USER'S MANUAL

SERIES 12XXX DIGITAL THYRISTOR CONVERTER FOR DC SERVO MOTOR

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Contents

1. General description

Series 12XXX are a new generation intelligent thyristor converters based on modern DSP/CPLD technologies. They are fed directly by the power mains and provide precise four quadrants speed control of motors. A reconfiguration of the converter concerning control loops, type of the used motor protections is performed by means of a specialized keypad terminal or PC (personal computer) via serial interface along with the use of system of parameters.

The converters of 12XXX series are designated for universal functioning and can be built - in any machine regarded as highly requirements to the electrical drive. They also have specialized incorporated interface for the control of the feeding axis in CNC – controlled machine tools and industrial robots.

2. Operating instructions, storage and transportation

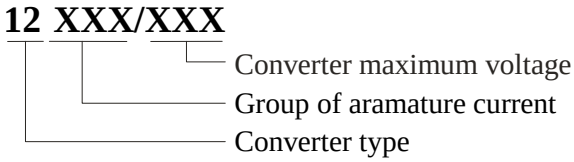
Thyristor converter series 4XXX can work, can be storage, and be transported in these conditions:

- Indoor temperature from 5º C to 50º C;
- Maximum relative humidity at 30ºC 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 35 Hz and acceleration less than 4.9 m/s^2.

3. Technical features

The converters of 12XXX series are arranged according to rated armature current and maximum voltage on the output of the converter.

Technical data are as shown on **table 1**.



Structure of signification

Converter type:	12010/130	12010/250	12030/130	12030/250	12080/250
Rated Armature current, A	12	12	31	31	80
Maximal armature current, A	60	60	155	155	400
Input power voltage[1], V	3x120	3x220	3x120	3x220	3x220
Input Frequency, Hz	45 ÷ 65				
Maximal armature voltage, V	130	250	130	250	250
Power contactor and dynamic braking	built in				external
Dynamic current limitation or armature current	programmable				
Range of speed control	1: 10 000				
Speed feedback	Tachogenerator or encoder				
Maximal voltage of tachogenerator, V	±120				
Analogue input	± 10V, 10k Ω				
Digital inputs	2 inputs, ±24V / 10mA				
Digital outputs	2 outputs relay type , $100V_{AC}$/0.3A, 24 V_{DC}/0.3A				
Serial interfaces[2]	RS 232C to 9600 bps RS 422 and RS 485 to 115 200 bps				
Working condition	Long lasting S1				
Degree of protection	IP20				
Measurements HxWxL, mm	350x131x176,5				405x156x 176,5

Table 1 Technical data

Notes:

[1] – It refers to the power voltage feeding the power rectifier of the armature;

[2] – Serial interface **RS 422** and **RS 485** are options which are assembled on order by the client.

4. Installation and dimensions

The components of the converters of 12XXX 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 on left side of the box. The processor control board together with the interface terminals and indications are installed perpendicular to the front panel. The dimensions and the locations of the interface and power terminals are given on **figure 1** and **figure 2**.

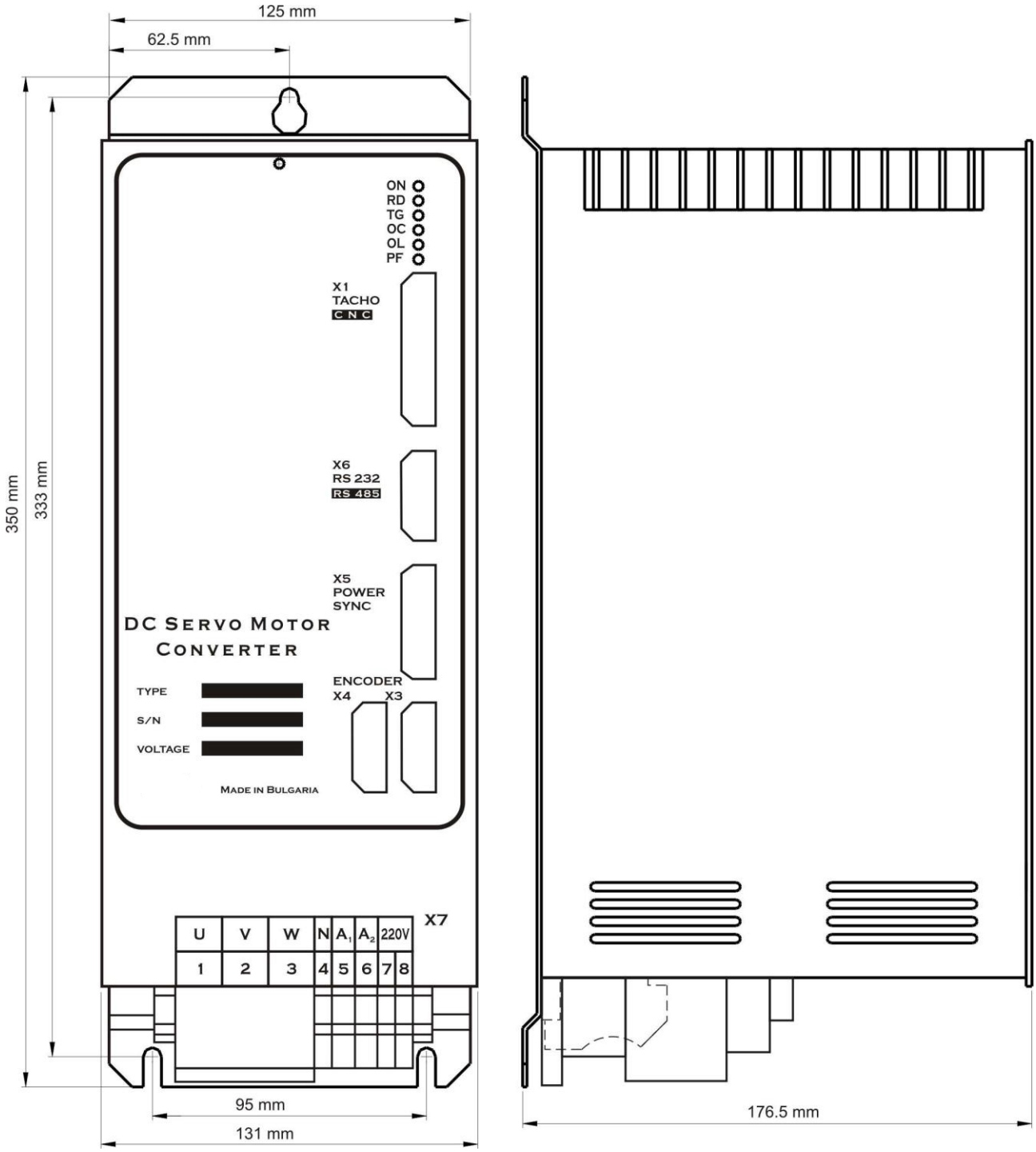


Figure 1 Connecting and overall dimensions of converters type 12010 and type 12030

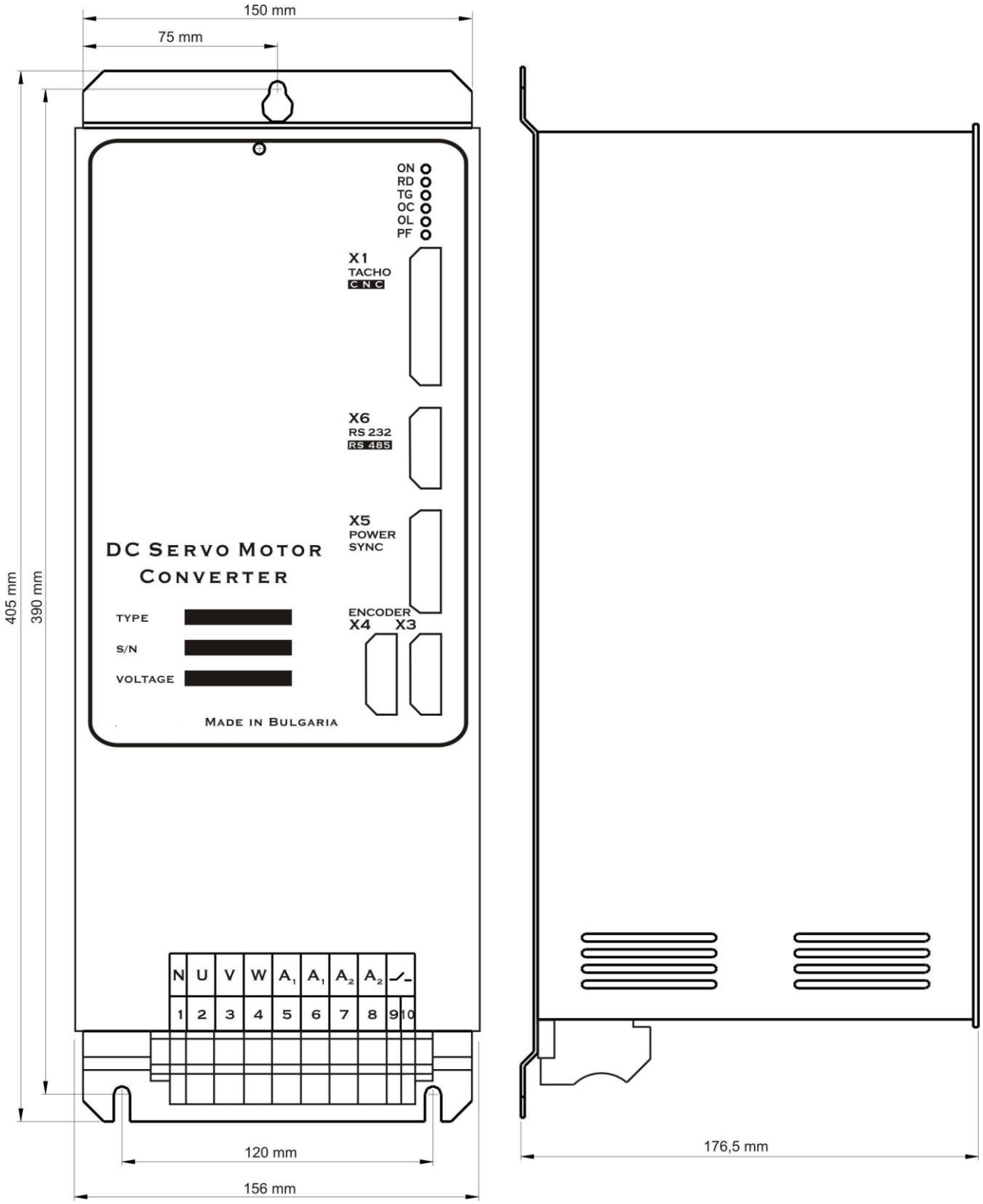


Figure 2 Connecting and overall dimensions of converters type 12080

On **figure 3** is shown convertor construction type 12010 and 12030 where different elements are placed.

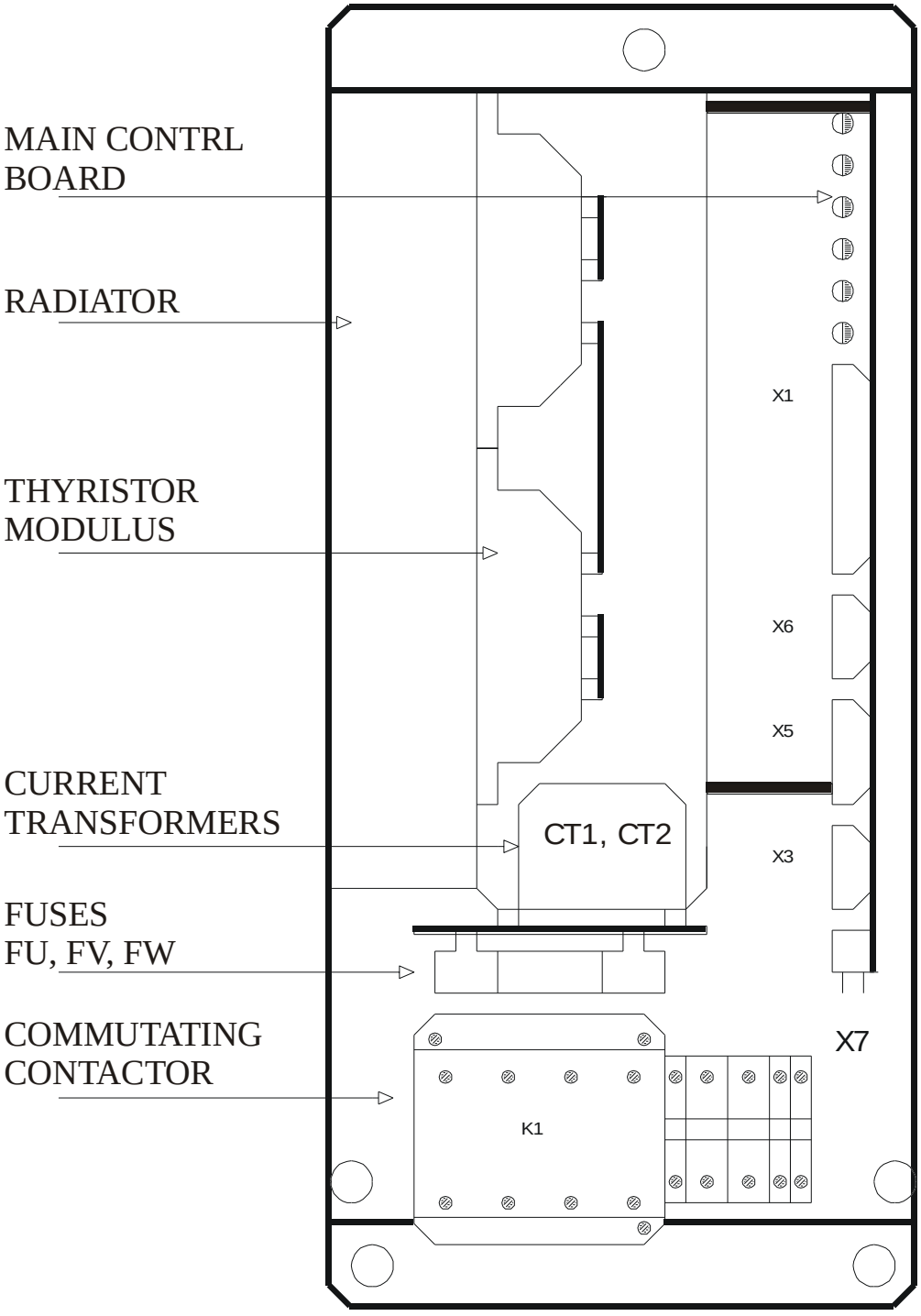


Figure 3 Converter type 12010 and 12030 elements positions

On **figure 4** is given converter construction type 12080 where different elements are placed.

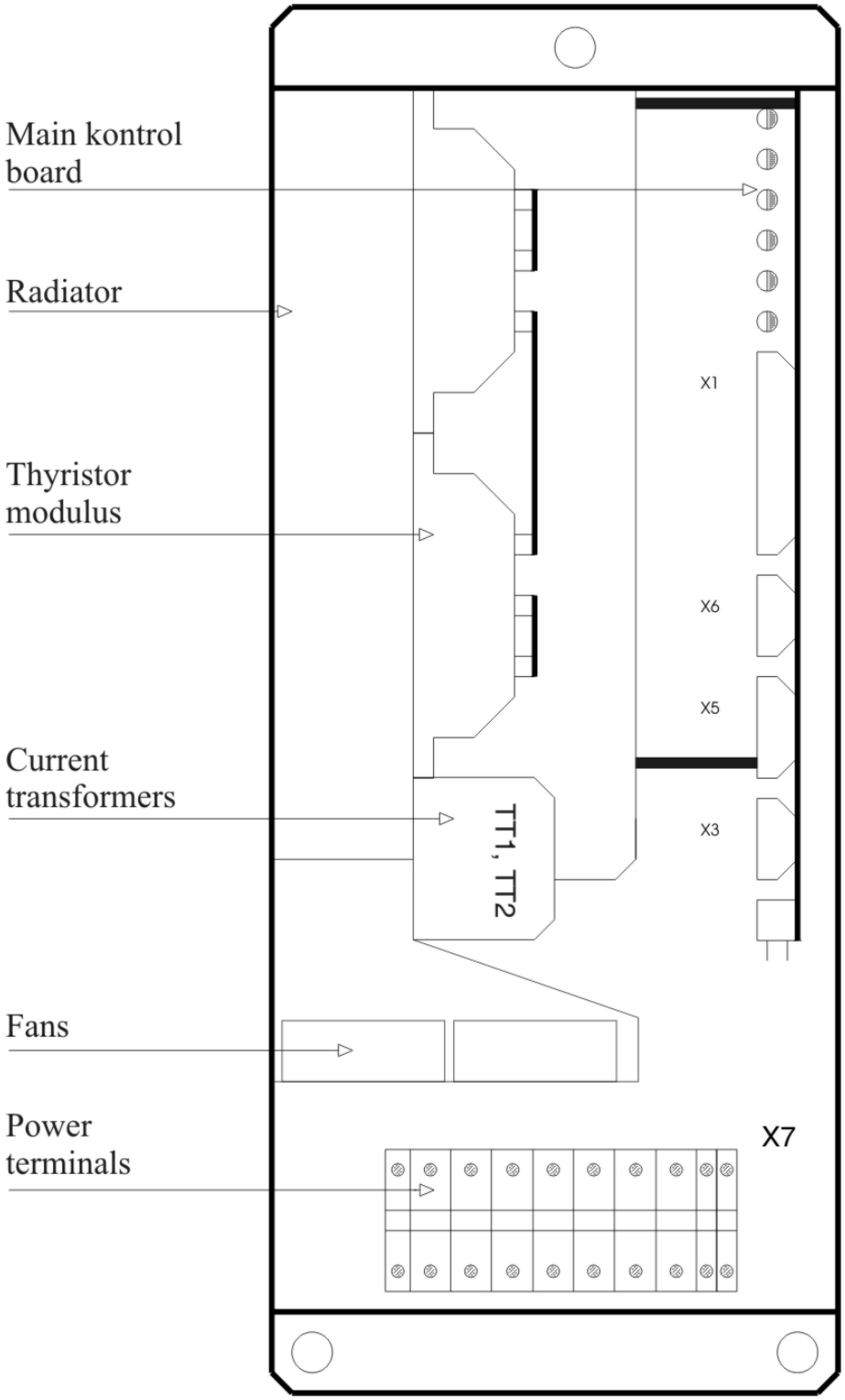


Figure 4 Positions of elements of converter type 12080

5. Interface and converter statues indication

5.1 X1 signal's interface

The signal's interface consists of:

– 2 digital inputs, galvanic isolated, voltage ± 24V_{DC}, input current to 10 mA. Input signal low level from 0 to 7V, and high level from 13 to 30V. They are used for control converter work;

– 2 digital outputs, relay type carrying capacity 0,3 A at 100 V_{AC}, and 0,3 A when voltage is 24 $V_{DC.}$ They show to the outside control device moment status of the converter;

– Differential analog input **Uref**. It is used to set motor speed rotating with analog bipolar signal;

– Analog input **Ubr** for tachogenerator;

– Inner voltage of converter **+12V** (X1.10) and **-12V** (X1.23).

Signal's interface **X1** is placed on 25 pins terminal at the upright side of the face panel.

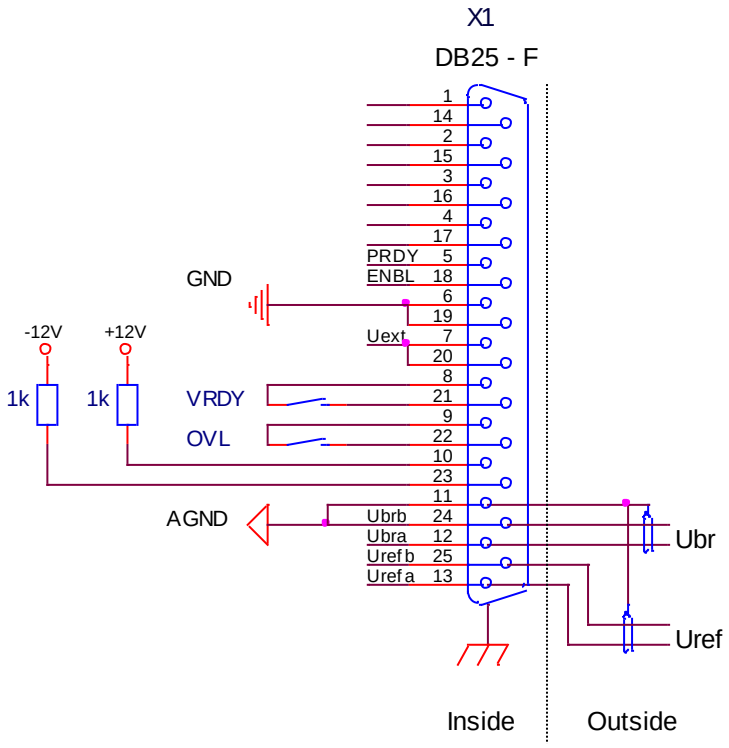


Figure 5 Description of signals and pins of the terminal signal's interface **X1**

Interface X1: Connector DB25 - F									
№	**Signal**	**№**	**Signal**	**№**	**Signal**	**№**	**Signal**	**№**	**Signal**
1	-	6	GND	11	AGND	16	-	21	VRDY1
2	-	7	+24 Vext	12	Ubra	17	-	22	OVL1
3	-	8	VRDY2	13	Urefa	18	ENBL	23	-12 Vint
4	-	9	OVL2	14	-	19	GND	24	Ubrb
5	PRDY	10	+12 Vint	15	-	20	+24 Vext	25	Urefb

Table 2 Description of signals and pins of the interface **X1**

5.1.1 Digital inputs

• **PRDY** (X1.5) – when command **PRDY** is received the built-in power contactor **K1** switches on. For converter type 12080 contactor **K1** is external and when command **PRDY** is received the relay contact X7.9-X7.10 closes. Then check about availability and correspondence of power synchronize voltage. When the converter is ready LED (Light Emitting Diode) indication **RD** lights in mode of constant lighting and relay output **VRDY** activates. When there is any error, the converter enters an emergency mode. When there is an emergency mode, the converter is ready after a second command **PRDY**.

Firstly, after switching the converter power supply to receiving the control signal **PRDY**, it is performed checking if there are the synchronizing voltages and the frequency of the power mains. If this checking is successful the indication **RD** activates in flicking mode;

Attention: It is recommended command **PRDY** to be in the function of emergency system of the machine and switch off when the emergency system activates. After failing of command **PRDY** the power contactor switches off and dynamic motor stopping activates. When the emergency system of the machine is repaired command **PRDY** restores and servo converter is ready.

• **ENBL** (X1.18) – converter work is available. When command **ENBL** is received converter work is available, power part is activated. LED **ON** lights and if any protection is not activated the speed reference is performed. Command **ENBL** performs only when status READY is approached and **VRDY** activates.

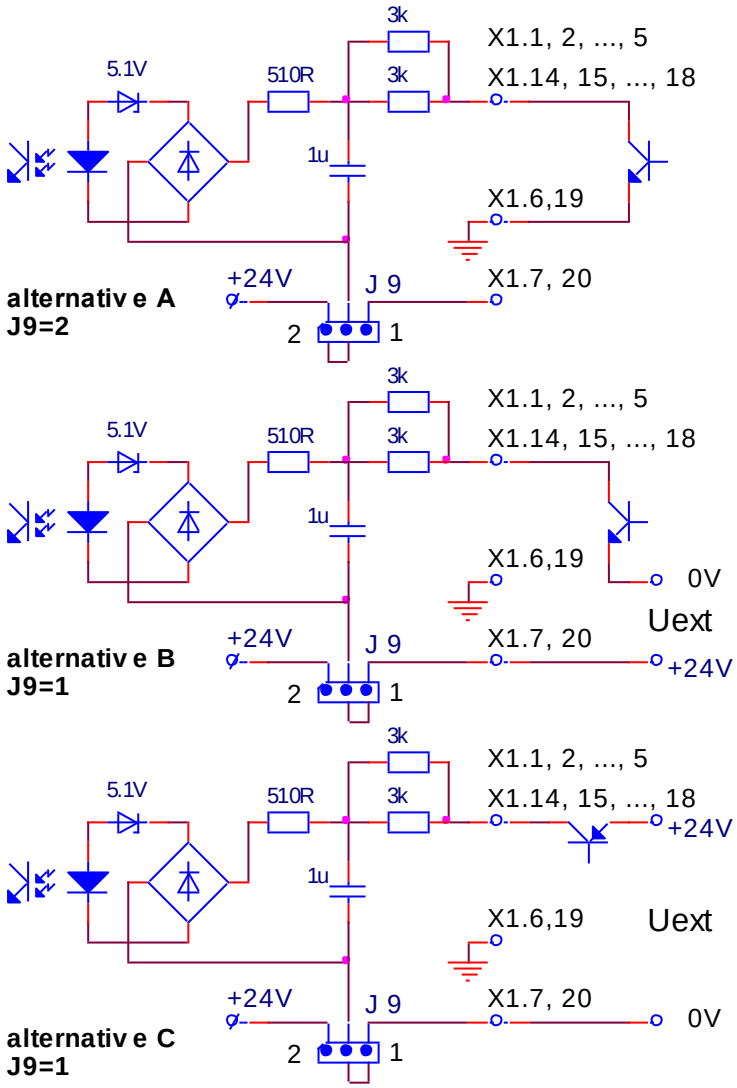


Figure 6 Structure of digital inputs

Power supply of digital inputs can be performed:

– Inner operative voltage **24V DC** of converter when shunt **J9** = INT, as it is given on **figure 6**, version **A**. In this case digital inputs can be selected by system outputs type **N**;

– External operative voltage **Uext** = 24 V DC when shunt **J9** = EXT, how is shown on **figure 6**, **version B** and **C**. On **figure 6** version **B** is shown selecting digital inputs of system output type **N** and on **figure 6**, **version C** – system output type **P**.

