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USER'S MANUAL

SERIES 4XXX DIGITAL THYRISTOR MAIN CONVERTER FOR DC MAIN MOTOR WITH INDEPENDENT EXCITATION

Contents

1. General description 4
2. Operating instructions, storage and transportation 5
3. Technical features 6
4. Installation and dimensions 7
5. Interface and converter status indication 11
5.1 Parallel interface X1 11
5.1.1 Digital inputs 11
5.1.2 Digital outputs 15
5.2 Analog interface X2 15
5.2.1 Differential analog input 16
5.2.2 Analog input for tachogenerator 16
5.2.3 Analog outputs 17
Two analog outputs are option which is assembled on the order by the client. 17
5.2.4 Others 17
5.3 Encoder interface - X3 и X4 17
5.4 Series interface X6 18
5.5 Power interface X7 18
5.5.1 Coverter controlling block supply 18
5.5.2 Converter power part supply 18
5.5.3 Wound field power part supply 19
5.5.4 Motor wound field supply 19
5.5.5 Motor armature supply 19
5.6 Converter status indications 23
6. Converter adjustment 27
6.1 Work with special terminal or personal computer 27
6.2 Functional converter circuit 28
6.3 Converter parameteres 28
6.4 Parameter description 32
6.4.1 Group 1 – parameters for variable watching 32
6.4.2 Group 2 – converter parameters 33
6.4.3 Group 3 – protection parameters 36
6.4.4 Group 4 – motor parameters 39
6.4.5 Group 5 – speed regulator 40
6.4.6 Group 6 – armature current parameters 41
6.4.7 Group 7 – EMF regulators and wound field parameters 42
6.4.8 Group 8 – orientation stopping parameters 42
6.4.9 Group 9 – output parameters 42
6.4.10 Group 10 – terminal parameters 43
6.4.11 Group 11 – error history 44
6.5 Errors in emergency mode 44
7. Assembling and connecting of the converter 46
7.1 General technical requirements to the assembling 46
7.2 Connecting of the converter 47
8. Connecting snd adjusting of the converter 50
8.1 Checking the supply voltages 50
8.2 Primary converter adjusting 52
8.2.1 Primary adjusting of the speed feedback 52
8.2.2 Adjusting the parameters connecting to the motor 53
8.3 Adjusting the nominal, maximal and minimal wound field current 53
8.4 Starting of the converter in proportional mode 54
8.5 Adjusting the protection from speed feedback fault 55
8.6 Adjusting the wound field current regulator 57
8.7 Checking the converter work in integral mode 58
9. Possible troubles shootings remedy actions 65
APPENDIX № 1 67

1. **General description**

Series 4XXX are a new generation intelligent thyristor converters based on modern DSP/CPLD technologies. They are fed directly by the power mains and provide two zone, four quadrants speed control of motors. In the first zone speed is regulated according to constant torque, and in the second zone to constant power. There are speed regulation mode and position mode. Adjusting all converter working modes is made by parameters system.

The converters of 4XXX series are designated for universal functioning and can be built-in in any machine regarded as highly requirements to the electrical device, also they have built-in functions, spesial for main devices of metalcutting machines with CNC. They have also extended interface which gives different variants for user's work.

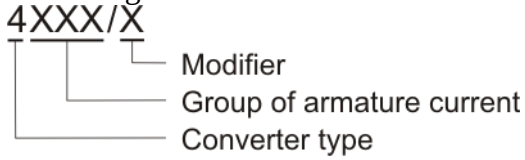
2. Operating instructions, storage and transportation

Thyristor converter series 4XXX can work , can be storage, and be transported in these conditions:

- Indoor temperature from 5^{o} C to 50^{o}C;
- Maximum relative humidity at 30^{o} C less than 80 % ;
- Equipment should not be stored above 1000 m above the sea level;
- Environment – There must be no aggressive liquids, gases, vapour and electric conductive dust or easily flammable and explosive materials in the room where the equipment is saved;
- The equipment must not be exposed to direct solar radiation;
- Installation vibration limits frequency from 1 to 35Hz and acceleration less than 4.9m /s^2.

3. Technical features

The converter technical features are given in chart 1.



Structure of symbols, signification of modification:

'M' – converters, made to special order of user – in this case there is different technical features, individual programme or user interface.

'R' – converter with user power block – assembly dimensions are individual for each performance.

Converter,type:		**4002**	**4003**	**4004**	**4005**	**4006**	**4007**	**4009**	**4011**	**4013**	**4016**	**4020**	**4025**	**4030**
Rated armature current	**A**	20	30	40	50	60	70	90	110	130	165	200	250	300
Maximal armature current	**A**	40	60	80	100	120	140	180	220	260	335	400	500	600
Power supply voltage	**V**	3x380,+10 / –15%												
Frequency of power supply voltage	**Hz**	45 ÷ 65												
Maximal voltage of motor armature	**V**	440												
Maximal current of motor wound field [1]	**A**	4 / 6 / 12												
Dinamic current limitation of armature		Programmable												
Maximal voltage of wound field		$320V_{DC}$ при $U_F = 380V_{AC}$												
Speed feedback /position		Tachogenerator or Encoder/Encoder												
Speed reference		Analog/parallel code/series interface												
Position reference		Parallel code/series interface												
Range of speed control		1:1000												
Orientation stopping		Built-in												
Maximum voltage of tachogenerator	**V**	± 193 at N_{MAX}												
Analog input		± 10V / 0 ÷ 10V / 0 ÷ -10V, 10ком												
Analog outputs [2]		2 outputs, ± 10V, 2 mA												
Digital inputs		18 inputs, ± 24V, 10mA												
Digital outputs		5 outputs relay type, $100V_{AC}$ / 0.3A, $24V_{DC}$ / 0.3A												
Series interfaces [3]		RS 232C до 9600 bps RS 485 до 115 200 bps												
Working codition		Long lasting S1												
Degree of protection		IP 20												
Dimensions HxWxL	**mm**	405x200x170				405x200x195				460x261x316,5			500x261 x316,5	

Table 1 Converters technical features

Notes:

[1] – given rated wound field current refers to standard performed converters. At user's order maximal wound field current can be to 25 A;

[2] – the two analog outputs are option, which is assembled on order by the client.

[3] – series interface **RS485** is option, which is assembled on order by the client.

4. Installation and dimensions

The components of the converters of 4XXX series are placed on a metal corpus. The mounting holes are on the upper and lower part of the back side of the converter. The power elements are installed on the radiator, which is assembled at the bottom of the box. Over the power elements is fixed a plate on which are assembled pulse separating transformers, rejector groups,and fuses. The processor control board together with the interface terminals and indications are installed on the front panel. The dimensions and the locations of the interface and power terminals are given on fig.1,fig.2,fig.3,and fig.4.

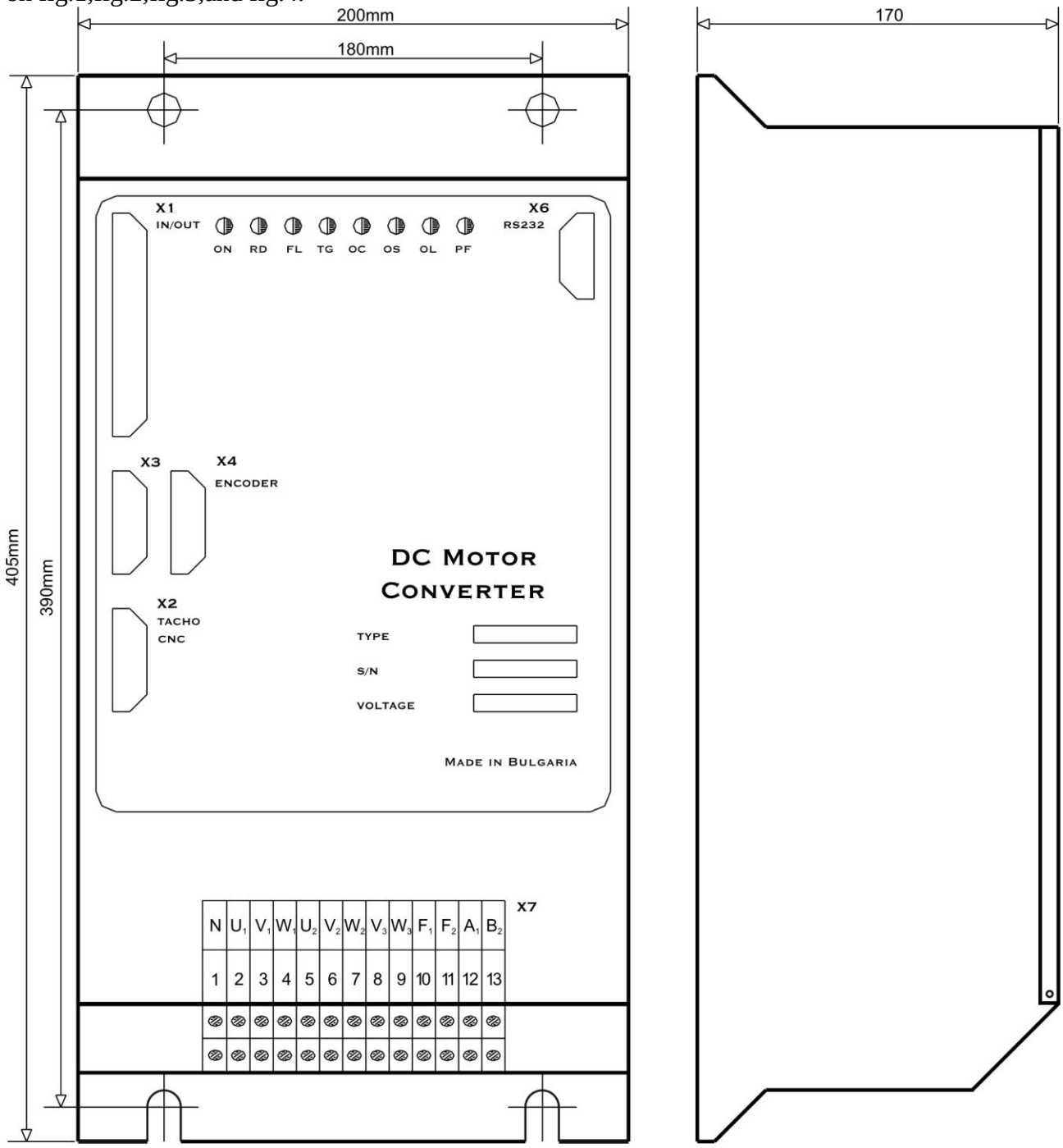


Fig. 1. Connecting and overall dimensions of converters type
4002, 4003, 4004 and 4005

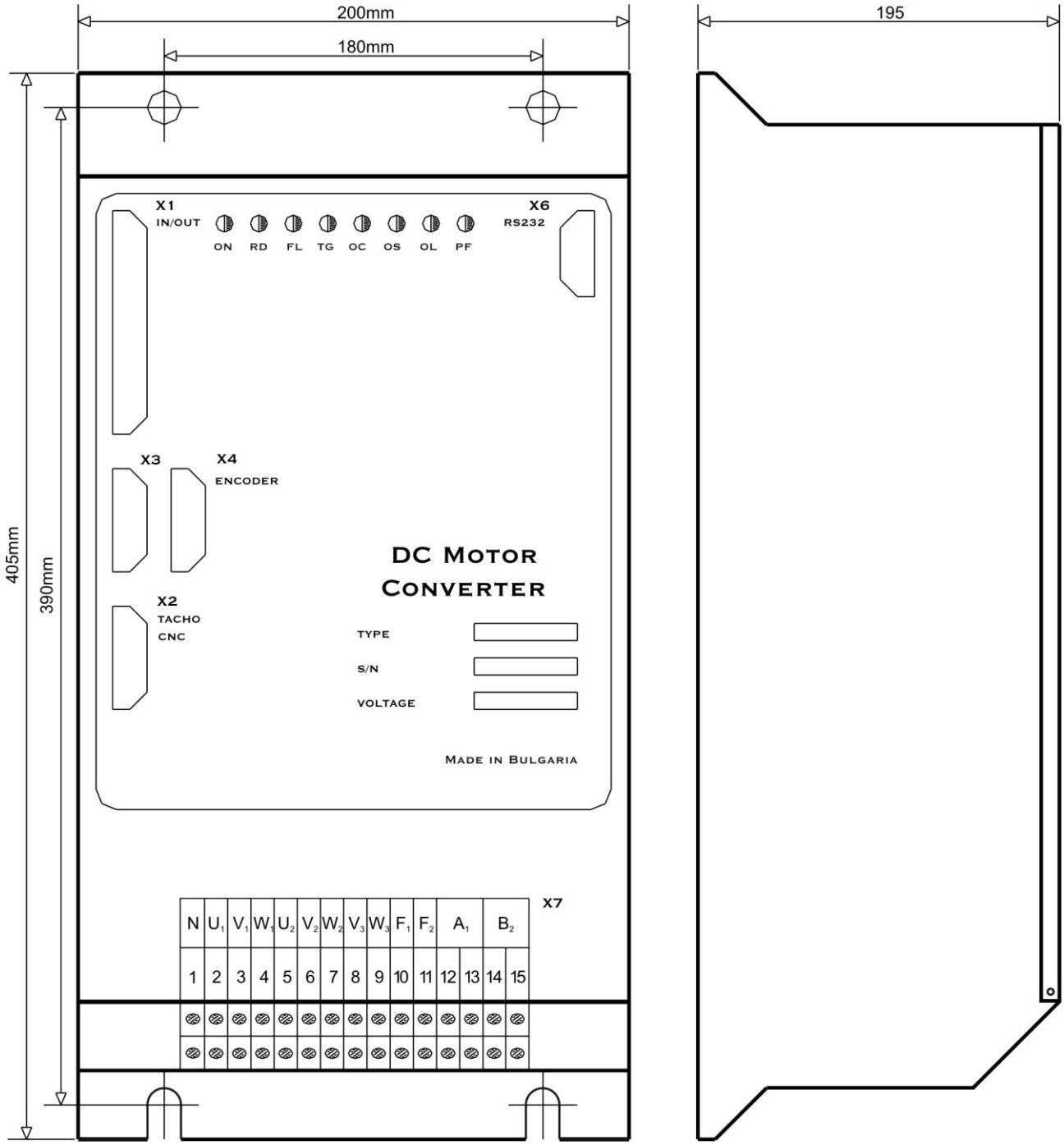


Fig. 2. Connecting and overall dimensions of converter type
4006, 4007, 4009 и 4011

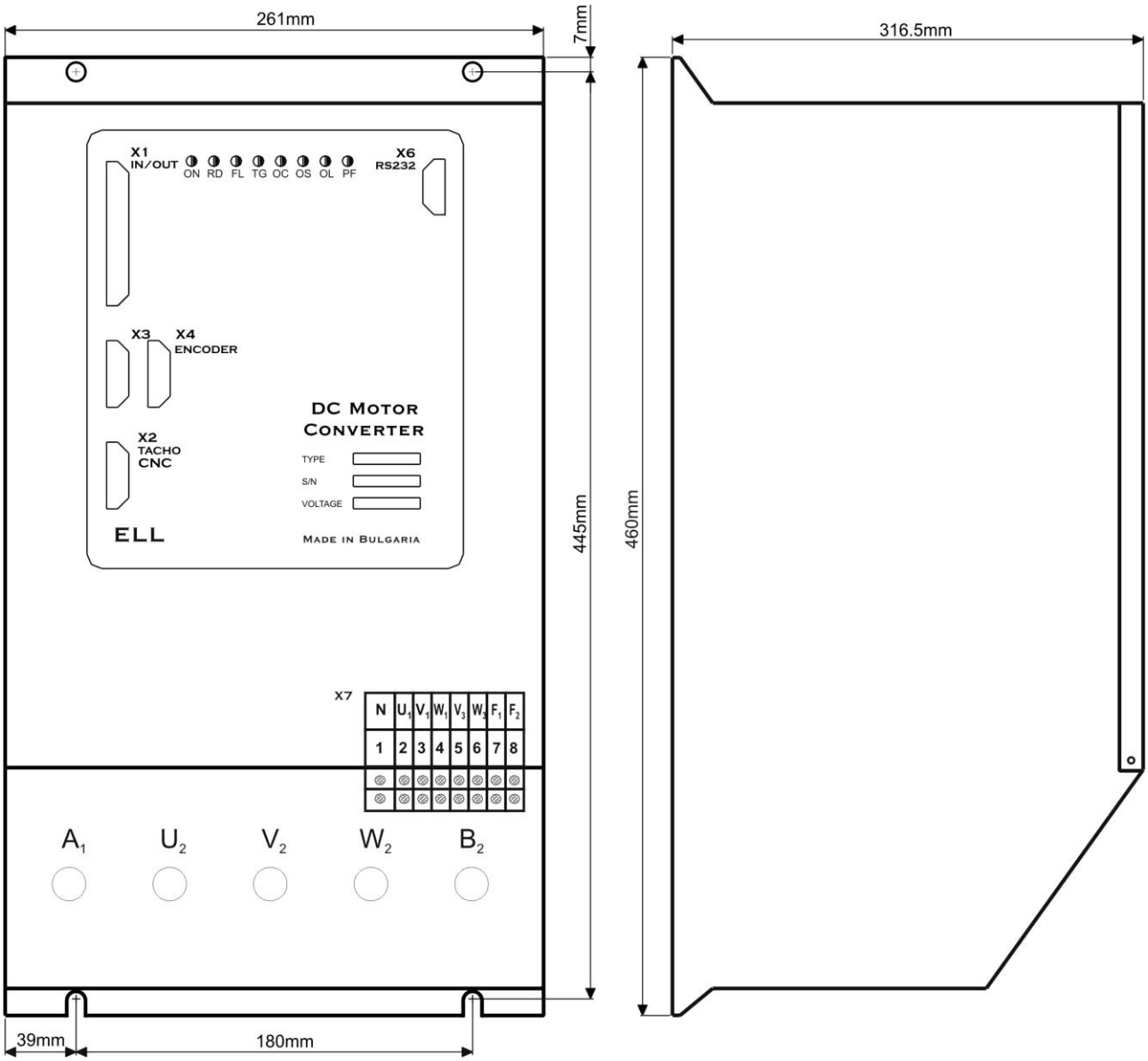


Fig. 3. Connecting and overall dimensions of converters type
4013, 4016, 4020

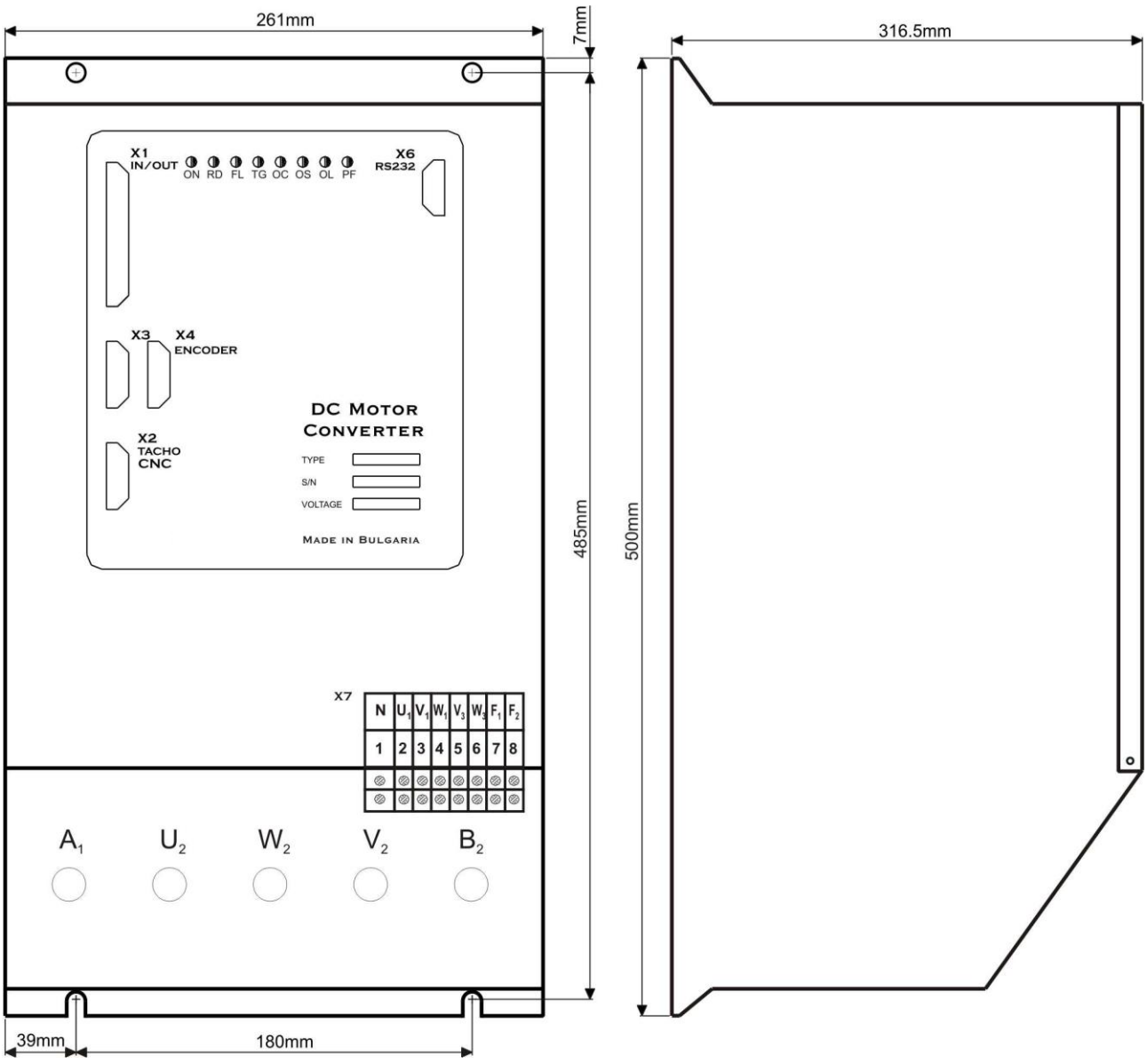


Fig. 4. Connecting and overall dimensions of converters type
4025, 4030

5. Interface and converter status indication

5.1 Parallel interface X1

Parallel interface consists of:

– 12 digital inputs: from **IN0** to **IN11**, galvanic isolated, voltage ± $24V_{DC}$ and input current to 10mA. Input signal low level from 0 to 7 V and high level from 13 to 30 V. They are used for speed and position reference by parallel digital code;

– 6 digital inputs: **ON**, **SR**, **SF**, **ORCM**, **TLL** and **TLH**, galvanic isolated, voltage ± $24V_{DC}$ and input current to 10mA. Input signal low level from 0 to 7V and high level from 13 to 30V. They are used for control converter work;

– 5 digital outputs: **RD**, **TL**, **ZS**, **SA** and **INPOS**, relay type, load capacity 0.3A at $100V_{AC}$ and 0.3A at $24V_{DC}$. They show to the outside control device moment status of the converter.

Parallel interface **X1** is led to 37pin terminal on the upleft part of the face panel. In table 2 is given correspondence between signals and parallel interface terminal **X1 pins**, and in fig.5 are given pin places and input structure.

Digtal inputs are universal and they are grouped into two groups. In the first group are inputs from **IN0** to **IN11**, and in second **ON**, **SR**, **SF**, **ORCM**, **TLL** and **TLH**. Inputs in each group can be selected individually by system outputs type **P** or **N**. Inputs in each group can be fed by outer voltage $24V_{DC}$ or by inner converter voltage. Variants of digital inputs connection are given in fig.6.

№	Signal	№	Signal	№	Signal	№	Signal	№	Signal
1	-	**9**	TLL	**17**	IN4	**25**	ON	**33**	IN9
2	INPOS1	**10**	Uinp2	**18**	IN2	**26**	SR	**34**	IN8
3	RD1	**11**	+24V	**19**	IN0	**27**	TLH	**35**	IN5
4	SA1	**12**	+24V	**20**	INPOS2	**28**	Uinp2	**36**	IN4
5	ZS1	**13**	Uinp1	**21**	RD2	**29**	GND	**37**	IN1
6	TL1	**14**	IN10	**22**	SA2	**30**	GND		
7	ORCM	**15**	IN8	**23**	ZS2	**31**	Uinp1		
8	SF	**16**	IN6	**24**	TL2	**32**	IN11		

Table 2 Correspondence between signals and pins of parallel interface terminal X1

5.1.1 Digital inputs

– **IN0** to **IN11** (X1.14…19 and X1.32…37). They are used for:

- Speed reference by parallel digital code 12 bits from inputs **IN0**...**IN11** when parameter **P02.09** = 0;
- Speed reference by parallel digital code 10 bits from inputs **IN2**...**IN11** when parameters **P02.09** = 0, **P02.11** = 1 and **P02.19 =** 1;
- Position reference of orientation stopping when parameter **P08.01** = 1.
- Position reference of orientation stopping when parameter **P08.01** = 1 and speed reference when parameter **P02.09** = 0. Before activating control signal **ORCM**, digital inputs **IN0**...**IN11** are taken as source of speed reference. When control signal **ORCM** is activated, inputs **IN0**...**IN11** are taken as source of position reference when function orientation stopping is performed;
- Choice of maximum speed of spindle shaft rotating, in case when it is used gearbox with variable coefficient of transmission between spindle shaft and motor and when parameters are: **P02.11**=1 и **P02.19**=1. As sensor of speed feedback is used encoder, placed on the spindle of the machine. By digital inputs **IN0** and **IN1** is chosen to 4 different coefficients of transmission. Maximal speeds of spindle rotating for given coefficient of transmission are set in parameters from **P02.20** to **P02.23.**

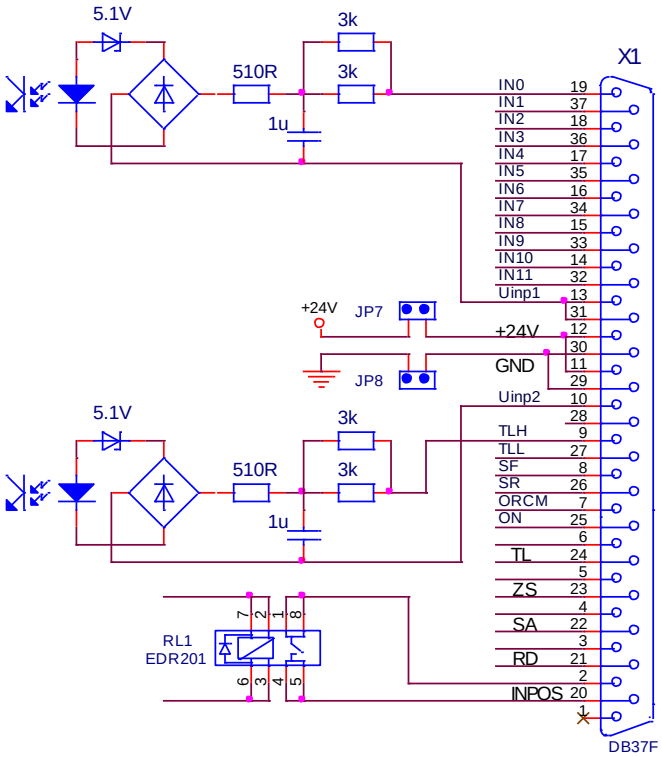


Fig.5 Correspondence between signals and pins of parallel interface terminal **X1** and electrical circuit of digital inputs and outputs.

– **ON** (X1.25) – enabling converter work. When control signal **ON** activates regulators work is enabled, power part activates and, if any protection does not activate, the reference is performed. Control signal **ON** is realized only when zero speed **ZS** activates. Timetables of realizing of control signal **ON** are given in fig.7.

– **SR** (X1.26) и **SF** (X1.8) – control signals of defining the motor rotating direction. They are used only when:

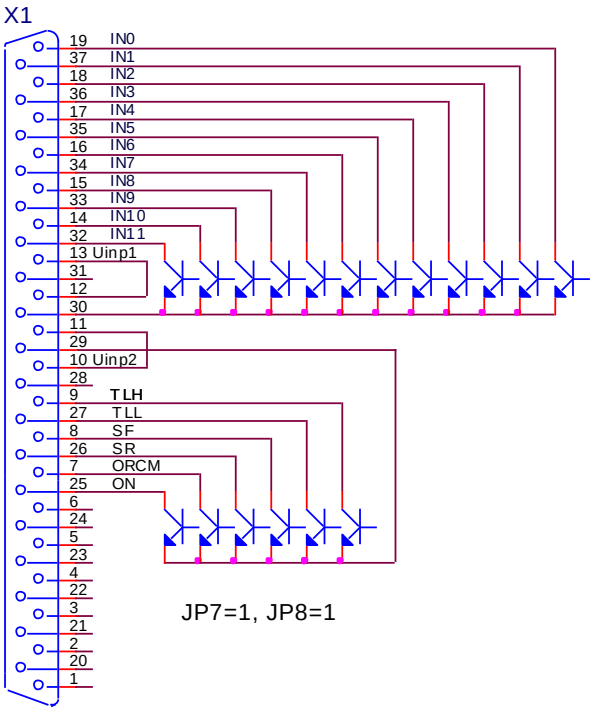
- Meaning of parameter **P02.09** = 0 – digital speed reference by parallel 12 bit code, set in inputs **IN0** ... **IN11** or 10 bit code, set in inputs **IN2** ... **IN11** when **P02.11** = 1 и **P02.19 =** 1;
- Meaning of parameter **P02.09** = 1 – analog uni voltage speed reference in range from 0 to +10V or from 0 to -10V, as the sign also point the rotating direction.

