Parameter 1-16. Magnetization voltage level.

Sets the voltage vector amplitude applied to the stator before start. Changing the voltage level allows you to achieve the desired effect of using this mode by adjusting the magnetization current.

Valid value range: 1 ÷ 100

Parameter 1-17. DC braking time, sec.

If this parameter is non-zero on start or when the release frequency is reached, DC braking activates, if this mode is selected. The parameter setting resolution is 0.1 sec. When the parameter value is zero, DC braking is not performed. The parameter setting resolution is 0.1 sec. DC braking is not performed when the parameter value is zero.

Valid value range: 0 ÷ 30.0 sec.

Parameter 1-18. DC braking force.

Sets the fixed voltage vector amplitude supplied to the stator. The higher this parameter the greater the current flows through the motor windings, thereby forming a significant braking torque.

Valid value range: 0 ÷ 100

Control mode parameters

There are 2 sources of engine rotation control, “A” and “B”. These parameters allow to configure two independent FC control locations (for example, the FC panel and the operator console on the machine). The control source can be changed (switched) at any moment of time.

Parameter 2-01. Control commands source "A".

This parameter sets the drive control commands source in group “A”.

As a control commands source for group "A" can be selected:

Source 0 - Front FC control panel (Fig. 4), commands are generated only by buttons on the front panel.

Source 1 - External control terminals (Fig. 7), commands are generated only by signals on digital isolated inputs.

Source 2 - Combined control, in which commands come both from the panel and from the terminals (the default value for selling and resetting to factory settings in menu item 7-03).

Source 3 - RS485 communication interface, control only by commands coming via the communication interface despite the selected control mode (see ModBus-RTU user manual).

Source 4 - A programmable script with FC front panel control (Fig. 4) despite the selected control mode.

Source 5 - A programmable script with external control terminals control (Fig. 8) despite the selected control mode.

Source 6 - A programmable script with combined control in which commands come both from the panel and from the terminals despite the selected control mode.

Valid value range: 0 ÷ 6

Parameter 2-02. The control mode from the source "A".

Depending on the selected control source there is a possibility to set the corresponding control mode:

Control mode 0 - closing and holding the START contact in the active state starts and continuously rotates the motor. If the START contact opens the FC starts stopping the motor. Changing the REVERSE contact state in case of mismatching of the actual and the desired rotation direction causes the motor to reverse. Closing and keeping the STOP contact in the active state leads to a complete drive stop regardless of the START and REVERSE contacts states.

Control mode 1 - closing and holding the START contact in the active state starts and continuously rotates the motor in the forward direction. Closing and holding the REVERSE contact in the active state starts and continuously rotates the motor in the opposite direction. If the START or REVERSE contact opens or simultaneously close - the motor stops. Closing and keeping the STOP contact in the active state leads to a complete drive stop regardless of the START and REVERSE contacts state.

Control mode 2 - short-term (pulse) closing of the START contact starts and continuously rotates the motor in the forward direction. Short-term (pulse) closing of the REVERSE contact starts and continuously rotates the motor in the opposite direction. In the case of a simultaneous pulse closure of the START and REVERSE contacts the motor will not be started. Short-term (pulse) closing or holding the STOP contact in the active state leads to a complete drive stop regardless of the START and REVERSE contacts state.

Control mode 3 - short-term (pulse) closing of the START contact starts and continuously rotates the motor. Short-term (pulse) closing of the REVERSE contact in case of mismatching of the actual and the desired rotation direction causes the motor reverse. Short-term (pulse) closing or holding the STOP contact in the active state leads to a complete drive stop regardless of the START and REVERSE contacts state.

Control mode 4 - the start and stop of the motor rotation is performed by the signal level at the analog input under the condition that it is selected by the group A reference channel. The motor starts when the task from the analog voltage exceeds the minimum speed by 0.4 Hz. The motor stops at an analog voltage level equal to a minimum frequency + 0.3Hz. For example, the minimum speed is set to 5 Hz, which means that the motor turns on when the task is 5.4 Hz and turns off when the task frequency is 5.3 Hz or less. Throughout the rest of the frequency range (up to the maximum speed) the motor is controlled by analog voltage. Changing the REVERSE contact state in case of mismatching of the actual and the desired rotation direction causes the motor to reverse. Closing and holding the STOP contact in the active state leads to a complete drive stop regardless of the REVERSE contact state and the signal level at the analog input.

Valid value range: 0 ÷ 4

When choosing a control source a restriction appears on the control modes available for use. In the table 4 the available modes are listed for each of the control commands sources.

Table 4. *Control modes restrictions*

Control source	Mode 0	Mode 1	Mode 2	Mode 3	Mode 4
Source 0 - Control panel	-	+	+	-	-
Source 1 - External control terminals	+	+	+	+	+
Source 2 - Combined (factory settings)	+	+	+	+	+
Source 3 - RS485 communication interface	**command control via RS485**				
Source 4 - Programmable script (from CU)	**control from script commands**				
Source 5 - Programmable script (from terminals)					
Source 6 - Programmable script (combined)					

Parameter 2-03. The motor shaft reverse rotation ban “A”.

If the value is “0” the FC allows rotation in both directions.

If the value is “1” the FC allows to rotate in only one direction (direct - with the off REVERSE status LED).

Valid value range: 0 ÷ 1

Parameter 2-04. Control commands source B.

This parameter sets the drive control commands source in group “B”. The same sources are available for selection as in menu item 2-01 except for the RS485 communication interface and programmable script.

Valid value range: 0 ÷ 2

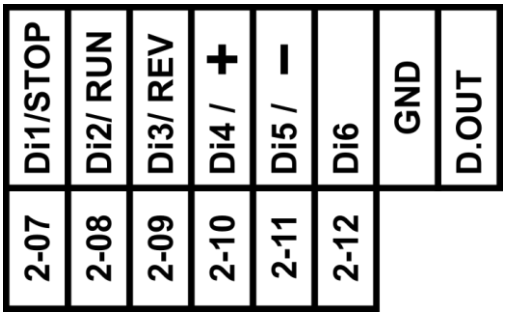
Parameter 2-05. The control mode from the source "B".

It has the same values as the control modes in menu item 2-02.

Valid value range: 0 ÷ 4

Parameter 2-06. The motor shaft reverse rotation ban "B".
It has the same values as menu item 2-03.
Valid value range: 0 ÷ 1

Parameter 2-07...2-12. Digital inputs operation modes Di1..6.



These parameters allow to assign the desired functions to the isolated digital inputs for controlling the drive, setting the frequency, counting pulses, etc. Each menu item corresponds to one of the digital inputs (Fig. 10). Table 5 below shows the available operating modes for digital inputs.

Figure 10. *Correspondence of digital inputs to menu items.*

Table 5. *Available functions list for digital inputs programming*

Mode	Operating mode description	Input inversion	Note
0	Digital input is not enabled	-	
1	The input is used as a STOP signal source	No	see menu item 2-02
2		Yes	
3	The input is used as a START signal source	No	see menu item 2-02
4		Yes	
5	The input is used as a REVERSE signal source	No	see menu item 2-02
6		Yes	
7	The input is used as a signal source for increasing the task “+”	No	see menu item 3-02
8		Yes	
9	The input is used as a signal source for decreasing the task “-”	No	see menu item 3-02
10		Yes	
11	The input is used as a signal source 1 of the preset frequencies switching line	No	see menu item 3-02
12		Yes	
13	The input is used as a signal source 2 of the preset frequencies switching line	No	see menu item 3-02
14		Yes	
15	The input is used as a signal source 3 of the preset frequencies switching line	No	see menu item 3-02
16		Yes	
17	The input is used as a signal source for switching control and reference groups «A» ⟷ «B»	No	The active level at the input activates the group of control sources and tasks “B”, otherwise group “A” is active. Can switch on-go.
18		Yes	
19	The input is used as a drive enable signal	No	An active input level allows to start the drive otherwise the drive is blocked from control actions. If during the rotation the work enable signal disappears, the motor coasts to a standstill with the following blocking.
20		Yes	
21	The input is used as an external alarm signal source	No	The active input level causes a complete shutdown of the drive with light and sound indication, with the following recording to the FC log.
22		Yes	

Mode	Operating mode description	Input inversion	Note
23	Timer start trigger of the relay output# 1	No	Starts the timer of the relay output# 1 on the signal edge at the digital input depending on the selected polarity. See menu item 6-02.
24		Yes	
25	Timer start trigger of the relay output# 2	No	Starts the timer of the relay output# 2 on the signal edge at the digital input depending on the selected polarity. (See menu item 6-03).
26		Yes	
27	Timer start trigger of the transistor output	No	Starts the timer of the transistor output on the signal edge at the digital input depending on the selected polarity. (See menu item 6-05).
28		Yes	
29	Drive acceleration / braking rate switch	No	The active signal level activates the drive in terms of acceleration / braking rates from group B, inactive level - from group A. Can switch on-go.
30		Yes	
31	Activation of programmable script by active input level	No	A constant active level starts and enables the programmed script. The inactive level immediately bans script execution and the drive stops.
32		Yes	
33	Activation of a programmable script on the edge of the active level at the input (pulse)	No	The edge of the active pulse starts the programmed script execution. Script execution can be stopped only from the STOP line.
34		Yes	
35	Programmable script initialization	No	Active pulse edge clears script operation history. The script starts from the first step.
36		Yes	
37	Distance initialization in meter mode	No	The active impulse edge recounts the new measured distance based on the current meter / pieces reference, with the previous counting being discarded.
38		Yes	
39	The input is used in high-speed pulse counter mode	No	Needs to be activated if the meter or pieces counting mode is used (menu item 6-08). By inverting the logic, the moment of pulse fixation is selected: rising edge or falling edge.
40		Yes	

When programming the digital inputs, modes duplication is not allowed and is checked automatically.

For example: *the digital input Di1 is configured as a STOP signal source, and if to set the Di3 input to the STOP signal source mode or the inverted STOP signal source, the Di1 input mode automatically resets to 0 (not used).*

Parameter 2-13. Displays the physical state of the digital inputs (Fig. 11) regardless of the settings of the control mode and frequency setter. Available for reading only.

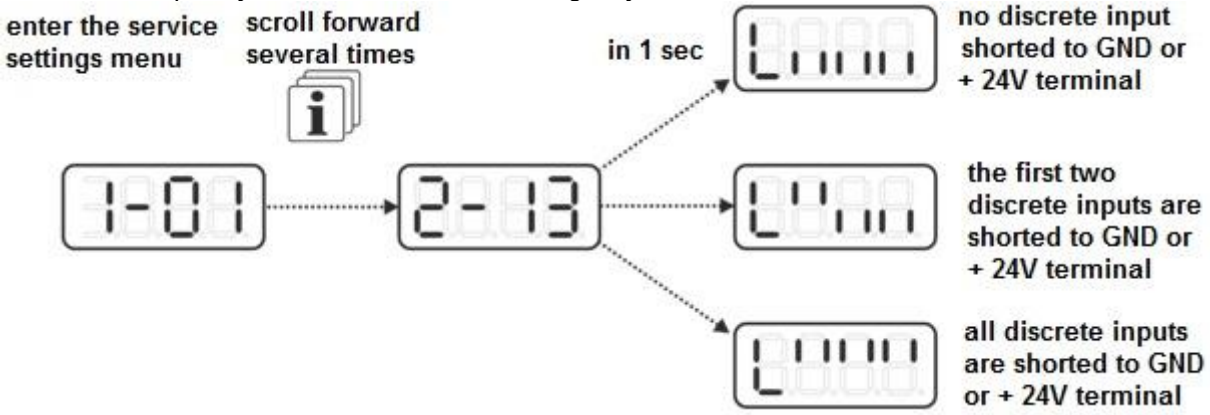


Figure 11. *Display format of the digital inputs status*

Parameter 2-13. FC response to an external control terminals operation error

Sets the FC response in case of a partial or complete external control terminals failure.

At value of 0 - the FC does not detect the terminals malfunction.

At value of 1 - the FC detects the terminals failure then completely stops the drive with emergency light and sound indication.

Valid value range: 0 ÷ 1

Frequency setter parameters

There are 2 sources for setting the motor speed "A" and "B". These parameters allow to configure two independent locations of FC frequency settings (for example, the FC panel and the operator console on the machine). The setting mode can be changed (switched) at any time.

Parameter 3-01. The speed command source “A”.

This parameter sets the motor speed setting source in group “A”.

