VIBRO BIT

26.51.66.133

Section "Calibration Procedure"

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EQUIPMENT "VIBROBIT 300"

Operation and Maintenance Manual

ВШПА.421412.300 РЭ

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The Instruction Manual is intended to familiarize users (customers) with main operating principles of equipment Vibrobit 300.

For additional information about the control modules refer to the setup instruction for the corresponding module.

Manufacturer SPE VIBROBIT LLC reserves the right to replace individual parts and components without impairing the equipment specifications.

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Contents

1 Description and operation

1.1 Equipment purpose

Vibrobit 300 equipment is intended for continuous stationary measuring, control and monitoring of mechanical condition parameters of steam and gas turbines, turbo-compresses, centrifugal pumps, and other bearing-mounted machines in the course of their operation.

The equipment carries out:

- measurement of parameters:
  - root-mean-square (RMS) value of bearing supports vibration velocity;
  - absolute vibration displacement of bearing supports;
  - relative vibration displacement of rotating shafts and other units;
  - relative displacement of rotating shafts;
  - relative displacement of bearing housings;
  - position of blocking elements and controls;
  - rotor speed;
  - inclination of cylinder supports, parts and units;
  - other process parameters represented by the unified DC signals;
- conversion of measured parameter values into unified DC signals;
- real-time calculation of additional parameters:
  - vibration harmonic components;
  - vibration rotational component and its phase;
  - vibration double rotational component and its phase;
  - low-frequency vibration;
  - high-frequency vibration;
  - parameter steps;
  - vibration amplitude coefficient;
- comparison of parameters with setpoints and signaling, their overrange, generation for the unified signaling system and relay signals protection;
- transmission of requested measured and calculated parameters via digital interface, to personal computer (PC), to a unit Automatic Process Control System (APCS), stations for imaging, archiving, equipment vibration alignment and vibration diagnostics;
- generation and transmission of the requested data set for parameter oscillography.

The equipment is used to measure the following parameters:

- sensors and converters of the Vibrobit 100 equipment;
- sensors process parameters with unified DC signals and rated metrological parameters.

The equipment is used both independently for signaling and equipment protection by the parameters limit levels and vibration alignment in own bearings proper and as part of APCS power units with vibration diagnostics functions.

The equipment complies with ГОСТ Р 55265.2-2012, ГОСТ Р 55263-2012, ГОСТ ISO 2954-97.

1.2 Equipment units

Table 1 states the full list of the equipment units.

Table 1

Description	Version type-code	Designation	Comment
Control module	MK10-DC MK10-DC-11 MK10-DC-001	ВШПА.421412.301 ВШПА.421412.301-01 ВШПА.421412.301-02	The module of measuring and monitoring of linear displacements, DC signals. Number of monitoring channels 4. СНП connector.
Ditto	MK11-DC MK11-DC-11 MK11-AC-11-S MK11-AC-11-S-СНП MK11-AC-11-S-R2	ВШПА.421412.3011 ВШПА.421412.3011-01 ВШПА.421412.3011-02 ВШПА.421412.3011-03 ВШПА.421412.3011-11	The module of measuring and monitoring of linear displacements, DC signals. Number of monitoring channels 2. DIN, СНП connector
"	MK20-DC MK20-DC-20 MK20-DC-20-СНП	ВШПА.421412.302 ВШПА.421412.302-01 ВШПА.421412.302-02	The module for measuring and monitoring of the relative vibration displacement excursion, AC signals. Number of monitoring channels 4. DIN, СНП connector
"	MK22-DC MK22-DC-11 MK22-DC-001 MK22-DC-001-R2 MK22-DC-001-R2-COMP.01	ВШПА.421412.3022 ВШПА.421412.3022-01 ВШПА.421412.3022-02 ВШПА.421412.3022-11 ВШПА.421412.3022-30	Universal module for measurement and monitoring of linear displacement, rotor speed, rotor eccentricity. Number of monitoring channels 4. СНП connector.
"	MK30-DC MK30-DC-20 MK30-DC-20-СНП	ВШПА.421412.303 ВШПА.421412.303-01 ВШПА.421412.303-02	The module for measuring and monitoring of the vibration velocity RMS, AC signals Number of monitoring channels 4. DIN, СНП connector
"	MK32-DC MK32-DC-11 MK32-DC-20 MK32-DC-001 MK32-DC-20-R2 MK32-DC-20-LF3 MK32-DC-20-LF4	ВШПА.421412.3032 ВШПА.421412.3032-01 ВШПА.421412.3032-02 ВШПА.421412.3032-03 ВШПА.421412.3032-11 ВШПА.421412.3032-20 ВШПА.421412.3032-21	Universal module for measurement and monitoring of vibration velocity RMS, vibration displacement excursion, AC signals. Number of monitoring channels 4. DIN connector
"	MK40-DC-11 MK40-DC-001 MK40-AC-11-S	ВШПА.421412.304 ВШПА.421412.304-01 ВШПА.421412.304-02	Universal module for measurement and monitoring of rotor speed. Number of monitoring channels 2. СНП connector
"	MK70	ВШПА.421412.307	The module of the safety shutdown logic. The number of logic inputs 16. Signaling of the inputs, outputs status. СНП connector
"	MK71 MK71-R2	ВШПА.421412.3071 ВШПА.421412.3071-01	The module of the safety shutdown logic. The number of logic inputs 48. Signaling of the inputs, outputs status. DIN connector
"	MK73	ВШПА.421412.3073	The module for gathering the setpoints status of the control modules in CVMS. The number of logic inputs 4. Signaling of inputs, outputs status. DIN connector

Continuation of Table 1

Description	Version type-code	Designation	Comment
"	MK90 MK91	ВШПА.421412.309 ВШПА.421412.3091	СНП connector. DIN connector. The module for testing the signaling and protection operation. Number of outputs 8. Generation of control modules input signals
"	MK95	ВШПА.421412.310	Diagnostic control module of measurement channels. Number of channels 4. DIN connector
Power supply module	МП24-50W-DIN МП24-50W-СНП МП24-60W-DIN МП24-60W-СНП	ВШПА.421412.311 ВШПА.421412.311-01 ВШПА.421412.311-02 ВШПА.421412.311-03	Power supply of sensors, control modules. Output voltage +24 V DIN, СНП connector
Ditto	МП24.1-50W МП24.1-60W МП24.1-85W	ВШПА.421412.313 ВШПА.421412.313-01 ВШПА.421412.313-10	Power supply module combined with signaling and protection testing module. Power supply of sensors, control modules. Output voltage of +24 V. Number of Outputs 8. Generation of control modules test signals. DIN connector
"	МП26-80W-D.port МП26-80W-USB	ВШПА.421412.314 ВШПА.421412.314-01	Power supply of sensors, control modules. Output voltage +24 V. DIN connector Digital data buses RS485, CAN (module status transfer). Inputs to determine status of relay outputs of other products. Open collector outputs. Module starting after a set time interval with energizing when supply voltage crossing "0". Digital indicator of the module main parameters status.
Control unit	BM22-OK BM22-P	ВШПА.421412.355 ВШПА.421412.355-01	The universal four-channel unit for measuring and monitoring of linear displacements, rotor speed, rotor eccentricity. Open collector outputs. Ditto. Relay outputs
Ditto	BM32-OK BM32-P	ВШПА.421412.354 ВШПА.421412.354-01	The universal four-channel unit for measuring and monitoring of vibration velocity RMS, relative vibration displacement excursion, AC signals. Open collector outputs. Ditto. Relay outputs

Continuation of Table 1

Description	Version type-code	Designation	Comment
"	BM61-P	ВШПА.421412.342	The two-channel unit for measuring of rotor speed and protection mechanism trip pin position. Relay outputs
Indication unit	БИ24 БИ34	ВШПА.421412.316 ВШПА.421412.318	Remote indication of measured parameters
Diagnostic interface module	MC01USB	ВШПА.421412.322	Providing communications between PC and modules for diagnostics and setup
Ditto	MC03 Bluetooth	ВШПА.421412.334	Providing communications between PC and modules for diagnostics and setup by Bluetooth wireless technology
Setup instrument	ПН31	ВШПА.421412.332	Intended to setup control modules without PC
CAN interface splitter	BRCAN01	ВШПА.421412.4003	The unit is designed for logic and galvanic isolation between two different CAN interfaces
Section	ПС03	ВШПА.421412.356.08 ВШПА.421412.356.08-01	Module arrangement of different section variants
Ditto	ПС10	ВШПА.421412.356.26	Ditto
"	ПС11	ВШПА.421412.356.31	"
"	ПС04	ВШПА.421412.356.07 ВШПА.421412.356.07-01	The arrangement of buffered examination signal modules
"	ПС05	ВШПА.421412.356.11	The arrangement of modules with shaft vibration dangerous level and step
"	ПС06	ВШПА.421412.356.21	To install power supply modules
"	ПЛК01	ВШПА.421412.356.05	Switching of control modules logical signals to section external connectors
"	ПЛК02	ВШПА.421412.357	Ditto
Framework	«Евромеханика 19» 3U 84HP (3HE–84TE)	–	To install control modules and power supply modules
Cabinet	RITTAL	–	To install the frameworks and cross-connect nodes
Section	ПС06	ВШПА.421412.356.21	To install power supply modules
Cabinet	RITTAL	–	To install the frameworks and cross-connect nodes
Unit	ABP	ВШПА.421412.162.13	Automatic Transfer Switching Device
Ditto	BST300.010	ВШПА.421412.371	Temperature sensor unit
"	DB9-MC-8	ВШПА.421412.450.016	Switching unit of RS485 interface, 8 channels
Stand	Вибробит 300	ВШПА.421412.300.370.01	Seismic resistant cabinet by Rittal with installed equipment

Note
1 DIN connector – module main switching connector DIN41612-396MRD.
2 СНП connector– module main switching connector СНП59-48В-23-2В.

The equipment is manufactured and supplied to the Customer according to the specification:

- as assembly units;

- as sets integrated into parameter control complex of one or several power units.

Operation documentation:

- Operation and Maintenance Manual ВШПА.421412.300 РЭ;

- Log book ВШПА.421412.300.XXX ФО or certificate ВШПА.421412.300.XXX ПС, where XXX – serial number of the project, order or product designation;

- Module setup instruction (included depending on used modules):
    - Control Modules Setup Instruction   ВШПА.421412.300 И1
    - MK10 Control Module Setup Instruction   ВШПА.421412.301 И1;
    - MK11 Control Module Setup Instruction   ВШПА.421412.3011 И1;
    - MK22 Control Module Setup Instruction   ВШПА.421412.3022 И1;
    - MK32 Control Module Setup Instruction   ВШПА.421412.3032 И1;
    - MK40 Control Module Setup Instruction   ВШПА.421412.304 И1;
    - MK70 Control Module Setup Instruction   ВШПА.421412.307 И1;
    - MK71 Control Module Setup Instruction   ВШПА.421412.3071 И1.

1.3 Equipment specifications and parameters

The equipment main specifications and parameters are shown in Tables 2 – 34.

Name and purpose of the equipment external circuits are stated in Annex A.

1.3.1 MK10 module

Table 2 – MK10 control module main parameters and specifications

Parameter description	Normal value
Number of measurement channels	4
Range of displacement measurement and signaling, (from and to inclusive), (S), mm	Determined by the module settings
Range of input signal measurement and signaling:	
• DC current, mA	1 – 5; 0 – 5; 4 – 20; 0 – 20
• DC voltage V	0.78 – 3.9
Input resistance, Ohm	
• DC current	787 ± 2; 191 ± 0.5
• DC voltage	not less than 50 000
Limits of permissible main relative error of displacement measurement,%	
• by digital indicator	±1.0
• by unified signal	±1.0
Readings update time, sec	0.5
Number of unified output DC signals	4
Unified output DC signal, mA	0 – 5; 1 – 5; 4 – 20
Load resistance of unified output signal, Ohm, not more than	500
Number of measurement channel setpoints	4
Number of module discrete outputs	12
Output discrete signals of the module	
• type	Open collector (OC)
• DC voltage, V, not more than	24
• output current, mA, not more than	100
Types of supported communications interfaces	RS485 (ModBus) CAN2.0B diagnostic I2C
Ambient air working temperature range (from and to inclusive), °C	+5...+45
Supply voltage, V	+(24±1.0)
Consumption current, mA, not more than	100

1.3.2 MK11 module

Table 3 – MK11 control module main parameters and specifications

Parameter description	Normal value
Number of measurement channels	2
Range of displacement measurement and signaling (from and to inclusive), (S), mm	Determined by the module settings
Range of input signal measurement and signaling:	
• DC current, mA	1 – 5; 0 – 5; 4 – 20; 0 – 20
• DC voltage, V	0.78 – 3.9
Input resistance, Ohm	
• DC current	768 ± 2; 191 ± 0.5
• DC voltage	not less than 50 000
Limits of permissible main relative error of displacement measurement,%	
• by digital indicator	± 1.0
• by unified signal	± 1.0
Readings update time, sec	0.25
Number of unified output DC signals	2
Unified output DC signal, mA	0 – 5; 1 – 5; 4 – 20
Load resistance of unified output signal, Ohm, not more than	500
Number of setpoints of each measurement channel	4
Number of the module discrete outputs	8
Output discrete signals of the module	
• type	Open collector (OC)
• DC voltage, V, not more than	24
• output current, mA, not more than	100
Types of supported communications interfaces	RS485 (ModBus) CAN2.0B diagnostic I2C
Ambient air working temperature range (from and to inclusive), °C	+5...+45
Supply voltage, V	
• for the version MK11-AC-11-S	(85 – 240)*, 50 Hz
• other versions	$+(24 \pm 1.0)$
MK11 consumption current in circuit +24 V, mA, not more than (ignoring the consumption current of the sensor and other external circuits)	100
* Maximum permissible voltage range from 85 to 265 V	

1.3.3 MK20 module

Table 4 – MK20 control module main parameters and specifications

Parameter description	Normal value
Number of measurement channels	4
Range of excursion measurement and signaling of relative vibration displacement (from and to inclusive), (Sr), mm	0.01 – 0.25; 0.02 – 0.50
Range of displacement measurement (from and to inclusive), (S), mm	0 – 1; 0 – 2
Range of input signal measurement and signaling: • DC current, mA • DC voltage, V • peak-to-peak excursion of sinusoidal AC current (RMS), mA • peak-to-peak excursion of sinusoidal AC voltage (RMS), V	1 – 5; 0 – 5; 4 – 20; 0 – 20 0.56 – 2.80 0 – 1.41; 0 – 5.656 0 – 0.792
Input resistance, Ohm: • DC current • DC voltage	560±1; 140±0.35 not less than 50 000
Measurement frequency ranges (from and to inclusive), (f), Hz: • peak-to-peak excursion of AC current or voltage input signal • low frequency component peak-to-peak excursion of AC current or voltage input signal • high frequency component peak-to-peak excursion of AC current or voltage input signal • peak-to-peak excursion and rotational component phase of AC current or voltage input signal	5 – 500 5 – $0.5f_{rev}$ $2f_{rev}$ – 500 0.05 – 160
Sinusoidal signal phase measurement range (from and to inclusive), (F), °	0 – 360
Limits of permissible main relative error of base frequency measurement by display and unified signal, %: • DC current or voltage • peak-to-peak excursion of AC current or voltage	 ±0.5 ±1.0
Limits of permissible main absolute error of input sinusoidal signal phase measurement, °	±4.0
Base measurement frequency, Hz	80 ± 1
Frequency response ripple within the frequency ranges, %: • (5 – 10) Hz • (10 – 250)Hz • (250 – 500)Hz • (0.05 – 160)Hz (for rotational components)	 +2.0; -10.0; ±2.0 +2.0; -10.0 ±2.0
Number of unified output DC signals	4
Unified output DC signal, mA	0 – 5; 1 – 5; 4 – 20
Load resistance of unified output signal, Ohm, not more than	500
Readings update time, sec	0.5
Number of measurement channel setpoints	3
Number of module discrete outputs	12
Module output discrete signals • type • DC voltage, V, not more than • output current, mA, not more than	 Open collector (OC) 24 100
Types of digital interfaces	RS485 (ModBus) CAN2.0B diagnostic SPI
Ambient air working temperature range (from and to inclusive), °C	+5…+45
Supply voltage, V	+(24±1.0)
MK20 consumption current by +24 V circuit, mA, not more than (ignoring the consumption current of the sensor and other external circuits)	120

1.3.4 MK22 module

Table 5 – MK22 control module main parameters and specifications

Parameter description	Normal value
Number of measurement channels	4
Range of excursion measurement and signaling of relative vibration displacement, eccentricity (from and to inclusive), (Sr), mm	0.01 – 0.25; 0.02 – 0.50
Range of displacement measurement and signaling (from and to inclusive), (S), mm	Determined by module settings
Ranges of rotor speed measurement and signaling, rpm	1 – 12 000
Range of input signal measurement and signaling: • DC current, mA • DC voltage, V • peak-to-peak excursion of sinusoidal AC current, mA • peak-to-peak excursion of sinusoidal AC voltage, V	1 – 5; 0 – 5; 4 – 20; 0 – 20 0.56 – 2.80 0 – 1.41; 0 – 5.656 0 – 0.792
Input resistance, Ohm • DC current, mA • DC Voltage, V	560 ± 2; 140 ± 0.5 at least 50 000
Measuring frequency ranges (from and to inclusive), (f), Hz: • pick-to-pick excursion and rotational component phase of the AC voltage or current input signal	0.05 – 160
Sinusoidal signal phase measurement range (from and to inclusive), (F), °	0 – 360
Limits of permissible main relative error of displacement measurement,% • by digital indicator • by unified signal	± 0,5 ± 1,0
Limits of permissible main relative error of base frequency measurement by display and unified signal,%: - pick-to-pick excursion of the AC voltage or current	± 1.0
Limits of permissible main absolute error of input sinusoidal signal phase measurement, °	± 4.0
Base measurement frequency, Hz	80 ± 1
Frequency response ripple within the frequency range 0.05 – 160 Hz (for rotational components), %	± 2.0
Limit of permissible main relative error of rotor speed measurement channel by unified output,%, max	±1.0
Limit of permissible main absolute error of rotor speed measurement channel by digital indicator, rpm, not more than	±2.0
Readings update time, sec	0.10
Number of unified output DC signals	4
Unified output DC signal, mA	0 – 5; 1 – 5; 4 – 20
Load resistance of unified output signal, Ohm, not more than	500
Number of measurement channel setpoints	4
Number of module discrete outputs	12
Module output discrete signals • type • DC voltage, V, not more than • output current, mA, not more than	Open collector (OC) 24 100
Types of digital interfaces	RS485 (ModBus) CAN2.0B diagnostic SPI
Ambient air working temperature range (from and to inclusive), °C	+5...+45
Supply voltage, V	+(24 ± 1.0)
MK22 consumption current by +24 V circuit, mA, not more than (ignoring the consumption current of the sensor and other external circuits)	100

1.3.5 MK30 module

Table 6 – MK30 control module main parameters and specifications

Parameter description	Normal value
Number of measurement channels	4
Range of vibration velocity RMS measurement and signaling (from and to inclusive), (V_e), mm/s	0.4 – 15.0; 0.8 – 30.0
Range of input signal measurement and signaling: • DC current, mA • DC voltage, V • AC current RMS, mA • AC voltage RMS, V	1 – 5; 0 – 5; 4 – 20; 0 – 20 0.56 – 2.80 0 – 1.41; 0 – 5.656 0 – 0.792
Input resistance, Ohm: • for DC or AC current signal • for DC or AC voltage signal	560±2; 140±0.5 not less than 50 000
Measuring frequency ranges (from and to inclusive), (f), Hz • AC current or voltage input signal RMS; • AC current or voltage input signal low frequency component RMS • AC current or voltage input signal high frequency component RMS • Input signal rotational component phase	10 – 1000 10 – $0.5f_{rev}$ $2f_{rev}$ – 1000 10 – 160
Sinusoidal signal phase measurement range (from and to inclusive), (F), °	0 – 360
Limits of permissible main relative error of base frequency measurement by display and unified signal, %: • DC current or voltage • AC current or voltage RMS	±0.5 ±1.0
Limits of permissible main absolute error of input sinusoidal signal phase measurement, °	±4.0
Base measurement frequency, Hz	80 ± 1
Frequency response ripple within the frequency ranges, %: • (10 – 20) Hz • (20 – 500) Hz • (500 – 1000) Hz	+2.0; -10.0 ±2.0 +2.0; -10.0
Frequency response attenuation at the frequency 50 Hz when measuring the input signal low-frequency component RMS, dB, not less than	50
Number of unified output DC signals	6
Unified output DC signal, mA	0 – 5; 1 – 5; 4 – 20
Load resistance of unified output signal, Ohm, not more than	500
Readings update time, sec	0.5
Number of measurement channel setpoints	3
Number of module discrete outputs	12
Module output discrete signals	OC, voltage not more than 24V, current not more than 100mA
Types of digital interfaces	RS485 (ModBus) CAN2.0B diagnostic SPI
Ambient air working temperature range (from and to inclusive), °C	+5...+45
Supply voltage, V	+(24±1.0)
MK30 consumption current by +24 V circuit, mA, not more than (ignoring the consumption current of the sensor and other external circuits)	120

1.3.6 MK32 module

Table 7 – MK32 control module main parameters and specifications

Parameter description	Normal value
Number of measurement channels	4
Range of displacement measurement and signaling (from and to inclusive), (S), mm	Determined by module settings
Range of vibration velocity RMS measurement and signaling (from and to inclusive), (Ve), mm/s	0.4 – 15.0; 0.8 – 30.0
Range of excursion measurement and signaling of absolute vibration displacement * (from and to inclusive), (S), mm	0.01 – 0.25; 0.01 – 0.50
Range of excursion measurement and signaling of relative vibration displacement (from and to inclusive), (Sr), mm	0.01 – 0.25; 0.02 – 0.50
Ranges of rotor speed measurement and signaling, rpm	1 – 12 000
Range of input signal measurement and signaling: • DC current, mA • DC voltage, V • RMS/peak-to-peak excursion of sinusoidal AC current, mA • RMS/peak-to-peak excursion of sinusoidal AC voltage, V	1 – 5;0 – 5;4 – 20;0 – 20 0.56 – 2.80 0 – 1.41; 0 – 5.656 0 – 0.792
Input resistance, Ohm • DC current, mA • DC Voltage, V	560 ± 2; 140 ± 0.5; 200 ± 0.5 at least 50 000
Measuring frequency ranges (from and to inclusive), (f), Hz • vibration velocity RMS measurement; • relative vibration displacement excursion • absolute vibration displacement excursion • vibration velocity RMS/relative vibration displacement excursion of rotational component	10 – 1000 5 – 500 0.8 – 200 0.05 – 160
The number of custom additional frequency measurements: • vibration velocity RMS measurement • relative/absolute vibration displacement excursion	4 1
Sinusoidal signal phase measurement range (from and to inclusive), (F), °	0 – 360
Value of unexpected and irreversible vibration components change during signaling, mm / s, not less	1.0**
Limits of permissible main relative error of displacement measurement,% • by digital indicator • by unified signal	± 0.5 ± 1.0
Limits of permissible main relative error of base frequency measurement by display and unified signal,%:	± 1.0
Limit of permissible main absolute error of rotor speed measurement channel by digital indicator, rpm, not more than	± 2.0
Limits of permissible main absolute error of input sinusoidal signal phase measurement, °	± 4.0
Limits of permissible relative actuation error of unexpected and irreversible vibration components change,%	± 10.0
Base measuring frequency, Hz	80 ± 1; 40 ± 1;
Frequency response ripple within the frequency ranges,%:	
for the measurement frequency range of (5 – 1000) Hz	for the measurement frequency range of (0.8 – 200) Hz	
• (5 – 20) Hz	• (0.8 – 2) Hz	+2.0; -10.0
• (20 – 500) Hz	• (2 – 160) Hz	±2.0
• (500 – 1000) Hz	• (160 – 200) Hz	+2.0; -10.0
Readings update time, sec	0.5
Number of unified output DC signals	4
Unified output DC signal, mA	0 – 5; 1 – 5; 4 – 20
Load resistance of unified output signal, Ohm, not more than	500

Table continued 7

Parameter description	Normal value
Number of setpoints	32
Number of module discrete outputs	14
Module output discrete signals • type • DC voltage, V, not more than • output current, mA, not more than	Open collector (OC) 24 100
Types of digital interfaces	RS485 (ModBus) CAN2.0B diagnostic SPI
Ambient air working temperature range (from and to inclusive), °C	+5...+45
Supply voltage	+(24 ± 1.0)
MK32 consumption current by +24 V circuit, mA, not more than (ignoring the consumption current of the sensor and other external circuits)	120
* The initial signal for this measurement type is the vibration velocity AC signal. The subsequent signal integration to the vibration displacement is carried out in the control module. ** The value according to ГОСТ Р 55265.2-2012. Can be changed on request.	

1.3.7 MK40 module

Table 8 – MK40 control module main parameters and specifications

Parameter description	Normal value
Number of measurement channels	2
Ranges of rotor speed measurement and signaling, rpm	1 – 12 000
Range of input signal measurement: • DC current, mA • DC voltage, V	1 – 5; 0 – 5; 4 – 20; 0 – 20 0.95 – 4.75
Input resistance, Ohm • DC current • DC Voltage	953 ± 2; 232 ± 0.5 not less than 50 000
Limits of permissible main relative error of rotor speed measurement channel by unified output, %, not more than	± 1.0
Limit of permissible main absolute error of rotor speed measurement channel by digital indicator, rpm, not more than	± 2.0
Readings update time, sec	0.1 — 1.0
Number of unified output DC signals	2
Unified output DC signal, mA	0 – 5; 1 – 5; 4 – 20
Load resistance of unified output signal, Ohm, not more than	500
Number of measurement channel setpoints	3
Number of discrete outputs	6
Number of synchronization outputs	2
Module output discrete signals, synchronization signals • type • DC voltage, V, not more than • output current, mA, not more than	Open collector 24 100
Types of supported digital interfaces	RS485 (ModBus) CAN2.0B diagnostic I2C
Ambient air working temperature range (from and to inclusive), °C	+5...+45
Supply voltage, V • for version MK40-AC-11-S • other versions	(85 – 240)*, 50Hz +(24 ± 1.0)
MK40 consumption current by +24 V circuit, mA, not more than (ignoring the consumption current of the sensor and other external circuits)	100
* Maximum permissible voltage range from 85 to 265 V	

1.3.8 MK70 module

Table 9 – MK70 control module main parameters and specifications

Parameter description	Normal value
Number of logic inputs	16
DC voltage signal range at logic inputs, V	0 – 5
Schmitt input buffer switching levels by the logic inputs, V	
• logic 1, not more than	3.5
• logic 0, not less than	1.5
The logic input pull-up resistor resistance to +5 V, Ohm	10 000 ±500
Number of safety shutdown discrete outputs	4
Module output discrete signals	OC, voltage not more than 24V, current not more than 100mA
Types of supported communication interfaces	RS485, CAN2.0B diagnostic I2C
Ambient air working temperature range (from and to inclusive), °C	+5...+45
Supply voltage	+(24 ± 1.0)
Consumption current, mA, not more than	100

1.3.9 MK71 module

Table 10 – MK71 control module main parameters and specifications

Parameter description	Value
Number of logic inputs (6 groups with 8 outputs each)	48
Number of logic inputs of the module block function	1
Number of logic inputs of the module reset	1
Number of additional CPLD-based inputs	2
Number of additional microcontroller-based inputs	2
DC voltage signal range at logic inputs, V	0 – 5
Schmitt input buffer switching levels by the logic inputs, V	
• logic 1, not more than	3.5
• logic 0, not less than (signal active level)	1.5
The logic input pull-up resistance to +5 V, Ohm	10 000 ±500
Number of CPLD-based safety shutdown discrete outputs	1
Number of additional CPLD-based outputs	2
Number of additional microcontroller-based outputs	2
OR signals outputs by groups	6
AC signal testing output	1
Module failure output	1
Module output discrete signals	OC, voltage not more than 24V, current not more than 100mA
Types of supported digital communication interfaces	RS485, CAN2.0B diagnostic I2C
Ambient air working temperature range (from and to inclusive), °C	+5...+45
Supply voltage	+(24 ± 1.0)
Consumption current, mA, not more than	50

1.3.10 MK73 module

Table 11 – MK73 control module main parameters and specifications

Parameter description	Normal value
Time for message analyzing, calculating a logical formula, updating logic outputs, s, no more	0,5
Number of module discrete outputs	4
Module output discrete signals - type - DC voltage, V, not more than - output current, mA, not more than	Open collector (OC) 24 100
Number of discrete inputs of the module	4
Schmitt input buffer switching levels by the logic inputs, V • logic 1, not more than • logic 0, not less than (signal active level)	 3,5 1,5
The logic input pull-up resistance to +5 V, Ohm	10 000 $\pm$ 500
AC signal testing output	1
Module failure output	1
Types of supported digital communication interfaces	RS485 (ModBus) CAN2.0B* diagnostic I2C
Ambient air working temperature range (from and to inclusive), °C	+5...+45
Supply voltage, V	+(24 $\pm$ 1,0)
MK73 consumption current by +24 V circuit, mA, not more than	100
CAN interface is used for service purposes. Receiving messages only.	

1.3.11 MK90 module

Table 12 – MK90 control module main parameters and specifications

Parameter description	Normal value
Number of outputs	8
Output signals (from and to inclusive) • DC voltage, V • sinusoidal AC voltage, V • pulse signal voltage, V	 $\pm$(0 – 10) 0 – 1,5 $\pm$(2 $\pm$ 0.5)
Sinusoidal signal frequency, Hz	50 $\pm$ 2
Pulse signal frequency range, Hz	1 – 170; 60 – 10000
Output resistance, Ohm	510 $\pm$ 25
Ambient air working temperature range (from and to inclusive), °C	+5...+45
Supply voltage, V	+(24 $\pm$ 1,0)
Consumption current, mA, not more than	100

1.3.12 MK91 module

Table 13 – MK91control module main parameters and specifications

Parameter description	Normal value
Number of outputs	8
Output signals (from and to inclusive.) • DC voltage, V • sinusoidal AC voltage, V • pulse signal voltage excursion, V • pulse signal DC bias, V	$\pm(0 - 10)$ $0 - 1.5$ $1.6 - 4.1$ $\pm(0 - 10)$
Sinusoidal signal frequency, Hz	50 ± 2
Pulse signal frequency range, Hz	$1 - 170; 60 - 10000$
Output resistance, Ohm • outputs 1-6 • outputs 7, 8	510 ± 25 510 ± 25; no more 10 *
Total current for all outputs, mA, not less	100
Ambient air working temperature range (from and to inclusive), °C	+5...+45
Supply voltage, V	$+(24 \pm 1.0)$
Consumption current, mA, not more than	100

** Resistance of outputs 7 and 8 is determined by the position of jumpers and is selected when configuring the module (see Annex E).

1.3.13 MK95 module

Table 14 – MK95 control module main parameters and specifications

Parameter description	Normal value
Number of measurement channels	4
Input signal measurement ranges: • DC current, mA • DC voltage, V • AC current RMS, mA • AC voltage RMS, V	$1 - 5; 4 - 20$ $0.56 - 2.80$ $0 - 1.41; 0 - 5.656$ $0 - 0.792$
Input resistance, Ohm: • for AC or DC current signal • for AC or DC voltage signal	$560 \pm 1; 140 \pm 0.35$ not less 100 000
Limits of permissible main relative error of the base frequency measurement by the output signal,%: • DC current and voltage • AC current and voltage RMS	 ± 0.5 ± 1.0
Frequency range of AC current and voltage input signal RMS measurement (from and to inclusive), (f), Hz:	$5 - 1000$
Base measuring frequency, Hz	80 ± 1
Frequency response ripple,%:	$\pm 2,0$
Output unified voltage signal, V	$0 - 10$
Output resistance, Ohm	102 ± 5
Supply voltage, V	$+(24 \pm 1.0)$
Consumption current, mA, not more than	100
Ambient air working temperature range (from and to inclusive), °C	+5...+45

1.3.14 БИ24/БИ34 indication unit

Table 15 – БИ24/БИ34 indication unit main parameters and specifications

Parameter description	Normal value
Number of decimals	4
Input signal range mA	1 – 5; 4 – 20
Input signal range, V	0.25 – 1.55
Input resistance, Ohm: • voltage • current (1 – 5) mA • current (4 – 20) mA	10000 220 88
Supported digital communication interfaces: • for versions C, IC • for versions R, IR	CAN2.0B RS485
Frequency measurement parameters (for versions I, IR, IC): • frequency measurement range (from and to inclusive), rpm • number of pulses per revolution	1 – 9999 1 («groove»); 60 («pinion»)
Ambient air working temperature range (from and to inclusive), °C	+5...+45
Supply voltage, V	+(24±1)
Consumption current, mA, not more than	70

1.3.15 МП24 power supply module

Table 16 – МП24 power supply module main parameters and specifications

Parameter description	Normal value
Supply voltage: • AC voltage, frequency 50Hz, V • DC voltage, V	 176 – 240* 246 – 350
Output power, W • МП24-50W • МП24-60W	 50 60
Output voltage, V	+(24±1)
Output voltage pulsation, mV, not more than	30
Efficiency,% not less than	85
Ambient air working temperature range (from and to inclusive), °C	+5...+45
* Maximum permissible voltage range from 176 to 264 V	

1.3.16 МП24.1 power supply module

Table 17 – МП24.1 power supply module main parameters and specifications

Parameter description	Normal value
Supply voltage:	
• AC voltage, frequency 50Hz, V	176 – 240*
• DC voltage, V	246 – 350**
Output power, W	
- МП24.1-50W	50
- МП24.1-60W	60
- МП24.1-85W	85
Output voltage, V	+(24 ± 1)
Output voltage pulsation, mV, not more than	30
Efficiency,% not less than	85
Ambient air working temperature range (from and to inclusive), °C	+5...+45
* Maximum permissible voltage range from 176 to 264 V	
** Only for versions МП24.1-50W, МП24.1-60W.	
Note - Parameters of measurement channels testing outputs correspond to table 13.	

1.3.17 МП26 power supply module

Table 18 – МП26 power supply module main parameters and specifications

Parameter description	Normal value
Supply voltage:	
- AC voltage, frequency 50Hz, V	176 – 240*
Output power, W	
- МП26-80W	80
Output voltage, V	+(24 ± 1)
Output voltage pulsation, mV, not more than	30
Efficiency,% not less than	85
Ambient air working temperature range (from and to inclusive), °C	+5...+45
* Maximum permissible voltage range from 176 to 264 V	
Note - Parameters of measurement channels testing outputs correspond to table 13.	

1.3.18 BM22 control unit

Table 19 – BM22 control unit main parameters and specifications

Parameter description	Normal value
Main parameters and specifications	correspond to table 5 for MK22 control module
Number of outputs + 24 V to power converters	4
Number of additional outputs +24 V	1+1*
Number of relay discrete outputs	4**
Number of OC discrete outputs	12***

Relay output discrete signals
   - type
   - DC voltage, not more than
   - AC voltage, not more than
	dry contact
	60 V, 7 A
	240 V, 7 A

Power Supply, V	AC 50 Hz 176 – 264 DC 246 – 370
Consumed power, W, not no more	25
Ambient air working temperature range (from and to inclusive), °C	+5...+45
* One output is protected against over-current up to 0.2 A.	
** The presence of relay discrete outputs is determined by the BM22 unit version.	
*** In the version with relay outputs, the number of open collector discrete outputs is reduced to two.	

1.3.19 BM32 control unit

Table 20 – BM32 control unit main parameters and specifications

Parameter description	Normal value
Main parameters and specifications	correspond to table 7 for the MK32 control module
Number of outputs + 24 V to power converters	4
Number of additional outputs +24 V	1+1*
Number of relay discrete outputs	4**
Number of OC discrete outputs	12***

Relay output discrete signals
   - type
   - DC voltage, not more than
   - AC voltage, not more than
	dry contact
	250 V, 7 A
	220 V, 7 A

Power Supply, V	AC 50 Hz 176 – 264 DC 246 – 370
Consumed power, W, not no more	25
Ambient air working temperature range (from and to inclusive), °C	+5...+45
* One output is protected against over-current up to 0.2 A.	
** The presence of relay discrete outputs is determined by the BM32 unit version.	
*** In the version with relay outputs, the number of open collector discrete outputs is reduced to two.	

1.3.20 BM61 control unit

Table 21 – BM61 control unit main parameters and specifications

Parameter description	Normal value
Main parameters and specifications	correspond to table 5 for the MK22 control module
Number of measurement channels:	
- rotor speed	1
- rotor protection mechanism trip pin protrusion	1
Measuring and signaling ranges	
- rotor speed, rpm	1 – 12000
- rotor protection mechanism trip pin protrusion, mm	0 – 6
Number of unified DC signals	2
Number of outputs + 24 V to power converters	4
Number of additional outputs +24 V	1+1*
Number of relay discrete outputs	4
Number of OC discrete outputs	2
Relay output discrete signals	
- type	dry contact
- DC voltage, not more than	250 V, 5 A
- AC voltage, not more than	220 V, 5 A
Power Supply, V	AC 50 Hz 176 – 264 DC 246 – 370
Consumed power, W, not no more	25
Ambient air working temperature range (from and to inclusive), °C	+5...+45
* One output is protected against over-current up to 0.2 A.	
Note - Other parameters and specifications correspond to table 5 for the MK22 control module.	

1.3.21 MC01 USB diagnostic interface module

Table 22 – MC01 USB diagnostic interface module main parameters and specifications

Parameter description	Normal value
Interface data rate, bit/s	19200
Supported control interfaces	I2C, SPI
Ambient air working temperature range (from and to inclusive), °C	+5...+45
Supply voltage, V	$+(5 \pm 0.2)$
Consumption current, mA, not more than	20

1.3.22 MC03 Bluetooth diagnostic interface module

Table 23 – MC03 Bluetooth diagnostic interface module main parameters and specifications

Parameter description	Normal value
Interface data rate, bit/s	19200
Supported control interfaces	Bluetooth version 2.0, I2C, SPI
Frequency range, output power, receiver sensitivity	Bluetooth version 2.0
Ambient air working temperature range (from and to inclusive), °C	+5...+45
Supply voltage, V	+(5 ± 0.2)
Consumption current, mA, not more than	50

1.3.23 BRCAN01 interfaces splitter

Table 24 – BRCAN01 interfaces splitter main parameters and specifications

Parameter description	Normal value
Data rates via the interface CAN1 and CAN2, kbit / s	40, 80, 100, 125, 200, 250, 500, 1000
Ambient air working temperature range (from and to inclusive), °C	+5...+45
Supply voltage, V	+18...+36
Consumption current, mA, not more than	50

1.3.24 Displacement measurement channel with sensors and converters of the Vibrobit 100 equipment

Table 25 – Displacement measurement channel main parameters and specifications

Parameter description	Normal value
Measurement range, mm	$0 - 360^{1)}$
Limit of permissible main reduced error of measurement, %	± 2.5
Limit of permissible reduced error of measurement in the whole operating temperature range of the sensor, converter, control module, %	± 6.0
1) The ranges of sensors and converters of Vibrobit 100 equipment.	