When the control signals **SF** and **SR** activate at the same time it is performed zero speed reference;

– **ORCM** (X1.7) – control signal of orientation stopping. When control signal **ORCM** activates, the rotating speed is fixed in so called “searching speed”and when there is zero pulse from encoder, the motor stops in the position given by parallel code of digital inputs **IN0**...**IN11** or by the value of parameter **P08.02** when **P08.01** = 0;

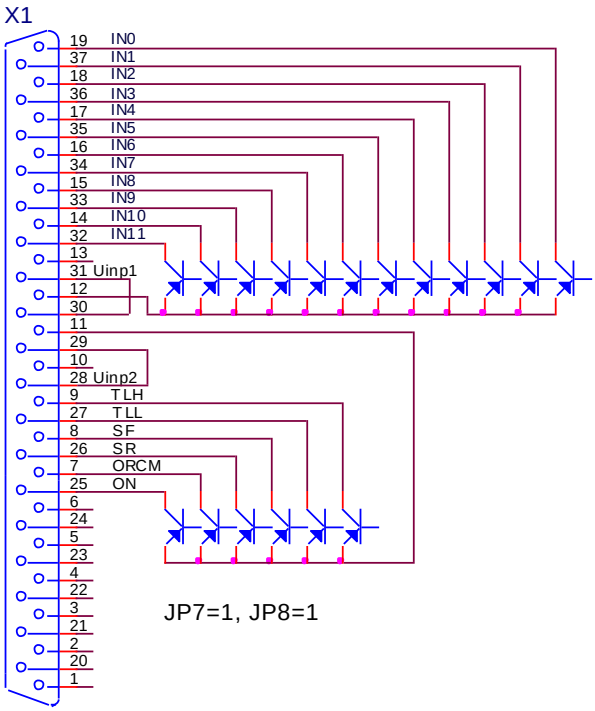
– **TLL** (X1.27) – control signal of torque limitation. When control signal **TLL** activates, the motor torque is limited to the value set in parameter **P09.05** in range from 1% to 100% from rated motor current $\mathbf{Ia_{NOM}}$ (parameter **P04.05**);

– **TLH** (X1.9) – control signal of torque limitation. When control signal **TLH** activates, the motor torque is limited to the value set in parameter **P09.04** in range from 10% to 100% from motor rated current $\mathbf{Ia_{NOM}}$ (parameter **P04.05**).



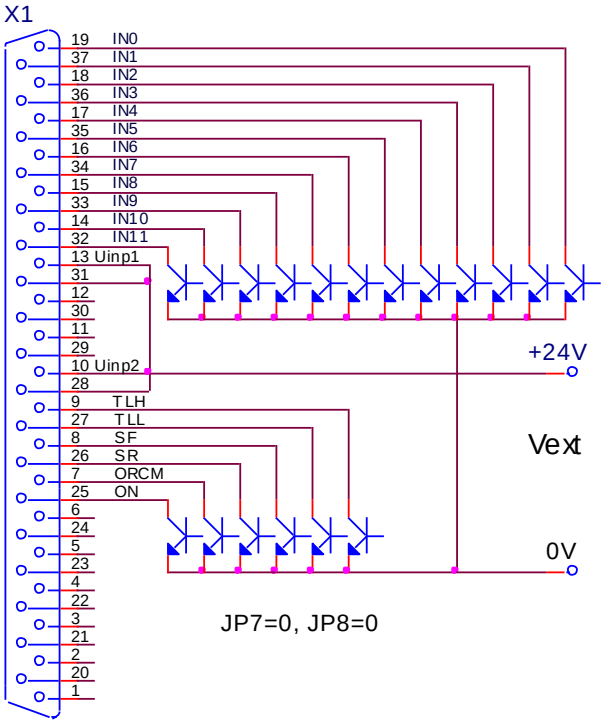
Variant 1

All inputs are selected by system outputs type **N** with inner power supply (**JP7**=1, **JP8**=1).



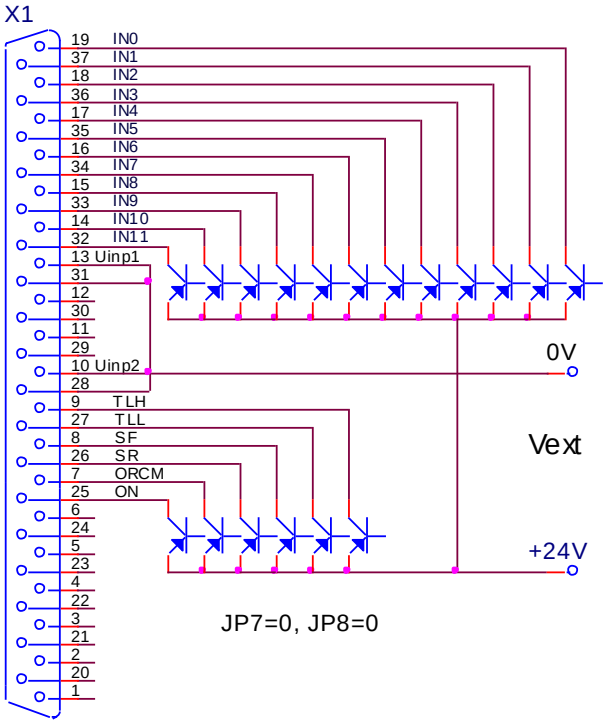
Variant 2

All inputs are selected by system outputs type **P** with inner power supply (**JP7**=1, **JP8**=1).



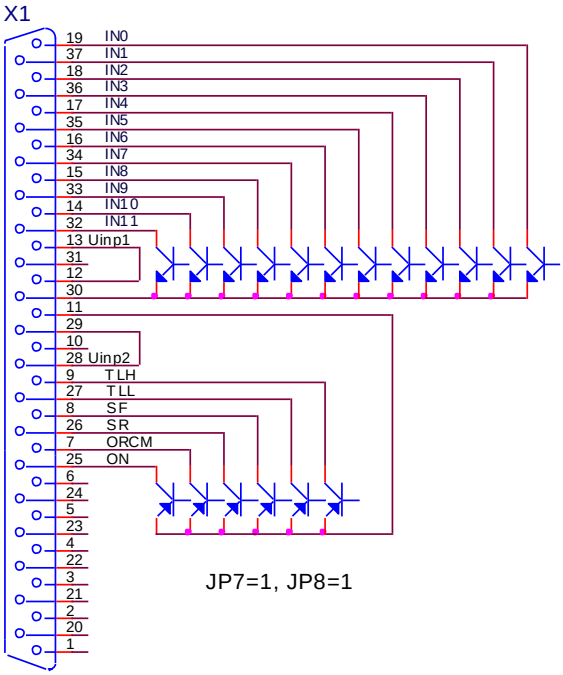
Variant 3

All inputs are selected by system outputs type **N** with outer power supply (**JP7**=0, **JP8**=0)



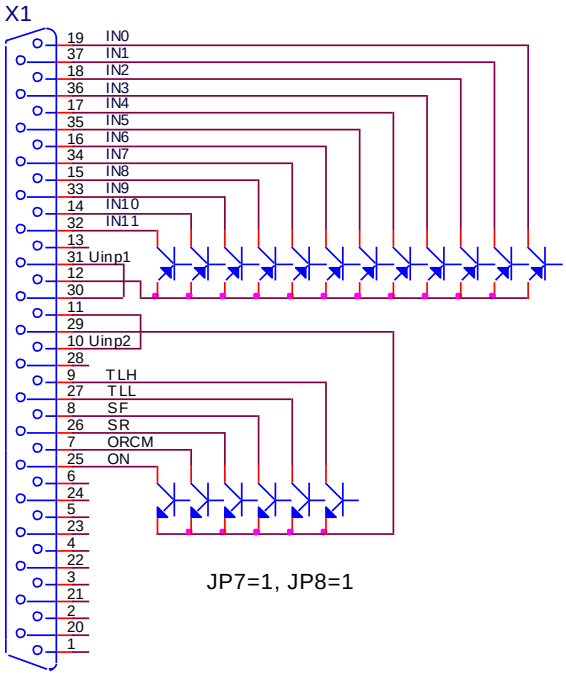
Variant 4

All inputs are selected by system outputs type **P** with outer power supply (**JP7**=0, **JP8**=0)



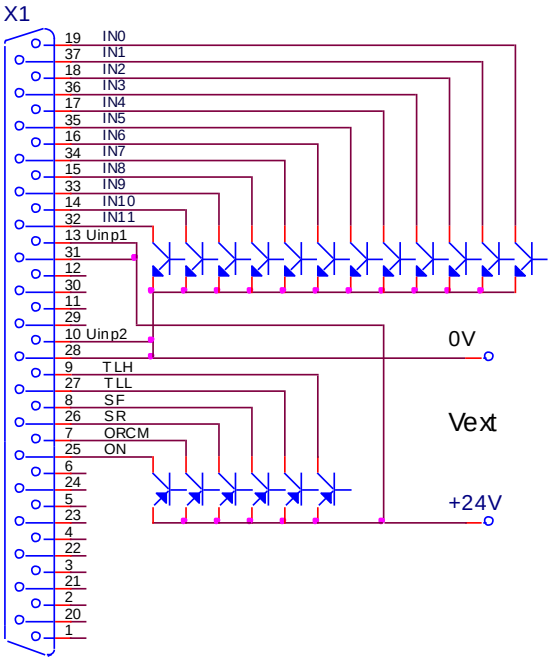
Variant 5

Inputs from **IN0** to **IN11** are selected by system outputs type **N**, others by system outputs type **P**, as all of them are with inner power supply (**JP7**=1, **JP8**=1)



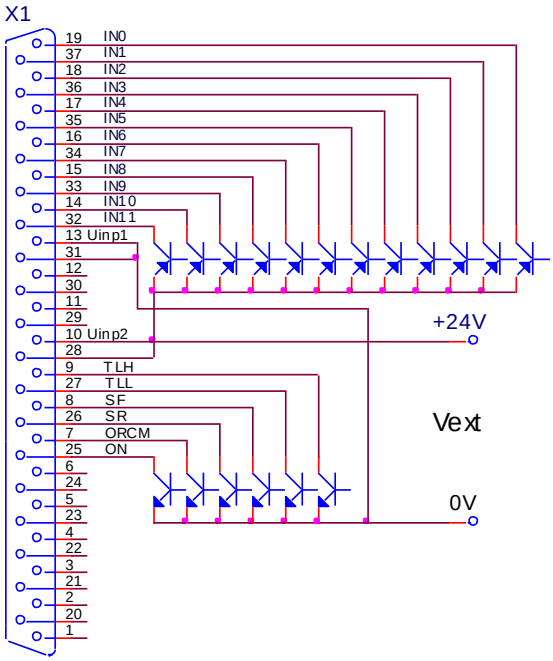
Variant 6

Inputs from **IN0** to **IN11** are selected by system outputs type **P**, others by system outputs type **N**, as all of them are with inner power supply (**JP7**=1, **JP8**=1)



Variant 7

Inputs from **IN0** to **IN11** are selected by system outputs type **N**, others by system outputs type **P**, as all of them are with outer power supply **(JP7**=0, **JP8**=0)



Variant 8

Inputs from **IN0** to **IN11** are selected by system outputs type **P**, others by system outputs type **N**, as all of them are with outer power supply (**JP7**=0, **JP8**=0)

Fig. 6 Variants of connecting digital inputs **IN0**…**IN11**

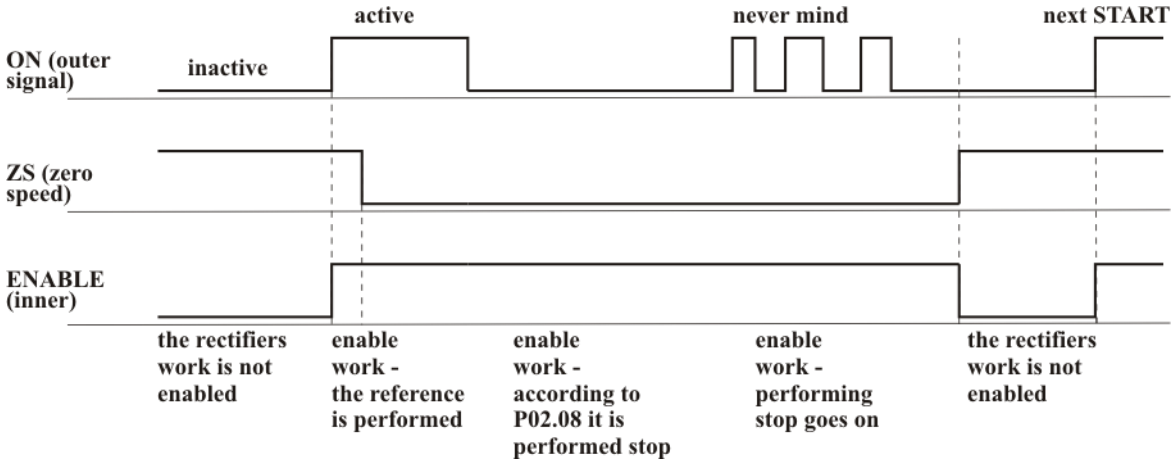


Fig. 7 Timing diagram of performing control signal **ON** and inner work enable

5.1.2 Digital outputs

- **RD** (X1.3, X1.21) – converter is ready. Output **RD** activates approximately 4 seconds after switching on power supply of converter if any protection is not activated. Two working mode of output **RD** are possible. Choice of mode is defined by parameter **P09.07**:
  - **P09.07 =** 0 – output of ready **RD** activates 4 seconds after switching on operative supply **U1**, **V1** and **W1**, power supply **U2**, **V2** and **W2** and excitation supply **V3** and **W3** at the same time;
  - **P09.07 =** 1 – output of ready **RD** activates 4 seconds after switching on operative supply **U1**, **V1** and **W1** and excitation supply **V3** and **W3**, as when control signal **ON** is activated without power supply hard protection **HPF** is activated and **LED** indication **PF** twinkling with a period of time 1 s**;**
- **TL** (X1.6, X1.24) – torque limitation. It activates when the converter works in mode of torque limitation by outer control signal **TLL** or **TLH**;
- **ZS** (X1.5, X1.23) – zero speed. It activates at rotating speeds under speed set as value of parameter **P09.01**;
- **SA** (X1.4, X1.22) – approached speed. It activates at rotating speed more than speed given as a meaning of parameter **P09.02**. The function speed approached is enable for speed more than the meaning of parameter **P09.03**;
- **INPOS** (X1.2, X1.20) – stopping in position. It activates in orientation stopping mode when the given position is approached to the limit set as value of parameter **P09.06**.

5.2 Analog interface X2

The analog interface **X2** is given in fig.8 and it consists of:

- differential analog input **Uref**;
- analog input of speed feedback when it works with tachogenerator **Ubr**;
- two programmable analog outputs **AOUT1** and **AOUT2**.

№	Signal	№	Signal	№	Signal	№	Signal	№	Signal
1	Ubra	4	Urefb	7	+12V	10	EARTH	13	AGND
2	Ubrb	5	AOUT1	8	-12V	11	EARTH	14	AGND
3	Urefa	6	AOUT2	9	EARTH	12	-	15	AGND

Table 3 Correspondence between signals and analog interface terminal **X2** pins

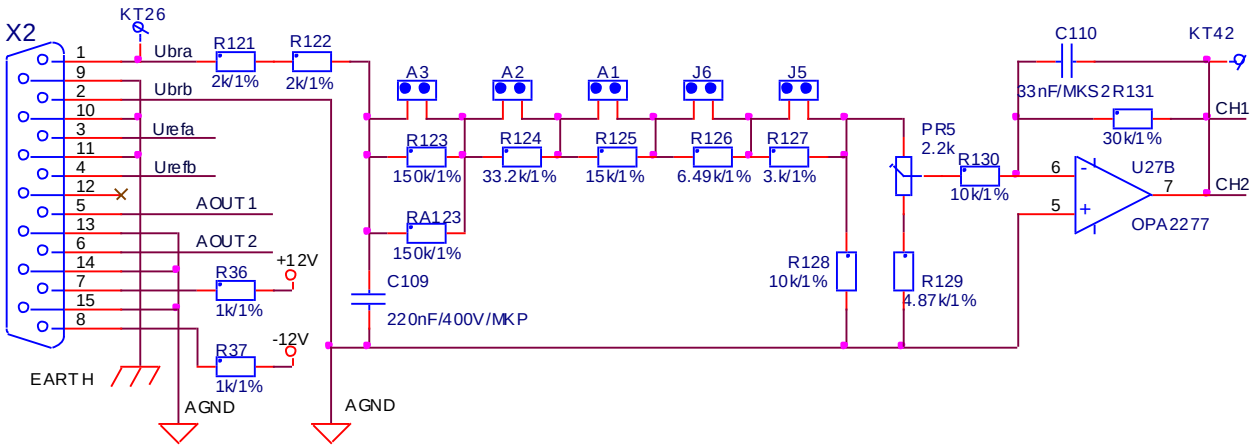


Fig.8 Corespondence between signals and analog interface terminal **X2** pins and electrical circuit of analog tachogenerator channel

5.2.1 Differential analog input

The defferential analog input **Uref** (X2.3, X2.4) is used to speed control with analog control signal when value of parameter **P02.09** = 1 or **P02.09** = 2.

5.2.2 Analog input for tachogenerator

The analog input for tachogenerator **Ubra** (X2.1, X2.2) is used in case when the sensor for speed feedback is tachogenerator. In fig. 8 is given the electric circuit of analog part of channel of speed feedback with tachogenerator.

Changing the speed feedback coefficient is made by shunts **A1, A2, A3, J5** and **J6**. Shunt places on the processor plate is given in fig.20. In table 4 is pointed shunt positions for different voltage ranges of tachogenerator at maximum speed. Precise adjustment of speed feedback coefficient at maximum speed is made by trimmer **RP5**, which place is given in fig.20.

№	J6	J5	A1	A2	A3	Ubrmax[V] **RP5** left	Ubrmax[V] **RP5** right
1	■	■	■	■	■	7.0	10.3
2		■	■	■	■	10.0	14.5
3	■		■	■	■	13.5	19.0
4			■	■	■	17.5	23.0
5	■	■		■	■	22.0	30.0
6	■			■	■	28.5	39.0
7				■	■	31.5	44.0
8	■	■	■		■	40.0	56.0
9	■		■		■	48.0	63.0
10	■	■			■	57.0	74.0
11					■	66.0	90.0
12		■	■	■		86.0	114.0
13		■		■		105.0	130.0
14		■	■			123.0	157.0
15						150.0	193.0

Table 4 Tachogenerator voltage at maximum speed
Note: Dark field means that there is a shunt**.**

5.2.3 Analog outputs

Two analog outputs are option which is assembled on the order by the client.

- **AOUT1** (X2.5) – analog output with range ±10V to analog ground **AGND** (X2.13, X2.14 and X2.15) and admissible load capacity 2mA. Signal of analog output **AOUT1** corresponds to variable selected by parameter **P09.08**;
- **AOUT2** (X2.6) – analog output with range ±10V to analog ground **AGND** (X2.13, X2.14 and X2.15) and admissible load capacity 2mA. Signal of analog output **AOUT2** corresponds to variable selected by parameter **P09.09**.

5.2.4 Others

- **AGND** (X2.2, 13, 14, 15) – analog ground. To it is measured input and output analog signals;
- **+12V** (X2.7) и **-12V** (X2.8) – inner converter voltage used for motor speed control by potensiometer as it is given in fig.19;
- **EARTH** (X2.9,10,11) – converter frame.

5.3 Encoder interface - X3 и X4

Interface **X3** for encoder (ENC) is led to 15pin terminal at the downleft part of the face panel. Input part circuit and pin places are given in **fig. 9**. Terminal **X4** is an extension of **X3** for access of other device to encoder signals.

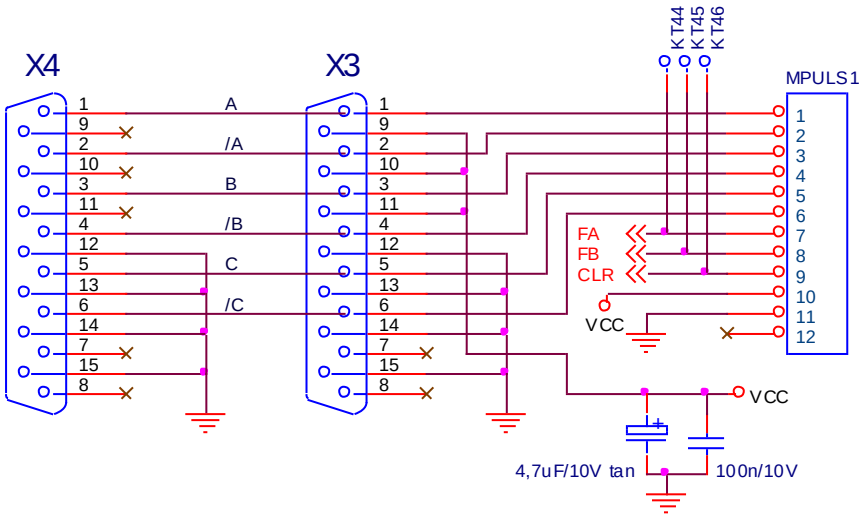


Fig.9 Electrical circuit and pin places of interface **X3** for encoder and its extension **X4**

№	Signal	№	Signal	№	Signal
1	A	**6**	/C	**11**	Vcc = +5V
2	/A	**7**	-	**12**	GND
3	B	**8**	-	**13**	GND
4	/B	**9**	Vcc = +5V	**14**	GND
5	C	**10**	Vcc = +5V	**15**	GND

Table 5 Correspondence between signals and pins of interface **X3** for encoder

5.4 Series interface X6

Physical realization of series interface **X6** is standard **RS232C**, with communication speed 9600 bps. Series interface **X6** is led to 9 pin terminal at upper part of face panel. To supply special terminal is led voltage **+5V** (X6.9). Pin places of series interface **X6** are given in **fig.10**.

Series interface **RS485** is an option.

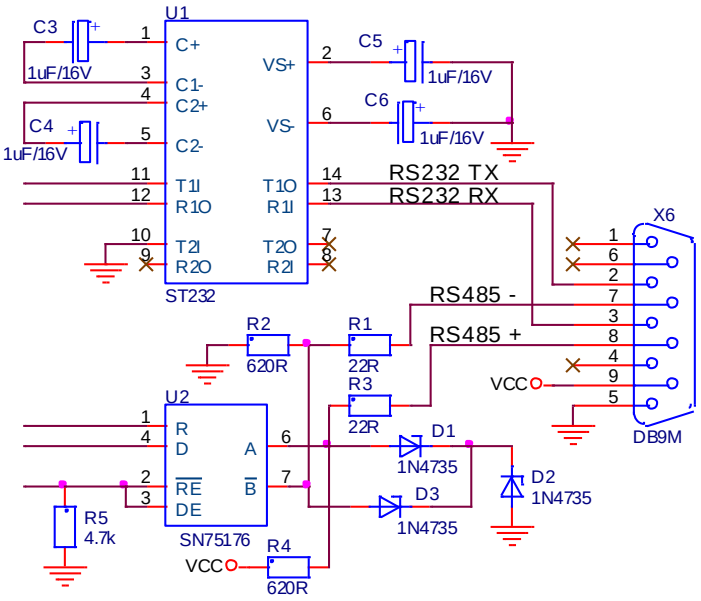


Fig.10 Electrical circuit and pin places of series interface **X6**

5.5 Power interface X7

Power interface **X7** is led to a terminal and it connects the converter to power supply mains, to the motor armature, to the motor wound field and to outer protective and commutating devices. Power interface **X7** consists of:

- supply **U1**, **V1** and **W1** to the converter controlling block;
- supply **U2**, **V2** and **W2** to the converter power part;
- supply **V3** and **W3** to the power excitation part;
- supply **F1** and **F2** to the motor wound field;
- supply **A1** and **B2** to the motor armature.

Electrical circuit of power block in set with synchronizing transformers is given in **fig.11**. Electrical circuit of power plate with pulse transformers and armature voltage sensors and wound field current is given in **fig.12**. Places of the elements and the terminals on power plate are given in **fig.13**.

5.5.1 Converter controlling block supply

Three-phase mains voltage, on the input of the commutating choke **CH1**, is connected to terminals **U1** (X7.2), **V1** (X7.3) and **W1** (X7.4) for supply and synchronizing the converter controlling block.

5.5.2 Converter power part supply

The three-phase voltage from the output of the commutating choke **CH1** is connected to terminals **U2** (X7.5), **V2** (X7.6) and **W2** (X7.7) to supply the converter power rectifier type 4002 to 4011 and respectively to the screw terminals **U2**, **V2** and **W2** of the converters type 4013 to 4030.

The protective conductor is switched on to terminal **N** (X7.1).

5.5.3 Wound field power part supply

In **fig. 16** is given a variant of the power part of the wound field supply by the transformer **TF1**. The voltage from the secondary coil of the wound field transformer **TF1** is switched on to terminals **V3** (X7.8) and **W3** (X7.9) to supply the converters type 4002 to 4011 excitation rectifier or to terminals **V3** (X7.5) and **W3** (X7.6) of converters type 4013 to 4030.

Primary coil of the wound field transformer must be connected to phases **L2** and **L3** power supply mains. If it is not observed the wound field synchronization will be wrong.

On the variant which is given in **fig.17** when it is not used an wound field transformer, **V3** (X7.8) and **W3** (X7.9) must be switched on to **V2** (X7.6) and **W2** (X7.7). If it is not observed the wound field synchronization will be wrong.

In **fig. 18** is given a variant when the power part of the wound field is connected by a separated choke **CH2** directly to phases **L2** and **L3** of power supply mains. If it is not observed the wound field synchronization will be wrong.

5.5.4 Motor wound field supply

The motor wound field is connected to terminals **F1** (X7.10) and **F2** (X7.11) of the power interface **X7** of converters type 4002 to 4011 and respectively to terminals **F1** (X7.7) and **F2** (X7.8) of converters type 4013 to 4030.

5.5.5 Motor armature supply

For converters type 4002, 4003, 4004 and 4005 the motor armature is connected to terminals **A1** (X7.12) and **B2** (X7.13). Switching circuits of the motor are given in fig. 16 and fig.17.

For converters type 4006, 4007, 4009 and 4011 terminals **A1** (X7.12, X7.13) and **B2** (X7.14, X7.15) are double and armature connecting to each terminal of power interface is made with two conductors. Connecting circuit is given in fig.18.

For converters type 4013, 4016, 4020, 4025 and 4030, the motor is connected with screw connections **A1**(X7.12) and **B2**(X7.13).