As the frequency setting source for the group "A" can be selected:

Source 0 - Front FC control panel (Fig. 4), frequency setting can be configured only by buttons on the front panel.

Source 1 - External control terminals (Fig. 7), frequency setting can come from digital or analog inputs.

Source 2 - Combined control in which the frequency settings can be changed both from the panel buttons and from the digital or analog inputs of the external control terminals.

Source 3 - RS485 communication interface, speed setting is generated only by a command via the communication interface, despite the selected frequency setting mode.

Source 4 - Programmable script, automatically frequency setting based on the current state of script execution, despite the selected frequency setting mode.

Valid value range: 0 ÷ 4

Parameter 3-02. Speed setting mode from the source "A".

Depending on the selected setting source, can be set the corresponding frequency setting mode:

Setting mode 0 - frequency change is performed discretely by “+” and “-” signals with a step of 0.1 Hz or 10 rpm from buttons on the control panel and / or by digital inputs of external control terminals depending on the selected setting source.

Setting mode 1 - the output frequency setting is formed by the signal level on AN.IN1.

Setting mode 2 - the output frequency setting is formed by the signal level on AN.IN2.

Setting mode 3 - the output frequency setting is uploaded from the preset frequencies by signal states combinations of the preset frequencies switching lines (see table 6).

Setting mode 4 - the output frequency setting is formed by the signal level on AN.IN1 or setting is uploaded from the preset frequencies by signal states combinations of the preset frequencies switching lines (see table 6).

Setting mode 5 - the output frequency setting is formed by the signal level on AN.IN2 or setting is uploaded from the preset frequencies by signal states combinations of the preset frequencies switching lines (see table 6).

Setting mode 6 - the output frequency level is generated by the built-in PID-controller. The signal from AN.IN1 is used as a task for the PID-controller.

Setting mode 7 - the output frequency level is generated by the built-in PID-controller. The PID-controller task is set by the “+” and “-” signals depending on the selected frequency setting source.

Valid value range: 0 ÷ 7

Table 6 shows the switching lines groups combinations of preset frequencies and frequencies uploaded with their help, where “1” - the line is active, “0” - the line is inactive.

To work with preset frequencies it's necessary to configure the digital inputs in menu items 2-7 ... 2-12.

Table 6. *Preset frequency switching combinations*

Line status 3	Line status 2	Line status 1	The output frequency setting formation
0	**0**	**0**	***Setting mode 3:*** Preset frequency 1 (menu item 3-20) ***Setting mode 4:*** AN.IN1 signal level ***Setting mode 5:*** AN.IN2 signal level
1	**0**	**0**	Preset frequency 2 (menu item 3-21)
0	**1**	**0**	Preset frequency 3 (menu item 3-22)

Line status 3	Line status 2	Line status 1	The output frequency setting formation
1	**1**	**0**	Preset frequency 4 (menu item 3-23)
0	**0**	**1**	Preset frequency 5 (menu item 3-24)
1	**0**	**1**	Preset frequency 6 (menu item 3-25)
0	**1**	**1**	Preset frequency 7 (menu item 3-26)
1	**1**	**1**	Preset frequency 8 (menu item 3-27)

When choosing one of the setting sources a restriction appears on the setting modes available for use. Table 7 shows the available modes for each of the setting sources.

Table 7. *Restrictions on setting modes*

Control source	Frequency setting modes							
	P.0	**P.1**	**P.2**	**P.3**	**P.4**	**P.5**	**P.6**	**P.7**
Source 0 - Control panel	**+**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Source 1 - External control terminals	**+**	**+**	**+**	**+**	**+**	**+**	**+**	**+**
Source 2 - Combined	**+**	**+**	**+**	**+**	**+**	**+**	**+**	**+**
Source 3 - RS485 communication interface	**the setting is formed by a command from RS485**							
Source 4 - Programmable script	**the setting is formed by the script**							

Parameter 3-03. Rotation speed setting commands source "B".

This parameter sets the motor speed setting source in group “B”.

The same sources are available for selection as in menu item 3-01 except for the RS485 communication interface and programmable script.

Valid value range: 0 ÷ 2

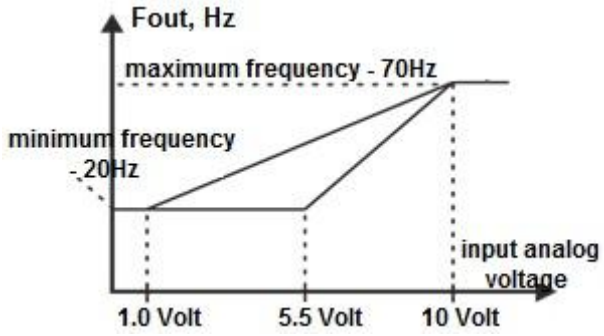
Parameter 3-04. Speed setting mode from the source "B".

It has the same values as in menu item 3-02.

Valid value range: 0 ÷ 7

Parameter 3-05. The minimum task signal level of the analog input 1 (AN.IN1).

This parameter allows to set the input analog signal level corresponding to the minimum speed (menu item 1-01) or the minimum task of the built-in PID controller. The parameter setting allows to generate a task not from the zero signal level at the analog input, but from any within the valid range (0 ÷ 10V or 0 ÷ 20mA). Figure 12 shows two reference voltage values - 1.0 and 5.5 Volts for one minimum frequency - 20 Hz. This parameter is set using the “+” and “-” buttons with an accuracy of 0.01 V / mA. Below this signal level, the frequency setting does not change, and is equal to the minimum value.



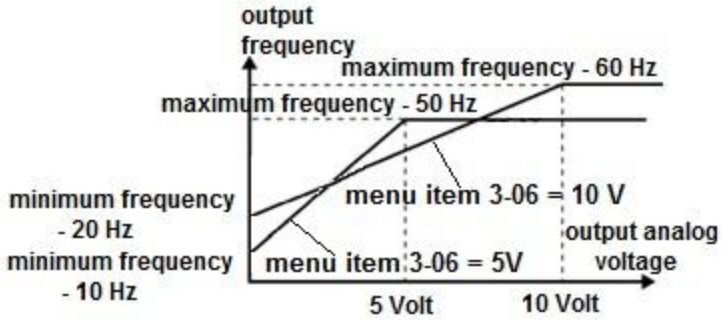
Valid value range:

0.00 ÷ 10.00V

0.00 ÷ 20.00mA (if AN.IN operating mode is selected - current loop)

Figure 12. *Scaling AN.IN at the lower end of the signal range*

Parameter 3-06. The maximum task signal level of the analog input 1 (AN.IN1).



If the frequency setting mode is from AN.IN1 then this parameter allows to bring into sync the output frequency value or the PID-controller task with the control analog signal level (Fig. 13). This parameter is set using the "+" and "-" buttons with an accuracy of 0.01 V / mA. In this case, the FC calculates the necessary gain of the analog channel by itself.

Figure 13. *Scaling AN.IN at the upper end of the signal range*

The factory default setting is 10.00 V.
Valid value range:
0.00 ÷ 10.00V
0.00 ÷ 20.00mA (if AN.IN operating mode is selected - current loop)

Parameter 3-07. Analog input 1 (AN.IN1) characteristic.

Determines the dependence type of a given speed or PID-controller task on the signal level at the analog input, as well as the signal being processed type: voltage or current.

At value of 0 - a direct dependence, i.e. an increase in the analog signal leads to an increase in the rotation speed (task). The analog input operates in voltage measurement mode.

At value of 1 - an inverse dependence, i.e. an increase in the analog signal leads to a decrease in the rotational speed (task). The analog input operates in voltage measurement mode.

At value of 2 - a direct dependence, i.e. an increase in the analog signal leads to an increase in the rotation speed (task). The analog input operates in current measurement mode. In this case, it's necessary to switch the DIP-switch.

At value of 3 - an inverse dependence, i.e. an increase in the analog signal leads to a decrease in the rotational speed (task). The analog input operates in current measurement mode. In this case, it's necessary to switch the DIP-switch.

Important! *In order AN.IN to operate in the current loop, it's necessary first to select the characteristic (mode) 2 or 3 in this menu item and then scale the input by setting the signal levels in menu item 3-05 and 3-06.*

Valid value range: 0 ÷ 3

Parameter 3-09. The minimum task signal level of the analog input 2 (AN.IN2).

Sets with an accuracy of 0.01 V / mA and has an similarity with menu item 3-05.

Valid value range:
0.00 ÷ 10.00V
0.00 ÷ 20.00mA (if AN.IN operating mode is selected - current loop)

Parameter 3-10. The maximum task signal level of the analog input 2 (AN.IN2).

Sets with an accuracy of 0.01 V / mA and has an analogy with menu item 3-06.

Valid value range:
0.00 ÷ 10.00V
0.00 ÷ 20.00mA (if AN.IN operating mode is selected - current loop)

Parameter 3-11. Analog input 2 (AN.IN2) characteristic.

Similar to menu item 3-07. If the PID-controller is used, then when the inverse signal dependence is selected, the controller works in inverse mode, i.e. the excess of the feedback signal over the task signal is compensated by the increase in the output frequency.

Valid value range: 0 ÷ 3

Parameter 3-12...3-19. Preset step time 1 ... 8 of the programmable script.

Valid value range: 0.1 ÷ 999.9 sec

Keep in mind that step time is the total acceleration / deceleration time to the required frequency + motor operation at this frequency.

Parameter 3-20...3-27. Preset frequencies.

In these menu items, preset frequencies are set when operating in the corresponding mode (see table 6). Also, this parameter allows to set the motor rotation direction when activating from a programmable script.

Valid value range: 0 ÷ 800 Hz

A short press of the MEMORY button switches the desired rotation direction; pressing and holding the MEMORY button for about 2 seconds fixes and stores in memory the set value of the frequency and rotation direction.

Parameter 3-28. PID-controller period.

This parameter allows to change the built-in PID-controller procedure call period (Fig. 14) in milliseconds. For slowly changing processes (e.g. temperature control), large period values must be set. For faster processes the period must be reduced.

Valid value range: 1 ÷ 100 ms

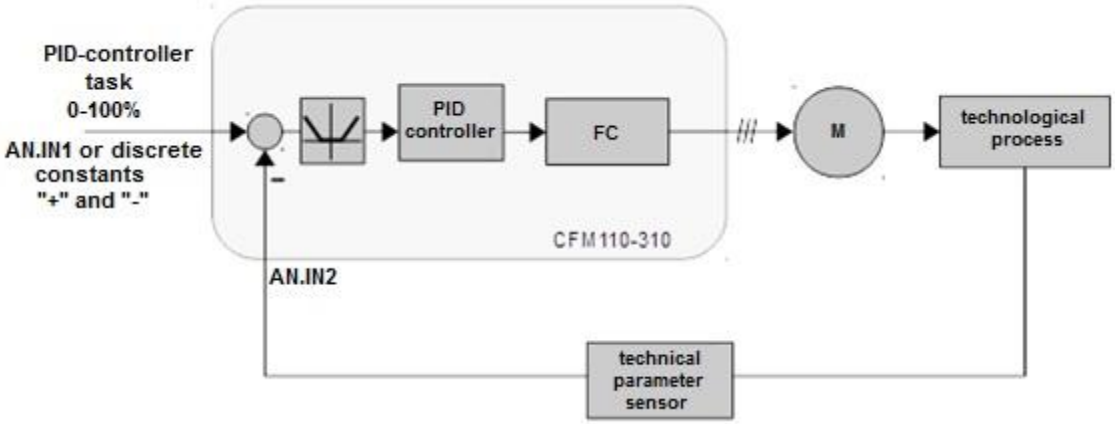


Figure 14. *The conditional PID-controller application scheme for process control*

FC setting example for operation with the PID-controller:

1. Set the task and control commands source from the terminals or combined (see menu items 2-01, 2-04 and 3-01, 3-03).
2. Select control mode 4 (see menu items 2-02, 2-05) - drive start and stop will be initiated by the controller, while the motor reverse will not be available. If a different control mode is selected, FC will automatically switch to operation according to mode 4.
3. Select setting mode 6 when a task forms from AN.IN1 or 7 when a task forms from "+" and "-" contacts (see menu items 3-02, 3-04).

After the PID-controller activation instead of the usual frequency setting it's necessary to set the controller in the range of 0..100.0% using the "+" and "-" contacts or a signal from AN.IN1.