Relative vibration displacement measurement channels with sensors and converters of the Vibrobit 100 equipment

1.3.25 Relative vibration displacement measurement channels with sensors and converters of the Vibrobit 100 equipment

Table 26 – Relative vibration displacement measurement channel main parameters and specifications

Parameter description	Normal value
Measurement range, mm	0.01 – 0.25; $0.02 - 0.50^{1)}$
Measurement frequency range, Hz	0.05 – 500
Limit of permissible main relative error of measurement, %	± 5.0
Frequency response ripple in frequency ranges, %: • (0.05 – 250) Hz • (250 – 500) Hz	 ± 2.5 +2.5; -10,0

Table 26 continued

Parameter description	Normal value
Limit of permissible relative error of measurement in the operating temperature range of the sensor, converter, control module in frequency ranges, % • (0.05 – 250) Hz • (250 – 500) Hz	 ± 8.0 +8.0; -10.0
1) The ranges of sensors and converters of Vibrobit 100 equipment.	

1.3.26 Vibration velocity RMS measurement channel with sensors and converters of the Vibrobit 100 equipment

Table 27 – Vibration velocity RMS measurement channel main parameters and specifications

Parameter description	Normal value
Measurement range, mm	0.4 – 15; 0.8 – 30[1)
Measurement frequency range, Hz	10 – 1000
Limit of permissible main relative error of measurement, %	± 3.0
Frequency response ripple in frequency ranges, %: • (10 – 20) Hz • (20 – 500) Hz • (500 – 1000) Hz	 +2.5; -20.0 ± 2.5 +2.5; -30.0
Limit of permissible relative error of measurement in the operating temperature range of the sensor, converter, control module in frequency ranges, % • (10 – 20) Hz • (20 – 500) Hz • (500 – 1000) Hz	 +8.0; -20.0 ± 8.0 +8.0; -30
1) The ranges of sensors and converters of Vibrobit 100 equipment.	

1.3.27 Rotor speed measurement channel with sensors and converters of the Vibrobit 100 equipment

Table 28 – Rotor speed measurement channel main parameters and specifications

Parameter description	Normal value
Rotor speed measurement range, RPM	0,5 – 12000
Limit of permissible main absolute error of sensor, converter, control module measurement in operating conditions by digital indicator, RPM	± 2.0
Limit of permissible main relative error of sensor, converter, control module measurement in operating conditions by unified signal, %	± 1.0

1.3.28 Surface tilt measurement channel with sensors and converters of the Vibrobit 100 equipment

Table 29 – Surface tilt measurement channel main parameters and specifications

Parameter description	Normal value	
Measurement range, mm	± 1.0[1]	$\pm 2.0; \pm 5.0$[1]
Limit of permissible main reduced error of measurement, %	± 6.0	± 3.0
Limit of permissible reduced error of measurement in the whole operating temperature range of the sensor, converter, control module, %	± 10.0	± 6.0
1) The ranges of sensors and converters of Vibrobit 100 equipment.		

1.3.29 Absolute vibration displacement measurement channel with sensors and converters of the Vibrobit 100 equipment

Table 30 – Absolute vibration displacement measurement channel main parameters and specifications

Parameter description	Normal value
Measuring ranges, mm	0.01 – 0.25; 0.01 – 0.50[1]
Measurement frequency range, Hz	0.8 – 200.0; 5.0 – 200.0[1]
Limit of permissible main reduced error of channel measurement with a frequency range of (5.0 – 200.0) Hz, %	± 3.00
Limit of permissible main relative error of channel measurement with a frequency range of (0.8 - 200.0) Hz, %	± 5.00
Frequency response ripple of the channel with a frequency range of (5.0 – 200.0) Hz, in frequency ranges, % - (5.0 – 200.0) Hz, %	+ 10.00; - 25.00
Frequency response ripple of the channel with a frequency range of (0.8 - 200.0) Hz, in frequency ranges, %: - (0.8 – 2.0) Hz - (2.0 – 160) Hz - (160 – 200) Hz	+5.0; -20.0 ± 5.0 +5.0; -10.0
Limit of permissible reduced error of channel measurement with a frequency range of (5.0 – 200.0) Hz in the operating temperature range of the sensor, converter, control module at a base frequency, %	+ 5.00; - 10.00
Limit of permissible reduced error of channel measurement with a frequency range of (0.8 – 200.0) Hz in the operating temperature range of the sensor, converter, control module at a base frequency, %	± 8.0
1) The ranges of sensors and converters of Vibrobit 100 equipment.	

1.3.30 BST300.010 temperature unit main parameters and specifications

Table 31 – BST300.010 temperature unit main parameters and specifications

Parameter description	Normal value
Number of channels	1
Temperature measurement range, °C	from -40 to +100
Unified output current range, mA	1 – 5
Temperature estimation accuracy, °C	± 4
Supply voltage, V	from +10 to +30

1.3.31 DB9-MC-8 switching unit

Table 32 – Main parameters

Parameter description	Normal value
Number of channels	8
Temperature measurement range, °C	from -40 to +100

1.3.32 Cabinet requirements necessary for the development of layout solutions

Table 33 – Cabinet

Name	Requirement
Servicing type	double-sided
Version	floor installation
Cable entry	from below
Mounting type	on pins
Heat generation, W, not more than	550
Fire load, MJ, not more than	3150
Safety class by НП-001	See p. 1.2.1.32 of ТУ 4277-003-27172678-12
Seismic resistance category by НП-031	See pr. 1.2.2.12,1.2.2.13 of ТУ 4277-003-27172678-12
Environmental requirements at normal operation mode [2]: • maximum temperature, °C • minimum temperature, °C	45 5
Environmental requirements at emergency operation mode in conditions of ventilation systems serviceability loss [2]: • maximum temperature, °C • minimum temperature, °C	32 5
Parameters of discrete outputs: • minimum switching current, mA • minimum switching power, W	1 0,25
Consumption power, W, not more than	800

[1] The relative humidity values for normal and emergency operation modes are indicated in p. 1.2.2.4 of ТУ 4277-003-27172678-12.

[2] Discrete outputs are electromechanical relays with signals of the "dry contact" type

1.3.33 Overall dimensions and weight

Table 34 – Equipment units overall dimensions and weight

Version type-code	Overall dimensions, mm	Weight, kg, not more than
МК10-DC, МК11-DC, МК20-DC, МК22-DC, МК30-DC, МК32-DC, МК70, МК71, МК71-R2, МК73, МК90, МК91, МК95, ПЛК01, ПЛК02	20.1x128.7x190	0.15
МК11-AC-11-S, МК11-AC-11-S-СНП, МК11-AC-11-S-R2, МК40-AC-11-S	40.3x128.7x190	0.30
МК10-DC-11, МК10-DC-001, МК11-DC-11, МК20-DC-20, МК20-DC-20-СНП, МК22-DC-11, МК22-DC-001, МК22-DC-001-R2, МК22-DC-001-R2-COMP.01, МК30-DC-20, МК30-DC-20-СНП, МК40-DC-11, МК40-DC-001, МК32-DC-11, МК32-DC-20, МК32-DC-20-R2, МК32-DC-001, МК32-DC-20-LF3, МК32-DC-20-LF4	40.3x128.7x190	0.20
МП24	40.3x128.7x190	0.60
МП24.1	40.3x128.7x190	0.70
МП26	40,3x128,7x190	0,70
БИ24	160x85x67	0.90
БИ34	88x35x72	0,30
ВМ22-ОК, ВМ32-ОК	70.8x128.7x265	1.15
ВМ22-Р, ВМ32-Р, ВМ61-Р	70.8x128.7x265	1.20
MC01 USB	81.5x24x17.5	0.10
MC03 Bluetooth	55.5x14x14	0.02
ПН31	140x70x20	0.20
ПС03, ПС04, ПС05, ПС06, ПС10, ПС11	483x132x235	2,10
BRCAN01	79x84x22.5	0,10
Unit ABP	195x170x75	0,90
Unit BST300.010	77.5x22.5x45	0,10
Unit DB9-MC-8	77.5x180x36	0,20
Framework "Евромеханика 19" 3U84HP	480x132x280	
RITTAL TS 8 1800x600x600; 2000x600x600 etc	610x625x1825 610x625x2025 etc.	
ВШПА.421412.300.370.01 Stand Vibrobit 300	620x635x2030	

1.3.34 Measurement channels (assembled sensors, converters and amplifiers in the transducer boxes, control modules, power supply modules, safety shutdown logic modules installed in the frameworks, frameworks in the cabinet, the ports are protected by SPD) executing safety shutdown functions (protection by the rotor axial offset, dangerous vibration level), correspond to the safety class according to 3Н according to ОПБ 88/97.

The remaining measurement channels correspond to the safety class 4Н according to ОПБ 88/97.

1.3.35 The equipment complies with the electromagnetic compatibility requirements of ГОСТ 32137-2013 for group III of version by resistance to interference with the quality performance criterion A when connecting communication lines via SPD, and also meets the electromagnetic emission standards class A equipment.

1.3.36 Industrial interference standards should comply with Class A, Group 1 according to ГОСТ Р 30805.22-2013.

1.3.37 Modules and control modules, indication units, power supply modules, indication units retain their parameters when exposed to a variable magnetic field of the mains frequency with intensity up to 100 A/m.

1.3.38 The equipment retain their parameters at a relative humidity up to 80% and temperature of plus 35° C (or lower) without moisture condensation.

1.3.39 The equipment retain its parameters in the atmospheric pressure range from 630 to 800 mm Hg.

1.3.40 Equipment warm-up time should not exceed 10 minutes, operating mode - continuous.

1.3.41 In terms of resistance to external influencing factors the equipment corresponds to the nominal values according to ГОСТ 30631-99 for the group M39.

1.3.42 IP rating of the units should comply with ГОСТ 14254-2015:

- control modules, power supply modules (as part of the cabinet) IP20;
- control units   IP20;
- indication units   IP32;
- CAN interfaces splitter BRCAN01   IP20;
- unit BST300.010, unit DB9-MC-8   IP20.
- cabinet RITTAL TS 8, stand Vibrobit 300   IP21;

1.3.43 Equipment preservation during long-term storage is not required. Equipment long-term storage should be carried out in packaged form, preferably in the manufacturer's container, in heated rooms with conditions 1 (Л), storage atmosphere type III according to ГОСТ 15150.

1.3.44 Equipment arrangement group at the NPP according to OTT08042462:

 • used sensors, converters, comparators, transducer boxes of equipment Vibrobit 100   4;
 • modules and control modules, power supply modules, indication units, frameworks and cabinets   5.

Converters and comparators of equipment Vibrobit 100 should be placed in transducer boxes during the operation.

Control modules, power supply modules should be placed in frameworks and frameworks - in cabinets.

1.3.45 When placing control modules, power supply modules, control units in the frameworks, frameworks - in cabinets, the equipment should be resistant to decontaminating media.

1.3.46 The equipment seismic resistance is rated as type II according to НП-031-01.

The equipment is seismic-resistant under the influence of earthquakes with an intensity of 8 points inclusive on the MSK-64 scale, with installation level above the zero mark up to 20 m.

1.3.47 All units of the equipment Vibrobit 300 are maintainable, interchangeable within the technical and metrological parameters.

1.3.48 The average time of the equipment recovery in operation is less than 0.5 hours.

Recovery is carried out by replacing the failed units with serviceable ones from spare parts, tools and accessories kit (SPTA).

1.3.49 Mean time between failures (MTBF) $T\alpha$, hours, not less (estimated):

    • parameter control module (one channel)   100000;
    • power supply module   100000;
    • control unit (one channel)   75000;
    • indication unit   70000;
    • control module MK71   200000;
    • control module MK73   300000;
    • unit BST300.010   100000;
    • unit DB9-MC-8   100000;
    • CAN interfaces splitter BRCAN01   100000.

1.3.50 The equipment assigned lifetime is 10 years minimum. The equipment service life when delivered to NPP is 30 years.

1.4 Equipment design and operation

The Vibrobit 300 equipment is a set of assembly units performing the functions of measuring and monitoring the parameters of DC/AC current or voltage periodic signals, pulse signals frequency, in stationary signal monitoring and information measuring systems of turbine generators or other equipment.

All equipment units have standard unified output signals:

- direct current (4 – 20) mA;

- discrete, open collector type;

- digital interfaces RS 485, CAN 2.0 B.

The standardized control interfaces and unified outputs make the Vibrobit 300 equipment functionally and electrically compatible with other types of measuring means and information-measuring systems.

The structural and functional design of the equipment units provides for assembling the monitoring systems different in purpose, composition and number of measured parameters.

Microcontrollers with high computational capability applied in Vibrobit 300 equipment provide for real-time multichannel digital processing of signals.

The block diagram of the parameter monitoring and measurement module is given in Figure 1.
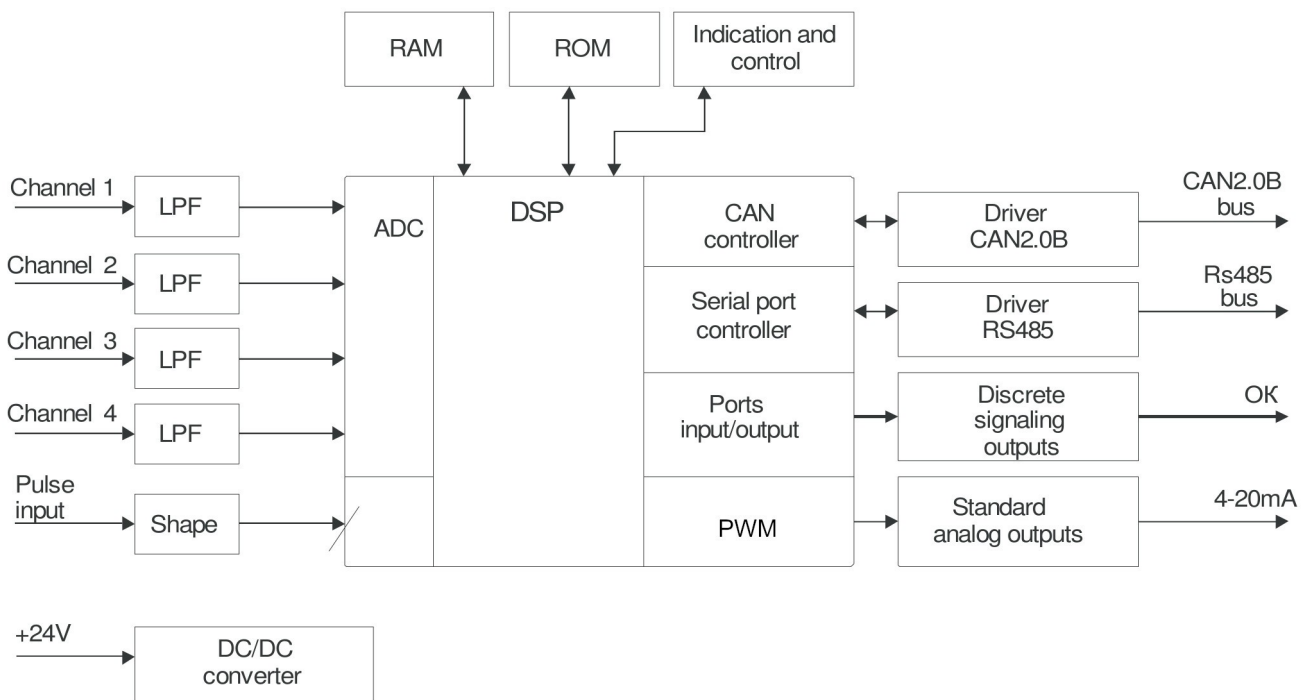
Figure 1 – Module block diagram

The output signals from the sensors and converters are transmitted to the module low pass filters (LPF), limiting the input signal spectrum and further to the microcontroller ADC. The signal processing results are transmitted to indicators, digital interfaces and analog shapers. The module synchronization input receives the equipment RPM signals permitting to calculate additional parameters, such as the rotational components amplitude, rotational components phase, etc.

The discrete output signals control the electromagnetic relays in the equipment signaling and protection circuits.

The front panels of the modules provide signal LEDs, digital 7-segment of graphic LCD indicators to visually monitor the equipment operation.

The digital communication interfaces RS485, CAN2.0B enable to remotely control the equipment operation in full and adjust its operation modes, thus the Vibrobit 300 equipment can be incorporated into existing or new APCS at minimum expense.

Figure 2 shows the equipment Vibrobit 300 connection block diagram.
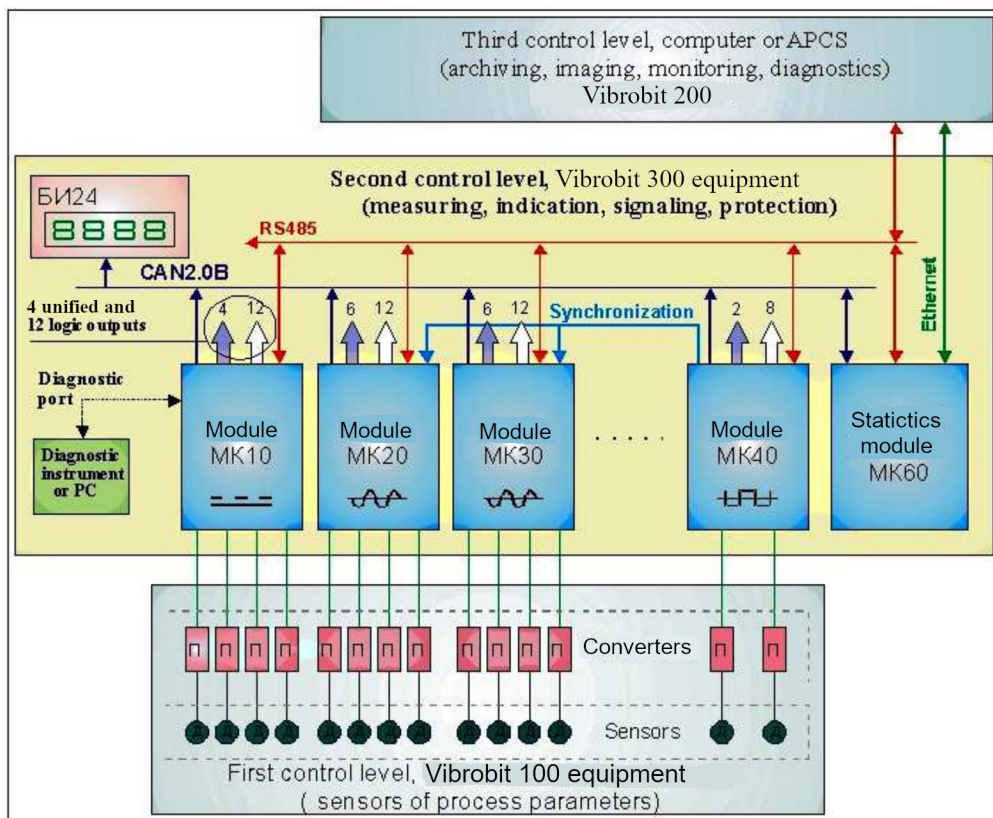
Figure 2 – Equipment Vibrobit 300 connection block diagram

1.5 Design and operation of the equipment units

1.5.1 MK10 module

The MK10 module is intended for measuring and control the linear displacements, DC signals via four independent measurement channels, executes functions of the equipment signaling and safety shutdown.

The MK10 main functions:

- measurement of the signal constant level via four independent measurement channels with the sensor serviceability monitoring function;
- four setpoints for each measurement channel with individual selection of the operating mode for each setpoint;
- four unified current outputs;
- twelve logic outputs with direct connection to the coils of signaling and safety shutdown relay;
- support of digital communication interfaces: RS485 with ModBus protocol; CAN2.0B; the diagnostic interface.

The MK10 is based on high-performance 8-digit microprocessor, providing parallel processing of signals from several measurement channels, integrating a large number of functions in a single module and supporting the modern digital control interfaces.

The MK10 module operates in real time with periodicity of the measurement result update of 500ms. The MK10 module performs the following main operations:

- measures the signal constant level via measurement channels;
- calculates the sensor current and monitors the sensor serviceability;
- calculates the real values of the measured parameter;
- compares the calculated parameter values with the setpoints and signals of the setpoints overrange;
- transmits the measured values to the unified outputs;
- generates the logic signaling;
- maintains data exchange via digital communication interfaces;
- indicates the measured values and processes the buttons pressing by the user.

The MK10 module is implemented with a simplified calibration method of input measurement channels and unified current outputs enabling to switch over the parameter measurement range or the unified output range without repeating calibration (or recalculating coefficients).

Twelve logic outputs with open collector (OC – low active level) enable the user to set the functional purpose of each output.

MK10 module operation modes setup is performed with a PC or a dedicated setup instrument ПН31. To setup the MK10 module with the PC, a program ModuleConfigurator.exe should be started on a computer, MK10 module should be connected to PC via the diagnostic interface module MC01 USB or MC03 Bluetooth.

The direct current +24V to power the sensors from the MK10 module is supplied through the resettable fuse 200 mA.

The MK10 module is delivered in several versions:

- **MK10-DC** – the limited indication system, front panel is 20mm. Setup, viewing the measured values and module status is possible only via digital communication interfaces.

- **MK10-DC-11** – the expanded indication and control system, front panel is 40mm. The front panel of the module incorporates a 7-segment digital indicator, additional LEDs and control buttons.

- **MK10-DC-001** – the expanded indication and control system, front panel is 40mm. The front panel of the module incorporates a special alphanumeric LCD for displaying the measurement results in all channels simultaneously.

1.5.2 MK11 module

The MK11 module is intended for measuring and monitoring the linear displacements, DC signals via two independent measurement channels, executes functions of the equipment signaling and safety shutdown.

The MK11 main functions:

- measurement of the signal constant level via two independent measurement channels with the sensor serviceability monitoring function;

- automatic indication switching to display the main measured parameter (channel 1);

- four setpoints for each measurement channel with individual selection of the operating mode for each setpoint;

- two unified current outputs;

- mode of testing the operation of measurement channels and elements of signaling, safety shutdown;

- eight logic outputs with direct connection to the coils of signaling and safety shutdown relay;

- support of digital communication interfaces: RS485 with ModBus protocol; CAN2.0B; the diagnostic interface;

- power supply from the source of DC +24 V and AC (85 – 240) V 50 Hz (depending on the module version).

The MK11 is based on high-performance 8-digit microprocessor, providing parallel processing of signals from several measurement channels, integrating a large number of functions in a single module and supporting the modern digital control interfaces.

The MK11 module operates in real time with periodicity of the measurement result update of 250ms. The MK11 module performs the following main operations:

- measures the signal constant level via measurement channels;

- calculates the sensor current and monitors the sensor serviceability;

- calculates the real values of the measured parameter;

- compares the calculated parameter values with the setpoints and signals of the setpoints overrange;

- transmits the measured values to the unified outputs;

- generates the logic signaling;

- maintains data exchange via digital communication interfaces;

- indicates the measured values and processes the buttons pressing by the user.

The MK11 module is implemented with a simplified calibration method of input measurement channels and unified current outputs enabling to switch over the parameter measurement range or the unified output range without repeating calibration (or recalculating coefficients).

Design of the MK11 module enables to test operation of the entire module measuring route and logic outputs. The measurement channels of the MK11 module are tested with buttons on the module front panel or by commands from digital communication interfaces.

Eight logic outputs with open collector (OC – low active level) enable the user to set the functional purpose of each output.

MK11 module operation modes setup is performed with a PC or a dedicated setup instrument ПН31. To setup the MK11 module with the PC, a program ModuleConfigurator.exe should be started on a computer, MK11 module should be connected to PC via the diagnostic interface module MC01 USB or MC03 Bluetooth.

The MK11 module is delivered in several versions:

- **MK11-DC** – the limited indication system, front panel is 20mm. Setup, viewing the measured values and module status is possible only via digital communication interfaces.

- **MK11-DC-11** – the expanded indication and control system, front panel is 40mm, module is powered by +24 VDC. The front panel of the module incorporates a 7-segment digital indicator, additional LEDs and control buttons.

- **MK11-AC-11-S** – the version is similar to the previous one except that it is powered from AC mains of (85 – 240) V 50 Hz, the module front panel has a power ON switch. This version is specifically advantageous when project requires an individual power source for each channel of mechanical values measurement, such as building the rotor axial offset monitoring circuit.

- **MK11-AC-11-S-R2** – similar to the previous version, has two RS485 interfaces

The direct current +24V to power the sensors from the MK11 module is supplied through the resettable fuse 200 mA.

The second measurement channel in the version MK11-AC-11-S can be used to monitor the power supply voltage level of +24 V for the sensor and the module itself.

1.5.3 MK20 module

The MK20 module is intended to measure the vibration displacement by the real-time spectral analysis of the sensor signals, executes functions of the equipment safety shutdown. The module is based on high-performance DSP processor enabling to implement a large set of calculated vibration parameters, to provide access to the measurement results and the initial data via the high-speed interfaces RS485 and CAN2.0B, to arrange a convenient user interface, a flexibly adjustable system of external warning and alarm signaling.

The MK20 module is rated for connection of four independent sensors of vibration displacement and two synchronization sensors. The equipment is protected against malfunctions by twelve power

outputs with OC and by six analog current outputs able to transmit the measurement results in the analog format of the variable scale.

The provided serial interfaces provide remote control, setup and registers the measurement statistics of the MK20 module. The module front panel also has a diagnostic connector for PC to setup and diagnose the MK20 module.

The MK20 module is delivered in two versions:

- **MK20-DC** – the limited indication system, front panel is 20mm. Setup, viewing the measured values and module status is possible only via digital communication interfaces.

- **MK20-DC-20** – the expanded indication and control system, front panel is 40mm. The front panel incorporates a graphical LCD 122x32 dots, additional LEDs and control buttons.

MK20 module operation modes setup is performed with a PC or a dedicated setup instrument. To setup the MK20 with the PC, a program ModuleConfigurator.exe should be started on a computer, MK20 should be connected to PC via the diagnostic interface module MC01 USB or MC03 Bluetooth.

The measured vibration parameters by the MK20 module:

- Rotational frequency F;

- Vibration displacement (5 – 500)Hz, 5Hz – F/2, 2xF – 500Hz;

- Vibration displacement ½, 1-10 rotational component;

- The phase of the 1-10 rotational component;

- Amplitude and phase measurement of the rotational components from 0.05Hz;

- Gap;

- Sensor serviceability monitoring;

- 3 setpoints of vibration displacement (5 - 500)Hz;

- 1 setpoint of the vibration displacement LF RMS of 5Hz – F/2;

- Step detection of the vibration displacement amplitude (5 - 500)Hz, the first rotational component amplitude, the first rotational frequency phase.

The vibration parameters are measured synchronously for all four channels with the periodicity of results updating of 0.5sec using the same algorithm.

To measure the vibration parameters in the unit different operation modes, two types of the fast Fourier transformation (FFT) are provided:

- 2048 samplings per second – the main FFT with the spectrum resolution from 1Hz to 1024Hz. It is used to calculate the majority of vibration parameters in the stationary mode of operation.

- 512 samplings per revolution – the auxiliary FFT with the resolution equal to the unit speed. The results of the auxiliary FFT are used to calculate the amplitude rotational components and the vibration displacement phase.

The MK20 module has 12 logic OC outputs with a high load capacity and 80 signal sources (16 per channel (64) + 16 system-wide). Each of 80 signal sourced is represented as a logic signal fed to the input of the software logic matrix. The logic matrix output is a 12 independent power keys OK.

The MK20 module has six analog current outputs each of which can be assigned with any calculated parameter with the adjustable scale and displacement. The signal from microprocessor pulse width modulation (PWM) output is sent to the input of the fourth order Butterwort analog filter with the cutoff frequency 100Hz. Generated at the filter output is an analog signal with the voltage from 0 to 3.3 V that is sent into the current-controllable stabilizer circuit.

The MK20 module supports three independent control interfaces:

- RS485 interface with partial implementation of ModBus RTU protocol (sufficient to control MK20);

- Support of CAN2.0B interface (only expanded messages);

- SPI slave interface for adjustment of MK20 operation parameters using dedicated instrument or the PC.

All interfaces can operate in parallel without interfering each other.

1.5.4 MK22 module

Universal 4-channel control module MK22 is designed to measure constant and tachometer sensor signals and turbine rotor bowing (eccentricity). MK22 is based on a high-performance 32-bit DSP processor, providing real time sensor signals processing (measurement frequency from 0.1 sec) and parallel support of digital communication interfaces.

Main function of the MK22 module measurement channels is the measurement of constant signals with period of 0.1 seconds (protection algorithms response time from 0.1 seconds). In addition to measuring constant signals, each channel of MK22 module can be configured to operate in extended mode:

- Channel 1 - rotor speed measurement (tachometric signal);

- Channel 2 - rotor speed measurement (tachometric signal);

- Channel 3 - rotor bowing (eccentricity) measurement (AC signal);

- Channel 4 - sensor signal linearization (DC signal), parameter calculation according to formula.

The standard set of measurement channel features includes:

- Sensor DC current measurement, sensor and communication lines serviceability monitoring;

- Parameter value calculation (with a period of 0.1s), averaging of measurement results, comparison with the setpoints;

- Stability control of the measured parameter, maintaining the parameter minimum and maximum values;

- Sending the calculated parameter values to a unified current output;

- Assigning meaningful symbolic name to measurement channels;

- Implementing additional algorithms for parameter measurement (individually for each channel).

Additional functions of the rotor speed measurement include

(for measurement channels 1 and 2):

- Rotor speed measurement period from 0.1 to 1.0 sec;

- Rotor speed measurement from 1 rpm at the control surface "Groove";

- Customizable number of pinion teeth (number of pulses per rotor revolution);

- The selection of sensor signal active edge;

- The repetition of the reference tachometer pulses to synchronize the control modules calculating rotational components and their phases (eg, modules, MK22,MK32)

- Detecting the rotor stop and the rotor stop signaling test.

MK22 module has the following features to measure the rotor bowing (eccentricity) (measurement channel 3):

- Measurement period 0.2 seconds (or one rotor revolution);

- The calculation of the rotor bowing by 1st rotational component or the sensor polyharmonic signal;

- The calculation of the harmonic components of the rotor bowing measurement sensor signal (2A excursion from ½ to 5 harmonics and their phases);

- Selection of the reference tachometer pulses input;

- Operation of the first, second measurement channels in the constant signal mode when using the third measurement channel in the "rotor bowing" mode;

- Synchronization of the tachometric pulses with the control surface "Pinion" (phases of rotational components are not calculated);

- Phase offset correction of the module LPF, converter and sensor mounting position relative to the control surface "groove";

- Rotor bowing measurement block when rotor speed exceeds the established limits.

Sensor constant signal linearization function can be enabled on the fourth measurement channel:

- The linearization method of piecewise linear approximation (current - value of the measured parameter);

- Up to 16 entries (15 segments) in the linearization table.

Other features of MK22 module include:

- The input signals of measurement channels: (0 (1) - 5) mA, (0 (4) – 20) mA, (0 – 3) V;

- 12 logical outputs with a custom algorithm for implementation of signaling and protection circuits;

- Four unified current outputs with the range software configuration;

- Supported communication interfaces: RS485, CAN2.0B, diagnostic interface;

- Service PC software for the current state visualization, module setup and calibration;

The module is manufactured in several versions:

- **MK22-DC** – narrow front panel 20 mm 3U, limited module signaling system;

- **MK22-DC-11** – 40 mm front panel 3U, bright 7-segment digital indicator with an advanced indication and module control system;

- **MK22-DC-001** – 40 mm front panel 3U, dedicated alphanumeric LCD displaying the measurement results on all channels simultaneously;

- **MK22-DC-001-R2** – advanced indication and control system, front panel 40 mm. Arranged on the module front panel is a dedicated alphanumeric LCD

displaying the measurement results on all channels simultaneously, LEDs of a limited indication system and control buttons;

- **MK22-DC-001-R2.COMP.01** – similar to MK22-DC-001-R2 with installed board of controlled comparators COMP.01-2CH-MK32-MS for measurement channels 1, 2

- Module single-supply operation with DC voltage +24 V, low power consumption;
- Converters (sensors) are powered via resettable fuse 200mA installed on the MK22 module board, DC voltage +24 V.

MK22 module setup is performed with a PC or a dedicated setup instrument ПН31. To setup the module with the PC, a program ModuleConfigurator.exe should be started on a computer, MK22 module should be connected to PC via the diagnostic interface module MC01 USB (PC USB interface) or MC03 Bluetooth.

1.5.5 MK30 module

The MK30 module is intended to measure the vibration velocity RMS by the real time sensor signals spectral analysis method; it performs the functions of the equipment safety shutdown. The module is based on the high-performance DSP processor, implementing a large set of the calculated vibration parameters, providing access to the measurement results and the initial data via the high-speed interfaces RS485 and CAN2.0B, organizing a convenient user interface, system of external warning and alarm signaling with flexible customization.

MK30 module is intended to connect up to four independent vibration velocity sensors and two synchronization sensors. To protect the equipment against malfunctions there are 12 power OC outputs, six analog current outputs transmitting the measurement results in the analog format with adjustable scale.

The provided serial interfaces enable to remotely control, setup and maintain the measurement statistics of the MK30 module. The module front panel also has a diagnostic connector for PC to setup and diagnose the MK30 module.

The MK30 module is supplied in two versions:

- **MK30-DC** – the limited indication system, front panel is 20mm. Setup, viewing the measured values and module status is possible only via digital communication interfaces;
- **MK30-DC-20** – the expanded indication and control system, front panel is 40mm. The front panel incorporates a graphical LCD 122x32 dots, additional LEDs and control buttons.

MK30 operation modes setup is performed with a PC or a dedicated setup instrument. To setup the MK30 with the PC, a program ModuleConfigurator.exe should be started on a computer, MK30 should be connected to PC via the diagnostic interface module MC01 USB or MC03 Bluetooth.

The measured vibration parameters and protective functions of the MK30 module:

- Rotational frequency F;

- Vibration velocity RMS (10 – 1000)Hz, 10Hz – F/2, 2xF – 1000Hz;

- Vibration velocity RMS ½, 1-10 rotational component;

- The phase of the 1-10 rotational component;

- Vibration displacement and the vibration displacement phase of the first rotational component;

- The peak-to-peak signal excursion and the signal shape coefficient;

- Sensor serviceability test;

- 3 setpoints of the vibration velocity RMS (10 -1000)Hz;

- 1 setpoint of LF vibration velocity RMS 10Hz – F/2;

- RMS step detection (10 -1000)Hz, RMS of the first rotational component, phase of the first rotational frequency.

The vibration parameters are measured for all four channels synchronously with the results update rate of 0.5sec using the same algorithm.

To measure the vibration parameters in the unit different operation modes, two types of the FFT are provided:

- 4096 samplings per second – the main FFT with the spectrum resolution from 1Hz to 2048 Hz. It is used to calculate the majority of vibration parameters in the unit stationary mode of operation.

- 512 samplings per unit revolution – the auxiliary FFT with the resolution equal to the unit speed. The results of the auxiliary FFT are used to calculate the amplitude rotational components and the vibration velocity phase.

The MK30 module has 12 logic OC outputs with a high load capacity and 80 signal sources (16 per channel (64) + 16 system-wide). Each of 80 signal sourced is represented as a logic signal fed to the input of the software logic matrix. The logic matrix output is a 12 independent power keys OK.

The MK30 module has six analog current outputs each of which can be assigned with any calculated parameter with the adjustable scale and displacement. The signal from microprocessor PWM output is sent to the input of the fourth order Butterwort analog filter with the cutoff frequency 100Hz. Generated at the filter output is an analog signal with the voltage from 0 to 3.3 V that is sent into the current-controllable stabilizer circuit.

The MK30 module supports three independent control interfaces:

- RS485 interface with partial implementation of ModBus RTU protocol (sufficient to control MK30);

- Support of CAN2.0B interface (only expanded messages);

- SPI slave interface for adjustment of MK30 operation parameters using dedicated instrument or the PC.

All interfaces can operate in parallel without interfering each other.

1.5.6 The MK32 module

Universal 4-channel control module MK32 is designed to measure the RMS and the AC signals excursion by real-time sensor signals spectral analysis method,

as well as to measure DC and tachometric signals. Executes functions of the equipment safety shutdown.

The MK32 is based on the high-performance 32-bit DSP processor, implementing a large set of the calculated parameters, providing access to the measurement results and the initial data via the high-speed interfaces RS485 and CAN2.0B, organizing a convenient user interface, system of external warning and alarm signaling with flexible customization.

Universal 4-channel MK32 control module implements all measurement types of the Vibrobit 300 equipment:

- Vibration velocity RMS of bearing supports;
- The total vibration velocity RMS vector, calculated by the rotational components;
- Rotor vibration displacement excursion;
- Bearing supports vibration displacement excursion calculated by an initial signal from the vibration velocity sensor by digital integration in the time domain
- Total vibration displacement excursion vector calculated by rotational components;
- Rotor absolute vibration displacement calculated by the rotational components;
- Total rotor absolute vibration displacement vector calculated by the rotational components;
- Rotor eccentricity;
- Rotor speed;
- Mechanical values represented by the DC signals.

The standard set of measurement channel features includes:

- Sensor DC current measurement, sensor and communication lines serviceability monitoring;
- Measurement of AC signal RMS and excursion (with integration in the time domain);
- Parameter value calculation (with a period of 0.5s), comparison with the setpoints;
- Measured parameter step monitoring;
- Sending the calculated parameter values to a unified current output;
- Assigning meaningful symbolic name to measurement channels;

In addition MK32 module has four virtual measurement channels. The value of virtual measurement channels is calculated based on the rotational components of the physical measurement channels.

The following functions are available for the virtual measurement channel:

- Integration of the argument 1;
- Addition of argument 1 and argument 2;
- Calculation considering the scaling factor,

where argument 1 and argument 2 are the parameter value of the physical or virtual measurement channel.

For each physical measurement channel provided are four customizable bandwidths. Each can be configured to work with both fixed and floating frequency limits. Bandwidths with floating limits are tied to the rotational component by the customization coefficients. The module measures the main parameter (RMS or AC signal excursion) for each bandwidth of each channel.

MK32 control module has a compatibility mode with MK20 and MK30 modules. In this mode, the MK32 module measures and displays the results of measurements similar to control modules MK20 and MK30.

In this mode are available additional options to select the information displayed on LCD and data display format.

Other features of MK32 module include:

- The input signals of measurement channels: (0 (1) - 5) mA, (0 (4) – 20) mA, (0 – 3) V;

- 14 logic outputs with operation algorithm customize in analytical form for implementation of signaling and protection circuits;

- Four independent unified current outputs with the range software configuration;

- Supported communication interfaces: RS485, CAN2.0B, diagnostic interface;

- Service PC software for the current state visualization, module setup and calibration;

MK32 module is available in several versions:

- ***MK32-DC*** – the limited indication system, front panel is 20mm. Setup, viewing the measured values and module status is possible only via digital communication interfaces;

- ***MK32-DC-20*** – the expanded indication and control system, front panel is 40mm. The front panel incorporates a graphical LCD 122x32 dots, additional LEDs and control buttons;

- ***MK32-DC-001 –*** 40 mm front panel 3U, dedicated alphanumeric LCD displaying the measurement results on all channels simultaneously;

- ***MK32-DC-11 –*** 40 mm front panel 3U, bright 7-segment digital indicator with an advanced indication and module control system;

- ***MK32-DC-20-R2*** – the expanded indication and control system, front panel is 40mm. The front panel incorporates a graphical LCD 122x32 dots, additional LEDs and control buttons.

- Module single-supply operation with DC voltage +24 V, low power consumption;

- Converters (sensors) are powered via resettable fuse 200mA installed on the MK32 module board, DC voltage +24 V.

MK32 module setup is performed with a PC or a dedicated setup instrument ПН31. To setup the module with the PC, a program ModuleConfigurator.exe should be started on a computer, MK32 module should be connected to PC via the diagnostic interface module MC01 USB or MC03 Bluetooth.