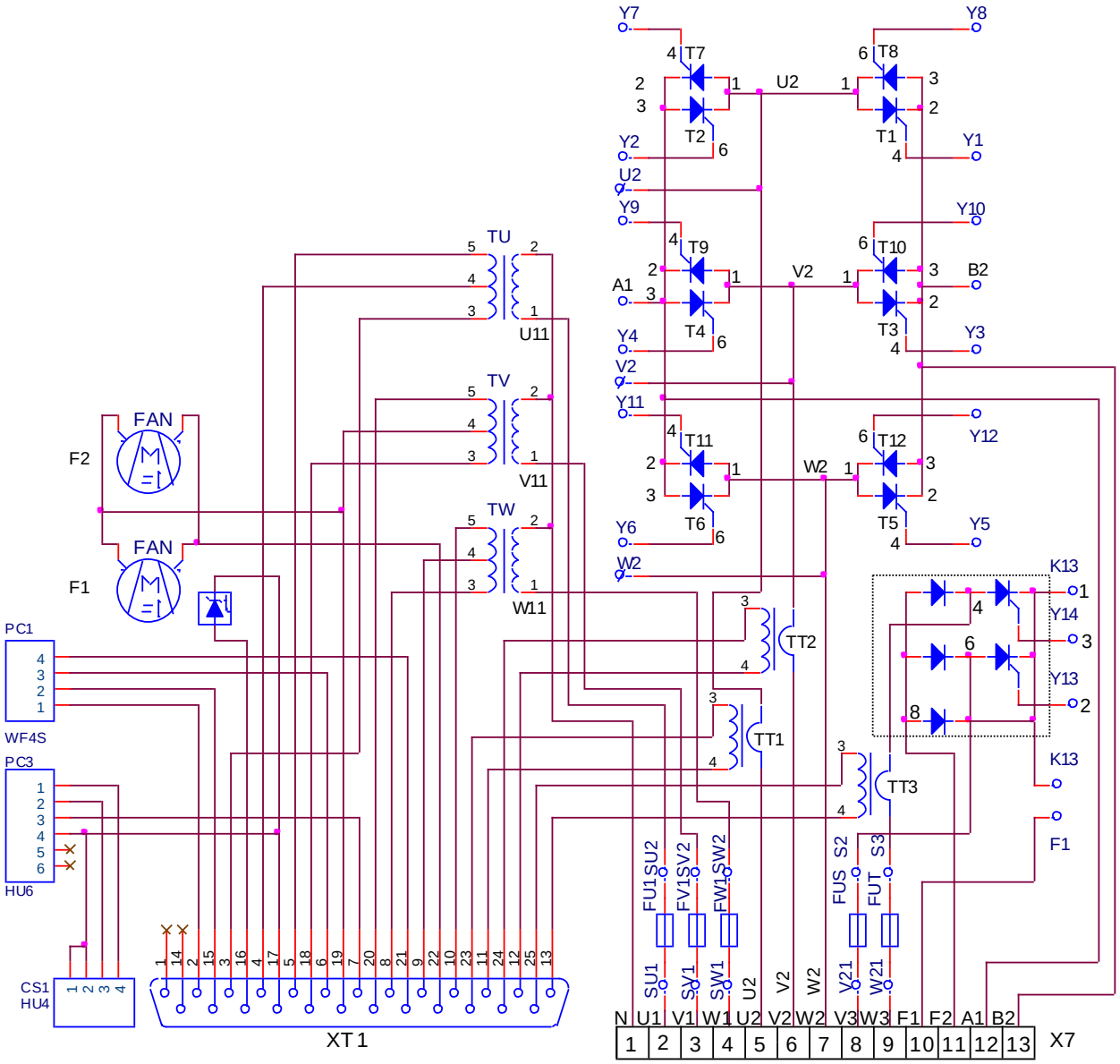


Fig. 11 Electrical circuit of converter power block

Note: Fans **F1** and **F2** are used in converters type 4005 …4030**.**

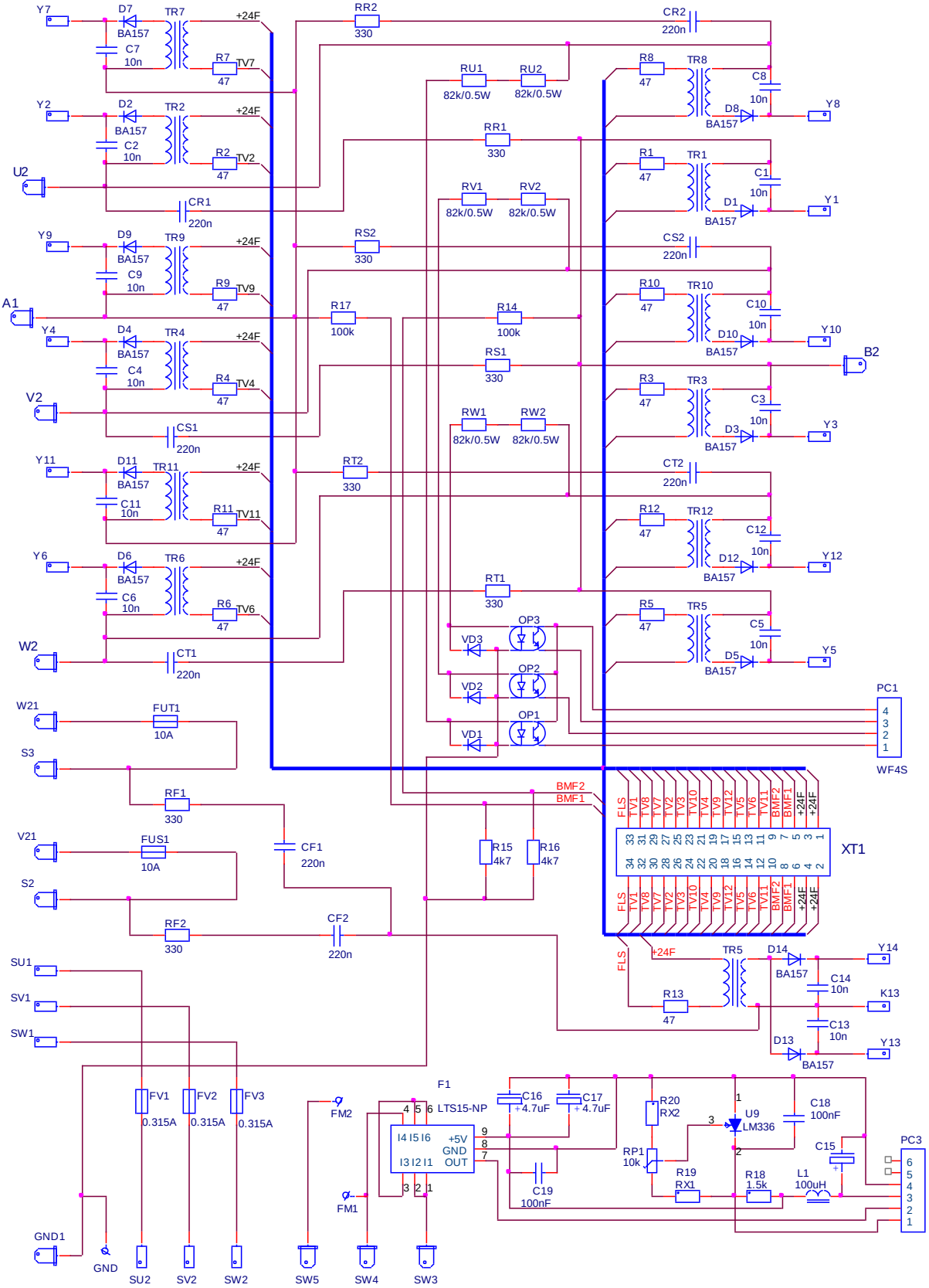


Fig.12 Elecrtical circuit of converter power plate

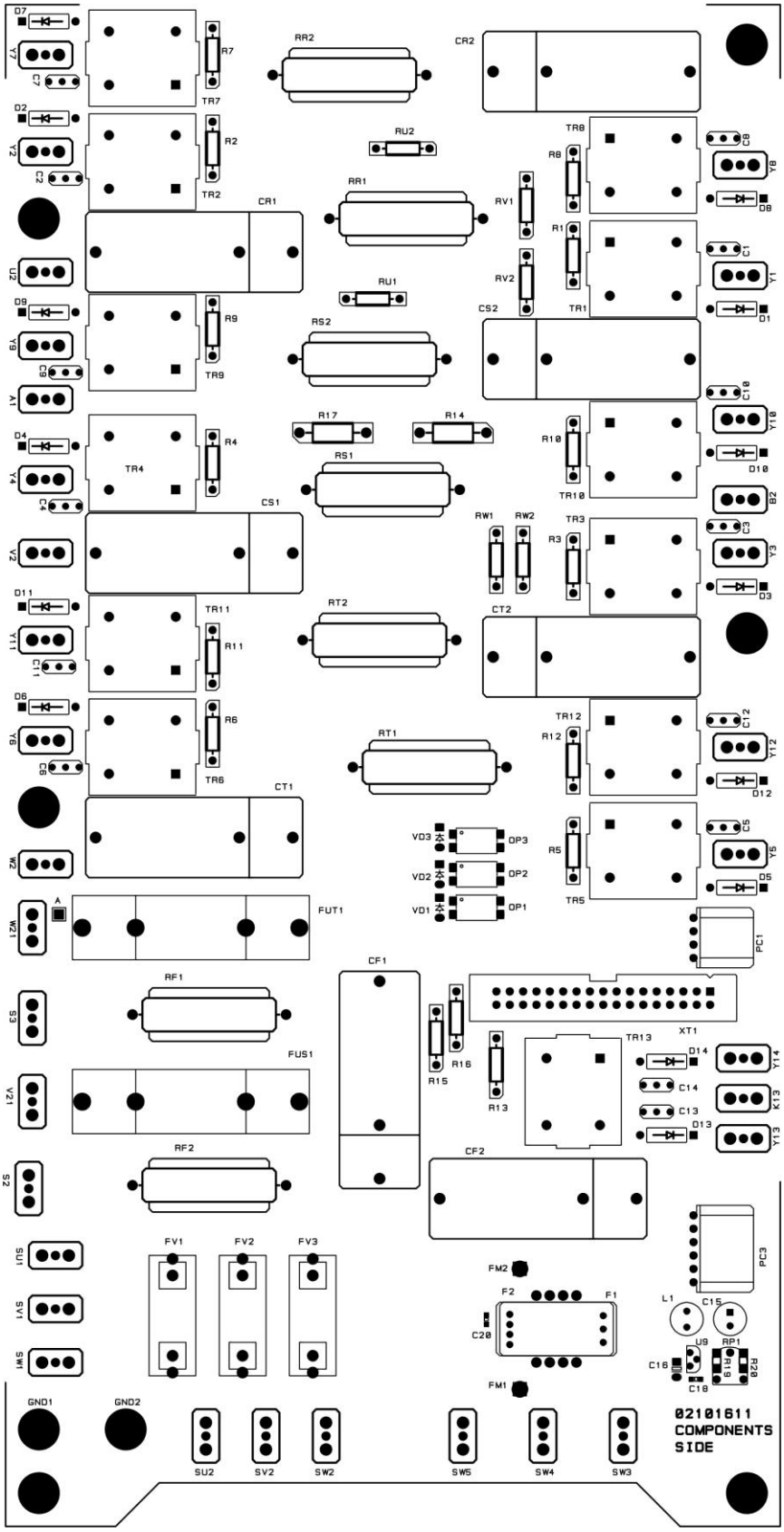


Fig. 13 Places of power plate elements and terminals

5.6 Converter status indications

At upper part of the face panel are placed 8 LEDs, which show the converter moment status. When any of them lights it means normal work mode or or there is an emergency mode.

LED indications of converter status are as follows:

- **in normal work mode**

RD – converter is ready to work;

ON – converter work is enabled;

- **in emergency work mode**

PF lights constantly – protection **SPF**. Disconnect or bad connection of any synchronizing voltage phase, there is something wrong in power and synchronizing supply voltage or they are not in phase;

PF flicks with a period of time 1 s – protection **HPF.** Disconnection of power supply voltage;

PF flicks with a period of time 0.3 s – protection **FRF.** Mains frequency is out of the admissible range or there is not synchronization;

OL lights constantly – protection **OLF** (**I^2t**). The motor is overloaded;

OL flicks with a period of time 1 s – protection **OHF.** The converter power block is overheated;

OS lights constantly – protection **SOS**. Overspeed of maximum given rotating speed;

OS flicks with a period of time 1s – protection **HOS**. Overspeed of maximum limited motor rotating speed;

OS flicks with a period of time 0.3s – protection **OVM**. Overvoltage of maximum given motor armature voltage;

OC lights constantly – protection **SOC.** Current in power rectifier is over given limited meaning **$Idrv_{LIM}$**;

OC flicks with a period of time 1 s – protection **HOC.** Current in power rectifier is over maximum limited meaning **$Idrv_{MLIM}$** or there is a short circuit in the power rectifier;

TG lights constantly – protection **TGF.** Disconnection of speed feedback at work with tachogenerator. Wrong connection, short circuit or disconnection in tachogenerator circuit;

TG flicks with period of time 1s – protection **ENF.** Disconnection in speed feedback at work with encoder. Wrong connection, short circuit or disconnection in encoder circuit;

TG flicks with a period of time 0.3 s – protection **PSB**. Positive speed feedback;

FL lights constantly – protection **SFL.** Wound field current is not in given limited values;

FL flicks with a period of time 1 s – protection **HFL.** There is not wound field current;

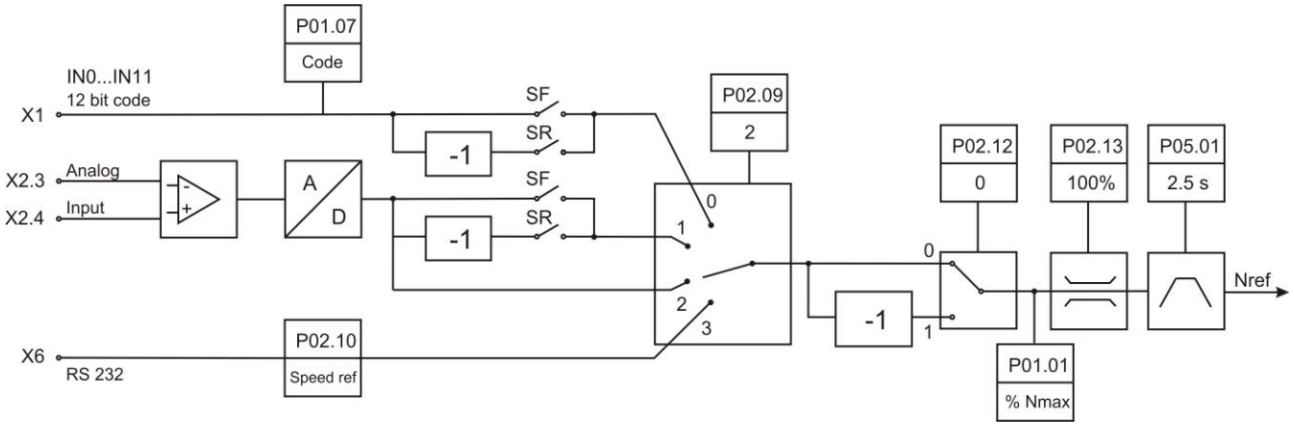
FL, **TG**, **OC**, **OS**, **OL**, **PF** light constantly – protection **ADC**. Something wong in analog-digital converter;

FL, **TG**, **OC**, **OS**, **OL**, **PF** flick with a period of time 1s – protection **EEF.** Error at work with EPROM.

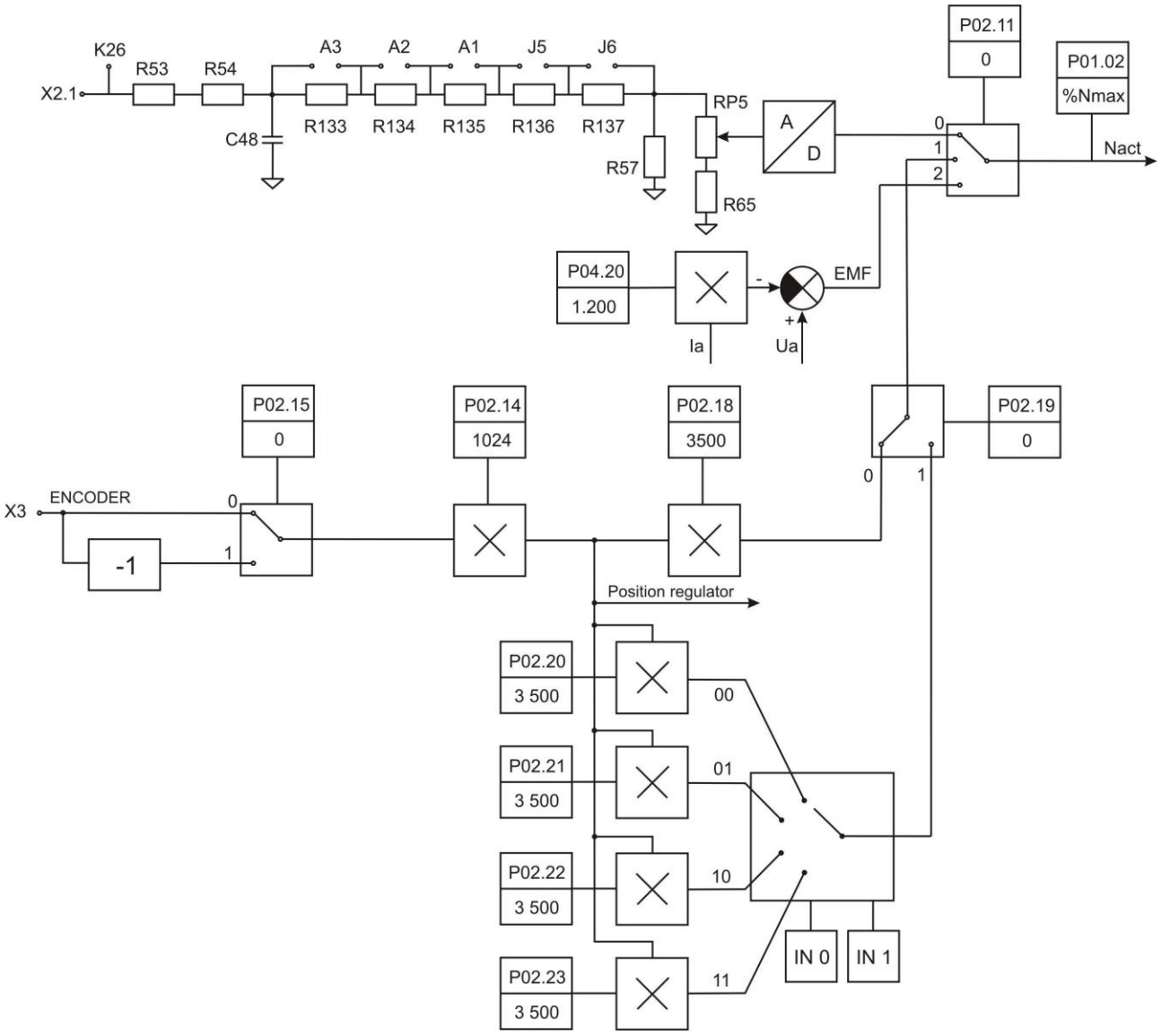
Notes:

1. More protection details see points **6.4.3** and **6.5**;

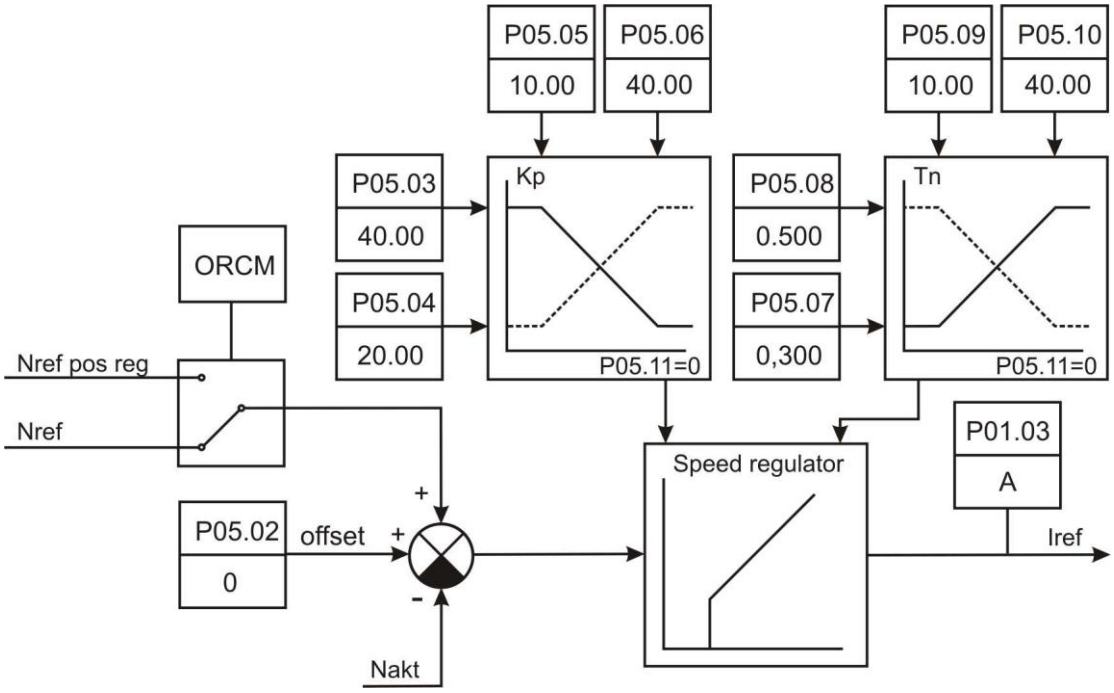
2. Hardware protections are fixed in the factory. When there is any hardware protection LED indications flick with a period of time 1s.



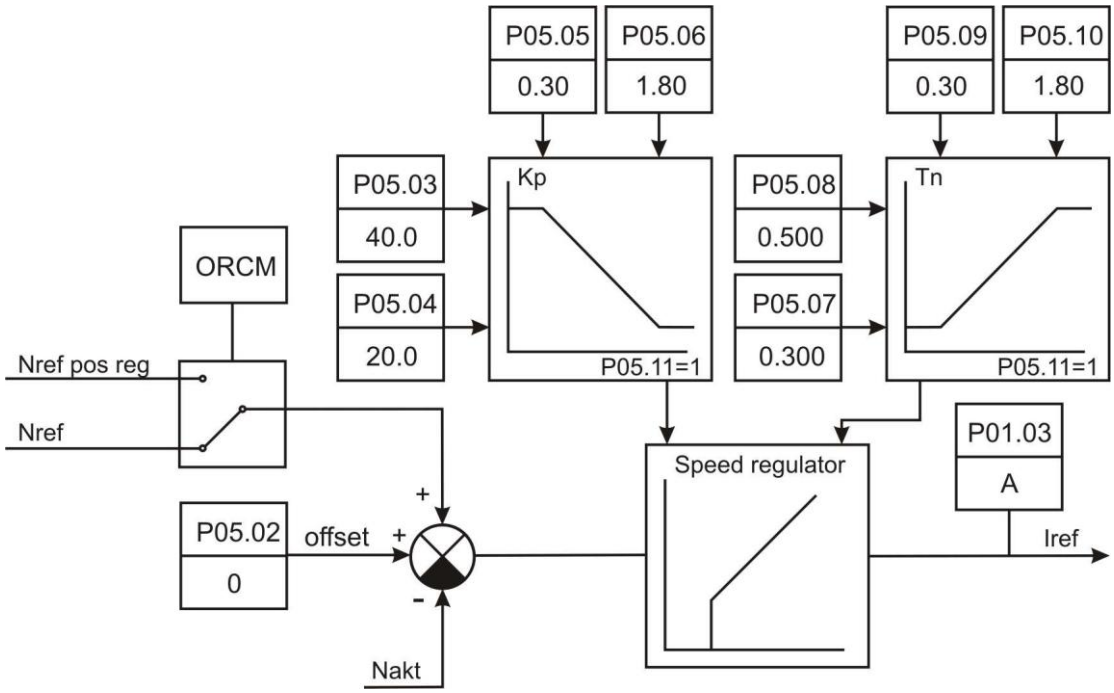
A Speed reference



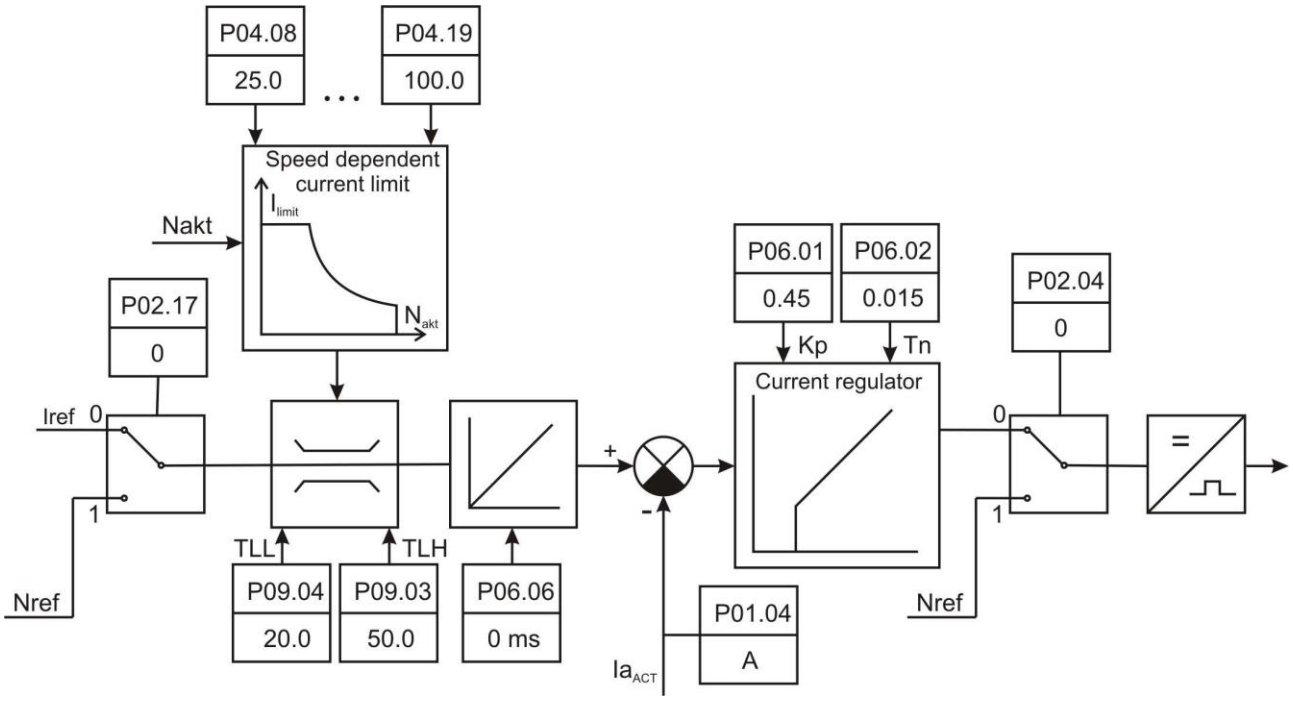
B Speed feedback



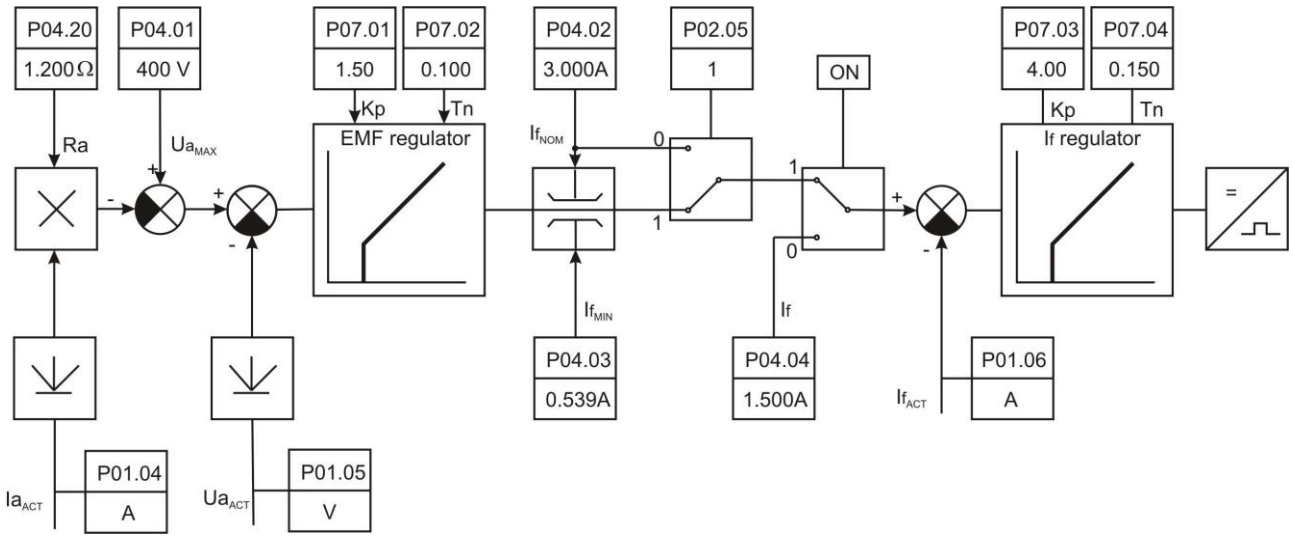
C.1 Speed regulator with adaptation in function of real speed



C.2 Speed regulator with adaptation in function of speed error



C.3 Armature current regulator



D EMF regulators and excitation current

Fig.14 Functional converter circuit

6. Converter adjustment

Adjustment is made through series interface **X6** by special terminal or personal computer.

ATTENTION!

Switching ON and OFF of the special terminal or personal computer to series interface X6 must be made only when converter power supply is OFF.

6.1 Work with special terminal or personal computer

By terminal in devise EPROM are set parameters, defining the work of the different functional blocks, motor parameters, limits in which protections and indications, giving information of converter status, are activated. When the converter works, on terminal indication can be led the meaning of all parameters, which indicate motor and converter work, and together with LED indication placed on upper part of the face panel will give the whole picture of their status constantly.

When power supply is switched ON, if there is not any error, on the terminal display is appeared a message **P01 Monitoring**, which points the chosen parameter group. Choice of a parameter group or a parameter also changing its meaning is made by the keys with signs:

ESC UP DOWN ENTER or signs ESC ⇑ ⇓ ⏎

By keys **UP** and **DOWN** first choose the desired parameter group, after that by key **ENTER** enter the parameter group and also by keys **UP** and **DOWN** choose the needed parameter, by key **ENTER** enter parameter editing mode. Changing the parameter value is performed by keys **UP** and **DOWN** too, after that this meaning is set by the key **ENTER**.

To come back into parameter choice mode is used the key **ESC,** and by **UP** and **DOWN** choose the needed parameter. If this parameter is from other group press the key **ESC** secondary and come back to choice parameter group menu.

Keep work with terminal software for personal computer (for example TERM95.exe from the packet NORTON COMMANDER). Series interface (COM1 or COM2 on the computer) is adjusted to 9600bps, 8N1, terminal emulsion - ANSI. It is used 4 keys,whose function is idenentity with the functions of the portable terminal:

"**o**" – ESCAPE, "**u**" – UP, "**d**" – DOWN, "**e**" – ENTER

When a parameter is chosen on the first line is displayed its number and a text which is given in thr third colomn of table 6, on the second line – parameter value. Changing of chosen parameter is made as it is pointed above.

You must work with **low** letters (CapsLock must be OFF). If you work in capital lettes, the protokolused for manual terminal is switched to (numbers are in HEX-format and any text is not written). To come back to work with personal computer is made by pressing any of the upper keys in low letters.

Notes:

1. If after pressing the key **ENTER**, the new parameter meaning is not set, check if this parameter is accessible in that mode;
2. If the parameter value can not be changed more from a meaning check if it is connected with other parameters or the limit of its change is approached;
3. In case there are parameters connecting each other it is necessary first to change these from which others deppend on.

6.2 Functional converter circuit

The functional converter circuit with adjusting and watching parameters is given in **fig.14.**

6.3 Converter parameteres

Parameters are grouped into eleven groups:

Group 1 – watching parameters

They show the meanings of the inner variables, controlling signals and signals to and from the motor. In this group are wound field parameters, armature current, rotating speed, armature voltage, digital inputs and outputs status, and accumulating protection errors. Values of these parameters is not set, they are only watched;

Group 2 – converter parameters

They define converter working modes, feedback choice, type of the speed reference, rotating direction, encoder choice, and all general technical features of a power block realization.

Group 3 – protection parameters

The protection parameters define control variable limits out of which the protections are activated.

Group 4 – motor parameters

By motor parameters it is set its general technical features. In this group are rated and maximal armature current, rated armature voltage, rated and minimal wound field current and dynamic current limiting of armature current.

Group 5 – Speed regulator parameters

By these parameters it is defined the coefficients of amplification, constant and parameters of speed regulator adaptation, and rampgenerator features.

Group 6 – armature current regulator parameters

Parameters in this group define the coefficient of amplification, and constant of armature current regulator and they regulate the amplitudes of current pulses in each phase.

Group 7 – parameters of regulators of EMF and wound field current.

The parameters in this group define the coefficient of amplification and constant of EMF regulators and wound field current.

Group 8 – parameter of position regulator

The parameters in this group define the input of position reference, correction of given position, position displacing, the coefficient of amplification of the position regulator, and show errors when it is performed orientation stopping.

Group 9 – output parameters

The parameters in this group define the levels of digital outputs activating, and variables for analog outputs.

Group 10 – terminal parameters

The parameters in this group define terminal working language and the time of indication refreshing.

Group 11 – error history

In **table 6** is given the list of parameters, their signs, and limits of their variations.