Important! *The changes range of the PID-controller task in the range of 0..100.0% corresponds to the signal variation range on AN.IN2 from the minimum value of menu item 3-09 = 0% to menu item 3-10 = 100%.*

Example: A temperature sensor is used with a measuring range of 0-150ºC and an output of 0 ... 10V. It is necessary the FC maintain a temperature of 35 ° C. At settings 3-09 = 0.00V and 3-10 = 10.00V the task on the FC display should be formed equal to 23.3%.

Parameter 3-29. The PID-controller proportional factor.

This parameter sets the error gain factor — the difference between the setpoint value and the feedback signal. An increase in this coefficient leads to an increase in the sensitivity of the controller, acceleration of error compensation. But excessive increase can lead to fluctuations in the controlled process.

With integral and differential coefficients equal to zero, the regulator proportional link can significantly compensate the error.

Valid value range: 1 ÷ 1000

Parameter 3-30. The PID-controller integral factor.

The PID-controller integrating element accumulates (integrates) a constant error value and allows to compensate

the deviation from the setpoint left after the proportional link operation. This parameter determines the integral component gain factor. A lower value increases the controller stability but slower compensates the error. A larger value allows to quickly compensate the error but with significant changes in the setting leads to overshoot and fluctuations. A value of 0 disables the integrating element.

Valid value range: 1 ÷ 1000

Parameter 3-31. PID-controller differential factor.

The differentiating link enhances the error derivative (rate of change) and allows to increase the controller speed, accelerates fluctuation damping. But too large values can lead to instability of the controlled process. For slow processes and with large noise in the sensor signal, the use of a differential link is impractical. A value of 0 disables the differentiating element.

Valid value range: 1 ÷ 1000

Parameter 3-32. PID-controller output restriction.

In the case of a large difference between the setpoint and the feedback signal the integral element begins to accumulate an error, thereby increasing the output frequency to the maximum (menu item 1-02). This parameter limits the permissible value of the regulator output signal in percentage from the allowed frequency range.

Valid value range: 0.1 ÷ 100.0%

Parameter 3-33. PID-controller deadband.

This parameter sets the error level that the PID-controller does not process, which in turn eliminates unnecessary controller response in the area of small mismatch. It should also be taken into account that an increase in the deadband leads to an increase in the static error of the parameter control.

Valid value range: 0.0 ÷ 15.0%

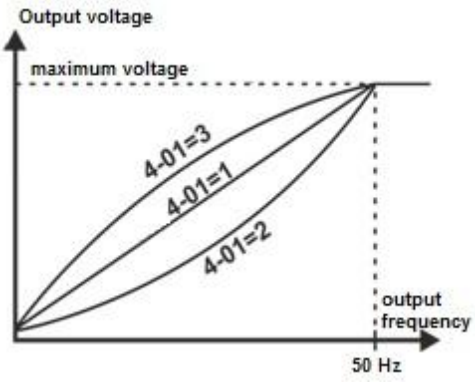
Motor control parameters

Parameter 4-01. Motor control mode.

Sets the motor control mode and the U / f dependence form.

At value of 01 - scalar mode, the output three-phase voltage is directly proportional to the set speed (the average curve at Fig. 15).

At value of 02 - scalar mode, the output three-phase voltage has a quadratic dependence on the set rotation frequency (lower curve at Fig. 15). The most mild mode, suitable for fan load.



At value of 03 - scalar mode, the output three-phase voltage has a slightly convex upward shape and is the most rigid - forced characteristic (upper curve at Fig. 15).

Used when a tangible increase in torque at low rotations is needed, achieved by magnetizing the machine. **It is forbidden to use during drive long-term operation** as may lead to overheating and failure of the motor.

Figure 15. *Fixed curves shapes of U / f dependence. (The graph shows a range of up to 50 Hz (menu item 5-02), because above this frequency all three graphs align in one horizontal line. That is, when the output frequency is higher than the nominal (menu item 5-02) voltage is not subject to correction.)*

At value of 04 - improved scalar control, the output three-phase voltage is directly proportional to the set speed and the actual load on the drive.

This mode differs from the previous ones by motor torque drop automatic correctable compensations in the entire range of its operating frequency, as well as slip compensation because of load at medium and high frequencies. In static modes, with the control system set up correctly, a high degree of astatism in the motor shaft rotation frequency can be achieved (rotations stabilization).

This control mode is divided into two operation zones: the lower frequency zone and the upper frequency zone, the boundary of which is set by the corner frequency.

In the lower frequency zone the FC switches to the current source mode and pumps a current of a predetermined value through the motor windings, regardless of the motor load, generates a constant torque.

After passing through the lower zone the FC switches to the voltage source mode and generates a voltage taking into account the fall compensation in the stator resistance. Through the motor windings flows as much current as it's required to overcome the load torque.

Slip compensation only works in the upper frequency zone and increases the output frequency depending on the current motor load.

Valid value range: 1 ÷ 4

For this mode operation it is necessary to enter the correct motor data, set the auto-compensation maximum levels and perform motor identification. This mode only works with general industrial 50 / 60Hz motors.

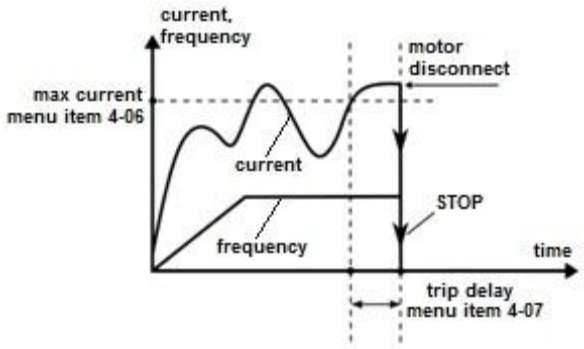
Parameter 4-05. The output voltage modulation frequency, the PWM frequency (kHz).

A low PWM modulation frequency (3-6 kHz) reduces the load on the FC power element and slightly increases the torque on the motor shaft due to higher stator ripple currents, but the motor works with a peculiar "squeak".

When increasing the cable length connecting the FC to the motor for more than 20 m it is necessary to reduce the output PWM modulation frequency. There 3,6,9 and 12 kHz are available for setting.

Valid value range: 3 ÷ 12 kHz

Parameter 4-06. Programmable maximum motor current.



The parameter determines the maximum motor current threshold, upon reaching which the countdown of overload time starts, menu item 4-07 (Fig.16). At the end of the countdown if the current has not decreased the motor is switched off and the frequency converter goes into emergency standby mode. If an overload occurs during operation but the drive has not yet crashed the corresponding overload warning is displayed.

Valid value range:

0.1 ÷ 20.0 A for converters of 2.2 - 3.3kW

0.1 ÷ 16.0 A for converters of 1.0 - 1.5 kW

Figure 16. *The programmable protection operation principle for the maximum motor current.*

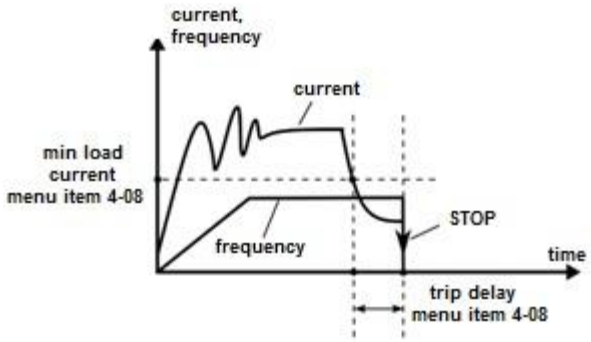
Parameter 4-07. Motor overcurrent trip delay.

Sets the drive trip delay duration due to programmable overload.

Valid value range: 0.1 ÷ 999.9 sec

Parameter 4-08. Programmable minimum motor current.

The parameter determines the minimum current consumption threshold in the drive operation steady-state mode (Set frequency = Output frequency) below which the countdown of underload time starts menu item 4-09 (Fig. 17). At the end of the countdown, if the current remains below a predetermined threshold, the motor turns off and the frequency converter goes into emergency standby mode. If a motor underload occurs during operation but the drive has not yet crashed the corresponding warning about low current consumption is displayed.



Valid value range:

0.1 ÷ 20.0 A for converters of 2.2 - 3.3kW

0.1 ÷ 16.0 A for converters of 1.0 - 1.5 kW

Figure 17. *The protection operation principle for the minimum motor current.*

This protection can be useful in cases when a belt drive is used and when the belt breaks it is necessary to emergency stop the drive with an alarm for maintenance personnel.

Parameter 4-09. Undercurrent trip delay.

Sets the drive trip delay duration due to programmable underload.

Valid value range: 0.1 ÷ 999.9 sec

Parameter 4-10. The FC response to the reduction in mains voltage.

Parameter 4-11. The FC response to the increase in mains voltage.

Parameter 4-12. The FC response to overcurrent.

Sets the FC response to an emergency.

At a value of 0 - At emergency the drive is switched off and goes into emergency operation with light and sound

alarms.

At a value of 1 - At emergency the drive switches to emergency operation mode with an alarm for the delayed restart time. After the time has elapsed, the motor automatically starts from the starting frequency if there is no forced restart blocking, the error has not been reset and the FC operating parameters are normal.

At a value of 2 - At emergency the drive switches to emergency operation mode with an alarm for the delayed restart time. After the time has elapsed, an automatic soft motor start from the turn-off frequency (output frequency at which the emergency occurred) is performed provided that there is no forced restart blocking, the error has not been reset and the FC operating parameters are normal.

At a value of 3 - At emergency the drive switches to emergency operation mode with an alarm for the delayed restart time. After the time has elapsed, an automatic soft motor start with a pickup at the motor shaft speed (the implementation of a special frequency search algorithm) is performed provided that there is no forced restart blocking, the error has not been reset and the FC operating parameters are normal.

Valid value range: 0 ÷ 3

Frequency search time when using an induction motor with a nominal frequency of 50 Hz is up to 7 seconds. The higher the actual shaft speed the faster the algorithm runs. Frequency search is performed only in a given direction of rotation. If the frequency is not found or the actual rotation direction does not match the set one, the inverter starts the motor from the starting frequency in the set direction.

If the working mechanism has the ability to accumulate kinetic energy and after turning off the motor the shaft rotation speed decreases for a long time it is recommended to use reaction 3. If the frequency search algorithm does not work on a particular machine or it is necessary to pick up the motor very quickly and at the same time there is a resource in FC power, reaction 2 can be applied. If the shaft stops quickly after turning off the motor then only reaction 1 should be used.

Parameter 4-13. The maximum number of attempts to automatically restart.

Sets the number of attempts to automatically start the drive after the FC failure within three minutes. The restarts number counter decreases by one value in three minutes after each failure in the drive and if no new ones arise (Fig. 18b).

When the attempts number is exceeded (Fig. 18a) the drive disconnected with corresponding alarm message.

Valid value range: 0 ÷ 10

Parameter 4-14. Automatic restart delay.

Sets the time delay between the failure and an attempt to automatically start the drive (Fig. 18).

Valid value range: 0 ÷ 60

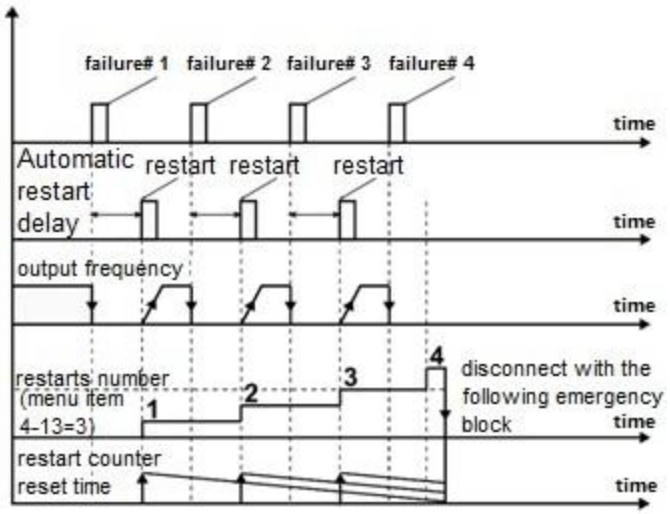


Figure 18. a) *Exceeding the permissible automatic restarts number in case of FC failure.*

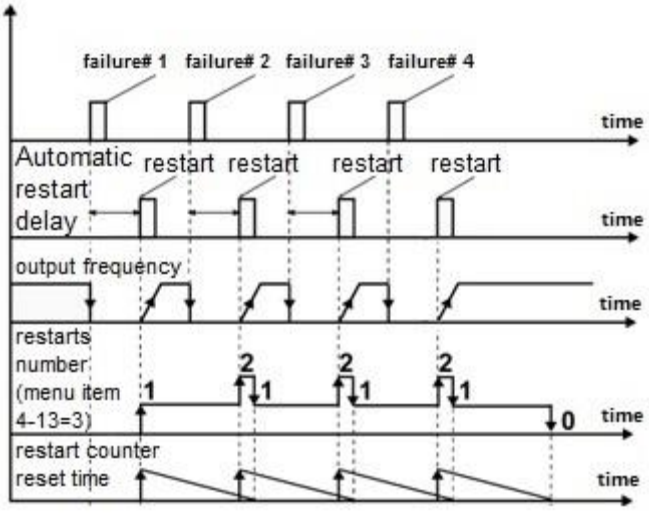


Figure 18. b) *The automatic restarts number counter operation principle in case of FC failure.*

Parameter 4-17. The torque compensation level below the corner frequency.