1.5.7 MK40 module

The two-channel control module MK40 is intended to measure the rotor tachometric signals. The MK40 is based on the high-performance microcontroller, processing sensor signals in the real time mode (the measurement periodicity is from 0.1 sec) and supporting parallel operation of the digital communication interfaces.

The channels operate synchronously and autonomously. The main functions of the measurement channels are the following:

- sensor DC current measurement, sensor and communication line serviceability monitoring;

- rotor speed measurement period from 0.1 to 1.0 sec (same for both measurement channels);

- rotor speed measurement from 1 RPM at the control surface «Groove»;

- the adjustable number of pinion teeth (number of pulses per rotor revolution);

- selection of the sensor signal active edge (determined by the jumper on the module board);

- repetition of reference tachometric pulses to synchronize the control modules calculating the rotational components and their phases (for example, the modules MK20, MK30);

- rotor stop detection and the rotor stop signaling testing (the STOP mode);

- comparison of the calculated frequency value with the setpoints (3 setpoints for each channel);

- determination of the rotor maximum speed;

- transmission of the calculated parameter value to the unified current output.

Other features of the MK40 module include:

- input signals of measurement channels: (0(1) – 5) mA; (0(4) – 20) mA; (0 – 5) V;

- six logic outputs with adjustable operation algorithm to implement the signaling and protection circuits;

- two unified current outputs with the range software adjustment;

- supported communication interfaces: RS485, CAN2.0B, diagnostic interface;

- PC service software for the current condition visualization, module setup and calibration;

- converters (sensors) are powered via resettable fuses 200mA, mounted on the MK40 module board, DC voltage +24V;

- generation of the test signal 50Hz for the version MK40-AC-11-S.

The MK40 module is available in several versions:

- **MK40-DC** – the narrow front panel 20mm 3U. Limited module status signaling system, power supply DC voltage +24V;

- **MK40-DC-11** – 40 mm front panel 3U, bright 7-segment digital indicator with an advanced indication and module control system, power supply DC voltage +24V;

- **MK40-DC-001** – 40 mm front panel 3U, dedicated alphanumeric LCD displaying the measurement results on all channels simultaneously, power supply DC voltage +24V;

- **MK40-AC-11-S** – 40 mm front panel 3U, bright 7-segment digital indicator with an advanced indication and module control system, power supply AC voltage 220V 50Hz and an ON/OFF toggle switch on the front panel.

MK40 module setup is performed with a PC or a dedicated setup instrument ПН31. To setup the module with the PC, a program ModuleConfigurator.exe should be started on a computer, MK40 module should be connected to PC via the diagnostic interface module MC01 USB or MC03 Bluetooth.

1.5.8 MK70 module

The MK70 module is intended to perform the logic signaling to generate the equipment safety shutdown signal. The MK70 module is based on the Altera CPLD. The operation logic of the safety shutdown outputs is set during the module manufacturing but can be adapted to the customer's specification.

The main functions of the MK70:
- 16 logic inputs;
- 4 safety shutdown OC outputs:

   – output one - the operation logic is set by the microswitches on the module board;
   – output two - any of 16;
   – output three - any 2 of 16 with the permission signal;
   – output four - the operation logic is set by the microswitches on the module board (only for the version MK70 J; MK70 J-CPU);

- the output delay from 0 to 3 sec configurable by the microswitches (only for outputs 1, 2 and 3);
- logic inputs status indication;
- Indication of the logic input number, first one to register the signal active level;
- transmission of the logic inputs/outputs status data via the digital communication interfaces RS485, CAN2.0B, the diagnostic interface (only for the version MK70 CPU; MK70 J-CPU);
- module status reset with a front panel button, by the external signal or a command via the digital communication interfaces.
- test signal generation - meander 61Hz with adjustable amplitude and DC component.

To transmit the MK70 module status data via the digital communication interfaces, installed on the MK70 board is the board PIC CPU 01 with a high-performance 8-digit microprocessor providing parallel gathering of logic inputs/outputs status data, supporting the modern digital control interfaces.

Operation modes of MK70 CPU module RS485, CAN2.0B interfaces are configured with a PC or a dedicated setup instrument ПН31. To setup the MK70 CPU module with the PC, a program mk70_setup.exe should be started on a computer, MK70 CPU module should be connected to PC via the diagnostic interface module MC01 USB or MC03 Bluetooth.

1.5.9 MK71 module MK71

The MK71 module is intended to perform the logic signaling and to generate the equipment safety shutdown signal. The MK71 module is based on the Altera complex programmable logic device (CPLD). The operation logic of the equipment safety shutdown outputs is set by the microswitches position on the module board. MK71 module implements the most of the logic circuits of turbine generators protection from a dangerous vibration level and a vibration step.

MK71 main functions:

- 48 logic inputs;

- 3 safety shutdown OC outputs;

- up to four auxiliary inputs/outputs;

- input for the safety shutdown logic reset and blocking;

- response delay from 0 to 3 sec configurable by microswitches;

- input logic signal configurable validity time for the vibration step logic protection circuits;

- logic inputs status indication;

- logic inputs/outputs status data transmission via the digital communication interfaces RS485, CAN2.0B, diagnostic interface;

- module status reset with a front panel button, by the external signal or a command via the digital communication interfaces;

- test signal generation.

The MK71 control module also has a version:

- **MK71-R2** - second RS485 interface added.

To transmit the MK71 module status data via the digital communication interfaces, installed on the MK71 board is a high-performance 8-bit microcontroller providing parallel gathering of logic inputs/outputs status data, supporting the modern digital control interfaces.

The safety shutdown logic operation is determined only by the microswitches position and does not depend on the microcontroller software.

Operation modes of MK71 module RS485, CAN2.0B interfaces are configured with a PC or a dedicated setup instrument ПН31. To setup the MK71 module with the PC, a program ModuleConfigurator.exe should be started on a computer, MK71 module should be connected to PC via the diagnostic interface module MC01 USB or MC03 Bluetooth.

1.5.10 MK73 module

The MK73 control module is designed to gather the control modules setpoints status in automated control systems via the CAN interface with further generation of logic signals for the upper level according to the specified algorithms (formulas).

MK73 main functions:

- gathering the control modules setpoints status with customizable event lists in each of which the modules (groups of modules) are arbitrarily defined and rules regulating the occurrence of these events;

- generation of logical signals according to specified algorithms (formulas) on one of the three outputs with direct connection to the windings of the signaling and safety shutdown relays;

- support for digital communication interfaces: RS485 with ModBus protocol, diagnostic interface;

- module failure signal;

- logic outputs status indication;

- module status reset with a front panel button, by the external signal or a command via the digital communication interfaces;
- test signal generation.

1.5.11 MK90 module

MK90 control module is intended for testing the equipment signaling and protection by any measurement channel. When testing no switching is performed with the tested measurement channel. Testing can be performed in any operating mode of the equipment.

MK90 control module is a configurable signal source imitating the signals from the sensors (converters).

Usually, when the section is manufactured, a room is reserved to install the MK90 providing connection to one or several control boards of the relevant signal type and adjustment of its information parameter. The reference signal from the MK90 is summed up with the sensor (converter) signal. The MK90 module can test up to eight similar measurement channels simultaneously.

1.5.12 MK91 module

MK91 control module is intended for testing the equipment signaling and protection by any measurement channel. MK91 module operation is similar to the module MK90 described above. The main differences from the MK90 module are:

- MK91 module main switching connector - DIN41612-396MRD;
- outputs 7 and 8 can be configured for voltage operation. The signal DC component and excursion are set at the stage of adjustment.

Voltage operation mode can be used to test the tachometric measurement channels.

1.5.13 MK95 module

MK95 control Module is intended for intermediate monitoring and research of the sensor signals (after the converter or amplifier) in the parameter measurement channel.

Sensor output signals are connected to the MK95 module differential input, then to the measurement control module.

MK95 module converts sensor signals to a unified signal (0 — 10) V.

MK95 module has 4 control channels. The output signals of each channel are displayed on the MK95 module front panel (connector type BNC) and the module main switching connector (for switching to the CVMS cabinet terminal blocks).

1.5.14 BM22 control unit

Universal 4-channel BM22 control unit is designed to measure sensor DC and tachometric signals and turbine rotor bowing (eccentricity). The control unit can be used as an independent device.

BM22 is based on a high-performance 32-bit DSP processor, providing real time sensor signals processing (measurement frequency from 0.1 sec) and parallel support of digital communication interfaces.

Structurally the BM22 control unit is based on the MK22 control module board.

For more information about MK22 control module, see section 1.5.4 and the setup instructions for the MK22 control module (ВШПА.421412.3022 И1).

BM22 control unit is available in two versions:

- BM22-OK – all logic outputs are type OC;
- BM22-P – four logic outputs are of relay type and two logic outputs are type OC.

Both versions of BM22 units are made with the front panel of 71 mm 3U, have dedicated alphanumeric liquid crystal display (LCD) capable of displaying the measurement results of all channels simultaneously.

The BM22 control unit has a built-in AC/DC converter of 30 W to connect the unit directly to a standard power supply of ~ 220 V.

Operation modes of BM22 unit are configured with a PC or a dedicated setup instrument ПН31. To setup the BM22 unit with the PC, a program ModuleConfigurator.exe should be started on a computer, BM22 unit should be connected to PC via the diagnostic interface module MC01 USB (PC USB interface) or MC03 Bluetooth. To operate the BM22 unit in ModuleConfigurator.exe program, select the MK22 module.

Converters (sensors) are powered through resettable fuses 200 mA DC voltage + 24 V.

1.5.15 BM32 control unit

Universal 4-channel BM32 control unit is designed to measure the AC signals RMS and excursion by the real-time sensor signals spectral analysis, as well as to measure the DC and tachometric signals. It performs the equipment safety shutdown functions.

The control unit can be used as an independent device.

The BM32 is based on the high-performance 32-bit DSP processor, implementing a large set of the calculated parameters, providing access to the measurement results and the initial data via the high-speed interfaces RS485 and CAN2.0B, organizing a convenient user interface, system of external warning and alarm signaling with flexible customization.

Structurally the BM32 control unit is based on the MK32 control module board.

For more information about MK32 control module, see section 1.5.6 and the setup instructions for the MK32 control module (ВШПА.421412.3032 И1).

BM32 control unit is available in two versions:

- BM32-OK – all logic outputs are type OC;
- BM32-P – four logic outputs are of relay type and two logic outputs are type OC;

Both versions of BM32 units are made with the front panel of 71 mm 3U, have dedicated alphanumeric liquid crystal display (LCD) capable of displaying the measurement results of all channels simultaneously.

The BM32 control unit has a built-in AC/DC converter of 30 W to connect the unit directly to a standard power supply of ~ 220 V.

Operation modes of BM32 unit are configured with a PC or a dedicated setup instrument ПН31. To setup the BM32 unit with the PC, a program ModuleConfigurator.exe should be started on a computer, BM32 unit should be connected to PC via the diagnostic interface module MC01 USB (PC USB interface) or MC03 Bluetooth. To operate the BM32 unit in ModuleConfigurator.exe program, select the MK32 module.

Converters (sensors) are powered through resettable fuses 200 mA DC voltage + 24 V.

1.5.16 BM61 control unit

BM61 control unit is intended for measurement and control of overspeed protection mechanism trip pin protrusion of steam and gas turbines. Implemented in BM61 unit are two measurement channels: rotor speed and protection mechanism trip pin position.

BM61 control unit is based of the MK22 control module board.

For more information about MK22 control module, see section 1.5.4 and the setup instructions for the MK22 control module (ВШПА.421412.3022 И1).

BM61 control unit is available in a version with four relay logic outputs and two OC logic outputs.

BM61 control unit is made with a front panel of 71 mm 3U, have dedicated alphanumeric liquid crystal display (LCD) capable of displaying the measurement results of all channels simultaneously.

The BM61 control unit has a built-in AC/DC converter of 30 W to connect the unit directly to a standard power supply of ~ 220 V.

Operation modes of BM22 unit are configured with a PC or a dedicated setup instrument ПН31. To setup the BM22 unit with the PC, a program ModuleConfigurator.exe should be started on a computer, BM22 unit should be connected to PC via the diagnostic interface module MC01 USB (PC USB interface) or MC03 Bluetooth. To operate the BM22 unit in ModuleConfigurator.exe program, select the MK22 module.

Converters (sensors) are powered through resettable fuses 200 mA DC voltage + 24 V.

1.5.17 БИ24/БИ34 indication unit

БИ24/БИ34 indication unit is intended for remote display of the measured parameter values and for independent frequency measurement. The БИ24/БИ34 is based on a high-performance 8-bit microcontroller. The microcontroller enables integration of a large number of functions in the single unit and support of modern control interfaces.

БИ24/БИ34 main functions of the БИ24/БИ34:

- RS485 interface support with partial implementation of Mudbugs RTU protocol;

- CAN2.0B interface support (only expanded messages);

- I2C slave interface for БИ24/БИ34 operating parameters configuration;

- speed measurement (RPM) with display format selection;

- configuration of information displayed on the indicators: after the energizing (reset), when waiting for a signal from the communication interfaces, in case of long-term absence of signals from the communication interfaces and upon stop detection in the frequency measurement mode;
- indicators light intensity adjustment.

Operation modes of БИ24/БИ34 are configured with a PC or a dedicated setup instrument ПН31. To setup the БИ24/БИ34 with the PC, a program ModuleConfigurator.exe should be started on a computer, БИ24/БИ34 should be connected to PC USB interface via the diagnostic interface module MC01 USB. БИ24/БИ34 cab be setup using setup instrument ПН31 via the diagnostic interface module MC03 Bluetooth using Bluetooth interface.

1.5.18 MC01 USB module

MC01 USB module is intended to connect modules and units of the Vibrobit 300 equipment to the PC through the USB interface. MC01 USB module is a converter of interfaces I2C and SPI into the USB depending on of the setup module and have the galvanic isolation between the PC and the setup module. The PC should have installed the virtual COM port drivers. MC01 USB is powered by the setup control module or unit.

1.5.19 MC03 Bluetooth module

MC03 BlueTooth is diagnostic interface module. It is intended to connect the control modules and units of equipment Vibrobit 300 with a PC via a standard Bluetooth radio interface. MC03 BlueTooth module can used for operational control over the module status, operating parameters setup and measurement channels calibration.

Communication with personal computer (or PDA) via Bluetooth wireless interface is possible only if it has a hardware Bluetooth module supporting the Serial Port Profile (SPP).

MC03 BlueTooth is powered by the setup control module or unit.

For detailed information about the module, see the device certificate ВШПА.421412.334 ПС.

1.5.20 МП24, МП24.1 and МП26 power supply modules

The power supply modules use pulse voltage converters rated for the input voltage from 176 to 240 V AC, from 47 to 63 Hz or from 246 to 350 V DC. The output generates the stabilized voltage +24 V.

The control circuit of the power supply modules signals the voltage overrange and blocks the output signaling relays when the equipment is switched on and off, power supply module failures, mains voltage fluctuations or loss.

A distinctive feature of the МП24.1 power supply module is a combination of signaling operation testing functions and the equipment protection by any measurement channel, similar to the MK91 module.

МП26 features are the availability of:

- digital data transfer buses - CAN (two lines) and RS485 (two lines);
- digital indicator displaying the selected parameters (output voltage, load current, ACDC converter heating temperature and the converter load level);

–   indication LEDs displaying the module status of the and the displayed parameter sign;

–   discrete outputs that can be used to operate the signaling by a certain setpoints pre-configured using the ModuleConfigurator software;

–   discrete inputs that can be connected to relay outputs of devices, limit switches, etc.

–   turn-on delays after a set time interval after applying the mains voltage, and the module will turn on when the AC voltage passes over "zero";

–   the module can transmit information about the output voltage, current, operating status via digital buses to upper-level systems.

1.5.21 ПН31 setup instrument

ПН31 setup instrument (the instrument below) is intended for viewing the measurement results and adjusting the operating parameters of the Vibrobit 300 equipment modules via the modules diagnostic interface. The instrument stores the database about the Vibrobit 300 equipment modules.

The instrument detailed operation is described in ВШПА.421412.332 РЭ. Setup Instrument. Operation and Maintenance Manual.

1.5.22 BST300.010 temperature sensor unit

BST300.010 temperature sensor unit is designed to evaluate the temperature in its installation zone. The temperature data is transmitted via a unified current output of 1...5 mA, which also powers the unit. For easy installation the unit is manufactured in the case with a DIN-rail attachment.

BST300.010 temperature sensor unit BST300.010 is not a measuring device. The temperature values obtained with BST300.010 can be used as estimates (calibration and verification is not required).

1.5.23 DB9-MC-8 switching unit

DB9-MC-8 switching unit is designed for switching the RS485 signals from terminal connections to DB9 type connectors.

1.6 Equipment marking

The marking is applied on front panels, printed boards, connectors, casings and other accessible places.

Marking content is determined in accordance with Annex D.

The marking contains:

- company trademark;

- type (symbol) of the assembly unit;

- serial number and year of manufacturing;

- symbol or purpose of indication, signaling, commutation and control elements;

- assembly unit version;

- type approval sign.

The marking application method depends on the operating conditions and is stated in the drawings. The method of the marking application should ensure its integrity during long-term operation.

The type approval mark is affixed to the technical documentation (instruction manual, form).

Sign type approval is applied to the technical documentation (operation and maintenance manual, logbook).

The equipment intended for delivery to the Atomic Power Station, corresponding to the third safety group according to ОПБ 88/97, is marked with "АС-3".

The marking of the shipping container complies with ГОСТ 14192-96.

The handling signs No.1, No.3, No.11 (No.14, No.19) are applied in the left-hand upper corner on the box two adjacent sides.

2 Intended use

2.1 Installation and mounting procedure

When carrying out installation and assembling of the equipment it is necessary to use the ROEI (Regulations for Operation of Electrical Installations), ПОТРМ-016-2001 (РД 153-34.0-03.150-00) (Interindustry Labor Safety Rules During Electrical Installations Operation), ORCEI (Operation Rules of Customer's Electrical Installations) and this Operation and Maintenance Manual.

Cabinets, frameworks and indication units should be connected to the common grounding bus.

The installation and mounting of the equipment should be done according to the project usually developed by the VIBROBIT Company.

The project includes the following:

- the cabinet, section appearance (the front panel);
- the installation diagram of the sensors, converters, boxes on the equipment;
- the electric schematic diagrams of sections;
- the harness diagrams in the section, cabinet;
- the diagrams of sections connection in the cabinet;
- the diagrams of external connections of the sensors, converters, cabinet.

For the installation location of sensors on the equipment see the Operation and Maintenance Manual of the Vibrobit 100 equipment ВШПА.421412.100 РЭ.

The equipment installation and mounting order

The equipment modules are installed directly in the frameworks 3U "Евромеханика 19".

The electric circuits of the frameworks are connected via the connectors. The framework connectors provide direct connection of cable wires (strands) with the wire cross section of not more than 2.5mm^2.

The framework body should be connected to the grounding bus.

The length of cable connections between the cabinet (secondary equipment) and the sensors, converters, indication unit - not more than 300 m with a wire cross section of 1 mm^2 and not more than 400 m with a wire cross section of 1.5 mm^2. The cable must be shielded and the screen should be connected to the grounding bus of the Vibrobit equipment of the upper level. It is recommended to lay the control circuit cables separately from the power and high-voltage ones.

2.2 The equipment operating procedure

2.2.1 Energizing

The supply voltage is fed to equipment sections through circuit breakers or power panel toggle-switches.

The equipment is energized via the channels or sections by closing the toggle switch «Power» on the module front panel.

The power supply module voltage is fed to the sensors, converters, control modules.

2.2.2 General information about the control modules MK10, MK11, MK20, MK22, MK30, MK32, MK40, control units BM22, BM32, BM61

All types of control module front panels have the following elements:

- handle for the module installation/removal from the section;
- captive screws;
- diagnostic interface connector **D.port**;
- hidden module reset button **Reset**;
- module status LED **Ok**.

The module status can be determined by the LED **Ok** color:

- *Green color* –the module operates normally;
- *Yellow color* – the output logic signaling is blocked by user or after the module reset;
- *Red color* – a fatal error in the module operation, the module operation is blocked;
- *Green (yellow) blinking color* – the sensor test error detected for one of the measurement channels.

2.2.2.1 Module version - DC

A narrow front panel (20mm wide) with a limited indication and control system. Measurement results can be viewed only by the digital communication interfaces. Additionally the module front panel contains:

- the green LED *'Pwr'* – the module power is on;
- the bi-color LED *'Ok'* -- indicates the module status;
- the yellow LED *'War'* – warning (the LED operation logic is determined by the user);
- the red LED *'Alarm'* – alarm (the LED operation logic is determined by the user).

2.2.2.2 Power on

After powering on, the module operating parameters are loaded from the nonvolatile memory. The operating parameters are divided into the sections:

- Parameters of the measurement channels;
- System parameters and the parameters of the communication interfaces.

A check sum is added to each operating parameters section in the nonvolatile memory in order to check the validity of the loaded data. If the calculated check sum is inconsistent with the sum recorded in the nonvolatile memory, it is assumed that the data are damaged and they cannot be used for the module operation.

Each section in the nonvolatile memory has main and reserve allocation. If section of the parameters is read from the nonvolatile memory with an error, then an effort is made to read the data from the reserve allocation in the nonvolatile memory.

If an error is detected in one of the operation parameters sections (the main or reserve section), the module operation is blocked, the signal active level appears at logic output 12 (except for MK11 and MK40 modules) and the LED **'Ok'** on the front panel will light red.

When the operation parameters are loaded normally, before operation the module performs its starting initialization.

After the module power-up (reset), the logic outputs operation is blocked for a set time. If the logic outputs operation is blocked, the LED *Ok* will light yellow.

2.2.2.3 The module reset

During the module reset, carried out the microcontroller hardware reset and the sequence of operations are performed corresponding to power up. The reasons for the control modules reset can be the following:

- module power up;

- reset by user's commands (by the button '**Reset**' on the module front panel or by the command via the digital communication interfaces);

- microcontroller supply voltage drop (power supply source failure);

- reset by the watchdog timer due to the microcontroller program «hangup».

To reset the module, briefly press the button 'Reset', then hold the button 'Reset' until the module is reset.

> *Note.* – The module reset is possible only after the identification data display (the module number, the year of manufacture) and the module initiation cycle completes.

2.2.3 MK10 module

The control and indication elements of the MK10 module are different depending on the version.

Figure 3 shows the appearance of the MK10 module front panels.

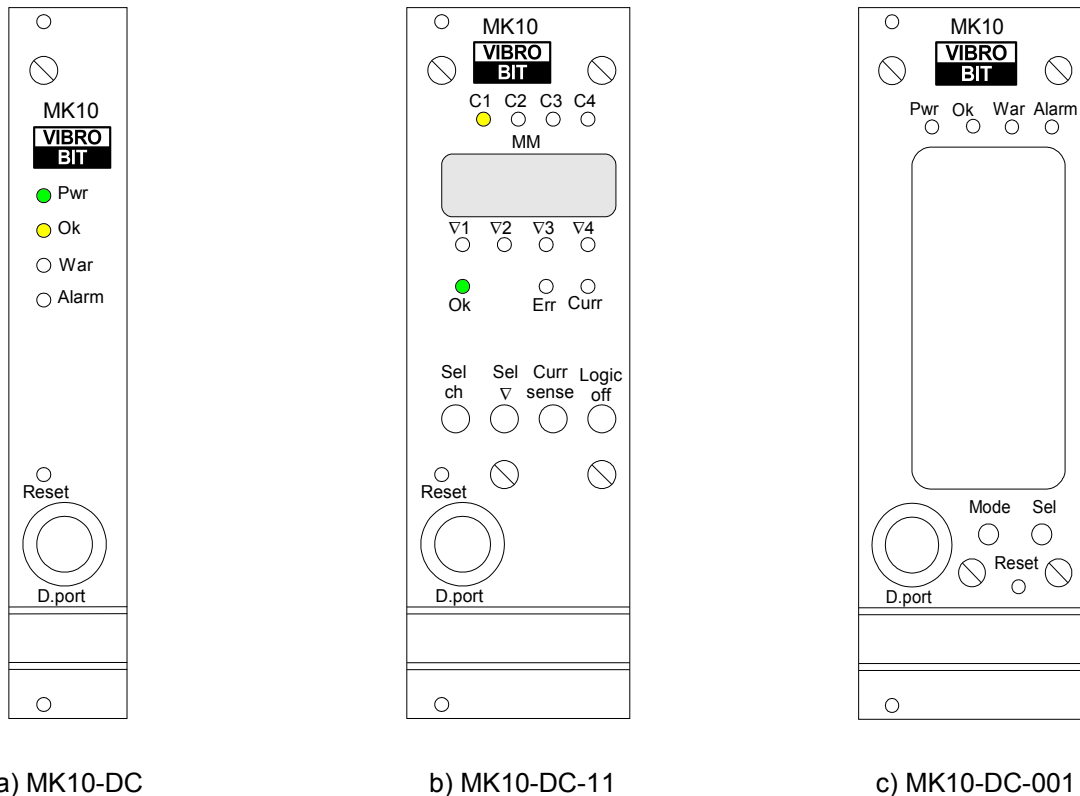a) MK10-DC   b) MK10-DC-11   c) MK10-DC-001

Figure 3 – Appearance of MK10 front panel

2.2.3.1 Version MK10-DC-11

The front panel of the MK10 module with a 7-segment 4-digit LED indicator, auxiliary signal LEDs and control buttons. The indicator in this MK10 module version simultaneously shows the information only by one of the measurement channels.

The front panel contains:

- four yellow LEDs *'C1', 'C2', 'C3'* and *'C4'* of the selected measurement channel indication;

- the digital 4-digit 7-segment indicator;

- four yellow LEDs *'∇1'*, *'∇2'*, *'∇3'* and *'∇4'* to indicate the parameter overrange beyond the relevant setpoints of the selected measurement channel. When showing the setpoint value, the corresponding setpoint LED blinks;

- the bi-color LED *'Ok'* indicates the module status;

- the red LED *'Err'* indicates failure of the selected measurement channel. LED *'Err'* blinks if the measurement channel operation normalizes, but the pause after the channel normalization has not been counted down and before the parameter testing by the setpoints;

- the yellow LED *'Curr'* indicates the displaying of the sensor current actual value;

- four control buttons:

  - *Sel ch* – measurement channel selection to indicate the parameter value and the measurement channel status (disabled measurement channel are not shown).

  - *Sel∇* – indicate the setpoints values (disabled setpoints are not shown).

  - *Curr sense* – indicate the sensor current.

  - *Logic off* – logic outputs operation block.

The measurement channels are switched over by pressing the button **'Sel ch'**. When a new measurement channel is selected, the indicator immediately shows the selected channel main parameter current value.

> **Note.** Switching to display the measurement channel information is not performed if this measurement channel is blocked in the MK10 module settings. If all measurement channels are blocked in the module settings, the indicator shows '**OFF**'.

The cyclic viewing of the setpoint values is performed by pressing the button **'Sel ∇'**. The indicator shows the setpoint value and the corresponding setpoint LED blinks. If the switching over to the next setpoint fails to occur during the preset time, the module will then indicate the main measured parameter value.

> **Note.** If a setpoint is disabled in the module settings, then indicator does not show this setpoint. If all setpoints are disabled, the indicator shows none of the setpoint values.

To indicate the sensor current press the button **'Curr sense'**. The indicator shows the sensor current in the in the format `##.##` even if sensor malfunction the is detected, in this case the LED **'Curr'** blinks.

Switching on/off the logic outputs is performed by pressing and holding the button **'Logic off'** until the operating mode of the logic outputs switches over. When the logic outputs operation is blocked, the LED '**Ok**' lights yellow and all logic outputs are inactive.

2.2.3.2 Version MK10-DC-001

The front panel of the MK10 module with dedicated alphanumeric LCD, signal LEDs and control buttons. The indicator simultaneously shows the measurement results and status of all measurement channels.

The front panel contains:

- dedicated LCD with built-in illumination;
- signal LEDs:
    - green LED **'Pwr'** – energizing the unit;
    - bi-color LED **Ok** — module status;
    - yellow LED **'War'** – warning (the LED operation logic is determined by the user);
    - red LED **'Alarm'** – alarm (the operation logic is determined by the user).

Two control buttons:
- button **'Mode'** – indication mode selection;
- button **'Sel'** – indicated data selection.

The symbols '∇**1**', '∇**2**', '∇**3**', '∇**4**' (in a frame) signal the monitored parameter value overrange beyond the setpoints.

Figure 4 – Example LCD indicator readings

The symbol '**Er**' (in a frame) indicates the sensor malfunction detected by this measurement channel, the measured parameter value is assumed zero (LCD displays zero), signaling by setpoints of the corresponding measurement channel is inactive.

As soon as the measurement channel operation normalizes, the symbol '**Er**' begins to blink, the unit counts down the measurement channel normalization time-out (set by the user).

To indicate the sensors DC current, press and hold the button **Mode** until LCD displays the sensor current value (by two channels simultaneously). When indicating the sensor current, the LCD displays the measurement unit symbols 'mA' and the symbols of the measured parameter value overrange beyond setpoints are not displayed. To restore the normal indication mode, hold the button **Mode** again or it restores automatically by time-out.

To display the setpoints values on the LCD, press and hold the button **Sel** until the first measurement channel sign **K1** and the first setpoint symbol ▽1 start blinking. By repeatedly (shortly-term) pressing the button **Sel**, it is possible to view all four setpoints of the current measurement channel. The setpoint values are displayed instead of measurement results. If setpoint is disabled (in the module settings), dashes are displayed instead of the setpoint values.

To view the setpoint values of another measurement channel, press the button **Mode** in the setpoint indication mode. The normal indication mode is restored by holding the button **Sel** again or automatically by time-out.

Logic outputs are switched on/off by simultaneous pressing and holding the buttons **Mode**-**Sel** until the logic outputs operating mode switches over. If the logic outputs are blocked, the LED **Ok** lights yellow and all logic outputs are inactive.

2.2.4 MK11 module

The control and indication elements of the MK11 module are different depending on the version.

Figure 5 shows the appearance of the MK11 module front panels.
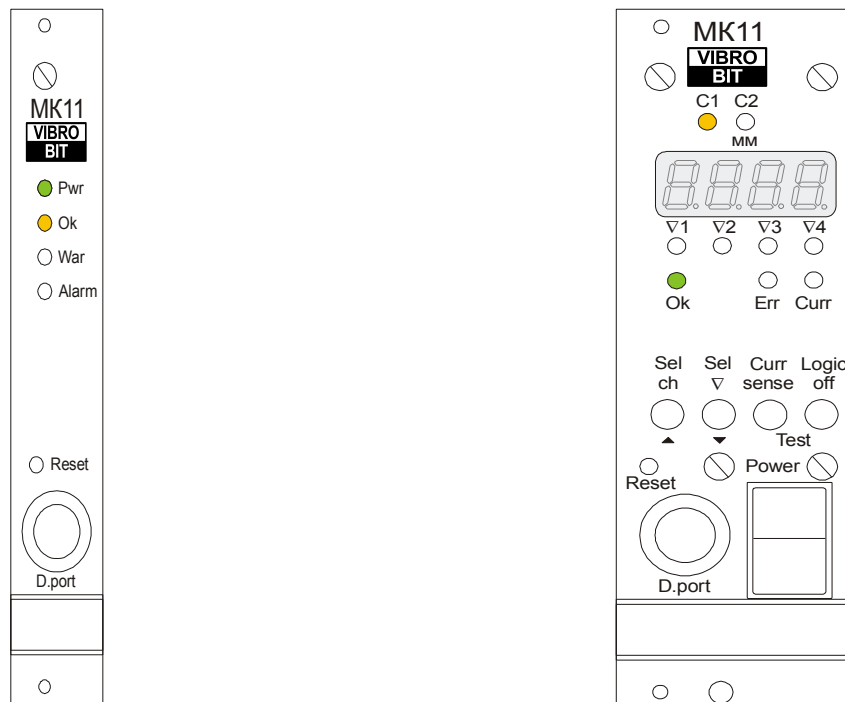
a) MK11-DC, MK11-DC-R2   b) MK11-AC-11-S, MK11-AC-11-R2

Figure 5 – Appearance of MK11 front panel

2.2.4.1 Version MK11-DC-11 and MK11-AC-11-S

MK11-DC-11 module version has extended indication and control elements. The front panel appearance of the MK11-AC-11-S module is shown in figure 5b. The MK11-DC-11 module front panel contains:

- two yellow LEDs **'C1'** and **'C2'** indicating the selected measurement channel. In the measurement channel 'Test' mode the LED of the selected measurement channel blinks;

- digital 4-digit 7-segment LCD indicating the parameter measured values and messages;

- four yellow LEDs **'∇1'**, **'∇2'**, **'∇3'** and **'∇4'** to indicate the parameter overrange beyond the relevant setpoints of the selected measurement channel. When showing the setpoint value, the corresponding setpoint LED blinks;

- the bi-color LED **'Ok'** indicates the module status;

- the red LED **'Err'** indicates failure of the selected measurement channel. LED **'Err'** blinks if the measurement channel operation normalizes, but the pause after the channel normalization has not been counted down and before the parameter testing by the setpoints;

- the yellow LED **'Curr'** indicates the displaying of the sensor current actual value (engineering information). When displaying the sensor current of the selected measurement channel indicator, the LED **'Curr'** blinks;

- four control buttons:

    - **Sel ch** – measurement channel selection to indicate the parameter value and the measurement channel status. In the mode 'Test' it is used to increase the DC at the selected measurement channel input;

    - **Sel∇** – indicate the setpoints values. In the mode 'Test' it is used to decrease the DC at the selected measurement channel input;

    - **Curr sense** – indicate the sensor current.

    - **Logic off** – logic outputs operation block.

The version MK11-AC-11-S has additional toggle switch **'Power'** installed on the MK11 module front panel to switch on the MK11 module power (commutes the input mains voltage).

The measurement channels are switched over by pressing the button **'Sel ch'**. When a new measurement channel is selected, the indicator immediately shows the selected channel main parameter current value.

> **Note.** Switching to display the second measurement channel information is not performed if this measurement channel is blocked in the MK11 module settings.

The cyclic viewing of the setpoint values is performed by pressing the button **'Sel ∇'**. The indicator shows the setpoint value and the corresponding setpoint LED blinks. If the switching over to the next setpoint fails to occur during the preset time, the module will then indicate the main measured parameter value.

> **Note.** If a setpoint is disabled in the module settings, then indicator does not show this setpoint. If all setpoints are disabled, the indicator shows none of the setpoint values.

To indicate the sensor current press the button *'Curr sense'*. The indicator shows the sensor current in the in the format ##.## even if sensor malfunction the is detected, in this case the LED *'Curr'* blinks.

Switching on/off the logic outputs is performed by pressing and holding the button *'Logic off'* until the operating mode of the logic outputs switches over. When the logic outputs operation is blocked, the LED '*Ok*' lights yellow and all logic outputs are inactive

2.2.4.2 The 'Test' mode

In MK11 module user can test operation of the module measurement channels, unified and logic outputs. When enabling the mode 'Test', sensor connected to the module input disconnects from the module input circuits. The module measuring inputs receive signals from the internal adjustable current generator or external test signals (determined by the jumper on the MK11 board).

To enable the 'Test' mode it is necessary to simultaneously press and hold the buttons *'Curr sense'* and *'Logic off'* until the current measurement channel switches into the 'Test' mode. In the 'Test' mode the LED of the selected measurement channel (*'C1'*, *'C2'*) blinks. To exit from the 'Test' mode it is necessary to press and hold the buttons *'Curr sense'* and *'Logic off'* until exiting the 'Test' mode.

> **Note.** 'Test' mode should be enabled for each module channel during the MK11 setup. If the 'Test' mode is disabled, switching to the 'Test' mode doesn't occur.

If the board jumpers selected the internal test signal generator mode, the user can use the button *'Sel ch'* to increase and the button *'Sel ▽'* to decrease the test signal DC level. Holding these buttons will continuously increase/decrease the test signal level.

> **Note.** In the 'Test' mode it is impossible to switch over to another measurement channel and view the setpoint values of the selected measurement channel.

The calculated actual current value in the 'Test' mode is compared with the permissible sensor current preset in the module, hence the module can switch over to the mode 'Sensor malfunction'. The calculated parameter value is compared with the setpoints and the logic signaling about the parameter value overrange beyond setpoints is generated. The user can view the current calculated value of the sensor current (press the button *'Curr sense'*), enable/disable the logic outputs block (by pressing the button *'Logic off'*) and change the test signal level (buttons *'Sel ch'* and *'Sel ▽'*).

> **Note.** The test signal level change should be permitted during the module setup for each measurement channel individually.

When enabling the 'Test' mode, the test signal assumes the level preset during the module setup. The 'Test' mode can be enabled for both channels simultaneously only by commands transmitted via the digital communication interfaces.

2.2.5 MK20, MK30 modules

After module reset by switching-on the power supply or pressing the button ' **Reset** ', the module self-diagnostics is performed with loading the operation parameters from a non-volatile memory.

The LCD displays the starting picture (the LED '*War*' blinks) with the following data (Figure6 a):

- Module type;
- Module decimal number;
- Module software version;
- Module serial number;
- Module self-diagnostics progress in percent.
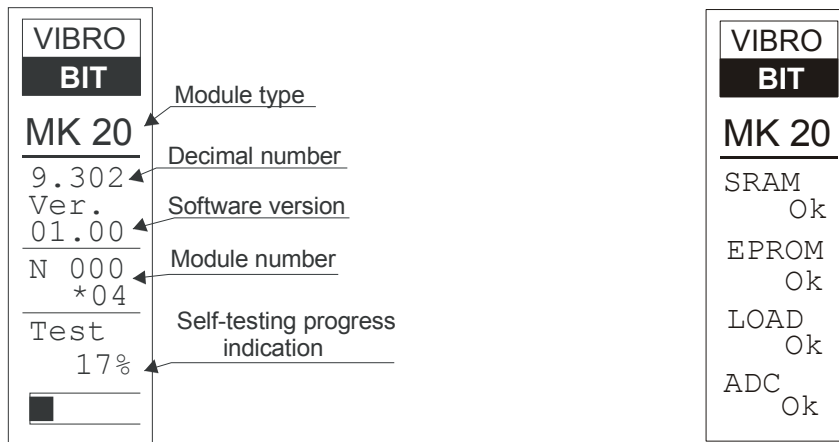
a) Starting information on LCD of MK20 module

b) Example of self-diagnostics results display of MK20

Figure 6 – Information display on the LCD

During the test, LCD displays the self-diagnostics results (see Figure 6 b).

The tests and their results have the following designations on the module LCD:

SRAM – the external RAM test:
  "ok" – RAM is OK;
  "err" – RAM malfunction.

EPROM –the nonvolatile memory test:
  "ok" – nonvolatile memory is OK;
  "err" – nonvolatile memory malfunction;
  "lock" – saving to the nonvolatile memory is disabled;

LOAD - testing the units checksum when loading from the nonvolatile memory:
  "ok" – all checksums matched;
  "err" – checksums inconsistency detected when loading the parameters;
  "war" – the parameters were loaded from the reserve section;
  "--" – the test was nor performed because the nonvolatile memory is faulty;

ADC – ADC test:
  "ok" – ADC is OK;
  "err" – ADC malfunction.

If the self-diagnostics result is satisfactory, in 1 second after the displaying results the module switches to the normal operation mode with measuring the vibration parameters.