№	Parameter name	Text	Variation limits	Measure
Group 01 – watching parameters				
P01.01	Current value of speed tefterence	Speed reference	-100.0 ÷ 100.0	% N_{MAX}
P01.02	Current value of actual speed	Speed actual	-110.0 ÷ 110.0	% N_{MAX}
P01.03	Current value of armature current reference	Curr arm ref	-270÷270 %Ia_{NOM}	A
P01.04	Current value of actual armature current	Curr arm actual	-270÷270 %Ia_{NOM}	A
P01.05	Current value of armature voltage	Arm voltage act	-600 ÷ 600	V
P01.06	Current value of wound field current	Field curr act	P04.03 ÷ P03.12	A
P01.07	Digital reference status	Status digit ref	-	code
P01.08	Digital inputs status	Status digit inp	-	code
P01.09	Digital outputs status	Status digit out	-	code
P01.10	Test of speed feedback	Test tacho fluct	-	% Ubr
P01.11	Current value of mains frequency	Line frequency	42.00 ÷ 68.00	Hz
P01.12	Current maximal deviation in synchronization	Max synchro dev	-800 ÷ 800	μs
P01.13	Maximal number of recorded synchronization breaks	Max synchr break	0 ÷ 50	-
P01.14	Maximal number of recorded power supply breaks	Max power break	0 ÷ 50	-
P01.15	Current value of position error	Error position	-	pulses
P01.16	Status of power thyristors	Status thyr	-	bin
Group 02 – converter parameters				
P02.01	Version of converter software	Software version	-	-
P02.02	Password of access (User password)	User password	11	-
P02.03	Restore of defaulting values	Default load	0, 1	-
P02.04	Converter working mode	Bypass PIDs	0, 1	-
P02.05	Work with weaken field	Field weakeening	0, 1	-
P02.06	Scaling the converter nominal current **$Idrv_{NOM}$**	Curr arm nominal	10.0 ÷ 300.0	A
P02.07	Range of excitation current sensor	If scale	0, 1, 2	-
P02.08	Mode " emergency stop"	Emergency stop	0, 1, 2	-
P02.09	Choice of the speed reference source	User source ref	0, 1, 2, 3	-
P02.10	Inner speed reference	Source of ref	-100.00÷100.00	% N_{MAX}
P02.11	Choice of the speed feedback	User feedback	0, 1, 2	-
P02.12	Changing the speed reference sign	Sign vel ref	0, 1	-
P02.13	Limitation maximal value of speed reference	Limit speed max	20.0 ÷ 100.0	% N_{MAX}
P02.14	Encoder pulse number	Encoder puls num	500 ÷ 2500	puls/rev.
P02.15	In phasing the motor rotating direction and the encoder	Encoder dir	0, 1	-
P02.16	Changing the sign of the speed feedback	Sigh vel fdbck	0, 1	
P02.17	Torque mode	Torque mode	0, 1	
P02.18	Encoder maximum speed at motor maximum speed	Encoder spd max	0 ÷ 20 000	min^{-1}
P02.19	Changing maximum speed enable	Change speed	0, 1	-
P02.20	First maximal speed	Speed max 1	0 ÷ 20 000	min^{-1}
P02.21	Second maximal speed	Speed max 2	0 ÷ 20 000	min^{-1}
P02.22	Third maximal speed	Speed max 3	0 ÷ 20 000	min^{-1}
P02.23	Fourth maximal speed	Speed max 4	0 ÷ 20 000	min^{-1}
Group 03 – protection parameters				
P03.01	Admissible break number in synchronization - protection **SPF**	Thr synchr break	5 ÷ 50	-
P03.02	Maximal recording break number in synchronization - protection **SPF**	Max synchr break	0 ÷ 50	-
P03.03	Maximal admissible deviation in synchronization - protection **SPF**	Thr synchro dev	100 ÷ 800	μs
P03.04	Current maximal deviation in synchronization - protection **SPF**	Max synchro dev	-800 ÷ 800	μs
P03.05	Admissible break number in power mains - protection **HPF**	Thr power break	5 ÷ 50	-

P03.06	Maximal recording break number in power supply mains - protection **HPF**	Max power break	0 ÷ 50	-
P03.07	Working mode of protection **HPF**	Enable HPF	0, 1	-
P03.08	Activating time of protection **OLF** ($\mathbf{I^2t}$) - motor overloaded	Threshold OLF	0.1 ÷ 60.0	s
P03.09	Working mode of protection **OHF**	Enable OHF	0, 1	-
P03.10	Threshold current $\mathbf{Idrv_{LIM}}$ of the converter - protection **SOC**	Threshold SOC	100.0 ÷ 250.0	% Ia_{NOM}
P03.11	Armature current when protection **TGF is activated**	Thresh Ua TGF	40.0 ÷ 80.0	% Ua_{MAX}
P03.12	Maximal wound field current $\mathbf{I_{FLMAX}}$ – protection **SFL**	Threshold FLmax	> P04.02	A
P03.13	Minimal wound field current $\mathbf{I_{FLMIN}}$ – protection **SFL**	Threshold FLmin	≤ P04.03	A
P03.14	Limited admissible speed $\mathbf{N_{LIM}}$ – protection **SOS**	Threshold SOS	100.0÷110.0	% N_{MAX}
P03.15	Activating threshold of armature over voltage protection – protection **OVM**	Threshold OVM	5.0 ÷ 20.0	% Ua_{MAX}
Group 04 – motor parameters				
P04.01	Maximal armature voltage $\mathbf{Ua_{MAX}}$	Ua max motor	100 ÷ 440	V
P04.02	Rated current of wound field $\mathbf{I_{FNOM}}$	If rated motor	0 ÷ 4, 6, 12	A
P04.03	Minimal wound field working current $\mathbf{I_{FMIN}}$	If min motor	5.00÷50.00, %I_{FNOM}	A
P04.04	Wound field current $\mathbf{I_{FON}}$ when control signal **ON** is switched off	If without ON	37÷100,%P04.02	A
P04.05	Rated armature current $\mathbf{Ia_{NOM}}$	Ia rated motor	50÷100 %$Idrv_{NOM}$	A
P04.06	Reserved	Reserve	-	-
P04.07	Reserved	Reserve	-	-
P04.08	Maximal speed $\mathbf{Nm_1}$ at p.1	Speed of p.1	25.0 ÷ P04.10	% N_{MAX}
P04.09	Maximal value of armature current $\mathbf{Ia_{MAX}}$ at p.1	Ia max of p.1	P04.11 ÷ 200	% Ia_{NOM}
P04.10	Maximal speed $\mathbf{Nm_2}$ at p.2	Speed of p.2	P04.08÷P04.12	% N_{MAX}
P04.11	Maximal value of armature current $\mathbf{Iam_2}$ at p. 2	Ia max of p.2	P04.09÷P04.13	% Ia_{NOM}
P04.12	Maximal speed $\mathbf{Nm_3}$ at p. 3	Speed of p.3	P04.10÷P04.14	% N_{MAX}
P04.13	Maximal value of armature current $\mathbf{Iam_3}$ at p. 3	Ia max of p.3	P04.11÷P04.15	% Ia_{NOM}
P04.14	Maximal speed $\mathbf{Nm_4}$ at p. 4	Speed of p.4	P04.12÷P04.16	% N_{MAX}
P04.15	Maximal value of armature current $\mathbf{Iam_4}$ at p. 4	Ia max of p.4	P04.13÷P04.17	% Ia_{NOM}
P04.16	Maximal speed $\mathbf{Nm_5}$ at p. 5	Speed of p.5	P04.14÷P04.18	% N_{MAX}
P04.17	Maximal value of armature current $\mathbf{Iam_5}$ at p. 5	Ia max of p.5	P04.15÷P04.19	% Ia_{NOM}
P04.18	Maximal motor speed $\mathbf{N_{MAX}}$ at p. 6	Speed of p.6	P04.16÷100.0	% N_{MAX}
P04.19	Maximal value of armature current $\mathbf{Iam_6}$ at p.6	Ia max of p.6	50.0 ÷ P4.17	% Ia_{NOM}
P04.20	Armature circuit resistance **Ra**	Ra motor	0.001 ÷ 10.000	Ohm
P04.21	Calculated value of armature circuit resistance	Ra motor calc	0.001 ÷ 10.000	Ohm
Group 05 – speed regulator parameters				
P05.01	Rampgenerator time	Ramp time speed	0.0 ÷ 20.0	s
P05.02	Offset of speed reference	Speed offset	-1024 ÷ 1024	discretes
P05.03	Coefficient of amplification of the speed regulator **Kp1**	Pgain sp reg Kp1	0.1 ÷ 100.0	-
P05.04	Coefficient of amplification of the speed regulator Kp2	Pgain sp reg Kp2	0.1 ÷ 100.0	-
P05.05	Threshold of working of the coefficient of amplification **Kp1**	Threshold Kp1	0.00 ÷ P05.06	%
P05.06	Threshold of working of the coefficient of amplification **Kp2**	Threshold Kp2	P05.05÷100.00	%
P05.07	Time constant of the speed regulator **Tn1**	Icomp sp reg Tn1	0.010 ÷ 3.000	s
P05.08	Time constant of the speed regulator **Tn2**	Icomp sp reg Tn2	0.010 ÷ 3.000	s
P05.09	Threshold of working of the time constant **Tn1**	Threshold Tn1	0.00 ÷ P05.10	%
P05.10	Working threshold of the time constant **Tn2**	Threshold Tn2	P05.09 ÷ 100.00	%
P05.11	Selecting the adaptation variable	Select variable	0, 1	-
Group 06 – armature current regulator parameters				
P06.01	Coefficient of amplification of the armature current regulator	P gain curr reg	0.01 ÷ 10.00	-

P06.02	Time constant of armature current regulator	I comp curr reg	0.012 ÷ 1.000	s
P06.03	Adjusting the phase L1 current amplitude	Curr peak L1	0 ÷ 128	discretes
P06.04	Adjusting the phase L2 current amplitude	Curr peak L2	0 ÷ 128	disrtetes
P06.05	Adjusting the phase L3 current amplitude	Curr peak L3	0 ÷ 128	discretes
P06.06	Time of the armature current ranpgenerator	Ramp time curr	0 ÷ 500	ms
Group 07 – EMF regulators and wound field current parameters				
P07.01	Coefficient of amplification of the wound field current regulator	Pg curr reg fld	0.01 ÷ 10.00	-
P07.02	Timeconstant of the wound field current regulator	Ic curr reg fld	0.010 ÷ 2.000	s
P07.03	Coefficient of amplification of the EMF regulator	Pgain EMF reg	0.10 ÷ 10.00	-
P07.04	Timeconstant of the EMF regulator	Icomp EMF reg	0.010 ÷ 2.000	s
Group 08 – orientation stopping parameters				
P08.01	Source of position reference at **ORCM**	Select pos ref	0, 1	-
P08.02	Position reference at **ORCM**	Source pos ref	0 ÷ 4096	pulses
P08.03	Offset of the given position at **ORCM**	Correct position	0 ÷ 4096	pulses
P08.04	Current value of position error	Error position	-	pulses
P08.05	Offset of the speed reference at **ORCM**	Offset pos spd	-8.0 ÷ 8.0	discretes
P08.06	Orientation stopping direction	Dir position	0, 1, 2	-
P08.07	Coefficient **К1** of the position regulator	Pgain pos reg K1	0.000 ÷ 0.500	-
P08.08	Coefficient **К2** of the position regulator	Pgain pos reg K2	0.30 ÷ 16.00	-
P08.09	Coefficient **К3** of the position regulator	Pgain pos reg K3	0.30 ÷ 16.00	-
Group 09 – output parameters				
P09.01	Speed threshold $\mathbf{N_{ZS}}$, under which **ZS is activated**	Thresh out ZS	0.5 ÷ 3.0	% N_{MAX}
P09.02	Speed threshold $\mathbf{N_{SA}}$, above which **SA is activated**	Thresh out SA	70.0 ÷ 95.0	% N_{REF}
P09.03	Output **SA working mode**	Mode SA	0.0 ÷ 20.0	% N_{MAX}
P09.04	Maximal armature current $\mathbf{Ia_{TLH}}$ at controlling signal **TLH**	Level of TLH	10.0 ÷ 100.0	% Ia_{NOM}
P09.05	Maximal armature current $\mathbf{Ia_{TLL}}$ at controlling signal **TLL**	Level of TLL	1.0 ÷ 100.0	% Ia_{NOM}
P09.06	Admissible deviation from given position when output **INPOS is switched ON**	Thresh out INPOS	0 ÷ 63	pulses
P09.07	Output of ready **RD working mode**	Mode RD	0, 1	-
P09.08	Selecting a variable for analog output **AOUT1**	Select AOUT1	0 ÷ 9	-
P09.09	Selecting a variable for analog output **AOUT2**	Select AOUT2	0 ÷ 9	-
Group 10 – terminal parameters				
P10.01	Selecting terminal language	Language	0, 1, 2	-
P10.02	Time for indication refreshing	Refresh rate	1 ÷ 1000	ms
Group 11 – error history				
P11.01	Error 1	Error 1	-	-
P11.02	Error 2	Error 2	-	-
P11.03	Error 3	Error 3	-	-
P11.04	Error 4	Error 4	-	-
P11.05	Error 5	Error 5	-	-
P11.06	Error 6	Error 6	-	-
P11.07	Error 7	Error 7	-	-
P11.08	Error 8	Error 8	-	-
P11.09	Error 9	Error 9	-	-
P11.10	Error 10	Error 10	-	-
P11.11	Reset errors	Reset errors	0, 1	-

Table 6 Parameters list

Notes:

1. Parameters in dark fields can be changed only after the password is inserted and controlling signal **ON** is switched off. Parameters in white fiels can be changed in all modes only after password is inserted;

2. Parameters from group **P01** meanings can ve watched witout inserting the password;

3. For the sake of convenience parameters showing accumulating errors of protections from group **P03** also enter in group **P01** of watching parameters.

6.4 Parameter description

6.4.1Group 1 – parameters for variable watching

Parameters from **P01.01** to **P01.16** allow watching variable values, describing motor and converter work. These parameters are of access in all modes.

- Parameter **P01.01** – current value of speed reference. It is defined in percentage from the maximal speed $\mathbf{N_{MAX}}$;
- Parameter **P01.02** – current value of actual speed. It is defined in percentage from maximal speed $\mathbf{N_{MAX}}$;
- Parameter **P01.03** – current value of armature current reference in amperes;
- Parameter **P01.04** – current value of actual armature current in amperes;
- Parameter **P01.05** – current value of armature voltage in volts with sign;
- Parameter **P01.06** – current value of actual wound field current in amperes;
- Parameters **P01.07** – current value of digital reference. The status of digital reference is given in binary code. Correspondence between active digital inputs and respective order is given in **table 7**;

Input	LCD	Input	LCD
IN11	100000000000	**IN5**	000000100000
IN10	010000000000	**IN4**	000000010000
IN9	001000000000	**IN3**	000000001000
IN8	000100000000	**IN2**	000000000100
IN7	000010000000	**IN1**	000000000010
IN6	000001000000	**IN0**	000000000001

Table 7 Correspondence between digital reference order and digital inputs status

- Parameters **P01.08** – current status of the digital inputs. Digital inputs status is given in binary code. Correspondence between active digital inputs and corresponding order is given in table 8;

Input	LCD
ON	100000
ORCM	010000
SR	001000
SF	000100
TLL	000010
TLH	000001

Table **8** Correspondence between orders and digital inputs status

- Parameters **P01.09** – current status of digital outputs. Digital outputs status is given in binary code. Correspondence between active digital outputs and corresponding orders is given in table 9.

Output	LCD
INPOS	10000
RD	01000
SA	00100
ZS	00010
TL	00001

Table 9 Correspondence between orders and digital outputs status

- Parameter **P01.10** – current value of the fluctuations of speed feedback voltage. Fluctuations are defined in percentages according to maximal value of the tachogenerator to its average value in time interval 1s. When the tachogenerator is all right in stable mode, the parameter **P01.10** value must not be more than 2 %;
- Parameter **P01.11** – current value of the power mains frequency in hertz;
- Parameter **P01.12 (P03.04)** – maximal recorded time of deviation between waited and registered synchronization pulse. Each recorded time more than the value of parameter **P03.03**, is registered as a synchronization error and it is accumulated in the counter of protection **SPF**. By key **UP** indication is reset and it is started new registration of deviation. The value of parameter **P01.12** is not written in PROM. Parameter **P01.12** allows watching the quality of the power supply mains;
- Parameter **P01.13 (P03.02)** – maximal number recorded serial breaks in the synchronization. Checking for breaks in the synchronization starts at the moment when the converter is switched ON. By key **UP** the indication is reset and it is started a new recording of the breaks. The value of the parameter **P01.13** is not written in PROM. If the number of the recorded breaks is more or equal to the value written in **P03.01**, protection **SPF is activated**. Parameter **P01.13** allows watching the quality of the power supply mains;
- Parameter **P01.14 (P03.06)** – maximal number recorded serial breaks in power mains to its restoring. Checking for breaks in the power supply mains starts at the moment of switching on the converter. By key **UP** the indication is reset and it starts a new registering of the breaks. The meaning of the parameter **P01.14** is not written in PROM. If the number of the recorded is more or equal to the meaning written in **P03.05**, protection **HPF** activates. Parameter **P01.14** allows watching the quality of the power supply mains;
- Parameter **P01.15 (P08.04)** – current error in the position when it is performed **orientation stopping**;
- Parameter **P01.16** – working status of the power thyristors. When you enter this parameter on the terminal display are appeared two groups of six orders zeros each which correspond to the number of thyristors in groups from **T1** to **T12** from left to right. When all of the thyristors work, all orders in the group must display zero, the checking is made of the two rotating directions. If any of the orders is stable in **1** it means that the corresponding thyristor is not worked and it must be repaired the reason of that.

6.4.2 Group 2 – converter parameters

- Parameter **P02.01** – version of the converter software;
- Parameter **P02.02** – password allowing parameter value changing. The password activetes to power supply switching off. When you insert **11** into parameter **P02.02**, the converter accepts the password and it show on the terminal **1-** a message of password accepted;
- Parameter **P02.03** – when you insert **1** into parameter **P02.03** it is restore understanding value of all parameters. Parameter **P02.03** is of access for changing when password is inserted and controlling signal **ON** is switched off.

– Parameter **P02.04** – converter working mode. Changing the parameter **P02.04** is not written into EPROM. Parameter **P02.04** has two meanings:

- **P02.04** = 0 – integral mode. This is a normal converter working mode. In integral mode current and speed regulators are switched on. When you switch on the converter parameter **P02.04** is always 0;
- **P02.04** = 1 – proportional mode. In proportional mode current and speed regulators are switched off and the converter works as a rectifier. Proportional mode is used at primary start and converter adjustment. The thyristor firing angle is defined by the value of parameter **P02.09** and it is inner limited to a safety value;

– Parameter **P02.05** – converter working mode with motor weakening field. Parameter **P02.05** has two meanings:

- **P02.05** = 0 – the motor works without weakening field only in the first zone. In this mode the work is allowed when parameter **P02.11** = [0, 1, 2];
- **P02.05** = 1 – the motor works with weakening field in the second zone. When the motor works with weakening field value of the parameter **P02.11** = [0, 1] is allowed. Speed feedback from motor armature voltage when **P02.11** = 2 can not ensure a normal work in the second zone. In the second zone motor armature voltage is constant, but the velocity is increased by decreasing wound field current;

– Parameter **P02.06** – scaling the converter nominal current $\mathbf{Idrv_{NOM}}$. By parameter **P02.06** is scaled current feedback, which permits all variables connecting with the armature current to be measured in amperes. The value of the parameter **P02.06** must correspond to the converter nominal current $\mathbf{Idrv_{NOM}}$., which is defined by loading resistors of measuring current transformers. The inserting value of the parameter **P02.06** is not changed at restoring the understanding values by **P02.03.**

Notes:

1. Nominal converter current is adjusted only in the cases when nominal motor current $\mathbf{Ia_{NOM}}$ is considerably less than the nominal current of the available converter $\mathbf{Idrv_{NOM}}$, for example more than 25%. Changing of the adjustment of the converter nominal current is described in Appendix 1;

2. Parameter **P02.06** is adjusted in the factory at the rated current of a definite converter;

3. Parameter **P02.06** is changed only when it is made a new adjustment of the converter rated current;

4. When the processor plate of the definite converter is replaced it is necessary to check if there is a correspondence between the adjustment to the converter nominal current and the value of parameter **P02.06** of this converter.

ATTENTION!

If the parameter P02.06 is not adjusted to the converter nominal current it is possible the motor will be overloaded.

It is not allowed adjusting the converter nominal current to the values more than given in table 1 for a definite converter. Otherwise it is possible the power block to be overloaded and the converter may be out of order.

– Parameter **P02.07** – range of the sensor for the wound field current. Parameter **P02.07** has three meaning:

- **P02.07 = 0** – range of the wound field current 0 ÷ 4 A. The conductor with labeling **F1** is placed in terminal **SW5**, and tha conductor with labeling **K13** is placed in terminal **SW3** of the power plate;
- **P02.07 = 1** – range of the wound field current 0 ÷ 6 A. The conductor with labeling **F1** is placedin the terminal **SW4**, and the conductor with labeling **K13** is placed in the terminal **SW3** of the power plate;

- **P02.07 = 2** – range of the wound field current 0 ÷ 12 A. The conductor with labeling **F1** is placed in terminal **SW5**, and the conductor with labeling **K13** is placed in the terminal **SW4** of the power plate.

  Placing of the terminals **SW3**, **SW4** and **SW5** on the power plate is given in fig. 13;

– Parameter **P02.08** – emergency stopping mode. Parameter **P02.08** can have the following three meanings;

- **P02.08 = 0** – after switching off the controlling signal **ON**, the converter power rectifier is switched off and the motor stops floating.
- **P02.08 = 1** – after switching off the controlling signal **ON**, the motor stops in time, given as a value of the parameter **P05.01 to zero speed N_{ZS}**, given with the parameter **P09.01** and the output **ZS is activated**. Power rectifier is switched off and the motor stops finally floating;
- **P02.08 = 2** – after switching off the controlling signal **ON**, the motor stops maximal fast to zero speed N_{ZS} set in parameter **P09.01** and output **ZS is activated**. The power rectifier is switched off and the motor stops finally floating;

– Parameter **P02.09** – choice of the speed reference source. It has four meanings:

- **P02.09 = 0** – speed reference with parallel 12 bit code from digital inputs **IN0**...**IN11**. Rotating direction is chosen by controlling signals **SR** and **SF.** The reference is performed only when there is one of the controlling signals **SR** and **SF.** The reference is not performed when the two signals are available or absent at the same time;

Note: When parameter **P02.18** = 1 and you work with gearbox with alternative coefficient of transmition, the reference is 10bit parallel code and it is performed by digital inputs **IN2** ... **IN11.**

- **P02.09 = 1** – speed reference from analog input U_{REF} in range **0 ÷ +10V** or in range **0 ÷ –10V**. Rotating direction is chosen by controlling signals **SR** and **SF**. Rotating direction is dependent on the reference sign, too. The reference is performed only when one of the controlling signals **SR** and **SF** is avaiable. The reference is not performed when the two controlling signals are available or absent at the same time;
- **P02.09 = 2** – speed referece from analog input U_{REF} in range from **–10V** to **+10V**;
- **P02.09 = 3** – speed reference by series interface **RS 232C**. in this case speed reference is defined from the meaning of the parameter **P02.10**.
- **Parameter P02.10** – inner speed reference when the parameter **P02.09** = 3. The meaning of the parameter **P02.10** is insert by the terminal. The meaning of the parameter **P02.10** is not written in EPROM;

– Parameter **P02.11** – choice the type of the speed feedback sensor. Parameter **P02.11** has three meanings:

- **P02.11 = 0** – speed feedback with tachogenerator;
- **P02.11** = **1** – speed feedback with encoder;
- **P02.11** = **2** – speed feedback from the motor EMF.

– Parameter **P02.12** – changing the speed reference sign. It can have two meanings:

- **P02.12** = 0 – the reference sign is the same;
- **P02.12** = 1 – the reference sign is inverted, independent on the reference source, chosen by parameter **P02.09**;

– Parameter **P02.13** – limiting reference at the maximal rotating speed. At this limiting the speed feedback scale is the same but speeds more than the one setting in parameter **P02.13 is not performed**;

– Parameter **P02.14** – encoder resolution. It is defined the encoder pulse number in one revolution;

– Parameter **P02.15** – phasing motor rotating and encoder directions. Parameter **P02.15** inverts the encoder pulse order and phases. It has two meanings:

- **P02.15 = 0** – stores the existed sequence;
- **P02.15 = 1** – inverts the existed sequence;

– Parameter **P02.16** – changing the speed reference sign. It has two meaning:
  - **P02.16 = 0** – stores the reference sign;
  - **P02.16 = 1** – invers the reference sign;
– Parameter **P02.17** – controlling the device on torque. Parameter **P02.17** is of access when controlling signal **ON** is switched off and it has two meanings:
  - **P02.17 =** 0 – mode of controlling the deviceon speed;
  - **P02.17 =** 1 – mode of controlling the device on torque. In thi mode parallel work of a number of devices is possible. When parameter **P02.17 =** 1 a speed feedback is not used and protection of its cutting is switched off;
– Parameter **P02.18** – encoder rotating speed at maximal motor speed and the meaning of parameter **P02.11** = 1. Maximal pulse frequency of each encoder phase is 220 kHz. When encoder is with 1024 puls./rev., maximal rotating speed is 12890 rev./min. When encoder is wiht 2500 puls./rev., maximal rotating speed is 5280 rev./min.
– Parameter **P02.19** – work enable with gearbox with shft paddles. This working mode is possible only in cases when the speed feedback is encoder, mounted on the machine spindle and between the motor and the spindle there is a redactor with shift paddles. Parameter has two meanings:
  - **P02.19 = 0** – work with constant coefficient of transmission between the motor and the spindle;
  - **P02.19 = 1 –** work with shifting coefficient of transmission between the motor and the spindle. Encoder is mounted on the machine spindle. Working speed of the gairbox is chosen by digital outputs **IN0** and **IN1**. In case of work with alternative coefficient of transmission when parameter **P02.19 =** 1 it uses digital speed reference when **P02.09 =** 0, and parallel reference code is only 10 bits by inputs **IN2** ... **IN11**;
– Parameter **P02.20** – first maximal spindle rotating speed at maximal motor rotating speed $\mathbf{N_{MAX}}$. It is performed when inputs **IN0** and **IN1** are not active. Parameter **P02.20** is of access only when controlling signal **ON** is switched off;
– Parameter **P02.21** – second maximal spindle rotating speed at maximal motor rotating speed $\mathbf{N_{MAX}}$. It is performed when input **IN0** is active. Parameter **P02.21** is of access only when controlling signal **ON** is switched off;
– Parameter **P02.22** – third maximal slindle rotating speed at maximal motor rotating speed $\mathbf{N_{MAX}}$. It is performed when input **IN1 is active**. Parameter **P02.22** is of access only when controlling signal **ON is switched off**;
– Parameter **P02.23** – fourth maximal spindle rotating speed at maximal motor rotating speed $\mathbf{N_{MAX}}$. It is performed when inputs **IN0** and **IN1** are active. Parameter **P02.23** is of access only when controlling signal **ON** is switched off;

ATTENTION!
Motor rotating speed must not be more than maximal speed for each chosen spindle rotating speed.

6.4.3 Group 3 – protection parameters

In the converter there are buil-in hardware and software protections for the general controlling variables. All protections labeled with sign **S** are addressed to software and protestion labeled with sign **H** to hardware.

Working threshold of software protections can be adjusted with parameters on dependent of the concrete use. Working threshold of the hardware protections are adjusted in the factory for converter protection and must not be changed.

If any protection is activated the converter switches the power rectifier and the corresponding LED indication lights.

The converter is ready for work after the reason of activating the protection is repaired and controlling signal **ON** is switched on again or electrical supply**.**

- **Software protection SPF - S**oft **P**hase **F**ault
  - Parameter **P03.01** – admissible number of recorded breaks in synchronization before activating protection **SPF.** If recorded break number in synchronization is more than meaning of parameter **P03.01**, protection **SPF** is activated and the LED indication **PF** lights constantly**;**
  - Parameter **P03.02 (P01.13)** – maximal number of the synchronization breaks recorded in sequence to its restore. Recording the breaks in synchronization starts at the moment of switching on the converter. By key **UP** or with switching off of the power supply indication is reset and it is starts a new recording of the breaks. The meaning of parameter **P03.02** is not written in EPROM**.** If recorded break number is more than the one written in **P03.01**, protection **SPF** activates. Parameter **P03.02** allows watching the quality of the power supply mains;
  - Parameter **P03.03** – admissible time of synchronization deviation. Time of synchronization deviation defines the length of the time interval when the synchronization pulse is waited. Synchronization pulses out of this interval are ordered as an error (break in synchronization).the number of breaks is accumulated in the counter of protection **SPF**;
  - Parameter **P03.04 (P01.12)** – maximal recorded time of deviation between waited and recorded synchronization pulse. By key **UP** or by switching off the power supply indication is reset and it starts a new recording of the deviation. The meaning of parameter **P03.04** is not written in EPROM**.** Parameter **P03.04** allows watching the quality of power supply mains;

Note - software protections have priority. When there is not a phase of synchronization and a phase of power supply at the same time protection **SPF** activates and LED indication **PF** lights constantly.