When operating in the usual scalar control mode determines the relative voltage addition (Fig. 19) to the selected characteristic before reaching the corner frequency. The correction allows to compensate the voltage drop on the motor stator active resistance, as well as increase the torque at the lowest frequencies. When operating in the improved scalar control mode this parameter sets the stator current level as a percentage of the nominal motor current, which flows through the windings and is stabilized, thereby stabilizing the motor torque regardless of the stator resistance.

If the parameter value is zero, the output voltage of the converter is determined; when the parameter is zero, the output voltage of the converter is determined by the menu item 4-01.

Valid value range: 0 ÷ 150

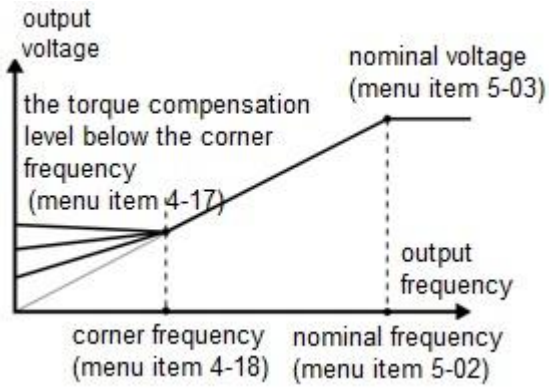


Figure 19. *The voltage correction principle below corner frequency in normal control mode.*

Remember that conventional induction self-ventilated motors cannot work with high current at low frequencies for a long time due to insufficient cooling.

Parameter 4-18. Corner frequency (in Hertz).

Sets the connection point of the lower and upper frequency zones.

When using the usual scalar mode, the upper frequency zone corresponds to operation on a given characteristic without corrections and the lower one corresponds to torque compensation due to voltage compensation.

When operating in the improved scalar control mode after going to the upper frequency zone the motor torque compensation structure is switched and the automatic slip compensation resolution is activated.

Valid value range: 5 ÷ 30

When using improved scalar control it is recommended to reduce the corner frequency to the minimum level at which the drive works stably while this frequency transitions, both up and down. To eliminate the control system "jitter" a hysteresis of switching the frequency zones equal to 2 Hz was introduced.

Parameter 4-19. The torque compensation level when higher than the corner frequency.

Sets the voltage drop automatic compensation maximum level in the stator and operates at frequencies higher than the corner frequency, provided that the drive operates in the improved scalar control mode.

Valid value range: 0 ÷ 150

The motor parameters must be set correctly and the motor identification must be done!

Parameter 4-20. The moment compensation time constant.

This parameter is designed to adjust the control system to a specific motor. When using improved scalar control with a specific motor, current and voltage self-oscillations can occur during automatic compensation, to suppress these fluctuations and increase the drive stability the time constant can be either increased or decreased. This parameter value is selected experimentally by achieving optimal drive operation.

Valid value range: 0.05 ÷ 99.99 sec

An excessive decrease in the parameter makes the drive abrupt and more responsive but can lead to the system inoperability due to the constant self-oscillations occurrence. An excessive increase in the parameter makes the drive more inertial and prone to oscillations due to a late reaction to a change in the motor load.

Parameter 4-21. Slip compensation at medium and high speeds (upper frequency zone).

Slip compensation only works when using the improved scalar control mode. The operation principle of this compensation is a proportional increase in the FC output frequency depending on the actual motor load. The use of this compensation helps to achieve drive astatism in shaft rotation speed in steady-state operating modes (stabilize

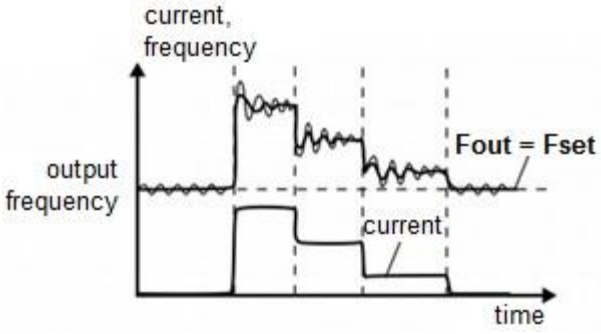
rotations).

Valid value range: 0 ÷ 150

The motor parameters must be set correctly and the motor identification must be done!

Parameter 4-22. The slip compensation time constant.

This parameter is designed to adjust the control system to a specific motor. When using improved scalar control with a specific motor, frequency self-oscillations can occur during automatic compensation, to suppress these fluctuations and increase the drive stability the time constant can be either increased or decreased. The changing time constant effect can be seen at Figure 20. This parameter value is selected experimentally by achieving optimal drive operation.



Valid value range: 0.05 ÷ 9.99 sec

Figure 20. *The slip compensation principle in case of correct and incorrect mode setting.*

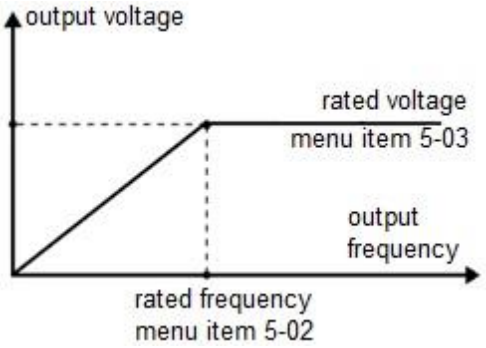
An excessive decrease in the parameter makes the drive abrupt and more responsive but can lead to the system inoperability due to the constant self-oscillations occurrence. An excessive increase in the parameter makes the drive more inertial and prone to oscillations due to a late reaction to a change in the motor load.

Motor parameters

Parameter 5-01. Rated motor revolutions (in rpm).

This parameter can be taken from the motor technical documentation or according to the data on the motor nameplate.

Valid value range: 200 ÷ 3000 rpm



Parameter 5-02. Rated motor frequency (in Hertz).

The parameter value is taken from the motor nameplate or its technical documentation and determines the nominal frequency of the three-phase voltage supplied to the motor stator (Fig. 21).

Valid value range: 40 ÷ 800 Hz

Figure 21. *The relationship between the rated motor frequency and its rated voltage.*

Parameter 5-03. Motor rated voltage (in Volts).

The parameter value is taken from the motor nameplate or its technical documentation and determines the motor nominal voltage at the rated frequency (Fig. 21).

Usually, 2 different voltage values are indicated on the motor nameplate: one for the star connection and the other one for the delta connection. You should enter the one that corresponds to the actual connection (winding connection diagram), for example 220V for Δ.

Valid value range: 36 ÷ 660 V

Parameter 5-04. Rated motor current (in Amperes).

The parameter value is taken from the motor nameplate or its technical documentation and determines the motor nominal current.

Valid value range: 0.2 ÷ 30 A

The correct rated motor current must be set, otherwise there is a risk of the motor and the FC failure.

The protection against motor overheating, the current restriction mode and the other FC systems are tied to this parameter.

Parameter 5-05. The motor phase winding impedance.

This parameter can be set manually or determined during the stator resistance automatic identification process.

Valid value range: 0.2-99.99 ohm

It must necessarily correspond to the real phase resistance when using the improved scalar control mode. In case of a significant difference between this parameter and the real one the control mode works incorrectly which may lead to equipment failure.

Parameter 5-07. The motor stator windings connection scheme.

This parameter determines the motor phase windings connection type.

Valid value range: 0 - Δ , 1 - Y

The parameter directly affects the motor phase winding resistance determining accuracy.

Parameter 5-08. Start of the motor stator winding automatic identification.

Setting the value 1 and then pressing the MEMORY button starts the stator phase automatic identification process.

Before starting the identification, it is necessary to enter all the nominal motor data from the nameplate or passport for this machine.

After pressing the “MEMORY" button, the FC automatically exits the settings menu with the following automatic voltage supply to the motor windings to determine the stator winding parameters. If the drive is blocked from the terminal or for any other reason, the identification procedure is suspended until the FC is allowed to operate. If the procedure is interrupted during execution by pressing the STOP button on the front panel, the corresponding message is displayed and the previous parameter values remain in the FC memory.

- The identification process is visualized in a special way (Fig. 22).
- At the end of the procedure, the message “SUCCESSFUL” appears on the display and the winding parameter value is automatically recorded in the FC memory.

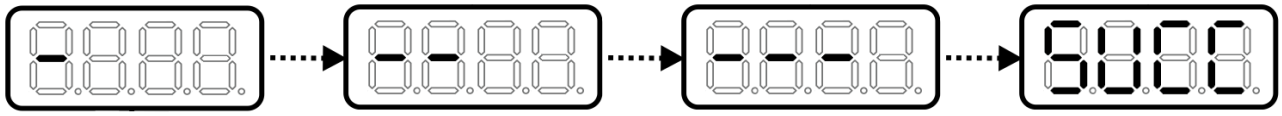


Figure 22. *Visual display of the motor stator winding identification procedure.*

Identification can only be started if the nominal, <u>CORRECT</u> parameters of the used motor are specified!

Due to the fact that FC automatically leaves the settings menu when starting the identification, it is recommended to perform identification at the very end of the FC settings when all the necessary parameters are already set and saved.

Parameter 5-11. The threshold for the start of the motor current limitation.

This parameter sets the threshold for starting the motor current limitation mode as a percentage of its rated current.

If the motor current consumption exceeds this setting, the FC starts to automatically reduce the output frequency with a given intensity, thereby striving to limit the actual current within the specified value, while the actual current can raise during processing by the algorithm.

Valid value range: 60,0 ÷ 300,0 %

Parameter 5-12. The current limit intensity.

This parameter value determines the output frequency (speed) reduction intensity depending on the overload level. It is selected experimentally to achieve a stable and efficient algorithm operation. If the working process is inertial then this parameter value must be reduced to ensure stable FC operation.

Valid value range: 0 ÷ 100%

Parameter 5-14. Current limiting mode reaction delay.

The parameter allows to adjust the current limiting mode sensitivity by implementing a reaction delay. It is necessary to set such values that can provide acceptable level of the current limitation efficiency and the drive resistance to oscillations.

Valid value range: 0.5 ÷ 15.0 sec

Parameter 5-16. Continuous thermal motor current.

Sets the continuous thermal current of a self-ventilated electric motor at which it is heated to a conditional temperature of 100%. In case of a temperature increase to a value above 115% the drive is emergency stopped (Fig. 23b).

The parameter has no restrictions at an output frequency of more than 30 Hz because presumably the cooling fan has sufficient capacity to efficiently cool the motor. At frequencies below 30 Hz, the continuous thermal current linear limitation relative to the specified one is done (Fig. 23a).

Valid value range: 0.0 ÷ 200.0%

There is no limit on thermal current for motors with rated frequencies above 60 Hz.