Place of shunt **J9**, by which it is selected the power source of digital inputs, is given on **figure 22**.

5.1.2 Digital outputs

• **VRDY** (X1.8, X1.21) – converter is ready. When command **PRDY** is received and there is no active protection, the converter is ready, and LED indication **RD** lights in mode of constant lighting. When

converter is ready relay output **VRDY** closes. When any of the protection switches, the readiness of the converter falls and relay output **VRDY** opens;

- **OVL** (X1.9, X1.22) – overloaded of converter. Relay output **OVL** is normally closed when the converter is ready. When there is overloaded or protection **OLF (I^2t)** or **OHF** activates, relay contact **OVL** opens, then the converter is not ready and relay output **VRDY** also opens.

5.1.3 Differential analog input

Differential analog input **Uref** (X1.13, X1.25) is used to set rotation speed of the motor by analog bipolar signal.

Range of input voltage of the differential analog input is ±10V when input resistance is no less 10 K.

5.1.4 Analog input for tachogenerator

Analog input for tachogenerator **Ubr** (X1.12, X1.24) is used in case when feedback speed sensor is tachogenerator, when parameter **P02.11** = 0.

On **figure 7** is given electrical circuit of analog input for speed feedback with tachogenerator. Changing the range of feedback input is performed by shunts **A1, A2, A3, A4, J5** and **J6**. In **table 3** is given shunt status for different range of analog input for speed feedback. Precise adjustment of the speed feedback in range ±10% for each range chosen by corresponding combination of shunts **A1, A2, A3, A4, J5** and **J6** is performed by trimmer **RP5**.

Place of shunts **A1**, **A2**, **A3**, **A4**, **J5** and **J6**, also trimmer **PR5**, by which it is chosen and adjusted the range of maximum voltage of the analog input for the tachogenerator, is given on **figure 22**.

№	J6	J5	A1	A2	A3	A4	Ubr RP5 in the middle
1	1	1	1	1	1	1	5,7
2	0	1	1	1	1	1	7,4
3	1	0	1	1	1	1	9,0
4	0	0	1	1	1	1	10,7
5	1	1	0	1	1	1	12,4
6	0	1	0	1	1	1	14,0
7	1	0	0	1	1	1	15,8
8	0	0	0	1	1	1	17,4
9	1	1	1	0	1	1	19,2
10	0	1	1	0	1	1	20,8
11	1	0	1	0	1	1	22,5
12	0	0	1	0	1	1	24,2
13	1	1	0	0	1	1	25,9
14	0	1	0	0	1	1	27,6
15	1	0	0	0	1	1	29,2
16	0	0	0	0	1	1	30,9
17	1	1	1	1	0	1	32,6
18	0	1	1	1	0	1	34,1
19	1	0	1	1	0	1	35,9
20	0	0	1	1	0	1	37,5
21	1	1	0	1	0	1	39,2
22	0	1	0	1	0	1	40,9
23	1	0	0	1	0	1	42,6
24	0	0	0	1	0	1	44,2
25	1	1	1	0	0	1	46,0
26	0	1	1	0	0	1	47,6
27	1	0	1	0	0	1	49,3
28	0	0	1	0	0	1	51,0
29	1	1	0	0	0	1	52,7
30	0	1	0	0	0	1	54,3
31	1	0	0	0	0	1	56,0
32	0	0	0	0	0	1	57,7
33	1	1	1	1	1	0	59,5
34	0	1	1	1	1	0	61,1

№	J6	J5	A1	A2	A3	A4	Ubr RP5 in the middle
35	1	0	1	1	1	0	62,8
36	0	0	1	1	1	0	64,5
37	1	1	0	1	1	0	66,3
38	0	1	0	1	1	0	68,0
39	1	0	0	1	1	0	69,8
40	0	0	0	1	1	0	71,3
41	1	1	1	0	1	0	73,0
42	0	1	1	0	1	0	74,7
43	1	0	1	0	1	0	76,4
44	0	0	1	0	1	0	78,0
45	1	1	0	0	1	0	79,8
46	0	1	0	0	1	0	81,4
47	1	0	0	0	1	0	82,1
48	0	0	0	0	1	0	84,7
49	1	1	1	1	0	0	86,5
50	0	1	1	1	0	0	88,1
51	1	0	1	1	0	0	89,8
52	0	0	1	1	0	0	91,4
53	1	1	0	1	0	0	93,2
54	0	1	0	1	0	0	94,8
55	1	0	0	1	0	0	96,5
56	0	0	0	1	0	0	98,2
57	1	1	1	0	0	0	99,9
58	0	1	1	0	0	0	101,5
59	1	0	1	0	0	0	103,2
60	0	0	1	0	0	0	105,0
61	1	1	0	0	0	0	106,6
62	0	1	0	0	0	0	108,2
63	1	0	0	0	0	0	109,9
64	0	0	0	0	0	0	111,6

Table 3 Voltage of the tachogenerator, when speed is maximum and reference is maximum

Note: Fields with **1** mean that there is a shunt.

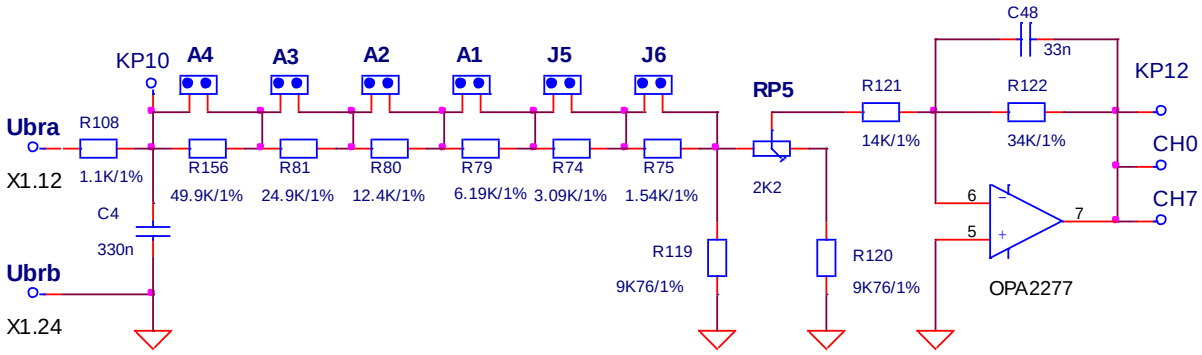


Figure 7 Structure of analog input for tachogenerator **Ubr**

5.1.5 Others

• **AGND** (X1.11,24) – analog ground. In relation to it all analogue signals are defined, including the feedback speed signal when tachogenerator is used;

• **+12V** (X1.10) and **-12V** (X1.23) – inner operating voltage. They are used to form bipolar voltage for motor speed by external variable resistor as it is given, on **figure 21**. When resistance of resistor is equal to 10 K, range of variety of voltage is ±10V.

5.2 Interface X3 and X4 for encoder

Interface for encoder **X3** is lead to 9 pins terminal at the bottom of face panel of converter. Scheme of input part of channel for encoder and correspondence of interface **X3** signals to pins of the terminal are given on **figure 8** and **table 4**. Converter works with encoder as a sensor of speed feedback when parameter **P02.11** = 1.

Interface **X4** is an extension of encoder interface **X3** and gives an access to encoder signals by other device. The correspondence between the signals of the interface **X4** and the terminal pins is given on **figure 8** and in **table 5**.

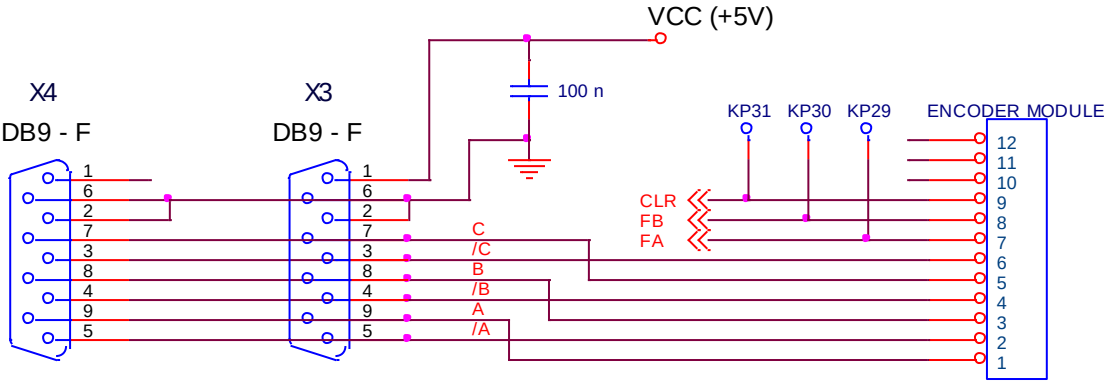


Figure 8 Electrical circuit and place of interface **X3** pins for encoder and its extension **X4**

Interface X3: Connector DB9 - F					
№	**Signal**	**№**	**Signal**	**№**	**Signal**
1	Vcc = +5V	4	/B	7	C
2	GND	5	/A	8	B
3	/C	6	GND	9	A

Table 4 Correspondence between signals and interface **X3** pins

Interface X4: Connector DB9 - F					
№	**Signal**	**№**	**Signal**	**№**	**Signal**
1	-	4	/B	7	C
2	GND	5	/A	8	B
3	/C	6	GND	9	A

Table 5 Correspondence between signals and interface **X4** pins

5.3 Interface of operative supply and synchronizing

Interface **X5** for operative supply and synchronizing consists of :

- Inputs **UPL1, UPL2** and **UPL3** for operative supply and synchronizing;
- Inputs **USL1, USL2** and **USL3** for converter synchronizing;
- Input **TOH** for contact temperature sensor of power transformer.

Electric circuit of the interface **X5** is given on **figure 9**. Correspondence between interface **X5** signals and terminal pins are given on **table 6**.

Interface **X5** for operative supply and synchronizing is lead on 15 pins terminal.

5.3.1 Operative supply of converter control block

Operative supply of converter control block is connected to **UPL1**(X5.8), **UPL2**(X5.7) and **UPL3**(X5.6) of interface **X5**. Scheme of the rectifiers for supply of converter control is given on **figure 9**.

Operative supply of converter must ensure lineal voltage 3x320V+10/-15% phase voltage 3x18V +10/-15%.

For operative supply can be used:

– Additional three phase coil of power transformer. It is possible using phase opposite connected coils with common lead and phase voltage 2x18V, as it is given on **figure 15**. In this case the operative supply coil can not be used for converter synchronizing.

– Three-phase coil of additional low-powered three-phase transformer;

– Three-phase coil consists of secondary coils of low-powered mono-phase transformers.

There is no requirement about in phase of coil of operative supply with power secondary coil of supply transformer only have to ensure needed lineal operative voltage for normal work. Synchronizing voltage are ensure by separate coil of power transformer when shunts **J1** = **J2** = **J3** = 1.

When operative supply of control block is used of synchronizing of converter it needs to observe requirements given in **p.5.3.2**.

5.3.2 Converter synchronizing

Converter synchronizing can be made by voltage of separate three-phase coil or by voltage of operative converter supply coil. Synchronizing voltage must be in phase with voltage of power secondary coil which supply power rectifier.

Connecting type of synchronizing coil is defined by the rules for synchronizing and by the type of connecting of first and secondary power coils of power transformer. Possible versions of synchronizing coil connection according to power coil connection are given in **Appendix 2**.

For converter synchronizing must be used lineal voltage 3x(26 ÷ 95)V +10/-15% (phase voltage 3x(15÷55)V+10/-15%).

Choice the source of synchronizing is made by shunts **J1, J2** and **J3**, which are placed on processor plate, given on **figure 22**.

Principal scheme of electrical circuit for forming synchronizing pulses is given on **figure 9**. Trimmer resistors **RP1, RP2** and **RP3** are for additional adjustment phase of synchronizing pulses if it is necessary.

When shunts are **J1 = J2 = J3** = 1 synchronizing is made by voltage of separate three-phase coil for synchronizing connected to **USL1**(X5.3), **USL2**(X5.2) and **USL3**(X5.1) of interface **X5**.

When shunts are **J1 = J2 = J3** = 2 synchronizing is made by voltage of three-phase coil for operative supply connected to **UPL1**(X5.8), **UPL2**(X5.7) and **UPL3**(X5.6) of interface **X5**.

Coil for synchronizing or coil for operative supply when it is used for synchronizing can be performed like:

– Separate three-phase coil of power transformer .Version with separate coils of power transformer for synchronizing and operative supply is given on **figure 15.** On **figure 16** is given version with common coil of power transformer for synchronizing and operative supply. On **figure 18** is given version with common coil for synchronizing and operative supply when it is used a power autotransformer.

– Three-phase coil of additional three-phase low-powered transformer. This version is used in cases when there is a power transformer but it is impossible to make an additional coil for synchronizing and it is given on **figure 17**;

– Three-phase coil consisted in secondary coils of low-powered mono-phase transformers. This version is used in cases when there is a power transformer but it is impossible to make additional coil for synchronizing. Versions with using of low-powered mono-phase transformer for synchronizing and operative supply of control block are given on **figure 19** and **figure 20**. To be in phase of coil for synchronizing and power secondary coil are used versions of coil connecting given in **Appendix 2**.

5.3.3 Input for external temperature sensor TOH

Input **TOH**(X5.11, X5.12) is for connecting outer contact temperature sensor for protection of power transformer from overheating. When shunt **J4** is out, given in **figure 9**, contact temperature sensor is sequent connected to output **OVL**. Place of shunt **J4** on the processor plate is given on **figure 22**. For temperature lower than temperature of activating the contact of temperature sensor must be normally closed.

Interface X5: Connector DB15 - M									
№	**Signal**	**№**	**Signal**	**№**	**Signal**	**№**	**Signal**	**№**	**Signal**
1	USL3	4	-	7	UPL2	10	AGND	13	-
2	USL2	5	-	8	UPL1	11	TOH1	14	AGND
3	USL1	6	UPL3	9	AGND	12	TOH2	15	AGND

Table 6 Correspondence between signals and pins of interface **X5**

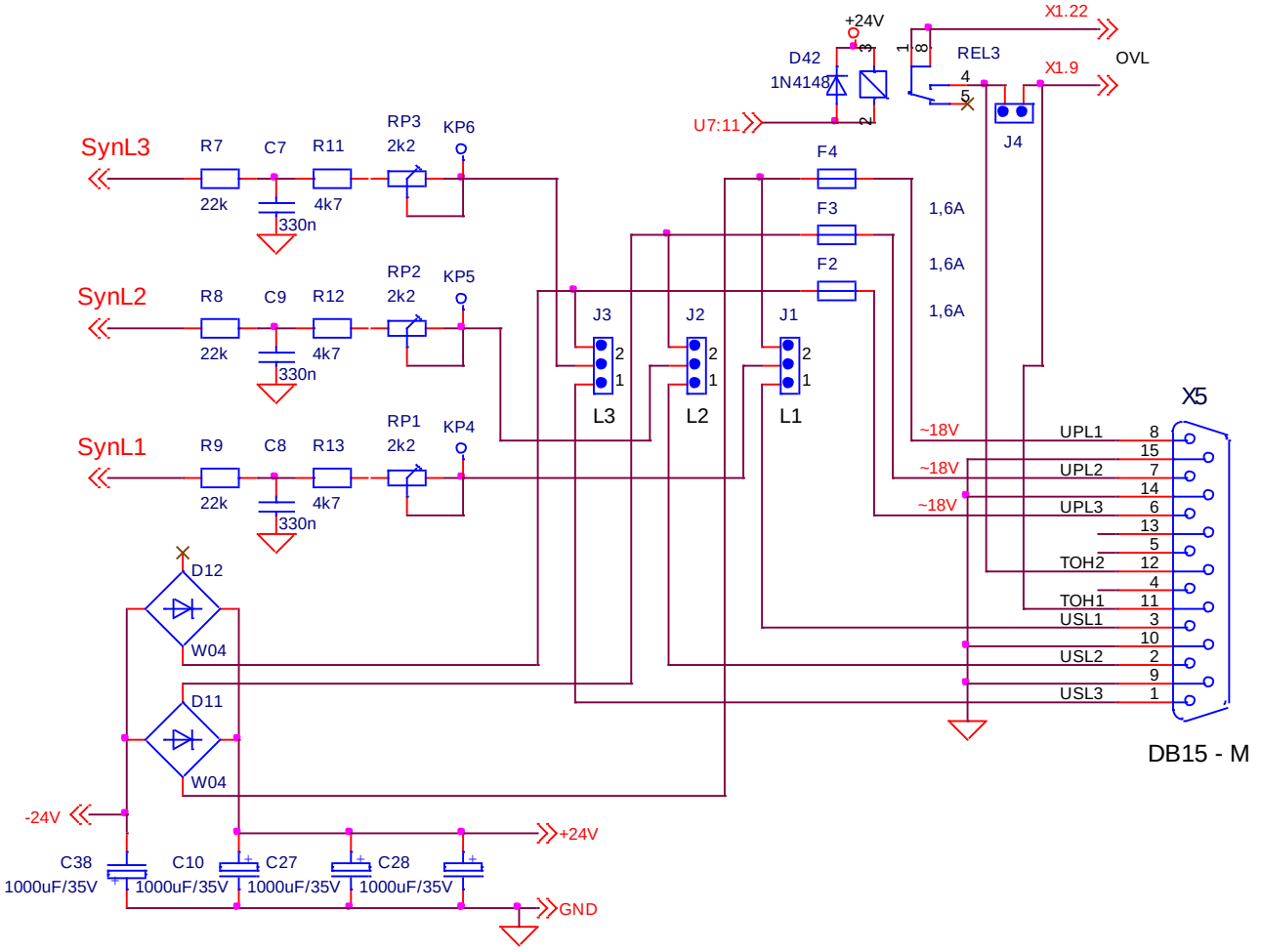


Figure 9 Principle scheme and pins of interface **X5** for synchronizing and operative supply of converter control

5.4 Serial interface X6

Physical realization of serial interface is standard **RS232C**, worked with 9600 bps. Serial interface **RS232C** is used by specialized terminal to adjusting parameters. For work with specialized terminal of the connector is lead system voltage +5V(X6.9).

Serial interface **RS422** and **RS485** are options.

The serial interface **X6** is connected with a 9 pins male connector. The correspondence between the signals and the pins of the connector is given on **figure 10** and in **table 7**.

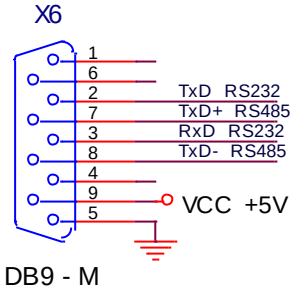


Figure 10 Scheme and pins placed of serial interface **X6**

Interface X6: Connector DB9 - M					
№	**Сигнал**	**№**	**Сигнал**	**№**	**Сигнал**
1	-	4	-	7	TxD– RS485
2	TxD RS232	5	GND	8	TxD+ RS485
3	RxD RS232	6	-	9	Vcc = +5V

Table 7 Correspondence between signals and pins of interface **X6**

5.5 Power interface X7

Power interface **X7** is lead on screw terminals connects converter to power transformer, the DC motor and external protective and contact devices.

Power interface **X7** consists of:

– Supply **U,V** and **W** on power part of the converter;

– Supply **A1** and **A2** on the armature of the DC motor;

– Supply operative circuit of the built-in contactor **K1** for commutation of power supply of voltage and dynamic stopping circuit for converter type 12010 and 12030;

– Relay output for operative control of external contactor **K1** for commutation of power supply voltage and dynamic stopping circuit of converter type 12080.

On **figure 11** is given principal scheme of power block with circuit for control of thyristors and power interface **X7** for converter type 12010 and 12030, and on **figure 12** – the converter type 12080.

5.5.1 Supply of power part of the converter

Power supply voltage from secondary coil of mains transformer is connected to terminals **U**(X7.1), **V**(X7.2) and **W**(X7.3) of power interface **X7**. Ground is connected to terminal **N**(X7.4).

5.5.2 Supply of the DC motor armature

Converters type12010 and 12030 DC motor is connected to power terminals **A1**(X7.5) and **A2**(X7.6) of the power interface **X7**. Connecting schemes of DC motor are shown on **figure 15**, **figure 16**, **figure 18**, **figure 19** and **figure 20**.

Converters type 12080 terminals **A1**(X7.5, X7.6) and **A2**(X7.7, X7.8) are double and connecting to each terminal of the armature is with two wires. Connecting scheme with the DC motor is given on **figure 17**.

5.5.3 Supply of the power contactor

Converters types 12010 and 12030 contactor **K1** for commutation of power supply voltage and the DC motor dynamic stopping circuit is built-in. To terminal **X7.7** and **X7.8** of the power interface **X7** is connected the operative supply voltage of **K1**.

The converter type 12080 contactor **K1** for commutation of the power supply voltage and dynamic stopping circuit is external. Relay output of the converter **X7.9** and **X7.10** commutates operative supply voltage of **K1**. Connecting scheme of contactor **K1** and the DC motor dynamic stopping circuit is given on **figure 17**.