- **Hardware protection HPF - H**ard **P**hase **F**ault
  - Parameter **P03.05** – admissible number recorded breaks in sequence in power supply mains when protection **HPF** activates**.** Protection **HPF** records falling voltage in one or more phases of the power supply mains. Breaks in power supply mains are recorded by hardware and they enter into the counter of protection **HPF**. When the number of recorded breaks is more than the meaning of parameter **P03.05**, protection **HPF** is activated and LED indication **PF** flicks with a period of time 1 s;
  - Parameter **P03.06 (P01.14)** – maximal number of recordedbreaks in sequence in power supply mains to its restore. Break recording starts at the moment of switching on the converter. By key **UP** or by switching off the power supply indication is reset and it **starts a** new break recording**.** The meaning of parameter **P03.06** is not written in EPROM**.** If the number of break recording is more than the meaning written in **P03.05** protection **HPF** activates. Parameter **P03.06** allows watching the quality of the power supply mains;
  - Parameter **P03.07** – working mode of hardware protection **HPF.** It has two meaning:
    - **P03.07** = **0** – in this mode protection **HPF** is switched off and appearing breaks in the power supply are not recorded in parameter **P03.06**. When there are any breaks in the power supply the converter is not switched off;
    - **P03.07** = **1** – in this mode protection **HPF** is switched on. When there are any breaks in the power supply they are recorded in parameter **P03.06**. When their number is more than the meaning of parameter **P03.05** the converter is switched off and LED indication **PF** flicks with a period of time 1s;

- **Hardware protection FRF - FR**equency **F**ault

Hardware protection **FRF** is activated at frequencyof the power supply mains out of the limits 42 to 68 Hz or there is not synchronization. When any of inner supply voltage +/-12V the synchronization does not work, too. When protection **FRF** is activated the LED indication **PF** flicks with a period of time 0.3s;

♦ **Software protection OLF – O**ver **L**oad **F**ault

– Parameter **P3.08** – time when the protection **OLF(I^2t)** activates from lasting motor overloaded at meaning of the armature current more than nominal current $\mathbf{Ia_{NOM}}$. When protection **OLF(I^2t)** activates LED indication **OL** lights constantly;

♦ **Hardware protection OHF – O**ver **H**eat **F**ault

– Parameter **P03.09** – it allows activating the protection **OHF** - overheating of the converter power block. It has two meanings:

- **P03.09 =** 1 **–** activating the protection **OHF** is allowed. When the temperature sensor of the power block switches on protection **OHF** activates and LED indication **OL** flicks with a period of time 1s;
- **P03.09 =** 0 – activation of the protection **OHF** is switched off.

♦ **Software protection SOC - S**oft **O**ver **C**urrent

– Parameter **P03.10** – limiting moment current $\mathbf{Idrv_{LIM}}$ in converter power rectifier. It is defined in percentages of the nominal motor current $\mathbf{Ia_{NOM}}$ by parameter **P04.05**. if power rectifier current is more than $\mathbf{Idrv_{LIM}}$ the software protection of overcurrent **SOC** is activated and LED indication **OC** lights constantly.

♦ **Hardware protection HOC - H**ard **O**ver **C**urrent

Hardware protection **HOC** of overcurrent. It ensures converter protection when the current in power rectifier is more than the converter maximal admissible current $\mathbf{Idrv_{MLIM}}$. The converter maximal admissible current $\mathbf{Idrv_{MLIM}}$ is defined from the limited current of the converter power elements. Hardware protection **HOC** is adjusted in the factory. When the protection **HOC** is activated the LED indication **OC** flicks with a period of time 1s;

♦ **Software protection STG- S**oft **T**acho**G**enerator fault

– Parameter **P03.11**– armature admissible voltage when the protection **STG** is activated when there is any fault in the speed feedback. As a speed feedback sensor is used tachogenerator. The protection algorithm is realized as a comparison of the tachogenerator voltage to the motor armature voltage. If the tachogenerator voltage is less than 5% of the one at the maximal speed $\mathbf{N_{MAX}}$, and the armature voltage is more than the meaning written in parameter **P03.11** for time more than 20 ms, the protection **STG** is activated and the LED indication **TG** lights constantly;

♦ **Hardware protection ENF - EN**coder **F**ault

Hardware protection **ENF** if there is any fault in the speed feedback or in the position when an encoder is used. If there is any fault if the speed feedback the protection **ENF** is activated and the LED indication **TG** flicks with a period of time 1s;

♦ **Hardware protection PFB - P**ositive **S**peed **B**ack

Hardware protection **PSB** from positive speed feedback with tachogenerator or encoder. In case of wrong connection of the speed feedback sensor the protection **PSB** is activated and the LED indication **TG** flicks with a period of time 0.3s;

♦ **Software protection SFL - S**oft **F**ield **L**oss

– Parameter **P03.12** – wound field maximal admissible current $\mathbf{I_{FLMAX}}$. It is recommended the meaning of parameter **P03.12** to be in range 110 ÷ 130 % of the meaning of parameter **P04.02.** When would field current is more than $\mathbf{I_{FLMAX}}$ the protection **SFL** activates and the **LED** indication **FL** lights constantly;

– Parameter **P03.13** – wound field minimal admissible current $\mathbf{I_{FLMIN}}$. It is recommended meaning of the parameter **P03.13** in range 70 ÷ 90% of the meaning of parameter **P04.03**.

When the wound field current is less than $\mathbf{I_{FLMIN}}$ the protection **SFL** is activated and the LED indication **FL** lights constantly;

♦ **Hardware protection HFL - H**ard **F**ield **L**oss

Hardware protection **HFL** activates in case of any loss in the motor wound field circuit. The threshold of the current when the hardware protection **HFL** activates is adjusted in the factory**.** When the hardware protection **HFL** activates the LED indication **FL** flicks with a period of time 1s;

♦ **Software protection SOS - S**oft **O**ver **S**peed

– Parameter **P03.14** – limited admissible rotating speed $\mathbf{N_{LIM}}$. At rotating speed more than $\mathbf{N_{LIM}}$ the protection **SOS** activates and the LED indication **OS** lights constantly;

♦ **Hardware protection HOS - H**ard **O**ver **S**peed

When the speed feedback is a tachogenerator and the velocity is more than 110.0 % $\mathbf{N_{MAX}}$ the hardware protection **HOS** activates and the LED indication **OS** flicks with a period of time 1s. Hardware protection **HOS** is adjusted in the factory;

♦ **Software protection OVM – O**ver **V**oltage **M**otor

– Parameter **P03.15** – working threshold of the protection **OVM** of the motor armature overvoltage. The meaning of the parameter **P03.15** defines admissible overregulation of the armature voltage in percentages of the maximal voltage at the second zone $\mathbf{Ua_{MAX}}$ (parameter **P05.05**). If armature voltage overregulation is more than the meaning of the parameter **P03.15**, the protection **OVM** activates and the LED indication **OS** flicks with a period of time 0.3s. Protection **OVM** ensures safety work of the converter when there is any wrong adjustment of the parameters of the wound field current, protection **SFL** and of the EMF regulator;

♦ **Hardware protection ADC - A**nalog **D**igital **C**onverter Fault

Hardware protection **ADC** if there is something wrong in the analog-digital converter work and the processor. When the protection **ADC** activates the LED indications **FL**, **TG**, **OC**, **OS**, **OL** and **PF** light constantly.

♦ **Hardware protection EEF - EE**prom **F**ault

Hardware protection **EEF** if there is something wrong in the PROM work. Hardware protection **EEF** activates at primary converter starting with a new software, too. To get away the problem in this case it is necessary the understanding parameters to be set. When the protection **EEF** activates the LED indications **FL**, **TG**, **OC**, **OS**, **OL** and **PF** flicks with a period of time 1s.

6.4.4 Group 4 – motor parameters

– Parameter **P04.01** – maximal armature voltage $\mathbf{Ua_{MAX}}$ in volts;

– Parameter **P04.02** – wound field nominal current $\mathbf{I_{FNOM}}$ [A], it depends on the current range chosen by parameter **P02.07**;

– Parameter **P04.03** – minimal wound field working current $\mathbf{I_{FMIN}}$, [A];

– Parameter **P04.04** – wound field current $\mathbf{I_{FON}}$ [A], when the controlling signal **ON is switched off**. The wound field current $\mathbf{I_{FON}}$ is stable 10 s after switching off the controlling signal **ON**. When the wound field current is $\mathbf{I_{FON}}$ the heating of non-working motor is reduced;

– Parameter **P04.05** – nominal armature current $\mathbf{Ia_{NOM}}$ in amperes. It has meaning from 50 to 100% of the converter nominal current $\mathbf{Idrv_{NOM}}$, written in **P02.06**;

– Parameter **P04.08** – maximal speed $\mathbf{Nm_1}$ at work with maximal current $\mathbf{Ia_{MAX}}$, defined by parameter **P04.09** (p. **1**, table **10**). It is defined in percentages of the maximal speed $\mathbf{N_{MAX}}$;

– Parameter **P04.09** – maximal armature current $\mathbf{Ia_{MAX}}$ at speed $\mathbf{Nm_1}$ defined by parameter **P04.08** (p. **1**, table **10**). It is defined in percentage of the armature nominal current $\mathbf{Ia_{NOM}}$. It has constant meaning from zero speed to speed $\mathbf{Nm_1}$ defined by parameter **P04.08**;

– Parameters **P04.10** ... **P04.19** – points of the dynamic current limit characteristic. Parameters **P04.08**...**P04.19** are allowed only when the password is chosen and the controlling signal **ON** is switched off.

When they are inserted it is necessary to observe the following rules:

- Points of the dynamic current limit characteristic are placed in range of rotating speed from 25% $\mathbf{N_{MAX}}$ to 100% $\mathbf{N_{MAX}}$ and in range of armature current from 50% $\mathbf{Ia_{NOM}}$ to 200% $\mathbf{Ia_{NOM}}$;
- Point **1** on the dynamic current limit characteristic gives the maximal rotating speed $\mathbf{Nm_1}$ at work with maximal current $\mathbf{Ia_{MAX}}$ and is defined by parameters **P04.08** and **P04.09**;
- Each following point must be with speed no less of the previous one and current less of the previous one.

Example defining of the dynamic current limit characteristic is given in table 10 and fig. 15.

Point	**1**	**2**	**3**	**4**	**5**	**6**
Parameter	**P04.09**	**P04.11**	**P04.13**	**P04.15**	**P04.17**	**P04.19**
$\mathbf{Ia_{MAX}}$ **%**	200	160	125	110	103	100
Parameter	**P04.08**	**P04.10**	**P04.12**	**P04.14**	**P04.16**	**P04.18**
$\mathbf{N_{MAX}}$ **%**	25	40	60	75	90	100

Table 10 Example table defining the parameters of the dynamic current limit characteristic

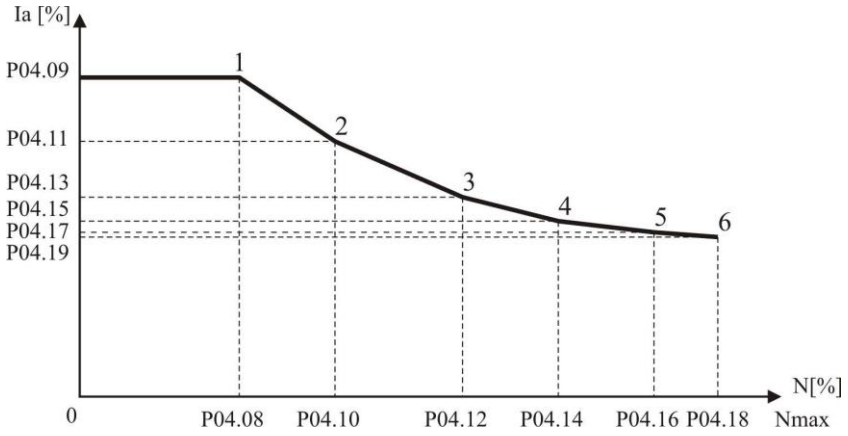


Fig. 15 Graphic of dynamic current limit characteristic

– Parameter **P04.20** – armature circuit resistance **Ra** in ohms. Precise defining of the armature circuit resistance has strong influence on the EMF regulator work;

– Parameter **P04.21** – calculated resistance of the armature circuit **Ra** in ohms. In cases when the resistance value of the armature circuit is not known or it is impossible to be measured, the parameter **P04.21** gives an approximately value when parameters **P04.01** and **P04.05** are inserted correctly.

6.4.5 Group 5 – speed regulator

– Parameter **P05.01** – time of the rampgenerator. The meaning of the parameter **P05.01** defines the time in which the maximal speed is approached and the time of stopping;

– Parameter **P05.02** – offset of the speed reference;

– Parameter **P05.03** – coefficient of amplification of the speed regulator **Kp1.** Range of acting of the coefficient of ampliffication **Kp1** is defined of the threshold given of the meaning of

parameter **P05.05**. When the adaptation variable is changed from the meaning of parameter **P05.05** to the meaning of parameter **P05.06**, the coefficient of amplification of the speed regulator is changed in linear law to meaning **Kp2**. When the coefficients of amplification are adjusting, the correlation between parameters **P05.05** and **P05.06** is defined by the chosen adaptation variable. In case of adaptation on accrual speed, the coefficient of amplification **Kp1** must be equal or more than the coefficient of amplification **Kp2**. In case of adaptation on current speed error, the coefficient of amplification **Kp1** must be equal or less of the coefficient of amplification **Kp2**;

- Parameter **P05.04** – coefficient of amplification of the speed regulator **Кр2.** The range of acting of the coefficient of amplification **Kp2** is defined by the threshold given with the meaning of parameter **P05.06**;
- Parameter **P05.05** – threshold of work variable of the coefficient of amplification **Кр1.** To the meaning of the chosen adaptation variable defined by parameter **P05.05**, the speed regulator works with coefficient of amplification **Кр1**. For values more than the meaning of parameter **P05.05** and less than the meaning of parameter **P05.06**, the coefficient of amplification of the regulator is changed on lineal law from **Кр1** to **Кр2**;
- Parameter **P05.06** – threshold of work variable of the coefficient of amplification **Кр2.** For meaning of the chosen adaptation variable more than the one defined by parameter **P05.06**, the speed regulator works with coefficient of amplification **Кр2**;
- Parameter **P05.07** – time constant of the speed regulator **Tn1.** The acting range of the time constant **Tn1** is defined by the threshold given by the meaning of parameter **P05.09**. When the adaptation variable is changed from the meaning of parameter **P05.09** to the meaning of parameter **P05.10**, the speed regulator time constant is changed in lineal law to meaning **Tn2**. When the timeconstant is adjusted the correlation between parameters **P05.09** and **P05.10** is defined by the chosen adaptation variable. In case of adaptation on actual speed the time constant **Tn1** must be equal or less than the time constant **Tn2**. In case of adaptation on current speed error the time constant **Tn1** must be equal or more than time constant **Tn2**;
- Parameter **P05.08** – time constant of the speed regulator **Tn2. The** acting range of the time constant **Tn2** is defined by the threshold given by the meaning of parameter **P05.10**;
- Parameter **P05.09** – threshold of the work variable of time constant **Tn1.** To the meaning of the chosen adaptation variable defined by parameter **P05.09**, the speed regulator works with timeconstant **Tn1**. For values more than the meaning of parameter **P05.09** and less than the meaning of parameter **P05.10** the regulator timeconstant is changed in lineal law from **Tn1** to **Tn2**;
- Parameter **P05.10** – threshold of work variable of timeconstant **Tn2.** Over the value of chosen adaptation variable defined by parameter **P05.10**, the speed regulator works with timeconstant **Tn2**;
- Parameter **P05.11** – choice of adaptation variable. Understanding parameter **P05.11** = 0. It has two meanings:

  - **P05.11 = 0** – actual motor speed. It is recommended at standard use of the converter, when it uses tachogenerator or encoder speed feedback and meaning of the parameter **P02.11** = [0,1];
  - **P05.11 = 1** – current speed error. It is recommended when it uses the motor EMF as a speed feedback and the meaning of the parameter **P02.11**=2;

Note: The meaning of understanding parameters **P05.03** to **P05.10** are fifferent for different adaptation variable defined by **P05.11.**

6.4.6 Group 6 – armature current parameters

- Parameter **P06.01** – coefficient of amplification of the armature current regulator;
- Parameter **P06.02** – timeconstant of the armature current regulator;
- Parameter **P06.03** – adjustment of the phase **L1** current amplitude;

- Parameter **P06.04** – adjustment of the phase **L2** current amplitude;
- Parameter **P06.05** – adjustment of the phase **L3** current amplitude;
- Parameter **P06.06** – time of the armature current rampgenerator. It is used for softing the strikes of the gears during the transients when it is used the ones, or the tachogenerator has fluctuations higher than 2% calculated by **P01.09** in stable working mode.

6.4.7 Group 7 – EMF regulators and wound field parameters

- Parameter **P07.01** – coefficient of amplification of the wound field current regulator;
- Parameter **P07.02** – timeconstant of the wound field current regulator;
- Parameter **P07.03** – coefficient of amplification of the EMF regulator. When the EMF regulator is optimum adjusting the overregulation of the armature voltage is limited at transients including at reversing;
- Parameter **P07.04** – timeconstant of the EMF regulator.

6.4.8 Group 8 – orientation stopping parameters

- Parameter **P08.01** – coice of the position reference source. It has two meaning:
  - **P08.01** = **0** – position reference is defined by the meaning of parameter **P08.02**;
  - **P08.01** = **1** – position reference is defined by parallel code of digital inputs **IN0**...**IN11**;
- Parameter **P08.02** – inner position reference at orientation stopping. Orientation stopping in position, given by parameter **P08.02**, is performed when parameter **P08.01** = 0. When meaning of parameter **P08.01** = 1, it is performed orientation stopping in position, given by parallel code of the digital inputs **IN0** ... **IN11**;
- Parameter **P08.03** – offset of the given position;
- Parameter **P08.04 (P01.15)** – current position error when it is performed orientation stopping;
- Parameter **P08.05** – offset of the speed reference when it is performed orientation stopping. By parameter **P8.05** is adjusted the precision of performing the given position;
- Parameter **P08.06** – choice of the rotating direction at orientation stopping. It has three meaning:
  - **P08.06 = 0** – the rotating direction is the same;
  - **P08.06 = +1** – right rotating;
  - **P08.06 = –1 –** left rotating.
- Parameters **P08.07**, **P08.08** и **P08.09** – coefficients of the position regulator. They are used of adjusting the position regulator, which algorithm is described by the expression:

$$U_n = U_{n-1} * P08.07 + P08.08*f(P08.09*\varepsilon) + P08.05$$

where:
Un – meaning of the position regulator output,
Un-$_1$ – meaning of the position regulator output from the previous calculation,
ε – position error

6.4.9 Group 9 – output parameters

- Parameter **P09.01** – speed N_{ZS}, when relay output **ZS** activates**.** Meaning of the parameter **P09.01** is defined in percentage of the maximal speed N_{MAX}. Changing of the parameter **P09.01** is in the limits 0.5 ÷ 3.0 % N_{MAX};
- Parameter **P09.02** – speed N_{SA}, when relay output **SA** activates when the function approached speed is performed. The meaning of parameter **P09.02** is defined in percentages of the speed reference N_{REF}. Changing of the parameter **P09.02** is in the limits 70.0 ÷ 95.0 % N_{REF};
- Parameter **P09.03** – working mode of the relay output **SA**. Parameter **P09.03** defines the speed when the function approached speed activates. Parameter **P09.03** has meaning from 0 to 20 % of the maximal speed N_{MAX};

– Parameter **P09.04** – current $\mathbf{Ia_{TLH}}$, to which the armature current at controlling signal **TLH,** defined in percentage of the motor nominal current $\mathbf{Ia_{NOM}}$ is limited;
– Parameter **P09.05** – current $\mathbf{Ia_{TLL}}$, to which the motor current at controlling signal **TLL**, defined in percentages of the motor nominal current $\mathbf{Ia_{NOM}}$ is limited;
– Parameter **P09.06** – admissible deviation from given position, when digital output **INPOS** activates at performing **orientation stopping**. Parameter **P09.06** defines precision of performing the given position;
– Parameter **P09.07** – working mode of the output **RD** of ready converter. Output **RD** activates if any protection does not activate. It has two meaning:
• **P09.07 = 0** – output of ready **RD** activates 4 seconds after switching on the operative supply **U1**, **V1** and **W1**, power supply **U2**, **V2** and **W2** and wound field supply **V3** and **W3** at the same time;
• **P09.07 = 1** – ready output **RD** activates 4 seconds after switching on only the operative sopply **U1**, **V1** and **W1** and wound field supply **V3** and **W3**. When the controlling signal **ON** is switched on without power supply, protection **HPF** activates and LED indication **PF** flicks with a period of time 1s.
– Parameter **P09.08** – choice of analog output variable **AOUT1** (see table11);
– Parameter **P09.09** – choice of analog output variable **AOUT2** (see table11);

Parameters **P09.06** and **P09.07**	**Active variable of the analog outputs**
0	Absolute actual meaning of the armature current. Range of the analog output from 0V to 10V, corresponding to the motor current changing from 0 to $\mathbf{Ia_{MAX}}$.
1	Absolute actual meaning of the motor rotating speed. Range of the analog output from 0V to 10V, corresponding to the speed changing from 0 to $\mathbf{N_{MAX}}$.
2	Actual motor rotating speed. Range of the analog output from –10V to +10V, corresponding ot the speed changing from –1.1 $\mathbf{N_{MAX}}$ to +1.1 $\mathbf{N_{MAX}}$.
3	Speed reference before ranpgenerator. Range of the analog output from –10V to +10V, corresponding of the reference changing from –100% to +100%.
4	Speed reference after rampgenerator. Range of the analog output from –10V to +10V, corresponding of the reference changing from –100% to +100%.
5	Actual meaning of the armature voltage. Range of the analog output from - 0V to +10V, corresponding to the voltage changing from –600V тодо +600V.
6	Actual motor wound field current. Range of the analog output from 0V to 10V, corresponding to the current changing from 0 to $\mathbf{I_{FMAX}}$
7	Current reference on the output of the speed regulator. Range of the analog output from –10V to +10V, corresponding to current reference changing from $\mathbf{-Ia_{MAX}}$ to $\mathbf{+Ia_{MAX}}$
8	Current reference after current limit. Range of analog output from –10V to +10V, corresponding to the current reference changing from $\mathbf{-Ia_{MAX}}$ to $\mathbf{+Ia_{MAX}}$
9	Reference of the thiristor firing angle on the current regulator. Range of the analog output from –10V to +10V, corresponding to the maximal meaning of the reference of the thyristor firing angle. The sign of the reference defines the polarity of the armature voltage.

Table 11 Choice of the analog output variables **AOUT1** and **AOUT2**

6.4.10 Group 10 – terminal parameters

– Parameter **P10.01** – choice of the terminal language. At adjusting it is chosen a menu language. It is not restore by understanding. It has three meaning:
• **P10.01** = **0** – English language;
• **P10.01** = **1** – Bulgarian language;
• **P10.01** = **2** – Russian language.

– Parameter **P10.02** – time of refreshing of the terminal indication.

6.4.11 Group 11 – error history

– Parameters from **P011.01 to P11.10** – parameters in which it is stored messages of errors in order of their appearance. If in a certain parameter there is not any message of error in it is written **EMPTY**. The messages of errors are written by text corresponding to the table 12. Last written message of error is stored in the parameter with the largest number. After fulling all parameters the oldest messages are reset automatically;

– Parameter **P11.11** – reset all of the error messages.

6.5 Errors in emergency mode

Appearing of the message **Error N XX** on the terminal display means an error which number is given in the last two orders. The message of an error is appered at its registration indeppendent of that in which mode is the converter. Recording error messages is stored in parameters in group **P11** in the cequence of their appearing. After pressing the button **ESC** the terminal status before error appearing is restored. The list of error messages is given in table12 and in table 13 is given the LED indication status when the emergency mode appears.

Error №	Text	Error description
Error N01	**S**oft **P**hase **F**ault	Disconnecting or out of phase power and synchronization voltages. Wrong ground connectionof the converter.
Error N02	**H**ard **P**hase **F**ault	Disconnection of the power supply voltage or the voltage of any of the phases.
Error N03	**FR**equency **F**ault	Power supply mains frequency is out of the admissible range or ther is not synchronization.
Error N04	**O**ver**L**oad **F**ault	The motor is overloaded.
Error N05	**O**ver**H**eat **F**ault	Power block is over heated when **P03.09**=1
Error N07	**S**oft **O**ver**C**urrent	Limited current $\mathbf{Idrv_{LIM}}$ of the converter power block is more than given by parameter P03.10.
Error N08	**H**ard **O**ver**C**urrent	Maximal admissible current $\mathbf{Idrv_{MLIM}}$ of the converter power block is over current.
Error N10	**S**oft **TG** fault	Wrong connection, short circuit or disconnection in the tachogenerator circuit. Wrong choice of the parameter **P03.11**
Error N11	**EN**coder **F**ault	Wrong connection, short circuit or disconnection in the encoder circuit.
Error N12	**P**os **S**peed**B**ack	Positive speed feedback.
Error N13	**S**oft **F**ield **L**oss	Wound field current is out of the given limits.
Error N14	**H**ard **F**ield **L**oss	Ther is not wound field current.
Error N16	**S**oft **O**ver**S**peed	Overspeed according to the one given by parameter **P03.14** limited speed $\mathbf{N_{LIM}}$
Error N17	**H**ard **O**ver**S**peed	Overspeed the maximal limited speed $\mathbf{N_{MLIM}}$.
Error N18	**O**ver**V**oltage **M**ot	Over voltage the maximal admissible armature voltage.
Error N19	**ADC** fault	There is something wrong in analog-digital converter.
Error N20	**EE**prom **F**ault	Error at work with EPROM.

Table 12 List of the errors

Note: Letters in bold respond to the protection meaning given in p.6.4.3.

Indication	Protection	Emergency mode description
LEDs lighting constantly		
PF	**SPF**	Disconnection or out of phase power and synchronization voptages. Wrong ground connection of the converter.
OL	**OLF**	The motor is overloaded.
OS	**SOS**	Overspeed according to the one given byparameter **P03.14** limited speed $\mathbf{N_{LIM.}}$
OC	**SOC**	Overcurrent according to given by parameter **P03.10** limited current $\mathbf{Idrv_{LIM}}$ of the converter power block.
TG	**STG**	Wrong connection, short circuit or disconnection in the tachogenerator circuit. Wrong choice of parameter **P03.11.**
FL	**SFL**	Wound field current is out of the given limits.
FL,TG,OC, OS,OL,PF	**ADC**	Fault in the analog-digital converter.
LEDs flicking with a period of time 1s		
PF	**HPF**	Disconnection of the power supply voltage or the voltage of any phase.
OL	**OHF**	Overheating of the power block when **P03.09**=1
OS	**HOS**	Overspeeded of the maximal limited speed $\mathbf{N_{MLIM}}$.
OC	**HOC**	Overcurrent of the maximal admissible current $\mathbf{Idrv_{MLIM}}$ of the converter power block.
TG	**ENF**	Wrong connection, short circuit or disconnection in the encoder circuits.
FL	**HFL**	Absence of the wound field current.
FL,TG,OC,OS,OL,PF	**EEF**	Error at work with EPROM.
LEDs flicking with a period of time 0.3 s		
PF	**FRF**	The power supply mains frequency is out of the admissible range or absence of the synchronization.
TG	**PSB**	Positive speed feedback.
OS	**OVM**	Overvoltage of the maximal admissible armature voltage.

Table 13 Converter LEDs indication status when there is any emergency mode.

7. Assembling and connecting of the converter

7.1 General technical requirements to the assembling

The converters and belonging to them commutative and protection equipment are mouted in a cabinet. When they are mounted it is necessary to observe the following rules:

- The converter is mounted in the vertical position. Its fixing must be made by opening for this purpose holes placed at the down and upper parts of the frame;
- Over and under the converter it is necessary to leave free space,no less than 100 мм, which ensure a vertical air circulation through the radiator of the power block;
- Use possible the shortest cables;
- Signals' conductors must not be mounted next to the power cables;
- Connecting of the analog signals must be made by screen cable and the screen is connected to the ground at the one end. The screen must be connected to X2.9, X2.10, and X2.11. The screen must not be used as a current-carrying conductor;
- Keep the meanings and the types of the protection elements, given in table14 and the minimal sections of the connecting conductors in correspondence to the circuits in fig.16, fig.17 and fig.18;
- Electrical connections must be performed in correspondence to the circuits in fig. 16, fig.17 and fig.18;

	3002/3003	**3004/3005**	**3006/3007**	**3009/3011**	**3013/3016**	**3020**	**3025/3030**
TC1	4 mm^2	6 mm^2	10 mm^2	2x10mm^2	25mm^2	35mm^2	50 mm^2
TC2	4 mm^2	4 mm^2	6 mm^2	10 mm^2	16mm^2	25 mm^2	35/50 mm^2
TC3	4 mm^2	6 mm^2	10 mm^2	16 mm^2	16 mm^2	16 mm^2	16 mm^2
TC4	4 mm^2	4 mm^2	6 mm^2	10 mm^2	10 mm^2	10 mm^2	10 mm^2
TC5	2.5 mm2						
TC6	3x1.00 mm2						
TC7	screen + 3x3 + 2x0.35 mm2						
TC8	screen + 2x0.35 mm2						
QF1 (auto off) Shneider Elektric, Кат №	C60ND 24602-16A / 24604-25A	C60ND 24620-32A / 24621-40A	C60ND 24623-50A / 24624-63A	C120ND 18387-80A / 18388-100A	Compact NB 31604-125A/ 31603-150A	Compact NB 31602-175A	Compact NB 31600-225A/ 31559-250A
Choke	PK0525	PK0548	PK02612	PK02715	PK021632	PK022550	PK022550
Fuses **FUS** and **FUT**	16A						
Fuses **FU**, **FV** and **FW**	0.315A						

Table 14 Minimal section of the connecting conductors, types and meaning of the protecting elements.

Notes:

1. It is allowed to use devices of other manufacturers with the same characteristics;

2. It is admissible using other chokes with inductivity no less than 0.2 mH and if they ensure normal work at nominal maximal motor current.

7.2 Connecting of the converter

Connecting of the converter depends on its type, on the type of the circuit of the motor wound field supply, on the type for speed feedback, on the type of CNC and on functions, which the converter performs.

In fig.16 is given connecting the converter of which:

- Supply of the wound field power part is with a transformer **TF1**;
- It is used a tachogenerator for a sensor of speed feedback;
- It is used an analog speed reference;
- It is used a limitation of the motor torque at two levels **TLH** and **TLL**;
- **CNC** is with relay outputs for controlling signals **ON**, **TLH** and **TLL**.