In case the self-diagnostics result is not satisfactory:

- The module does not switch to the normal operation mode;

- LCD always displays the test results;

- The output logic and analog signaling is blocked;

- 12-th logic output has an active signal level;

- The bi-colored LED '*Ok*' on the front panel lights red;

- The user customizable red '*Alarm*' and the yellow '*War*' LEDs are on;

- The user can only reset the module.

To display the vibration parameters measurement results the MK20, MK21, MK30 modules have a graphic 32x122 pixel LCD (only for the version ''DC-20') and four signal LEDs permitting to quickly evaluate the device status.

The data indication modes are switched by two buttons '*Mode*' and '*Sel*' installed on the module front panel below the LCD (only for the version 'DC-20').

It permitted to deliver the MK20, MK30 modules without LCD and the control buttons (version 'DC'), then the measurement results can be accessed only via the external control interfaces: RS-485, CAN2.0B and the diagnostic port SPI.

2.2.5.1 Control buttons

The MK20, MK30 modules (version 'DC-20') has two buttons to control the module and the indication modes installed on the front panel and one hidden button, the device reset button (Figure Figure 7).
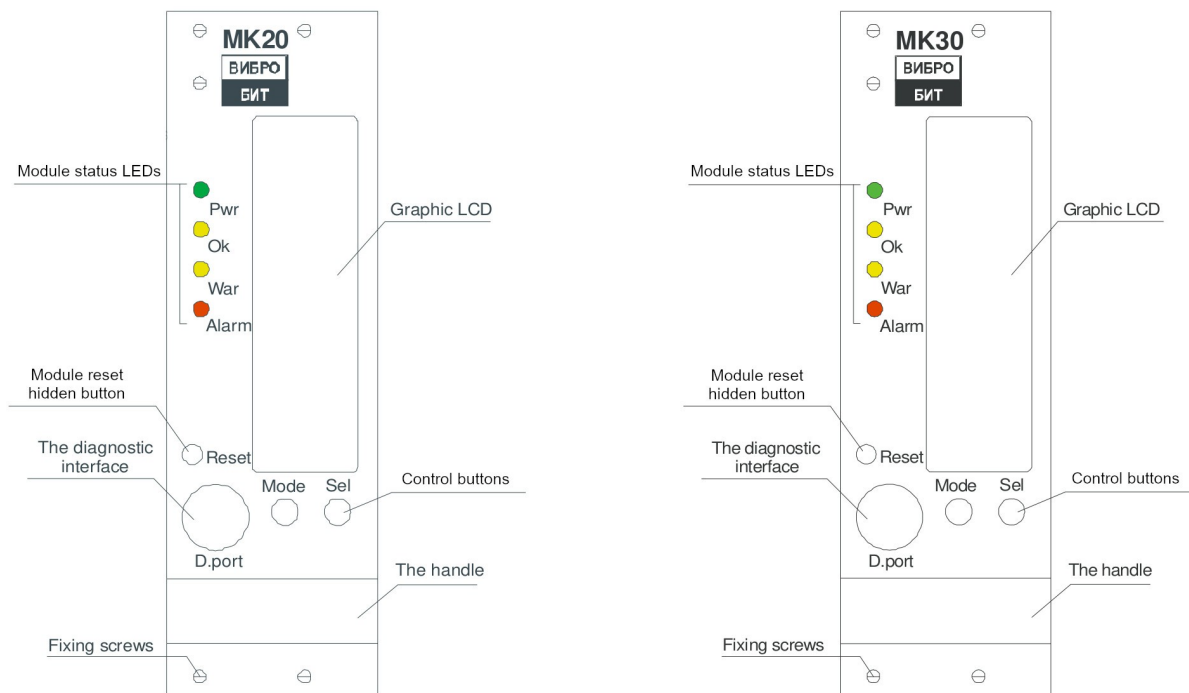
a) front panel of MK20 module
(version 'MK20-DC-20' 40mm)

b) front panel of module MK30
(version 'MK30-DC-20' 40mm)

Figure 7 – Appearance of front panels of MK20 and MK30 modules

The purpose of the buttons:

The button No. 1 **Mode** – switching the measurement results displaying mode «full display» of the channel information or «histograms» mode. If no histograms are setup in the system, no switching to the histograms mode will be executed.

The button No. 2 **Sel** – pressing button in the «histograms» mode cyclically switches over the setup histograms to display on the LCD. Pressing the button in the «full display» mode switches over the measurement channels.

The button No. 3 **Reset** - is hidden to prevent accidental pressing. The module is reset by pressing the button in a certain sequence: briefly press the button '***Reset***', release, press again and hold until the module is reset.

There are some combinations of pressing the buttons to control the module status:

Long holding of the buttons **Mode and Sel** – switches on/off the output logic signaling. The function of output logic signaling blocking can be useful when it is necessary, for example, to test the sensor connected to the module without danger to cause the unit emergency shutdown.

Long holding of the button **Mode** - in the «full display» mode resets all flags (signaling) of the detected parameter «steps» for the measurement channel displayed on the LCD.

Long holding of the button **Sel** - in the «histograms» mode initiates the setpoint values display mode, if the setpoints are provided for the displayed parameter.

The vibration parameters measurement results are displayed in one of the two the modes:

- **"histograms"**;
- channel **"full information"**.

Both these indication modes provide a flexible setup of the displayed data format to easily change the number and format of the displayed parameters without correcting the program code.

The information in the «histograms» data display mode is presented as four colored columns, which height is proportional to the displayed parameter values. The leftmost column corresponds to the first measurement channel, the rightmost column corresponds to the fourth measurement channel.

In the «full information» indication mode LCD displays only the parameters values corresponding to the current measurement channel in the preset format. The data display format is the same for all measurement channels.

The upper LCD line shows the measurement channel number. The user adjusts the remaining 14 lines.

- type of displayed data can be selected for each line;
- parameter numerical value in the preset format;
- text message (5 symbols) according to the measurement channel status register signaling flags;
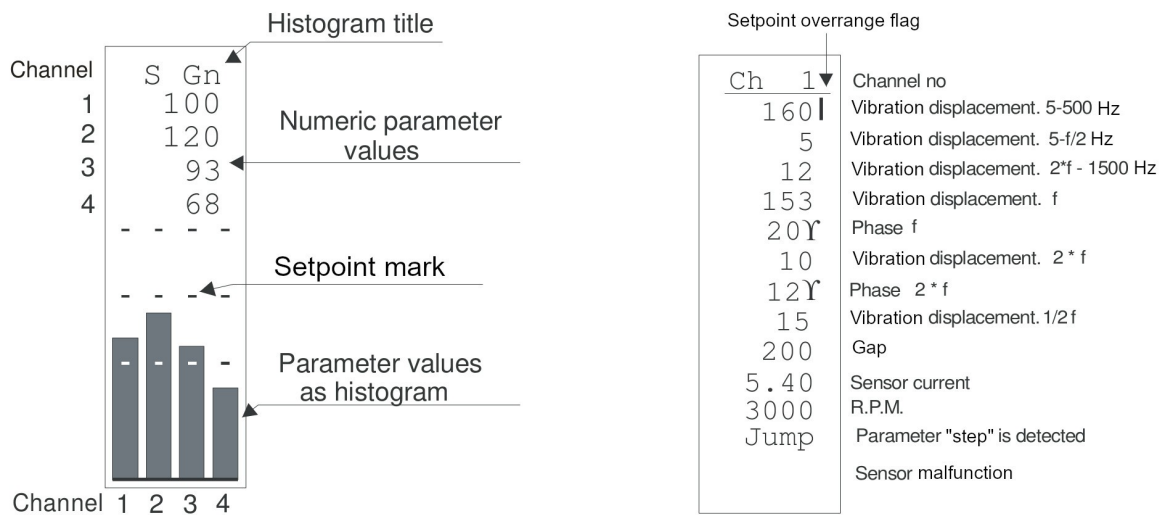- empty line.

2.2.5.2 Information displaying on the LCD (version 'DC-20') of the MK20 module

Eight histograms are registered by default (Figure Figure 8 a):

1. Vibration displacement amplitude (5 – 500)Hz;
2. LF vibration displacement amplitude 5Hz – F/2;
3. HF vibration displacement amplitude 2xF – 500Hz;
4. Sensor current;
5. Amplitude of the vibration displacement first rotational component;
6. Phase of the vibration displacement first rotational component;
7. Amplitude of the vibration displacement second rotational component;
8. Phase of the vibration displacement second rotational component.

By default, the LCD lines in the mode **«full information»** are configured as follows (Figure Figure 8 b):

1. Vibration displacement amplitude (5 – 500)Hz;
2. LF vibration displacement amplitude 5Hz – F/2;
3. HF vibration displacement amplitude 2xF – 500Hz;
4. Amplitude of the vibration displacement first rotational component;
5. Phase of the vibration displacement first rotational component;
6. Amplitude of the vibration displacement second rotational component;
7. Phase of the vibration displacement second rotational component;
8. Amplitude of the vibration displacement 1/2 rotational component;
9. Vibration displacement gap;
10. Sensor current;
11. Speed;
12. Empty;
13. Messages about the "step" detection (vibration displacement of (5-500)Hz, amplitude and phase of the vibration displacement first rotational component;
14. Sensor malfunction message.

a) Example of data display as "histograms" for MK20 module

b) Example of information display in "**full information**" mode for MK20 module

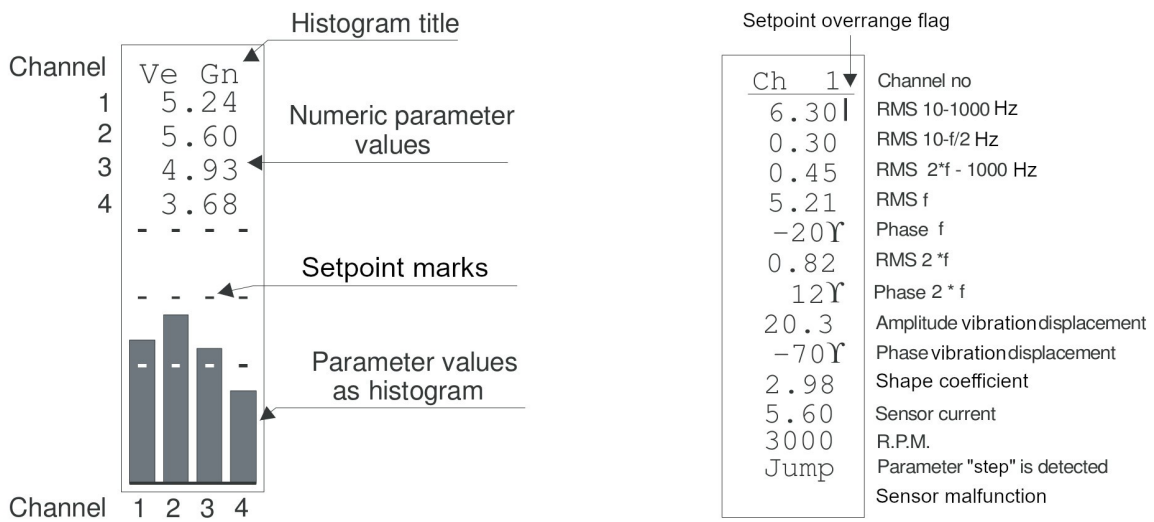Figure 8 – Displayed information on the LCD

2.2.5.3 Information displaying on the LCD (version 'DC-20') of the MK30 module

Eight histograms are registered by default (Figure Figure 9 a):

1. Total vibration velocity RMS (10 – 1000)Hz;
2. LF vibration velocity RMS 10Hz – F/2;
3. HF vibration velocity RMS 2xF – 1000Hz;
4. Sensor current;
5. RMS of the vibration velocity first rotational component;
6. Phase of the vibration velocity first rotational component;
7. RMS of the vibration velocity second rotational component;
8. Phase of the vibration velocity second rotational component.

By default, the LCD lines in the mode **«full information»** are configured as follows (Figure Figure 9 b):

1. Total vibration velocity RMS (10 – 1000)Hz;
2. LF vibration velocity RMS 10Hz – F/2;
3. HF vibration velocity RMS 2xF – 1000Hz;
4. RMS of the vibration velocity first rotational component;
5. Phase of the vibration velocity first rotational component;
6. RMS of the vibration velocity second rotational component;
7. Phase of the vibration velocity second rotational component;
8. Amplitude of the first rotational component vibration displacement;
9. Phase of the first rotational component vibration displacement;
10. Signal shape coefficient;
11. Sensor current;
12. Speed;
13. Messages about the "step" detection (total RMS, RMS and phase of the vibration velocity first rotational component);
14. Sensor malfunction message.

a) Example of data display as **"histograms"** for MK30 module
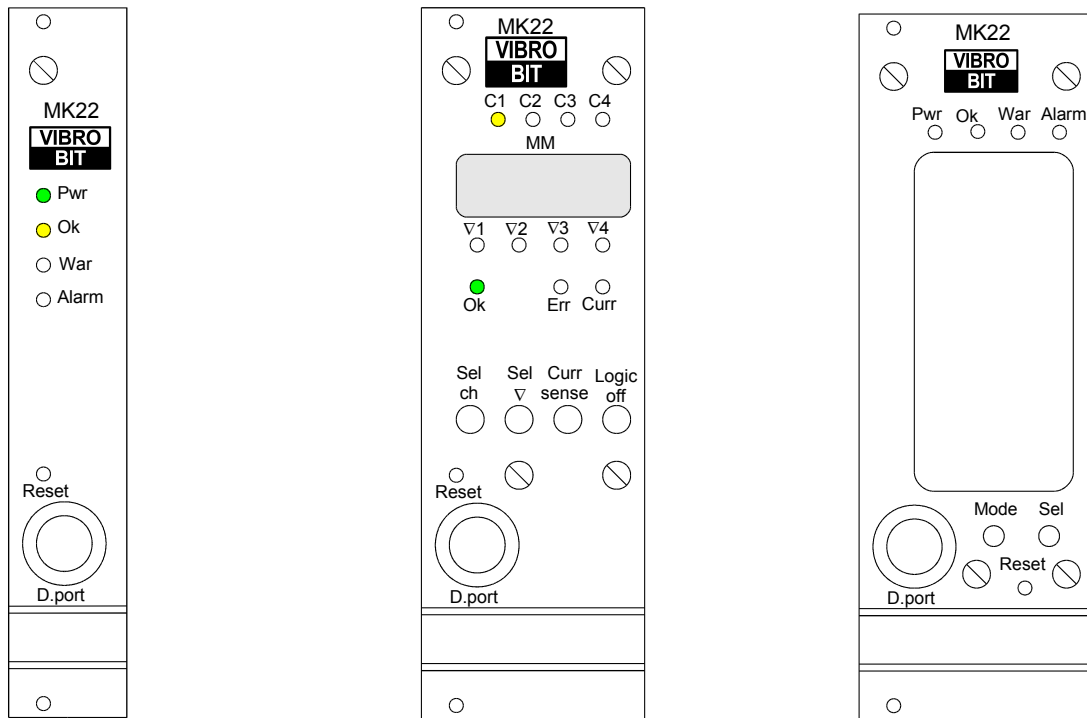
b) Example of information display in **"full information"** mode for MK30 module

Figure 9 – Displayed information on the LCD

2.2.6 MK22 module

The control and indication elements of the MK22 module are different depending on the version.

Figure 10 shows the appearance of the MK22 module front panels

a) MK22-DC, MK22-DC-R2   b) MK22-DC-11, MK22-DC-11-R2   c) MK22-DC-001,
                                                                                            MK22-DC-001-R2

Figure 10 – Appearance of MK22 front panels

2.2.6.1 Versions MK22-DC-11, MK22-DC-11-R2

The front panel of the MK22 module with a 7-segment 4-digit LED indicator, auxiliary signal LEDs and control buttons (Figure 10 b). The indicator in this MK22 module version simultaneously shows the information only by one of the measurement channels.

The front panel contains:

- Four yellow LEDs *'C1', 'C2', 'C3'* and *'C4'* indicating the selected measurement channel;
- Digital 4-digit 7-segment LCD indicating the parameter measured values and messages;
- Four yellow LEDs *'∇1'*, *'∇2'*, *'∇3'* and *'∇4'* to indicate the parameter overrange beyond the relevant setpoints of the selected measurement channel. When showing the setpoint value, the corresponding setpoint LED blinks;
- The bi-color LED *'Ok'* indicates the module status;
- The red LED *'Err'* indicates failure of the selected measurement channel. LED *'Err'* blinks if the measurement channel operation normalizes, but the pause after the channel normalization has not been counted down and before the parameter testing by the setpoints;

- The yellow LED *'Curr'* indicates the displaying of the sensor current actual value (engineering information). When displaying the sensor current of the selected measurement channel, the LED *'Curr'* blinks;

- Four control buttons:

  - *Sel ch* – measurement channel selection to indicate the parameter value and the measurement channel status;

  - *Sel∇* – indicate the setpoints values. (disabled setpoints are not shown);

  - *Curr sense* – indicate the sensor current.

  - *Logic off* – logic outputs operation block.

- Hole to press the hidden button *Reset*;

- The diagnostic interface connector;

- The handle for the module easy removal from the framework.

The measurement channels are switched over by pressing the button *'Sel ch'*. When a new measurement channel is selected, the indicator immediately shows the selected channel main parameter current value.

Note. Switching to display the measurement channel information is not performed if this measurement channel is blocked in the MK22 module settings. If all measurement channels are blocked in the module settings, the indicator shows '*OFF*'.

The cyclic viewing of the setpoint values is performed by pressing the button *'Sel ∇'*. The indicator shows the setpoint value and the corresponding setpoint LED blinks. If the switching over to the next setpoint fails to occur during the preset time, the module will then indicate the main measured parameter value.

Note. If a setpoint is disabled in the module settings, then indicator does not show this setpoint. If all setpoints are disabled, the indicator shows none of the setpoint values.

To indicate the sensor current press the button *'Curr sense'*. The indicator shows the sensor current in the in the format ##.## even if sensor malfunction the is detected, in this case the LED *'Curr'* blinks.

Switching on/off the logic outputs is performed by pressing and holding the button *'Logic off'* until the operating mode of the logic outputs switches over. When the logic outputs operation is blocked, the LED '*Ok*' lights yellow and all logic outputs are inactive.

Each measurement channel can be configured to display its own measured parameter value display format (Table 35). While attempting to display a value outside the permissible value limits for the format, the indicator will show the maximum permissible value (for negative values - the minimum permissible).

Table 35 – Data display formats on the MK22 module indicator

Mode code	Display format	Permissible values
0	#.###	from 0.000 to 9.999
1	##.##	from -9.99 to 99.99
2	###.#	from -99.9 to 999.9
3	####	from -999 to 9999

2.2.6.2 Version MK22-DC-001, MK22-DC-001-R2

The front panel of the MK22 module with dedicated alphanumeric LCD, signal LEDs and control buttons (Figure 10 c). The indicator simultaneously shows the measurement results and status of all measurement channels.

The front panel contains:

- Dedicated LCD with built-in illumination

- Signal LEDs:

  - Green LED **'Pwr'** – energizing the unit;

  - Bi-color LED **Ok** — module status;

  - Yellow LED **'War'** – warning (the LED operation logic is determined by the user);

  - red LED **'Alarm'** – alarm (the operation logic is determined by the user).

Two control buttons:

- Button **'Mode'** – indication mode selection;

- Button **'Sel'** – indicated data selection.

The symbols '∇1', '∇2', '∇3', '∇4' (in a frame) signal the monitored parameter value overrange beyond the setpoints.

Figure 11 – Example of data display on LCD

The symbol '**Er**' (in a frame) indicates the sensor malfunction detected by this measurement channel, the measured parameter value is assumed zero (LCD displays zero), signaling by setpoints of the corresponding measurement channel is inactive.

As soon as the measurement channel operation normalizes, the symbol '**Er**' begins to blink, the unit counts down the measurement channel normalization time-out (set by the user).

To indicate the sensors DC current, press and hold the button **Mode** until LCD displays the sensor current value (by two channels simultaneously). When indicating the sensor current, the LCD displays the measurement unit symbols 'mA' and the symbols of the measured parameter value overrange beyond setpoints are not displayed. To restore the normal indication mode, hold the button **Mode** again or it restores automatically by time-out.

To display the setpoints values on the LCD, press and hold the button **Sel** until the first measurement channel sign **K1** and the first setpoint symbol ∇1 start blinking. By repeatedly (shortly-term) pressing the button **Sel**, it is possible to view all four setpoints of the current measurement channel. The setpoint values are displayed instead of measurement results. If setpoint is disabled (in the module settings), dashes are displayed instead of the setpoint values.

To view the setpoint values of another measurement channel, press the button **Mode** in the setpoint indication mode. The normal indication mode is restored by holding the button **Sel** again or automatically by time-out.

Logic outputs are switched on/off by simultaneous pressing and holding the buttons **Mode-Sel** until the logic outputs operating mode switches over. If the logic outputs are blocked, the LED **Ok** lights yellow and all logic outputs are inactive.
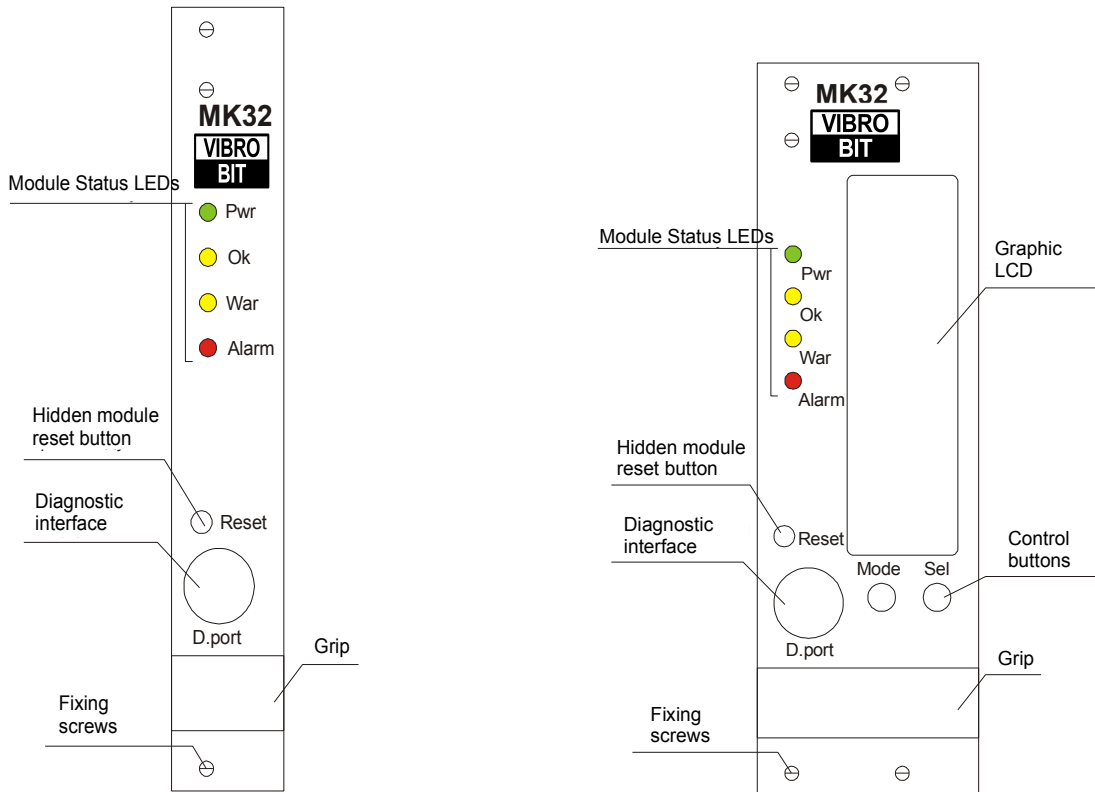
2.2.7 MK32 module

MK32 module is available in versions: MK32-DC, MK32-DC-R2, MK32-DC-20, MK32-DC-20-R2.

Figure 12 shows the appearance of the MK32 module front panels.

a) MK32-DC, MK32-DC-R2   b) MK32-DC-20, MK32-DC-20-R2

Figure 12 – Appearance of the MK32 module front panels

2.2.7.1 Versions MK32-DC-20, MK32-DC-20-R2

The modules are provide with four signal LEDs mounted on the module front panel (Figure Figure 12):

- Green LED *'Pwr'*– normal power supply voltage indication;

- Bi-color LED *'Ok'* – module status indication:

  - Green color – module normal operation, logic signaling is enabled;

  - Yellow color – module normal operation, output logic signaling is blocked;

  - Red color – module operation fatal error, output logic and analog signaling is blocked;

- Yellow LED **'War'** – warning (LED engaging conditions are user-determined, by configuring the logic rules similar to logic outputs);

- Red LED *'Alarm'* – alarm (LED engaging conditions are user-determined, by configuring the logic rules similar to logic outputs).

In addition to the signal LEDs, provided in the modules for vibration parameters measurement results displaying are a graphical LCD 32x122 and two control buttons (Figure Figure 12).

The data indication modes are switched by two buttons '*Mode*' and '*Sel*' installed on the module front panel below the LCD

2.2.7.2 Control buttons

There are two buttons to control the module and the indication modes installed on the front panel and one hidden button, the device reset button.

The purpose of the buttons:

The button No. 1 **Mode** – switching the measurement results displaying mode «full display» of the channel information or «histograms» mode. If no histograms are setup in the system, no switching to the histograms mode will be executed.

The button No. 2 **Sel** – pressing button in the «histograms» mode cyclically switches over the setup histograms to display on the LCD. Pressing the button in the «full display» mode switches over the measurement channels.

The button No. 3 **Reset** - is hidden to prevent accidental pressing. The module is reset by pressing the button in a certain sequence: briefly press the button '**Reset**', release, press again and hold until the module is reset.

There are some combinations of pressing the buttons to control the module status:

Long holding of the buttons **Mode and Sel** blocks the output logic signaling. The function of output logic signaling blocking can be useful when it is necessary, for example, to test the sensor connected to the module without danger to cause the unit emergency shutdown.

Long holding of the button **Mode** - in the «full display» mode resets all flags of the detected parameter «steps» and if necessary also the step detection algorithms for the channel displayed on the LCD.

2.2.7.3 Information display on the LCD

The vibration parameters measurement results are displayed in one of the two the modes:

- As **"histogram"**;
- **"full information"** on the channel.

Both these indication modes provide a flexible setup of the displayed data format to easily change the number and format of the displayed parameters without correcting the program code. Several display formats are provided to indicate the parameters numerical values. While attempting to display a value outside the permissible value limits for the format, the indicator will show the maximum permissible value (for negative values - the minimum permissible).

Table 36 – Formats of data display on the display MK32 module

Mode code	Display format	Permissible value
0	#.###	from 0.000 to 9.999
1	##.##	from −9.99 to 99.99
2	###.#	from −99.9 to 999.9
3	####	from −999 to 9999

Display Mode 'histogram'

The information in the «histograms» data display mode is presented as four colored columns, which height is proportional to the displayed parameter values. The leftmost column corresponds to the first measurement channel, the rightmost column corresponds to the fourth measurement channel (Figure Figure 13).

The LCD upper row shows the histogram name. At the bottom of the histogram name, starting with the first channel displayed are the parameter numeric values in the preset format.

If setpoints are provided for the displayed parameter, they are shown as dashes for each channel individually.

The data display mask is applied to the channel status register. If at least one status bit is set to '1' by the mask, the channel histogram will not be plotted and instead of a numeric value displayed will be the number zero.

Figure 13 – Example of data display as "histograms" for MK32 module

When switching to the "**histogram**" display mode, the LCD will successively in cycle display all the registered histogram.

The negative values histogram is plotted by the absolute value, and the numerical value is displayed as negative.

If the histogram displays the parameter provided with setpoints, the setpoint level is displayed as dashes (Figure Figure 13).
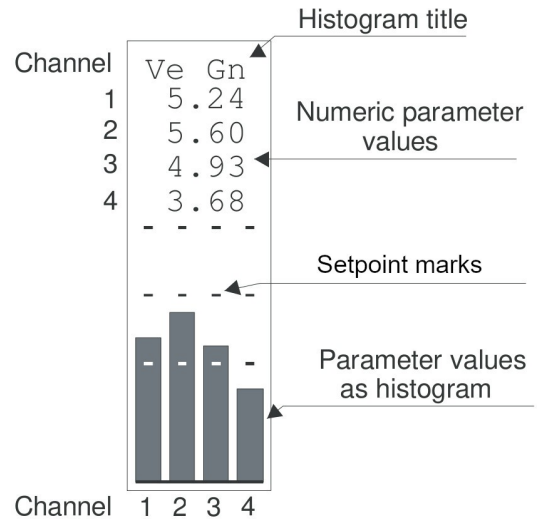
Histogram indication setup by default:

Eight histograms are registered by default in the AC signals excursion measurement mode:

- Vibration displacement excursion (5 – 500)Hz or (0.8 – 200) Hz (depending on the measurement frequency range);
- LF vibration displacement excursion 5Hz – F/2*;
- HF vibration displacement excursion 2xF – 500Hz;
- Sensor current;
- Excursion of the vibration displacement first rotational component*;
- Phase of the vibration displacement first rotational component*;
- Excursion of the vibration displacement second rotational component*;
- Phase of the vibration displacement second rotational component*.

*Note: * - not implemented for the measurement frequency range of (0.8 - 200) Hz*

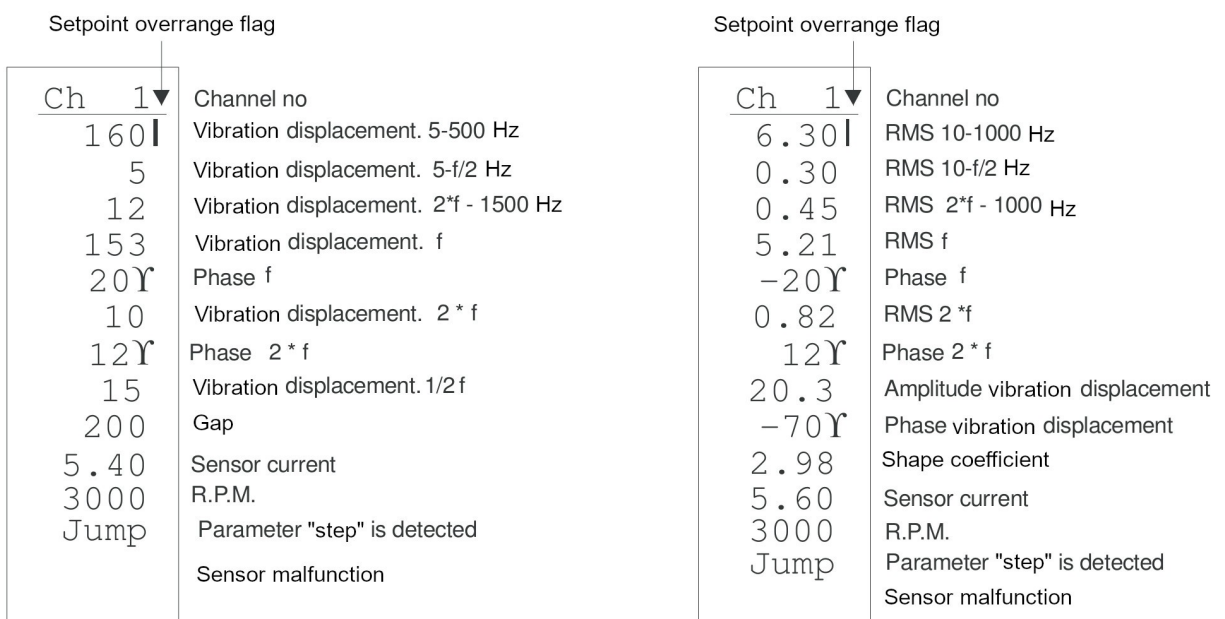Eight histograms are also registered by default in the AC signals RMS measurement mode:

- Total vibration velocity RMS (10 – 1000) Hz;
- LF vibration velocity RMS 10 Hz – F/2;
- HF vibration velocity RMS 2F – 1000 Hz;

- Sensor current;

- RMS of the vibration velocity first rotational component;

- Phase of the vibration velocity first rotational component;

- RMS of the vibration velocity second rotational component;

- Phase of the vibration velocity second rotational component.

Display Mode *'full information'*

In the «**full information**» display mode LCD indicates only the parameters values corresponding to the current measurement channel in the preset format. The data display format is the same for all measurement channels.

The upper LCD line shows the measurement channel number. The remaining 14 lines show information on the selected measurement channel according to the type of the measured value (Figure Figure 14).

Setpoint overrange flag

Ch 1▼	Channel no
160❙	Vibration displacement. 5-500 Hz
5	Vibration displacement. 5-f/2 Hz
12	Vibration displacement. 2*f - 1500 Hz
153	Vibration displacement. f
20ϒ	Phase f
10	Vibration displacement. 2 * f
12ϒ	Phase 2 * f
15	Vibration displacement. 1/2 f
200	Gap
5.40	Sensor current
3000	R.P.M.
Jump	Parameter "step" is detected
	Sensor malfunction

Setpoint overrange flag

Ch 1▼	Channel no
6.30❙	RMS 10-1000 Hz
0.30	RMS 10-f/2 Hz
0.45	RMS 2*f - 1000 Hz
5.21	RMS f
−20ϒ	Phase f
0.82	RMS 2 *f
12ϒ	Phase 2 * f
20.3	Amplitude vibration displacement
−70ϒ	Phase vibration displacement
2.98	Shape coefficient
5.60	Sensor current
3000	R.P.M.
Jump	Parameter "step" is detected
	Sensor malfunction

a) Example of information display in a **'full information'** mode when measuring the vibration displacement excursion
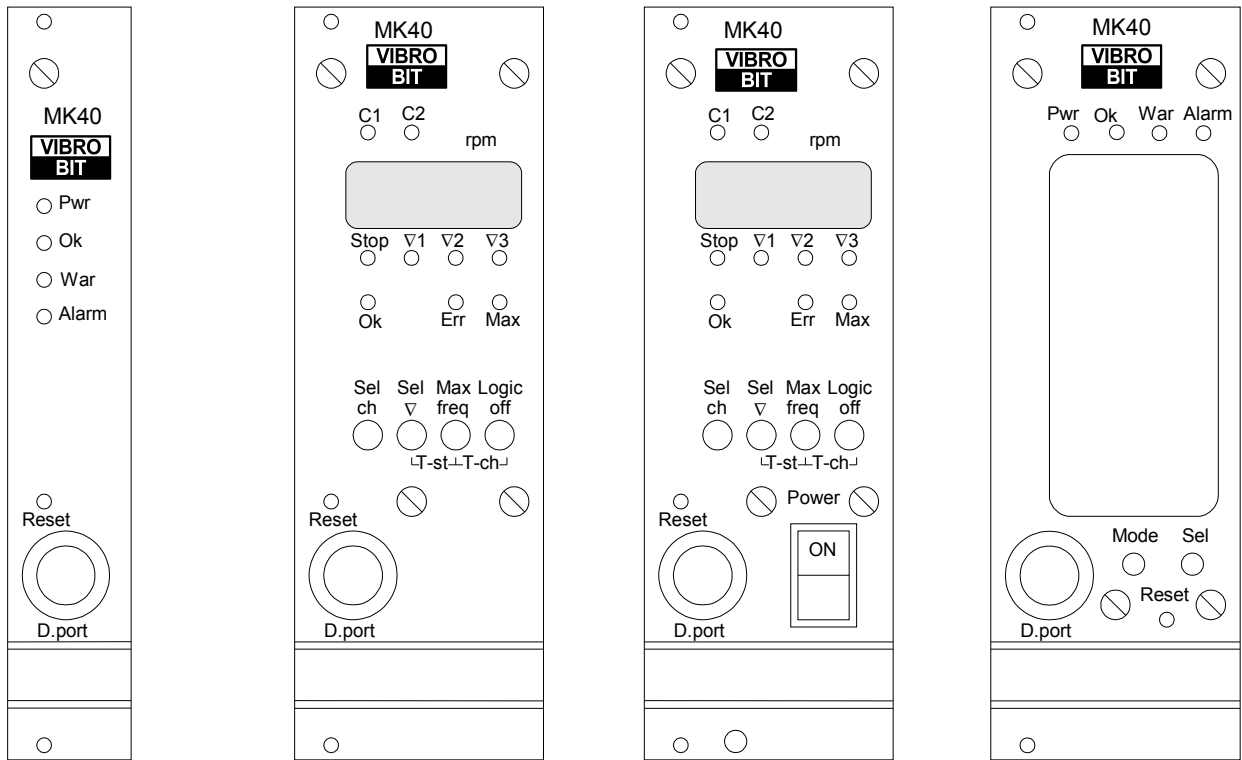
b) Example of information display in a **'full information'** mode when measuring the vibration RMS

Figure 14 – Information display on the LCD

2.2.8 MK40 module

The control and indication elements of the MK40 module are different depending on the version.

Figure 15 shows the appearance of the MK40 module front panels

a) MK40-DC   b) MK40-DC-11   c) MK40-AC-11-S   d) MK40-DC-001

Figure 15 – Appearance of MK40 module front panels

2.2.8.1 Versions MK40-DC-11, MK40-AC-11-S

The front panel of the MK40 module has the 7-segment 4-digit LED indicator, the auxiliary signaling LEDs and control buttons. This variant of the MK40 module has the indicator displaying simultaneously the information only through one of the measurement channels.

The front panel contains:

- the 7-segment digital indicator to display measurement results;
- signaling light-emitting diodes:
    - bi-color LED *Ok* — the module status;
    - yellow LEDs *C1, C2* — the selected measurement channel. When the LEDs *C1, C2* blink, they indicate that the test signal is fed to the input of the respective measurement channel;
    - yellow LED *Stop* — the rotor mode «STOP». When the user checks the «STOP» signaling, LED *Stop* blinks;
    - yellow LEDs *∇1, ∇2, ∇3* — measured parameter overrange beyond the setpoints. When the setpoints are displayed, the relevant LED blinks;
    - red LED *Err* — measurement channel malfunction. The LED **Err** blinks when the time-out of measurement channel normalization is counted down;
    - yellow LED *Max* – the rotor maximum speed indication. The LED *Max* blinks when the indicator displays the sensor DC current;

- control buttons:

  - **Sel ch** — Switching between measurement channels. If the measurement channel is disabled (during module setup) the information on the given measurement channel isn't displayed on the indicator;

  - **Sel ∇** — viewing the setpoints values. If setpoint is disabled (during module setup), then the corresponding setpoint value is not displayed on the indicator. If you hold down the button **Sel ∇** the indicator shows the sensor DC current

  - **Max freq** — viewing the rotor maximum speed of the. If you hold down the button **Max freq** the rotor maximum speed is reset;

  - **Logic off** — long-time holding blocks/enables the module logic signaling;

- power supply switch **Power** (only for version MK40-AC-11-S).

When indicator displays additional information (maximum speed, setpoints values, etc.), the module automatically switches to displaying the rotor maximum speed after the preset time-out countdown (30 seconds by default).

The second measurement channel of the MK40 module can be configured to the measuring mode of the module supply voltage +24V of the module. After selecting the indication of the second measurement channel by the time-out, the display automatically switches over to showing the measurement results of the first channel.

When the buttons **Sel ∇** and **Max freq** are held simultaneously, the «STOP» is enabled/disabled to test the signaling (the mode «STOP» testing permission should be indicated in the module settings). When enabling the «STOP» signaling testing, the LED **Stop** blinks. The module automatically cancels the «STOP» signaling testing mode when the preset time-out is counted down.