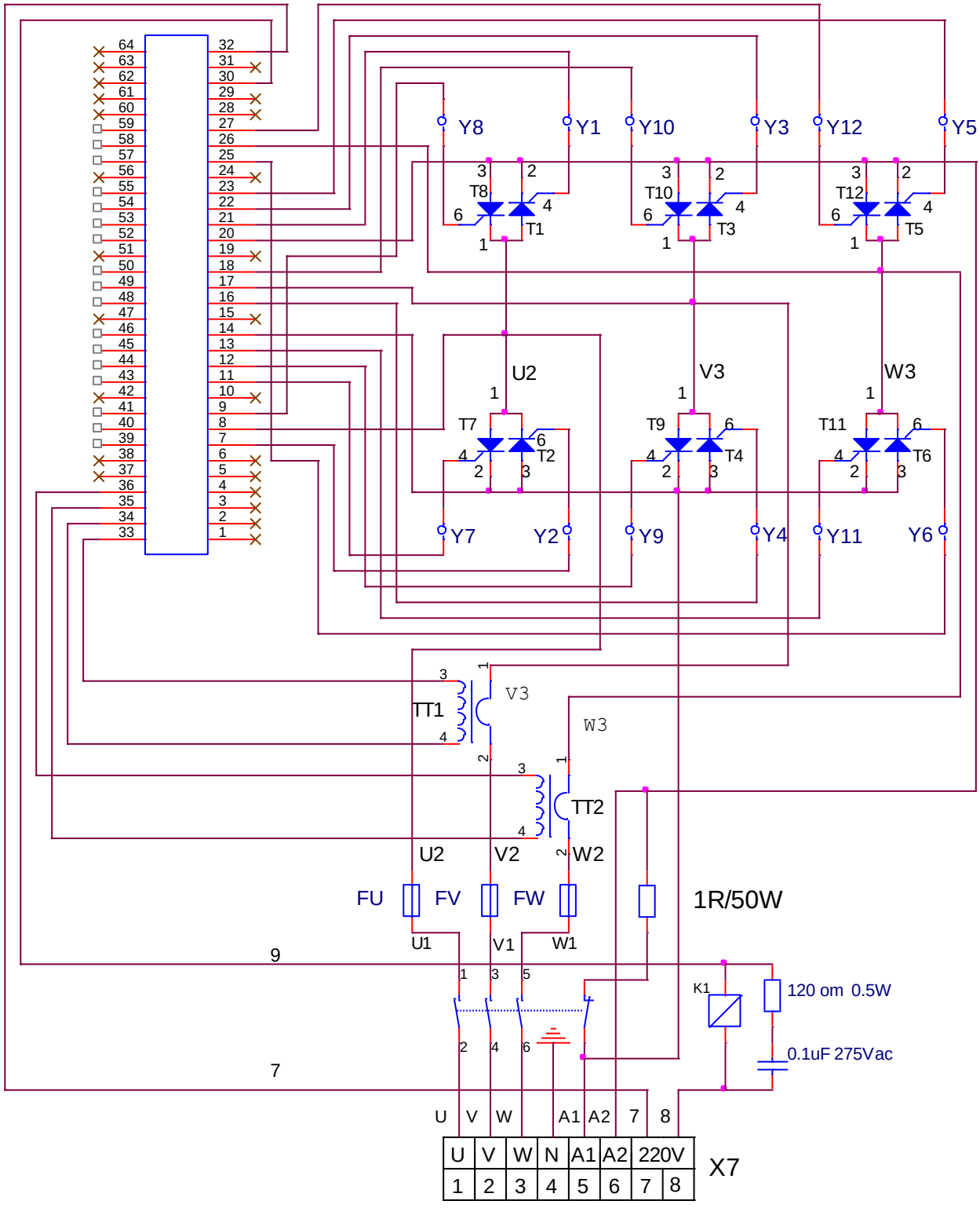


Figure 11 Electrical circuit of power block for converter type 12010 and 12030

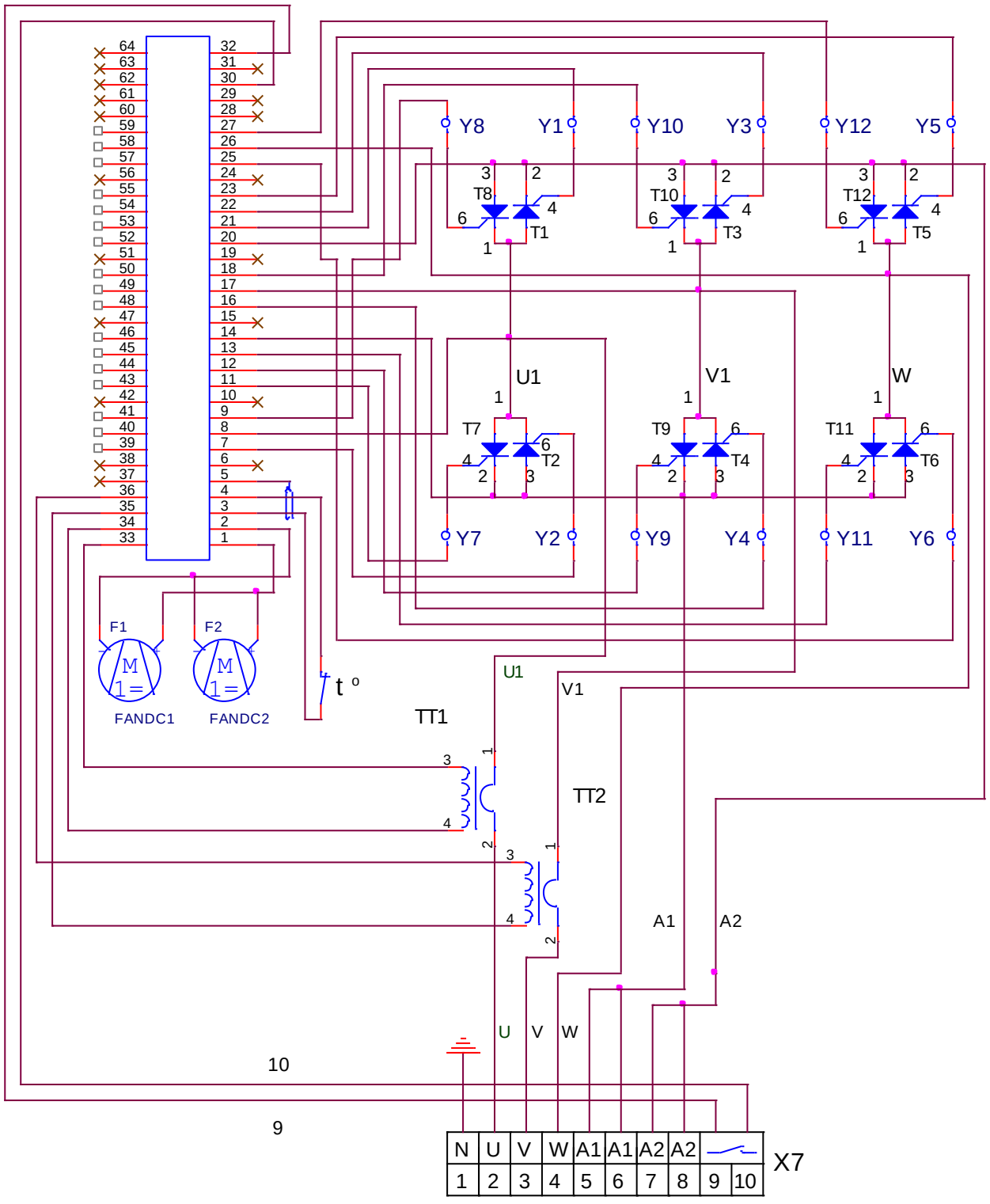


Figure 12 Electrical circuit of power block for converter type 12080

5.6 Indication for converter status

At the top part of the face panel are placed 6 LED indications which show the moment converter status. Lighting of each of them means a normal work mode or emergency mode.

LED indications for converter status are:

- **normal converter work mode**

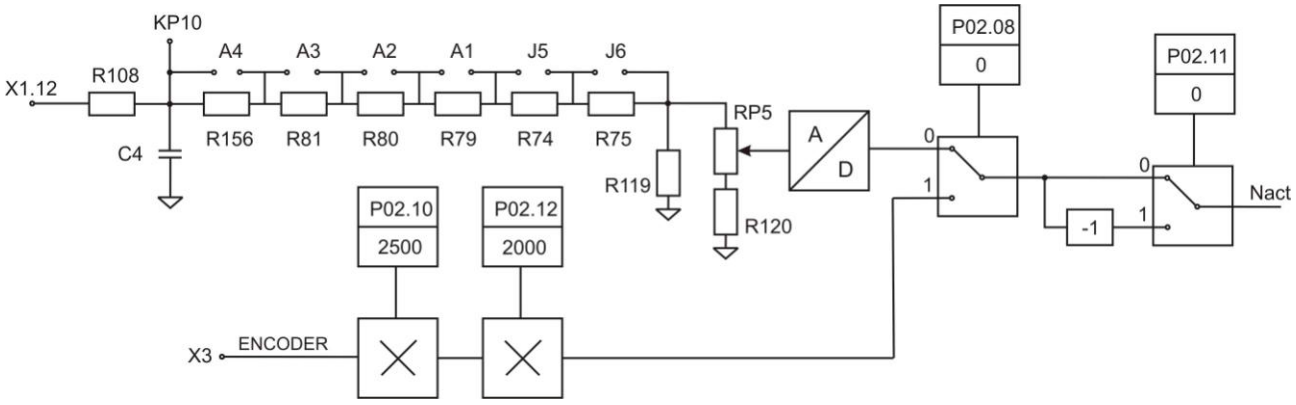
RD flicks with a period of time 1 s **–** ready of the converter at switching the power supply;
RD lights constantly – ready of the converter after receiving the control signal **PRDY**;
ON lights constantly – the converter work is able after receiving the control signal **ENBL**.

- **in emergency converter work mode**

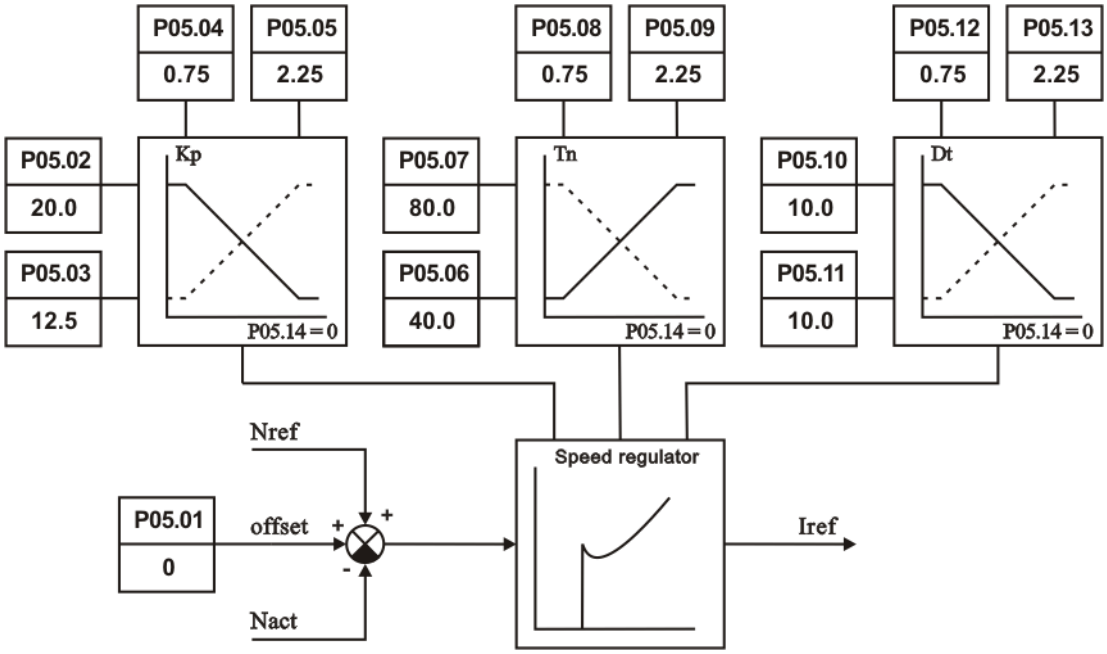
PF lights constantly – protection **SPF**. Disconnect or bad connection in any phase of synchronizing voltage. There is something wrong in phase power and synchronizing voltage.
PF flicks with period 1s – protection **HPF**. There is disconnection in power supply.
PF flicks with period 0.3s – protection **FRF**. Frequency of power mains is out of admissible range.
OL lights constantly – protection **OLF**. Protection $\mathbf{I^2t}$ is activated by overload of DC motor;
OL flicks with period 1s – protection **OHF**. Protection of overheated of converter power block is activated;
OL flicks with period 0.3s. – Protection **SOS**. Over-speed of DC motor rotating;
OL flicks with period 0.3s. – Protection **OVM**. There is over maximum armature voltage;
OC lights constantly – protection **SOC**. Current in power rectifier is overrated;
OC flicks with a period 1s – protection **HOC**. Current in power rectifier is over maximum rated $\mathbf{Idrv_{MLIM}}$ or there is a short circuit in the converter power rectifier;
TG lights constantly – protection **STG**. Disconnect of speed feedback when it works with tachogenerator. There is wrong connection, short circuit or disconnection in the circuit of tachogenerator;
TG flicks with period 1s – protection **ENF**. There is disconnection of speed feedback, when it works with encoder. There is wrong connection, short circuit or disconnection in the encoder circuit;
TG flicks with period 0.3s – protection **PSB**. There is positive speed feedback;
TG, OC, OL, PF – light constantly - protection **ADC**. Trouble in **ADC** (Analog to digital conversion);
TG, OC, OL, PF – flick with a period 0.3s – protection **EEF**. Trouble in EEPROM.

Notes:

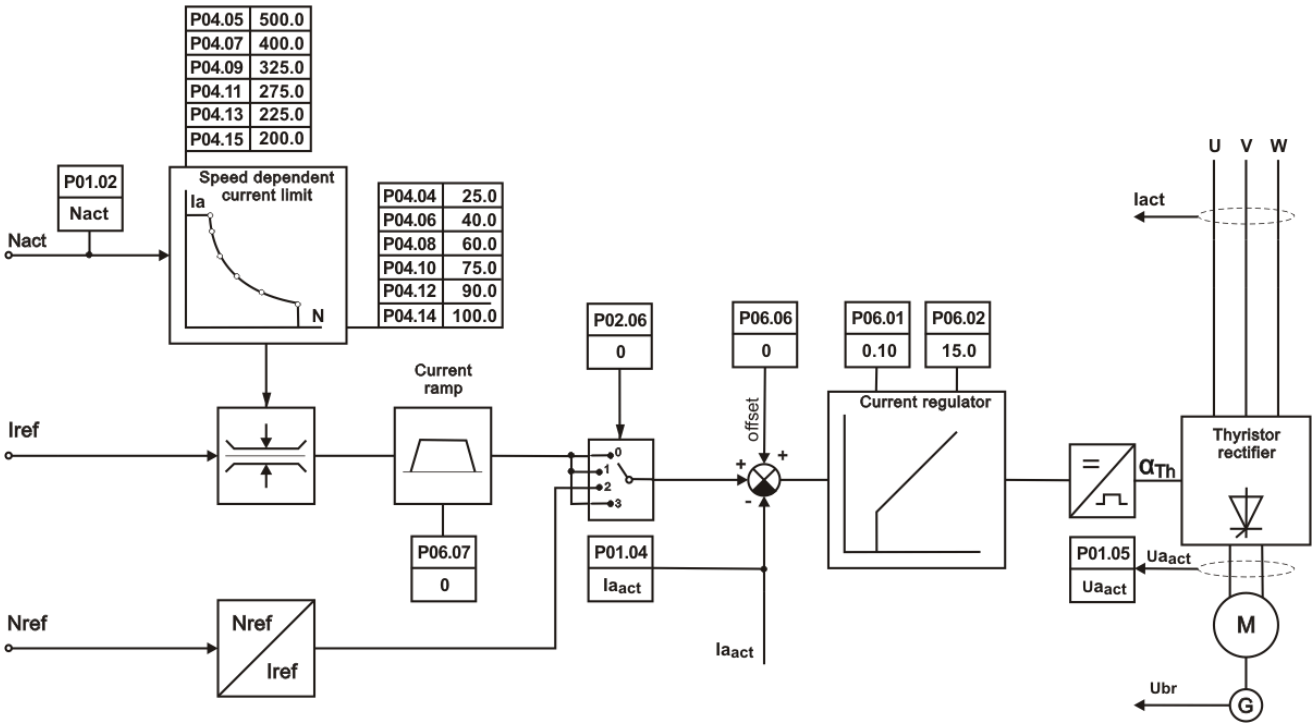
1. For more protection description see issues **6.3.3** and **6.4**;
2. LED indications, when hardware protections are activated, work in flick mode with period of time 1s.



A Speed feedback circuit



B Speed regulator with adaptation in function of real speed



C current armature regulator

Figure 13 Converter functional scheme

6. Converter adjustment

Converter parameters adjustment is made by serial interface **X6** by specialized terminal or PC.

ATTENTION!

Specialized terminal or PC has to be switched on and off to serial interface X6 only when converter power voltage is off.

If terminal indication does not flash after converter power is on it means control part is damaged.

Switch off the power supply and contact the authorized service company.

6.1 Work with specialized terminal or PC

Parameters defining work of each functional block parameters of main motor characteristics and limit parameters for protections are set in power free ROM memory by terminal helping. During the work all parameters for motor and converter work can be displayed by terminal and together with LED indication which is placed at the top of the face panel you can see full status of the converter and motor.

When the power voltage is on, and if there is not any mistake a message **P01 Monitoring** appears on the terminal display and it means the chosen group of parameters. Choosing the parameters group or a parameter also changes the parameters value. It is made by keys, placed below the indication with sign.

ESC UP DOWN ENTER or signs **ESC** ⇑ ⇓ ◅┘

Parameter or group of parameters number increases or decreases by **UP** and **DOWN**. Entering chosen parameters group happens by pressing key **ENTER** first. Parameter numbers increase or decrease by keys **UP** and **DOWN**. Pushing key **ENTER** for second time enters in edit parameter mode and on the terminal display appears the value of the chosen parameter. Changing the value is made at the same manner as the parameter number. Chosen value of the parameter is written in the memory by pressing key **ENTER**.

To come back in mode of choosing a parameter number is made by pressing the key **ESC** one time, second pressing the key **ESC** chooses parameters group mode. In case when a parameter value is changed but the key **ENTER** is not pressed, but key ESC is pressed changing is not set. When you change the value of a parameter, keeping keys **UP** and **DOWN** pressed for time, when they change more than twenty discretes from a decimal order it starts changing the higher order. Releasing the key cancels this mode.

Work is kept by terminal program for PC too (e.g. TERM95.exe from the packet NORTON COMMANDER or standard terminal program of MS WINDOWS _ HYPERTERMINAL). The serial interface (COM1 or COM2 of the computer adjusts to 9600bps, 8 bits for data N – without parity / odd checking 1-stop bit , emulation of the terminal - ANSI. It uses 4 keys which functions are the same as keys of portable terminal:

“o” – ESCAPE, “u” – UP. “d” – DOWN. “e” – ENTER.

When we select a parameter on the first line appears not only its number but also a text which is given in the third column of **table 8,** its value is on the second line. Changing the selected parameter value is made on upper manner.

When we work with terminal program for PC we have to work with lower case (CapsLock is OFF). If we work with capital letters the protocol used in manual terminal is switched (numbers are in HEX-format and text is not written). Coming back to work with PC is by pressing any of indication upper keys with lower case.

Notes:

1. If after pressing the key ENTER the new value of the parameter is not set, check whether the parameter is available in this mode;

2. If a parameter stops changing more than a value check if it depends on other parameter or it has reached its changing limit;

3. When same parameters depend on each other first change these from which others depend on.

6.2 Functional converter scheme

On **figure 13** is given functional converter scheme with place of influence of each parameter. Each parameter is given its default value.

6.3 Converter parameters

Parameters are divided into 8 groups:

Group 01 – parameters for watching

They indicate values of inner variables, control signals and signals to and from DC motor. In this group are included parameters for armature current, rotating speed, armature voltage, status of digital inputs and outputs and accumulation protection errors. Values of these parameters can not be changed – they only can be seen.

Group 02- converter parameters

They determine converter work mode, choosing of feedback, type of speed reference, rotating direction, chosen encoder and all general technical features of the power block.

Group 03 – protection parameters

Limits of controlling variables, which guarantee safe converter work, are defined by protection parameters.

Group 04 – DC motor parameters

By parameters of this group is set the main technical DC motor features. In this group are parameters of rated and maximum armature current, rated armature voltage and dynamic current limit of armature current.

Group 05 – Speed regulator parameters

These parameters define amplification gain, time constants and adaptation of speed controller.

Group 06 –current armature controller parameters

These parameters define amplification gain and time constant of armature current controller and make equal current pulses in each phase.

Group 07 – terminal parameters

Parameters in this group determine terminal working language and the frequency of indication refreshing.

Group 08 – error history

These parameters register protection activating in order of their appearance. When the registers are full, the error messages are reset automatically in order of their appearance.

This list of parameters, their sign and limits of their variation are given in **table 8**.

Terminal displays not only parameters information but information of emergency mode in converter work.

If a message **Error N XX** appears it means that there is an emergency mode which number is given in the last two orders of the message. A message of emergency mode appears when it is registered, independent of converter mode and without additional user's action.

Registered error announcements are saved in parameters group **P08** in order of their appearance. After pressing the key ESC it is restore the previous status, before appearing the error. In **table 12** and **table 13** are given detailed data for announcements of emergency modes and reasons of their appearance.

№	Name of the parameter	Text	Limit of variation	Measure
Group 01 – parameter for watching variables				
P01.01	Current value of speed reference	Speed reference	-100.0 ÷ 100.0	% N_{MAX}
P01.02	Current value of real speed	Speed actual	-110.0 ÷ 110.0	% N_{MAX}
P01.03	Current value of armature current reference	Curr arm ref	-600.0 ÷ 600.0 %P02.07	A
P01.04	Current value of real armature current	Curr arm act	-600.0 ÷ 600.0 %P02.07	A
P01.05	Current value of armature voltage	Arm voltage act	-250.0 ÷ 250.0	V
P01.06	Status of digital input	Status digit inp	-	bin
P01.07	Reserved	RESERVED	-	-
P01.08	Status of digital output	Status digit out	-	bin
P01.09	Reserved	RESERVED	-	-
P01.10	Test of speed feedback	Test tacho fluct	-	% Ubr
P01.11	Current value of net frequency	Live frequency	42.00 ÷ 68.00	Hz
P01.12	Current max diversion in synchronizing	Max synchro dev	-800 ÷ 800	µs
P01.13	Max number registered breaks in synchronizing	Max synchr break	0 ÷ 50	-
P01.14	Max number registered breaks in power	Max power break	0 ÷ 50	-
P01.15	Status power thyristors	Status thyr	-	bin
P01.16	Current value of power supply armature voltage	Power voltage	-	V
P01.17	Current value of the encoder pulse number	Act enc puls num	-	imp
Group 02 – converter parameters				
P02.01	Version of converter software	Software version	-	-
P02.02	Access password	User password	11	-
P02.03	Restoring parameter values by default	Default load	0, 1	-
P02.04	Image of user's parameters	Make param image	0, 1	-
P02.05	Restoring the user's parameters	Read param image	0, 1	-
P02.06	Work mode of the converter	Mode control	0, 1, 2	-
P02.07	Converter nominal current **$Idrv_{NOM}$**	Curr arm nominal	5,0 ÷ 100.0	A
P02.08	Calculated equivalent resistance R26, R27	R26,27 calc	-	Ω
P02.09	Choice the source of speed reference	Users source ref	0, 1, 2	-
P02.10	Speed reference when **P02.09** = 1	Source of ref	-100.00 ÷100.00	% N_{MAX}
P02.11	Choice of speed feedback	User feedback	0, 1	-
P02.12	Changing the speed reference sign	Sign vel ref	0, 1	-
P02.13	Changing speed feedback sign - tahogenerator	Sign vel fdbck	0, 1	-
P02.14	Changing speed feedback sign - encoder	Sign enc fdbck	0, 1	-
P02.15	Encoder resolution	Encoder puls num	100 ÷20000	imp/min^{-1}
P02.16	Encoder rotating speed when motor speed is max	Encoder sp max	100 ÷ 20000	min^{-1}
P02.17	Waiting the relay output of ready **VRDY**	Wait VRDY	0 ÷ 30000	ms
Group 03 – protection parameters				
P03.01	Allowed number breaks in synchronizing – protection **SPF**	Thr synchr break	5 ÷ 50	-
P03.02	Max number registered breaks in synchronizing – protection **SPF**	Max synchr break	0 ÷ 50	-
P03.03	Max allowed diversion in synchronizing – protection **SPF**	Thr synchro dev	100÷800	µs
P03.04	Current max diversion in synchronizing – protection **SPF**	Max synchro dev	-800 ÷ 800	µs
P03.05	Allowed number breaks in power – protection **HPF**	Thr power break	5 ÷ 50	-
P03.06	Max number registered breaks in power – protection **HPF**	Max power break	0 ÷ 50	-
P03.07	Work mode of protection **HPF**	Enable HPF	0, 1	-
P03.08	Time for activating of protection **OLF (I^2t)** from motor overloaded	Threshold OLF	0,10 ÷ 5.00	s