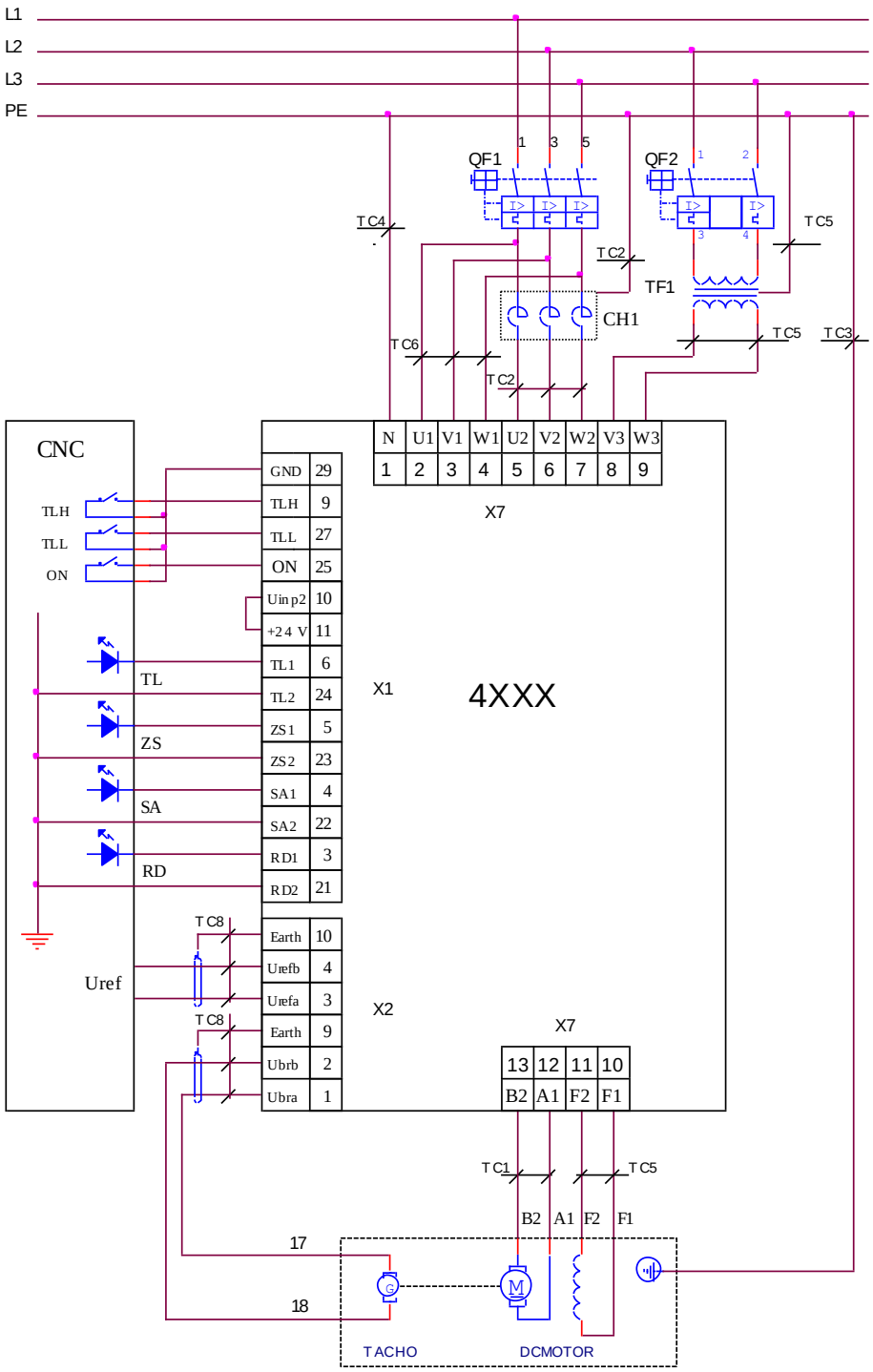


Fig.16 Circuit of the converter connecting

In fig.17 is given converter connecting of which:

– Supply of the wound field power part is by the power choke **CH1**;
– It is used encoder for the speed feedback sensor;
– It is used an analog speed reference;
– It is used an limitation of the motor torque at two levels **TLH** and **TLL**;
– **CNC** is with relay outputs for the controlling signals **ON**, **TLH** and **TLL**.

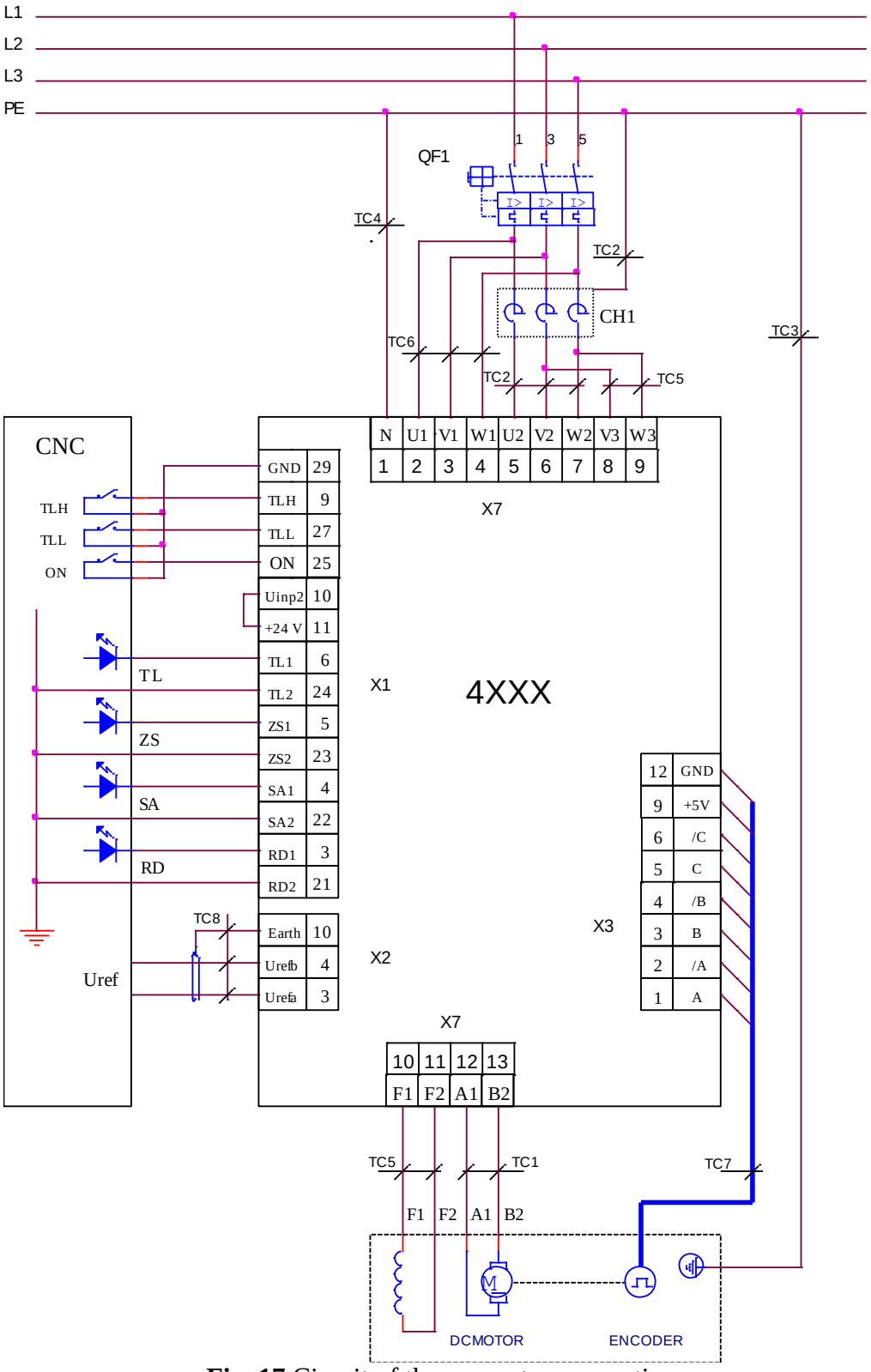


Fig. 17 Circuit of the converter connecting

In fig. 18 is given connecting of the converter of which:

– Supply of the wound field power part with additional choke **CH1**;
– It is used an encoder as a speed feedback sensor;
– It is used analog speed reference ;
– It is used limiting of the motor torque at two levels **TLH** and **TLL**;
– **CNC** is with system outputs type **N** for the controlling signals **ON**, **TLH** and **TLL**.

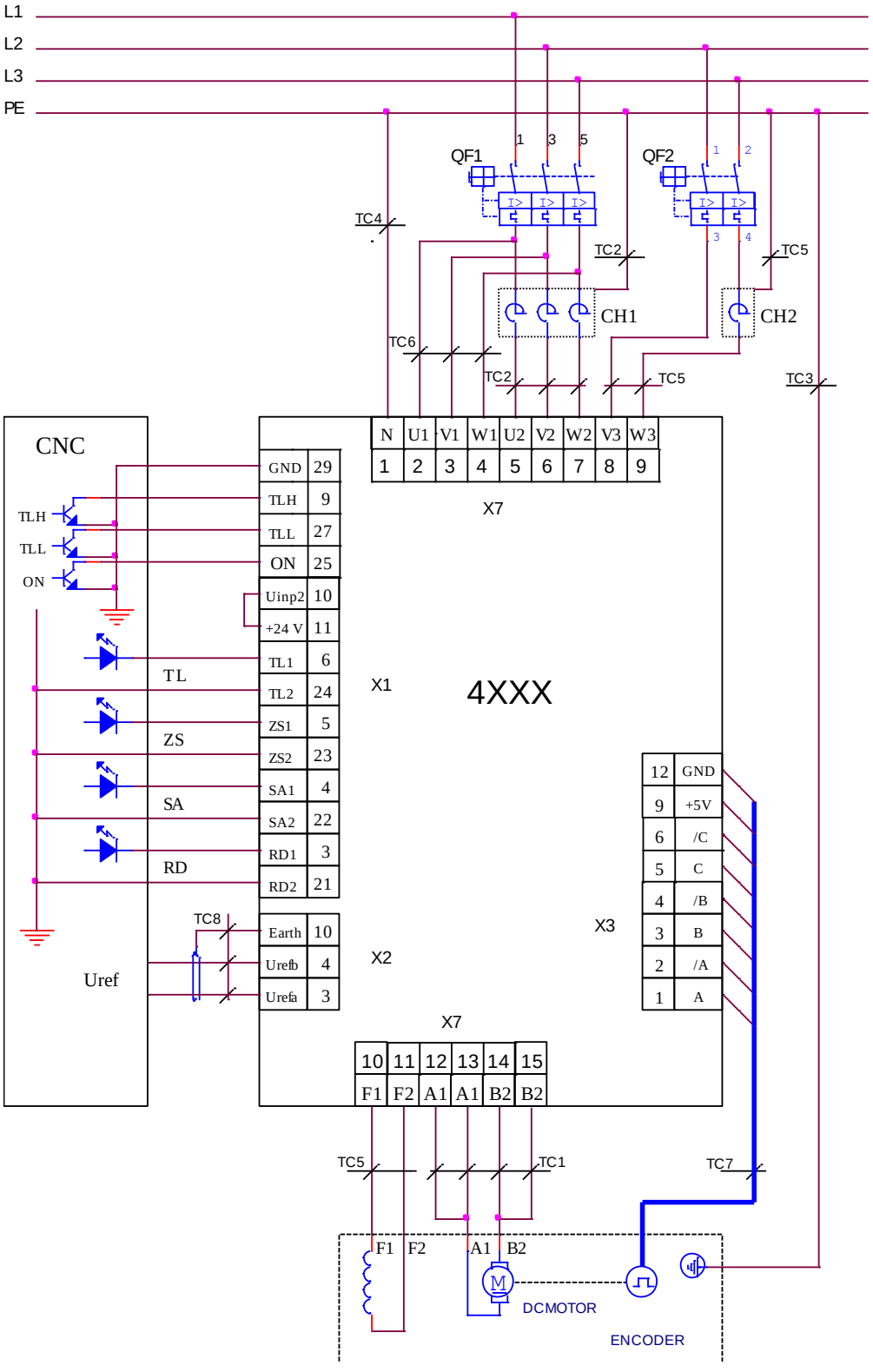


Fig. 18 Circuit of the converter connecting

8. Connecting snd adjusting of the converter

For starting the converter are necessary the next equtpments:

- Voltmeter with range to 500 $V_{AC/DC}$, class 1.5;
- Digital revolution-meter;
- Amperemeter with range to +/-10A_{DC}, class 1.5;
- oscilloscope;
- switcher for controlling signal **ON**;
- switcher for switching the rotation direction **SF** / **SR**;
- swicher for switching of **RUN** / **STOP**;
- variable resistor 10 K;
- terminal for adjusting the parameters.

8.1 Checking the supply voltages

To the converter are connected operative voltage **U1**(X7.2), **V1**(X7.3) and **W1**(X7.4) and power supply voltage **U2**(X7.5), **V2**(X7.6) and **W2**(X7.7), according to the circuit given in fig.19. during this checking the motor is not switched on to the converter.

To the series interface **X6** of the converter is switched on special terminal for adjusting the parameters.

Switch on the power supply voltage to the converter. LED **PF** activates as it flicks in the first two seconds. In this interval of time the power supply voltage frequency and in-pfase of the operative and power voltage are defined. After that LED **PF** is switched off and LED **RD** activates.

If the LED **PF** goes on to light, check if the operative supply voltage and power supply voltage are in-phase. Measure the voltage between terminals **U1**(X7.2) and **U2**(X7.5). if the connection is right the voltage between them is equal to 0V. If case the voltage between them is 380V, it means that there is an error in connection. Switch off the voltage anf repair the mistake. The same action is repeated for **V1**(X7.3) and **V2**(X7.6) and for **W1**(X7.4) and **W2**(X7.7). the order of the phases is no matter and it is defined automatically by the coverter.

Transformer **TF1** isolates galvanic the motor wound field coil from supply maims. It carries the voltage between wound field coil and the compensation coil of the motor, and it is decreased the possibility of electrical break between them. Using of transformer is recommended at motors which are used more of their resources. At choice of a tranformer **TF1** it is necessary to ensure the nominal voltage and current of the motor wound field.

ATTENTION!

Primary coil of the transformer TF1 must be connected to phases L2 and L3, and the secondary coil is connected to terminals with lables V3(X7.8) and W3(X7.9) as it is given in fig.16 and fig.19.

After finishing this checking supply of the converter is switched off.

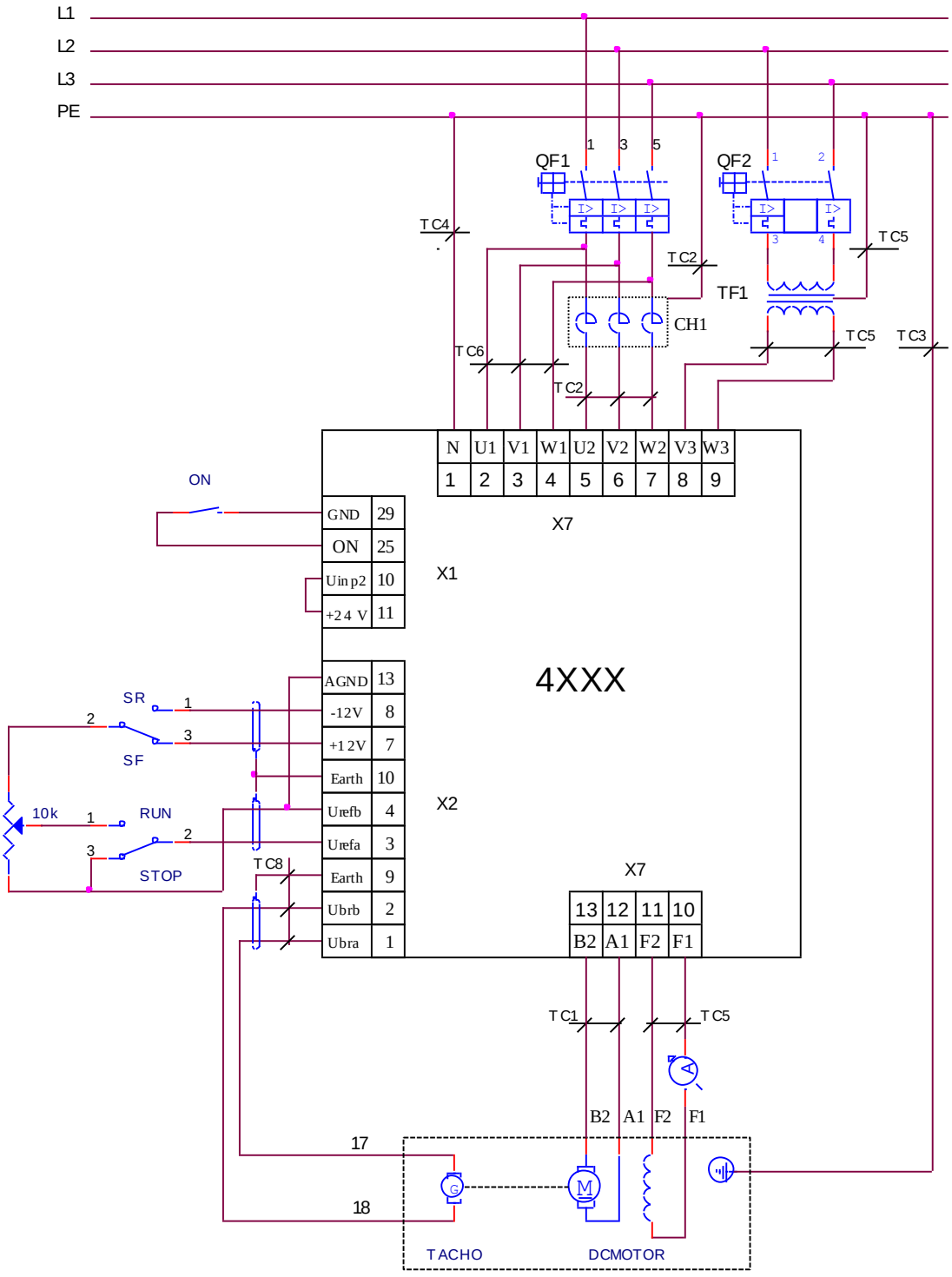


Fig.19 Connection circuit of the converter at adjusting.

8.2 Primary converter adjusting

8.2.1 Primary adjusting of the speed feedback

- **speed feedback with tachogenerator**

The converter is adjusted to work with tachogenerator by understanding and parameter **P02.11** = 0.

The tachogenerator voltage $\mathbf{Ubr_{MAX}}$ at the motor maximal rotating speed is defined by the expression:

$$\mathbf{Ubr_{MAX} = (N_{MAX} / 1000) * Ubr_{1000}},$$

where:

$\mathbf{N_{MAX}}$ – the motor maximal rotating speed;

$\mathbf{Ubr_{1000}}$ – tachogenerator voltage at 1000 min^{-1}.

By so calculated maximal tachogenerator voltage $\mathbf{Ubr_{MAX}}$ is chosen the voltage range in table 2. The converter face panel is opened and the protection cover of the processor plate is moved down. Bridges **J5**, **J6**, **A1**, **A2** and **A3** are placed in positions corresponding to the given combination for the chosen range from table 2.

- **Speed feedback with encoder with constant coefficient of transmission**

Switch the converter supply and insert the password **P02.02** = 11. According to the type of the encoder insert the meaning of the following parameters:

- Parameter **P02.11** – it chooses an encoder as a speed feedback by inserting the meaning of the parameter **P02.11** = 1;
- Parameter **P02.14** – insert the number of the pulses per a revolution of the encoder;
- Parameter **P02.18** – insert the rotating speed of the encoder at maximal motor speed;
- Parameter **P02.19** – insert the meaning **P02.19 =** 0 **to** forbid the speed shift. By understanding **P02.19** = 0.

- **Speed feedback with encoder with changeable coefficient of transmission**

Switch on the converter supply and insert the password **P02.02** = 11. According to the type of the encoder insert the meaning of the next parameters:

- Parameter **P02.11** – it chooses an encoder as a speed feedback by setting the meaning of the parameter **P02.11** = 1;
- Parameter **P02.14** – insert the number of the pulses per a revolution of the encoder;
- Parameter **P02.19** – insert the meaning **P02.19 =1** for permission the work with gearbox with speed changing;
- Parameter **P02.20** – insert the maximal speed of the encoder for the first maximal speed. It is performed when inputs **IN0** and **IN1 are not** active**;**
- Parameter **P02.21** – insert the maximal speed of the encoder for the second maximal speed. It is performed when the digital input **IN0** activates**;**
- Parameter **P02.21** – insert the maximal speed of the encoder for the third maximal speed. It is performed when the digital input **IN1** activates**;**
- Parameter **P02.23** – insert the maximal speed of the encoder for the fourth maximal speed. It is performed when the digital inputs **IN0 and IN1** activate at the same time;

Note – when the mode of the speed feedback with encoder by shifting coefficient of transmission is chosen **P02.19 =1 and** mode of reference with parallel code **P02.09**=0, it is worked with 10bit code from **IN2** to **IN11,** because the other inputs are used for choice of the maximal speed at different gears.

- **Speed feedback with motor EMF**

Switch the converter supply and insert the password **P02.02** = 11. Insert the meaning of the next parameters:

– Parameter **P02.11** – insert the meaning **P02.11** = 2 and choose the motor EMF for the speed feedback sensor;
– Parameter **P02.05** – insert the meaning **P02.05** = 0 and choose the work without weakened motor field.

Note – in this case the maximal motor speed respond to the nominal motor speed and it is approached at voltage $\mathbf{Ua_{MAX}}$, which meaning is written in parameter **P04.01**. If it is necessary a lower maximal speed in parameter **P04.01 must** be written corresponding lower voltage.

8.2.2 Adjusting the parameters connecting to the motor

Insert the meaning of the parameters which defined working and limiting characteristics of the motor:

– Parameter **P04.01** – motor armature voltage $\mathbf{Ua_{MAX}}$ in volts;
– Parameter **P04.02** – nominal wound field current $\mathbf{I_{FNOM}}$. Insert the meaning of the wound field nominal current from the motor table;
– Parameter **P04.03** – minimal working wound field current $\mathbf{I_{FMIN}}$ in amperes, corresponding to the motor maximal speed;
– Parameter **P04.04** – motor wound field current $\mathbf{I_{FON}}$ in amperes when the controlling signal **ON** switched off. At primary starting of the converter the meaning of the parameter **P04.04** is chosen to be equal to the meaning of the parameter **P04.02**. Precise calculated the meaning of the parameter **P04.04** is given in point 8.3;
– Parameter **P04.05** – nominal motor armature current $\mathbf{Ia_{NOM}}$ in amperes;
– Parameters from **P04.08** to **P04.19** – points of the dynamic current characteristic;
– Parameter **P04.09** – maximal motor armature current $\mathbf{Ia_{MAX}}$;
– Parameter **P04.20** – resistance of the armature circuit **Ra**. If the armature resistance is unknown it may be used the approximately calculated meaning of the parameter **P04.21**. Calculated meaning of the parameter **P04.21** may be used only after inserting the right meanings of the parameters **P04.01** and **P04.05**;
– Parameter **P03.12** – limited maximal wound field current $\mathbf{I_{FLMAX}}$ in amperes when the protection **SFL** activates. At primary converter starting the meaning of the parameter **P03.12 is** saved by understanding. Pricise calculaded of the meaning of the parameter **P03.12** is given in point 8.3;
– Parameter **P03.13** – limited minimal wound field current $\mathbf{I_{FLMIN}}$, when the protection **SFL** activates. At the primary converter starting the meaning of the parameter **P03.13** is saved by understanding. Pricise calculated of the meaning of the parameter **P03.13** is given in point 8.3;
– Parameter **P03.15** – threshold of activating of the protection **OVM** from over voltage of the armature voltage.

8.3 Adjusting the nominal, maximal and minimal wound field current

The supply is switched off and the motor is connected to the converter as in series in the wound field coil circuit is connected amperemeter with range $12A_{DC}$.

Check if the range of the wound field current sensor corresponds to the nominal wound field current. Conductors with lables **F1** and **K13** is placed in the terminals of the power plate as followed:

– **SW5** and **SW3** for range 4 A;
– **SW4** and **SW3** for range 6 A;
– **SW5** and **SW4** for range 12 A;

Placed of the terminals **SW3**, **SW4** and **SW5** on the power plate is given in fig.13.

Attention - conductor with lable F1 is always placed in terminal SW4 or SW5.

Switch on the converter supply again. Controlling signal **ON** is switched off and the amperemeter measures the wound field current $\mathbf{I_{FON}}$.

By parameter **P04.02** is regulated the motor wound field current to approaching its passport nominal meaning $\mathbf{I_{FNOM}}$. At each changing the meaning of the parameter **P04.02** automatically in time about 8 – 10 s, the motor wound field current is defined by parameter **P04.02** and it is registered by the amperemeter. After finishing the time the wound field current $\mathbf{I_{FON}}$ is equal to the current defined by parameter **P04.04**. The meaning of the parameter **P04.02** must be more or equal to the meaning of the parameter **P04.04**.

After adjusting the wound field nominal current $\mathbf{I_{FNOM}}$ by parameter **P04.04** is defined the wound field current $\mathbf{I_{FON}}$ when the controlling signal **ON** is switched off. It is recommended meaning in range of 50–100% of the meaning of parameter **P04.04**.

Insert in parameter **P04.03** the meaning of the minimal wound field working current $\mathbf{I_{FMIN}}$ from the table of the motor in discretes. If on the table of the motor this current is not given the meaning of the parameter **P04.03** is chosen about 20 % or more of the meaning of the parameter **P04.02**.

During the adjusting does not work to protect **SFL** is necessary to keep the following:

- Minimal wound field current $\mathbf{I_{FLMIN}}$ (down threshold of the protection **SFL**) defined by parameter **P03.13** to have meaning about 70÷90% of the minimal wound field working current $\mathbf{I_{FMIN}}$ defined by parameter **P04.03**;
- Maximal wound field current $\mathbf{I_{FLMAX}}$ (upper theshould of the protection **SFL**) defined by parameter **P03.12** to have meanings between 120% and 130% of the nominal wound field current $\mathbf{I_{FNOM}}$ defined by parameter **P04.02**.

If the nominal wound field current is unknown $\mathbf{I_{FNOM}}$ only the wound field voltage $\mathbf{U_{FNOM}}$ is known the wound field current is devined on the following manner:

- Measure the active resistance of the field wound at room temperature;
- Measured resistance is multiplied by the coefficient **1.2** and the result is the resistance $\mathbf{R_F}$ of the field wound when the motor is heated;
- Calculate the field current $\mathbf{I_{FNOM}}$ by expression:

$$\mathbf{I_{FNOM} = U_{FNOM} / R_F},$$

As after the current is stable check the wound supply voltage which must be in range from 75 to 85% of the nominal voltage given on the table.

- Adjusting of the other parameters connecting with the motor wound field is made in sequence given above.

Note - it is recommended when the motor working temperature is stable to check the supply wound field voltage and if it is more than the nominal voltage, the wound field nominal current to be decreased.

8.4 Starting of the converter in proportional mode

Primary converter starting with a motor is made in proportional mode. In this mode the speed reculator and the armature current regulator are switched off and they do not influence on the converter work, i. e. the motor can work at low speed when the tachogenerator/encoder is switched off or it is not in-phase. The protection of the speed feedback fault is also switched off. In proportional mode of converter work is made checking of the tachogenerator, adjusting of the circuit of the speed feedback and checking if all of the thyristor work.

Starting of the converter in proportional mode is made by inserting the meaning of the parameter **P02.04** = 1. Changing of the parameter **P02.04** is not written in the EPROM and at each converter switching on the meaning of the parameter **P02.04** = 0, i. e. the converter works in integral mode.

In proportional mode the source of the speed reference, which gives the thyristor firing angle, is chosen by parameter **P02.09**. The reference is inner limited to a safety meaning.

The controlling signal **ON** is switched **o**n and the motor is rotated.

By parameter **P01.10** are watched the fluctuation of the tachogenerator voltage. When the tachogenerator is in good working order, in stable mode, the meaning of parameter **P01.10** must not be more than 2%. At meaning of parameter **P01.10**, more than 2%, it is necessary to check or repaire the tachogenerator.

To check if the tachogenerator connecting is correct compare the meaning of parameters **P01.02** and **P01.05**. If the tachogenerator connecting is correct the two parameters must be with equal signs. When the meanings of the parameters **P01.02** and **P01.05** have different signs, it is possible following two cases:

- The motor rotating direction responds to the given reference. Change the tachogenerator connecting;
- The motor rotating direction is opposite to the given reference. Change the motor armature connecting.

When it is used an encoder as a speed feedback sensor, checking the correctitude of its connecting is made as it is compared the meaning of parameters **P01.02** and **P01.05**. When the connecting of the encoder is correct the two parameters must be with equal signs. When the meaning of the two parameters are with different signs it is possible two cases:

- The motor rotating direction responds to the given reference. Change the encoder connecting (for example two phases – **A** and **/A**) or the meaning of parameter **P02.15**;
- The motor rotating direction is opposite to the given reference. Change the motor armature connecting.

In proportional mode is made adjusting the channel of the speed feedback. By changing the thyristor firing angle is given a defined rotating speed, for example 10% of the maximal speed $\mathbf{N_{MAX}}$, measured by digital revolution-meter. By the variable resistor **RP5**, given in fig.20 the meaning of parameter **P01.02** (reduced from % to speed) and the indicationof the revolution-meter are made equal.

To check the work of the power rectifier thyristors the form of the armature current in control point **КТ20** is watched on the oscilloscope. The measurement is made to the ground led in control point **KT16**. The controlling signal **ON** is switched on and it is given a low rotating speed - for example 5 % from $\mathbf{N_{MAX}}$. Check the form of the motor armature current by the oscilloscope. Watched pulses of the armature current must be every 3.3 ms and the difference between the amplitudes no more than 20 %. Return the motor rotating direction watch the motor armature current again. When there is big difference between each first and fourth pulse equal them by variable resistor **RP4**. When there is difference between pulses between one phase and other (different next), equal them by variable resistors **P06.03**, **P06.04** and **P06.05**. If it is impossible to equal them insert meaning of the parameters **P06.03** = **P06.04** = **P06.05** = 0 and equal the difference by variable resistors **P1**, **RP2** and **RP3**. When armature current pulses for a phase are absent check the thyristor controlling circuit.