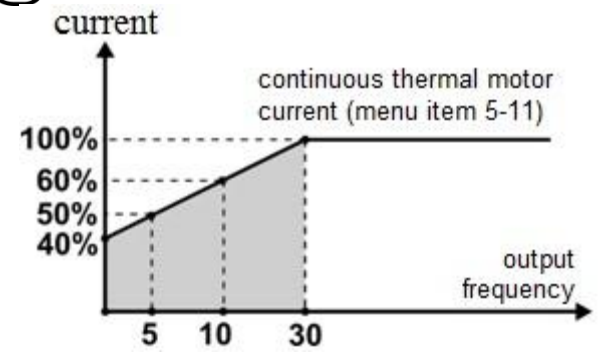


Figure 23. a) *Continuous thermal current limitation in the lower frequency range*

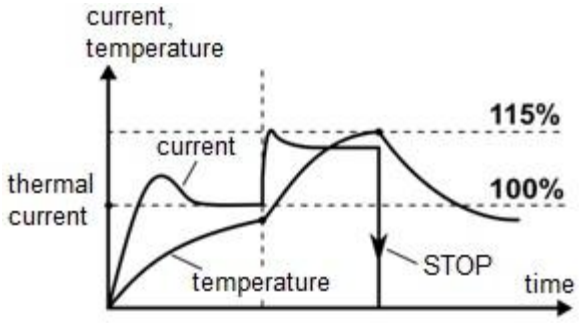
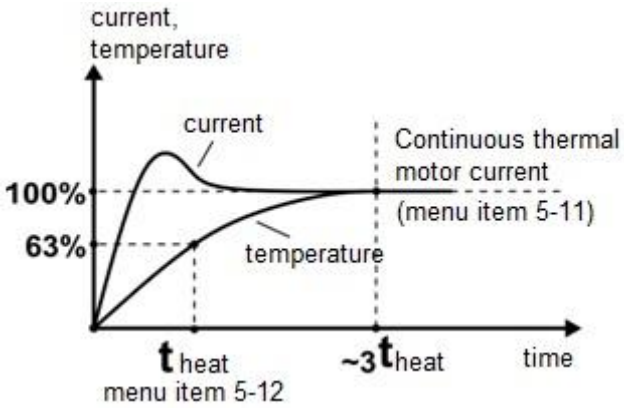


Figure 23. b) *The motor overheating protection operation principle*

Parameter 5-17. Motor heating time constant.



This parameter sets the time in which the electric motor heats up to a conditional temperature of 63% during the long thermal current flow. The transition process of heating and cooling the motor is aperiodic in nature (Fig. 24).

Valid value range: 1 ÷ 9999 sec

Figure 24. *The transition process of heating.*

Parameters of peripherals

Parameter 6-01, 6-03. RELAY1 and RELAY2 control mode.

This parameter determines the relay output and analog output operation mode in the "open collector" mode.

Valid value range: 0 ÷ 20

Table 8. *The relay and analog output operation modes (open collector)*

#	Relay output operation mode	Note
0	The relay turns on only when a three-phase voltage is applied to the motor "OPERATION"	Informs that a rotating three-phase voltage vector is supplied to the motor stator.

#	Relay output operation mode	Note
1	The relay turns on only when rotating and the equality of the output and the set speeds	Informs that the drive is in a steady dynamic state. This function hysteresis is 1 Hz for frequency tuning both up and down.
2	The relay turns on if there are active errors in the drive operation, turns off only after resetting all accumulated errors "ERROR"	The relay turns on at the first detection of any activated protection and turns off if the STOP contact is pressed while the motor is stopped
3	The relay turns on if the analog control voltage corresponds to exceeding the maximum speed (menu item 1-02) and at the same time the frequency setting mode from AN.IN is selected	It can be used to indicate an open connection to the current sensor (4-20mA) at the analog input. A “living zero” absence signal formation occurs when the signal level is below half the set minimum threshold in menu item 3-05, 3-09.
4	The relay only activates during DC braking "DC BRAKING"	In this mode the relay duplicates the FC function during braking. Can be used to activate external devices to ensure a more reliable stop (see menu items 1-17, 1-18).
5	The relay is activated only when the rotation direction is set. "REVERSE"	This mode informs about the direction where the motor rotates or is going to rotate.
6	The relay turns on when the FC output frequency is higher than the preset frequency No. 1	This mode can be used as additional to the frequency setting mode from preset values or in the switchable acceleration / deceleration rates mode. For example, when accelerating to the set frequency the drive uses acceleration rate A, which allows to reach desired mechanism speed less intensively without overloads and then activate the acceleration rate B and dynamically bring the drive to the set speed. If there is no rotation the relay is inactive.
7	The relay turns on when the FC output frequency is lower than the preset frequency No. 1	
8	The relay turns on when the FC is powered and there is no rotation or DC braking "READY"	Can be used as a diagnostic signal.
9	The relay turns on when the FC temperature is above 40°C and turns off when the temperature is below 38°C	Allows to control an external fan if there is not enough natural heat dissipation.
10	The relay turns on at the end of the set distance / pieces when the meter mode is activated	The section end or the drive start is a trigger to start the corresponding relay output timer. The timer starts at trigger activation and at the same time the relay is activated. At the end of the count the relay turns off.
11	The relay turns on when the motor starts, turns off when the timer is triggered.	
12	The relay turns off when the motor starts, turns on when the timer is triggered and remains on continuously.	Drive start, voltage drop, capacitor charging relays are triggers for starting the relay output timer. The timer starts at trigger activation and at the same time the relay turns off. The relay is activated at the end of the count.
13	The relay turns on when the voltage of 220V drops	
14	The relay turns on after charging the capacitors, duplicating the charging relay.	
15	Relay operation according to the timer from an external trigger (digital input)	The active signal rising edge at the discrete input selected as a trigger starts the relay output timer. The relay is active while the timer counts, the relay turns off at the end of the count.
16	Relay operation according to the timer from an external trigger (inverse mode)	The active signal rising edge at the discrete input selected as a trigger starts the timer. The relay is inactive while the timer counts, the relay turns on at the end of the count.
17	The relay is activated if there are active warnings in the drive "ATTENTION"	Informs that the drive does not fully function due to incorrect settings or if the current FC parameters are outside the normal range.

#	Relay output operation mode	Note
18	Relay duplicates drive lock status "LOCKED"	The relay is active if the drive is currently blocked from control actions.
19	The relay turns on when the programmable script is in an activated state.	The relay serves as the programmed script algorithm execution indicator.
20	The relay turns on for the set time when the programmable script has completed a cycle (switching from the last programmed step to the first)	The relay informs the external equipment and the operator about the script execution cycle end. May be useful for building automated systems.

Parameter 6-02, 6-04. On / Off timers of RELAY1 and RELAY2.

This parameter sets the relay output timer period for operation in modes using it. The relay response time setting resolution is 0.1 sec.

Valid value range: 0.1 ÷ 999.9 sec (16 min 40 sec).

Parameter 6-05. Digital (D.OUT) and analog outputs (AN.OUT) operating mode.

With set values from 0 to 20 the outputs operate in discrete mode in accordance with the table 8 to menu items 6-01, 6-03.

With the set mode values from 20 to 28 the analog output generates a voltage signal proportional to the selected parameter (Table 9), while the digital output works with PWM modulation and period duty cycle according to the selected parameter.

Table 9. *Analog output operation modes*

#	Analog output operation mode	Note
21	The FC output frequency relative to the minimum speed (menu item 1-01)	When rotating the DAC output voltage over zero the minimum speed is taken
22	The FC output frequency relative to zero	DAC output voltage proportional to output speed
23	Motor current consumption values	DAC output voltage proportional to the FC output current
24	The FC output frequency relative to the minimum speed (menu item 1-01)	When rotating the DAC output voltage over zero the minimum speed is taken
25	The FC set frequency relative to zero	DAC output voltage proportional to the set speed
26	FC power section temperature	DAC output voltage proportional to the FC power section temperature
27	Actual DC bus voltage	DAC output voltage proportional to bus voltage
28	Actual AC bus voltage (mains)	

Valid value range: 0 ÷ 28

Parameter 6-06. Analog output transmission factor.

This parameter allows to bring into sync the analog output voltage level to the selected parameter maximum value.

To calculate the coefficient use the following formula:

$$C_t = \left[\frac{746688}{\mathbf{X_{max}}}\right] * \left[\frac{\mathbf{U_{out}}}{\mathbf{10V}}\right]$$

Where:

$\mathbf{X_{max}}$ - the parameter maximum value transmitted to the analog output (*for example*: menu item 1-02 “Maximum frequency” = 50.0Hz and the analogue output operation mode is 21.22,24 or 25, then $\mathbf{X_{max}}$ = 500).

$\mathbf{U_{out}}$ - output voltage value which must correspond to $\mathbf{X_{max}}$.

Valid value range: 1 ÷ 5000

Parameter 6-07. On / Off analog output timer.

This parameter sets the discrete output timer period for operation in modes using it.

The analog output response time setting resolution is 1 second.

Valid value range: 1 ÷ 9999 sec (166 min 39 sec).

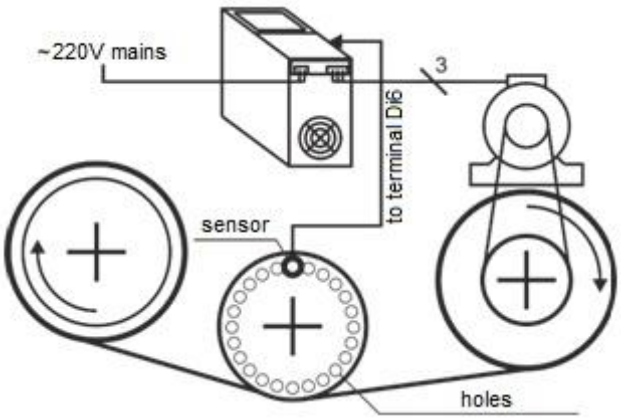
FC mode for systems with conveyor and pulling mechanisms

The FC has a function for counting pieces or meters (traveled, scrolled, moved). When operating in meter counting mode it is possible to use modes with preliminary braking before the drive stop followed by a stop signal by means of switching programmable relay outputs. To activate this mode it is necessary to configure the corresponding menu items 6-08, 6-09, 6-10, 2-01, 2-02, 3-01 and 3-02.

After successfully activating the counting mode the main menu item for setting meters or pieces becomes available, which is displayed with two points on the right on the indicator (the first point after the third digit, the second point after the fourth, tenths of a meter).

The setting resolution is 1 meter / pcs.

Each time the drive is started the meters / pieces set value is stored, which, if there are no changes, is maintained throughout the entire operation and after the inverter is turned off.



The stored value is used as the reboot value, i.e. after the mechanism reaches measured segment end the task is rebooted and the FC starts pulling / counting the segment of the same length. In this mode the contacts “+” and “-” specify the length that must be measured.

The output from the pulse sensor is connected to one of the high-speed digital inputs, which must be set accordingly in the service menu (menu items 2-10 ... 2-12). The analog input is used to adjust the drive speed during movement and is switched on according to a model scheme.

Figure 25. *FC connection when operating in counter mode*

The distance at which the braking starts can be set in menu item 6-10, if the meter mode with braking is used. The pulse sensor calibration can be done in the corresponding item of the service menu (6-09), where it is necessary to enter the distance traveled between the sensor pulses.

Parameter 6-08. Meter mode.

This parameter activates the meter / counter mode in which the FC counts pulses and perform certain actions according to the selected mode.

The following operation modes in the count mode are provided:

Mode 0 - meter / pieces counting is inactive.

Mode 1 - the measured segment length is set by the contacts "+" and "-", the speed by the signal from AN.IN1 or AN.IN2. In this mode can set the braking start time (transition from a given speed to the minimum (menu item 1-01) using menu item 6-10.

Mode 2 - the measured segment length is set by pre-set values from m.i. 3-21..3-23, speed by signal from AN.IN1 or AN.IN2. The uploading preset values principles is described in the table below. For the mode operation configure the digital inputs according to table 10.

Table 10. *Predefined lengths uploading*

Line 2 status	Line 1 status	The output frequency task formation
0	0	Preset length 1 (menu item 3-20)

Line 2 status	Line 1 status	The output frequency task formation
1	**0**	Preset length 2 (menu item 3-21)
0	**1**	Preset length 3 (menu item 3-22)
1	**1**	Preset length 4 (menu item 3-23)

In this mode can also be set the braking start time (switching from a given speed to the minimum (menu item 1-01) using m.i. 6-10.

Mode 3 - the measured segment length is set by the contacts "+" and "-", the speed by the signal from AN.IN1 or AN.IN2. There is no braking in this mode. Upon reaching the measured segment end a predetermined length is automatically rebooted after which the new segment measurement begins and *the motor does not stop.*

Mode 4 - The pieces number setting mode (pulses). The quantity is set by the contacts "+" and "-", the speed by the signal from AN.IN1 or AN.IN2. There is no braking in this mode. After counting the last piece (pulse) the set quantity is automatically rebooted after which a new countdown begins *and the motor does not stop.*

Valid value range: 0 ÷ 4

To signal the achievement of the given segment end or the last counted piece (pulse) an appropriate relay output mode or "open collector" output is provided (menu item 6-01 or 6-05 = 10). In this case can be set the delay by using the corresponding output timer.