№	Name of the parameter	Text	Limit of variation	Measure
P03.09	Work mode of protection **OHF**	Enable HPF	0, 1	-
P03.10	Limit allowed speed $\mathbf{N_{LIM}}$ - protection **SOS**	Threshold SOS	100.0 ÷ 110.0	% N_{MAX}
P03.11	Limit current $\mathbf{Idrv_{LIM}}$ – protection **SOC**	Threshold SOC	105.0 ÷ 125.0	% Ia_{MAX}
P03.12	Armature voltage when protection **STG** is activating	Tresh Ua TGF	40.0÷80.0	% Uamax
P03.13	Reserved	RESERVED	-	-
P03.14	Reserved	RESERVED	-	-
P03.15	Reserved	RESERVED	-	-
P03.16	Working mode of protection **OLF**	Enable OLF	0, 1	-
P03.17	Armature voltage of activating the protection **OVM**	Threshold OVM	110.0 ÷ 130.0	% Uamax
Group 04 – motor parameters				
P04.01	Maximum armature voltage $\mathbf{Ua_{MAX}}$	Ua max motor	10 ÷ 250	V
P04.02	Max motor speed in motor name plate	N max motor	100 ÷ 10000	min-1
P04.03	Real max motor speed	N max motor real	100 ÷ 10000	min-1
P04.04	Maximum speed $\mathbf{Nm_1}$ of p.1	Speed of p.1	25.0 ÷ P04.06	% N_{MAX}
P04.05	Maximum armature current value $\mathbf{Ia_{MAX}}$ of p.1	Ia max of p.1	P04.07 ÷ 500.0	% Ia_{NOM}
P04.06	Maximum speed $\mathbf{Nm_2}$ of p.2	Speed of p.2	P04.04÷P04.08	% N_{MAX}
P04.07	Maximum armature current value $\mathbf{Iam_2}$ of p.2	Ia max of p.2	P04.09÷P04.05	% Ia_{NOM}
P04.08	Maximum speed $\mathbf{Nm_3}$ of p.3	Speed of p.3	P04.06÷P04.10	% N_{MAX}
P04.09	Maximum armature current value $\mathbf{Iam_3}$ of p.3	Ia max of p.3	P04.11÷P04.07	% Ia_{NOM}
P04.10	Maximum speed $\mathbf{Nm_4}$ of p.4	Speed of p.4	P04.08÷P04.12	% N_{MAX}
P04.11	Maximum armature current value $\mathbf{Iam_4}$ of p.4	Ia max of p.4	P04.13÷P04.09	% Ia_{NOM}
P04.12	Maximum speed $\mathbf{Nm_5}$ of p.5	Speed of p.5	P04.10÷P04.14	% N_{MAX}
P04.13	Maximum armature current value $\mathbf{Iam_5}$ of p.5	Ia max of p.5	P04.15÷P04.11	% Ia_{NOM}
P04.14	Maximum motor speed $\mathbf{N_{MAX}}$ of p.6	Speed of p.6	P04.12÷100.0	% N_{MAX}
P04.15	Maximum armature current value $\mathbf{Iam_6}$ of p.6	Ia max of p.6	100.0÷P04.13	% Ia_{NOM}
Group 05 – speed regulator parameters				
P05.01	Speed offset	Speed offset	-1024 ÷ 1024	discretes
P05.02	Amplification gain of speed regulator **Kp1**	Pgain sp reg Kp1	0.1 ÷ 100.0	-
P05.03	Amplification gain of speed regulator **Kp2**	Pgain sp reg Kp2	0.1 ÷ 100.0	-
P05.04	Work threshold of the gain **Kp1**	Threshold Kp1	0.00 ÷ P05.05	%
P05.05	Work threshold of the gain **Kp2**	Threshold Kp2	P05.04÷100.00	%
P05.06	Integral time-constant of speed regulator **Tn1**	Icomp sp reg Tn1	1.0÷1000.0	ms
P05.07	Integral time-constant of speed regulator **Tn2**	Icomp sp reg Tn2	1.0÷1000.0	ms
P05.08	Work threshold of integral timeconstant **Tn1**	Threshold Tn1	0.00 ÷ P05.09	%
P05.09	Work threshold of integral timeconstant **Tn2**	Threshold Tn2	P05.08 ÷ 100.00	%
P05.10	Differential timeconstant **Dt1**	Dcomp sp reg Dt1	0.1 ÷ 100.0	-
P05.11	Differential timeconstant **Dt2**	Dcomp sp reg Dt2	0.1 ÷ 100.0	-
P05.12	Work threshold of the differential timeconstant **Dt1**	Threshold Dt1	0.00 ÷ P05.13	%
P05.13	Work threshold of the differential timeconstant **Dt2**	Threshold Dt2	P05.12÷100.00	%
Group 06 – parameters of the armature current regulator				
P06.01	Amplification gain of current regulator	P gain curr reg	0.01 ÷ 2.00	-
P06.02	Integral time-constant of current regulator	I comp curr reg	10.0 ÷ 1000.0	ms
P06.03	Adjustment of the current amplitude of phase L1	Curr peak L1	-512 ÷ 512	µs
P06.04	Adjustment of the current amplitude of phaseL2	Curr peak L2	-512 ÷ 512	µs
P06.05	Adjustment of the current amplitude of phase L3	Curr peak L3	-512 ÷ 512	µs
P06.06	Current offset	Offset curr	-50÷50% P02.05	A
P06.07	Current ramptime	Ramp time curr	0 ÷ 500	µs
Group 07 – terminal parameters				
P07.01	Terminal language	Language	0, 1, 2	-
P07.02	Refreshing time	Refresh rate	1 ÷ 1000	ms
Group 08 – Error history				
P08.01	Error 1	Error 1	-	-
P08.02	Error 2	Error 2	-	-

№	Name of the parameter	Text	Limit of variation	Measure
P08.03	Error 3	Error 3	-	-
P08.04	Error 4	Error 4	-	-
P08.05	Error 5	Error 5	-	-
P08.06	Error 6	Error 6	-	-
P08.07	Error 7	Error 7	-	-
P08.08	Error 8	Error 8	-	-
P08.09	Error 9	Error 9	-	-
P08.10	Error 10	Error 10	-	-
P08.11	Error 11	Error 11	-	-
P08.12	Error 12	Error 12	-	-
P08.13	Error 13	Error 13	-	-
P08.14	Error 14	Error 14	-	-
P08.15	Error 15	Error 15	-	-
P08.16	Error 16	Error 16	-	-
P08.17	Reset errors	Reset errors	-	-

Table 8 List of parameters

Notes:

1. Parameters in the black fields can be changed only after writing the password and command **ENBL** is off. Parameters in white fields can be changed in all modes only after writing the password;
2. Parameters value can be read without writing the password;
3. For the sake of convenience parameters which show accumulated errors from protections group **P03** are in group **P01** of watching parameters, too.

6.4 Describing the parameters

6.4.1 Group 01- parameters for watching variables

Parameters from **P01.01** to **P01.13** enable watching the values of the variables which describe converter and motor work .These parameters are accessible in all modes.

- Parameters **P01.01** – current value of speed reference. It is defined as a percentage of maximum speed **Nmax**;
- Parameter **P01.02** – current value of real speed. It is defined as a percentage of maximum speed **Nmax**;
- Parameter **P01.03** – current value of armature current reference. It is given in amperes without a sign;
- Parameter **P01.04** – current value of actual armature current. It is given in amperes without a sign;
- Parameter **P01.05** – current value of armature voltage. It is given in volts with a sign;
- Parameter **P01.06** – status of the digital inputs. The status of the digital inputs is given in binary code. Correspondence between active digital inputs and corresponding order is given in **table 9**.

Input	LCD
PRDY	1000000000
ENBL	0100000000

Table 9 Correspondence between status of the digital inputs and indication orders

- Parameter **P01.07** – reserved;
- Parameter **P01.08** – status of digital outputs. The status of digital outputs is given in binary code. Correspondence between the active digital outputs and corresponding order is given in **table 10**.

Output	LCD
VRDY	00010
OVL	00001

Table 10 Correspondence between the status of digital outputs and indication orders

- Parameter **P01.09** – reserved;
- Parameter **P01.10** – current value of fluctuation of speed feedback voltage. The fluctuations are defined in percentage of the quotient of maximum tachogenerator voltage value to its average value **Ubr** per a 1s. For a right tachogenerator in a fixed mode, the value of the parameter **P01.10** must be less than 2%;
- Parameter **P01.11** – current value of the power mains frequency defined in Hz.
- Parameter **P01.12**(**P03.04**) – maximum registered time of diversion between waiting and registered pulse of synchronizing during the converter work. By key **UP** of the terminal reset displayed value and it starts new registering of the diversion. Parameter **P01.12** value is not written in power free memory.
- Parameter **P01.13(P03.02)** – maximum number registered sequence breaks in synchronizing to its restoration. Keeping watching synchronizing breaks starts when the converter is **ON.** By key **UP** parameter **P01.13** is reset and starts new registering of breaks. Value of parameter **P01.13** is not written in power free memory. If number of registered synchronizing breaks is more than value written in parameter **P03.01**, protection **SPF** activates;
- Parameter **P01.14(P03.06)** – max number of registered sequence breaks in power mains to its restoration. Watching for breaks in power mains starts when the converter is **ON**. The value of the parameter **P01.14** is not written in power free memory. By key **UP** the value is reset and starts a new registering of breaks. If the registered break number is more than the value written in **P03.05**, protection **HPF** activates;
- Parameter **P01.15** – work status of the power thyristors. When we open this parameter, on the terminal display there are two groups of 6 orders 0 /zeros/, which correspond to thyristor number of groups from **T1** to **T12**, from left to right. When all thyristors work, all orders in the group must be **0**. Checking is made for both rotating directions. If any of orders is **1**, it means that corresponding thyristor does not work and must be repaired;
- Parameter **P01.16** – current value of converter power supply voltage. It shows the effective value of lineal power voltage in V;

– Parameter **P01.17** – actual value of the encoder pulses number. It displays the pulses number from zero's to zero's pulse. The number of the registered pulses must correspond to the pulses in encoder name plate. If number of registered pulses is less that means the encoder generates more than one zero pulse. During the check the rotation direction must not be changed, as in this case it is wrong.

6.4.2 Group 02 – converter parameters

– Parameter **P02.01** – version of converter software;
– Parameter **P02.02** – password allowing changing parameter values. When power is OFF the password is not active. When we write value **11** in parameter **P02.02**, the converter accept the password and on the terminal display is appeared value **1** – it is a message for accepting the password;
– Parameter **P02.03** – When we write **1** in parameter **P02.03** we restore values by default of all parameters. Parameter **P02.03** can be changed when the password is in and command **ENBL** is OFF;
– Parameter **P02.04** – image of user's parameters. When value 1 is set in parameter P02.04 an image of user's parameters is written in EEPROM;
– Parameter **P02.05** – restore the user's parameters. When 1 is set in parameter P02.05 the values of the user's parameters are restored;
– Parameter **P02.06** – converter work mode. Change of parameter P02.06 is not written in EPROM. Parameter **P02.06** accepts three values:
  • **P02.06** = 0 – speed control mode (integral mode). In this mode the converter works in speed control mode by given speed defined by **P02.09**. In integral mode current and speed regulators are switched on. When the converter is switched on to the power supply the value of parameter **P02.06** = 0 always;
  • **P02.06** = 1 – proportional mode. In this mode all the regulators are OFF and the converter works as a rectifier. Proportional mode is used when we start the converter for the first time and adjust it. The thyristor firing angle is given according to chosen value of **P02.09** and inner is limited to safety value;
  • **P02.06** = 2 – Torque control mode. In this mode the speed regulator is OFF and torque (armature current) is given is given directly to the DC motor according to chosen source by **P02.09.** Maximum value responses to maximum torque (current) of the DC motor.
  Attention: In this mode if the DC motor is without load it rotates with over speed.

– Parameter **P02.07** – Scale of the channel for measuring the armature current. By parameter **P02.07** we scale the armature current circle, which allows measure all current variables in A (amperes). Parameter **P02.07** value must response to nominal converter current $\mathbf{Idrv_{NOM}}$, chosen by measured resistors **R26** and **R27** of armature current sensor. Setting the parameter **P02.07** value is not changed when we restore the understanding values by parameter **P02.03**. The correspondence between equivalent value of measured resistors **R26** and **R27** and the converter nominal current is given in parameter **P02.08**;
Attention: Changing the value of parameter **P02.07** without changing loading resistors of the current sensor does not change DC motor current.

– Parameter **P02.08** – value of the equivalent resistance of the measured resistors **R26** and **R27**. The converter nominal current $\mathbf{Idrv_{NOM}}$ is defined by the value of the equivalent resistance of the measured resistors **R26** and **R27**. The two resistors are in parallel connection. Place of the resistors is given in **figure 22**. In case, when it is used a motor with nominal armature current less than the nominal current of adjusted converter in factory, it needs it to be adjusted. At this the converter working characteristics, given in **table 1**, are the same.

For the chosen nominal current $\mathbf{Idrv_{NOM}}$ the equivalent resistance of the measured resistors **R26** and **R27** is defined by expression:

$$\mathbf{Re = 400 / Idrv_{NOM}}$$

Where:

Re – equivalent resistance in ohms [Ω];
$\mathbf{Idrv_{NOM}}$ - converter nominal current in amperes [A];

By given expression the value of parameter **P02.08** is calculated.
Each resistor must be with power no less than 250 mW.
For values of **Re** less than 20 Ω must be used two resistors.

For values of **Re** more than 20 Ω may be used one resistor.

For example:
When $\mathbf{Idrv_{NOM}}$ = 32 A, **Re** = 400/32 = 12.5 Ω.
Choose the nearest value **R26** = **R27** = 24 Ω.

ATTENTION:
– For the correct calculation the value of the equivalent resistance in parameter **P02.08**, first the value of the converter nominal current must be given correctly in parameter **P02.07**;
– When you adjust the converter nominal current, it must not be more than the value of the nominal current of that converter, given in table 1;
– If the converter nominal current is very different from the motor nominal current, it is possible the device adjustable features become worse.

– Parameter **P02.09** – choice a source which gives the speed:
  - **P02.09** = 0 – analog bipolar speed reference ±10V.
  - **P02.09** = 1 – digital speed reference with a sign. It is defined by the value of parameter **P02.10**;
  - **P02.09** = 2 – digital speed reference by series interface RS485/RS422 (option).
– Parameter **P02.10** – inner digital reference of velocity in proportional mode when parameter **P02.09** = 1. It is defined in percentage of max speed with a sign. When the converter is started the parameter value is always **P02.10** = 0;
– Parameter **P02.11** – choice type of the speed feedback. Parameter **P02.11** has two meanings:
  - **P02.11** = 0 – speed feedback with tachogenerator;
  - **P02.11** = 1 – speed feedback with encoder.
– Parameter **P02.12** – changing the sign of the speed reference. It can be:
  - **P02.12** = 0 – the speed reference sign is the same;
  - **P02.12** = 1 – the speed reference sign is inverted.
– Parameter **P02.13** – change the feedback sign with tachogenerator. Parameter **P02.13** has two meanings:
  - **P02.13** = 0 – save the existing sign;
  - **P02.13** = 1 – invert the existing sign.
– Parameter **P02.14** – change the feedback sign with encoder. Parameter **P02.14** has two meanings:
  - **P02.14** = 0 – save the existing sign;
  - **P02.14** = 1 – invert the existing sign.
– Parameter **P02.15** – the encoder resolution. It defines the encoder pulse number per one revolution;
– Parameter **P02.16** – rotating velocity of encoder when the DC motor speed is max and parameter **P02.11** = 1. Max allowed converter input frequency for the pulses of each phase of the encoder is 220kHz. Encoder with 1024 imp/rev max rotating velocity is 12890 rev/min. Encoder with 2500imp/rev max rotating speed is 5280 rev/min.
Note: It is important to know what the max output frequency of the encoder is. For example encoder with max frequency 100 kHz and 2500 imp/rev max speed is 2400min $^{-1}$.
– Parameter **P02.17** – waiting the relay output **VRDY**. It inserts the time of appearance of ready (output **VRDY**) after control signal **PRDY** (control signal switch on the power supply);
Note: It is recommended time 500 ms, in which the protection will establish. At older FANUC systems and other similar it is recommended time 0 ms, because they require a fast response and if any protection activates, **VRDY** is switched off immediately. In these cases, the control signal for work **ENBL** is taken in 400 ms after the control signal **PRDY**, to ensure time of protection checking ends.

6.4.3 Group 03 – protection parameters

In converter are built-in hardware and software protections for the main controlled variables. All protections with sign **S** are software and protections with sign **H** are hardware.

Software protection activating thresholds are adjusted by parameters according to the concrete use.

Thresholds of the hardware protection activating are factory-made for converter protection and must not be changed.

If any protection activates the converter switches OFF the power rectifier and corresponding LED indication lights.

The converter is ready to work after repairing the part causes protection activating and secondary switching ON command **PRDY** or switching on the power mains.

- **Software protection SPF** / **S**oft **P**hase **F**ault /
  Software protection **SPF** is from converter synchronizing wrong work.

– Parameter **P03.01** – allowed number registered breaks in synchronizing to activating protection **SPF.** If the number of registered breaks in synchronizing is more than the value of parameter **P03.01**, protection **SPF** activates and converter stops working. Power contactor **K1** switches OFF (for converter 12080 relay contact - X7.9 and X7.10 opens) and LED indication **PF** lights constantly. Converter will be ready to work after protection **SPF** activating when command **PRDY** is activated secondary;

– Parameter **P03.02**(**P01.11**) – max number registered sequence breaks in synchronizing to its restore. Watching for breaks in synchronizing starts when converter is ON. With key **UP** on the terminal or when the converter power is OFF the value is reset and starts new registering of breaks. If number of registering breaks in synchronizing is more than the value written in **P03.01** protection **SPF** is activated. Parameter **P03.02** allows watching quality of power mains;

– Parameter **P03.03** – allowed time of synchronizing diversion. Time of synchronizing diversion defines duration of time interval in which synchronizing pulse is waited. Synchronizing pulses out of this time interval are registered as an error (break in synchronizing). Number of errors is accumulated in the counter of protection **SPF**;

– Parameter **P03.04** (**P01.10**) – max registered time of diversion between waited and registered impulse of synchronizing during the converter work. When the registered time is with sign minus synchronizing pulse is ahead of, when the sign is plus it is delay from waiting time. By terminal key **UP** or by switching OFF the converter from power net parameter is reset and starts new registering of diversion. Parameter **P03.04** value is not written in power free memory. Parameter **P03.04** allows watching power net quality.

- **Hardware protection HPF** / **H**ard **P**hase **F**ault /
  Protection **HPF** of something wrong in converter power.

– Parameter **P03.05** – allowed number registered sequence breaks in power mains to activating protection **HPF**. Protection **HPF** registers failing voltage of one or more phases of the power mains. Breaks in power mains are registered hardware and set in the error counter of protection **HPF.** If the number of registered breaks is more than value of parameter **P03.05**, the protection **HPF** activates and LED indication **PF** flicks with a period 1s.

Notes:
1. When there is a failing of synchronizing phase and a power voltage at the same time protection **SPF** activates and LED indication **PF** lights constantly, because software protection has priority;
2. When the phases are changed between power and synchronizing voltage protection **HPF** activates, because it is registered hardware.

– Parameter **P03.06** **(P01.12)** – max number registered sequence break in power mains to its restore. Watching for breaks in power mains starts at the moment when the converter is switched ON. By terminal key **UP** the value is reset and starts new break registering. Value of parameter **P03.06** is not written in power free memory. If number of registered breaks in power mains is more than the value written in **P03.05** protection **HPF** activates. Parameter **P03.06** allows watching the quality of power mains;

– Parameter **P03.07** – working mode of hardware protection **HPF**. It can be:
  - **P03.07** = 0 – in this mode protection **HPF** is OFF and any breaks in power supply are not registered by parameter **P03.06**. If there is any mistake in power supply converter is not switched OFF;
  - **P03.07** = 1 – in this mode protection **HPF** is switched ON. When there are any breaks in power supply they are registered in parameter **P03.06** and when their number is more than value of parameter **P03.05**, converter is switched OFF and LED indication **PF** flicks with a period 1s.

- **Hardware protection FRF** / **FR**equency **F**ault /
  Hardware protection **FRF** of power net frequency out of allowed limits.

Protection **FRF** is activated when power mains frequency is out of the limits from 42 to 68 Hz or there is not any synchronization. When any of the inner voltage ± 12 V of the controlling circuit faults, the

synchronization does not work, too. When the protection FRF activates the LED **PF** indication flicks with a period 0.3s.

- **Software protection OLF** / **O**ver **L**oad **F**ault /
  Software protection **OLF (I^2t)** is from DC motor durative overloaded.

– Parameter **P03.08** – time in which protection **OLF (I^2t)** starts recognizing overloaded when the armature current value is more than motor nominal current **Ia_{NOM}**. When protection **OLF (I^2t)** activates the converter stops working, the power contactor **K1** switches OFF (at converters 12080 the relay output X7.9 and X7.10 opens) and LED **OL** indication lights constantly. After activating the protection **OLF (I2t)**, the converter is ready to work again, only when the signal **PRDY** activates secondary. It is recommended the value of parameter **P03.08** is from 0.2 to 0.4 s;

– Parameter **P03.16** – activation of the protection OLF(12t) from durative motor overloading is allowed. It has two meanings:
  - **P03.16** = 0 – activation of the protection **OLF** is switched off;
  - **P03.16** = 1 – activation of the protection **OLF** is allowed.

- **Hardware protection OHF** / **O**ver **H**eat **F**ault /
  Hardware protection **OHF** is overheated the converter power block.

– Parameter **P03.09** – allowing working of protection **OHF** – overheating of converter power block. It can be:
  - **P03.09** = 0 – action of protection **OHF** is switched OFF;
  - **P03.09** = 1 – action of protection **OHF** is allowed. When the contact temperature sensor of power bock is activated protection **OHF** is activated and LED **OL** indication flicks with a period 1s.

- **Software protection SOS** / **S**oft **O**ver **S**peed /
  Protection **SOS** is when rotating speed is over allowed.

– Parameter **P03.10** – limited allowed rotating speed **N_{LIM}.** When DC motor rotates with a speed over **N_{LIM}** protection **SOS** activates. When the protection **SOS** activates the converter stops working, the power contactor **K1** switches OFF (for convertors 10280 relay contact X7.9 and X7.10 opens) and LED **OL** indication flicks with a period 0.3s. After protection **SOS** activates converter will be ready to work after second command **PRDY**;

- **Software protection SOC / S**oft **O**ver **C**urrent /
  Protection **SOC** is moment over current of power rectifier limit current.

– Parameter **P03.11** – limit moment current **$Idrv_{LIM}$** of the converter power rectifier, defined in percentage to the DC motor nominal current **Ia_{NOM}**, whose value is given in parameter P04.05. When the power rectifier current is more than **$Idrv_{LIM}$** software current protection **SOC** activates converter stops working, power contactor **K1** switches OFF (for converter 12080 relay contact X7.9 and X7.10 opens) and LED **OC** indication lights constantly. After activating protection **SOC** converter is ready to work after a second command **PRDY**;

- **Hardware protection HOC / H**ard **O**ver **C**urrent /
  Protection **HOC** is moment over current of converter power block max allowed current.

Hardware protection **HOC** protects converter when the power rectifier current is more than max allowed **$Idrv_{MLIM.}$** Max allowed current **$Idrv_{MLIM}$** is defined by limited current of converter power elements, hardware protection **HOC** is factory-made. When the hardware protection **HOC** activates, converter stops working, power contactor **K1** switches OFF (for convertors type 12080 relay contact X7.9 and X7.10 opens) and LED **OC** indication flicks with a period 1s. After activating protection **HOC** converter will be ready to work after a second command **PRDY**.

- **Software protection STG / S**oft **T**acho**G**enerator fault /
  Protection **STG** is from failing of feedback when the converter works with tachogenerator.

– Parameter **P03.12** – allowed armature voltage when the protection **STG** break speed feedback is activated. In the algorithm of protection **STG** is the comparison between tachogenerator voltage and DC motor armature voltage. If the tachogenerator voltage is lower than 5% of the voltage when the speed is max - **N_{MAX}** and armature voltage is higher than the value of parameter **P03.12** for more than 20ms protection **STG** is activated and LED **TG** indication lights constantly. When protection **STG** is

activated converter stops working, power contactor **K1** switches OFF (for converters 12080 relay contact X7.9 and X7.10 opens). After activating protection **STG** converter starts working after a second command **PRDY**.

Note - Protection **STG** works only in integral mode.

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

Protection **ENF** – failing speed feedback when converter works with an encoder.

When the encoder is connected wrong or break circuits of encoder protection **ENF** activates and LED **TG** indication flicks with a period 1s. Protection **ENF** activates only if the converter works with encoder as a speed feedback when the parameter **P02.11** = 1.

Note - Protection **ENF** works only in integral mode.

- **Hardware protection PSB / P**ositive **S**peed **B**ack **/**

Protection **PSB** is from positive speed feedback.

When speed feedback is positive, when tachogenerator or encoder is connected wrong protection **PSB** activates and LED **TG** indication flicks with a period 0.3s.

Note - Protection **PSB** works only in integral mode.