When the buttons **Max freq** and **Logic off** are held simultaneously, the external test signal is connected/disconnected to the input of the measurement channel (the test signal connection permission should be indicated in the module settings). Upon the external test signal connection, the LEDs of the respective measurement channels **C1**, **C2** blink. The module automatically disconnects the external test signal when the preset time-out is counted down.

2.2.8.2 Version MK40-DC-001

The front panel of the MK40 module with dedicated alphanumeric LCD, signal LEDs and control buttons. The indicator simultaneously shows the measurement results and status of both measurement channels.

The front panel contains:

- Dedicated LCD with built-in illumination

- Signal LEDs:

  - Green LED **'Pwr'** – energizing the unit;

  - Bi-color LED **Ok** — module status;

  - Yellow LED **'War'** – warning (the LED operation logic is determined by the user);

  - red LED **'Alarm'** – alarm (the operation logic is determined by the user).
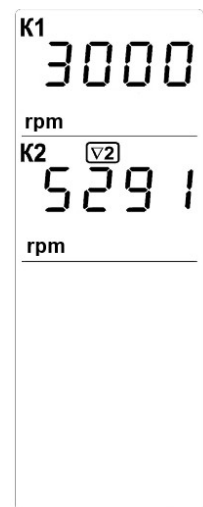

Figure 16 – Example of LCD data display

Two control buttons:

- Button **'Mode'** – indication mode selection
- Button **'Sel'** – indicated data selection

The symbols '∇1', '∇2', '∇3' (in a frame) signals of the monitored parameter value overrange beyond setpoint. The Figure 16 shows the example of the frequency value overrange beyond second setpoint.

The symbol '**Er**' (in a frame) shows that the sensor malfunction has been detected in this measurement channel, the measured parameter value is assumed to be zero (LCD shows dashes), the signaling according to the setpoints of the relevant measurement channel is inactive.

When the measurement channel operation normalizes, the symbol '**Er**' begins to blink, the time-out of the measurement channel normalization (set by the user) is counted down.

In the «STOP» mode, the frequency value is assumed zero to be, a meaningless decimal point is displayed after the digit '0'. When «STOP» signaling testing, the meaningless decimal point blinks after of the frequency value.

When the test signal is connected to the measurement channel input, an empty frame blinks in the upper right-hand measurement channel data display area of non-existent setpoint 4.

In the power supply measurement mode by the second channel, indicator lower part shows the module current power supply voltage, the regular information from the second measurement channel is not displayed.

To indicate the maximum speed, press the **Mode**, the LCD displays the speed value (from two channels simultaneously). When displaying the maximum speed on the LCD, the symbols of measurement units 'RPM' blink, the symbols of the measured parameter value overrange beyond the setpoints are not displayed. The normal indication mode restored by repeated pressing the button **Mode** or automatically by time-out.

To indicate the sensor DC current, press and hold the button **Mode** until LCD displays the sensor current value (from two channels simultaneously). When displaying the sensor current on the LCD, the symbols of measurement units 'mA' will appear, and the symbols of the measured parameter value overrange beyond the setpoints are not displayed. The normal indication mode restored by repeated pressing the button **Mode** or automatically by time-out.

To view the setpoints values, press and hold the button **Sel** until the sign of the first measurement channel **K1** and the symbol of the first setpoint ∇1 start blinking. When the button **Sel** is pressed again (shortly), all three setpoints of the current measurement channel are displayed. The setpoint values are displayed instead of the measurement results. If setpoint is disabled (during the unit setup), dashes appear instead of the setpoint values.

To view the setpoints values of another measurement channel, press the button **Mode** in the setpoints display mode. The normal indication mode is restored by holding the button **Sel** again or automatically by time-out.

The logic outputs are enabled/disabled by pressing and holding the buttons **Mode**-**Sel** simultaneously until the logic outputs operating mode switches over. When the logic outputs are blocked, the LED **Ok** lights yellow and all logic output are inactive.

2.2.9 MK70 module

Upon powering on, all safety shutdown outputs and indicators on the module front panel are inactive (Figure 17). When pressing the button **Reset** (or the signal active level at the **Reset** input), the module switches over to initialization status, and the LED **Ok** blinks. The LED **Ok** lights in the module normal operation mode.

When the signal has active level at the logic input, the relevant logic inputs status LED illuminates. If the active signal level is removed from the logic input, the LED of the relevant logic input blinks indicating that active signal level was previously present at this logic input.

The two-digit 7-segment indicator displays the number of the first actuated logic input. If signal active levels appear simultaneously at several logic inputs (providing no actuation of any logic input is registered before), the indicator displays the number of the input with the least serial number. Further indicator readings do not change until the module is reset.

If the outputs status LEDs illuminate, it means that the relevant output is active. The blinking output status LED signals the countdown of the output actuation delay (the output has the inactive signal level). The output becomes active only when the status at the logic inputs corresponds to the output actuation logic throughout the delay time. The active output is not affected by the logic inputs status. Only module reset makes it inactive.

Figure 17 – Front panel of MK70 module

If any logic output does not participate in protection and engagement of the corresponding LED is unwanted, it can be disconnected by removing the jumper on the MK70 board.

The MK70 module operation logic variants provide implementation of the majority of the protection logics recommended by leading turbine manufacturers.

The operation logic is determined by the position of microswitches SA1 and the logic output to which the safety shutdown relay winding.

For the detailed descriptions refer to ВШПА.421412.307 И1. MK70 Control Module Setup Instruction.

Output 1 can be configured to one of the several safety shutdown logics against a dangerous vibration levels in the two supports of one rotor or adjacent supports of two rotors. The microswitches SA1.1 – SA1.3, determine the logic variant.

Output 2 has the active signal level if the active signal level is present at one of 16 logic inputs of the MK70 module (logic – any of 16).
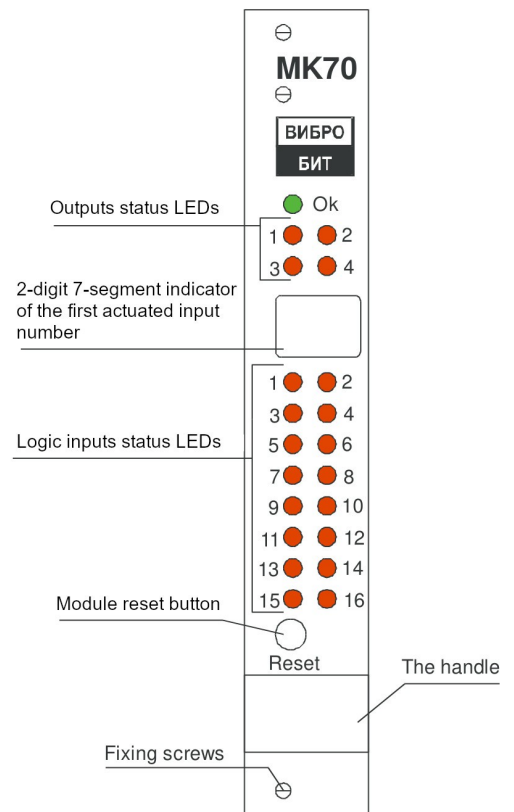
Output 3 has the active signal level if two out of 16 logic inputs of the MK70 module has the active signal level, and the MK70 permits the active signal level at the input (logic – any two out of 16 with the permission signal).

Logic output 4 is intended to generate the unit protection logic by unexpected and irreversible vibration level change (vibration "step"). For protection logic operation by vibration "step", the MK70 board has a separate CPLD microchip that is installed only in module version MK70 J and MK70 J-CPU (output 4 is always inactive in other MK70 module versions).

2.2.10 MK71, MK71-R2 modules

The logic inputs of MK71, MK71-R2 modules are split into several functioning groups:

- 48 inputs participating in the safety shutdown logic;
- safety shutdown logic reset input;
- input of blocking the safety shutdown logic operation;
- 2 additional inputs connected to CPLD;
- 2 additional inputs connected to microcontroller.

48 safety shutdown inputs are grouped into six groups each with eight inputs. A LED is provided on the module front panel in the *'Input'* unit to indicate the status of each group.

Each of 48 inputs has the following functions:

- actuation memory;
- active status validation by time.

The actuation memory determines which logic input had the active signal level (the memory function has no time mark). The memory is reset during the CPLD reset.

The MK71, MK71-R2 modules front panel contains (Figure Figure 18):

- four module status LEDs:
    - green LED *'Pwr'* - module energizing;
    - bi-color LED *'Ok'* - module status indication:
        - green color - module normal operation;
        - yellow color - operation of the logic outputs connected to the microcontroller is blocked;
        - red color - module operation error;
        - blinking - protection logic reset status;
    - yellow LED *'War'* - warning (the operation logic is determined by the user);
    - red LED *'Alarm'* - alarm (the operation logic is determined by the user);
- six red LEDs of the '*Input*' unit - the logic inputs status;
- three red LEDs of the '*Output*' unit - protection outputs status;
- reset button *'Reset'*;
- diagnostic interface connector *'D.port'*;
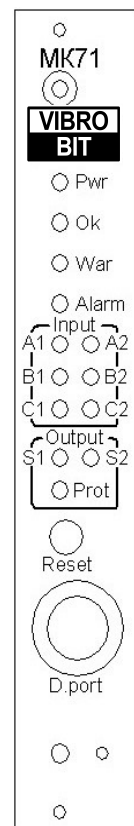

Figure 18

LEDs of the '*Input*' unit signal the logic inputs status of the combined into groups each with eight inputs:

- LED *'A1'* - logic inputs L1A-1 - L1A-8
- LED *'A2'* - logic inputs L2A-1 - L2A-8
- LED *'B1'* - logic inputs L1B-1 - L1B-8
- LED *'B2'* - logic inputs L2B-1 - L2B-8
- LED *'C1'* - logic inputs L1C-1 - L1C-8
- LED *'C2'* - logic inputs L2C-1 - L2C-8.

LEDs of the '*Input*' unit show the logic inputs status. If LED of the '*Input*' unit illuminates, one of the logic inputs of the respective group has the active signal. The '*Input*' unit LED blinking means that one of the logic inputs of the respective group had the active level, while all other inputs of the group had the inactive signal level.

LEDs of the '*Output*' unit show the status of CPLD- controlled protection logic outputs:

- <u>not illuminated</u> — the logic output has the inactive signal level;
- <u>blinks</u> — the logic inputs status combination corresponds to the safety shutdown logic (set by the microswitches), the time-out is counted down to change the logic output into the active status (protection actuation);
- <u>illuminates</u> — the logic output is in the active status (protection actuated), the logic inputs status does not affect the protection output.

The LEDs *'Ok'*, *'War'*, *'Alarm'* are controlled by the microprocessor installed on the MK71 board. The LEDs *'War'*, *'Alarm'* can be assigned with the additional signaling of the logic inputs/outputs status or the module status in general.

The button *'Reset'* resets the CPLD logic and the microcontroller.

The safety shutdown logic implemented on CPLD is independent of the microcontroller status and operating mode. Eight microswitches on the module board set the specific implementation of the logic circuit.

The MK71 module is optimized to construct logic chains of 8 and 16 nodes (measuring control modules generating logic signals). It is allowed to cascade the MK71 modules to elongate the safety shutdown logic chains.

2.2.11 MK90, MK91 modules

MK90 and MK91 modules are used to test the signaling and protection actuation. The test is performed with the inoperative equipment after the sensors and converters are connected and adjusted to the initial position.

Figures 19 and 20 shows the appearance of the MK90 and MK91 modules front panels respectively.

The measurement channels of control modules are connected to the MK90 (MK91) by pressing one of the buttons «1» - «8» on the MK90 (MK91) front panel. The shape and polarity of the reference signal are selected using the toggle switches and controller on the MK90 (MK91) module front panel. The position of toggle switches and the output adjustable parameter for different signal types are shown in Table 37.

The reference signal for the vibration velocity channels should be fed to the input «IN» of the sensors ДПЭ22МВ, ДПЭ22П, ДПЭ23МВ, ДПЭ23П. In this case, the serviceability of the whole vibration velocity measurement channel is tested.

Process signaling actuation monitoring is carried out by smooth change of the measured parameter.

MK91 module has an additional function - outputs seven and eight can be configured for voltage testing of the tachometric measurement channels.
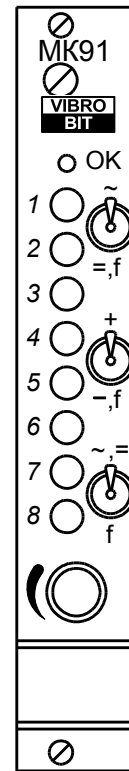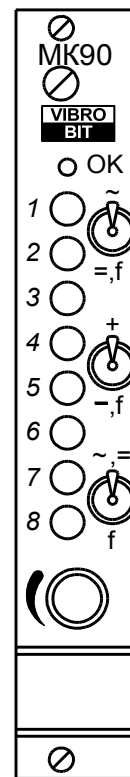
Figure 19 − Front panel of MK90 module

Figure 20 − Front panel of MK91 module

Table 37 − The position of the toggle switches and the output adjustable parameter of the MK90, MK91

The output adjustable parameter of the MK90, MK91	The position of the toggle switch			Recommended for the control module
	«~» / «=,f»	«+» / «-,f»	«~,=» / «f»	
DC voltage level	«=,f»	«+»;«-,f»	«~,=»	MK10, MK11, MK22
AC voltage amplitude	«~»	-	«~,=»	MK20, MK30, MK32
Pulse signal frequency	«=,f»	«-,f»	«f»	MK22, MK32, MK40

2.2.12 MK95 module

Control module MK95 is connected to the measurement channel according to the diagram stated in Annex G. The diode connection in parallel with the differential input allows you to maintain the measurement channel serviceability if the MK95 module is absent in the section.

When connecting measuring devices (voltmeter, oscilloscope, etc..) to connectors *Out1* − *Out4* on the front panel (Figure 21), sensor (converter) signals can analyzed. The module switching connector receives signals similar to the signals on the connectors *Out1* − *Out4* on the module front panel through additional buffers.

The module measurement channel is adjusted by two resistors (indicated for channel one): R9 - offset; R12 - gain.

MK95 module setup sequence (for channel one):

1. Assemble the MK95 module calibration circuit (Figure 31).

2. Feed DC signal, corresponding to the sensor lower range (1 mA or 4 mA) to the MK95 module input.

3. Use resistor R9 to the output OUT1 voltage is 0 V.

4. On an input of the module MC 95 connect DC signal, corresponding to the upper range of the sensor (5 mA or 20 mA).

5. Set by a resistor R12 to set voltage of 0 V at the output OUT1.

6. Repeat steps 2-5 until output signal matches the input one without changing the resistance of resistors R9, R12.

Configure other channels in a similar way.

Output DC voltage (current input signal) is calculated according to the formula:

$$U = (I - I_o) \cdot K_{pr} , \tag{1}$$

where U - output voltage, V;

I - input current, mA;

I_o - sensor current lower range (1 mA or 4 mA), mA

K_{pr} - conversion factor, V/mA:

• for the range (1-5) mA — 2,5 V/mA;

• for the range (4-20) mA — 0,625 V/mA.

Output DC voltage (voltage input signal) is calculated according to the formula:

$$U = (U_i - 0,56) \cdot 4,464; \tag{2}$$

where U - output voltage, V;

U_i - input voltage, V.

Output AC voltage RMS (current input signal) is calculated according to the formula:

$$U_{skz} = I_{skz} \cdot K_{pr}, \tag{3}$$

where: U_{skz} - output AC voltage RMS, V;

I_{skz} - input AC current RMS, mA;

K_{pr} - conversion factor, V/mA:

• for the range (1-5) mA — 2,5 V/mA

• for the range (4-20) mA — 0,625 V/mA.

To calculate the parameter value corresponding to the output voltage of the MK95 module, the DC voltage or AC voltage RMS (depending on the measured parameter type) is divided by parameter conversion factor K, which is determined by the table of Annex J or calculated by the formula:

$$K = K_{pr} \cdot Kn, \tag{4}$$

where K_{pr}- conversion factor of the MK95 module,
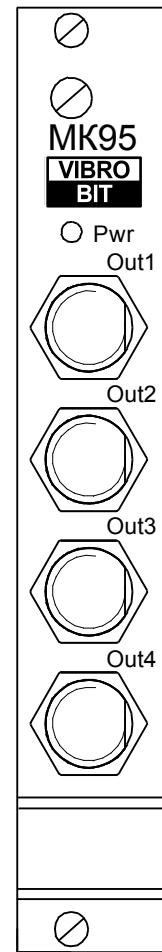
Figure 21 − Front panel of MK95 module

Kn - conversion factor of the sensor/converter (ref. Tables 7, 11 – 14 ВШПА.421412.100 РЭ Equipment VIbrobit 100. Operations and Maintenance Manual).

2.2.13 BM22 and BM61 control units

Figure 22 shows the appearance of the BM22 and BM61 control units front panels.

Figure 22 − Front panel of BM22 and BM61 control units

The front panel contains:

- dedicated LCD with built-in illumination;
- signal LEDs:
- green LED **'Pwr'** – unit energizing;
- bi-color LED **Ok** — unit status;
- yellow LED **'War'** – warning (the LED operation logic is determined by the user);
- red LED **'Alarm'** – alarm (the operation logic is determined by the user);
- three control buttons:
- button **'Mode'** – indication mode selection;
- button **'Sel'** – indicated data selection;
- button *Fn* – additional functions (not used);
- hole to press the hidden button *Reset*;
- toggle switch *Power* – power supply on/off ~220 V;
- diagnostic interface connector **D.port**;
- handle for the module easy removal from the framework.

Purpose and operation description LCD, LEDs *Pwr*, *Ok*, *War*, *Alarm*, control buttons *Mode*, *Sel* correspond to the description in p. 2.2.6.2 for the MK22 control module.

2.2.14 BM32 control unit

Figure 23 shows the appearance of the BM32 control unit front panel.
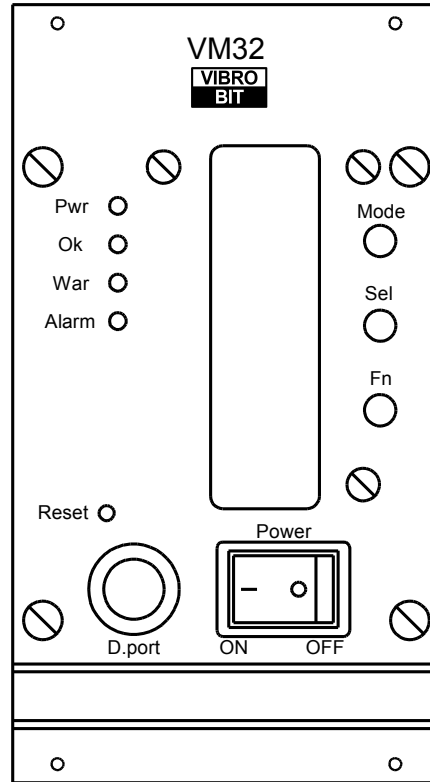
Figure 23 − Front panel of BM32 control unit
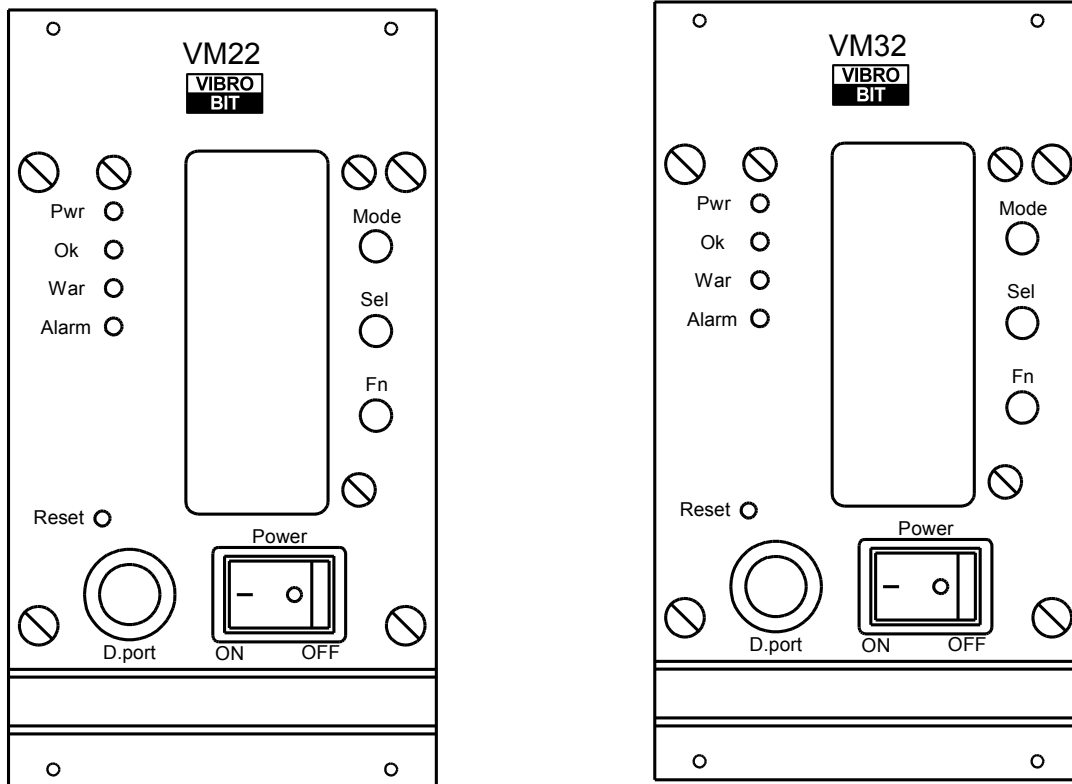
The front panel contains:

- dedicated LCD with built-in illumination;
- signal LEDs:
- green LED **'Pwr'** – unit energizing;
- bi-color LED **Ok** –– unit status;
- yellow LED **'War'** – warning (the LED operation logic is determined by the user);
- red LED **'Alarm'** – alarm (the operation logic is determined by the user);
- three control buttons:
- button **'Mode'** – indication mode selection;
- button **'Sel'** – indicated data selection;
- button *Fn* – additional functions (not used);
- hole to press the hidden button *Reset*;
- toggle switch *Power* – power supply on/off ~220 V;
- diagnostic interface connector **D.port**;
- handle for the module easy removal from the framework.

Purpose and operation description LCD, LEDs *Pwr*, *Ok*, *War*, *Alarm*, control buttons *Mode*, *Sel* correspond to the description in p.p. 2.2.7.1, 2.2.7.2 for the MK32 control module.

2.2.15 MC01 USB module

The MC01 USB module is a diagnostic interface board intended to connect the modules of the Vibrobit 300 equipment to the PC. The MC01 USB module can be used to carry out the operational monitoring of the modules status, operating parameters configuring and calibration of the measurement channels.

The MC01 USB module connects to the PC via the USB interface with the cable USB A-B (included into the delivery set), virtual COM port drivers should be installed on a PC (see Annex D). The MC01 USB is connected to the control modules with КС01 cable and to the БИ24 module -- with КС02 cable (included into the delivery set). The MC01 USB module has a galvanic isolation between the USB interface and the communication interface of the Vibrobit 300 equipment modules. It is permitted to connect the MC01 USB to the Vibrobit 300 equipment modules when the power is on.
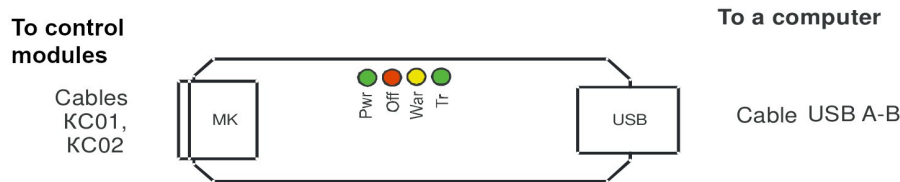
Figure 24 – Appearance of MC01 USB

The MC01 USB module has four LEDs indicating the current status:

- **'Pwr'** (green) – on when the power is supplied to the MC01 USB from the control module

- **'Off'** (red) – on when none of the operation modes has been selected for data exchange with the control module (SPI or I2C mode). As soon as the PC commands the connection to the control module, the LED '*Off*' goes out.

- **'War'** (yellow) – if an error occurs during the data exchange with the control module, relating to the data exchange protocol, the LED '*War*' goes on.

- **'Tr'** (green) – blinks during the data exchange with the control module signaling that the connection is normal.

When connecting the Vibrobit 300 equipment control module to the PC, first the MC01 USB is connected to the respective PC interface. Then the MC01 USB is connected using the cable КС01 or КС02 to the adjustable control module or unit. When the connection is normal and power is fed to the control module or unit, the LEDs **'Pwr'**, **'Off'** are on.

2.2.16 MC03 Bluetooth module

The MC03 BlueTooth module is shaped as a small white cylinder with two side recesses. For connection to the control modules and units, the module has a diagnostic interface plug at the end, which is used to install the MC03 BlueTooth the corresponding socket of the Vibrobit 300 equipment control modules and units. The MC03 BlueTooth is connected to the БИ24 module via the adapter П2 (9.323.04) (included into the delivery set).

MC03 BlueTooth can be connected to the Vibrobit 300 equipment modules and units with power on.
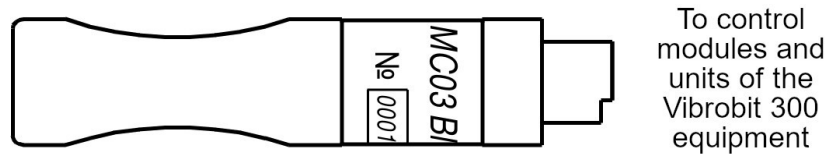
Figure 25 – Appearance of MC03 Bluetooth

Under the white light-conductive casing, there are three LEDs installed to indicate the current status:

- **Pwr** (green) – on when the power is supplied to the MC03 Bluetooth from the control module or unit, blinks during data exchange with the control module indicating a normal connection.

- **War** (red) – if an error occurs during the data exchange with the control module, relating to the data exchange protocol, the LED '**War**' goes on.

- **Bl** (blue) – on upon a successful connection to PC via Bluetooth interface.

At normal connection and the power supply fed to the control module or unit, the LED **Pwr** will be on.

2.2.17 BST300.010 temperature sensor unit

The unit is made in a housing manufactured by Phoenix Contact with a DIN-rail attachment, where the printed circuit board remains open. The temperature sensor unit is based on the Microchip analog temperature sensor TC1047AVNB. The temperature sensor is located on the board inner side, air circulation around the sensor is provided by due to the board milling perforation of a special shape.
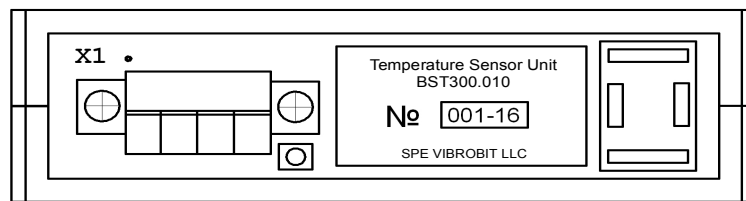
Figure 26 – Appearance of the BST300.010 temperature sensor unit

2.2.18 DB9-MC-8 switching unit

The unit is made in a housing manufactured by Phoenix Contact with a DIN-rail attachment, where the printed circuit board remains open. The board may be used to switch signals from DB-9 connectors to terminal connections.
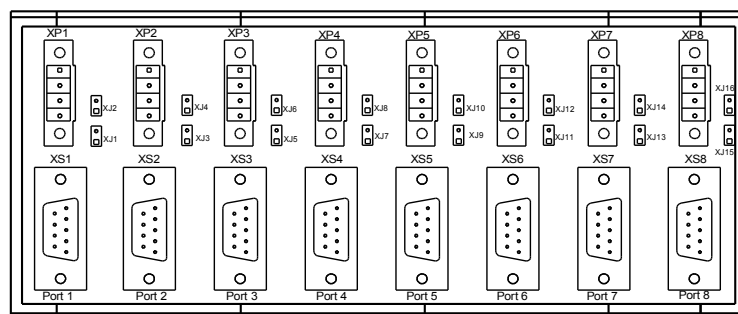
Figure 27 – Appearance of the DB9-MC-8 switching unit

3 Maintenance

3.1 Equipment maintenance

Maintenance is carried out to keep the equipment normal operation throughout the service life.

3.1.1 Recommended types and periodicity of the equipment maintenance:

- preventative inspection – monthly;
- scheduled maintenance – during the equipment repair;
- periodic verification or calibration according to section 3.3;
- decommissioning.

3.1.2 Preventative inspection includes:

- visual examination of sections, control modules and units, power supply modules;
- evaluation of the equipment operation.

All units of the equipment should be dry, intact and secured.

The equipment operation is evaluated using the information of PC database, recorders, signaling operation, parameters measurement by other instruments or systems. Detected are the cases when the parameters deviate from the settings. All cases of zero parameter values on the operating equipment to be checked. The detected faulty units to be replaced.

3.1.3 The scheduled maintenance includes:

- disassembly of sections control modules and units, power supply modules;
- inspection and cleaning of the equipment;
- identification and replacement of faulty units;
- calibration, testing of the equipment units.

The equipment units, depending on the contamination, are to be cleaned with a brush, fabric or a rag moistured with alcohol. Dust is removed from control modules with a brush or blowing with the air cleaned from mechanical dust, oil or moisture. The equipment units operation should be tested on stands. The detected defects should be remedied.

Check the control units output voltage of + 24 V.

3.1.4 Decommissioning includes the equipment power-off and dismantling. There are no additional requirements for disposal, because the equipment does not contain hazardous substances.

3.1.5 A complete actuation check of the Vibrobit 300 CVMS signaling setpoints TA-1 ÷ 8 is required after completing the scheduled and unscheduled repairs of the CVMS instrumentation stands. The period between complete checks of the signaling setpoints actuation should not exceed the calibration interval (2 years).

3.2 Routine repairs

Routine repairs are performed as and when the equipment fails by replacing the faulty units. The equipment malfunction signaling is indicated in subsection 2.2. Troubleshooting is stated in table 38. Faulty equipment components may be repaired only by the manufacturer.

Table 38 – Troubleshooting

Failure description	Possible cause	Remedy
No voltage +24V when the module is switched on	1. Power supply unit fuse is burnt 2. No mains voltage 3. Short-circuit in the load circuits 4. The power supply module is faulty	1. Check and replace the fuse. 2. Identify and eliminate the absence. 3. Check the power supply unit load resistance, eliminate the short-circuit. 4. Replace the faulty power supply module.
The LED *'Alarm'* of the power supply module is on	1. Pulsation of voltage +24V 2. The supply voltage is beyond the tolerance limits according to pp. 1.3.15, 1.3.16	Check the voltage +24V, measure pulsation. Replace the power supply module.
During the equipment operation, the control module readings equal to zero or are unrealistic	1. The sensor is faulty 2. The control module is faulty	Replace the sensor or the control module
Control module readings overrange the setpoint, but the setpoint LED does not illuminate or the LED illuminates below the setpoint	The control module is faulty	Replace the control module

Caution. **When replacing the Vibrobit 300 equipment modules, it is necessary to check the adjustment of the new module for compliance of its operation parameters with the old module:**

- **Scale and setpoints values by the measurement channels;**
- **Logic outputs switching matrix;**
- **Unified outputs range;**
- **Sensor test setpoints levels;**
- **Data rate and address for the communication interfaces RS485, CAN2.0B;**
- **Other module operation parameters.**

It is also necessary to check the proper position of the controls on the module board (see Annex E) to comply with the required operation mode.

3.3 Calibration procedure

This section establishes the methods of primary and periodic equipment calibrations.

The periodic calibration is performed during the equipment operation within routine or preventative repairs of the testes equipment, once every two years.

The primary sensors and converters used with the equipment should be calibrated separately in accordance with the methods in the operation documents.

Equipment can be calibrated as part of the parameter measurement channel and directly on the tested equipment.

Vibrobit 300 equipment items able to measure the various parameters, are calibrated only in part of the metrological parameters, for which they are adjusted.

3.3.1 Calibration operations

During calibration it is necessary to implement the operations stated in Table 39.

Table 39

Operation description	Calibration item No.	Operation to be carried out during	
		primary calibration	periodic calibration
1 Visual inspection	3.3.5.1	Yes	Yes
2 Try-out	3.3.5.2.1 3.3.5.2.2	Yes	Yes
3 Determination of the measurement errors of the control modules and units	3.3.5.3.1 3.3.5.3.2 3.3.5.3.3 3.3.5.3.4 3.3.5.3.5.1 3.3.5.3.5.2	Yes	Yes
4 Determination of the frequency response ripple of the control modules and units	3.3.5.3.6 3.3.5.3.7	Yes	Yes
5 Determination of the measurement errors of the measurement channels	3.3.5.4.1 3.3.5.4.2 3.3.5.4.3 3.3.5.4.4	Yes	Yes
6 Determination of the frequency response ripple of the of the measurement channels	3.3.5.4.5.1 3.3.5.4.5.2	Yes	Yes

3.3.2 Calibration means

During calibration it is necessary to apply the calibration means, stated in the table 40.

Table 40

Calibration item No.	Description and type of the main or auxiliary calibration mean; designation of the regulatory document establishing the technical requirements and (or) metrological and main technical parameters of the calibration mean *
3.3.5.1	1 Multimeter АКТАКОМ АВМ-4306 (ГРСИ No.27587-04).
3.3.5.2.1	2 Multimeter Keithley Model 2001 ** (ГРСИ No.25787-08).
3.3.5.2.2	3 Universal voltmeter В7-78/1 cl.0.5 (ГРСИ No.52147-12).
3.3.5.3.1	4 Resistance box Р4831 cl. 0.1 ГОСТ 23737-79.
3.3.5.3.2	5 Generator АКТАКОМ АНР-1003 (ГРСИ No.27122-04).
3.3.5.3.3	6 Appliance СП50 (ВШПА.421412.164).
3.3.5.3.4	7 Power supply module МП24 (ВШПА.421412.311).
3.3.5.3.5.1	8 Installation of the 2nd category according to МИ 2070-90 (ГРСИ No.09314-83).
3.3.5.3.5.2	
3.3.5.3.6	
3.3.5.3.7	
3.3.5.4.1	
3.3.5.4.2	
3.3.5.4.3	
3.3.5.4.4	
3.3.5.4.5.1	
3.3.5.4.5.2	

Notes:

 * It is permitted to replace the instruments and equipment with the similar ones regarding their metrological parameters.

 ** Required only for MK32 control modules in frequency range of (0.8 — 200) Hz.

3.3.3 Safety requirements

Calibrating means and auxiliary equipment should have the protective grounding.

3.3.4 Calibration conditions

The following conditions should be observed during calibration:

- ambient temperature from plus 18 to 25°C;

- relative air humidity from 45 to 80 %;

- atmospheric pressure not established;

- supply voltage of the control modules + (24 ± 0.5) V;

- input voltage of the power supply modules, control modules MK11-AC-11-S and MK40-AC-11-S, The control units – industrial network supply voltage from 215.6 to 224.4 V; industrial network AC from 49.5 to 50.5 Hz;

- sound pressure level – not exceeding 65 dB;

- load resistance of the output unified signal (500±10) Ohm;

- levels of external electrical and magnetic fields, as well as vibration effect at the installation place of measuring instruments, matching and measuring devices shall not exceed the normal values established by related regulatory documents.

3.3.5 Calibration procedure

During calibration procedures it is necessary to keep records of the measuring results during testing (calibration report). The report may be kept in arbitrary form.

3.3.5.1 Visual inspection

During visual inspection check the following:

- cleanness of module and unit, status of front panel, indicators, controls;
- absence of damages;
- presence of markings.

3.3.5.2 Try-out

3.3.5.2.1 When trying-out the control module and unit carry out the following operations:

- assemble the calibration electrical circuit according to the figures 28 – 31;
- supply several electrical signal values to the item output, make sure it is measured and displayed on the indicator and whether the output unified signal is available.

3.3.5.2.2 When trying-out the parameter measurement channel, the following operations should be performed:

- install sensor on the stand *;
- assemble the calibration electrical diagram according to the figure 32;
- switch on the power supply source and, by changing parameter on the stand, try-out the measurement channel operation.

Use stands and appliances for testing and calibration of Vibrobit 100 equipment according ВШПА.421412.100 РЭ, Annex M.

3.3.5.3 Determination of metrological parameters of control modules and units

3.3.5.3.1 Determination of DC current measurement error of MK10, MK11, MK20, MK22, BM22, MK30, MK32, BM32, BM61 control modules and units

The test is carried out according to the electrical diagram in accordance with Figure 28.
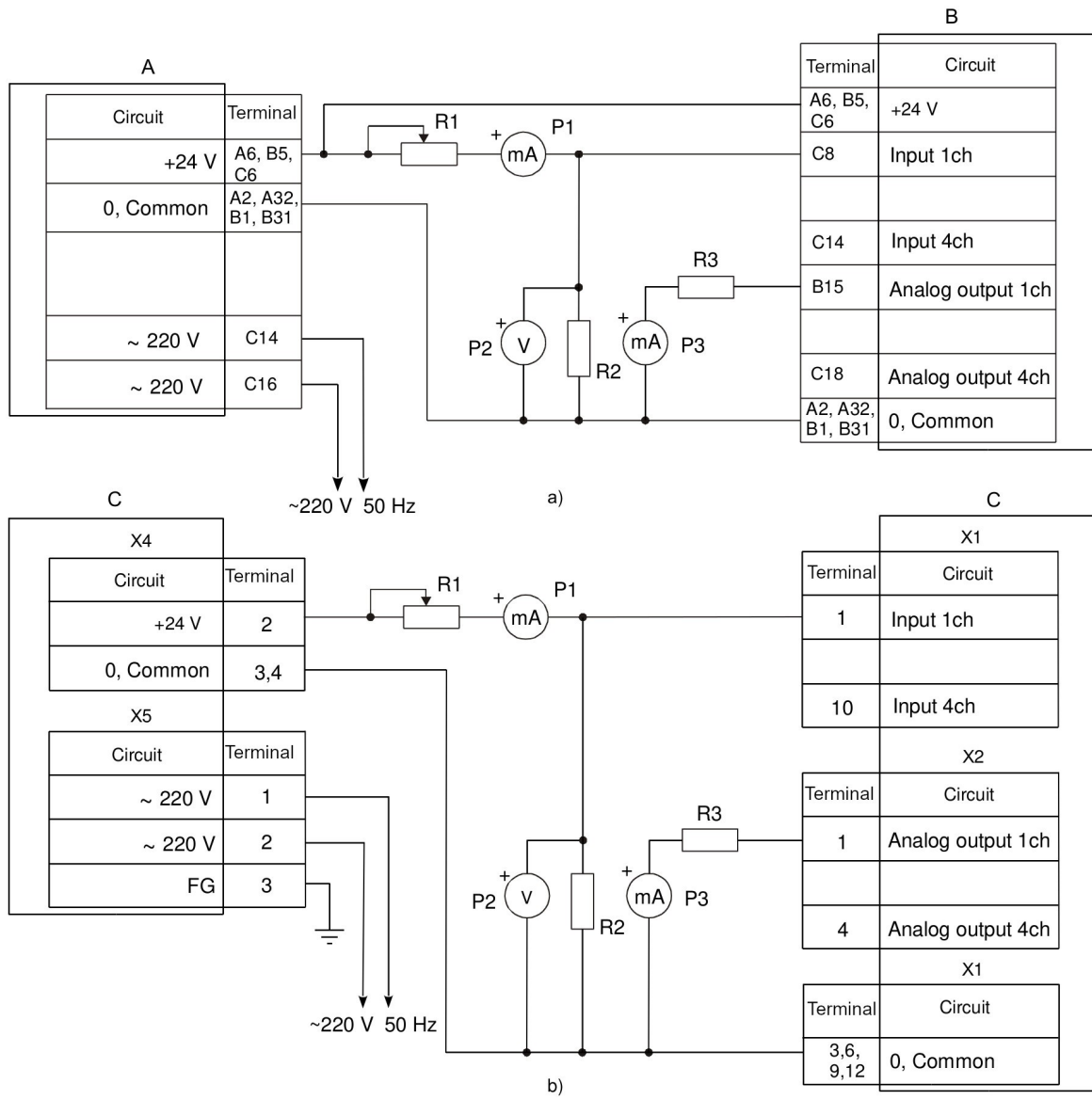
A – МП24;
B – control module;
C – control unit;
R1 – resistance box, 100 kOhm;
R2, R3 – resistors (500±10) Ohm, 0.5W;
P1, P3 – DC milliammeter (0-20) mA, cl. 0.2;
P2 – DC voltmeter cl. 0.1.
Note.- P2, R2 are used to check the voltage measurement channels.