Parameter 6-09. Length sensor pitch.

This parameter sets the step between the sensor labels (responses, pulses). Calibration Accuracy - 0.01mm.

As the meter any sensor having a discrete output and providing appropriate performance, for example, inductive, optical slotted, capacitive, etc., can be used. The pulse repetition rate from the length sensor should not exceed 10 kHz while the pulse duration should be at least 20 μs, otherwise the FC may not record the sensor operation.

Valid value range: 0.01 ÷ 199.99 mm

Parameter 6-10. The distance at which braking starts.

This parameter sets the distance at which the drive must go into the exhaust mode at minimum speed before stop. I.e. if the segment length is set to 10m and the value is set to 1.5m in this parameter then the drive rotates at a given frequency until 8.5m passed. At reaching the mark of the remaining distance equal to 1.5 m the drive switches to braking mode and at the minimum frequency (menu item 1-01) pulls the segment to the end.

Valid value range: 0 ÷ 10.0 m

Setting the FC for meter / counter operation

1. *Select the desired meter mode (menu item 6-08).*
2. *Set the task commands source from the terminals or combined (see 3-01, 3-03).*
3. *Select the reference mode from the signal from AN.IN1, AN.IN2 or the PID-controller (PID only for meter modes without braking) (see menu items 3-02, 3-04).*
4. *Configure one of the three high-speed digital inputs to the pulse counter mode (see p. 2-7 ... 2-12). If the meter mode is not configured correctly, a warning appears on the display. The message displayed until all the above items are correctly configured.*

Important! *In meter mode blocked:*
- the ability to switch between tasks and control groups "A" and "B". Work is performed according to the "A" group settings.
- the ability to operate in control mode 4 (see menu item 2-01) "start and stop by AN.IN signal" when the meter modes with braking are activated.

Parameter 6-12. RS-485 baud rate.

This parameter is used to set the transmission speed between the FC and external devices via the RS-485 communication network.

Table 11. *Available FC exchange rates*

Value	1	2	3	4	5	6
Speed, bps	**4800**	**9600**	**19200**	**38400**	**56000**	**115200**

Valid value range: 1 ÷ 6

Parameter 6-13. The device address or device ID.

This parameter sets the FC network address, which is necessary to identify it in the network with the Modbus RTU exchange protocol.

Valid value range: 1 ÷ 247

Parameter 6-14. Parity / Stop bits control.

In this menu item the Modbus RTU protocol frame data structure is configured.

Table 12. *Frame data structures supported by the inverter*

Value	Description
0	**One stop bit, no parity control. Factory setting.**
1	**One stop bit, parity control**
2	**One stop bit, odd control**
3	**Two stop bits, no parity control.**
4	**Two stop bits, parity control**
5	**Two stop bits, odd control**

Valid value range: 0 ÷ 5

Parameter 6-15. RS-485 watchdog timer.

The RS-485 watchdog timer is designed to control the messages timely receipt via the Modbus RTU protocol. At each correct (error-free) message receipt the timer restarts the countdown; if messages do not come or come with errors an error signal is generated upon reaching the end of the set countdown time. The behavior in this case can be configured in the corresponding parameter.

The time is set in seconds with a resolution of 0.1 s.

Valid value range: 0.1 ÷ 30.0 s

Parameter 6-16. Response to an RS-485 communication error.

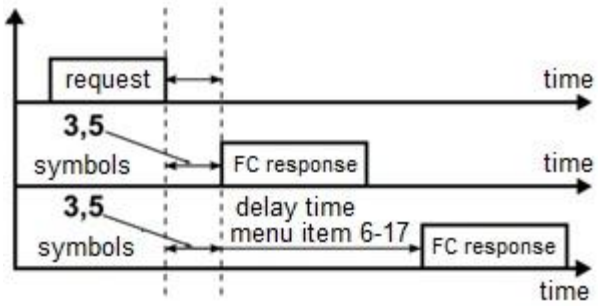
This parameter determines the FC response to the error signal from the RS485 watchdog timer.

The parameter value equals to 0 - no response to a communication error.

The parameter value equals to 1 - in case of a communication error the motor stops rotating and the drive recordes the error.

Valid value range: 0 ÷ 1

Parameter 6-17. FC response delay via RS-485.



This parameter sets the delay duration between receiving a request to the converter and sending a response to this request (Fig. 26). It can be used to build a complex network communication algorithm.

Figure 26. *Forming the FC response delay principle.*

Configuring the FC for operation via RS485 network

1. Set the baud rate, data structure, FC address and loss of communication behavior if the watchdog timer is activated.
2. If it is necessary to control the drive via a communication network, select the control commands source (menu item 2-01 = 3 (RS485).
3. If you need to set the speed via network commands, select the task commands source (3-01 = 3 (RS485).

Important! If the task or control source is selected from RS485 then front panel is deactivated and a communication interface panel (optional) is installed in the panel connector. As a result, control or reference from the front panel becomes impossible, this should be taken into account when programming the FC.

Network operation is possible only in group "A", control from external control terminals can be configured in group "B".

The FC setting example for network operation:

- FC network address: 122
  menu item 6-13 = 122
- Bit rate 19,200 bps
  menu item 6-12 = 3
- Data structure: one stop bit, parity control
  menu item 6-14 = 1
- Watchdog timer for 10 seconds
  menu item 6-15 = 10.0
- If no communication, stop the motor
  menu item 6-16 = 1
- Motor rotation control commands are received via RS485
  control source (menu item 2-01 = 3 (RS485)
- The frequency task is formed by a signal from AN.IN2
  task source (menu item 3-01 = 1 (external control terminals)
  task mode (menu item 3-02 = 2)

A detailed description of the available ModBus commands and their formation principles is available in the "ModBus RTU in CFM110-310 User Manual"

User's parameters

Parameter 7-01. FC set frequency display mode selection.

The value in this paragraph determines how the given frequency is displayed, namely in Hz or rpm.

The parameter value equals 1 - FC displays the set speed in revolutions per minute.

The parameter value equals 0 - FC displays the output three-phase voltage set frequency in Hertz with an accuracy of 0.1 Hz.

Valid value range: 0 — 1

Parameter 7-02. Password to enter the service menu.

The converter has a two-level access protection system to the FC settings menu.

In order to completely restrict access to the FC settings, it is necessary to set the non-zero password value in this menu item. By default (at sale) the password value is "0" and access to the service menu is only partially restricted.

After saving the password, when the next time log-in, the service mode is completely blocked and the password is requested.

To remove the password, must enter the previously saved password, i.e. deblock the entrance to the service mode and then set 0 in this menu item.

If the password is entered wrongly then the next attempt to enter is provided only in 15 seconds after the error message with the corresponding code is displayed.

If the password is forgotten, then there is a "super password" which allows to change / reset the lost password. Its value is **2576**.

By default (at sale), the FC has a ***PARTIAL RESTRICTION***. This restriction is imposed only on those items and values the change of which by an unskilled user can lead to the FC or external equipment failure.

To remove the partial restriction, there is an “advanced user super password”. Its value is **161**.

After entering this password an advanced user is registered until the next FC power off and all restrictions are removed.

Valid value range: 0 ÷ 9999

Parameter 7-03. Configurations upload.

In this menu item, can upload the inverter settings (all the menu items described above) from earlier saved by the user or reset to default settings.

You can see the default parameters value in table 3.

Valid value range: 0 ÷ 2

Resetting to default settings can be done in two ways:

- When working in the service menu, it is necessary to set the value of 0 in this menu item (7-03) and press the "MEMORY" key.
- When powering the FC, simultaneously hold down the buttons [i], [➡] and [−] for 2 seconds, after that the FC goes into the service mode and displays the menu item 7-03, the value of which is 0. To confirm the reset, press the [⬅] "MEMORY" button.

Parameter 7-04. Saving user configuration.

In this menu item can save the FC settings to one of two user configurations. To do this, you have to configure all FC menu items in accordance with the process requirements. After setting, select the configuration number in this menu item to which you want to save and press the "MEMORY" button.

Valid value range: 1 - 2

It is important to remember that when writing to the user configuration, everything that was written to it before - is erased!

Parameter 7-05. User parameter display mode.

This parameter allows to configure the user parameter display mode in the main FC menu (Fig. 5). The following modes are available:

Mode 0 - displays the output voltage frequency in the format “Hxx.x” up to a frequency of 99 Hz with an accuracy of a Hertz tenths and in the format “Hxxx” above a frequency of 99 Hz with an accuracy of a whole Hertz.

Mode 1 - a user-scalable parameter display with a linear dependence on the estimated output frequency. Scaling is done by setting the required scaling factor and the decimal separator location (see menu items 7-06 and 7-07).

Mode 2 - displays the output voltage actual value in the "dxxx" format, where xxx is the voltage in Volts.

Mode 3 - displays the AN.IN1 incoming current or voltage in the “Lxxx” format, where xxx is the signal level in Volts or mA.

Mode 4 - displays the AN.IN2 incoming current or voltage in the “Lxxx” format, where xxx is the signal level in Volts or mA.

Mode 5 - the integrated PID-controller feedback signal level with display in Fxxx format, where xxx - feedback signal level in %.

Mode 6 - displays the motor thermal state in the “hxxx” format , where xxx is the motor temperature in %.

Mode 7 - displays the AC mains current voltage in the “Pxxx” format, where xxx is the voltage in Volts.

Valid value range: 0 ÷ 7

Parameter 7-06. The user parameter scaling factor.

Using this factor, the mechanism linear speed indication can be configured in m/s (mm/s, m/min, etc.), the pressure of the environment in the pipeline pumped by the pump, and other values proportional to the FC output frequency.

For example: When the FC output frequency is 40 Hz, the conveyor belt speed reaches 11.3 m/s.

To display the belt speed in m/s do the following:

1. Enable the display mode of the scalable user parameter (see menu item 7-05).
2. Calculate and set the scaling factor according to the following formula:

$$C_s = \frac{11.3\left[\frac{m}{s}\right]}{40[Hz]} = 0.2825$$

3. Set the decimal separator to the desired position.

*The coefficient can be set equal to **0.3** and display without a decimal point, because in this case the fractional part is discarded and only the whole result remains after multiplication.*

*To increase accuracy by one decimal point place, a coefficient can be set equal to **2.8** and display it in tenths by setting the decimal separator position is "tenths".*

*In case of need to more accurately evaluate the parameter, the coefficient value can be set to **28.3** and the decimal point location is "hundredths".*

Valid value range: 0.1 ÷ 199.9

It is important to remember that the maximum displayed number is 9999, 999.9, 99.99, 9.999 and in cases where the obtained scaling result is greater than the specified values - the display is limited to this maximum.

Parameter 7-07. Decimal separator location in user parameter.

The value recorded in this parameter determines the decimal separator location on the display when the scalable user parameter is displayed (see menu item 7-05).

The parameter value equals to 0 - there is no decimal point; displays with accuracy to the digits XXXXX;

The parameter value equals to 1 - point after the third digit, displays with accuracy to the tenth XXX.X;

The parameter value equals to 2 - point after the second digit, displays with accuracy to the hundredths XX.XX;

The parameter value equals to 3 - point after the first digit, displays with accuracy to the thousandths X.XXX.

Valid value range: 0 ÷ 3

Parameter 7-08. Sound indication ban (buzzer).

If necessary, the FC sound indication can be turned off.

The parameter value equals to 1 - sound indication is on.

The parameter value equals to 2 - sound indication is off.

Valid value range: 0 — 1

Parameter 7-09. The LED indicator brightness adjustment.

This menu item allows to set the required indicator brightness depending on the actual operating conditions: direct sunlight, dark indoor, etc.

The brightness change resolution is 5%.

Valid value range: 5 ÷ 115 %

Parameter 7-10. Parameter displayed during the FC initialization.

Using this parameter can be selected the value displayed when the FC is switched on (initialized).

The parameter value equals to 0 - displays the set meters/pcs during initialization when the meter counter mode is activated. If the mode is not activated, the set frequency is displayed.

The parameter value equals to 1 - during initialization displays the set frequency in Hz (rpm) or the PID-controller reference in % if it is activated.

The parameter value equals to 2 - during initialization a user parameter is displayed.

Parameter 7-11. Programmable script operation mode.