When current pulses for a phase are absent choose the parameter **P01.16** and define which of the thyristors does not work. When you determine which thyristor does not work switch off the converter supply and check the thyristor and its controlling circuit.

8.5 Adjusting the protection from speed feedback fault

By parameter **P03.11** choose the armature maximal admissible voltage when protection **STG,** of speed feedback fault, activates. If meaning of parameter **P03.11** are low it is possible during the transients the protection activates without a real problem. And in opposite, when meaning of the parameter **P03.11** are high, it is possible the protection **STG** does not work and the motor approaches high rotating speed.

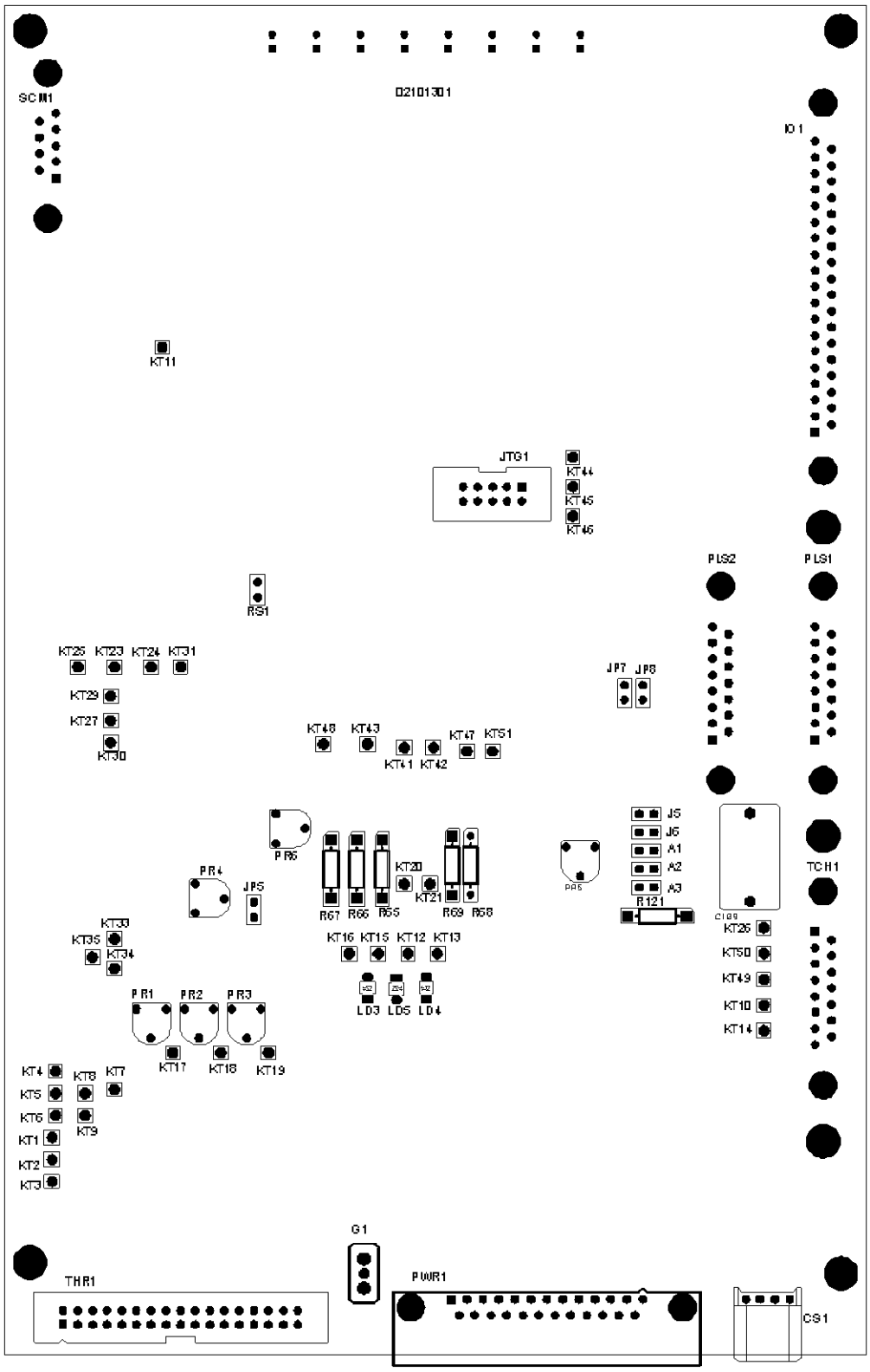


Fig. 20 Placement of the adjusting elements on the processor plate

8.6 Adjusting the wound field current regulator

Watch the form of the wound field current form at the controlling point **KT51** by the oscilloscope. Give the zero rotating speed, switch on the controlling signal **ON** and watch the increasing of the wound field current. After switching on the controlling signal **ON** and time about 10s, the wound field current decreases to $\mathbf{I_{FON}}$, defined by parameter **P04.04**. the optimal form of the wound field current characteristic during the transient is given in fig.21.

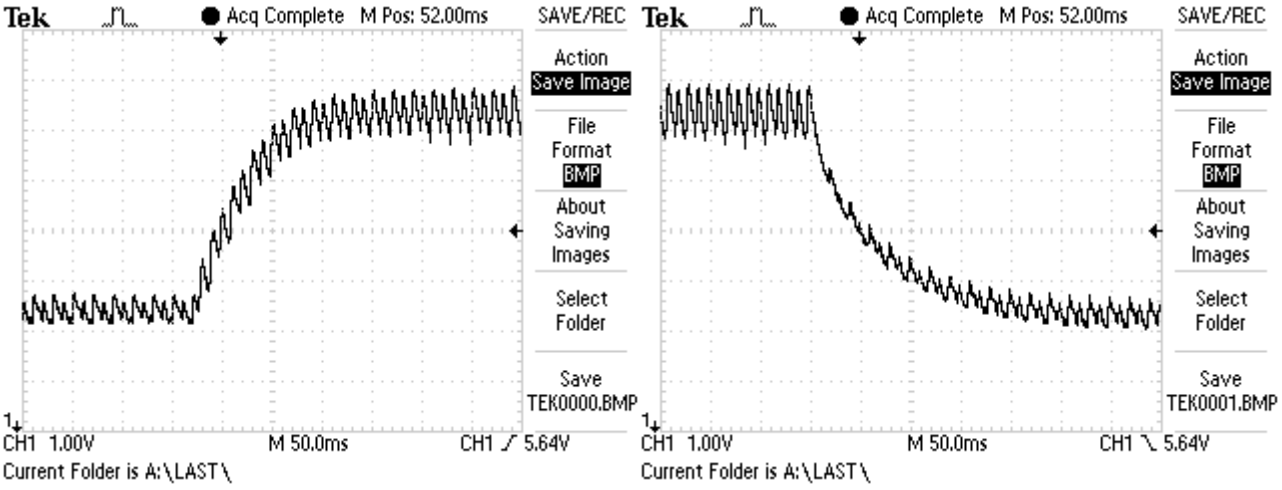


Fig 21 Form of the current characteristic at optimal adjustment of the wound field current regulator

For adjusting the wound field current regulator use parameters **P07.01** and **P07.02**. The parameters **P07.01** and **P07.02** have the following influence on the work of the current regulator:

- Parameter **P07.01** – coefficient of amplification of the wound field current regulator. Typical meaning of parameter **P07.01** are from 1.00 to 3.00. At high meaning of parameter **P07.01** the tendency to selfexcitation is increased. At low meaning of parameter **P07.01** time of approaching the given wound field current is increases;
- Parameter **P07.02** – tineconstant of the wound field current regulator. Typical meaning of parameter **P07.02** are from 0.500 to 2.000 s. At low meaning of parameter **P07.02** the speed of the reaction of the wound field current regulator is increased but the tendency to fluctuation is increased, too.

At high meaning of parameter **P07.02** the time of approaching the given wound field current is increased.

At high meaning of parameter **P07.01** and low meaning of parameter **P07.02,** it is watched overregulation and tendency to fluctuation of the wound field current during the transients. The form of the wound field current characteristic is given in fig. 22.

At low meaning of parameter **P07.01** and high meaning of parameter **P07.02,** it is watched a lasting transient at approaching to given wound field current. The form of the wound field current characteristic is given in fig.23.

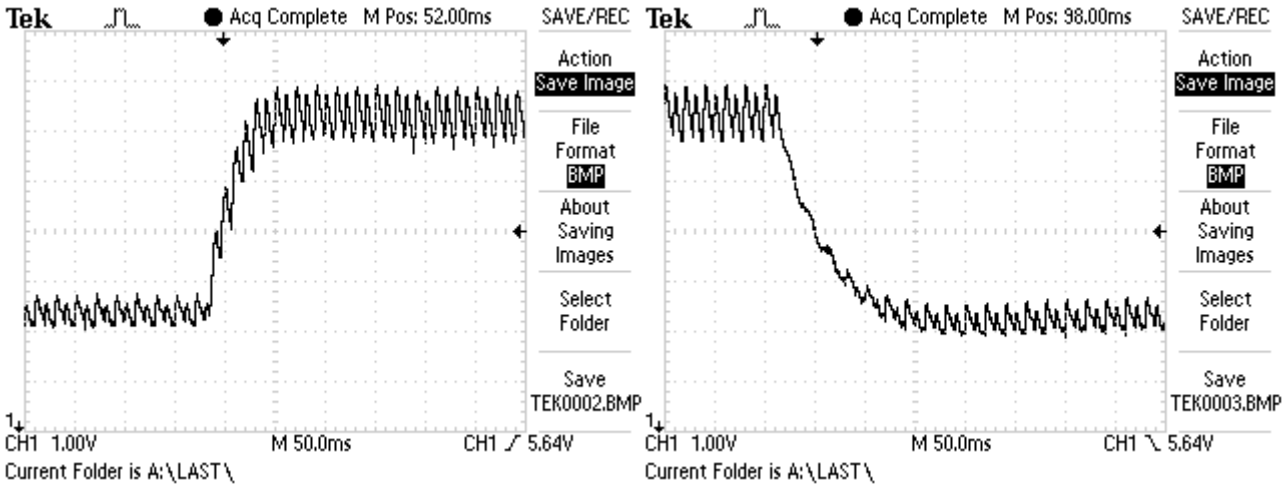


Fig. 22 Form of the wound field current characteristic at high meaning of parameter **P07.01** and low meaning of parameter **P07.02** with overregulation and tendency to fluctuation

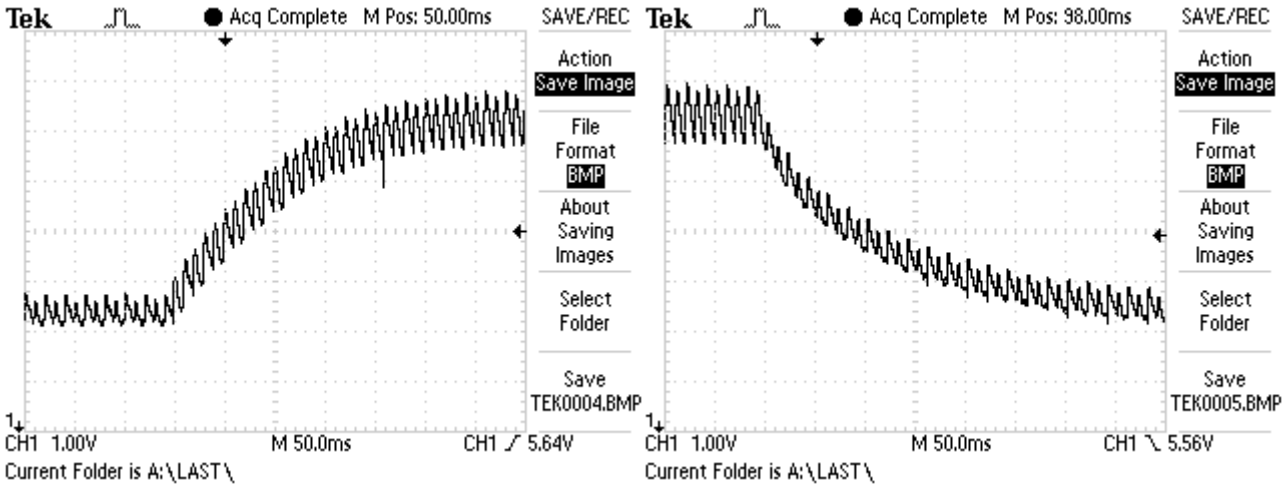


Fig. 23 Form of the wound field current characteristic with lasting transient at low meaning of parameter **P07.01** and highmeaning of parameter **P07.02**

8.7 Checking the converter work in integral mode

After finishing the adjustment in proportional mode the controlling signal **ON** is switched off. Insert meaning of parameter **P02.04** = 0 for moving in integral work mode. Choose meaning of parameter **P05.01** (time of the rampgenerator) according to requiring device dynamics and inert mass of the load. At high meaning of parameter **P05.01** the motor works with low accelerations.

Switch on the controlling signal **ON** and increase the rotating speed slow and watch the armature voltage by parameter **P01.05,** and wound field current by parameter **P01.06**. Register the voltage when the wound field current starts decreasing and the device enter into the second zone. If the device does not enter the second zone, check if the field wound is connected correct, according to the circuits in fig. 16, fig17, and fig 18 (**do not use phase L1**).

For precise calibrating of the speed feedback give the speed reference 50% of the maximal speed $\mathbf{N_{MAX}}$. Measure the motor rotating speed by a revolution-meter and calculate the ratio of actual speed to maximal motor speed $\mathbf{N_{MAX}}$, in percentage. Compare the calculated ratio to the meaning of parameter **P01.02**. If it is necessary fix the precise meaning of parameter **P01.02,** by the variable resistor **RP5.**

After finishing the adjustments and if there is a controlling device higher level (CNC), to the converter is connected controlling interface. After that the converter is checked in all requiring machine working modes. When all of the requirements are done the machine is ready for work. Switch off the supply voltage and the converter is closed.

If the converter work is not precise enough adjust the armature current regulator, speed regulator and EMF regulator. For the quality of the adjustment is judged by the transients of the armature current characteristic, motor speed.

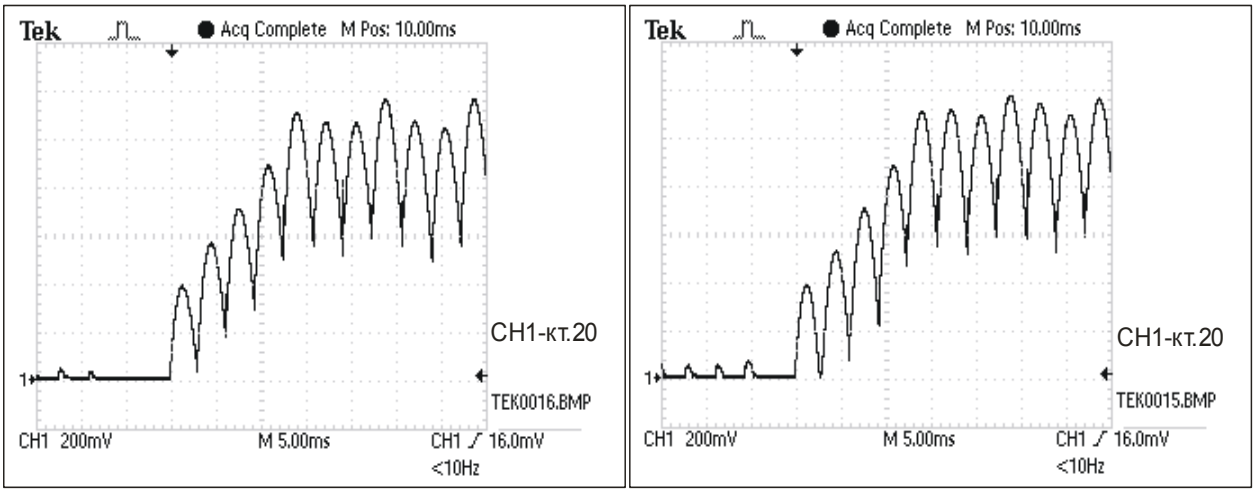
Switch off the supply. Ensure the motor idling including taking apart.

- **Adjusting the armature current regulator**

Switch on the converter supply. Insert the password by parameter **P02.02** = 11. To switch off the rampgenerator insert meaning of parameter **P05.01** = 0. Switch on the controlling signal **ON**.

Give speed reference at a leap from zero meaning to 80 % of the nominal speed. Watch the form of the armature current in controlling point **КТ20** by oscilloscope. The armature current must approaches its maximal meaning to the fourth pulse without visible overregulating, as the amplitude of the fourth and fifth pulse must not be more than stable maximal meaning. After that givezero speed at a leap and watch the armature current form.

The optimal form of the armature current characteristic at lightning acceleration and stopping of the motor is given in fig.24. Pay attention that the armature current is in absolute measurement without a sign.



acceleration stoppng

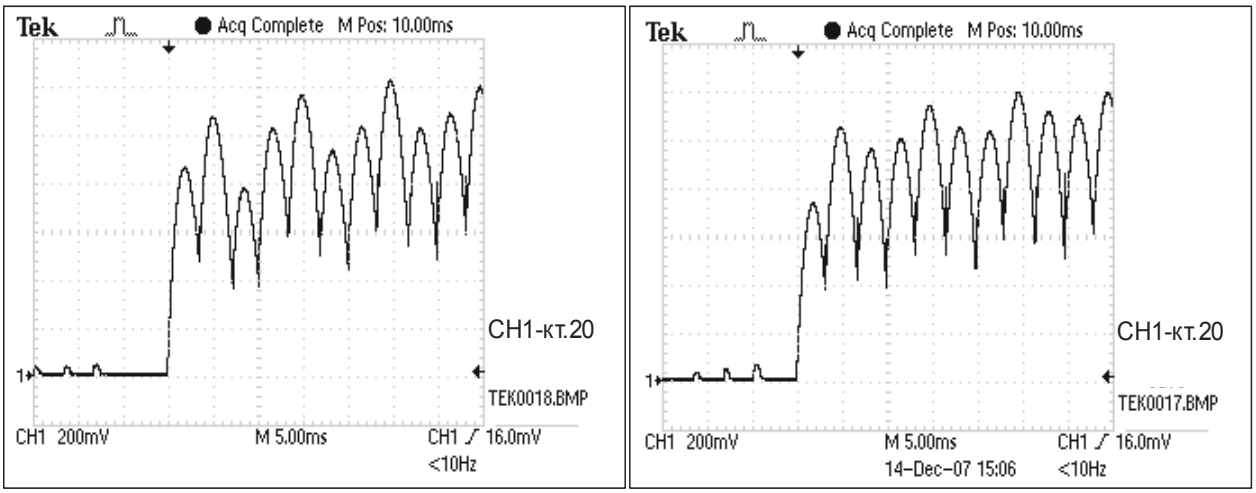
Fig. 24 Form of the armature current characteristic at lightning acceleration and stopping when the adjusting of the armature current regulator is optimal

For adjusting the current regulator use parameters **P06.01** and **P06.02**. The parameters **P06.01** and **P06.02** influence on the work of the current regulator as following:

- Parameter **P06.01** – coefficient of amplification of the poit regulator. Typical meaning of parameter **P06.01** are from 0.10 to 0.50. At high meaning of the parameter **P06.01** the "hard" of the device increases and its tendency to its selfexitation, too. At low meaning of the parameter **P06.01** the time for approaching the stable current;
- Parameter **P06.02** – timeconstant of the current regulator. Typical meanings of parameter **P06.02** are from 12.0 to 40.0 ms. At low meanings of parameter **P06.02** the speed of the current regulator reaction increases and its tendency to selfexcitation increases, too. At high meanings of parameter **P06.02** the time of approaching to the stable current increases.

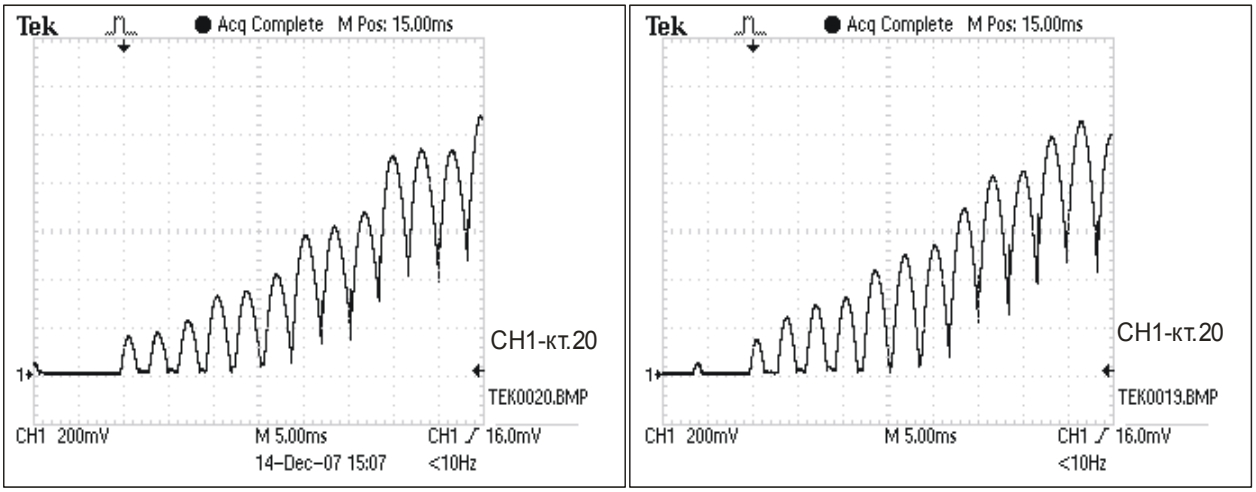
At high meaning of parameter **P06.01** and low meaning of parameter **P06.02** it is watched high current overregulation during the transients. The armature current characteristic with overregulation at lightning acceleration and stopping are given in fig. 25. In this case it is possible the protection **SOC** activates.

At low meaning of parameter **P06.01** and high meaning of parameter **P06.02** it is watched a lasting transient to approaching the stable current. The armature current characteristic at lightning acceleration and stopping with lasting transient are given in fig. 26.



acceleration stopping

Fig. 25 Armature current characteristics with overregulation at high meaning of parameter **P06.01** and low meaning of parameter **P06.02**



acceleration stopping

Fig. 26 Armature current characteristics with lasting transient at low meaning of parameter **P06.01** and high meaning of parameter **P06.02**

- **Adjusting the speed regulator**

After adjusting the current regulator check the speed regulator.

The speed regulator is with adaptive adjustment of its parameters in function of actual speed when **P05.11** = 0 or in function of the speed error when **P05.11** = 1. By understanding the adaptive adjustment of the speed regulator is in function of actual speed. In this case at speeds lower of the nominal speed, i. e. in the first zone, the speed regulator works with higher coefficient of amplification and lower time constant that is approached higher dynamics. At work in the second zone with speeds higher than the nominal and with weakening motor field it is necessary to work with a lower coefficient of amplification and with higher time constant to ensure stable work.

Adjusting the speed regulator is made at two levels – at low rotating speeds in the first zone and at high rotating speed in the second zone.

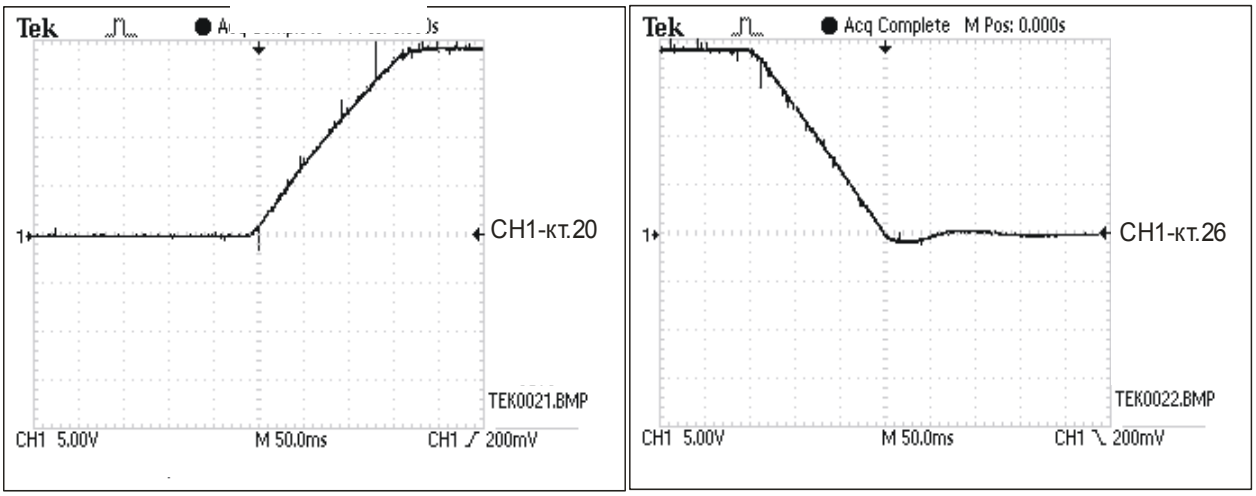
Give a speed reference at a leap from zero meaning to 90 % of the nominal speed. Watch the form of the speed characteristc in control point **КТ26**. It is admissible one leap of the speed that is not more than 5% of the stable meaning. When there are fluctuations in the speed and high overregulations, by parameters **P05.03** to **P05.10** it is adjusted the speed regulator. Parameters influence on the converter work as following:

– Parameters **P05.03** and **P05.04** – coefficients of amplification of the speed regulator. Their typical meanings are from 3 to 30. At high meanings of the parameters the "hard" of the device increases and its tendency to selfexcitation, too. At low meaning of parameters the time for approaching to the given speed increases;
– Parameters **P05.07 and P05.08** – time constants of the speed regulator. Typical meaning s of the parameters are from 40.0 to 500.0 ms. At low meanings of the parameters the reaction speed of the current regulator increases and its tendency to selfexcitation increases, too. At high level of the parameters the time for approaching the given speed increases.

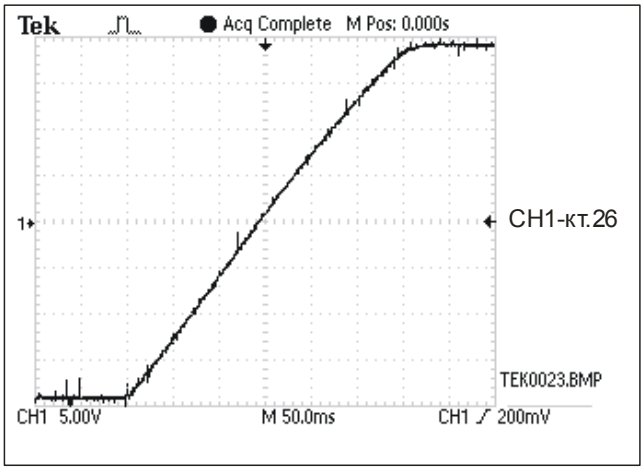
At high meanings of the parameters **P05.03 and P05.04** and low meanings of the parameters **P05.07** and **P05.08** is watched high overregulation of the speed during the transient. At low meaning of the parameters **P05.03** and **P05.04** and high meaning of the parameters **P05.07** and **P05.08** is watched lasting transient to approaching to the given speed.

After that give zero speed at a leap and watch the form of the speed transient.

Transients at speed 90% of the nominal speed (work only in the first zone) for optimal adjusted regulator at acceleration, stopping and reverse of the motor are given in fig.27.



acceleration stopping

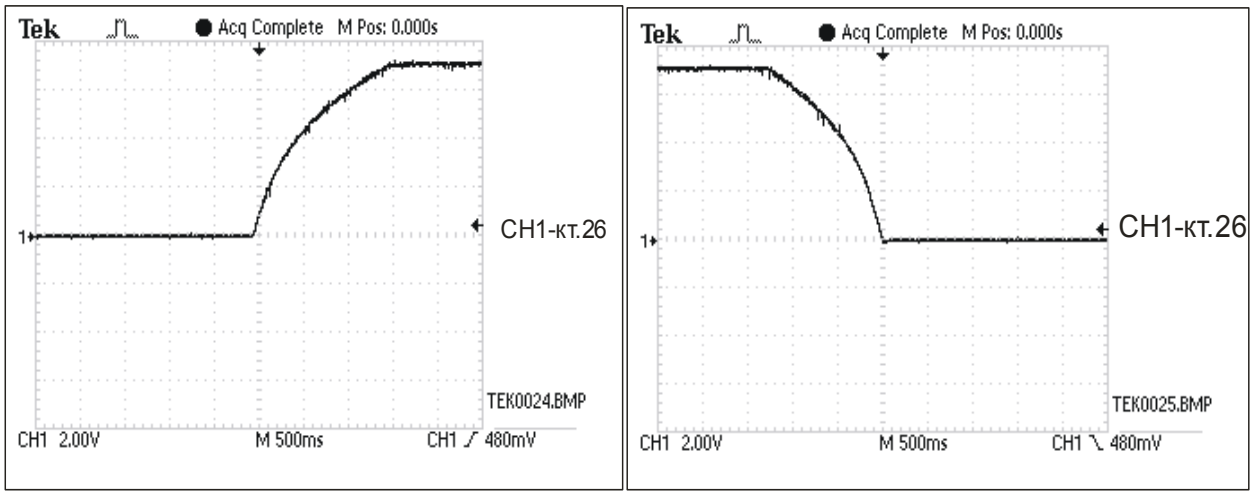


Reverse

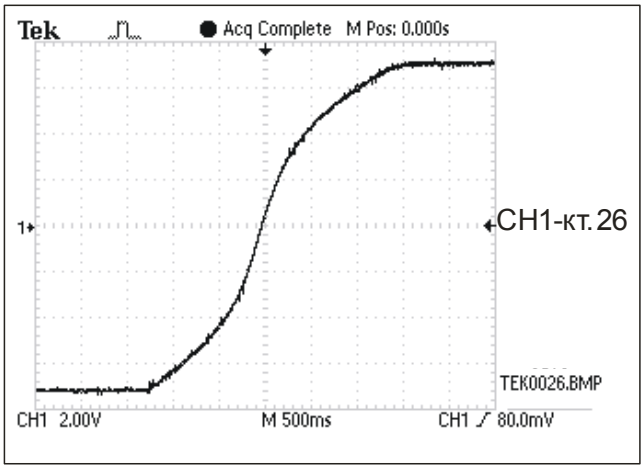
Fig. 27 Characteristics of the speed during the acceleration, stopping, and reverse at optimal adjusting of the speed regulator in the first working zone

Transients at maximal speed for optimal adjusting speed regulator during the acceleration, stopping, and reverse of the motor are given in fig.28.