Figure 28

1) Use the resistance box (R1) to set a number of DC current (DC voltage) values by the instrument P1 (P2) and read (record) the parameter and unified signal value by the module digital indicator and the milliammeter P3.

Values of MK10, MK11 modules input signals, for which the measurement error is determined:

1.0;	2.0;	3.0;	4.0;	5.0	mA
4.0;	8.0;	12.0;	16.0;	20.0	mA
0.78;	1.56;	2.34;	3.12;	3.90	V

Values of MK20, MK22, MK30, MK32, BM32, BM61 modules input signals for which the measurement error is determined:

1.0;	2.0;	3.0;	4.0;	5.0	mA
4.0;	8.0;	12.0;	16.0;	20.0	mA
0.56;	1.12;	1.68;	2.24;	2.80	V

2) The measurement error value is determined according to the formulas (5) – (10):

- for the digital indicator:

  module setup corresponds to the input signal voltage measurement

$$\delta = \frac{U_y - U_i}{U_i} \cdot 100\,\% \tag{5}$$

module setup corresponds to the input signal current measurement

$$\delta = \frac{I_y - I_i}{I_i} \cdot 100\,\% \tag{6}$$

module setup corresponds to the parameter measurement, input signal voltage

$$\delta = \frac{K_1\left(1 + \dfrac{4 \cdot (|S_M| + S_i)}{S_{PR}}\right) - U_i}{U_i} \cdot 100\,\% \tag{7}$$

module setup corresponds to the parameter measurement, input signal current

$$\delta = \frac{K_1\left(K_4 + \dfrac{K_3 \cdot (|S_M| + S_i)}{S_{PR}}\right) - I_i}{I_i} \cdot 100\,\% \tag{8}$$

$$S_{PR} = |S_M| + |S_P| \tag{9}$$

– for output unified signal (20%; 40%; 60%; 80%; 100% of the range upper value), if DC current signal is fed to a unified output:

$$\delta = \frac{K_2 \cdot (I_o - I_{он}) - (I_i - I_{iн})}{I_i - I_{iн}} \cdot 100\,\% \tag{10}$$

where U_y – voltage by digital indicator readings, V;

U_i – input voltage by voltmeter P2, V;

I_y – current by the digital indicator, mA;

I_i – input current by the milliammeter P1, mA;

K_1, K_2, K_3, K_4 – scaling factors;

S_M, S_P – measurement range limits (with minus, plus sign), mm, mm/m;

S_i – digital indicator readings, mm, mm/m;

S_{pr}– parameter measurement range, mm, mm/m;

I_O – unified signal by the milliammeter P3, mA;

I_{OH} – lower current value of the output unified signal (1, 4 mA);

I_{iH} – input current lower value (0 mA), mA.

Output unified signal (4-20) mA:

Channel input signal	K_1	K_2	K_3	K_4
DC current (1 – 5) mA	1.0	0.25	4.0	1.0
DC current (0 – 5) mA	1	0.3125	5.0	0
DC current (4 – 20) mA	4.0	1.0	4.0	1.0
DC current (0 – 20) mA	4.0	1.25	5.0	0
DC voltage (0.78 – 3.90) V	0.78	0.195	–	–
DC voltage (0.56 – 2.80) V	0.56	0.14	–	–

Input unified signal (1-5) mA

Channel input signal	K_1	K_2	K_3	K_4
DC current (1 – 5) mA	1.0	1.0	4.0	1.0
DC current (0 – 5) mA	1	1.25	5.0	0
DC current (4 – 20) mA	4.0	4.0	4.0	1.0
DC current (0 – 20) mA	4.0	5.0	5.0	0
DC voltage (0.78 – 3.90) V	0.78	0.195	–	–
DC voltage (0.56 – 2.80) V	0.56	0.14	–	–

Output unified signal (0-5) mA

Channel input signal	K_1	K_2	K_3	K_4
DC current (1-5) mA	1.0	0.8	4.0	1.0
DC current (0-5) mA	1.0	1.0	5.0	0
DC current (4-20) mA	4.0	3.2	4.0	1.0
DC current (0-20) mA	4.0	4.0	5.0	0

Note - for unified signal of (0-5) mA, the main error is determined for 40%, 60%, 80%, 100% of the input signal range upper value.

3) Determine measurement error on all channels of the module. The control module is considered to have passed the test if the main relative measurement error maximum value after the test does not exceed the value specified in:

- p. 1.3.1 for MK10;
- p. 1.3.2 for MK11 module;
- p. 1.3.3 for MK20 module;
- p. 1.3.4 for MK22 module and BM22, BM61 units;
- p. 1.3.5 for MK30 module;
- p. 1.3.6 for MK32 module and BM32 unit.

3.3.5.3.2 Determination of AC current measurement error of MK20, MK22, BM22, MK30, MK32, BM32, BM61 control modules and units

The test of MK20, MK22, BM22, MK30, MK32, BM32, BM61 modules and units is carried out according to the electrical diagram in accordance with Figure 29.

For the MK22 control module, BM22 and BM61 units, the tests are carried out on channel 3.
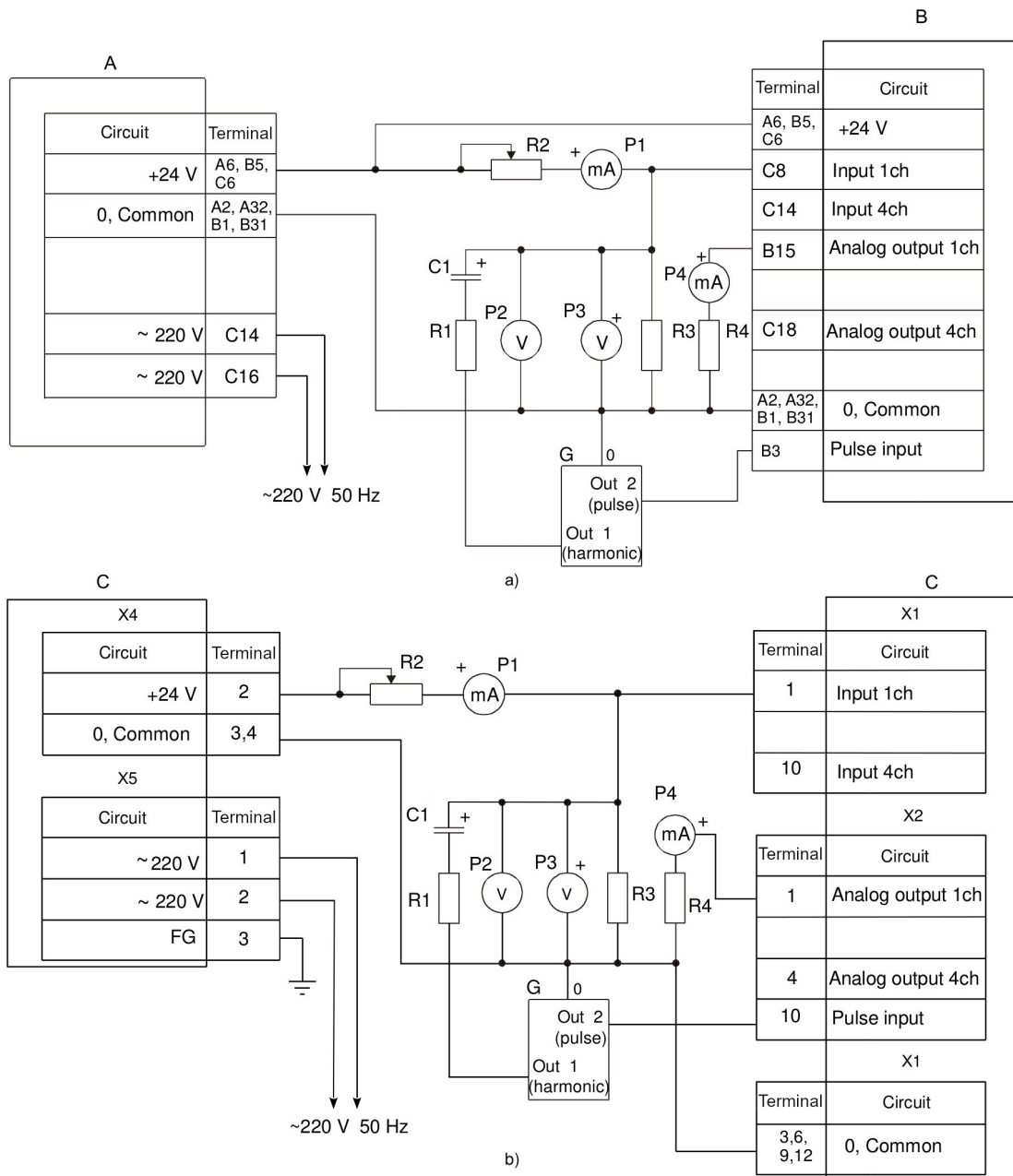
A – МП24;
B – control module;
C – control unit;
G – arbitrary waveform generator ACK-4106;
R1, R3, R4 – resistors (500±10) Ohm, 0.5W;
R2 – resistor box, 100 kOhm;
C1 – capacitor 1000 uF, 16 V
P1, P4 – DC milliammeter of (0-20) mA, cl. 0.2;
P2 – AC voltmeter Rin ≥ 1.0 MOhm, cl. 0.6;
P3 – DC voltmeter of cl. 0.1.
Note – P3, R3 - are used to check the voltage measurement channels.

Figure 29

3.3.5.3.2.1 Determination of AC current or voltage excursion measurement error of МК20, МК22, ВМ22, МК32, ВМ32, ВМ61 control modules and units.

1) Use the resistor R2 to set the DC current (3±0.2) mA or (12±0.8) mA according to the milliammeter P1 for AC channel or the DC voltage (1.7±0.1) V by the voltmeter P3 for AC voltage channel.

2) Set the base frequency 80 Hz (for frequency measurement range of (0.8 – 200) Hz set the base frequency of 40 Hz) and the amplitude of rectangular pulses +5 V at the generator G pulse output.

3) Use generator G at the base frequency to set a sequence of AC voltage values at harmonic output by the voltmeter P2:

39,59; 79,18; 118,78; 158,37; 197,96 mV for a base frequency of 80 Hz;

44,43; 88,86; 133,28; 177,71; 222,14 mV for a base frequency of 40 Hz.

Read the parameter and unified signal value on the liquid crystal display (LCD) and the milliammeter P4.

4) Calculate the measurement error using the formula:

- for LCD:

module setup corresponds to the input signal voltage measurement

$$\delta = \frac{0,35355 \cdot U_y - U_i}{U_i} \cdot 100 \; \% \tag{11}$$

module setup corresponds to the parameter measurement, input signal voltage

$$\delta = \frac{\dfrac{U_{pr} \cdot S_i}{S_{pr}} - U_i}{U_i} \cdot 100 \; \% \tag{12}$$

- for the output unified signal (4-20) mA, if the DC current signal is fed to the unified output:

$$\delta = \left(\frac{I_o \cdot U_{pr}}{4 \cdot U_{pr} + 16 \cdot U_i} - 1 \right) \cdot 100 \; \%, \tag{13.1}$$

- for the output unified signal (0-5) mA, if the DC current signal is fed to the unified output:

$$\delta = \frac{0,2 \cdot I_o \cdot U_{pr} - U_i}{U_i} \cdot 100 \; \% \tag{13.2}$$

$$U_{pr} = 0,19796 \; V$$

Where U_y – voltage by the digital indicator readings, V;

U_i – input AC voltage by the voltmeter P2, V;

U_{pr} – AC voltage measurement range, V;

S_i – digital indicator readings, μm;

S_{pr} – channel parameter measurement range, μm;

I_o – unified signal by the milliammeter P3, mA.

5) Determine measurement error on all channels of the module.

The control module is considered to have passed the test if the main relative measurement error maximum value after the test does not exceed the value specified in:

- p. 1.3.3 for MK20 module;
- p. 1.3.4 for MK22 module and BM22, BM61 units;
- p. 1.3.6 for MK32 module and BM32 unit.

3.3.5.3.2.2 Determination of AC current or voltage RMS measurement error of MK30, MK32, BM32 modules and units.

1) Use the resistor R2 to set the DC current (3±0.2) mA or (12±0.8) mA according to the milliammeter P1 for AC channel or the DC voltage (1.7±0.1) V by the voltmeter P3 for AC voltage channel.

2) Set the base frequency 80 Hz and the amplitude of rectangular pulses +5 V at the generator G pulse output.

3) Use generator G at the base frequency to set a sequence of AC voltage values at harmonic output by the voltmeter P2:

$$0{,}084; \ 0{,}168; \ 0{,}252; \ 0{,}336; \ 0{,}420 \ V$$

Read the parameter and unified signal value on the liquid crystal display (LCD) and the milliammeter P4.

4) Calculate the measurement error using the formula:

- for LCD:

  module setup corresponds to the input signal voltage measurement

$$\delta = \frac{U_y - U_i}{U_i} \cdot 100 \ \% \tag{14}$$

  module setup corresponds to the parameter measurement, input signal voltage

$$\delta = \frac{\dfrac{U_{pr} \cdot S_i}{S_{pr}} - U_i}{U_i} \cdot 100 \ \% \tag{15}$$

- for the output unified signal (4-20) mA, if the DC current signal is fed to the unified output:

$$\delta = \left(\frac{I_o \cdot U_{pr}}{4 \cdot U_{pr} + 16 \cdot U_i} - 1 \right) \cdot 100 \ \%, \tag{16.1}$$

- for the output unified signal (0-5) mA, if the DC current signal is fed to the unified output:

$$\delta = \frac{0{,}2 \cdot I_o \cdot U_{pr} - U_i}{U_i} \cdot 100 \ \% \tag{16.2}$$

$$U_{pr} = 0{,}420 \ V$$

Where U_y – voltage by the digital indicator readings, V;

U_i – input AC voltage by the voltmeter P2, V;

U_{pr} – AC voltage measurement range, V;

S_i – digital indicator readings, µm;

S_{pr} – channel parameter measurement range, µm;

I_o – unified signal by the milliammeter P3, mA.

5) Determine measurement error on all channels of the module.

The control module is considered to have passed the test if the main relative measurement error maximum value after the test does not exceed the value specified in:

- p. 1.3.5 for MK30 module;
- p. 1.3.6 for MK32 module and BM32 unit.

3.3.5.3.3 Determination of the sinusoidal AC current or voltage phase measurement error of the MK20, MK30, MK32, BM32 control modules and units

The test is carried out according to the electrical diagram in accordance with Figure 29.

1) Use the resistor R2 to set the DC current (3±0.2) mA or (12±0.8) mA according to the milliammeter P1 for AC channel or the DC voltage (1.7±0.1) V by the voltmeter P2 for AC voltage channel.

2) Set the frequency 10 Hz and the amplitude of rectangular pulses +5 V at the generator G pulse output.

3) Set sinusoidal AC voltage at the generator G harmonic output by the voltmeter P2 $0,8 \cdot U_{pr}$

4) Use generator to set a sequence of sinusoidal signal phase values at harmonic output G: 0; 90; 180; 270; 330 degrees and read (record) the phase value by LCD.

5) Calculate the absolute measurement error, °, using the formula:

$$\delta = \varphi_P - \varphi_i, \tag{17}$$

Where φ_P – signal phase value on the LCD, °;

φ_i – signal phase value by the generator, °.

Here the phase means the time interval in degrees (0-360) from the sinusoidal signal amplitude zero value during transition from the negative to positive value before the pulse amplitude positive edge at the generator output 2.

6) Determine the measurement error at the following frequencies: 20; 40; 80; 160 Hz.

7) Test all the channels of the module.

The control module is considered to have passed the test if the main absolute measurement error maximum value after the test does not exceed the value specified in:

- p. 1.3.3 for MK20 module;
- p. 1.3.5 for MK30 module;
- p. 1.3.6 for MK32 module and BM32 unit.

3.3.5.3.4 Determination of the rotor speed measurement error of the MK22, BM22, MK32, BM32, BM61, MK40 control modules and units

The test of module and unit is carried out according to the electrical diagram in accordance with Figure 30.

For MK22, BM22, MK32, BM32, BM61 control modules and units the tests are carried out on channels 1 and 2.
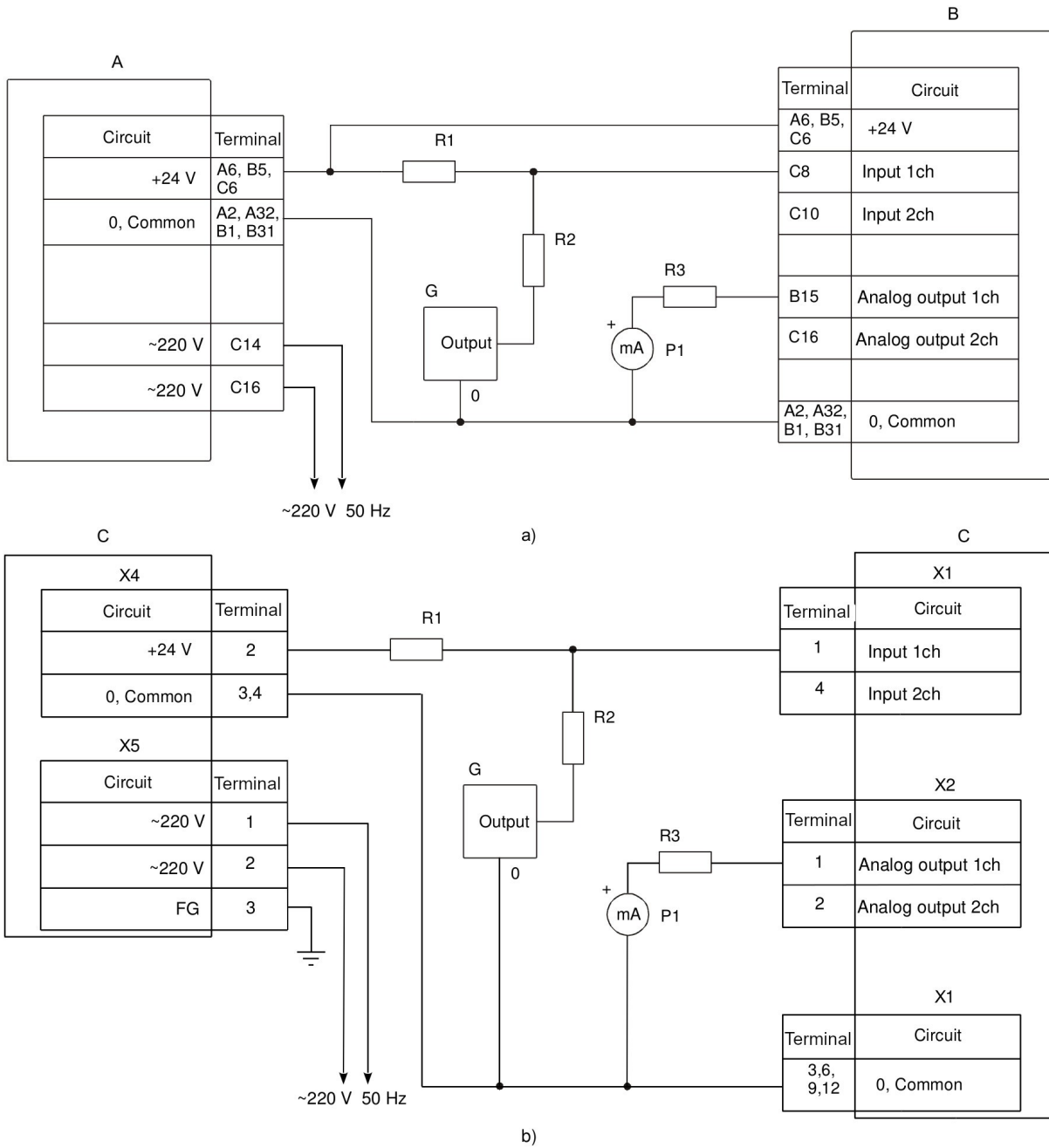
A – МП24;

B – control module;

C – control unit;

G – rectangular pulse generator (error not more than 0.01Hz);

R1– resistor (2.4±0.05) kOhm, 0.5W;

R2– resistor (100±2) Ohm, 0.5W;

R3– resistor (500±10) Ohm, 0.5W;

P1 – DC milliammeter (0-20) mA, cl. 0.2.

Figure 30

1) Set the frequency 0.05 Hz and the rectangular pulses amplitude +5V at the generator output.

2) Take the digital indicator readings.

3) Use generator to set a sequence of frequency values: 1; 5; 10; 25; 50; 80; 100; 160 Hz, take (record) readings by digital indicator and milliammeter

4) Calculate the measurement error using the formulas:

- for the digital indicator, rpm:

$$\Delta = N_i - 60 \cdot f_i \tag{18}$$

- for unified signal (4-20) mA

$$\delta = \left(\frac{I_o \cdot f_{pr}}{4 \cdot f_{pr} + 16 \cdot f_i} - 1 \right) \cdot 100\ \%, \tag{19.1}$$

- for unified signal (0-5) mA

$$\delta = \frac{0{,}2 \cdot I_o \cdot f_{pr} - f_i}{f_i} \cdot 100\ \% \tag{19.2}$$

$$f_{pr} = 160\,\text{Hz}$$ or 100% of the frequency measurement range by a unified signal.

Where N_i – digital indicator readings, RPM;

f_i – generator frequency, Hz;

I_o – unified signal by the milliammeter P1, mA;

f_{pr} – frequency measurement range by unified signal, Hz.

5) Determine measurement error on all channels of the module.

The control module is considered to have passed the test if the main measurement error maximum value at all channels does not exceed the value specified in:

p. 1.3.4 for MK22 module and BM22, BM61units;

p. 1.3.6 for MK32 module and BM32 unit;

p. 1.3.7 for MK40 module.

3.3.5.3.5 Determination of the MK95control module measurement error

Module is calibrated according to the electrical diagram in accordance with Figure 31.
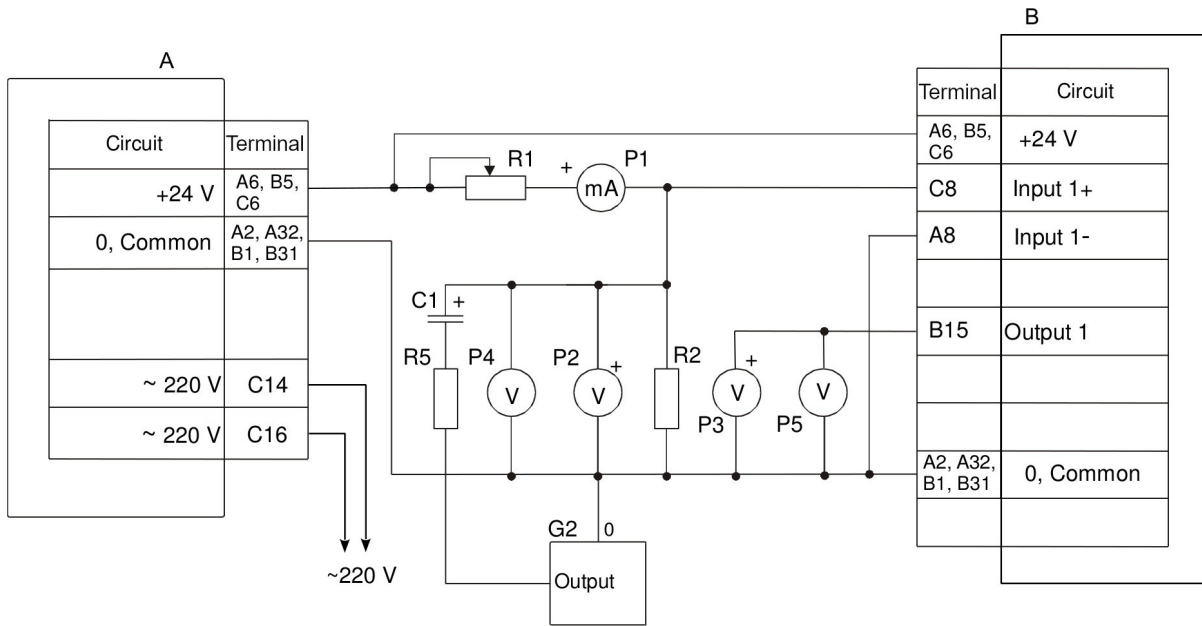
A – МП24;

B – MK95;

G2 – low-frequency generator;

R1 – resistor box, 100 kOm;

R2, R4, R5 – resistors (500±10) Ohm, 0.5W;

C1 – capacitor 1000 uF, 16 V (when measuring at a frequency of 0,05 Hz not less than 50000 uF);

P1 – DC milliammeter of (0-20) mA, cl. 0.2;

P2, P3 – DC voltmeter of cl. 0.1;

P4, P5 – AC voltmeter Rin $\geq$ 1.0 MOhm, cl. 0.6.

Note – P2, R2 are used to check the voltage measurement channels.

Figure 31

3.3.5.3.5.1 Determination of the DC current or voltage measurement error

Measurement error is determined by the method of p. 3.3.5.3.1.

Note.

1. Calculate the error according to the formula (10), where:

Uy is the output voltage according to the readings of voltmeter P3 of Figure 29;

Ui is the voltage calculated according to the formula (1) or (2).

2. Values of the MK95 module input signals should be taken from p. 3.3.5.3.1. The error is not calculated for the initial values of the input signal (for example, 1.0 (4.0)).

The control module is considered to have passed the test if the main measurement error maximum value at all channels does not exceed the value specified in p. 1.3.13.

3.3.5.3.5.2 Determination of the AC current or voltage RMS measurement error.

Measurement error is determined by the method of p. 3.3.5.3.2.

Note.

1. Calculate the error according to the formula (14), where:

Uy is the output voltage according to the readings of voltmeter P5 of Figure 29;

Ui is the voltage calculated according to the formula (3).

2. MK95 module the input signals values (Irms), mA:

0.282; 0.564; 0.846; 1.128; 1.410

1.1312; 2.2624; 3.3936; 4.5248; 5.6560

The control module is considered to have passed the test if the main measurement error maximum value at all channels does not exceed the value specified in p. 1.3.13.

3.3.5.3.6 Determination of the frequency response (FR) ripple of MK20, MK30, MK32, BM32 control modules and units

The module test is carried out according to the electrical diagram in accordance with Figure 29.

1) Use the resistor R2 to set the DC current (3±0.2) mA or (12±0.8) mA according to the milliammeter P1 for AC channel or the DC voltage (1.7±0.1) V by the voltmeter P3 for AC voltage channel.

2) Set the base frequency 80 Hz (for frequency measurement range of (0.8 – 200) Hz set the base frequency of 40 Hz) and the amplitude of rectangular pulses +5 V at the generator G pulse output.

3) Use generator G at base frequency to set AC by voltmeter P2 and re- $0.8 \cdot U_{PR}$ ' (record) parameter values by LCD indications:

  - common level;

  - low-frequency component (LF) *;

  – high-frequency component (HF) *.

  *Note: * - Not monitored for the frequency measurement range of (0.8 – 200) Hz.*

4) Use generator G to set a number of harmonic signal frequencies according to Table 41, maintaining the set voltage value by the voltmeter P2 and read (record) the parameter values by LCD indication.

5) Calculate the frequency response ripple using the formula:

$$\delta = \frac{S_i - S_\delta}{S_\delta} \cdot 100\ \%,$$ (20)

Where S_i – parameter value at the measurement frequency;

  S_δ – parameter value at the base frequency.

The base frequency values, Hz:

  - for the parameter common level– 80 (40, for measurement frequency range (0.8 - 200) Hz);

  - parameter LF component – 20 (none, for measurement frequency range (0.8 - 200) Hz);

  - parameter HF component – 200 (none, for measurement frequency range (0.8 - 200) Hz).

Table 41 – A number of the harmonic signal frequency values

Parameter description	Generator frequency, Hz												
	0.05		0.1		0.5		1.0		2.0		5.0		10
	5	10	20	40	50	80	125	200	250	300	350	400	500
	10	20	40	50	80	125	200	250	500	600	700	800	1000
	0.8	1	2	3.15	5	10	20	40	80	100	160	180	200
Input signal voltage of 0.8 * Upr, mV (except for the measurement range of (0.8 - 200) Hz)													
Input signal voltage for the measurement range of (0,8 - 200) Hz, mV	3.554	4.443	8.886	13.995	22.214	44.429	88.858	177.72	355.43	444.29	710.86	799.72	888.58
The display reading:													
- common signal level													
- LF component													
- HF component													
FR ripple, %:													
- common signal level													
- LF component													
- HF component													

*Note: * For LF component - up to 2 / F;*

For HF component - from 2xF.

6) Determine the frequency response ripple in all the channels of the module.

7) Determination of the frequency response ripple in the frequency measurement range (0.05 – 10) Hz.

When measuring the input signal with the frequency (0.05 – 10) Hz, the generator G frequency should correspond to the input signal frequency. The frequency response ripple is calculated from the peak-to-peak excursion value (RMS) of the first rotational component displayed on LCD.

The control module is considered to have passed the test if the frequency response ripple maximum value after the test does not exceed the value specified in:

-    p. 1.3.3 for MK20 module;

-    p. 1.3.5 for MK30 module;

-    p. 1.3.6 for MK32 module and BM32 unit.

3.3.5.3.7 Determination of the AC current or voltage channels frequency response ripple of MK95 control module.

Determination of frequency response ripple is carried out by the method of p. 3.3.5.3.6.

The control module is considered to have passed the test if the frequency response ripple maximum value after the test does not exceed the value specified in p. 1.3.13.

3.3.5.4 Determination of the measurement channels metrological parameters

Calibration should be carried out in compliance with the requirements for safety, conditions and calibration means stated in section 3.3 of the ВШПА.421412.100 РЭ Operation and Maintenance Manual.

The test is carried out according to the electric schematic diagram in accordance with Figure 32, except for the absolute vibration displacement channel with the ДПЭ22МВ*В*15НГ sensor, to be calibrated according to figure 33
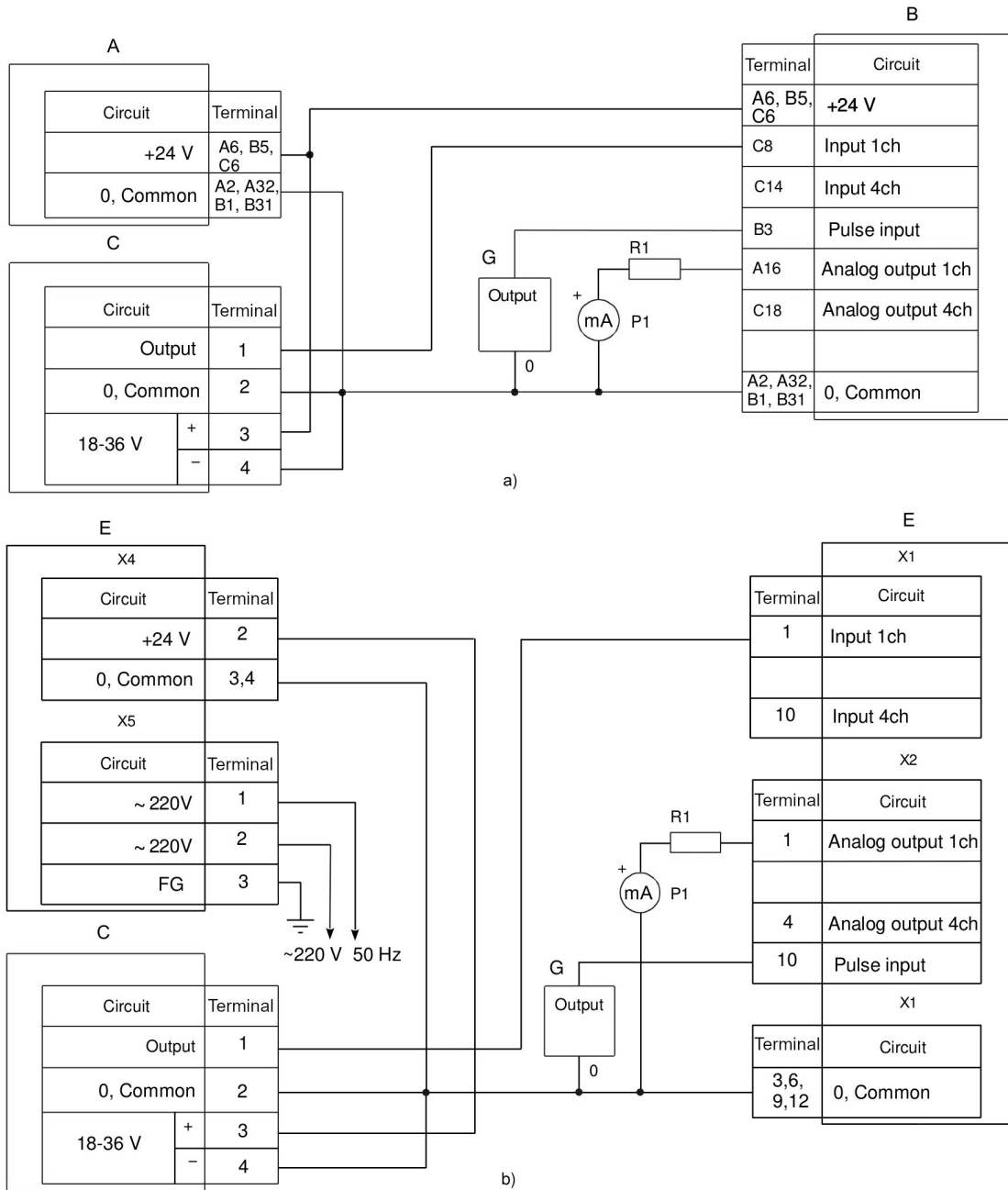
A – МП24;
B – МК10 (МК11, МК20, МК22,МК30, МК32, МК40);
C – equipment Vibrobit 100 (ИП34, ИП42, ИП44, ДВТ82, К22, ДПЭ22МВ, ДПЭ22П, ДПЭ23МВ, ДПЭ23П except for sensor ДПЭ22МВ*И*15НГ);
E – control unit;
G – rectangular pulse generator Г6-33;
R1– resistor (500±10) Ohm, 0.5W;
P1 – DC milliammeter (0-20) mA, cl. 0.2.
Note – The generator is used when measuring the relative vibration displacement in the frequency range (0.05 - 10) Hz.

Figure 32

A   — Sensor;
B   — Control module;
C   — Power supply;
P1   — DC Milliammeter 0-50 mA, cl. 0.1;
R1** — Resistor (500±5) ohm 0.5 W / (2000±20) ohm 0.5 W;
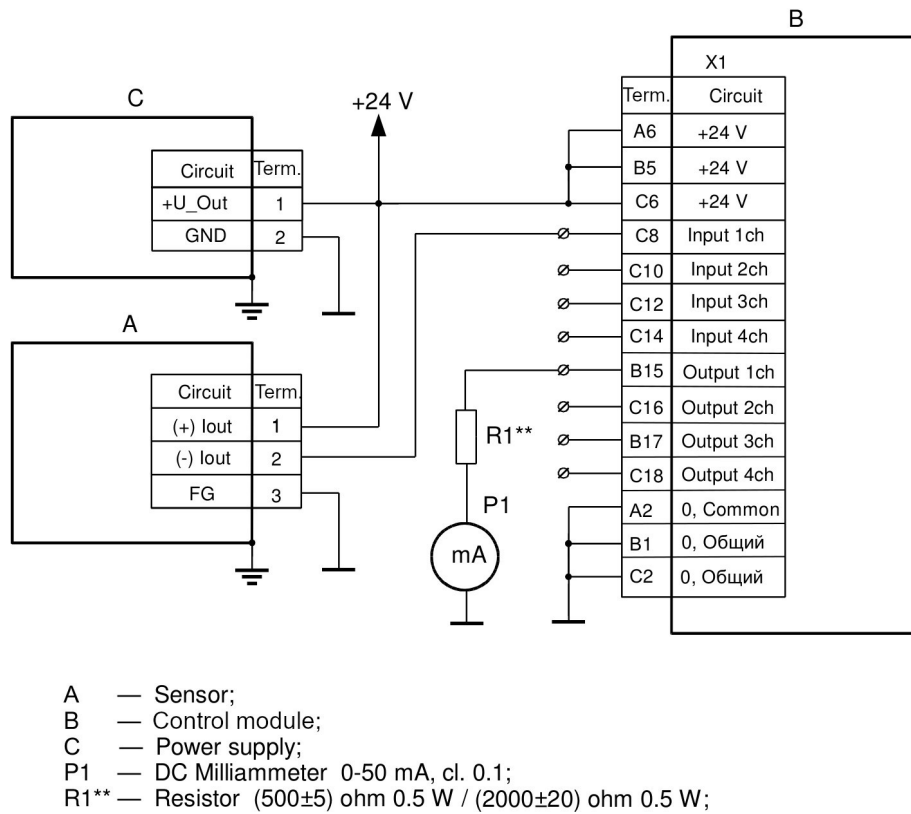
Figure 33

3.3.5.4.1 Determination of the main measurement error of displacement channel, surface tilt

The sensor and converter measurement range should comply with the module measurement channel range.

Arrange sensor on the stand in the position where the module digital indicator reads zero. This sensor position on the stand is zero, displacement on the stand is counted from the zero position.

Consecutively set a number of displacements on the stand approximate equal to 0; 25; 50; 75; 100% (-50; -25; 0; +25; +50%) of the measurement range, use the digital indicator and milliammeter to read the displacement and unified signal.

Determine the main measurement error using the formulas:

– for digital indicator

$$\delta = \frac{S_c - S_i}{S_{PR}} \cdot 100\,\%$$

(21)

$$S_{PR} = |S_M| + |S_P|$$

(22)

- for unified signal (4-20) mA

$$\delta = \frac{0{,}0625 \cdot S_{PR}\,(I_o - 4) - (|S_M| + S_i)}{S_{PR}} \cdot 100\,\%,$$

(23.1)

– for unified signal (0-5) mA

$$\delta = \frac{0{,}2 \cdot S_{PR} \cdot I_o - (|S_M| + S_i)}{S_{PR}} \cdot 100\,\%$$

(23.2)

Where S_c – digital indicator reading with the minus or plus sign (sensor displacement direction from the zero position), mm, mm/m;

S_i – displacement on the stand with the minus or plus sign, mm, mm/m;

S_M, S_P– displacement variation range with the minus or plus sign, mm, mm/m;

S_{PR} – parameter measurement range, mm, mm/m;

I_o – unified signal, mA.

The error maximum value should comply with the requirements in p.p. 1.3.24, 1.3.28.