The converter provides the ability to program a sequential script (Fig. 27) in 8 steps. For each step can be programmed the step time, frequency and the motor rotation direction. To do this, refer to menu items 3-12 ... 3-27.

The script can be programmed of at least 1 and a maximum of 8 steps.

This parameter sets the script operation mode.

At a value of 00 - the script operates in a single mode with the start from a button or from a digital input.

Pressing a button or activating a digital input starts a one-time script execution; upon the last programmed step completion the FC turns off the motor and waits for the next start.

At a value of 01 - the script operates in a cyclic mode with the start from a button or from a digital input.

Pressing a button or activating an input starts the script and it starts to cycle one pass after another until it is deactivated by the function terminal / STOP button.

To work with the script an appropriate relay or transistor output mode is provided (menu items 6-01, 6-02, 6-05 = 20). At the end of the actions sequence the script generates a request to turn on the relay for a user-specified time (menu items 6-02, 6-04, 6-07).

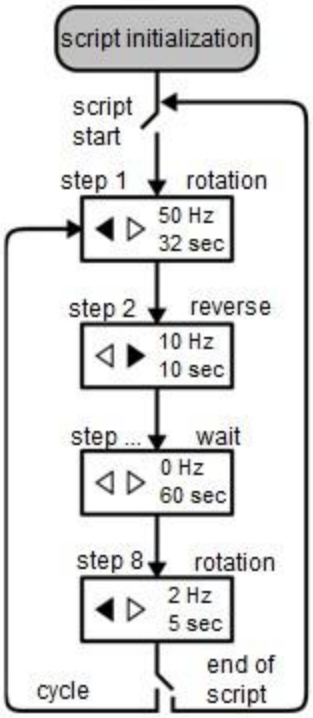


Figure 27. Programmable script executing example.

Parameter 7-12. Programmable script reset mode.

When working with a script, several FC response types to the various situations occurrence are provided.

Script initialization - the operation history (current step) is cleared and when the script is reactivated the work is performed from the first step, as when the first time it was turned on.

Script pause - the history (current step) is not affected, the state is freezed, when reactivated the script starts from the place where it was interrupted (including the counted time of the step).

At a value of 00 - if the script is deactivated by the STOP command then it is initialized the next time it is activated. If during the script operation the drive crashes or the drive manual blocking from the terminal has been performed, a pause is done.

At a value of 01 - Script is initialized regardless of the reason for deactivating it.

At a value of 02 - Script goes into a pause state regardless of the reason for deactivating it.

At a value of 03 - If the script is deactivated by the STOP command, it is put into a pause state. If during the script operation the drive crashes or the drive is manually blocked from the terminal then it is initialized.

Configuring the FC to operate with a programmable script

1. Set control and tasks sources from the programmable script (menu items 2-01 and 3-01).
2. Program the desired terminals to operate with the script (menu items 2-07..2-12).
3. Set the time (menu items 3-12..3-19) and the frequency with direction (menu items 3-20 ... 3-27) for each script step.
4. Set the programmable script operation mode (menu item 7-11).
5. Set up the script initialization mode (items 7-12).

Parameter 7-14. FC software version.

FC software version is displayed when opening this menu item. The value of v5.00 should be displayed for the FC with this manual.

Pressing the button ⬅ displays the build version of the specified software in bXXX format and shows the difference between the firmwares in the same software version.

This parameter is available for reading only and cannot be changed.

Parameter 7-15. The FC serial number.

Thousands of FC serial number are displayed when opening this menu item.

Pressing the button ⬅ displays hundreds, tens and units of the serial number.

For example, if the FC serial number = 23456 then when open the menu item the number 23 can be seen and by pressing the "MEMORY" button the number 456 is displayed.

This parameter is available for reading only and cannot be changed.

Parameter 7-16. Converter running hours (days / hours / minutes / seconds) and checking the forced cooling fan rotation.

The FC operating time is displayed in days (the time at which a three-phase voltage is supplied to the inverter output) when opening this menu item. Pressing the “MEMORY” button ⬅ displays the running hours with the “h” index, the next pressing displays minutes and seconds in mm.ss format (Fig. 28).

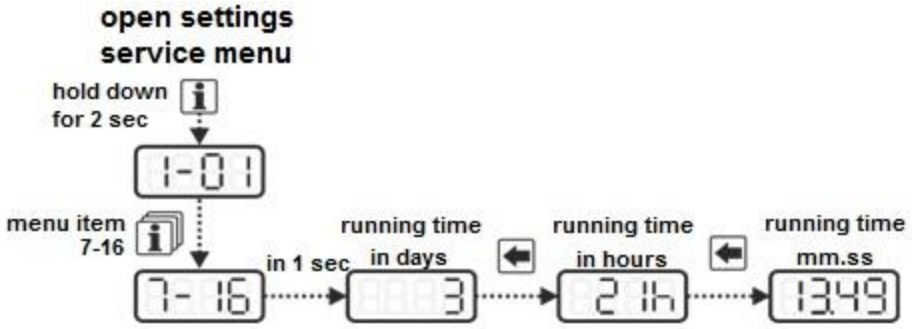


Figure 28. *The running time display example*

Upon entering this menu item, the fan turns on regardless of the actual radiator temperature and turns off only when the menu item is changed.

This parameter is available for reading only and cannot be changed.

Parameter 7-17….7-28. FC errors log (history).

The most recent error is displayed in the menu item 7-17, the penultimate one in the menu item 7-18, etc. Each mentioned menu item has a nested subitem with the FC parameters in the moment of an error (Fig. 29). Subitem switching is done by the "MEMORY" ⬅ button cyclically with a long beep when entering the first subitem.

The first subitem - the error code is represented in the Erxxx format (xxx - code).

The second subitem - the time when the error occurred. Displayed in running time (in days).

The third subitem - the time when the error occurred. Displayed in running time (in hours).

The fourth subitem - the time when the error occurred. Displayed in mm.ss format.

The fifth subitem - the voltage on the DC bus in the uXXX format (where XXX is the recorded voltage).

The sixth subitem - the input AC voltage in the uXXX format (where XXX is the recorded voltage).

The seventh subitem - the instantaneous FC current at the moment of the error. It is displayed in xAx format (where x, respectively, are integers and tenths of an ampere).

The eighth subitem - the FC power part temperature in degrees Celsius.

The ninth subitem - the FC output frequency, Hz.

The tenth subitem - the FC set frequency, Hz.

These parameters are available for reading only and cannot be changed manually.

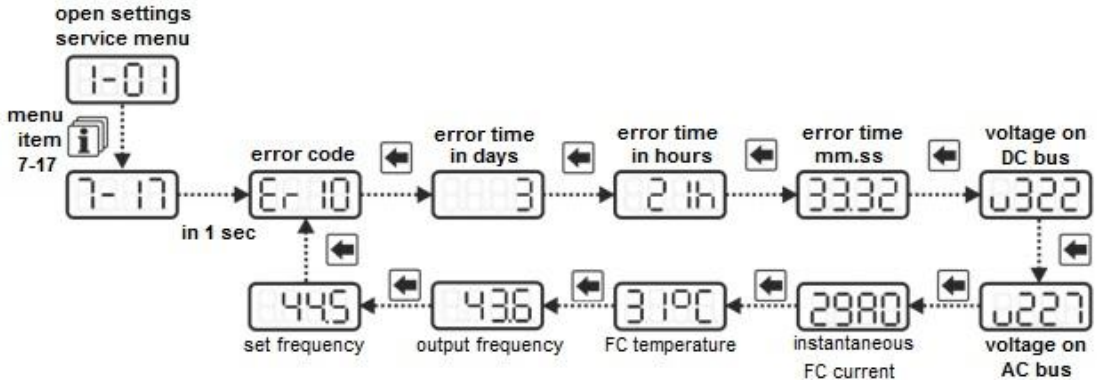


Figure 29. *One case overview from the error log in the service menu.*

6.5 FC ERRORS AND WARNINGS CODES LIST

Code	Error description	Possible reason	Recommendations on eliminating
Er10	**Fast overcurrent.** *If automatic restart by current is not configured, it completely disconnects the drive and switches the inverter to emergency mode.*	Short circuit in the motor phases, in the connecting wires, ground fault or the FC excessive instantaneous overload.	■ Recalculate the drive operating mode. ■ Check motor windings and connecting wires. ■ Measure the windings insulation resistance relative to the machine body.
Er11			
Er12	**Short circuit in the motor phases.** *If automatic restart by current is not configured, it completely disconnects the drive and switches the FC to emergency mode.*	Short circuit in motor phases or connecting wires. It is checked only at start.	■ Check connecting wires and motor windings. If occurs when the **motor is disconnected**, the FC is malfunctioning.
Er13	**Short circuit in the FC in idle mode.** *Puts the FC in emergency mode with a 3 sec alarm reset block.*	FC power part short circuit	■ FC malfunction.
Er14	**Short circuit in the FC brake transistor circuit.** *Puts the FC in emergency mode.*	Short circuit between brake resistor connection terminals.	■ Check the braking resistor impedance (if any) as well as the wires connected to the resistor for a short circuit. ■ In the case of the error with the disconnected resistor from the FC terminals - the FC malfunction.
Er17	**Low programmable current error.** *Performs a complete drive shutdown and switches the FC to emergency mode.*	Underloaded drive in steady state. The problem is in the drive mechanics.	■ Check the drive mechanical part. ■ Possible FC malfunction.
Er18	**Programmable current excess error.** *If automatic restart by current is not configured, it completely disconnects the drive and switches the FC to emergency mode.*	Programmable current overload. The motor is overloaded.	■ Recalculate drive operation mode. ■ Reduce the load on the motor shaft. ■ Increase the maximum current threshold. ■ Increase acceleration time if overload occurs when the drive starts.
Er19	**FC integrated current overload.** *If automatic restart by current is not configured, it completely disconnects the drive and switches the FC to emergency mode and blocks the control for 15 seconds but not earlier than the power unit cools down below 60 °C.*	The FC is overloaded. Each next start with overload will be shorter in duration compared to the previous one.	■ Recalculate drive operation mode. ■ Reduce the load on the motor and FC. ■ Make sure that the converter's power is correctly selected. ■ Check the motor windings wiring diagram.

Code	Error description	Possible reason	Recommendations on eliminating
Er20	**Low voltage error on the DC bus during rotation.** *If automatic restart is not configured on low voltage, it completely disconnects the drive and switches the FC to emergency mode.*	During the drive operation, the voltage drops below an acceptable level at which it is possible to create sufficient torque on the motor shaft.	■ Check the FC supply voltage. ■ Change the supply phase (for single-phase inverters). ■ Check if the FC power has been selected correctly. ■ Check all supply phases for being open (for three-phase inverters). ■ Increase the motor acceleration time if the voltage drops during acceleration. ■ Check the motor windings connection.
Er21	**Overvoltage error in the bus during rotation.** *If automatic restart on overvoltage is not configured, it completely disconnects the drive and switches the FC to emergency mode.*	The voltage on the DC bus is above the limit. The braking resistor does not have time or is not able to dissipate all the generated energy (if connected).	■ Connect a braking resistor if missing. ■ Check the braking resistor technical condition. ■ Increase braking time. ■ Check supply voltage. ■ Use other motor braking types.
Er22	**Overvoltage error in the bus in the FC idle mode.** *Switches the FC to emergency mode.*		■ Check the supply voltage and wiring diagram, there is possible connection between two mains phases (for single-phase inverters).
Er23	**Low voltage error in AC mains during rotation.** *If automatic restart is not configured on low voltage, it completely disconnects the drive and switches the FC to emergency mode.*	During the drive operation, the voltage drops below an acceptable level at which it is possible to create sufficient torque on the motor shaft.	■ Check the FC supply voltage. ■ Change the supply phase (for single-phase inverters). ■ Check if the FC power has been selected correctly. ■ Check all supply phases for being open (for three-phase inverters). ■ Increase the motor acceleration time if the voltage drops during acceleration. ■ Check the motor windings connection.
Er25	**Low voltage error in the power supply bus of the inverter power drivers.** *Completely disconnects the drive and switches the FC to emergency mode.*	The supply voltage in the control system is reduced - the FC power part failure is possible.	■ FC malfunction. **Report a problem to the manufacturer's service department.**
Er40	**Charging resistors overheated.** *It puts the FC to emergency mode with a control block for 30 seconds.*	The FC charging resistors overheating due to the frequent turning on and off the shunt relays cycles.	■ Check mains supply. ■ Increase the drive automatic restart delay time at a reduced supply voltage.
Er41	**FC overheated.** *Completely disconnects the drive and switches the FC to emergency mode and blocks the control for 3 minutes but not earlier than the power unit cools down below 60 °C.*	The FC power section temperature is out of range.	■ Check the cooling fan working efficiency. ■ Check if there air passage along the inverter circuit. ■ Install the inverter to the heat sink base. ■ Reduce the load on the motor