- **Hardware protection OVM / O**ver **V**oltage **M**otor **/**

– Parameter **P03.17** – threshold of activating the protection **OVM** from armature over voltage. The value of the parameter **P03.17** defines admissible armature over voltage in percentage to the maximum voltage Ua_{MAX} (parameter **P04.01**). If the armature over voltage is more than the value of parameter P03.17, the protection **OVM** activates and the LED indication **OS** flicks with a period of time 0.3 s. The protection **OVM** ensures safety work of the converter when the speed feedback is adjusted wrong;

- **Hardware protection ADC / A**nalog **D**igital **C**onverter fault **/**

Hardware protection **ADC** – something wrong in Analog to Digital Conversion.

Hardware protection **ADC** activates when the ADC does not work correctly. When protection **ADC** activates LEDs **TG, OC, OL** and **PF** light constantly.

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

Hardware protection **EEF** is when something is wrong in power free memory.

When there is something wrong in power free memory protection **EEF** activates. Hardware protection **EEF** activates and when converter starts first time with a new software. When protection **EEF** activates LEDs **TG, OC, OL** and **PF** flick with a period 1s. Problem will be solved it needs to be set understanding parameters. If protection **EEF** activates secondary the power free memory has to be changed in authorizing service.

6.4.4 Group 04 – motor parameters

– Parameter **P04.01** – max armature voltage $\mathbf{Ua_{MAX}}$ in V (volts);
– Parameter **P04.02** – maximum motor speed from motor name plate;
– Parameter **P04.03** – motor maximum working speed. It is the real maximum speed at which the motor will work in the concrete use;
– Parameter **P04.04** – limited speed **Nm1** when DC motor works with max armature current $\mathbf{Ia_{MAX}}$ defined by parameter **P04.05** (**p.1**, **table 11**). It is defined in percentage of max speed $\mathbf{N_{MAX}}$;
– Parameter **P04.05** – max value of armature current $\mathbf{Ia_{MAX}}$ when the speed is **Nm1** defined by the parameter **P04.04** (**p.1**, **table 11**). It is defined in percentage of armature nominal current $\mathbf{Ia_{NOM}}$;
– Parameters **P04.06 – P04.15** – points of dynamic current limit characteristic.

Parameters **P04.04** – **P04.13** are allowed only when the password is chosen and command **ENBL** is switched OFF.

When parameters defining characteristic of dynamic current limit are set it needs to follow next rules:

- Points of dynamic current limit characteristic are placed in speed rotating rate from 25% $\mathbf{N_{MAX}}$ to 100% $\mathbf{N_{MAX}}$ and armature current rate from 50% $\mathbf{Ia_{NOM}}$ to 500% $\mathbf{Ia_{NOM}}$;
- Point **1** of dynamic current limit characteristic is defined with limit rotating speed $\mathbf{Nm_1}$ defined by parameter **P04.04** and max armature current $\mathbf{Ia_{MAX}}$ defined by parameter **P04.05**;
- Each following point has to be when speed is no less than the limit speed and current lower than the limit.

One example of defining parameters of dynamic current limit characteristic is given in **table 11** and in **figure 14**.

Point	1	2	3	4	5	6
Parameter	**P04.05**	**P04.07**	**P04.09**	**P04.11**	**P04.13**	**P04.15**
Ia_{NOM} %	500	400	325	275	225	200
Parameter	**P04.04**	**P04.06**	**P04.08**	**P04.10**	**P04.12**	**P04.14**
N_{MAX} %	50	55	60	67	80	100

Table 11 Example table defining parameters of the dynamic current limit characteristic

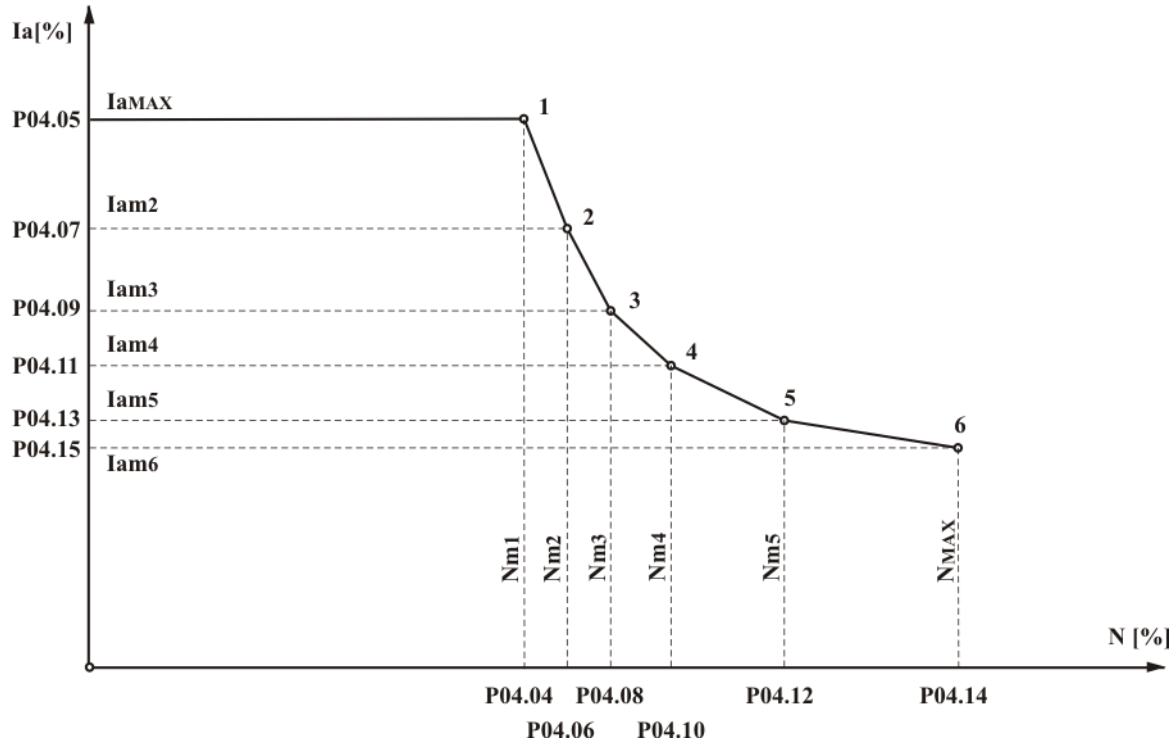


Figure 14 Graphic of dynamic current limit characteristic

6.4.5 Group 05 – parameters of speed regulator

- Parameter **P05.01** – speed offset determined in discrete;
- Parameter **P05.02** – amplification gain of the speed regulator **Kp1.** Action range of the amplification gain **Kp1** is defined by the threshold given with parameter **P05.04** value. When adaptation variable changes from parameter **P05.04** value to parameter **P05.05** value the amplification constant of speed regulator changes lineal to value **Kp2**;
- Parameter **P05.03** – amplification constant of speed regulator **Kp2.** Action range of amplification constant **Kp2** is defined by threshold given with parameter **P05.05** value;
- Parameter **P05.04** – threshold of gain work **Kp1**. Speed regulator works with amplification gain **Kp1** to value of chosen adaptation variable defined with parameter **P05.04**. Amplification constant of regulator is changed lineal from **Kp1** to **Kp2**, for values more than parameter **P05.04** value and less than parameter **P05.05** value;
- Parameter **P05.05** – threshold of gain work **Kp2.** Speed regulator works with amplification gain **Kp2** for value of the chosen adaptation variable more than the value of parameter **P05.05**;
- Parameter **P05.06** – integral time constant of speed regulator **Tn1**. Active range of integral constant **Tn1** is defined with the threshold given with value of parameter **P05.08**. When variable changes for adaptation from value of **P05.08** to value of parameter **P05.09**, integral constant of speed regulator changes lineal from value **Tn1** to **Tn2**;
- Parameter **P05.07** – integral time constant of speed regulator **Tn2.** Active range of integral constant **Tn2** is defined by threshold given with value of parameter **P05.09**;

- Parameter **P05.08** – variable threshold for work of integral constant **Tn1**. Speed regulator works with the integral constant **Tn1** to value of chosen adaptation variable defined by parameter **P05.08**. Constant changes lineal from **Tn1** to **Tn2** for values more than value of parameter **P05.08** and less than value of parameter **P05.09**;
- Parameter **P05.09** – variable threshold for work with integral constant **Tn2**. Speed regulator works with integral constant **Tn2** for chosen adaptation variable value more than value of parameter **P05.09**;
- Parameter **P05.10** – differential constant of speed regulator **Dt1.** Activating range of differential constant **Dt1** is defined by threshold given with parameter **P05.12** value. When adaptation variable changes from value of parameter **P05.12** to value of parameter **P05.13** regulator differential constant changes lineal from **Dt1** to **Dt2**;
- Parameter **P05.11** – differential constant of speed regulator **Dt2.** Activating range of differential constant **Dt2** is defined by threshold given with value of parameter **P05.13**;
- Parameter **P05.12** – threshold of variable for work of differential constant **Dt1**. Speed regulator works with differential constant **Dt1** to chosen adaptation variable value, defined by parameter **P05.12**. Differential constant changes lineal from **Dt1** to **Dt2** for chosen adaptation variable values more than parameter **P05.12** value and less than value of parameter **P05.13**;
- Parameter **P05.13** – threshold of variable for work of differential constant **Dt2**. Speed regulator works with differential constant **Dt2** to chosen adaptation variable values more than the value of parameter **P05.13**;

6.4.6 Group 06 – parameters of armature current regulator

- Parameter **P06.01** – regulator amplification gain of armature current;
- Parameter **P06.02** – integral constant of armature current regulator;
- Parameter **P06.03** – adjusting of phase **L1** current amplitude;
- Parameter **P06.04** – adjusting of phase **L2** current amplitude;
- Parameter **P06.05** – adjusting of phase **L3** current amplitude;
- Parameter **P06.06** – armature current offset. It is used when there is uncompensated static load of the vertical axes. When the vertical axis is switched ON in static mode (for example stay in position) given armature current value is recognized by parameter **P01.03** after which give removing of armature current with sign and value which response to given armature current. It moves the vertical axis in a new position and checks given current and it must be near zero.
- Parameter **P06.07** – time of the ramp-generator of the armature current regulator. It is recommended to be used only in cases, when there is any play in the mechanical gear between motor and the load.

6.4.7 Group 07 – terminal parameters

- Parameter **P07.01** – terminal language. Parameter **P07.01** value is not restored understanding. It accepts three values:
  - **P07.01** = 0 – English language;
  - **P07.01** = 1 – Bulgarian language;
  - **P07.01** = 2 – Russian language.
- Parameter **P07.02** – terminal indication refreshing time.

6.4.8 Group 08 – error history

- Parameters from **P08.01** to **P08.16** – parameters where are written error announcements in order of their appearing. Where there is not any announcement in chosen parameter is written announcement **EMPTY**. The error announcements are written in text corresponding to **table 12**. Last written error announcement is saved in parameter with the biggest number. After filling all parameters the oldest error is deleted automatically;
- Parameter **P08.17** – clear error announcements.

6.5 Error indication

When an announcement **Error N XX** appears on terminal display it means that there is an error which number is given in last two orders. Error announcement appears when it is registered in any converter mode. When we press key **ESC** terminal status which was before appearing the error is restore. In **table 12** are given error announcements and in **table 13** LED indication when there is an emergency mode.

Error №	Text	Error description
Error N 01	**S**oft **P**hase **F**ault	Break or out of phase power and synchronizing voltage. Wrong converter ground.
Error N 02	**H**ard **P**hase **F**ault	Break power supply or voltage of any phase.
Error N 03	**FR**equency **F**ault	Frequency of power net out of allowed range or absence of synchronizing
Error N 04	**O**ver**L**oad **F**ault	Motor overloaded.
Error N 05	**O**ver**H**eat **F**ault	Converter power block overheated when **P03.09** = 1.
Error N 06	**S**oft **O**ver**S**peed	Over speed given by parameter **P03.10** limit speed $\mathbf{N_{LIM}}$.
Error N 07	**S**oft **O**ver**C**urrent	Over current given by parameter **P03.11** limit current $\mathbf{Idrv_{LIM}}$ of converter power block.
Error N 08	**H**ard **O**ver**C**urrent	Over current of max allowed current $\mathbf{Idrv_{MLIM}}$ of converter power block.
Error N 10	**S**oft **TG** fault	Wrong connection, short circuit or break of tachogenerator circuit. Wrong chosen parameter **P03.12**.
Error N 11	**EN**coder **F**ault	Wrong connection or break encoder circuit.
Error N 12	**P**os **S**peed**B**ack	Positive speed feedback.
Error N 19	**ADC** fault	Trouble in analog digital conversion.
Error N 20	**EE**prom **F**ault	Trouble when we work with power free memory.
Error N 26	**O**ver**V**oltage **M**ot	Over voltage max allowed armature voltage.

Table 12 List of errors displayed on specialized terminal

Note: Letters in bold response of protection sign in **p.6.3.3**.

Correspondence between converter status and LED indication when there is any emergency mode is given in **table 13**.

LED	Protection	Description of emergency mode
Constantly lighting LED		
PF	**SPF**	Break or out of phase synchronizing and power voltage. Wrong converter ground.
OL	**OLF**	Overloaded motor and protection $\mathbf{I^2t}$ is ON.
OC	**SOC**	Over-current given in parameter **P03.11** limited current $\mathbf{Idrv_{LIM}}$ of converter power block.
TG	**STG**	Wrong connecting, short circuit or break of tachogenerator circuit. Wrong chosen parameter **P03.12**.
TG, OC, OL, PF	**ADC**	Trouble in analog-digital converter.
Flashing with a period 1 s.		
PF	**HPF**	Break of power supply or voltage of any phase.
OL	**OHF**	Overheat of converter power block when **P03.09** = 1.
OC	**HOC**	Over-current of max allowed current $Idrv_{MLIM}$ of converter power block.
TG	**ENF**	Wrong connection or break circuit of the encoder.
TG, OC, OL, PF	**EEF**	Trouble in power free memory.
Flashing with a period 0.3 s		
PF	**FRF**	Power net frequency is out of allowed range. Out of synchronizing.
OL	**SOS**	Over-speed of given with parameter **P03.10** limit speed $\mathbf{N_{LIM}}$.
OL	**OVM**	Protection of overvoltage of max allowed armature voltage.
TG	**PSB**	Positive speed feedback.

Table 13 Status of LED indication of converter when there is an emergency mode.

7. Installation and connecting of the converter

7.1 General technical requirement when it is installed

Converters of 12XXX series as well as the commutating protective components which belong to the set of the electrical drive are installed in an electrical cabinet. You should bear in mind the following instructions when you install the converter:

– Mount the unit vertically. The mounting is performed only by the mounting holes, located in the upper and lower part of the box;

– Leave at least 100mm free space for air circulation at the top and bottom of the converter;

– Electrical connections must be in correspondence with the circuits of **p. 7.2.**

– Minimum section of the connecting conductors has to correspond to given in **table 14**;

– Wires should be as short as possible;

– Do not mount the signal conductors near the power conductors;

– Connecting the tachogenerator to analog input **Ubr** and the source of the speed reference to differential analog input **Uref** of the converter must be done by means of a shielded cable as the shield of the cable must be connected in one end only. Do not use the shield of the cable as acurrent-carring core;

– Use type and values of the protection elements, given in **table 14**.

	12010	12030	12080
TC1	4.0 mm2	6.0 mm2	2x10.0 mm2
TC2	2.5 mm2	6.0 mm2	10.0 mm2
TC3	2.5 mm2	6.0 mm2	10.0 mm2
TC4	0.5mm2		
TC5	Screen + 2 x 0.35mm2		
TC6	Screen + (3 x 3 + 2) x 0.35 mm2		
TC7	1 mm2		
QF1 – automatically switchers Shneider Elektric[1]	C60ND[2]	C60ND[2]	C60ND[2]
Fuses F2, F3 and F4	1,6A		
Fuses FU, FV and FW	20 A	32 A	80 A / outer installation /

Table 14 Minimum section of the connecting conductors. Types and values of the protection elements.

Notes:

[1] - It is allowed using other devices with the same characteristics;

[2] - Current class of automatic switcher is defined from the power of the supply transformer and the number of the DC motors connected to it;

[3] - When two or more converters are supplied and synchronizing at the same operative supply coil of the transformer it is recommended summary section of the conductor from star centre of the coil to analog ground **AGND** (X5.14,15) to be no less from 0.5 mm^2.

7.2 Converter connecting

Converter connecting depends on its type, type of the transformer, chosen type of the synchronizing and control operative supply, type of the speed feedback, system type and etc.

On **figure 15** is given example scheme of converters type 12010 and 12030 connecting when we use the transformer in electrical cabinet. Used in this example transformer is type M64.704.001.

Nominal lineal voltage of the power secondary coil of the transformer is **U1V1W1** – 3x120V, **U2V2W2** – 3x90V and **U3V3W3** – 3x60V. Choice of the coil where is connected the converter is defined by the max voltage of the DC motor armature.

Nominal operative supply voltage for converter control is $2x18V_{AC}$ from the secondary two-phase coil with middle terminal.

Converter synchronizing is made by separate secondary coil of the transformer. Shunts defined the synchronizing are placed in position **J1 = 1**, **J2 = 1**, **J3 = 1**. Nominal phase voltage of the synchronizing coil is $3x55V_{AC}$ to star centre **N4**.

Operative supply voltage of the power contactor **K1** is $220V_{AC}$.

Supply voltage of the digital inputs is external and system output of the CNC are type **N**.

Converter speed feedback is realized with built-in in DC motor tachogenerator.

On **figure 16** is given example scheme of the converters type 12010 and 12030 connection with common secondary coil of the transformer of the operative supply and synchronizing of the converter control. Nominal lineal voltage of the coil **x1y1z1** is $3x32V_{AC}$.

Shunts defining the source of the synchronizing are placed in position **J1 = J2 = J3 = 2**.

Nominal lineal voltage of the power secondary coil **XYZ** is to $3x220V_{AC}$ and is defined by DC motor max armature voltage. In **Appendix 1** is written methods about calculating of the power transformer.

For supply of the digital inputs is used inner operative voltage $\mathbf{24V_{DC}}$ and the outputs of the CNC are type **N**.

Converter speed feedback is realized with Built-in in DC motor encoder which is connected to interface **X3** and is supplied by it. To watch positions the system is used interface **X4** which is an extension of **X3**.

Attention: For systems different from FANUC where there is not built-in command **PRDY** is recommended to use the emergency machine system as it is given on **figure 16**.

On **figure 17** is given example scheme of converter type 12080 connection. For operative supply and synchronizing of converter control is used common secondary coil of additional three-phase transformer **TF2**. Nominal lineal voltage of coil **x1y1z1** is $3x32V_{AC}$.

Shunts defining the source of synchronizing are in position **J1 = J2 = J3 = 2**.

Power contactor **K1**, resistor of dynamic stopping **Rdyn** and power fuses **FU, FV**, and **FW** are external.

DC motor armature is connected to double power converter terminal **A1**(X7.5,X7.6) and **A2**(X7.7,X7.8).

For supply of digital inputs are used external operative voltage, when the place of shunt **J9** = **EXT**, system outputs of CNC are type **P**.

Encoder is connected to system and is supplied by it. Converter speed feedback signal is analog and is made by system.

On **figure 18** is given an example scheme of converter type 12XXX connected to autotransformer **ATF1**. For operative supply and converter synchronizing is used common coil **x1y1z1n** connected in star and nominal lineal voltage $3x32V_{AC}$.

Shunts defining the source of synchronizing are in position **J1 = J2 = J3 = 2.**

For supply of digital inputs is used inner operative voltage, when the place of shunt **J9** = **INT**, and system outputs are type **N**.

Converter speed feedback is realized with built-in encoder which is connected to interface **X3** and is supplied by it. For watching the system position is used interface **X4** which is external of **X3**.

On **figure 19** is given a scheme of converter type 12XXX connecting where for operative supply and synchronizing is used common coil which is connected of the secondary coils of three low power monophase transformer **TF2, TF3** and **TF4**. Secondary coil of these transformer corresponding to condition of in phase are connected in star with lead star centre but first in triangle.

Shunts defining the source of synchronizing are in position **J1 = J2 = J3 = 2**.

Supply voltage of the digital inputs is external and system outputs of CNC are type **N**.

Converter speed feedback is built-in in the DC motor encoder which is connected to interface **X3**. Encoder is supply by system.

On **figure 20** is given electrical scheme of connecting the devices to two-axis system with CNC and converter type 12XXX.

It uses power transformer **TF1** with common secondary coil **XYZ** to supply two converters.

For operative supply and synchronizing is used a common coil – connecting of the secondary coil of three low-power mono-phase transformers **TF2, TF3** and **TF4.** Secondary coil of these transformers corresponding to condition of in phase are connected in star with lead star centre and first are in star, too.

Shunts defined the source of synchronizing are in position **J1 = J2 = J3 = 2**.

Encoder of each axis is connected to system and is supplied by it. Signal of converter speed feedback is analogue and is made by system.

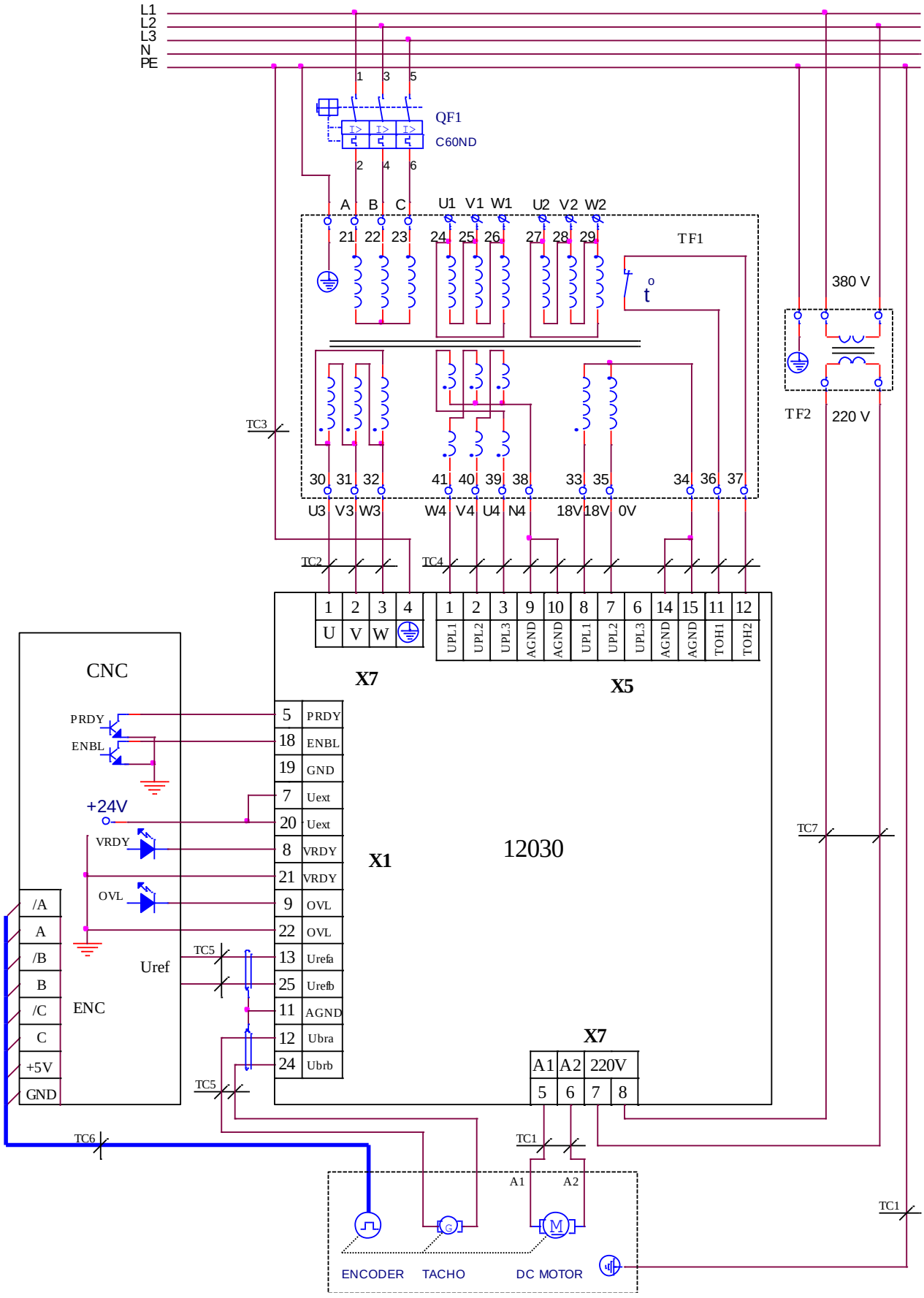


Figure 15 Connection converters 12030 to DC motor and to power supply transformer with separate synchronizing and operative coils (for example type M64.704.001)