3.3.5.4.2 Determination of the main error in the channel measuring the relative and absolute vibration displacement

Arrange sensor on the vibration stand, set a number of vibration displacement values equal to 12.5; 25; 50; 75; 100% of the measurement range at a base frequency, use digital indicator and milliammeter to monitor the readings of vibration displacement and unified signal. Sensors of the relative vibration displacement should be installed with a gap of 0.5 (1.0) mm

Determine the main relative measurement error using the formulas:

- for digital indicator

$$\delta = \frac{S_c - S_i}{S_i} \cdot 100\,\% \tag{24}$$

- for unified signal (4-20) mA

$$\delta = \left(\frac{I_o \cdot S_{PR}}{4 \cdot S_{PR} + 16 \cdot S_i} - 1 \right) \cdot 100\,\% \tag{25.1}$$

– for unified signal (0-5) mA

$$\delta = \frac{0{,}2 \cdot I_o \cdot S_{PR} - S_i}{S_i} \cdot 100\,\% \tag{25.2}$$

where S_c – readings on LCD, μm, mm (mm/s);

S_i – vibration displacement on the stand, μm, mm (mm/s);

I_o – unified signal, mA;

S_{pr} – measurement range, μm, mm (mm/s).

Determine the main reduced measurement error using the formulas (21) and (23.1; 23.2), at the same time take the value S_M equal to zero.

The maximum error value should comply with the requirements in p. 1.3.25.

3.3.5.4.3 Determination of the main error of the vibration velocity RMS measurement channel

Vibration velocity sensor measurement range should comply with the module measurement channel range or exceed it by 25%.

Calibration is carried out by the method of p. 3.3.5.4.2, where vibration velocity RMS is the parameter.

The maximum error value should comply with the requirements in p. 1.3.26.

3.3.5.4.4 Determination of the main error of the rotor speed measurement channel

Calibration is carried out using the СП50 appliance.

Connect СП50 to the power source and generator according to the electrical diagram in Figure 34.
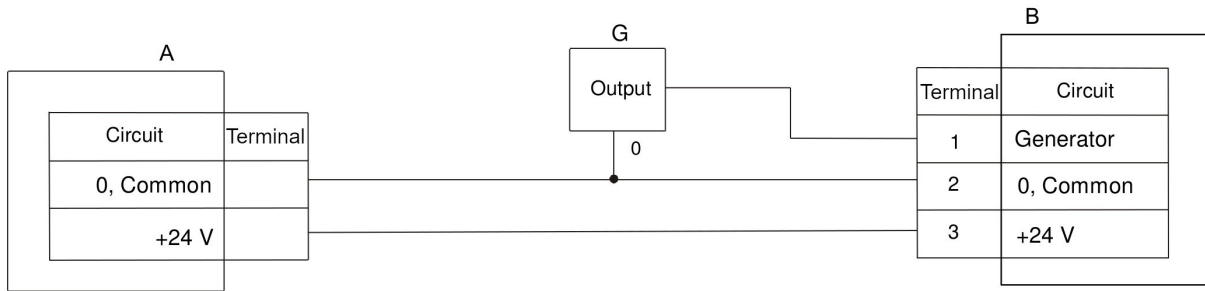
A – stabilized DC voltage source;
B – СП50;
G – generator.

Figure 34

Set frequency 10Hz with voltage 1V at the generator output. Install the sensor into СП50 in accordance with Figure M.6 ВШПА.421412.100 РЭ. The sensor installation depth into the СП50 should result in the rectangular pulses $0.5T_n$, with the frequency 10Hz at the comparator output.

Use generator to consecutively set a number of frequencies equal to 12.5; 25; 50; 75; 100% of the measurement range. Read the speed and unified signal readings by the module indicator and milliammeter (unified output).

Determine the main measurement error using the formulas:

- for digital indicator, RPM

$$\delta = N_p - 60 \cdot f_i \tag{26}$$

- for unified output (4-20) mA

$$\delta = \left(\frac{I_o \cdot f_{pr}}{4 \cdot f_{pr} + 16 \cdot f_i} - 1 \right) \cdot 100\,\% \tag{27.1}$$

   – for unified output (0-5) mA

$$\delta = \frac{0{,}2 \cdot I_o \cdot f_{pr} - f_i}{f_i} \cdot 100\,\% \tag{27.2}$$

$$f_{np} = \frac{N_{pr}}{60}, \tag{28}$$

where N_n – speed by the module digital indicator, RPM;

     f_i – generator frequency, Hz;

     I_o – unified signal, mA;

     f_{pr} – speed measurement range by the unified signal, Hz;

     N_{pr} – speed measurement range by the unified signal, RPM.

The maximum error value should comply with the requirements in p. 1.3.27.

3.3.5.4.5 Determination of frequency response ripple of vibration velocity RMS and vibration displacement measurement channel

3.3.5.4.5.1 Determination of frequency response ripple of vibration velocity RMS measurement channel

The calibration is carried out according to the electric schematic diagram in accordance with Figure 32.

Install sensor on the vibration stand, reproduce oscillations with vibration velocity RMS frequency and amplitude in accordance with table 42, take readings of the control module digital indicator and enter them in the table 42.

Table 42 – A number of harmonic signal frequency values

Parameter description	Oscillation frequency of the vibration stand, Hz**												
	0.05		0.1		0.5		1.0		2.0		5.0		10
	5	10	20	40	50	80	125	200	250	300	350	400	500
	10	20	40	50	80	125	200	250	500	600	700	800	1000
Vibration velocity RMS value by stand, mm/s;*		5	5	5	5	5	5	5	5	5	5	5	5
Vibration displacement value by stand, μm *	10	10	10	10	10	10	10	10	10				
Readings of the control module or unit													
Frequency response ripple, %													
* It is permitted to set other vibration velocity or vibration displacement values depending on the vibration stand technical parameters.													
** Values of the vibration stand oscillations depend on the item measurement frequency range.													

Calculate frequency response ripple using the formula (20),

where S_i – vibration velocity RMS value at measurement frequency;

S_δ – vibration velocity RMS value at basic frequency.

Basic measurement frequency of 80 Hz.

Vibration velocity channel frequency response ripple is determined in the frequency range (10-1000) Hz.

Vibration velocity RMS measurement channel considered serviceable if the frequency response ripple maximum values do not exceed values stated in p. 1.3.26.

3.3.5.4.5.2 Determination of frequency response ripple of relative vibration displacement measurement channel

The measurement channel is calibrated according to the electric schematic diagram in accordance with Figure 32.

Install sensor on the vibration stand, reproduce oscillations with vibration displacement frequency and amplitude in accordance with table 42, monitor the readings of the control module digital indicator and enter them in the table 42.

Determine the frequency response ripple using the formula (22),

where S_i – relative vibration displacement value at measurement frequency;

S_δ – relative vibration displacement value at basic frequency.

Basic measurement frequency is 80 Hz.

Frequency response ripple of the relative vibration displacement channel is determined in the frequency range (5-500) Hz.

Use СП50 appliance to test the measurement channel frequency response in the frequency range from 0.05 to 10 Hz.

Relative vibration displacement measurement channel considered serviceable if the frequency response ripple maximum values do not exceed values stated in p. 1.3.25.

3.3.5.4.5.3 Determination of frequency response ripple of absolute vibration displacement measurement channel

Install sensor on the vibration stand, reproduce oscillations with vibration displacement frequency and amplitude in accordance with table 43, monitor the readings of the control module digital indicator and enter them in the table 43.

Table 43 – A number of vibration displacement frequency and excursion values

Vibration stand oscillation frequency, Hz	0.8	1	2	3.15	5	10	20	40	80	100	160	180	200
	5		10		16		30		45	80	120	160	200
Vibration displacement value by stand - for measurement range (0.8 - 200) Hz, µm *	250	250	250	250	250	250	250	250	250	250	250	250	250
- for measurement range (5 - 200) Hz, µm *	25		25		25		25		25	25	25	25	25
Vibration displacement value - by the control module digital indicator, µm													
- by the unified output, mA													
* It is permitted to set other values depending on the vibration stand technical parameters.													

Determine the frequency response ripple using the formula (20),

where S_i – absolute vibration displacement value at measurement frequency, µm (mm);

S_δ – absolute vibration displacement value at basic frequency, µm (mm).

Base frequency for the frequency range (0.8 - 200) Hz is 40 Hz and for frequency range (5 - 200) Hz – 16 Hz respectively.

Absolute vibration displacement measurement channel considered serviceable if the frequency response ripple maximum values do not exceed values stated in p. 1.3.29.

3.3.6 Calibration results execution

Positive calibration results shall be entered into the logbook and formalized as the calibration certificate.

4 Transportation and Storage

4.1 Equipment Transportation

The packaged equipment should withstand transportation to any distance by road and rail transport (in enclosed vehicles), water transport (in ship holds), air transport (in pressurized compartments).

Transportation conditions - Ж according to ГОСТ 25804.4–83.

The packaged equipment should withstand the following transportation conditions:

- temperature from minus 50°C to plus 50°C;
- relative humidity of 95% at 35°C;
- vibration (acting along the three mutually perpendicular axes of the container) when transported by railway, motor vehicle and aircraft within the frequency range (10 – 55) Hz at the vibration displacement amplitude of 0.35 mm and vibration acceleration of 5g;
- impacts with the shock acceleration peak value of 10g, shock pulse duration 10 ms, number of impacts (1000 ± 10) in the direction indicated on the container.

4.2 Equipment Storage

The equipment storage as to environment climatic aspects influence should comply with the conditions 3 (Ж3) as per ГОСТ 15150–69. Storage period shall not exceed 24 months from the date of manufacturing.

Long-term storage of the equipment shall be carried out in the packaging, inside the heated premises as per 1 (Л) according to ГОСТ 15150–69.

5 Manufacturer's Guarantees

5.1 Manufacturer guarantees the equipment compliance with specifications when observing operation, storage, transportation and installation conditions.

5.2 Guaranteed shelf life is 24 months since manufacturing.

5.3 Guarantee service life is 24 months since placed into service, but not more than 48 months since manufacturing date.

5.4 If the instrument is sent to Manufacturer for warranty repair, it is necessary to state the detected failure.

6 Disposal

6.1 The equipment does not contain substances hazardous for humans and the environment.

6.2 Disposal of the equipment shall be carried out through disassembly of separate units. Metal, electrical-installation, cables items are used for recycling.

Annex A

(informative)

Description and purpose of the equipment external circuits

Table A.1 - MK10 module

Terminal number	Designation	Purpose
A2, B1, C2 A32, B31, C32	GND	Common
A6, B5, C6	Power +24V	Supply voltage +24V input /output
B7	+24 V sense CH1	Output voltage +24V for feeding channel 1 converter
B9	+24 V sense CH2	Output voltage +24V for feeding channel 2 converter
B11	+24 V sense CH3	Output voltage +24V for feeding channel 3 converter
B13	+24 V sense CH4	Output voltage +24V for feeding channel 4 converter
C8	Input CH1	Measurement channel 1 input
C10	Input CH2	Measurement channel 2 input
C12	Input CH3	Measurement channel 3 input
C14	Input CH4	Measurement channel 4 input
B15	Analog out 1	Unified output of measurement channel 1
C16	Analog out 2	Unified output of measurement channel 2
B17	Analog out 3	Unified output of measurement channel 3
C18	Analog out 4	Unified output of measurement channel 4
A20	LG_OUT_1	Logic output 1
A22	LG_OUT_2	Logic output 2
A24	LG_OUT_3	Logic output 3
A26	LG_OUT_4	Logic output 4
B19	LG_OUT_5	Logic output 5
B21	LG_OUT_6	Logic output 6
B23	LG_OUT_7	Logic output 7
B25	LG_OUT_8	Logic output 8
C20	LG_OUT_9	Logic output 9
C22	LG_OUT_10	Logic output 10
C24	LG_OUT_11	Logic output 11
C26	LG_OUT_12	Logic output 12
A28	CAN-GND	CAN2.0B interface
B27	CAN-H	
C28	CAN-L	
A30	RS485-GND	RS485 interface
B29	RS485-B(-)	
C30	RS485-A(+)	

Table A.2 - MK11 module

Terminal number	Designation	Purpose	Note
A2, B1, C2 A32, B31, C32	GND	Common	
A6, B5, C6	Power +24V	Supply voltage +24V input /output	
B7	+24 V sense CH1	Voltage +24 V output to power the measurement channel 1 converter	
B9	+24 V sense CH2	Voltage +24 V output to power the measurement channel 2 converter	
C8	Input CH1	Measurement channel 1 input	
C10	Input CH2	Measurement channel 2 input	
A12, B11, C12, C18	FG	Faraday grounding of AC / DC Switching Power Supply	
C14	~L220 V	Mains voltage AC 220 V 50 Hz	
C16	~N220 V		
A16	Analog out 2	Unified output of measurement channel 2	
B15	Analog out 1	Unified output of measurement channel 1	
A18	Test 2	The test signal of channel 2	
B17	Test 1	The test signal of channel 1	
A20	LG_OUT_1	Logic output 1	
A22	LG_OUT_2	Logic output 2	
A24	LG_OUT_3	Logic output 3	
A26	LG_OUT_4	Logic output 4	
B19	LG_OUT_5	Logic output 5	
B21	LG_OUT_6	Logic output 6	
B23	LG_OUT_7	Logic output 7	
B25	LG_OUT_8	Logic output 8	
A28	CAN-GND	CAN2.0B interface	
B27	CAN-H		
C28	CAN-L		
A30	RS485-GND	RS485 interface No.1	
B29	RS485-B		
C30	RS485-A		
C29	RS485-B	RS485 interface No.2	1
B30	RS485-A		
1. For version MK11-AC-11-S-R2			

Table A.3 - MK20, MK30 module

Terminal number	Designation	Purpose
A2	GND	Common
A4	logic Input	Logic input
A6	+24 V	Module supply voltage
A16	Aout 5	Analog output 5
A18	Aout 6	Analog output 6
A20	Lout 1	Logic output 1
A22	Lout 2	Logic output 2
A24	Lout 3	Logic output 3
A26	Lout 4	Logic output 4
A28	CAN GND	Common of CAN interface
A30	RS485 GND	Common of RS485 interface
A32	GND	Common
B1	GND	Common
B3	Fin 1	Main pulse input
B5	+24 V	Module supply voltage
B7	Spw 1 +24 V	Sensor supply voltage of channel 1
B9	Spw 2 +24 V	Sensor supply voltage of channel 2
B11	Spw 3 +24 V	Sensor supply voltage of channel 3
B13	Spw 4 +24 V	Sensor supply voltage of channel 4
B15	Aout 1	Analog output 1
B17	Aout 3	Analog output 3
B19	Lout 5	Logic output 5
B21	Lout 6	Logic output 6
B23	Lout 7	Logic output 7
B25	Lout 8	Logic output 8
B27	CAN H	Wire H of CAN interface
B29	RS485 B(-)	Wire B(-) of RS485 interface
B31	GND	Common
C2	GND	Common
C4	Fin 2	Standby pulse input
C6	+24V	Module supply voltage
C8	Sin 1	Channel 1 input
C10	Sin 2	Channel 1 input
C12	Sin 3	Channel 1 input
C14	Sin 4	Channel 1 input
C16	Aout 2	Analog output 2
C18	Aout 4	Analog output 4
C20	Lout 9	Logic output 9
C22	Lout 10	Logic output 10
C24	Lout 11	Logic output 11
C26	Lout 12	Logic output 12
C28	CAN L	Wire L of CAN interface
C30	RS485 A(+)	Wire A(+) of RS485 interface
C32	GND	Common

Table A.4 - MK22 module

Terminal number	Designation	Purpose	Note
A2, B1, C2 A32, B31, C32	GND	Common	
A6, B5, C6	Power +24 V	Supply voltage +24V input /output	
B3	Fin 1	Main pulse input	
C4	Fin 2	Standby pulse input	
B7	+24 V sense CH1	Voltage +24 V output to power the measurement channel 1 converter	
B9	+24 V sense CH2	Voltage +24 V output to power the measurement channel 2 converter	
B11	+24 V sense CH3	Voltage +24 V output to power the measurement channel 3 converter	
B13	+24 V sense CH4	Voltage +24 V output to power the measurement channel 4 converter	
C8	Input CH1	Input of measurement channel 1	1
C10	Input CH2	Input of measurement channel 2	1
C12	Input CH3	Input of measurement channel 3	1
C14	Input CH4	Input of measurement channel 4	1
B15	Analog out 1	Unified output of measurement channel 1	
C16	Analog out 2	Unified output of measurement channel 2	
B17	Analog out 3	Unified output of measurement channel 3	
C18	Analog out 4	Unified output of measurement channel 4	
A20	LG_OUT_1	Logic output 1	2
A22	LG_OUT_2	Logic output 2	2
A24	LG_OUT_3	Logic output 3	2
A26	LG_OUT_4	Logic output 4	2
B19	LG_OUT_5	Logic output 5	2
B21	LG_OUT_6	Logic output 6	2
B23	LG_OUT_7	Logic output 7	2
B25	LG_OUT_8	Logic output 8	2
C20	LG_OUT_9	Logic output 9	2
C22	LG_OUT_10	Logic output 10	2
C24	LG_OUT_11	Logic output 11	2
C26	LG_OUT_12	Logic output 12	2, 3
A28	CAN-GND	CAN2.0B interface, common	
B27	CAN-H	CAN2.0B interface, line H	
C28	CAN-L	CAN2.0B interface, line L	
A30	RS485-GND	RS485 interface, common	
B29	1-RS485-B(-)	RS485 interface No.1, line B	
C30	1-RS485-A(+)	RS485 interface No.1, line A	
B30	2-RS485-B(-)	RS485 interface No.2, line B	4
C29	2-RS485-A(+)	RS485 interface No.2, line A	4

Notes:
1. If the channel is not used, then output can be left unconnected, this channel should be disabled in the module settings.
2. The operation logic is determined during module setup.
3. In case of parameters reading failure from non-volatile memory, the active level will be present. It is recommended to assign all the module failure signals (sensor test, etc.) to this output.
4. For versions: MK22-DC-001-R2, MK22-DC-001-R2.COMP.01.

Table A.5 - MK32 module

Terminal number	Designation	Purpose	Note
A2, B1, C2 A32, B31, C32	GND	Common	
A6, B5, C6	Power +24 V	Input / output voltage supply +24 V	
B3	Fin 1	Primary pulse input	
C4	Fin 2	Additional pulse input	
B7	+24 V sense CH1	Voltage +24 V output to power the measurement channel 1 converter	
B9	+24 V sense CH2	Voltage +24 V output to power the measurement channel 2 converter	
B11	+24 V sense CH3	Voltage +24 V output to power the measurement channel 3 converter	
B13	+24 V sense CH4	Voltage +24 V output to power the measurement channel 4 converter	
C8	Input CH1	Measurement channel input 1	1
C10	Input CH2	Measurement channel input 2	1
C12	Input CH3	Measurement channel input 3	1
C14	Input CH4	Measurement channel input 4	1
B15	Analog out 1	Unified output of measurement channel 1	
C16	Analog out 2	Unified output of measurement channel 2	
B17	Analog out 3	Unified output of measurement channel 3	
C18	Analog out 4	Unified output of measurement channel 4	
A20	LG_OUT_1	Logic output 1	2
A22	LG_OUT_2	Logic output 2	2
A24	LG_OUT_3	Logic output 3	2
A26	LG_OUT_4	Logic output 4	2
B19	LG_OUT_5	Logic output 5	2
B21	LG_OUT_6	Logic output 6	2
B23	LG_OUT_7	Logic output 7	2
B25	LG_OUT_8	Logic output 8	2
C20	LG_OUT_9	Logic output 9	2
C22	LG_OUT_10	Logic output 10	2
C24	LG_OUT_11	Logic output 11	2
C26	LG_OUT_12	Logic output 12	2, 3
A28	CAN-GND	Interface CAN2.0B, common	
B27	CAN-H	Interface CAN2.0B, line H	
C28	CAN-L	Interface CAN2.0B, line L	
A30	RS485-GND	Interface RS485, common	
B29	1-RS485-B(-)	Interface RS485 №1, ine B	
C30	1-RS485-A(+)	Interface RS485 №1, line A	
B30	2-RS485-B(-)	Interface RS485 №2, line B	
C29	2-RS485-A(+)	Interface RS485 №2, line A	

Notes:
1. If the channel is not used, then output can be left unconnected, this channel should be disabled in the module settings.
2. The operation logic is determined during module setup.
3. In case of parameters reading failure from non-volatile memory, the active level will be present. It is recommended to assign all the module failure signals (sensor test, etc.) to this output.
4. For version MK32-DC-20-R2

Table A.6 - MK40 module

Terminal number	Designation	Purpose
A2, B1, C2 A32, B31, C32	GND	Common
A6, B5, C6	Power +24 V	Input of supply voltage +24V
B7	+24V sense CH1	Voltage +24 V output to power the measurement channel 1 converter
B9	+24V sense CH2	Voltage +24 V output to power the measurement channel 2 converter
C8	Input CH1	Input of measurement channel 1
C10	Input CH2	Input of measurement channel 2
B15	Analog out 1	Unified output of measurement channel 1
A16	Analog out 2	Unified output of measurement channel 2
A20, A22	Strob 1	Synchronization pulses output of measurement channel 1
A24, A26	Strob 2	Synchronization pulses output of measurement channel 2
B17	Test 1	Test pulses input of measurement channel 1
A18	Test 2	Test pulses input of measurement channel 2
B19	Logic out 1	Logic output 1
B21	Logic out 2	Logic output 2
B23	Logic out 3	Logic output 3
B25	Logic out 4	Logic output 4
C20, C22	Logic out 5	Logic output 5
C24, C26	Logic out 6	Logic output 6
A12, B11, C12, C18	FG	Faraday grounding of AC/DC converter Should be connected to the cabinet grounding
C14	L220 V	Mains voltage AC 220 V 50 Hz input
C16	N220 V	
A28	CAN-GND	CAN2.0B interface
B27	CAN-H	
C28	CAN-L	
A30	RS485-GND	RS485 interface
B29	RS485-B(-)	
C30	RS485-A(+)	

Table A.7 - MK70 module

Terminal number	Designation	Purpose
A2, B1, C2 A32, B31, C32	GND	Common
A6, B5, C6	Power +24 V	Input of supply voltage +24V
A12	Output 1	Logic output 1
A14	Output 2	Logic output 2
A8	Output 3	Logic output 3
A10	Output 4	Logic output 4
C16	Input 1	Logic output 1
B15	Input 2	Logic output 2
C14	Input 3	Logic output 3
B13	Input 4	Logic output 4
C12	Input 5	Logic output 5
B11	Input 6	Logic output 6
C10	Input 7	Logic output 7
B9	Input 8	Logic output 8
C24	Input 9	Logic output 9
B23	Input 10	Logic output 10
C22	Input 11	Logic output 11
B21	Input 12	Logic output 12
C20	Input 13	Logic output 13
B19	Input 14	Logic output 14
C18	Input 15	Logic output 15
B17	Input 16	Logic output 16
C8	Input Enable	Logic permission input for output 3
A16	Reset	MK70 logic reset input
B25	Test out 1	Output 1 of the test signal 61Hz
C26	Test out 2	Output 2 of the test signal 61Hz
A28	CAN-GND	CAN2.0B interface
B27	CAN-H	
C28	CAN-L	
A30	RS485-GND	RS485 interface
B29	RS485-B(-)	
C30	RS485-A(+)	

Table A.8 - MK71 module

Terminal number	Designation	Purpose	Note
A2, B1, C2 A32, B31, C32	GND	Common	
A6, B5, C6	Power +24 V	Input of supply voltage +24V	
A4	L-RES	CPLD reset input (safety shutdown logic)	1, 2
B3	L-ENA	Safety shutdown logic block	1
C4	L-ADD1	CPLD additional logic input 1	1
A8	L1A-1	Logic input L1A-1	1
A10	L1A-2	Logic input L1A-2	1
A12	L1A-3	Logic input L1A-3	1
A14	L1A-4	Logic input L1A-4	1
A16	L1A-5	Logic input L1A-5	1
A18	L1A-6	Logic input L1A-6	1
A20	L1A-7	Logic input L1A-7	1
A22	L1A-8	Logic input L1A-8	1
B7	L1B-1	Logic input L1B-1	1
B9	L1B-2	Logic input L1B-2	1
B11	L1B-3	Logic input L1B-3	1
B13	L1B-4	Logic input L1B-4	1
B15	L1B-5	Logic input L1B-5	1
B17	L1B-6	Logic input L1B-6	1
B19	L1B-7	Logic input L1B-7	1
B21	L1B-8	Logic input L1B-8	1
C8	L1C-1	Logic input L1C-1	1
C10	L1C-2	Logic input L1C-2	1
C12	L1C-3	Logic input L1C-3	1
C14	L1C-4	Logic input L1C-4	1
C16	L1C-5	Logic input L1C-5	1
C18	L1C-6	Logic input L1C-6	1
C20	L1C-7	Logic input L1C-7	1
C22	L1C-8	Logic input L1C-8	1
A24	OUT-L1A	Logic output 'OR ' of group L1A	3
B23	OUT-L1B	Logic output 'OR ' of group L1B	3
C24	OUT-L1C	Logic output 'OR ' of group L1C	3
A26	OUT-PR	Main output of the safety shutdown logic	4
C26	OUT-ADD1	CPLD additional logic output 1	4
B25	TEST	Test signal output	5
A28	CAN-GND	CAN2.0B interface, common	
B27	CAN-H	CAN2.0B interface, line H	
C28	CAN-L	CAN2.0B interface, line L	
A30	RS485-GND	RS485 interface, common	
B29	1-RS485-B(-)	RS485 interface №1, line B	
C30	1-RS485-A(+)	RS485 interface №1, line A	

Continuation of the table A.8

Terminal number	Designation	Purpose	Note
B30	2-RS485-B(-)	RS485 interface №2, line B	6
C29	2-RS485-A(+)	RS485 interface №2, line A	6
A3	L-CPU1	Microcontroller additional logic input 1	1
B4	L-CPU2	Microcontroller additional logic input 1	1
C3	L-ADD2	CPLD additional logic input 2	1
A7	L2A-1	Logic input L2A-1	1
A9	L2A-2	Logic input L2A-2	1
A11	L2A-3	Logic input L2A-3	1
A13	L2A-4	Logic input L2A-4	1
A15	L2A-5	Logic input L2A-5	1
A17	L2A-6	Logic input L2A-6	1
A19	L2A-7	Logic input L2A-7	1
A21	L2A-8	Logic input L2A-8	1
B8	L2B-1	Logic input L2B-1	1
B10	L2B-2	Logic input L2B-2	1
B12	L2B-3	Logic input L2B-3	1
B14	L2B-4	Logic input L2B-4	1
B16	L2B-5	Logic input L2B-5	1
B18	L2B-6	Logic input L2B-6	1
B20	L2B-7	Logic input L2B-7	1
B22	L2B-8	Logic input L2B-8	1
C7	L2C-1	Logic input L2C-1	1
C9	L2C-2	Logic input L2C-2	1
C11	L2C-3	Logic input L2C-3	1
C13	L2C-4	Logic input L2C-4	1
C15	L2C-5	Logic input L2C-5	1
C17	L2C-6	Logic input L2C-6	1
C19	L2C-7	Logic input L2C-7	1
C21	L2C-8	Logic input L2C-8	1
A23	OUT-L2A	Logic output 'OR ' of group L2A	3
B24	OUT-L2B	Logic output 'OR ' of group L2B	3
C23	OUT-L2C	Logic output 'OR ' of group L2C	3
A25	OUT-CPU1	Microcontroller logic output 1	3, 5
B26	OUT-CPU2	Microcontroller logic output 2	3, 5
C25	OUT-ADD2	CPLD additional logic output 2	4
A27	OUT-ERR	Microcontroller logic output 3 (malfunction)	3, 5

Notes:

1. Unconnected inputs are in an inactive logic status due to pull-up resistors.

2. Reset input does not affect the service functions operation (of microcontroller).

3. The status of logic outputs is not locked by the trigger.

4. Logic output active state is locked by the trigger. Switching to the passive status occurs when safety shutdown resetting resets (CPLD).

5. Controlled by the microcontroller.

6. For version MK71-R2

Table A.9 - MK90 module

Terminal number	Designation	Purpose
A2	GND	Common
A6	+24 V	Module supply voltage
A32	GND	Common
B1	GND	Common
B5	+24 V	Module supply voltage
B9	Out 1	Output 1
B11	Out 2	Output 2
B13	Out 3	Output 3
B15	Out 4	Output 4
B17	Out 5	Output 5
B19	Out 6	Output 6
B21	Out 7	Output 7
B23	Out 8	Output 8
B31	GND	Common
C2	GND	Common
C6	+24 V	Module supply voltage
C10	Out 1`	Output 1`
C12	Out 2`	Output 2`
C14	Out 3`	Output 3`
C16	Out 4`	Output 4`
C18	Out 5`	Output 5`
C20	Out 6`	Output 6`
C22	Out 7`	Output 7`
C24	Out 8`	Output 8`
C32	GND	Common

Table A.10 - MK91 module

Terminal number	Designation	Purpose
A2	GND	Common
A6	+24 V	Supply voltage of the module
A10	Out 2	Output 1`
A12	Out 4	Output 2`
A14	Out 6	Output 3`
A16	Out 8	Output 4`
A18	Out 10	Output 5`
A20	Out 12	Output 6`
A22	Out 14	Output 7`
A24	Out 16	Output 8`
A32	GND	Common
B1	GND	Common
B5	+24 V	Supply voltage of the module
B9	Out 1	Output 1
B11	Out 3	Output 2
B13	Out 5	Output 3
B15	Out 7	Output 4
B17	Out 9	Output 5
B19	Out 11	Output 6
B21	Out 13	Output 7
B23	Out 15	Output 8
B31	GND	Common
C2	GND	Common
C6	+24 V	Supply voltage of the module
C32	GND	Common

Table A.11 - MK95 module

Terminal number	Designation	Purpose
A2	GND	Common
A6	+24 V	Supply voltage of the module
A8	Input 1 -	Input 1-
A10	Input 2 -	Input 2-
A12	Input 3 -	Input 3-
A14	Input 4 -	Input 4-
A32	GND	Common
B1	GND	Common
B5	+24V	Supply voltage of the module
B7	Input 1+	Input 1+
B9	Input 2+	Input 2+
B11	Input 3+	Input 3+
B13	Input 4+	Input 4+
B15	Output 1	Output 1
B17	Output 3	Output 3
B31	GND	Common
C2	GND	Common
C6	+24 V	Supply voltage of the module
C8	Input 1+	Input 1+
C10	Input 2+	Input 2+
C12	Input 3+	Input 3+
C14	Input 4+	Input 4+
C16	Output 2	Output 2
C18	Output 4	Output 4
C32	GND	Common

Table A.12 – БИ24 unit

Terminal number	Designation	Purpose
1	RS485-B/CAN-H	Wire B(-) RS485 / H CAN
2	RS485-A/CAN-L	Wire A(+) RS485 / L CAN
3	COUNT	Pulse input
4	GND	Common
5	+24 V	Supply voltage +24V
6	GND	Common power supply
7	RS485/CAN-GND	Common of RS485/CAN interface

Table A.13 – БИ34 unit

Connector	Terminal number	Designation	Purpose
X1	1	RS485-B/CAN-H	Wire B(-) RS485 / H CAN
X1	2	RS485-A/CAN-L	Wire A(+) RS485 / L CAN
X1	3	GND	Common
X1	4	+24 V	Supply voltage +24 V
	4		
X2	1	RS485-B/CAN-H	Wire B(-) RS485 / H CAN
X2	2	RS485-A/CAN-L	Wire A(+) RS485 / L CAN
X2	3	GND	Common
X2	4	+24 V	Supply voltage +24 V
X3	1	COUNT	Pulse input
X3	2	GND	Common power supply
X3	3		
X4	1	+5 V	+5 V
X4	2	SCL	Clock line
X4	3	SDA	Data line
X4	4	GND	Common

Table A.14 - МП24 module
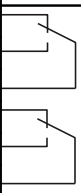
Terminal number	Designation	Purpose
C14	L 220 V	Mains voltage AC 220V 50Hz
C16	N 220 V	
A18	FG	Grounding
B17	FG	
C18	FG	
A6	+24 V	Output +24V, 1A
B5	+24 V	
C6	+24 V	
A2	GND	Common
B1	GND	
C2	GND	
A32	GND	
B31	GND	
C32	GND	
B11	OK	Malfunction, module signals input
C30	NC1	Relay contacts, output
B29	NO1	
B27	COM1	
C26	NC2	
B25	NO2	
C28	COM2	

Table A.15 - МП24.1 module
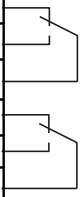
Terminal number	Designation	Purpose
A2	GND	Common
A6	+24 V	Output +24 V
A10	Out 2	Output 1`
A12	Out 4	Output 2`
A14	Out 6	Output 3`
A16	Out 8	Output 4`
A18	Out 10	Output 5`
A20	Out 12	Output 6`
A22	Out 14	Output 7`
A24	Out 16	Output 8`
A32	GND	Common
B1	GND	Common
B5	+24 V	Output +24 V
B9	Out 1	Output 1
B11	Out 3	Output 2
B13	Out 5	Output 3
B15	Out 7	Output 4
B17	Out 9	Output 5
B19	Out 11	Output 6
B21	Out 13	Output 7
B23	Out 15	Output 8
B31	GND	Common
C2	GND	Common
C6	+24 V	Output +24 V
C10	OK	Malfunction, module signals input
C14	L 220 V	Mains voltage AC 220 V 50Hz
C16	N 220 V	
C18	FG	Grounding
C30	NC1	
B29	NO1	
B27	COM1	Relay contacts, output
C26	NC2	
B25	NO2	
C28	COM2	
C32	GND	Common

Table A.16 - МП26 module

Terminal number	Designation	Purpose
A2	GND	Common
A4	1Wire Sens	Bus 1Wire Signal
A6	+24 V	Output +24 V
A20	Logic out 1	Discrete output1
A22	Logic out 2	Discrete output2
A24	Logic out 3	Discrete output3
A26	Logic out 4	Discrete output4
A28	CAN-GND	Common of CAN buses
A30	RS485-GND	Common of RS485 buses
A32	GND	Common
B1	GND	Common
B3	Logic in1	Discrete input1
B5	+24 V	Output +24 V
B27	1-CAN-H	CAN bus line H-1
B29	1-RS485-B(-)	RS485-1 bus line B
B31	GND	Common
B4	1Wire Com	Bus 1Wire common
B28	2-CAN-L	CAN bus line L-2
B30	2-RS485-A(+)	RS485-2 bus line A
C2	GND	Common
C4	Logic in2	Discrete input2
C6	+24 V	Output +24 V
C14	L 220 B	Mains voltage "phase" AC 220 V 50 Hz
C16	N 220 B	Mains voltage "zero" AC 220 V 50 Hz
C18	FG	Grounding
C28	1-CAN-L	CAN bus line L-1
C30	1-RS485-A(+)	RS485-1 bus line A
C32	GND	Common
C27	2-CAN-H	CAN bus line H-2
C29	2-RS485-B(-)	RS485-2 bus line B

Table A.17 – BM22 unit

Connector X1		
Terminal number	**Designation**	**Purpose**
1	Input chanel 1	Input of measurement channel 1
2	+24 V sense CH1	Voltage +24 V output to power the measurement channel 1 converter
3	GND	Common
4	Input chanel 2	Input of measurement channel 2
5	+24 V sense CH2	Voltage +24 V output to power the measurement channel 2 converter
6	GND	Common
7	Input chanel 3	Input of measurement channel 3
8	+24 V sense CH3	Voltage +24 V output to power the measurement channel 3 converter
9	GND	Common
10	Input chanel 4	Input of measurement channel 4
11	+24 V sense CH4	Voltage +24 V output to power the measurement channel 4 converter
12	GND	Common
Connector X2		
Terminal number	**Designation**	**Purpose**
1	Analog out 1	Unified output of measurement channel 1
2	Analog out 2	Unified output of measurement channel 2
3	Analog out 3	Unified output of measurement channel 3
4	Analog out 4	Unified output of measurement channel 4
10	Impulse input 1	Main pulse input
11	Logic out 1	Logic output 1
12	Logic out 2	Logic output 2
5,6,7,8,9	-	not used
Connector X3 for the unit version BM22-OK		
Terminal number	**Designation**	**Purpose**
1	Logic out 3	Logic output 3
2	Logic out 4	Logic output 4
3	Logic out 5	Logic output 5
4	Logic out 6	Logic output 6
5	Logic out 7	Logic output 7
6	Logic out 8	Logic output 8
7	Logic out 9	Logic output 9
8	Logic out 10	Logic output 10
9	Logic out 11	Logic output 11
10	Logic out 12	Logic output 12
11,12	-	not used

Continuation of the table A.17

Connector X3 for the unit version BM22-P		
Terminal number	Designation	Purpose
1	Logic out 3 NC	Relay output 3
2	Logic out 3 NO	
3	Logic out 3 COM	
4	Logic out 4 NC	Relay output 4
5	Logic out 4 NO	
6	Logic out 4 COM	
7	Logic out 5 NC	Relay output 5
8	Logic out 5 NO	
9	Logic out 5 COM	
10	Logic out 12 NC	Relay output 12
11	Logic out 12 NO	
12	Logic out 12 COM	
Connector X4		
Terminal number	**Designation**	**Purpose**
1	+24 V Protect	Output + 24 V via the resettable fuse 0.2 A to power external devices
2	+24 V	Output + 24 V to power external devices
3	GND	Common
4	GND	Common
5	-	not used
6	-	not used
7	RS485-A(+)	RS485 interface
8	RS485-B(-)	
9	RS485-GND	
10	CAN-H	CAN2.0B interface
11	CAN-L	
12	CAN-GND	
Connector X5		
Terminal number	**Designation**	**Purpose**
1	L220 V	Input of mains voltage AC 220V 50Hz
2	N220 V	
3	FG	Faraday grounding of AC/DC converter Should be connected to the cabinet grounding

Table A.18 – BM32 unit

| Connector X1		
Terminal number	**Designation**	**Purpose**
1	Input chanel 1	Input of measurement channel 1
2	+24 V sense CH1	Voltage +24 V output to power the measurement channel 1 converter
3	GND	Common
4	Input chanel 2	Input of measurement channel 2
5	+24 V sense CH2	Voltage +24 V output to power the measurement channel 2 converter
6	GND	Common
7	Input chanel 3	Input of measurement channel 3
8	+24 V sense CH3	Voltage +24 V output to power the measurement channel 3 converter
9	GND	Common
10	Input chanel 4	Input of measurement channel 4
11	+24 V sense CH4	Voltage +24 V output to power the measurement channel 4 converter
12	GND	Common
Connector X2		
Terminal number	**Designation**	**Purpose**
1	Analog out 1	Unified output of measurement channel 1
2	Analog out 2	Unified output of measurement channel 2
3	Analog out 3	Unified output of measurement channel 3
4	Analog out 4	Unified output of measurement channel 4
9	Logic input 1	Logic input
10	Impulse input 1	Main pulse input
11	Logic out 1	Logic output 1
12	Logic out 2	Logic output 2
5,6,7,8	-	not used
Connector X3 for the unit version BM32-OK		
Terminal number	**Designation**	**Purpose**
1	Logic out 3	Logic output 3
2	Logic out 4	Logic output 4
3	Logic out 5	Logic output 5
4	Logic out 6	Logic output 6
5	Logic out 7	Logic output 7
6	Logic out 8	Logic output 8
7	Logic out 9	Logic output 9
8	Logic out 10	Logic output 10
9	Logic out 11	Logic output 11
10	Logic out 12	Logic output 12
11	Logic out 13	Logic output 13
12	Logic out 14	Logic output 14