Check the transients at reference of the maximal speed at a leap to check the device work in the tow zones.



acceleration stopping



Reverse

Fig. 28 speed characteristics at acceleration, stopping, and reverse at optimal adjustment of the speed regulator at maximal speed

The oscillogram at reverse has **S**-figure shape as aresult of the dynamic current limiting of the armature current of the motor which brings to decreasing of the acceleration when the speed increases.

After finishing the adjusting of the current and speed regulators insert meaning of parameter **P05.01** (time of the rampgenerator), according to the required dynamics of the device and the inert load.

- **Adjusting of the EMF regulator**

For adjusting the EMF regulator give the rotating speed 90 % of the maximal speed of the motor and do the reverse of the rotating. Watch the field current at controlling point **KT51** the armature voltage at controling point **KT48** by osciloscope. Optimal diagrams of the armature voltage characteristic and fteld current characteristic are given in fig. 29.

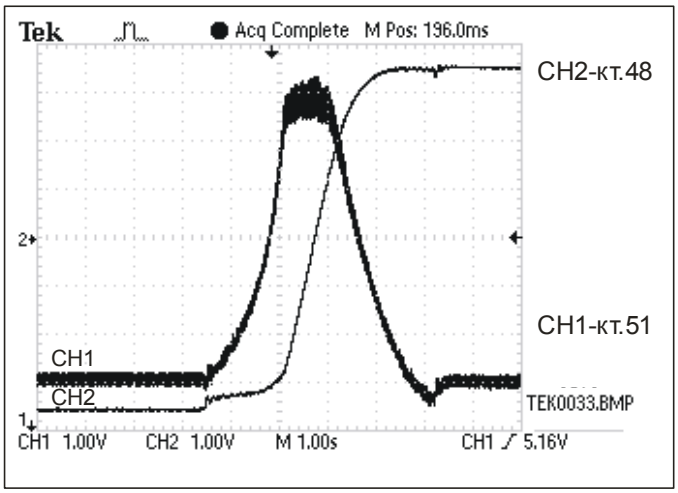


Fig. 29 Form of the armature voltage and field current characteristics at optimal adjustment of the EMF regulator at reverse

For adjusting the EMF regulator use parameters **P07.03** and **P07.04**. Parameters **P07.03** and **P07.04** influence on the EMF regulator work as following:

- Parameter **P07.03** – coefficient of amplification of the EMF regulator. Typical meanings of the parameter **P07.03** are from 1.00 to 5.00. At high meaning of the parameter **P07.03** the tendency to selfexcitation increases. At low meanings of the parameter **P07.03** the overregulation of the armature voltage increases;
- Parameter **P07.04** – time constant of the EMF regulator. Typical meanings of parameter **P07.04** are from 0.05 to 0.50 s. At low meanings of the parameter **P07.04** the reaction speed of the EMF regulator increases and the tendency to selfexcitation increases, too. At high meanings of parameter **P07.04** time to approaching the stable armature voltage increases.

At high meanings of parameter **P07.03** and low meanings of parameter **P07.04** it is watched selfexcitation of the armature voltage during the transient. Armature voltage and field current characteristics with tendency to selfexcitation at reverse are given in fig.30.

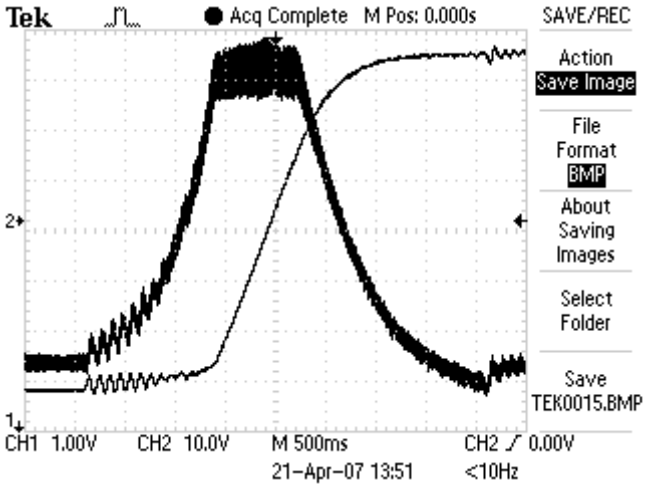


Fig. 30 Armature voltage and field current with tendency to selfexcitation at high meaning of parameter **P07.03** and low meaning of parameter **P07.04**

At low meaning of parameter **P07.03** and high meaning of parameter **P07.04** it is watched overregulation of the armature voltage. Armature voltage and field current characteristics with overregulation are given in fig. 31.

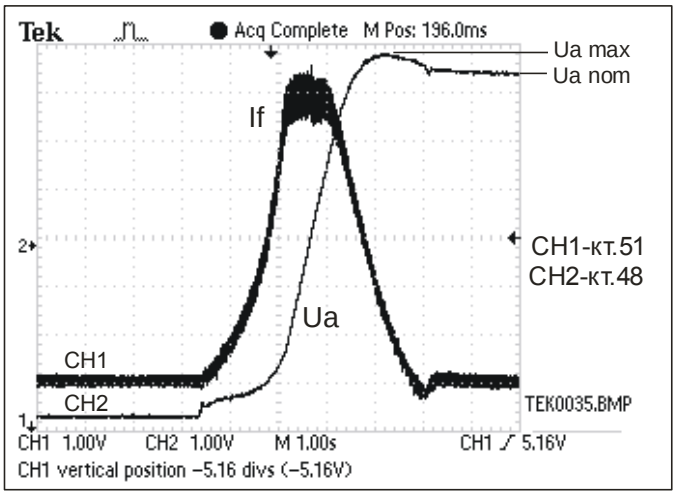


Fig. 31 Armature voltage and field current characteristics with overregulation at low meanings of parameter **P07.03** and high meanings of parameter **P07.04**

When the EMF regulator and field current are adjusted wrong the protection of over voltage of the armature – LED indication **OS** flicks with a period of time 0.3s. In this case it is recommended to start adjusting the EMF regulator at lower rotating speed and it increses gradually.

ATTENTION!

1. The meaning of parameter P04.20 (resistance of the armature circuit Ra), influences strongly on the EMF and it is recommended to insert its real meaning or approximative meaning of Ra from parameter P04.20.

2. For more precise adjustment of the EMF regulator it is recommended to use the adaptive adjustments of the EMF regulator with lower meanings of P05.04 and higher of P05.08.

The converter adjustment finishes.

ATTENTION!

The measurements of all signals is made to the common ground – КТ16.

The terminal numbers of the motor tachogenerator in fig. 16 and fig. 19 coresponds to motors, made in "DINAMO SL" – Sliven town. F_1 and F_2 are lables for beginning and end of the field wound, A_1 – means beginning of the armature coil, B_2 – end of the compensational coil.

9. Possible troubles shootings remedy actions

Name, indication and situations	Possible reason	Method for testing and eliminating the problem
1.When the supply voltage is switched on, the protection SPF activates. LED PF lights constantly.	A phase absences or power and synchronization voltage are out of phase.	Check power and operative supply voltage, if there is in-phase and good quality of the connection. Check the ground.
2. When the device is on and the sinal ON is given, the protection HPF activates. LED PF flicks with aperiod of time 1s.	A phase of the power supply voltage absences.	Check the status of power supply and the quality of the connection.
3.When the power supply voltage is switched on protection FRF activates. LED PF flicks with a period of time 0.3s	The frequency of the mains are out of limits 42 to 68Hz. The synchronization absences.	Check if there are synchronization voltages. Check the mains frequency. Check if there is ± 12V.
4. When the power supply voltage is on and the signal ON is given the current switcher activates.	Thyristor has failed or short circuit in power block.	Disconnect the connection of power supply and motor armature. By ohmmeter check the resistance between terminals U2, V2, W2 to A1,after that to B2 to define the thyristor that has failt.
5. When the device is on and signal ON is given the protection SOC or HOC activates. LED OC lights constantly or flicks with a period of time 1s.	Thyristor has failed, short circuit in motor armature circuit. Synchronization and power voltage are out of phase when the protection HPF (P03.07=0) is off.	Disconnect the connections of power supply and motor armature. By ohmmeter check the resistance between terminals U2, V2, W2 to A1, after that to B2 to define the thyristor that failt. Check the correspondence beween synchronization and power voltage.
6. When the device works at defined speeds the protection OC activates. LED OC lights constantly or flicks with a period of time 1s.	High fluctuations in the speed feedback circuit.	1. Check the quality of the speed feedback in P01.09 at stable working speed and at meanings higher than 2% repair or replace the sensor. 2.If is impossible to repair it is admissible to set in P06.06 from 150 to 200ms.
7. When the device is on, the fuses FUT or FUS have blown.	Thyristor has failed, short circuit in the field blockor motor wound.	Replace the failed thyristor. Diagnostics and repair the motor.
8. When the device is on, the signal ON is given and the reference is giving gradually the fuses FUT and FUS have blown.	Short circuit between motor field and armature. It is appeared when the field is without tansformer.	By ohmmeter check the isolation resistance between field and armature circuits, and at meaning under 2 MΩ, the motor must be repaired.
9. When the signal ON and speed reference are given, in one of the directions at transient the usual "growling" of the motor is heard.	There are "missing" pulses in armature current.	The converter is starting in proportional mode at P02.04=1 and by parameter P01.16 define failed thyristor. Check the circuit of the conyrolling pulses and the thuristor itself.
10. When both signal ON and speed reference are active the motor loaded and the speed "fluctuates".	There is a shunt in the motor armature or in the tachogenerator.	Start the device in proportional mode and the motor starts to rotate as a "step" motor. Switch off the signal ON, and when there is field current rotate the motor shaft by hand. If the resistance moment increases in definite zones it means that there is a shunt in the motor armature. If the resistance moment does not increase that means that the shunt is in tachogenerator.
11. When the speed reference is over the nominal the device is not perform them and the protection **OVM** activates. LED **OS** flicks with a period of time 0.3s	The device does not enter the second zone.	Check the meaming of parameter **P04.03**. Check whetherthe meaning oa parameter **P01.05** is more than the one of **P04.01**. Check the supply phases of the field (do not use phase L1).

Name, indication and situations	Possible reason	Method for testing and eliminating the problem
12. After motor repairing, when it starts, at low speed the device fluctuates the field current and the protection **SFL** activates. LED **FL** lights constantly.	The motor repairing is of poor wuality.	Check the connection of the additional poles and the motor compensation coil.
13. After motor starts at low speed the protection **STG** activates. LED **TG** lights constantly.	The speed feedback (tachogenerator) is absent or the protection adjusting is wrong.	Check the connection of the tachogenerator and its good working order. Increase the meaning of parameter **P03.11**.
14. After the motor starts at low speed the protection **STG** activates**.** LED **TG** flicks with a period of time 1s.	The speed feedback is absent /position – encoder/.	Check the connection of the encoder and its good working order.
15. After activating the signal **ON** the protection **SFL** activates. LED **FL** lights constantly.	Wrong chosen parameters **P04.02** and **P03.12** or fluctuating of the field current regulator.	Check the meaning of parameters **P04.02** and **P03.12**. If it is necessary set the meaning of **P03.12** in range from 120÷130% of **P04.02**. Adjust the field current regulator by parameters **P07.01** and **P07.02**.
16. After activating the signal **ON** and speed reference is near to maximal the protection **SFL** activates. LED **FL** lights constantly.	Wrong chosen parameters **P04.03** and **P03.13**.	Check the meanings of parameters **P04.03** and **P03.13** and if it is necessary set the meaning of **P03.13** in range 70÷90% of the meaning of parameter **P04.03**.
17. After activating the signal **ON** and speed reference is near to maximal the protection **SOS** activates. LED **OS** lights constantly.	Overspeeded maximal speed.	Check the meaning of parameter **P03.14.**
18. During the work the protection **OLF (I^2t)** activates**.** LED **OL** lights constantly.	Overloaded motor.	Check the machine working modes. If it is necessary replace the device with more powerful device. Check the meaning of **P03.08**.
19. During the work the protection **OHF** activates. LED **OL** flicks with a period of time 1s.	Overheated power block.	Switch off and cool the converter. Provide the converter power block with better ventilation.

APPENDIX № 1

Adjusting of the converter nominal current

In cases when it is necessary to use a motor with nominal armature current **Ia_{NOM}**, considerably lower than the nominal current of the converter, for example more than 25%, change the adjustment of the converter nominal current **$Idrv_{NOM}$**. By this the working characteristics of the converter, given in table 1 are the same.

The nominal current of a power block is define by the equivalent meaning parallel connected load resistors **R65**, **R66** and **R67** in the circuit of the secondary coils of the measuring current transformers. Places of the loaded resietors **R65**, **R66** and **R67** of the processor plate is given in fig. 20.

The nominal converter current **$Idrv_{NOM}$**, corresponding meanings of the measuring resistors **R65**, **R66** and **R67** and their equivalent meaning **Reqv** are given in table 15;

$Idrv_{NOM}$	**20**	**30**	**40**	**50**	**60**	**70**	**90**	**110**	**130**	**160**	**200**	**250**	**300**
Rcal	33.5	22.3	16.75	13.4	11.16	9.57	7.44	6.09	5.15	4.18	3.35	2.68	2.23
R65	68	43	51	39	36	30	22	18	15	12	10	8.2	6.8
R66	68	47	51	39	36	30	22	18	15	12	10	8.2	6.8
R67	x	x	51	43	30	27	24	18	16	13	10	8.2	6.8
Reqv	34.00	22.45	17.00	13.40	11.25	9.64	7.54	6.00	15.20	4.10	3.33	2.73	2.26

Table 15 Correspondence between the meaning of resistors **R65**, **R66** and **R67** and the nominal converter current

Notes:

1. The meaning of all resistors in table 15 are in ohms.
2. All resistors with resistance more than 20 Ω must be withpower 0.25W.
3. All resistors with resistance less than 20 Ω must be with power 0.5W.

ATTENTION!

The meaning of parameter P02.06 must correspond to the nominal converter current $Idrv_{NOM}$. If the device works out of this conditions it is possible overheating of the motor.

It is not admissible the meanings of the converter nominal current more than these given in table 1 for a converter. in other case it is possible the power block will be overloaded and the converter will be out of order.

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PASSPORT

THYRISTOR MAIN CONVERTER FOR DC MAIN MOTOR WITH INDEPENDENT EXCITATION

TYPE: ……

S. No: ……..……..

Software: …….

Guarantee card

Name of the device :

“Thyristor main converter for main motor with independent excitation type:…….. ”

Series №: ……..

Date of made: ……..

Guarantee period - 24 months of the date of starting operation, but no more than 27 months of date of made.

Manager : _____
/ /

Guarantee ovligations

1. The produser guarantees good working order of the device when there are not damages during the transport and at conditions of operation, given in user’s manual.
2. The device which is out of order during the guarantee period through producer’s fault is put in o claim.
3. The guarantee falls away if any of the components of the device is repaired by a person without the requisite qualification.
4. The damages made by careless operation and when the device is connected to mains which does not respond to the norms, are at user’s expense.
5. For all questions connected with operation or repairing the device, the client must call the produser.

Set of the delivery

- **Converter** **- 1бр.**
- **User’s manual** **- 1бр.**

Passport **- 1бр.**
Table of parameters **- 1бр.**

TABLE OF PARAMETERS

CONVERTER, TYPE: .....
SERIES №: .....

1. HARDWARE ADJUSTMENT

Power supply voltage .....
Nominal armature current .....
Maximal armature current .....
Maximal armature voltage .....
Nominal wound field current .....
Maximal wound field voltage .....
Tachogenerator .....
Orientation stopping .....
Encoder .....
Rotating speed reference .....
Digital inputs .....
Digital outputs .....

2. SOFTWARE ADJUSTMENT – MEANING OF PARAMETERS

№	Name of the parameter	Limits of variation	Measure	Meaning	New meaning
Group 01 – watching parameters					
P01.01	Current meaning of speed reference	-100.0 ÷ 100.0	% N_{MAX}	-	-
P01.02	Current meaning of actual speed	-110.0 ÷ 110.0	% N_{MAX}	-	-
P01.03	Current meaning of the armature current reference	-270 ÷ 270 % Ia_{NOM}	A	-	-
P01.04	Current meaning of the armature actual current	-270 ÷ 270 % Ia_{NOM}	A	-	-
P01.05	Current meaning of the armature voltage	-600 ÷ 600	V	-	-
P01.06	Current meaning of the wound field current	P04.03 ÷ P03.12	A	-	-
P01.07	Digital reference status	-	code	-	-
P01.08	Digital input status	-	code	-	-
P01.09	Digital output status				
P01.10	Test of the speed feedback	-	% Ubr	-	-
P01.11	Current meaning of the mains frequency	42.00 ÷ 68.00	Hz		-
P01.12	Current maximal deviation in synchronization	-800 ÷ 800	μs	-	-
P01.13	Maximal number recorded breaks in synchronization	0 ÷ 50	-	-	-
P01.14	Maximal number recorded breaks in power supply	0 ÷ 50	-	-	-
P01.15	Current meaning of position error	-	pulses	-	-
P01.16	Power thyristor status	-	bin	-	-
Group 02 – converter parameters					
P02.01	Version of the converter software	-	-	-	-
P02.02	Password of access	11	-	11	-
P02.03	Restore the understanding meaning	0, 1	-	0	-
P02.04	Converter working mode	0, 1	-	0	-
P02.05	Work with weakening field	0, 1	-	1	
P02.06	Scaling the converter nominal current **$Idrv_{NOM}$**	10.0 ÷ 300.0	A	-	
P02.07	Range of the field current sensor	0, 1, 2	-	1	
P02.08	Mode “emergency stopping”	0, 1, 2	-	1	
P02.09	Choice of the speed reference source	0, 1, 2, 3	-	2	

№	Name of the parameter	Limits of variation	Measure	Meaning	New meaning
P02.10	Inner speed reference	-100.00÷100.00	% N_{MAX}	0.00	
P02.11	Choice of speed feedback	0, 1, 2	-	0	
P02.12	Change the speed reference sign	0, 1	-	0	
P02.13	Limitation of the maximal meaning of the speed reference	20.0 ÷ 100.0	% N_{MAX}	100.0	
P02.14	Encoder resolution	500 ÷ 2500	pus./rev.	1024	
P02.15	Rotating directions of motor and encoder in phase	0, 1	-	0	
P02.16	Change the speed feedback sign	0, 1	-	0	
P02.17	Control over torque	0, 1	-	0	
P02.18	Encoder rotating speed at maximal motor speed	0 ÷ 20 000	min^{-1}	3500	
P02.19	Enable switching on of the maximal speed	0, 1	-	0	
P02.20	First maximal speed	0 ÷ 20 000	min^{-1}	3500	
P02.21	Second maximal speed	0 ÷ 20 000	min^{-1}	3500	
P02.22	Third maximal speed	0 ÷ 20 000	min^{-1}	3500	
P02.23	Fourth maximal speed	0 ÷ 20 000	min^{-1}	3500	
Group 03 – protection parameters					
P03.01	Admissible number breaks in synchronization - protection **SPF**	5 ÷ 50	-	5	
P03.02	Maximal number recorded breaks in synchronization - protection **SPF**	0 ÷ 50	-	-	-
P03.03	Maximal admissible deviation in synchronization - protection **SPF**	100 ÷ 800	μs	400	
P03.04	Current maximal deviation in synchronization - protection **SPF**	-800 ÷ 800	μs	-	-
P03.05	Admissible number breaks in mains - protection **HPF**	5 ÷ 50	-	5	
P03.06	Maximal number recorded breaks in mains - protection **HPF**	0 ÷ 50	-	-	-
P03.07	Working mode of protection **HPF**	0, 1	-	1	
P03.08	Time of activating protection **OLF** (**I^2t**) of motor overloaded	0.1 ÷ 60.0	s	10.0	
P03.09	Working mode of protection **OHF**	0, 1	-	0	
P03.10	Converter limit current **$Idrv_{LIM}$** - protection **SOC**	100.0 ÷ 250.0	% Ia_{NOM}	230.0	
P03.11	Armature voltage when the protection **TGF** activates	40.0 ÷ 80.0	% Uamax	50	
P03.12	Wound field maximal current **I_{FLMAX}** – protection **SFL**	> P04.02	A	7.000	
P03.13	Wound field minimal current **I_{FLMIN}** – protection **SFL**	≤ P04.03	A	0.174	
P03.14	Admissible limit current **N_{LIM}** - protection **SOS**	100.0 ÷ 110.0	% N_{MAX}	105.0	
P03.15	Threshold of activating the protection armature overvoltage - protection **OVM**	5.00 ÷ 20.00	% Ua_{MAX}	15.00	
Group 04 – motor parameters					
P04.01	Maximal armature voltage **Ua_{MAX}**	100 ÷ 440	V	400	
P04.02	Wound field nominal current **I_{FNOM}**	0 ÷ 4, 6, 12	A	3.000	
P04.03	Wound field minimal working current **I_{FMIN}**	5.00 ÷ 50.00 % I_{FNOM}	A	0.539	
P04.04	Wound field current **I_{FON}** when the signal **ON** is off	37 ÷ 100 % P04.02	A	1.500	
P04.05	Armature nominal current **Ia_{NOM}**	50 ÷ 100 % $Idrv_{NOM}$	A	34.0	
P04.06	Reserve	-	-	-	-
P04.07	Reserve	-	-	-	-
P04.08	Maximal speed **Nm_1** в т.1	25.0 ÷ P04.10	% N_{MAX}	25.0	
P04.09	Maximal meaning of the armature current **Ia_{MAX}** in p.1	P04.11 ÷ 200	% Ia_{NOM}	200.0	
P04.10	Maximal speed **Nm_2** in p.2	P04.08 ÷ P04.12	% N_{MAX}	40.0	
P04.11	Maximal meaning of the armature current **Iam_2** in p.2	P04.09 ÷ P04.13	% Ia_{NOM}	160.0	

№	Name of the parameter	Limits of variation	Measure	Meaning	New meaning
P04.12	Maximal speed **Nm_3** in p.3	P04.10 ÷ P04.14	% N_{MAX}	60.0	
P04.13	Maximal meaning of armature current **Iam_3** in p.3	P04.11 ÷ P04.15	% Ia_{NOM}	125.0	
P04.14	Maximal speed **Nm_4** in p.4	P04.12 ÷ P04.16	% N_{MAX}	75.0	
P04.15	Maximal meaning of the armature current **Iam_4** in p.4	P04.13 ÷ P04.17	% Ia_{NOM}	110.0	
P04.16	Maximal speed **Nm_5** in p.5	P04.14 ÷ P04.18	% N_{MAX}	90.0	
P04.17	Maximal meaning of the armature current **Iam_5** in p.5	P04.15 ÷ P04.19	% Ia_{NOM}	103.0	
P04.18	Maximal speed **N_{MAX}** in p.6	P04.16 ÷ 100.0	% N_{MAX}	100.0	
P04.19	Maximal meaning of the armature current **Ia_{L6}** in p.6	50.0 ÷ P04.17	% Ia_{NOM}	100.0	
P04.20	Resistance of the armature circuit **Ra**	0.001 ÷ 10.000	Ω	1.200	
P04.21	Resistance of armature circuit - calculated	0.001 ÷ 10.000	Ω	-	-
Group 05 – speed regulator parameters					
Parameter P05.11 = 0 Adaptation vareable – actual rotating speed					
P05.01	Time of the rampgenerator	0.0 ÷ 20.0	s	2.5	
P05.02	Offset of speed reference	-1024 ÷ 1024	discretes	0	
P05.03	Coefficient of amplification of the speed regulator **Кр1**	0.1 ÷ 100.0	-	40.0	
P05.04	Coefficient of amplification of the speed regulator **Кр2**	0.1 ÷ 100.0	-	20.0	
P05.05	Work threshold of the coefficient of amplification **Кр1**	0.00 ÷ P05.06	%	10.00	
P05.06	Work threshold of the coefficient of amplification **Кр2**	P05.05 ÷ 100.00	%	40.00	
P05.07	Time constant of speed regulator **Tn1**	0.010 ÷ 3.000	s	0.300	
P05.08	Time constant of speed regulator **Tn2**	0.010 ÷ 3.000	s	0.500	
P05.09	Work threshold of time constant **Tn1**	0.00 ÷ P05.10	%	10.00	
P05.10	Work threshold of time constant **Tn2**	P05.09 ÷ 100.00	%	40.00	
P05.11	Choice of the adaptation variable	0, 1	-	0	
Parameter P05.11 = 1 Adatation variable – speed error					
P05.01	Time of rampgenerator	0.0 ÷ 20.0	s	2.5	
P05.02	Offset of speed reference	-1024 ÷ 1024	discretes	0	
P05.03	Coefficient of amplification of speed regulator **Кр1**	0.1 ÷ 100.0	-	40.0	
P05.04	Coefficient of amplification of speed regulator **Кр2**	0.1 ÷ 100.0	-	20.0	
P05.05	Work threshold of coefficient of amplification **Кр1**	0.00 ÷ P05.06	%	0.30	
P05.06	Work threshold of coefficient of amplfication **Кр2**	P05.05 ÷ 100.00	%	1.80	
P05.07	Time constant of speed regulator **Tn1**	0.010 ÷ 3.000	s	0.300	
P05.08	Time constant of speed regulator **Tn2**	0.010 ÷ 3.000	s	0.500	
P05.09	Work threshold of time constant **Tn1**	0.00 ÷ P05.10	%	0.30	
P05.10	Work threshold of time constant **Tn2**	P05.09 ÷ 100.00	%	1.80	
P05.11	Choice of the adaptation variable	0, 1	-	1	
Group 06 – armature current regulator parameters					
P06.01	Coefficient of amplification of the armature current regulator	0.01 ÷ 10.00	-	0.45	
P06.02	Time constant of armature current regulator	0.012 ÷ 1.000	s	0.015	
P06.03	Adjusting of the current amplitude of phase **L1**	0 ÷ 128	discretes	0	
P06.04	Adjusting of the current amplitude of phase **L2**	0 ÷ 128	discretes	0	
P06.05	Adjusting of the current amplitude of phase **L3**	0 ÷ 128	discretes	0	
P06.06	Time of the armature current rampgenerator	0 ÷ 500	ms	0	
Group 07 – EMF and field regulators parameters					
P07.01	Coefficient of amplification of the field current regulator	0.01 ÷ 10.00	-	1.50	
P07.02	Time constant of the field current regulator	0.010 ÷ 2.000	s	0.100	
P07.03	Coefficient of amplification of the EMF regulator	0.10 ÷ 10.00	-	4.00	
P07.04	Time constant of EMF regulator	0.010 ÷ 2.000	s	0.150	

№	Name of the parameter	Limits of variation	Measure	Meaning	New meaning
Group 08 – orientation stopping parameters					
P08.01	Position reference source at **ORCM**	0, 1	-	0	
P08.02	Position reference at при **ORCM**	0 ÷ 4096	pulses	0	
P08.03	Offset of given position at **ORCM**	0 ÷ 4096	pulses	0	
P08.04	Current meaning of position error	-	pulses	-	-
P08.05	Offset of the speed reference at **ORCM**	-8.0 ÷ 8.0	discretes	0.0	
P08.06	Orientation stopping direction	0, 1, 2	-	1	
P08.07	Coefficient **K1** of the position regulator	0.000 ÷ 0.500	-	0.125	
P08.08	Coefficient **K2** of the position regolator	0.30 ÷ 16.00	-	1.50	
P08.09	Coefficient **K3** of the position regulator	0.30 ÷ 16.00	-	2.50	
Group 09 – output parameters					
P09.01	Speed threshold $\mathbf{N_{ZS}}$, under which protection **ZS** activates	0.5 ÷ 3.0	% N_{MAX}	2.0	
P09.02	Speed threshold $\mathbf{N_{SA}}$, over which protection **SA** activates	70.0 ÷ 95.0	% N_{REF}	85.0	
P09.03	Work mode of output **SA**	0.0 ÷ 20.0	% N_{MAX}	2.0	
P09.04	Maximal armature current $\mathbf{Ia_{TLH}}$ at signal **TLH**	10.0 ÷ 100.0	% Ia_{NOM}	50.0	
P09.05	Maximal armature current $\mathbf{Ia_{TLL}}$ at signal **TLL**	1.0 ÷ 100.0	% Ia_{NOM}	20.0	
P09.06	Admissible deviation of given position when output **INPOS** activates	0 ÷ 63	pulses	16	
P09.07	Work mode of ready output **RD**	Mode RD	0, 1		
P09.08	Choice of the variable of analog output **AOUT1**	0 ÷ 9	-	0	
P09.09	Choice of the variable of analog output **AOUT2**	0 ÷ 9	-	1	
Group 10 – terminal parameters					
P10.01	Adjusting terminal language	0, 1, 2	-	0	
P10.02	Time of indication refreshing	1 ÷ 1000	ms	1000	
Group 11 – error history					
P11.01	error 1	-	-	EMPTY	-
P11.02	error 2	-	-	EMPTY	-
P11.03	error 3	-	-	EMPTY	-
P11.04	error 4	-	-	EMPTY	-
P11.05	error 5	-	-	EMPTY	-
P11.06	error 6	-	-	EMPTY	-
P11.07	error 7	-	-	EMPTY	-
P11.08	error 8	-	-	EMPTY	-
P11.09	error 9	-	-	EMPTY	-
P11.10	error 10	-	-	EMPTY	-
P11.11	Error reset	0, 1	-	0	-

Examiner:	**Sign:**	**Date:**