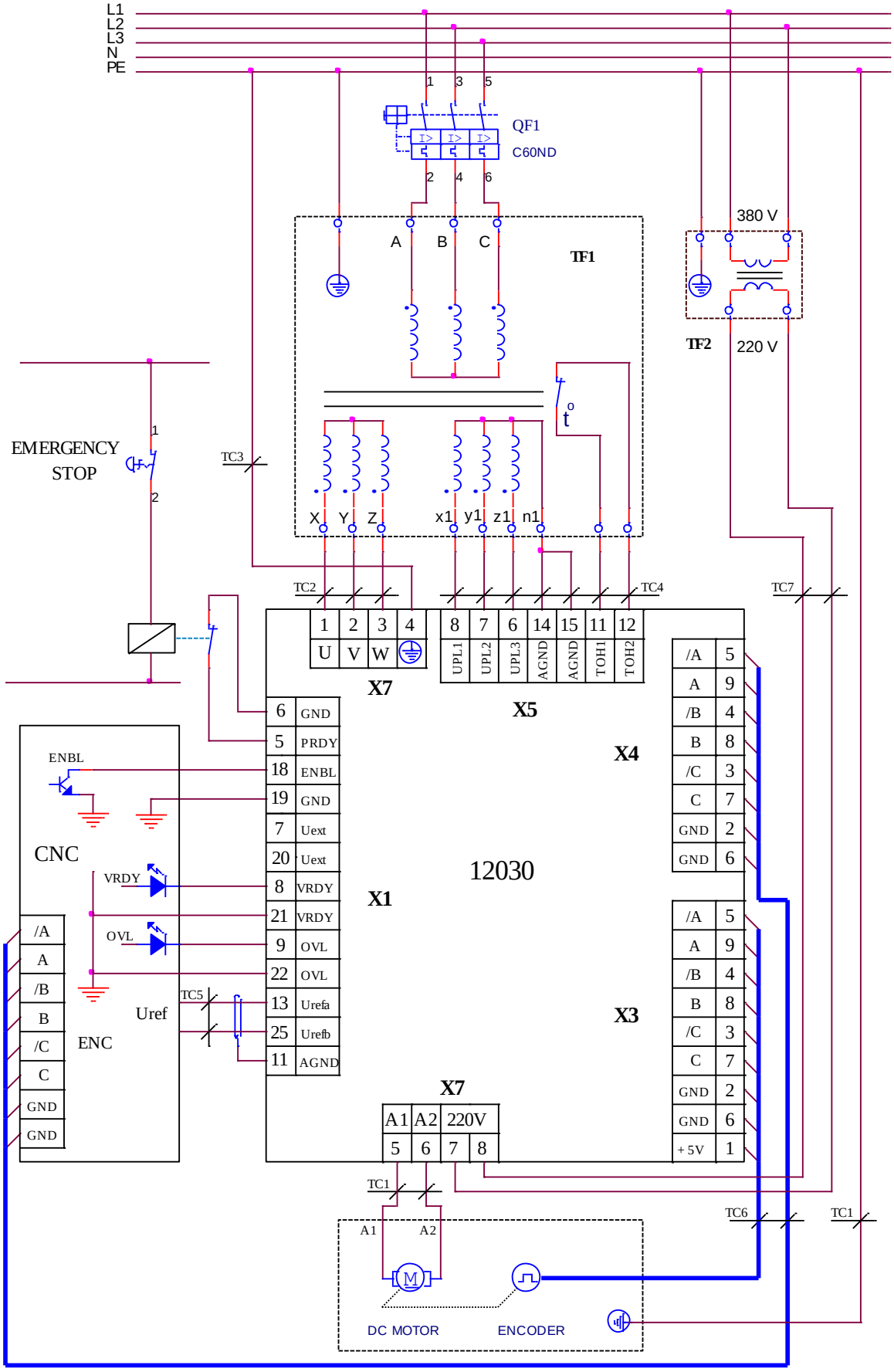


Figure 16 Connection the converter 12030 to the mains transformer with common three-phase operative and synchronizing coil and DC motor.

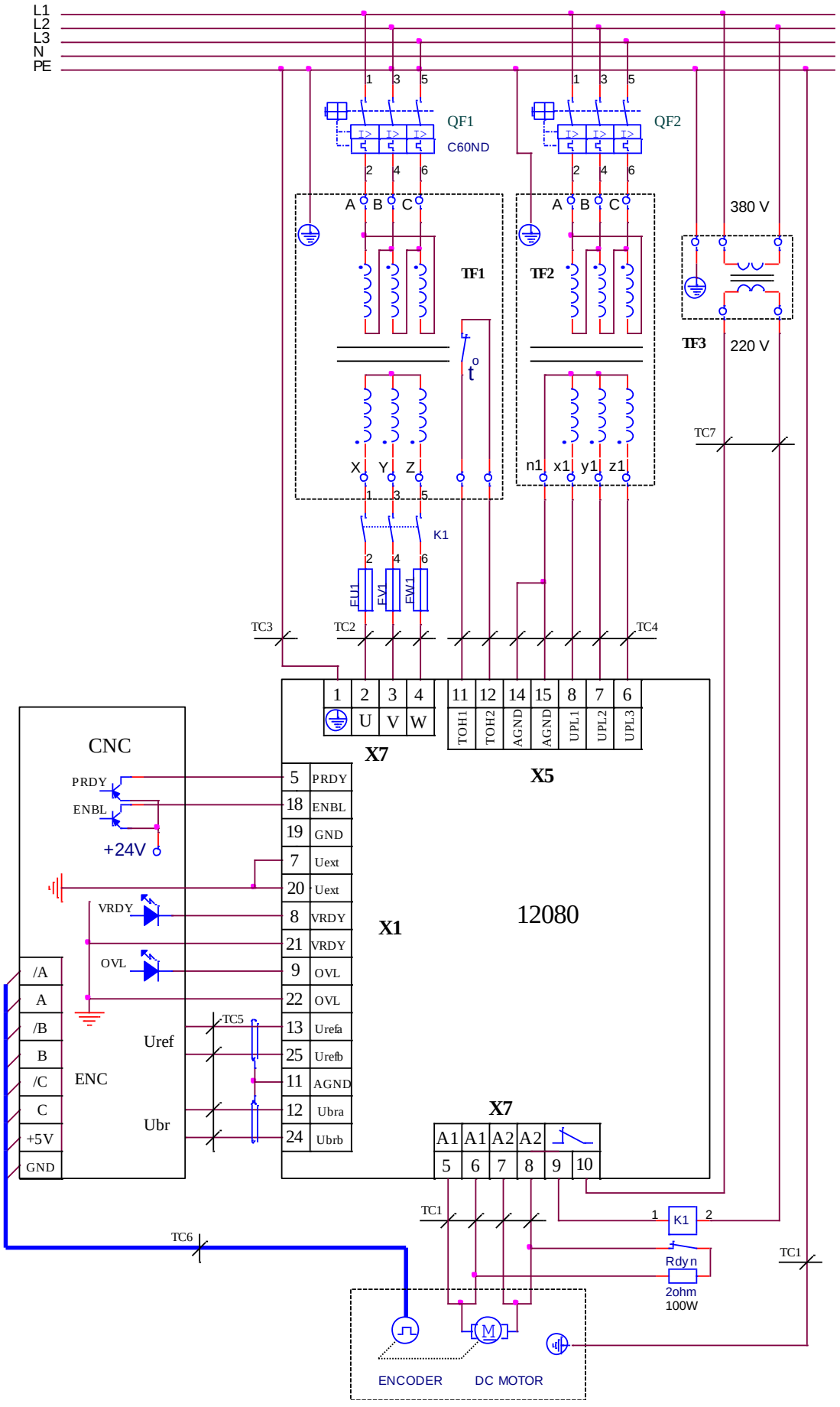


Figure 17 Connection the converter 12080 to additional three-phase transformer with common three-phase operative and synchronizing coil

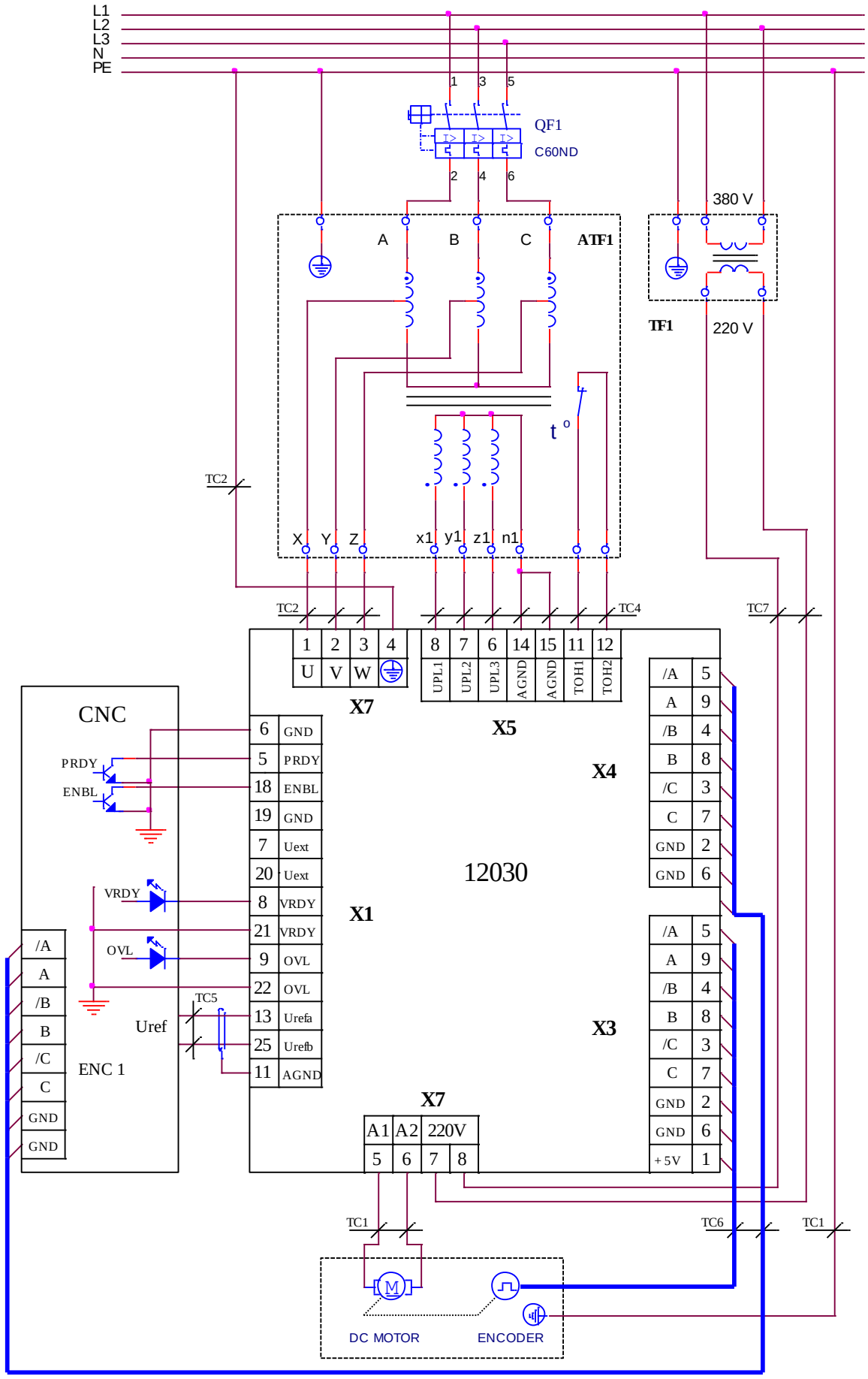


Figure 18 Connection converter 12030 to power supply autotransformer with common coil for operative supply and synchronizing

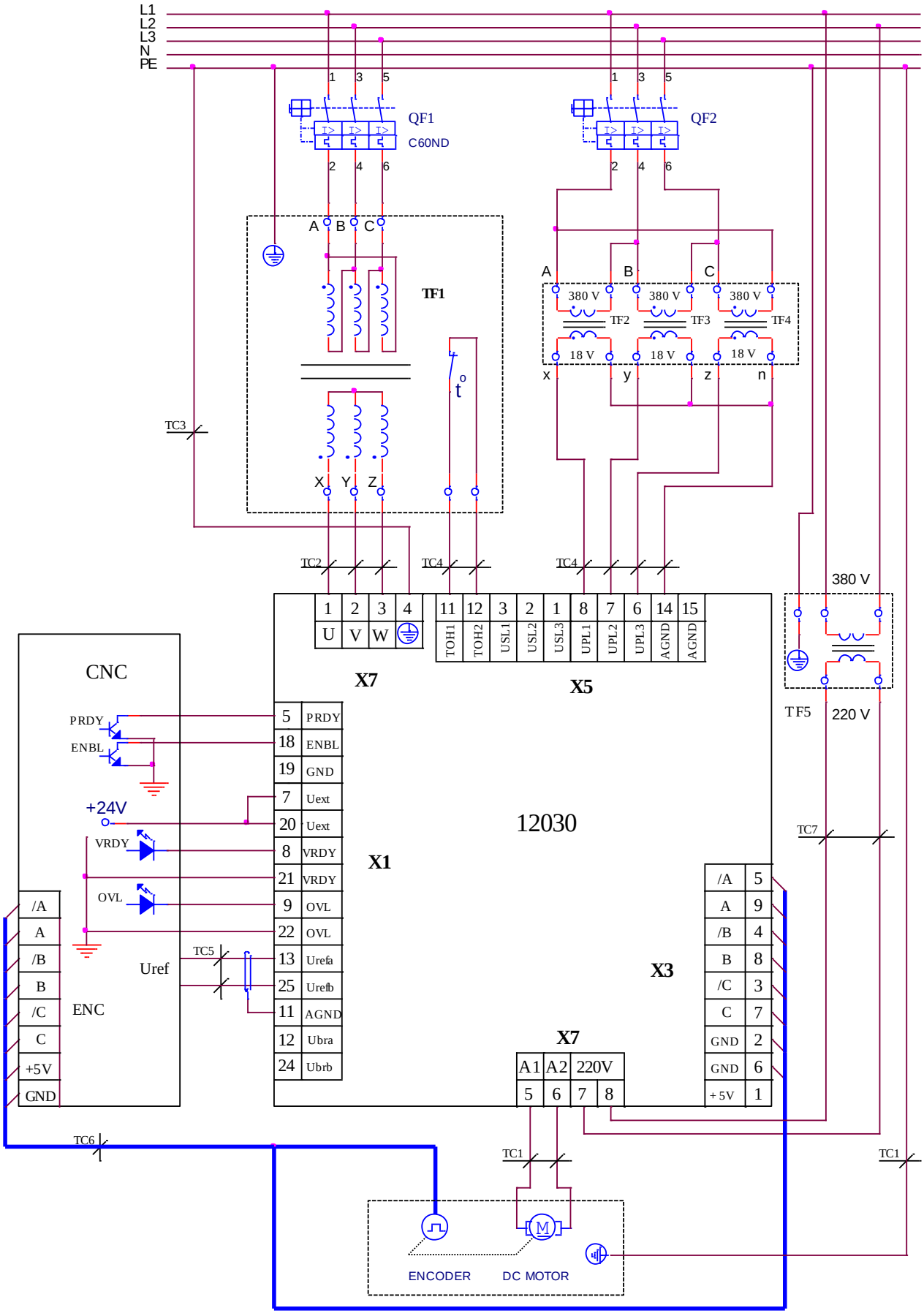


Figure 19 Connection converter 12030 to the mains transformer and separate group mono-phase transformers for operative supply and synchronizing

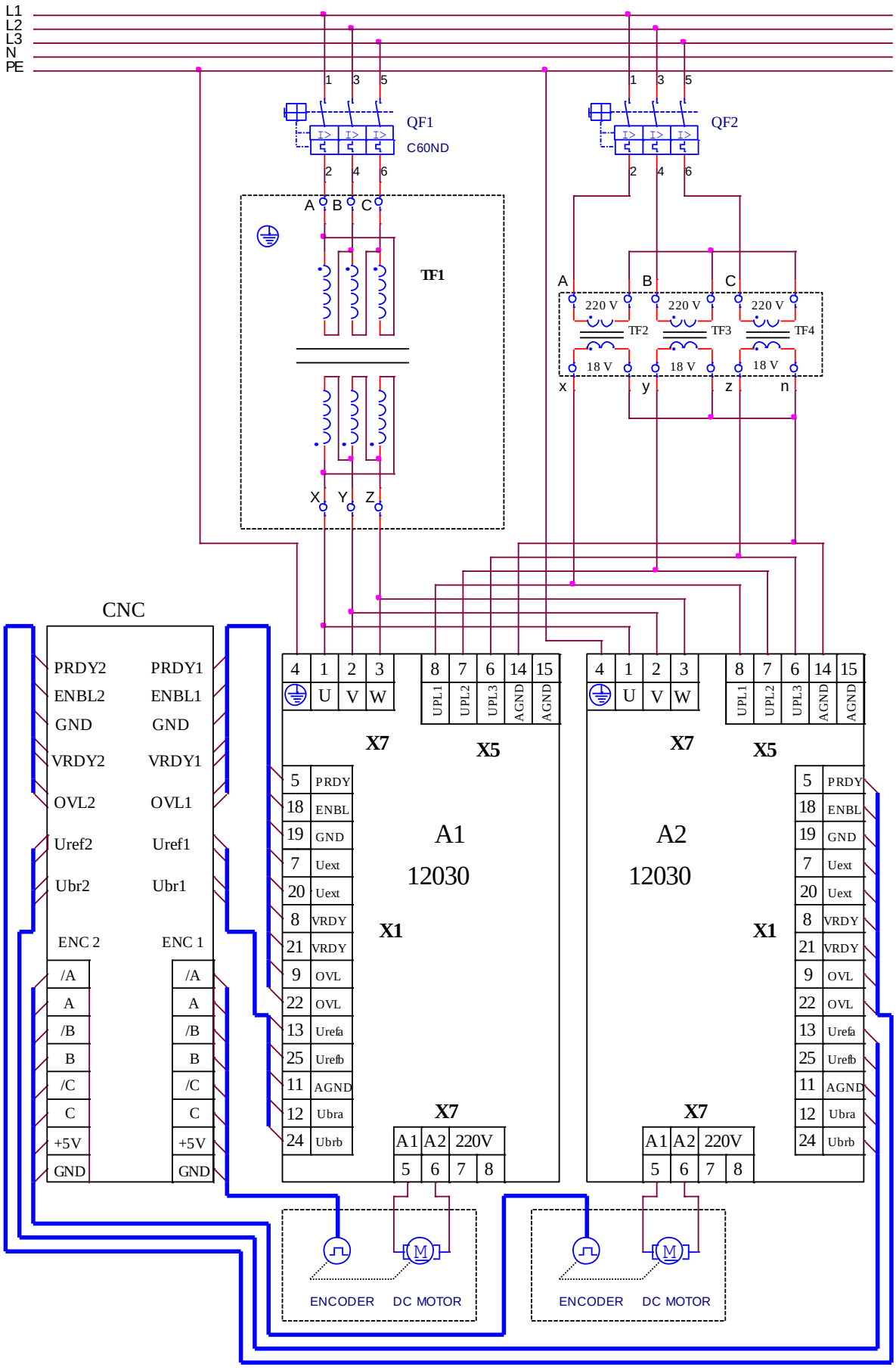


Figure 20 Connecting two axis system with CNC and converter 12030 to power supply transformer with common secondary coil and separate group mono-phase transformers for operative supply and synchronizing

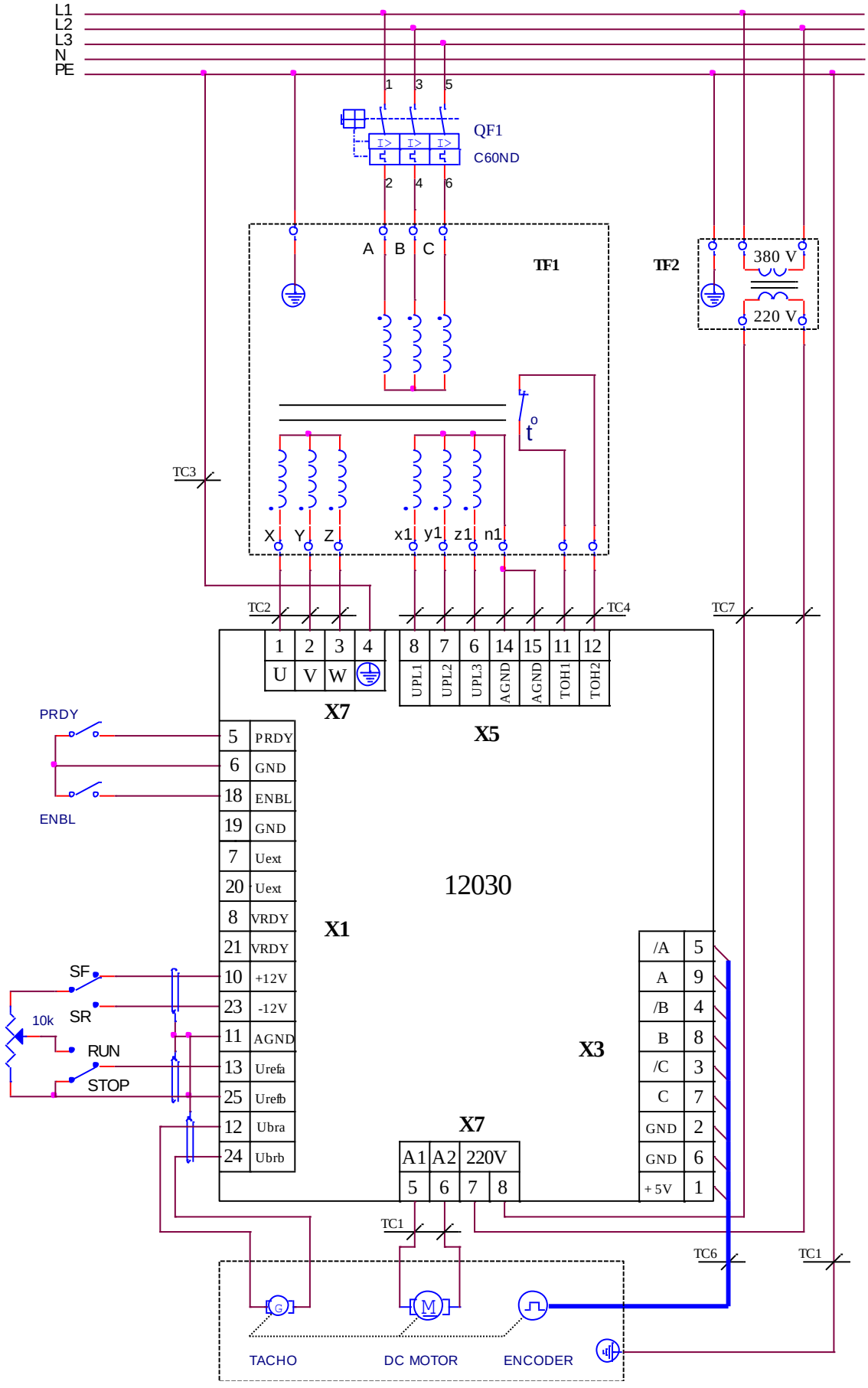


Figure 21 Connection converter 12030 when it is first started

8. Starting the converter

It is made by some stages with helping these devices:

– Voltmeter with range to 500$V_{AC/DC}$, class 1.5;
– Digital revolution-meter;
– Oscilloscope;
– Switcher for switching ON command **PRDY**;
– Switcher for switching ON command **ENBL**;
– Switcher **SF/SR**;
– Switcher **RUN/STOP**;
– Variable resistor 10k;
– Terminal for adjusting parameters.

8.1 Checking power and synchronizing voltage

To converter are connected power supply voltage **U**(X7.1), **V**(X7.2) and **W**(X7.3) and operative supply voltage **UPL1**(X5.8), **UPL2**(X5.7), and **UPL3**(X5.6) according to schemes given on **figure 15**, **figure 16**, **figure 17**, **figure 18**, **figure 19** and **figure 20**.

During this checking DC motor is not switched ON to converter.

Specialized terminal for adjusting parameters is connected to converter serial interface **X6.**

Open face panel of converter to reach to control plate.