Code	Error description	Possible reason	Recommendations on eliminating
			and the FC.
Er45	**Motor overheated.** *Completely disconnects the drive and switches the FC to emergency mode.*	The calculated motor temperature exceeded the threshold of 115%.	■ Reduce the load on the motor. ■ Recalculate and increase the continuous thermal current level if possible.
Er50	**Disconnection error from the master device in the operation mode via the RS485 network.** *Completely disconnects the drive and switches the FC to emergency mode.*	There was an unacceptably long pause during the data exchange between the inverter and the master device.	■ Check the connection settings. ■ Check connecting wires and interface conversion modules. ■ Increase watchdog time.
Er51	**A complete or partial failure of the isolated control terminals has been detected.** *Completely disconnects the drive and switches the FC to emergency mode.*	There was a malfunction in the FC external control terminals.	■ Disconnect the FC from the mains and reconnect, if the terminals do not work - FC malfunction. ■ It is possible to reconfigure the terminals in case of a partial failure, **consult the manufacturer's service department.**
Er52	**Error from an external source.** *Completely disconnects the drive and switches the FC to emergency mode.*	An external malfunction active level appeared on one of the digital inputs at the appropriate setting.	■ Check additional equipment.
Er60	**The motor output phases checking error.** *Cancel of start and switching to emergency mode.*	During the motor start it was found out that one of the phases at the FC output is missing.	■ Check the wiring from the motor on the inverter terminal block. ■ Check the wires integrity and their crimping quality. ■ Check wiring in motor terminal box.
Er61	**Frequency search depending on voltage algorithm error.** *Rotation pickup cancel and switching the FC to emergency mode.*	It occurs at an attempt to start or automatically restart the drive in pickup mode with a frequency scan in case when the algorithm does not have enough voltage to search for a frequency or the motor is not connected to the FC.	■ The motor stator resistance is too high - refuse to use this algorithm on the specified machine. ■ Check motor connection to the FC. ■ Inverter measuring nodes faulty.
Er62	**Frequency search algorithm error.** *Rotation pickup cancel and switching the FC to emergency mode.*	It occurs at an attempt to start or automatically restart the drive in pickup mode with a frequency scan in case when found frequency is outside the programmable limits.	■ Motor shaft speed is out operating limits - check drive mechanics. ■ Internal frequency search algorithm logic failure, if it is permanent - **refuse to use this mode and inform the manufacturer's service department.**
Er64	**Repeated automatic restarts number error.** *Cancel of restart and holding the FC in emergency mode.*	Ran out of the automatic restart attempts number, the drive remains in emergency mode until it is reset from the control panel.	■ Do a comprehensive drive operating mode review. ■ Change the response type to an accident. ■ Increase the restart delay

Code	Error description	Possible reason	Recommendations on eliminating
			time or the attempts number, if necessary.
Er65	**Restart error due to rotation direction.** *Cancel of restart and holding the FC in emergency mode.*	During the restart delay time the user programmatically changed the desired drive rotation direction **which is unacceptable.** The drive remains in emergency mode until it is reset from the control panel.	If a long restart delay is programmed, it is necessary to remember and understand that the drive tries to automatically return to the state that preceded the accident and if the operating conditions changed, restart does not make any sense.
Er66	**the motor stator resistance identification process start error.** *Completely disconnects the drive and switches the FC to emergency mode.*	The inverter is not in normal standby (idle) mode.	■ Stop the drive. ■ Reset active alarms.
Er67	**Motor stator resistance identification process error by saturation voltage.** *Completely disconnects the drive and switches the FC to emergency mode.*	Excessively high stator winding resistance at high rated current.	■ Set the correct rated motor current level. ■ Select a converter that matches the motor power.
Er68	**Motor stator resistance identification process error by value.** *Completely disconnects the drive and switches the FC to emergency mode.*	A specific resistance value has not passed the validation test.	■ Set the correct level of the rated motor current. ■ Perform the measurement yourself using a specialized device. Then enter the resistance value manually in the setup menu.
Er69	**The motor stator resistance identification process error by the measured signal noise.** *Completely disconnects the drive and switches the FC to emergency mode.*	The measured signals are very noisy. The procedure is complicated.	■ To retry. ■ Perform the measurement yourself using a specialized device. Then enter the resistance value manually in the setup menu.
Er70	**Non-volatile memory operation error.** *Completely disconnects the drive and switches the FC to emergency mode.*	There was a failure while working with the FC non-volatile memory.	■ Re-initialize the inverter (disconnect from the mains and re-connect it with a delay). ■ Check the programmed settings correctness in the service menu and **report the problem to the manufacturer's service department.**
Er71	**System failure.** *Completely disconnects the drive and switches the FC to emergency mode.*	A critical error or unauthorized device reset has occurred.	**Report it to the manufacturer's service department.**
Er72	**The integrated power factor corrector operation error.** *Completely disconnects the drive and switches the FC to emergency mode without reset option.*	A critical error in the FC hardware has occurred.	**Report the error to the manufacturer's service department.**
Er80	**General user access error.** *Indication only.*	A general user tried to change locked parameters.	■ Enter the advanced user password (see menu item 7-02).
Er81	**The setup menu accessing error.**	The setup menu was	■ Enter the correct password.

Code	Error description	Possible reason	Recommendations on eliminating
	Indication only.	completely locked. The entered password is not correct.	■ Enter the super password for a one-time access (see menu item 7-02).
Er82	**Internal failure in access restriction system.** *Indication only.*	FC program part error.	■ **Reboot the FC.** **Report the error to the manufacturer's service department.**

WARNINGS CODES LIST

Code	Error description	Recommendations on eliminating
At10	**The meter mode is incorrectly configured. Activation failed.**	■ Carefully reread the section on setting the meter mode in the FC and do the correct settings in the service menu.
At11	**The PID controller operating mode is incorrectly configured. Activation failed.**	■ Carefully reread the section on setting up and using the PID-controller. Set the PID-controller correctly in the service menu.
At12	**The FC is over the normal temperature zone and is prone to overheating..**	■ Check if the cooling fan starts. ■ Check if the ventilation windows in the device case blocked. ■ Reduce motor load. ■ Install an additional cooling fan.
At14	**Attempts to start the drive rejected. The voltage on the bus is not normal.**	■ Check and normalize the FC supply voltage.
At15	**The motor has heated above 100% and is prone to overheating.**	■ Check if the motor overheat protection setting is correct. ■ Reduce motor load.
At16	**The analog input (AN.IN) is incorrectly configured. Operation on the analog channel is not possible.**	■ Correctly scale the analog input in the service menu.
At17	**PFC is trying to turn on and the drive is running.**	■ Stop the drive.
At18	**Incorrect programmable script operation time.**	■ Correctly configure each script action.
At19	**The stator winding resistance identification procedure has been forcibly interrupted.**	■ It should be noted that when the identification is canceled, the resistance is not determined, the drive operation is not possible in the advanced scalar control mode.
At20		
At21	**The motor is overloaded by the user's current.**	■ Reduce motor load. ■ Set a higher motor overload current level.
At22	**The motor is underloaded by the user's current.**	■ Stop the drive and check all mechanical components integrity. ■ Set lower underload current level.

7. POSSIBLE REASONS OF MALFUNCTIONING

Malfunction	Possible reason and solution
Motor speed cannot be controlled from the buttons on the front	- The source and/or reference mode is incorrectly configured. In order to set the frequency from the panel, it is necessary to set 0 or 2 in menu item 3-01 and 0 in menu item 3-02.

Malfunction	Possible reason and solution
panel	- Incorrectly programmed frequency adjustment limits. It is necessary to check the service menu items 1-01 and 1-02 - minimum and maximum speeds. - Faulty membrane buttons on the control panel keyboard. Contact the service center.
The motor runs jerkily with a frequency of 1-3 seconds	- Check input voltage. To do this, press the button ⓘ four times to display the voltage on the DC bus. Without load (rotation) its value should be in the range of 300-340V. For FC with PWM is 390 +/- 10V. If during rotation this value drops to 250-280V, then it indicates a “weak” mains. To eliminate this situation, it is necessary to exclude: thin or long supply wires, joints or poor-quality connections in the wires. Change the supply phase, if there is less loaded, with a higher voltage or lower internal resistance. Also can reduce the FC output frequency, which can also reduce the load on the mains.
The motor does not “hold” the load, “pulls badly”	- Check the motor connection, the motor windings must be delta connected, provided that the motor is designed to operate on 220V. Can increase the output voltage efficiency by lowering the PWM modulation frequency to 3 kHz. To do this, set the value "3" in the service menu item 4-05. Menu items 5-02 and 5-03 also affect the characteristic stiffness and determine to what frequency the output voltage can increase evenly. Typical value when connecting standard motors (50 Hz, 220V) menu item 5-02 = 50 Hz, menu item 5-03 = 220V, but to increase the torque on the shaft at an output frequency from 30 to 50 Hz, the rated voltage value can be slightly increased. If the motor "does not pull" at low speeds when using general scalar control, it is necessary to increase the correction voltage (menu item 4-17). The higher the value of this menu item, the more voltage is supplied to the motor at an output frequency from 1 to the corner frequency (see menu item 4-18). The correction voltage level at low frequencies linearly decreases to the corner frequency (20 Hz by default) and above this frequency does not affect the output voltage characteristics stiffness.
Motor does not start	- Make sure that the power circuit is connected correctly: ■ check if the control panel digital indicator is on ■ check whether the motor is connected correctly (check the contact terminals tightening density) ■ check whether the reverse lock function is set (the service menu items 2-03 and 2-06) ■ check the motor windings resistance with an ohmmeter when the frequency converter is disconnected from the mains (the resistance values between the phases should be the same)
When connected to the network, the firmware version is displayed for 3 seconds and the indication goes out. Does not respond to buttons.	- The FC control mode via the RS485 interface (ModBus-RTU) was accidentally set. The control panel is disabled in this mode. To exit this operating mode, first disconnect the FC. Press and hold the two buttons ⓘ and ➡ of the installed control panel, and then apply the supply voltage to the inverter by holding the buttons for 3 seconds until the inverter enters service mode. Then, from the service mode, disable the operation via RS485, for this it is necessary to set the values other than 3 in menu items 2-01 and 3-01.
Does not glow, even when power is applied.	- The reason may be in the power supply crate, charging resistor, etc. It can only be fixed at the manufacturer's service center.
The software version is displayed, the V indicator flashes.	- Low mains voltage.

8. MAINTENANCE

CFM converters are made on a modern elemental base: power switches - IGBT (bipolar transistor with insulated gate); control system - on a specialized microcontroller, etc. with the widespread use of surface mount elements (SMD) and automated circuit board mounting.

Cooling system - with forced airflow (using fans).

To maximize the FC uptime, a monthly inspection and, if necessary, the preventive maintenance described below should be carried out.

Inspection and maintenance must be carried out by qualified personnel!

8.1 PERIODICAL INSPECTION

Below are the main points that need to be checked:

1. Whether the motor operates normally (unusual sounds, excessive heat, vibration, unusual LED behavior, etc.).
2. Whether the environmental conditions are acceptable for the FC operation (temperature, humidity, air pollution, cooling conditions, etc.).
3. Whether the mains voltage is within acceptable limits (measurement with a voltmeter)

8.2 PREVENTIVE MAINTENANCE

Attention! Before carrying out maintenance, it is recommended to disconnect the mains voltage, wait 2 minutes after the LED indicators go out, for a complete FC capacitors discharge.

1. Check the wiring on the power terminals, external control terminals and relay outputs, if necessary, tighten them, abide by the necessary force.
2. Check conductors and insulation for damage.
3. Check insulation resistance with a megger
4. If the FC has not been switched on for a long time, it is necessary to turn it on without a motor at least once every two years and confirm the preservation of its functional capabilities.
5. Clean the radiator from dust and dirt (vacuum), control panel, connectors and other FC places. Remember that dust and dirt can shorten the FC life or cause it to fail.