Choose the source of converter synchronizing voltage:

– When synchronizing is separate coil of supply transformer, shunts **J1, J2** and **J3** are in position **1**. In this case synchronizing is made by voltage of **USL1**(X5.3), **USL2**(X5.2) and **USL3**(X5.1) of the interface **X5**;

– When synchronizing is from the coil of operative supply converter control shunts **J1, J2** and **J3** are in position **2**. In this case synchronizing is made by voltage of **UPL1**(X5.8), **UPL2**(X5.7) and **UPL3**(X5.6) of the interface **X5**.

Connect power supply voltage to **U**(X7.1), **V**(X7.2), **W**(X7.3) and operative voltage to **URL1**(X5.8), **UPL2**(X5.7) and **UPL3**(X5.6). If it is used additional coil for converter synchronizing the synchronizing voltage is switched to **USL1**(X5.3), **USL2**(X5.2), **USL3**(X5.1) of interface **X5**.

Switch ON the converter power. The control circuit checks if there are synchronizing voltages and power supply mains frequency. If the synchronizing voltages are all right and mains frequency is in admissible range the LED **RD** indication lights in flashing mode with a period of time 1 s.

When there is not one or more synchronizing phases protection **SPF** activates and LED **PF** lights constantly.

When there are not all of the three synchronizing phases the protection **FRF** activates and the LED **PF** indication flicks with a period of time 0.3 s.

When any of the protections SPF or FRF activates, switch OFF converter power and check for:

– Positions of shunts **J1, J2** and **J3**;
– Break of synchronizing voltage phase;
– Suitable fuses **F2, F3** and **F4**, placed on the control plate, given on **figure 22**.

After repairing the reason and switching on the converter power supply secondary, if the checking is successful the LED indication **RD** activates in flicking mode.

When command **PRDY** is given the built-in power contactor **K1** switches ON (type 12080 relay contact X7.9 – X7.10 closes and contactor **K1** is external). Converter makes check for presence and correspondence of power and synchronizing voltage. When connecting is right and there is voltage of all phases contactor **K1** (or relay contact X7.9 – X7.10 for type 12080) stays in ON and LED **RD** indication switches ON – lights constantly. Relay output **VRDY** activates.

When there is not correspondence between power and synchronizing voltage or voltage of any phase absents, protection **HPF** switches ON and power contactor **K1** (or relay contactor X7.9 – X7.10 for type 12080) switches OFF. LED **RD** indication switches OFF and LED **PF** indication lights in flashing mode with a period 1s.

Switch OFF converter supply and check for:

– Break or cross phases of synchronizing and power voltage;
– Suitable fuses **F2**, **F3** and **F4**;
– Suitable fuses **FU**, **FV** and **FW**.

Switch ON converter power and check presence and correspondence of power and synchronizing voltage again.

Check lineal power supply voltage by parameter **P01.15** which value to 130V corresponds to converter 12XXX/130 and value from 130 to 250V – 12XXX/250.

Attention: It is not allowed converters 12XXX/130 work with power voltage more than 130V, because there is a danger to be damaged. If converters 12XXX/250 work with power voltage less than 130V protection **SPF** will be activated without any reason.

After finishing this check converter power is switched OFF.

Notes:

1. Synchronizing coil voltage must be in phase with secondary coil of power supply voltage. For this purpose should be observed requirements to the synchronizing coil given in **p. 5.3.2** and **Appendix 2**;
2. If these requirements are not observed between these coil voltage will exist phase difference which in some cases can be 30ºel. They can not be registered by protection **HPF** which watches for out of phase 120ºel i.e. for phase exchange;
3. Finally check of in phase between the voltage of synchronization coil and power secondary coil is made in proportional mode, as it is given in p. 8.3.

8.2 Primary converter adjusting

8.2.1 Choose max DC motor speed for concrete using

When DC motor rotating max speed in a machine is slower than the DC motor speed it needs to adjust the DC motor max speed corresponding to the machine speed. It is not allowed with a purpose to get machine speed to adjust converter max speed higher than given in the motor table.

Example:

DC motor with max rotating speed 1500 min^{-1} is connected to ball screw with a step 10mm directly, as at this the moving maximum speed of the support will be 15 m/min.

If the allowed max machine moving speed will be 5 m/min, that corresponds to the DC motor max speed 500min^{-1}. When the DC motor maximum rotating speed is adjusted wrongly, for example it stays 1500min^{-1}, so when we give the system moving 0.5m/min, responding to 50 min^{-1}, the motor real rotating speed is 150min^{-1}, i.e. the actual speed is three times higher from given and waited by system. This leads to over-regulating speed, also including the whole closed system to be excited, i.e. there may be speed fluctuation /moving in pushes/.

When the system is of firm FANUC and other analog, reference for max speed is ±7 V. To converters 12XXX, in purpose of university, it is accepted the reference of maximum speed to be ±10 V. Therefore, when converters 12XXX work with systems of given type, it needs system to be adjusted at this speed, so when it is given 7V needed machine max moving speed to be reached.

Example: When reference is 7V the motor max speed must be 500min^{-1} the system must be adjusted to max speed equal to 500*10/7=714min^{-1}.

Attention: DC motor max speed must be response to machine max work speed.

8.2.2 Pre-adjusting of speed feedback

- **Speed feedback with tachogenerator**

Converter is factory-made for work with tachogenerator and parameter **P02.11** = 0.

Tachogenerator voltage when DC motor rotating speed is max is defined with the formula:

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

where:

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

$\mathbf{Ubr_{1000}}$ – tachogenerator voltage when motor speed is 1000 min^{-1}.

According to counting max tachogenetaror voltage choose the range from **table 3** and shunts **J5**, **J6**, **A1, A2, A3** and **A4** must be placed corresponding to chosen combination.

- **Speed feedback with encoder**

Switch ON the converter supply and on terminal display is appeared the announcement **P01 Monitoring**.

When you work with an encoder, insert value of the parameter **P02.11 = 1**.

According to the encoder revolution by parameter **P02.15** insert the pulse number per revolution.

Define rotating speed of the encoder when the motor speed is max as there are two cases:

– When the encoder is mounted on the DC motor directly, i.e. with reduction factor 1 – in parameter **P02.16** insert max DC motor speed $\mathbf{N_{MAX}}$;
– When the encoder is connected to DC motor with any reduction and the reduction factor is different from 1 in parameter **P02.16** insert the encoder speed corresponding to DC motor max speed $\mathbf{N_{MAX}}$.

Checking the right insert encoder speed in parameter **P02.16** is made as we give 50% of the machine fast motion and by parameter **P01.02** is read the real speed of the DC motor. I given and real speed are different by correction of the value of parameter **P02.16** these two speeds are made equal.

8.2.3 Adjustment of converter nominal current

When we choose a converter for a type motor, we have to know that converter nominal current $\mathbf{Idrv_{NOM}}$ should be equal or more than the motor nominal current $\mathbf{Ia_{NOM}}$.

The converter nominal current is adjusted by measured resistors **R26** and **R27**. After inserting in parameter **P02.07** the motor nominal current by parameter P02.08 can be defined the value of the equivalent resistance of the resistors **R26** and **R27** in ohms.

Note: It is not allowed adjusting the nominal current of the type converter higher than given in **table 1**.

8.2.4 Adjusting the motor parameters

Insert parameter values which have direct relation to work and limited allowed motor characteristics:

– Parameter **P04.01** – max voltage of the motor armature $\mathbf{Ua_{MAX}}$;

Note: When chosen max speed is lower than given in motor name plate, insert in parameter **P04.01** value of the armature maximum voltage, corresponding to this maximum speed.

– Parameter **P04.02** – motor max speed from its name plate;
– Parameter **P04.03** – maximum motor working speed in this use;
– Parameter **P04.04** – motor max speed $\mathbf{Nm_1}$ to which is allowed work with max armature current $\mathbf{Ia_{MAX}}$;
– Parameter **P04.05** – max motor armature current $\mathbf{Ia_{MAX}}$;
– Parameters from **P04.06** to **P04.15** – points **2** ÷ **6** of the curve of the motor dynamic current limit.

Switch OFF the converter supply.

8.3 Starting converter in proportional mode

First starting converter with DC motor is made in proportional mode. In this mode speed and armature current regulators are switched OFF and do not influence on converter work i.e. the DC motor may work at low speed without switching on or out of phase speed sensor (tachogenerator or encoder). Protection of break speed feedback in this mode is switched OFF, too.

In converter proportional working mode is made:

– Checking for in phase between the voltage of synchronizing coil and secondary power coil of the mains transformer for the last time;
– Checking the tachogenerator status;
– Adjustment and in-phasing the circuit of speed feedback;
– Checking work of converter power rectifier;
– Checking thyristor works.

Connect the motor armature to converter and switch ON power supply of the converter.

Insert the password. Choose converter proportional working mode when parameter **P02.06** = 1. Change of the parameter **P02.06** is not written in EEPROM and each time when the power supply of the converter is switched on, value of the parameter **P02.06** = 0, i.e. the converter works in integral mode.

Choose the source of reference of thyristor firing angle with parameter **P02.09**:

– **P02.09** = 0 – work with analog bipolar reference defined by value and sign of differential input **Uref** voltage;
– **P02.09** = 1 – work with digital reference which value is written in parameter **P02.10** in percentage to max speed $\mathbf{N_{MAX}}$ with a sigh of rotating direction.

When we work in proportional mode reference of firing angle is internal limited to safe motor speed, because it works without speed feedback.

Switch ON the command **PRDY** and LED **RD** indication lights.

Switch ON the command **ENBL** and LED **ON** indication lights.

Give reference for firing thyristors and the motor rotates.

If when the reference is zero, but motor rotates with high speed that means the synchronizing voltage leads phase power voltage.

If the motor starts rotating when the reference is high that means synchronizing voltage lag phase from power.

In these cases, check the circuit of connecting the synchronizing coil if it responses to given in **p. 5.3.2** and **Appendix 2**.

By parameter **P01.10** it is watched the fluctuations of the tachogenerator voltage. When tachogenerator is correct in established mode value of parameter **P01.10** must not be more than 2%. When the value is more than 2% it needs tachogenerator to be check or repaired.

To check if the speed feedback is in phase values of parameters **P01.02** and **P01.05** are compared. When the connection is correct both parameters must be with the same signs. When values of the two parameters are different by sign, the following two cases are possible:

- **Speed feedback with tachogenerator**

– The motor rotating direction corresponds to the given reference. Change the connection of the tachogenerator or invert the sign of the feedback by parameter **P02.13**;

– The motor rotating direction is opposite to the given reference. Change the connection of the motor armature or invert the sign of the reference and the sign of the feedback by parameters **P02.12** and **P02.13**;

- **Speed feedback with encoder**

– The motor rotating direction corresponds to the given reference. Change the connection of the encoder (for example two phases – **A** and /**A**) or invert the sign of the feedback by parameter **P02.14**;

– The motor rotating direction is opposite to the given reference. Change the connection of the motor armature or invert the sign of the reference and the sign of the feedback by parameters **P02.12** and **P02.14**.

Check the work of converter power rectifier as you watch the form of armature current in control point **KP20** to ground – control point **KP8** with an oscilloscope. Checking is made at low motor rotating speed – for example 5% of max speed $\mathbf{N_{MAX}}$**.** Return motor rotating direction and watch motor armature current again. Watched pulses of armature current must be with interval 3.3 ms and the amplitude difference no more than 20%. If there is difference between each first and fourth pulses they can be made equal by thrimmer **RP4**. When there is difference between one phase current and other i.e. different one to other pulses they can be made equal by parameters **P06.03**, **P06.04** and **P06.05**. In case that they can not be made equal parameters are reset and the difference in pulse amplitude is made equal by thrimmers **RP1**, **RP2** and **RP3**.

When any of the current pulses of any phase absences choose parameter **P01.15** and define which thyristor does not work, switch OFF converter supply and check the thyristor and its control circuit.

8.4 Protection adjusting

- **Adjusting of break speed feedback protection**

Protection **STG** of break speed feedback works as it compares the motor armature voltage and real speed. In parameter **P03.12** is written armature voltage in percentage of maximum inserted in **P04.01** when the break speed feedback protection **STG** is activated. For the correct function of protection **STG** needs maximum armature voltage $\mathbf{Ua_{MAX}}$ to be insert correctly in parameter **P04.01**. When the device is adjusted at max speed lower than motor's speed in parameter **P04.01** must be insert corresponded to the speed max armature voltage.

When the value, written in parameter **P04.01,** is much higher than the real one, it is possible the protection **SOS** activates before protection **STG**.

When the value, written in parameter **P04.01**, is much lower than the real one, it is possible the protection **STG** activates without any reason in ordinary working conditions.

- **Adjusting the protection SOC of maximum armature over current**

When the motor max current, given in parameter **P04.05**, it is recommended in parameter **P03.11** to be inserted a new value, equal to 125% of new max motor current.

- **Adjusting protection OLF of motor overloaded**

When converter works with limit max motor current under 500% and load with raising moment of inertia it is allowed raising the value of **P03.08** than understanding one as it should not allowed motor overheated.

- **Adjusting the protection OHF of power block overheated**

When the thyristor converter works with built-in temperature sensor (for example12080) it needs protection to be activated with **P03.09** = 1.

- **Adjusting protection SOS of over-speed max speed**

When max speed is reached and there is over-regulation protection activates it is allowed raising value of parameter to **P03.11** = 110.

- **Adjusting the protection OVM of over-voltage of the max armature voltage**

Protection **OVM** of maximum armature over-voltage activates when real armature voltage is more than the value of parameter **P03.17**. When parameter **P04.01** is inserted wrongly the protection activates when the speed is lower than the maximum one.

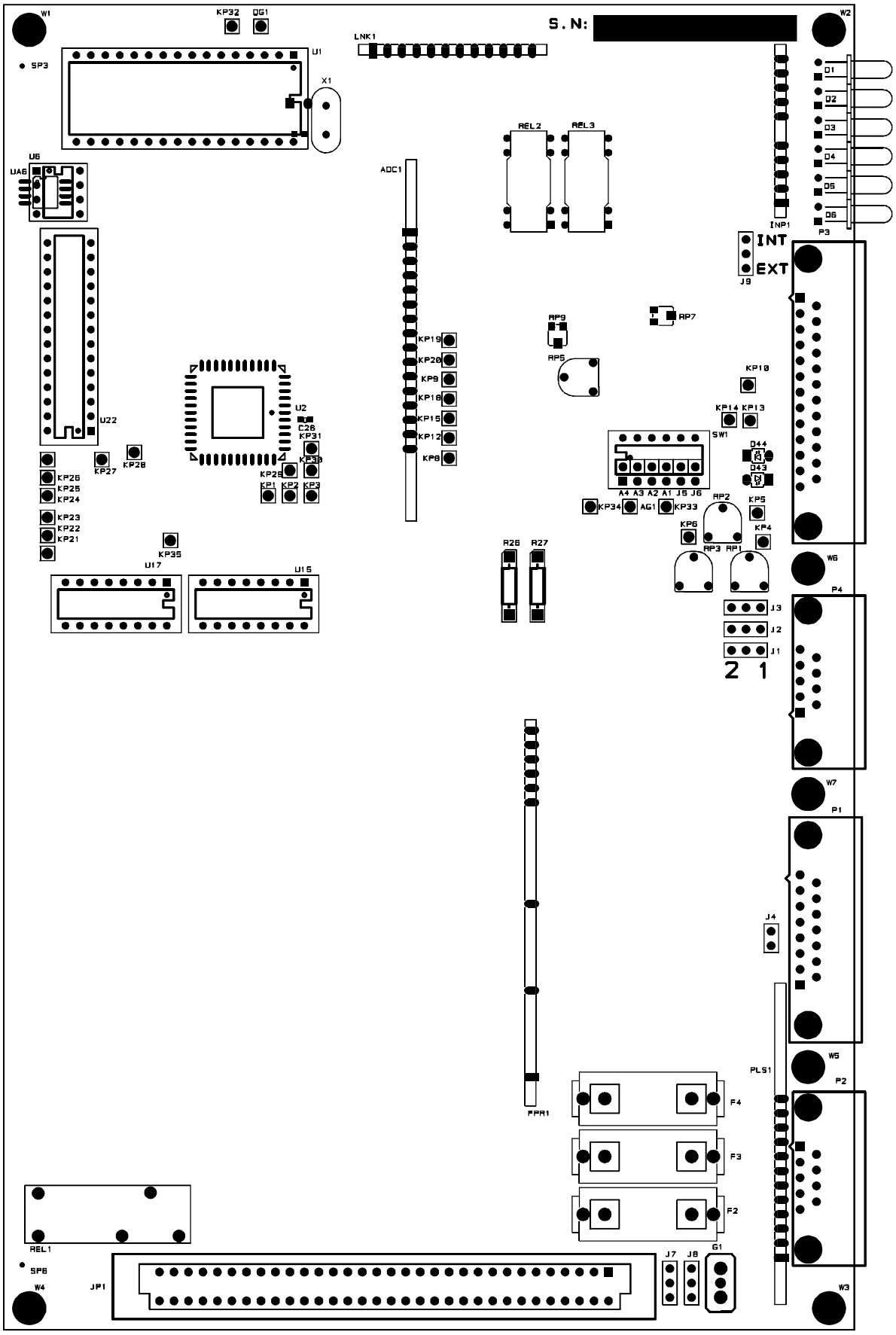


Figure 22 Positions of the adjusting elements on the control board

8.5 Starting the converter in integral mode

After finishing upper checking switch OFF command **ENBL**.

Insert value in parameter **P02.06 = 0**, to move in speed control of converter mode (integral mode).

Give command **ENBL** and motor rotates with speed defined by reference **Uref**.

For precise calibration of the speed feedback give speed reference 50% of $\mathbf{N_{MAX}}$ and by trimmer **RP5** reach the reference speed counted by revolution-meter.

After finishing the adjustments and when there is a control device higher level (CNC) to converter the control interface is connected to converter. Next check the converter in all wished machine working modes. When it performs all requirements the machine is ready for work. Switch OFF the supply voltage and close the converter.

When the work is not good enough it must adjust current and speed regulators of the converter.

There is a possibility the motor to work in tick over including and by demounting from the machine.

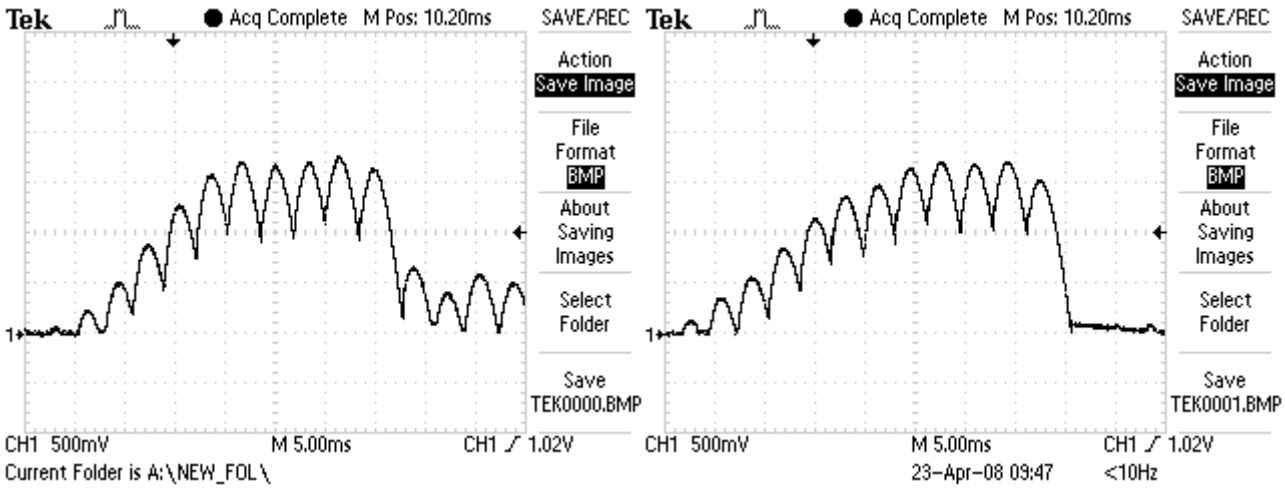
For adjusting quality we may judge according to transient processes of current and motor speed.

- **Adjusting the armature current regulator**

Switch ON the command **ENBL**.

Give a leap reference from zero (0) to 40% of max speed $\mathbf{N_{MAX}}$. Watch form of armature current in control point **KP20**. Armature current should reach the rate of its max to fourth or fifth pulses without visual overshoot and their amplitude should not be higher than established max value. After that give a leap reference to zero speed again and watch form of armature current curve.

Optimal form of armature current curve when the motor rotates rapidly and when it stops is given on **figure 23**. Remember that we watch the absolute value of armature current without a sign.



Acceleration Stopping

Figure 23 Form of motor current curve when it accelerates and stops when the adjusting of armature current regulator is optimal

Parameters **P06.01** and **P06.02** are used for adjusting the current regulator. Parameters **P06.01** and **P06.02** influence on the work of the current regulator as:

- Parameter **P06.01** – gain of current regulator. Typical values of parameter **P06.01** are from 0.10 to 0.50. When parameter **P06.01** value is bigger the "strong" of the equipment increases but it may be self-energetic. When parameter **P06.01** values are smaller time of reaching the fixed current increases;
- Parameter **P06.02** – time-constant of current regulator. Typical values of parameter **P06.02** are from 12.0ms to 40.0ms. When parameter **P06.02** has smaller values the reaction speed of current regulator increases but it may be self-energetic. When parameter **P06.02** has high values time for reaching established current increases.

When parameter **P06.01** has high values and parameter **P06.02** has a low value there is high current over-regulating during the transient process. Armature current curve with over-regulating when motor rotates rapidly and stops are given on **figure 24**. In this case it is possible protection **SOC** activates.

When parameter **P06.01** has low value and parameter **P06.02** has high value there is there is a long transient process to reach the established current. Armature current curve when motor rotates rapidly and stops are given on **figure 25**.

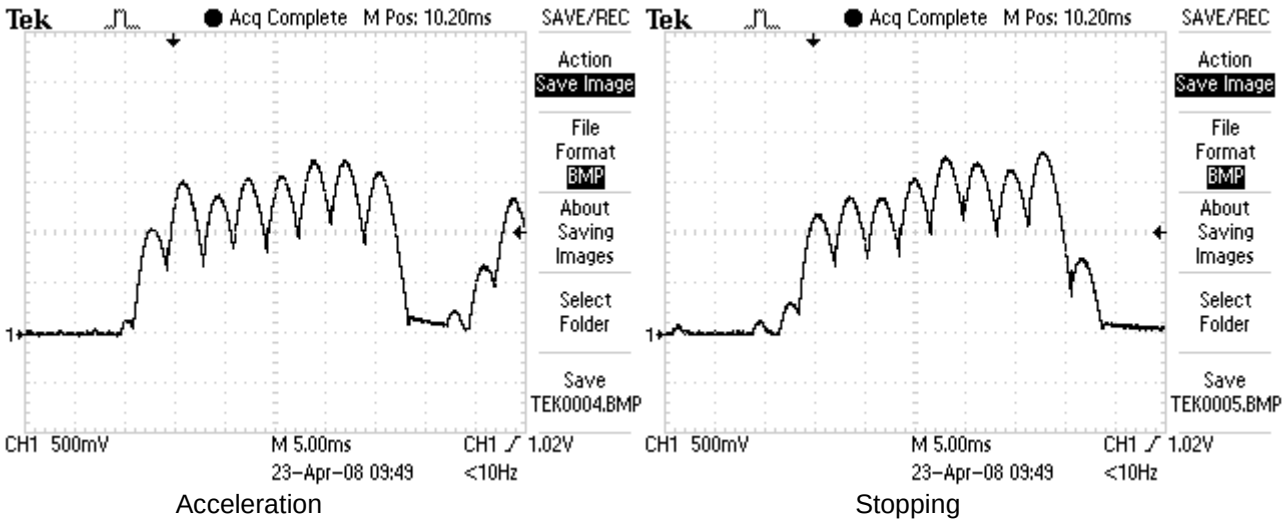


Figure 24 Current curves with over-regulating when parameter **P06.01** has high value and parameter **P06.02** has low value

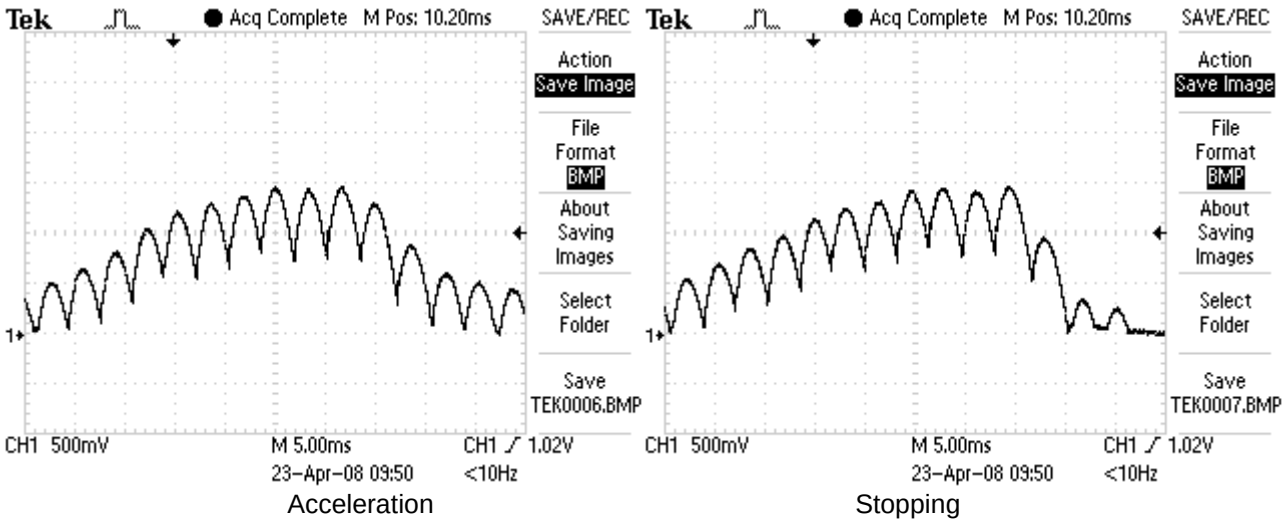
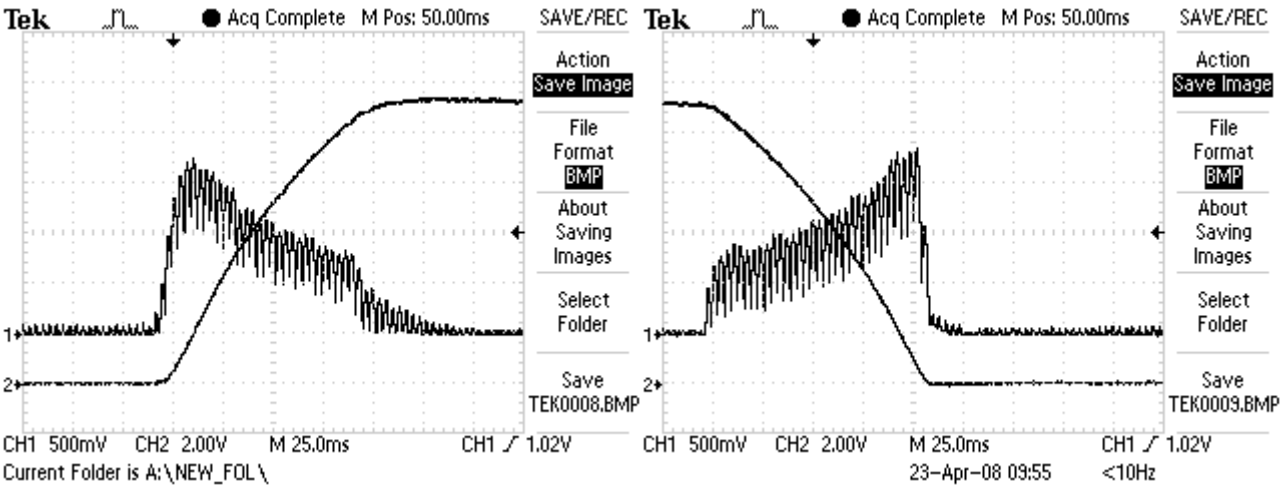


Figure 25 Current curve with lasting transient process when parameter **P06.01** has low value and parameter **P06.02** has high value

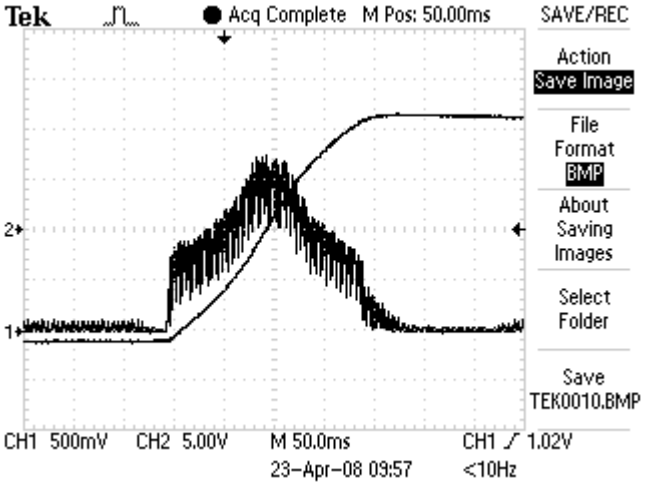
- **Adjusting the speed regulator**

  After adjusting the current regulator it is made checking the speed regulator.

  Give a step speed reference from 0 to 100% of max speed and vice versa and also reverse. Watch speed form in control point **KP10** and current in **KP20** on an oscilloscope. Forms of processes when speed regulator is optimal adjusting, is given on **figure 26**. It allows a single speed leap which is not more than 5% of the established value.



Acceleration Stopping



Reverse

Figure 26 Speed and current curves when speed regulator is optimal adjusting

When speed regulator is optimal adjusting the speed transient processes are without visual over-regulating. The transient speed process when it reverses has **S**-form, because of dynamic current limit according to speed working in armature current form.

For optimal work of speed regulator in different modes there is adaptive adjusting its parameters.

Parameters influence on the converter work as:

- Parameters **P05.02** and **P05.03** – amplification constant of speed regulator. When parameters have high values the motor acceleration increases and time of reaching given speed decreases and over-regulating increases (over-speed of given speed) but the motor may be self-energetic. When parameters have low values time of reaching given speed increases;
- Parameters **P05.06** and **05.07** – integral time-constant of speed regulator. When parameters have low values reaction speed of speed regulator increases which decreases speed error but the system may be self-energizing. When parameters have high values time of reaching given speed increases;
- Parameters **P05.10** and **P05.11** – differential time-constant of speed regulator. Increasing the parameter value leads to decreasing the over-regulating (over-speed the given speed) and speed damping increases. When parameters have high values the system may self-energizing according to their leading influence.

When we start the system with unknown motor directly in the machine not only one parameter may be incorrect. In this case first adjust the speed regulator in low working speed as optimizing parameters **P05.02**, **P05.06** and **P05.10** to uniform motion without any pulses needed position accuracy. Increase the work speed and adjust parameters **P05.03**, **P05.07** and **P05.11** when the work in whole range and all modes is correct.

When we adjust the speed regulator it is recommended to keep in mind these definitions.

1. When we increase the amplification constants **Kp1 (P05.02)** and **Kp2 (P05.03)** integral time-constants **Tn1 (P05.06)** and **Tn2 (P05.07)** must be decreased in same proportion;

2. When we decrease the amplification constants **Kp1 (P05.02)** and **Kp2 (P05.03)** integral time-constants **Tn1 (P05.06)** and **Tn2 (P05.07)** must be increased in same proportion;

3. Differential time-constant **Dt1 (P05.10)** and **Dt2 (P05.11)** should be 50% of absolute value of amplification constants **Kp1 (P05.02)** and **Kp2 (P05.03)**.

8.6 Converter starting in torque controlling mode

In this mode system works only when other motor in the system leads. It may work in adding torque mode and in subtraction the torque (brake mode) according to the sign of given torque.

When we start converter in controlling torque mode it should be started and adjusted in speed control in idling mode according to **p. 8.5.** After adjusting in controlling speed mode connect the motor to the load and insert next parameters:

– Parameter **P02.06** = 2 – controlling torque mode;

– Parameter **P04.01** – motor armature max voltage $\mathbf{Ua_{MAX}}$, responding to max limit speed of acceleration over which protection **SOS** of over-speed max speed activates. As motor speed and its armature voltage are changed in lineal law we can limit speed to wishing value with armature voltage.

Attention: In this mode if the motor is without load it can self accelerate so the load should be connected hopefully.

9. Possible trouble shootings and remedy actions

Situation	Possible reason	Method for testing and eliminating the problem
1.When we give operative supply protection **FRF** activates. LED **PF** flicking with a period 0.3s.	Absence of synchronizing	Check if the synchronizing source is chosen correctly by **J1**, **J2** and **J3** positions.
2. When we give command **PRDY** protection **HPF** activates. LED **PF** flicking with a period 1s.	Phase lost and/or synchronizing and power out of phase.	Check if there is power and operative supply in phase, quality of connections. Check grounding.
3. When we switch ON the device and give command **PRDY** fuses **FU**, **FV** and **FW** blow. Protection **SOC** or **HOC** activates.	Short circuit in two or more thyristors or short circuit in power block	Break connections of power supply and motor armature. By ohm-meter check between terminals **U2**, **V2**, **W2** to **A1**, after that to **A2** to defining the damaged thyristor.
4. After switching the device ON and **ENBL** signal is ON protection **SOC** or **HOC** activates. It is possible fuses **FU**, **FV** and **FW** have blown.	Short circuit in one thyristor or short circuit in power block.	Break connections of power supply and motor armature. With ohmmeter check between terminals **U2**, **V2**, **W2** to **A1**, after that to **A2** to determine the damaged thyristor.
5. When both **ENBL** signal and speed reference are active the usual "growling" of the motor can be heard in transient process in one of direction of motor rotation.	There are "missing" pulses of armature current.	Start converter in proportional mode when **P02.06**=1 and with parameter **P01.15** check which thyristor does not work. Check circuit of its control and thyristor.
6. When both **ENBL** signal and speed reference are active motor is loaded and speed "fluctuates".	There is a shunt in motor armature.	In proportional mode motor starts rotating as "stepped". Switch OFF command **ENBL** and rotate motor shaft by hand. If the resistance moment increases in definite zones it means that there is a shunt in motor armature.
7. After starting the device protection **STG** activates at low motor speed. LED **TG** lights constantly.	Wrong connection, short circuit or break the circuit of tachogenerator.	Check connecting of the tachogenerator and its good working conditions. Check parameter **P03.12**.
8. After starting the device protection **ENF** activates at low speed. LED **TG** flicking with a period 1s.	Wrong connection, break or short circuit in encoder circuit.	Check connecting of the encoder and its good working conditions.
9. After starting the motor protection **PSB** activates. LED **TG** flashing with a period 0.3s.	Positive speed feedback.	Reverse the speed feedback sign by parameter **P02.13** = 1 or **P02.14** = 1.
10 While the device is working **OLF(I2t)** protection activates. LED **OL** lights constantly.	Over-loaded motor.	Check working mode of the machine. If necessary replace with more powerful drive. Check also parameter **P03.08** value.
11. While the device is working protection **OHF** activates (only to12080 and when parameter **P03.09** = 1). LED **OL** flashing with a period 1s.	Over-heated power block.	Switch OFF the converter and cool it. Provide power block of the converter with better ventilation.
12. During transient processes **SOC** protection becomes active. LED **OC** lights constantly.	Over-current the max allowed current $Idrv_{LIM}$.	Current regulator setting should be optimized. Check parameters **P03.11**, **P06.01**, **P06.02** values.

Appendix 1

Methods of defining of power transformer

Input data for calculations:

Nominal motor armature current	-	**Ia_{NOM}**
Max motor armature voltage	-	**Ua_{MAX}**
Lineal secondary voltage of operative coil	-	**U_3l**
Phase secondary voltage of operative coil	-	**U_3f**
Phase current of operative coil	-	**I_3f**

Calculation data

Lineal voltage of power secondary coil	-	**U_2I**
Phase voltage of power secondary coil	-	**U_2f**
Phase current of power secondary coil	-	**I_2f**
Type transformer power		**St**

Calculation formulas:

Power secondary coil 2:

U_2l = 0.850 * **Ua_{MAX}** [V]

U_2l = 0.490 * **Ua_{MAX}** [V]

I_2f = 0.817 * **Ia_{NOM}** [A]

Operative secondary coil 3:

U_3l = 32.0 [V]

U_3f = 18.4 [V]

I_3f = 1.0 [A]

Type transformer power

St = 1.26 * **Ia_{NOM}** * **Ua_{MAX}**

Connecting the transformer coils:

First coil – triangle

Secondary coil – star

When a device services one cutting tool it allows two power supply two or three converters with one transformer, its power is defined by the most power device. Each next device common power is raised with 20%. It is recommended motor should have equal max voltage.

ATTENTION:
Power and synchronizing voltage must be in phase.

Appendix 2

Scheme of synchronizing coil connected according to connecting schemes of first and secondary power transformer coils.

№	Power three-phase transformer			Additional three-phase transformer / mono-phase transformers for synchronizing and operative supply	
	Power coils		Synchronizing coil		
	First	Secondary		First	Secondary
1	Star	Star	Star with lead star centre	Star	Star with lead star centre
	Autotransformer			Triangle	Zigzag with lead centre
2	Star	Triangle	Zigzag with lead centre	Star	Zigzag with lead centre
				Triangle	Star with lead centre
3	Triangle	Triangle	Zigzag with lead centre	Triangle	Zigzag with lead centre
				Star	Star with lead centre
4	Triangle	Star	Star with lead centre	Triangle	Star with lead centre
				Star	Zigzag with lead centre
5	Triangle	Zigzag	Zigzag with lead centre	Triangle	Zigzag with lead centre
				Star	Star with lead star centre

P A S S P O R T

THYRISTOR CONVERTER FOR DC SERVO MOTOR

TYPE:……

S.№……

SOFTWARE:……

BULMACH Sp. z o. o.
ul. Chełmska 21 budget. 19
00-724 Warsaw
Poland
Tel.: +48 22 840 65 68
+48 22 841 07 98
+48 22 642 82 60
Fax: +48 22 112 12 23
e-mail: poczta@bulmach.pl

GUARANTEE CARD

Name of device:

“Thyristor converter for DC servo motor, type ……”

Series № ……

Date of made: ……

Guarantee period – 24 months from the date of working but no more than 28 months of date of made.

Manager: ……

Guarantee duties

1. Firm guarantees device working when there are no transport damages and there is working conditions given in user’s manual.
2. Device damaged during the guarantee period through producer fault puts in claim.
3. Guarantee falls if components of the device are repaired by a person without needed qualification.
4. Damages caused by neglected working as connecting to mains not as given in instructions are on account of user.
5. All questions with working and repairing the device the user should call to the firm producer.

Equipment

- Converter - 1p.
- User’s manual - 1p.

Passport - 1p.

Parameter table - 1p.

PARAMETERS TABLE

CONVERTER, TYPE .....

SERIES № .....

1. HARDWARE ADJUSTMENT

Power supply voltage .....
Nominal armature current .....
Max tachogenerator voltage .....
Digital inputs .....
Digital outputs .....

2. SOFTWARE ADJUSTMENT – PARAMETER VALUES

№	Parameter name	Range of changing	Unit	Standard value	New value
Group 01 – watching parameters					
P01.01	Current value of speed reference	-100.0 ÷ 100.0	% N_{MAX}	-	-
P01.02	Current value of real speed	-110.0 ÷ 110.0	% N_{MAX}	-	-
P01.03	Current value of armature current reference	-600.0÷600.0 % P02.07	A	-	-
P01.04	Current value of real armature current	-600.0600.0 % P02.07	A	-	-
P01.05	Current value of armature voltage	-250.0 ÷ 250.0	V	-	-
P01.06	Status of digital inputs	-	bin	-	-
P01.07	Reserved	-	-	-	-
P01.08	Status of digital outputs	-	bin	-	-
P01.09	Reserved	-	-	-	-
P01.10	Test of speed feedback	-	% Ubr	-	-
P01.11	Current value of net frequency	42.00 ÷ 68.00	Hz	-	-
P01.12	Current max diversion in synchronizing	-800 ÷ 800	µs	-	-
P01.13	Max number registered breaks in synchronizing	0 ÷ 50	-	-	-
P01.14	Max number registered breaks in power	0 ÷ 50	-	-	-
P01.15	Status power thyristors	-	bin	-	-
P01.16	Current value of armature supply voltage	-	V	-	-
P01.17	Current value of the encoder pulse number	-	imp	-	-
Group 02 – converter parameters					
P02.01	Version of converter software	-	-	-	-
P02.02	Access password	11	-	11	-
P02.03	Restoring parameter values by default	0, 1	-	0	-
P02.04	Image of user's parameters	0, 1	-	0	-
P02.05	Restoring the user's parameters	0, 1	-	0	-
P02.06	Converter working mode	0, 1, 2	-	0	
P02.07	Converter nominal current **$Idrv_{NOM}$**	5.0 ÷ 100.0	A	12.0	
P02.08	Calculated equivalent resistance **R26**, **R27**	-	Ω	-	-
P02.09	Choice of source of speed reference	0, 1, 2	-	0	
P02.10	Speed reference when **P02.09** = 1	-100.00÷100.00	% N_{MAX}	0.00	

№	Parameter name	Range of changing	Unit	Standard value	New value
P02.11	Choice of speed feedback	0, 1	-	0	
P02.12	Changing of speed reference sign	0, 1	-	0	
P02.13	Changing of speed feedback sign - tahogenerator	0, 1	-	0	
P02.14	Changing of speed feedback sign - encoder	0, 1	-	0	
P02.15	Encoder resolution	100 ÷ 20000	imp / min^{-1}	2500	
P02.16	Encoder rotating speed when motor speed is max	100 ÷ 20000	min^{-1}	2000	
P02.17	Waiting relay output of ready **VRDY**	0 ÷ 30000	ms	0	
Group 03 – protection parameters					
P03.01	Allowed number breaks in synchronizing - protection **SPF**	5 ÷ 50	-	10	
P03.02	Max number registered breaks in synchronizing - protection **SPF**	0 ÷ 50	-	-	-
P03.03	Max allowed diversion in synchronizing – protection **SPF**	100÷800	µs	400	
P03.04	Current max diversion in synchronizing - protection **SPF**	-800 ÷ 800	µs	-	-
P03.05	Allowed number breaks in power – protection **HPF**	5 ÷ 50	-	10	
P03.06	Max number registered breaks in power - protection **HPF**	0 ÷ 50	-	-	-
P03.07	Working mode of protection **HPF**	0, 1	-	1	
P03.08	Time of activating of protection **OLF(I^2t)** of motor over-loaded	0.10 ÷ 5.00	s	0.40	
P03.09	Working mode of protection **OHF**	0, 1	-	0	
P03.10	Limit allowed speed N_{LIM} – protection **SOS**	100.0 ÷ 110.0	% N_{MAX}	105.0	
P03.11	Limit current $Idrv_{LIM}$ of converter – protection **SOC**	105.0 ÷ 125.0	% Ia_{MAX}	115.0	
P03.12	Armature voltage of activating the protection **STG**	40.0 ÷ 80.0	% Ua_{MAX}	50.0	
P03.13	Reserved	-	-	-	-
P03.14	Reserved	-	-	-	-
P03.15	Reserved	-	-	-	-
P03.16	Working mode of protection **OLF**	0, 1	-	1	
P03.17	Armature voltage of activating the protection **OVM**	110.0 ÷ 130.0	% Ua_{MAX}	115.0	
Group 04 – motor parameters					
P04.01	Max armature voltage Ua_{MAX}	10 ÷ 250	V	98	
P04.02	Max motor speed in motor name plate	100 ÷ 20000	min^{-1}	2000	
P04.03	Real max motor speed	100 ÷ 20000	min^{-1}	2000	
P04.04	Max speed Nm_1 в т.1	25.0 ÷ P04.06	% N_{MAX}	25.0	
P04.05	Max current value Ia_{MAX} в т.1	P04.07 ÷ 500.0	% Ia_{NOM}	500.0	
P04.06	Max speed Nm_2 в т.2	P04.04÷P04.08	% N_{MAX}	40.0	
P04.07	Max current value Iam_2 в т.2	P04.09÷P04.05	% Ia_{NOM}	400.0	
P04.08	Max speed Nm_3 в т.3	P04.06÷P04.10	% N_{MAX}	60.0	
P04.09	Max current value Iam_3 в т.3	P04.11÷P04.07	% Ia_{NOM}	325.0	
P04.10	Max speed Nm_4 в т.4	P04.08÷P04.12	% N_{MAX}	75.0	
P04.11	Max current value Iam_4 в т.4	P04.13÷P04.09	% Ia_{NOM}	275.0	
P04.12	Max speed Nm_5 в т.5	P04.10÷P04.14	% N_{MAX}	90.0	
P04.13	Max current value Iam_5 в т.5	P04.15÷P04.11	% Ia_{NOM}	225.0	
P04.14	Max motor speed N_{MAX} в т.6	P04.12÷100.0	% N_{MAX}	100.0	
P04.15	Max current value Iam_6 в т.6	100.0 ÷ P04.13	% Ia_{NOM}	200.0	
Group 05 – speed regulator parameters					
P05.01	Speed offset	-1024 ÷ 1024	discretes	0	
P05.02	Amplification gain of speed regulator **Кр1**	0.1 ÷ 100.0	-	20.0	
P05.03	Amplification gain of speed regulator **Кр2**	0.1 ÷ 100.0	-	12.5	

№	Parameter name	Range of changing	Unit	Standard value	New value
P05.04	Work threshold of amplification gain **Kp1**	0.00 ÷ P05.05	%	0.75	
P05.05	Work threshold of amplification gain **Kp2**	P05.04÷100.00	%	2.25	
P05.06	Integral time-constant of speed regulator **Tn1**	1.0 ÷ 1000.0	ms	40.0	
P05.07	Integral time-constant of speed regulator **Tn2**	1.0 ÷ 1000.0	ms	80.0	
P05.08	Work threshold of integral timeconstant **Tn1**	0.00 ÷ P05.09	%	0.75	
P05.09	Work threshold of integral timeconstant **Tn2**	P05.08÷100.00	%	2.25	
P05.10	Differential timeconstant **Dt1**	0.1 ÷ 100.0		10.0	
P05.11	Differential timeconstant **Dt2**	0.1 ÷ 100.0		10.0	
P05.12	Work threshold of differential timeconstant **Dt1**	0.00 ÷ P05.13	%	0.75	
P05.13	Work threshold of differential timeconstant **Dt2**	P05.12÷100.00	%	2.25	
Group 06 – parameters of the armature current regulator					
P06.01	Amplification gain of current regulator	0.01 ÷ 2.00	-	0.13	
P06.02	Integral time-constant of current regulator	10.0 ÷ 1000.0	ms	15.0	
P06.03	Adjusting of current amplitude of phase L1	-512 ÷ 512	µs	0	
P06.04	Adjusting of current amplitude of phase L2	-512 ÷ 512	µs	0	
P06.05	Adjusting of current amplitude of phase L3	-512 ÷ 512	µs	0	
P06.06	Current offset	-50.0 ÷ 50.0 %P02.05	A	0.0	
P06.07	Current ramp	0 ÷ 500	µs	0	
Group 07 – terminal parameters					
P07.01	Terminal language	0, 1, 2	-	0	
P07.02	Refreshing time	1 ÷ 1000	ms	1000	
Group 08 – error history					
P08.01	Error 1	-	-	EMPTY	
P08.02	Error 2	-	-	EMPTY	
P08.03	Error 3	-	-	EMPTY	
P08.04	Error 4	-	-	EMPTY	
P08.05	Error 5	-	-	EMPTY	
P08.06	Error 6	-	-	EMPTY	
P08.07	Error 7	-	-	EMPTY	
P08.08	Error 8	-	-	EMPTY	
P08.09	Error 9	-	-	EMPTY	
P08.10	Error10	-	-	EMPTY	
P08.11	Error11	-	-	EMPTY	
P08.12	Error12	-	-	EMPTY	
P08.13	Error13	-	-	EMPTY	
P08.14	Error14	-	-	EMPTY	
P08.15	Error15	-	-	EMPTY	
P08.16	Error 16	-	-	EMPTY	
P08.17	Error reset	0, 1	-	0	

Note:

1. Password access value to parameter edition is 11.
2. Parameters in black fields can be changed only when the password is available and command **ENBL** is switched OFF. Parameters in white fields can be changed in all modes only after writing the password;
3. Parameters value can be read without writing the password.

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