Continuation of the table A.18

Connector X3 for the unit version BM32-P		
Terminal number	**Designation**	**Purpose**
1	Logic out 3 NC	Relay output 3
2	Logic out 3 NO	
3	Logic out 3 COM	
4	Logic out 4 NC	Relay output 4
5	Logic out 4 NO	
6	Logic out 4 COM	
7	Logic out 5 NC	Relay output 5
8	Logic out 5 NO	
9	Logic out 5 COM	
10	Logic out 12 NC	Relay output 12
11	Logic out 12 NO	
12	Logic out 12 COM	
Connector X4		
Terminal number	**Designation**	**Purpose**
1	+24 V Protect	Output + 24 V via the resettable fuse 0.2 A to power external devices
2	+24 V	Output + 24 V to power external devices
3	GND	Common
4	GND	Common
5	-	not used
6	-	not used
7	RS485-A(+)	RS485 interface
8	RS485-B(-)	
9	RS485-GND	
10	CAN-H	CAN2.0B interface
11	CAN-L	
12	CAN-GND	
Connector X5		
Terminal number	**Designation**	**Purpose**
1	L220 V	Input of mains voltage AC 220V 50Hz
2	N220 V	
3	FG	Faraday grounding of AC/DC converter Should be connected to the cabinet grounding

Table A.19 – BM61 unit

Connector X1		
Terminal number	**Designation**	**Purpose**
1	Input chanel 1	Input of measurement channel 1
2	+24 V sense CH1	Voltage +24 V output to power the measurement channel 1 converter
3	GND	Common
4	Input chanel 2	Input of measurement channel 2
5	+24 V sense CH2	Voltage +24 V output to power the measurement channel 2 converter
6	GND	Common
7	Input chanel 3	Input of measurement channel 3
8	+24 V sense CH3	Voltage +24 V output to power the measurement channel 3 converter
9	GND	Common
10	Input chanel 4	Input of measurement channel 4
11	+24 V sense CH4	Voltage +24 V output to power the measurement channel 4 converter
12	GND	Common
Connector X2		
Terminal number	**Designation**	**Purpose**
1	Analog out 1	Unified output of measurement channel 1
2	Analog out 2	Unified output of measurement channel 2
3	Analog out 3	Unified output of measurement channel 3
4	Analog out 4	Unified output of measurement channel 4
10	Impulse input 1	Main pulse input
11	Logic out 1	Logic output 1
12	Logic out 2	Logic output 2
5,6,7,8,9	-	not used
Connector X3		
Terminal number	**Designation**	**Purpose**
1	Logic out 3 NC	Relay output 3
2	Logic out 3 NO	
3	Logic out 3 COM	
4	Logic out 4 NC	Relay output 4
5	Logic out 4 NO	
6	Logic out 4 COM	
7	Logic out 5 NC	Relay output 5
8	Logic out 5 NO	
9	Logic out 5 COM	
10	Logic out 12 NC	Relay output 12
11	Logic out 12 NO	
12	Logic out 12 COM	

Continuation of the table A.19

Connector X4		
Terminal number	Designation	Purpose
1	+24 V Protect	Output + 24 V via the resettable fuse 0.2 A to power external devices
2	+24 V	Output + 24 V to power external devices
3	GND	Common
4	GND	Common
5	-	not used
6	-	not used
7	RS485-A(+)	RS485 interface
8	RS485-B(-)	
9	RS485-GND	
10	CAN-H	CAN2.0B interface
11	CAN-L	
12	CAN-GND	
Connector X5		
Terminal number	Designation	Purpose
1	L220 V	Input of mains voltage AC 220V 50Hz
2	N220 V	
3	FG	Faraday grounding of AC/DC converter Should be connected to the cabinet grounding

Table A.20 – MC01 USB and MC03 Bluetooth modules

Terminal number	Designation	Purpose
1	+5 V	Power supply +5 V
2	SCL	Synchronization line of SPI and I2C interfaces
3	SDA	Data line of SPI and I2C interfaces
4	GND	Common

Table A.21 – Pin assignment of the BST300.010 temperature sensor unit connector X1

Terminal number	Designation	Purpose
1	(+)Iout	Unified current output (+)
2	(-)Iout	Unified current output (-)
3	FG	PCB bonding
4	FG	PCB bonding

Table A.22 – DB9-MC-8 switching unit

Connectors XP1...XP8		
Terminal number	Designation	Purpose
3	Data+(B)	Line B of RS485 interface
4	Data-(A)	Line A of RS485 interface
5	GND	Common
Connectors XS1...XS8		
1	Data+(B)	Line B of RS485 interface
2	Data-(A)	Line A of RS485 interface
3	GND	Common

Annex B

(informative)

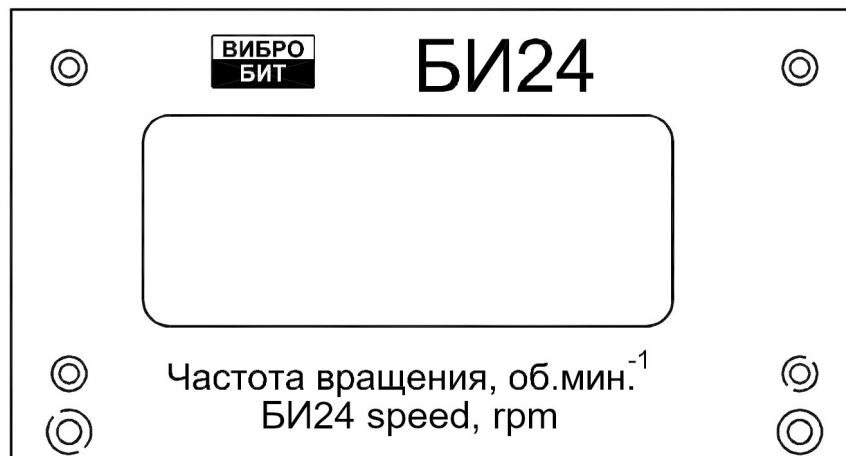## Front panels of control modules, control, power supply and indication units
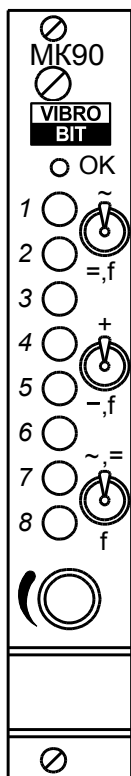

Figure B.1 – БИ24 unit
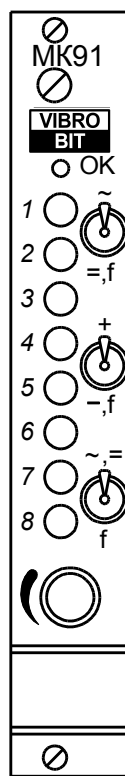

Figure B.2 – MK90 module
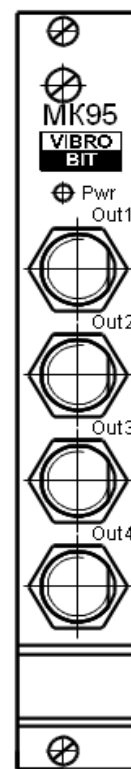
Figure B.3 – MK91 module

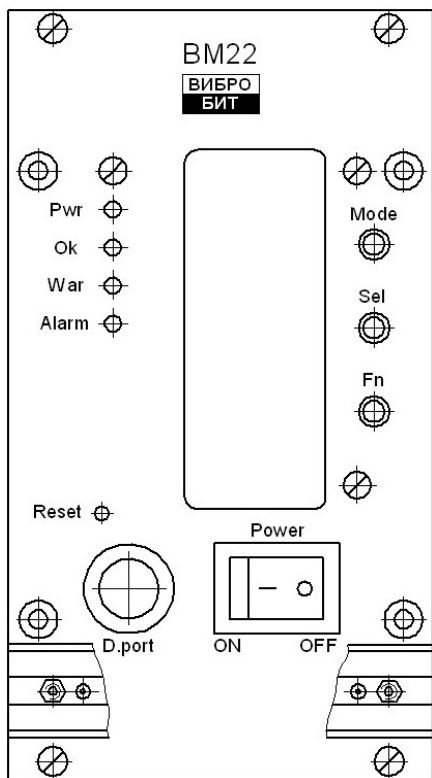Figure B.4 – MK95 module

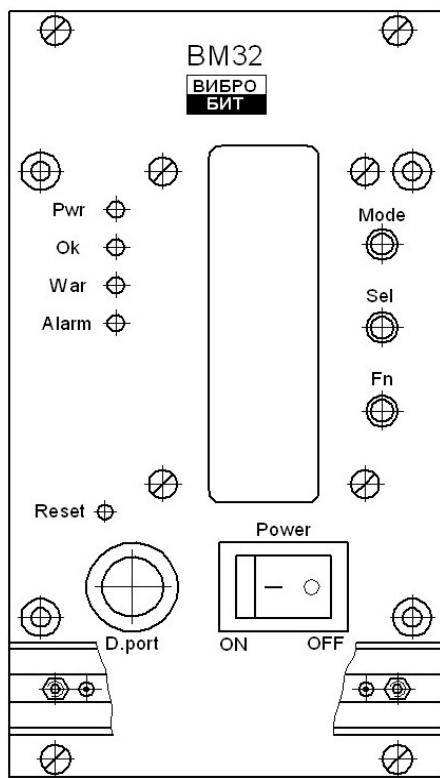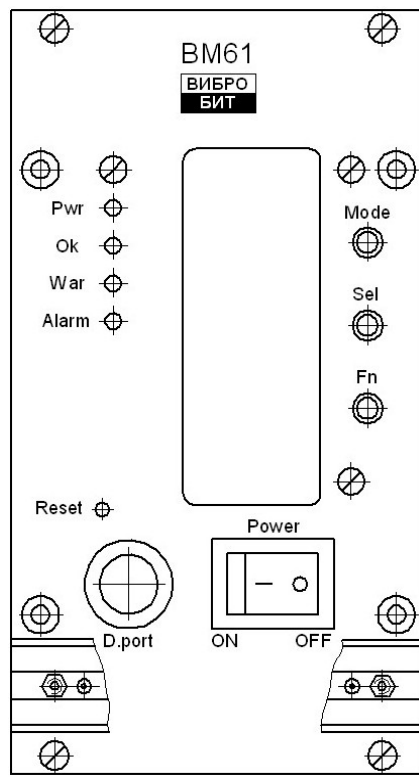Figure B.5 – BM22 control unit   Figure B.6 – BM32 control unit   Figure B.7 – BM61 control unit
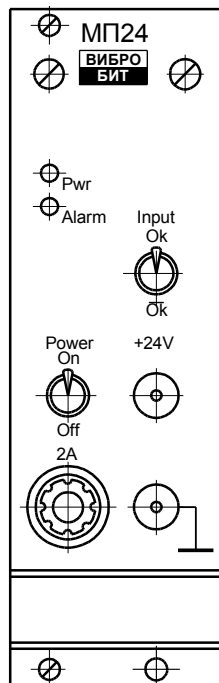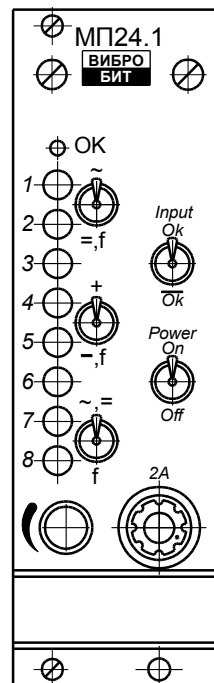
Figure B.8 – МП24 power supply unit

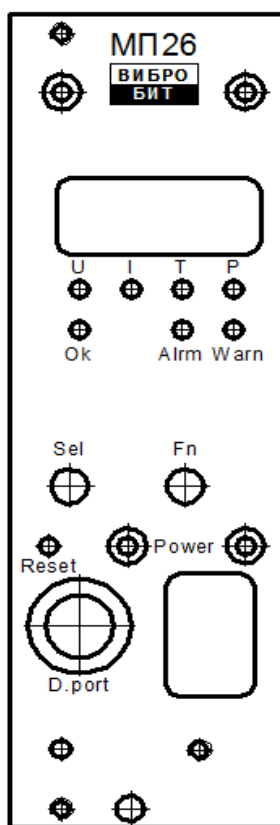Figure B.9 – МП24.1 power supply unit

Figure B.10 – МП26 power supply unit

Annex C

(informative)

Overall drawings of assembly units
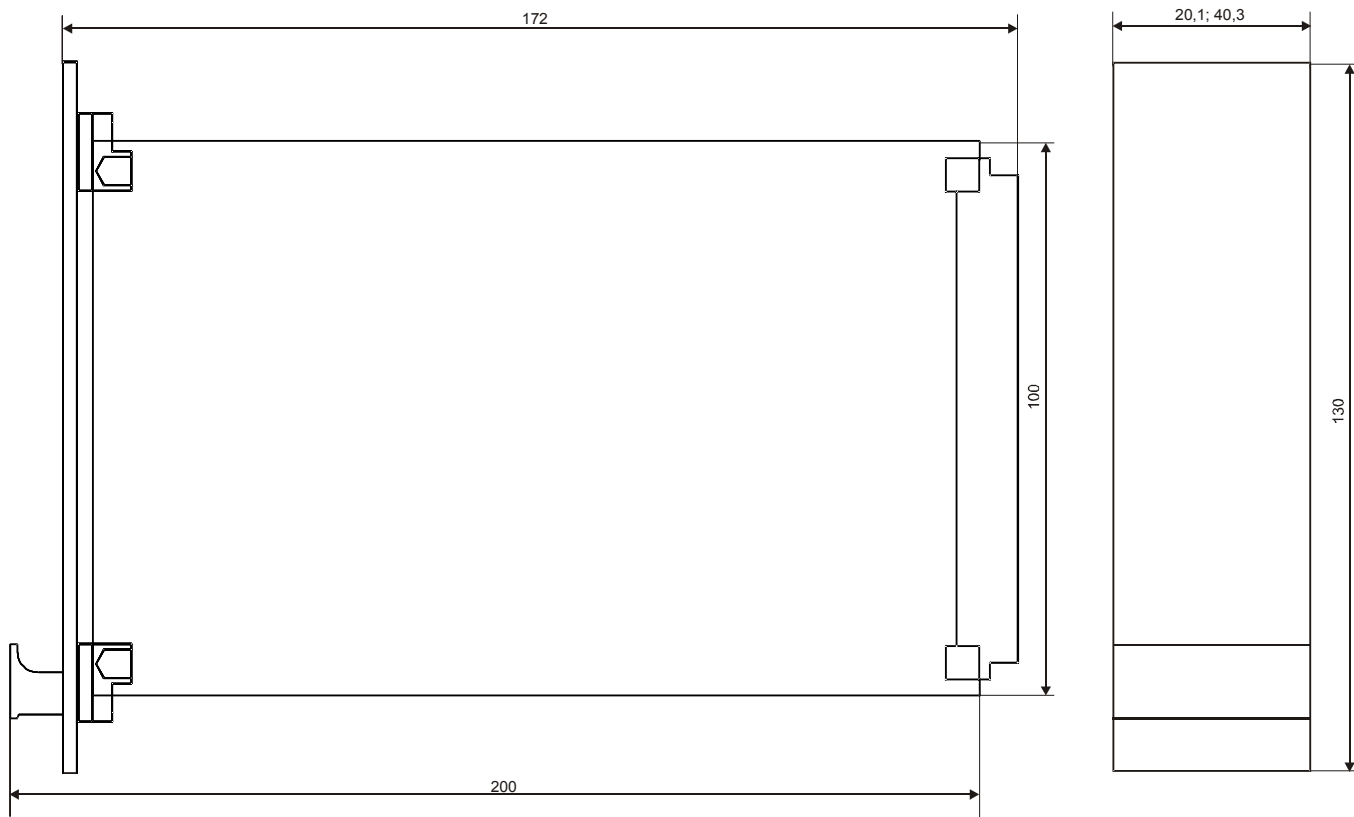
Figure C.1 – Control modules, power supply modules

Частота вращения, об.мин.$^{-1}$
БИ24 speed, rpm

Installation window

2 hole. M4

Figure C.2 – БИ24 indication unit

Figure C.3 – БИ34 indication unit

Window for framework installation 134x149mm (max)

Figure C.4 – Framework

Figure C.5 – Control units

Anchor bolts M10 protruding (60±0.5)mm from the concrete foundation.

Figure C.6 – Cabinet 1800x600x600 by RITTAL

Annex D

(mandatory)
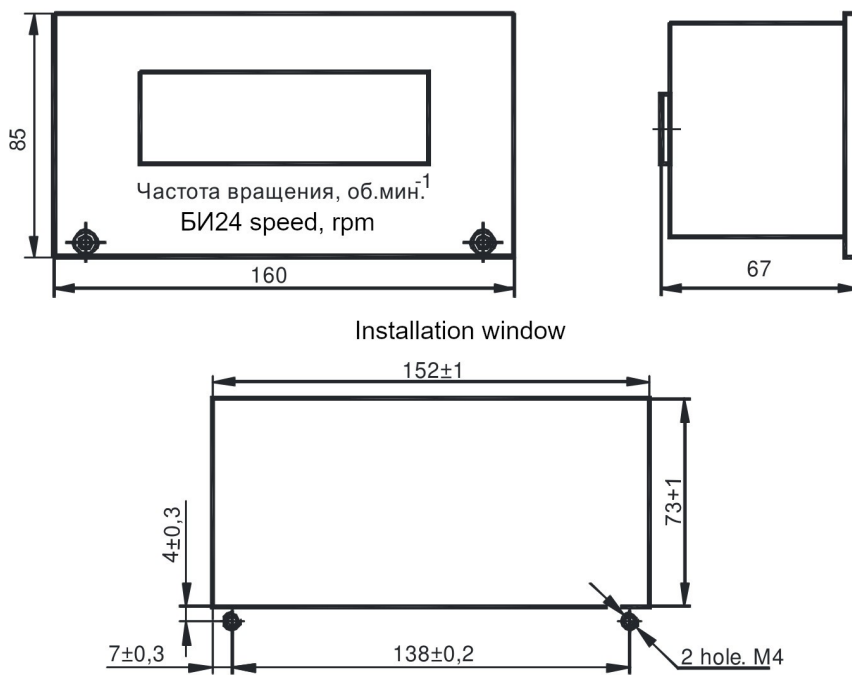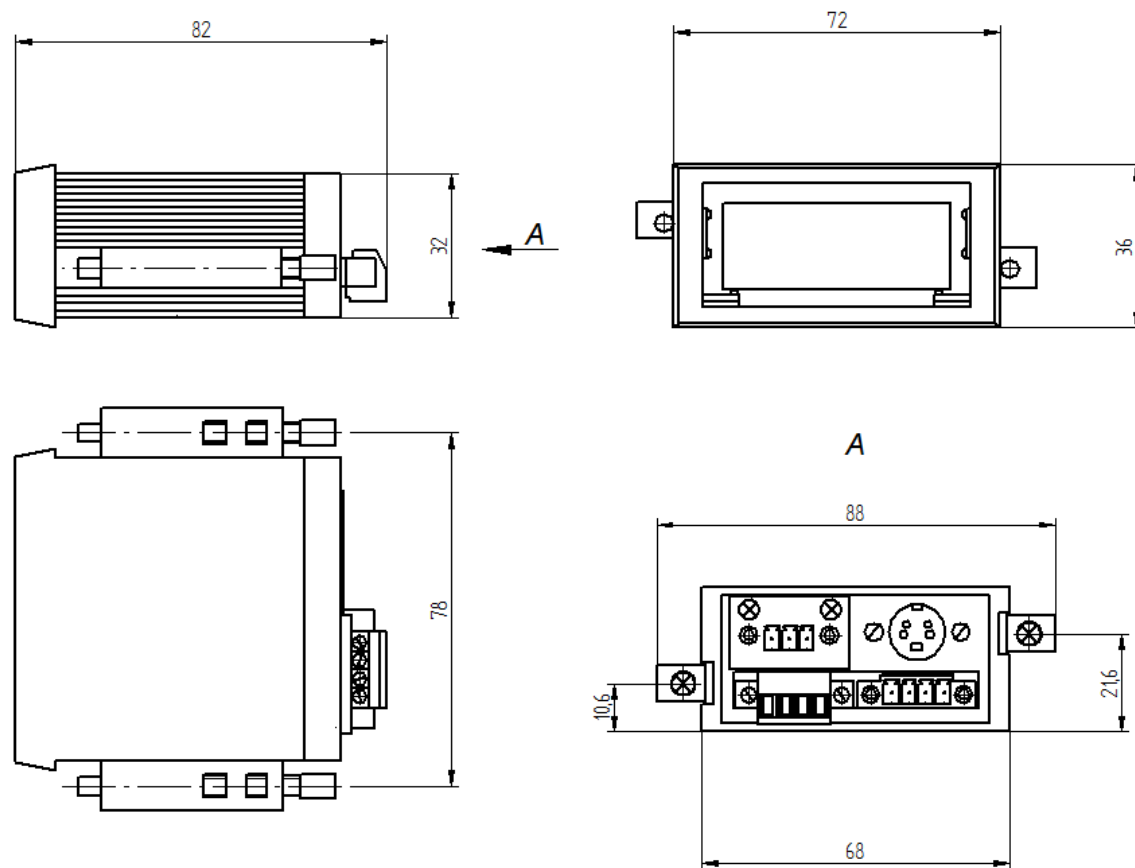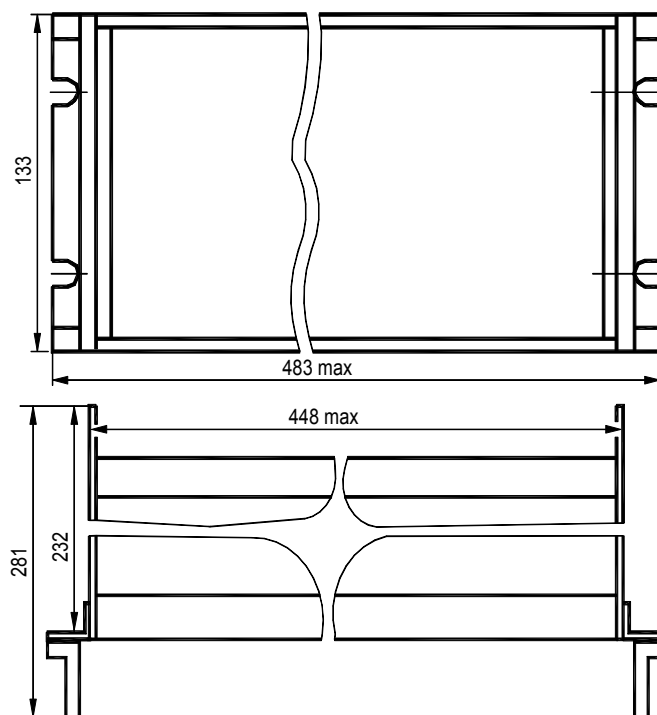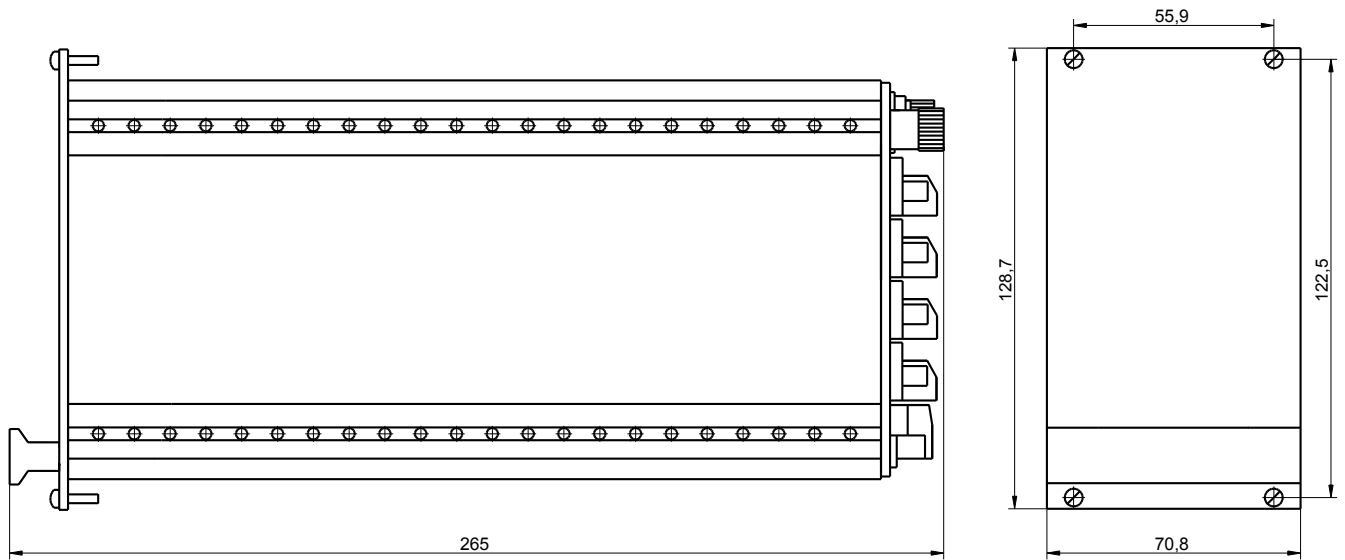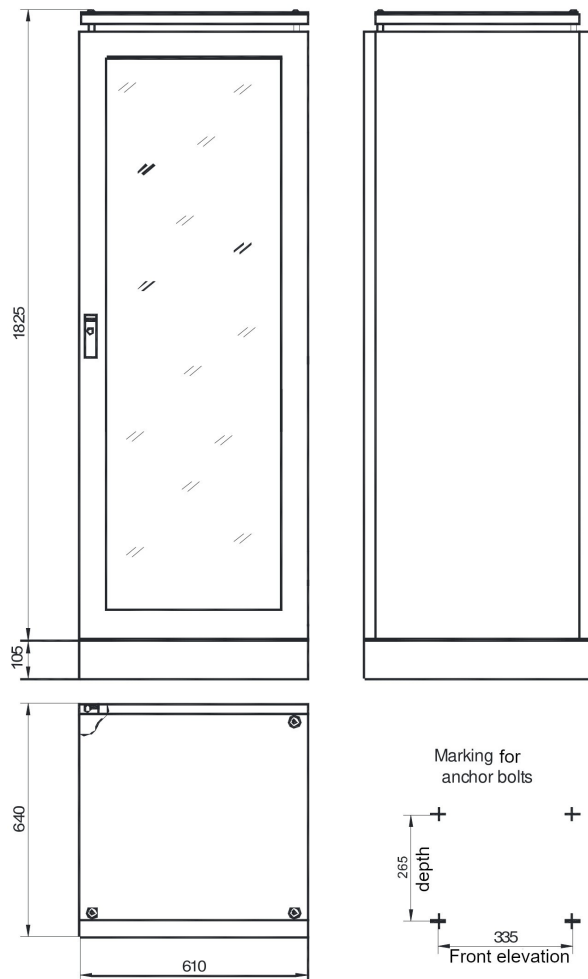
Equipment marking

D.1 MK10, MK20, MK22, MK30, MK32, MK40, MK70, MK71 control modules

Control modules marking includes:

- Module type: MK10, MK20, MK22, MK30, MK32, MK40, MK70, MK71;

- Module serial number and year of manufacturing;

- Unified outputs operation mode: A (1-5mA), B (4-20mA);

- Erector number;

- Adjuster number;

- Order number.

The example of the MK20 module marking:

MK20	module No. -	Mode	Erector	Adjuster	Order

Full information about the module setup (measurement ranges, setpoint levels by the measurement channels, parameters of communication interfaces, logic signaling setup, etc.) is given in the relevant module logbook.

D.2 БИ24/БИ34 indication unit

Indication unit marking includes:

- type;

- version;

- number of pulses per revolution (for versions frequency measurement);

- serial number and year of manufacturing.

Table D.2 – The Marking

Device type	Version	Number of pulses per revolution (for versions I, IR, IC)
БИ24	I – Pulse counting input (frequency measurement) R – RS485 interface IR – frequency measurement and RS485 interface C – CAN 2.0B interface IC – frequency measurement and CAN 2.0B interface	1 – 1 60 – 60
БИ34	IR – frequency measurement and RS485 interface IC – frequency measurement and CAN 2.0B interface IR-X – frequency measurement and RS485 interface and a set of mating connectors IC-X – frequency measurement and CAN 2.0B interface and a set of mating connectors	1 – 1 60 – 60

Example of marking of БИ24 indication unit, intended for frequency measurement during operation on a control surface "Pinion" (60 teeth) and support of RS485 interface.

БИ24	IR	60

For additional information about the indication unit operation parameters (pulse frequency measurement, parameters of communication interfaces, etc.), ref the relevant indication unit logbook/setup form.

Example of marking of БИ34 indication unit, intended for frequency measurement during operation on a control surface "Pinion" (60 teeth) and support of CAN interface with mating connectors.

БИ34	IC-X	60

For additional information about the indication unit operation parameters (pulse frequency measurement, parameters of communication interfaces, etc.), ref the relevant indication unit logbook/setup form.

D.3 BM22, BM32, BM61 control units

Control unit marking includes:

- control unit type: BM22, BM32, BM61;

- version: OK, P;

- serial number and year of manufacturing.

Example of BM32 control unit marking with output of "Open collector" type:

```
┌─────────────────────────────────┐
│ ВИБРО                           │
│ БИТ          BM32               │
│   SPE                           │
│ VIBROBIT LLC   ┌──────┐         │
│                │  OC  │         │
│ www.vibrobit.ru No.│001-11│     │
└─────────────────────────────────┘
```

Full information about the control unit setup (measurement ranges, setpoint levels by the measurement channels, parameters of communication interfaces, logic signaling setup, etc.) is given in the relevant control unit setup form.

Annex E

(informative)

Controls location and purpose

E. 1 MK10 control module

Figure E. 1

Jumpers S1, S2, S3, S4 – measurement channels 1, 2, 3, 4 mode selection correspondingly

Removed	Voltage operating mode
1-2	Current operating mode (4-20) mA
2-3	Current operating mode (1-5) mA

Jumper S5 – terminator 120Ohm of RS485 bus

Removed	Terminator disconnected from bus
Installed	Terminator connected to bus

Jumper S6 – terminator 120Ohm of CAN bus

Removed	Terminator disconnected from bus
Installed	Terminator connected to bus

E. 2 MK11-DC, MK11-DC-11, MK11-AC-11-S control modules
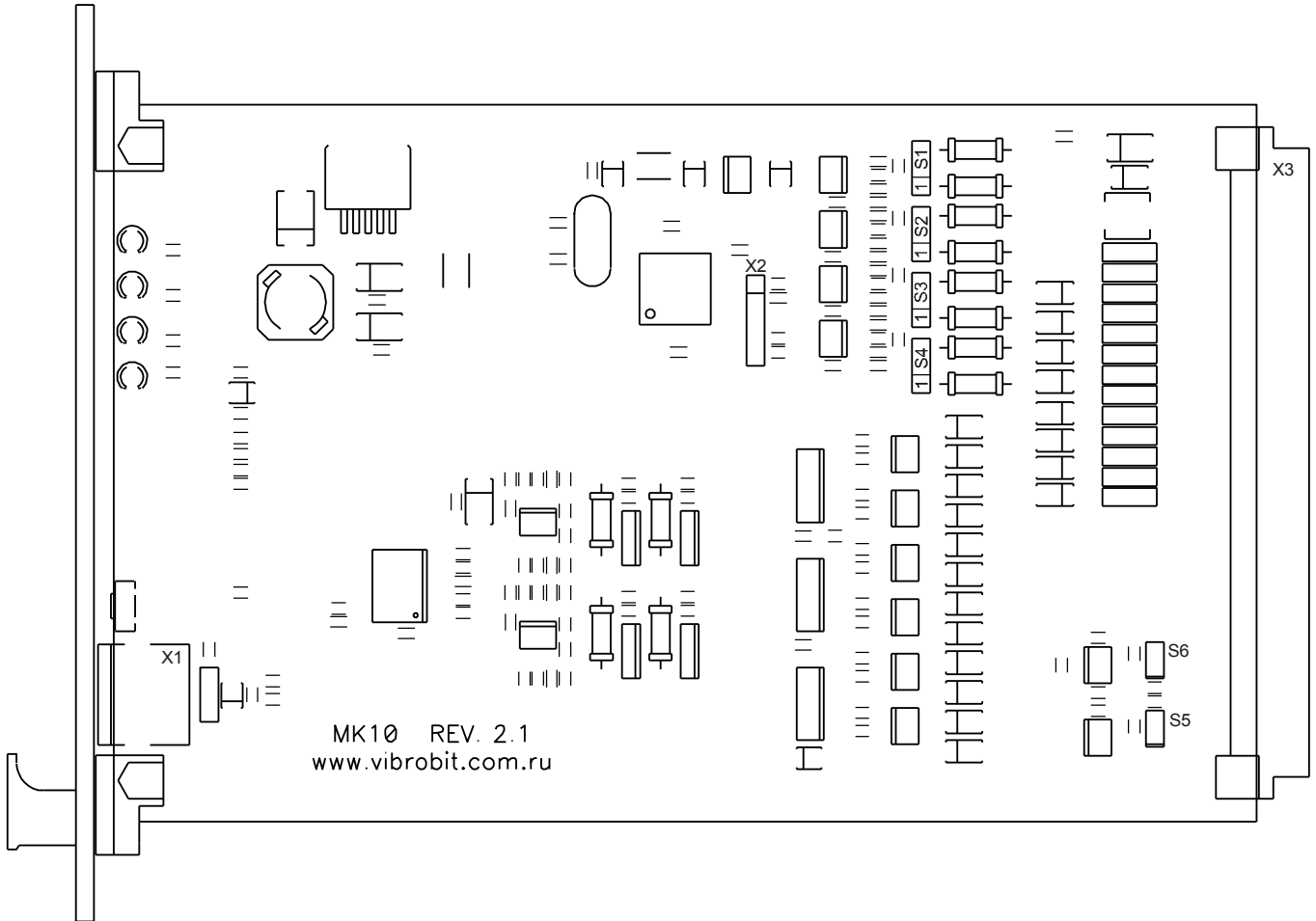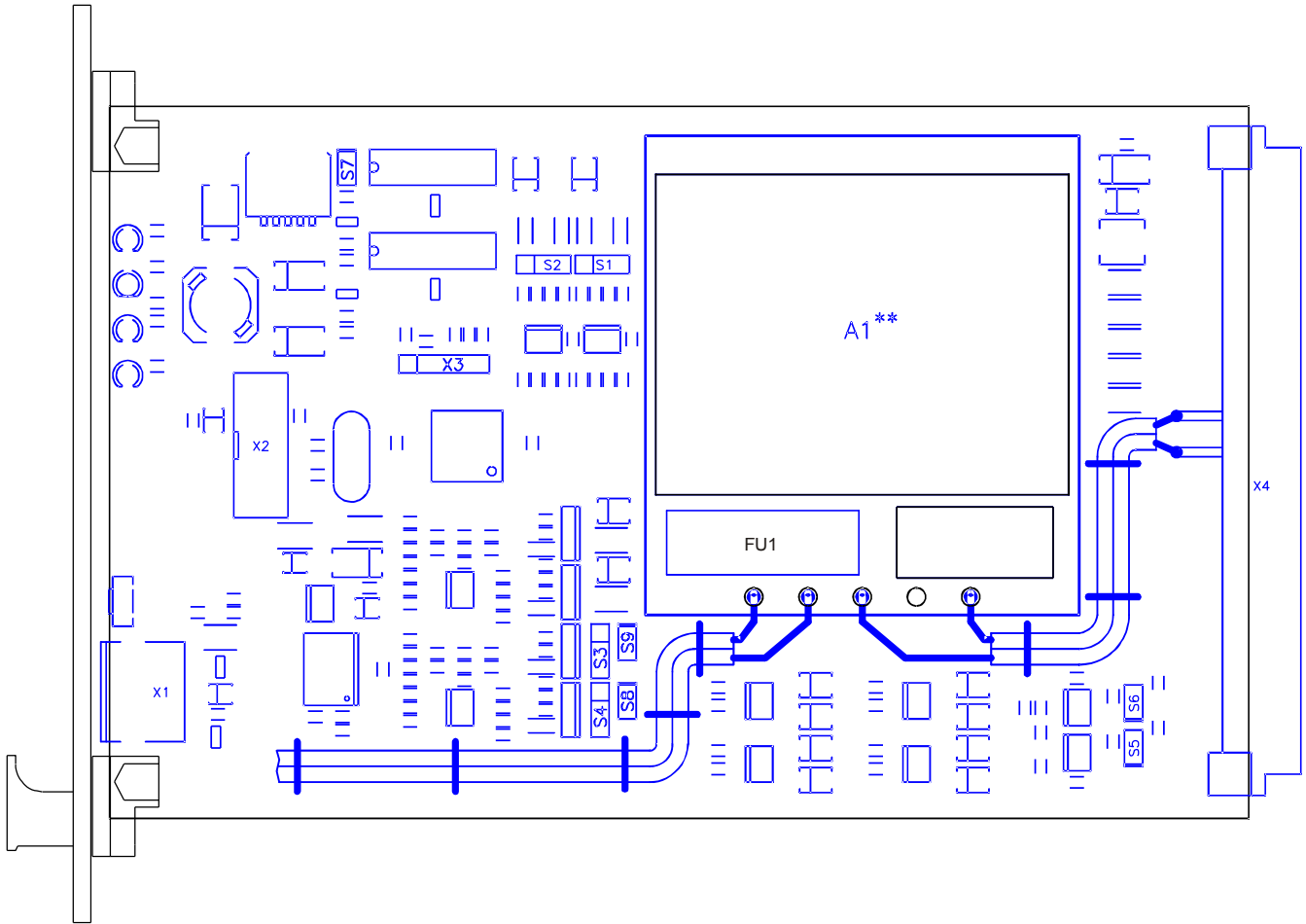

Figure E. 2

Jumpers S1, S2 – measurement channels 1, 2 mode selection correspondingly

Removed	Voltage operating mode
1-2	Current operating mode (4-20) mA
2-3	Current operating mode (1-5) mA

Jumpers S3, S4 – test signal mode selection the for measurement channels 1, 2 (correspondingly)

Removed	Disabled
1-2	Current operating mode (0-20) mA
2-3	Voltage operating mode (0-4.096) V

Jumpers S9, S8 – test signal of channels 1, 2 connection to the connector X4 terminals

Removed	Not connected
Installed	Connected

Jumper S5 – terminator 120 Ohm of RS485 bus

Removed	Terminator disconnected from bus
Installed	Terminator connected to bus

Jumper S6 – terminator 120 Ohm of CAN bus

Removed	Terminator disconnected from bus
Installed	Terminator connected to bus

E. 3 MK11-AC-11-S-R2 control module

Figure E. 3

Jumpers S1, S2 – measurement channels 1, 2 operation mode selection (correspondingly)

Position	Mode
Removed	Voltage operating mode (0 – 4.096) V
1-2	Current operating mode (4 - 20) mA
2-3	Current operating mode (1 - 5) mA

Jumpers S3, S4 – test signal operation mode selection the for measurement channels 1, 2 (correspondingly)

Position	Mode
Removed	Disabled
1-2	Current operating mode (0-20) mA
2-3	Voltage operating mode (0-4.096) V

Jumpers S5, S6 – terminator 120Ohm of RS485 No.1, CAN2.0B bus (correspondingly)

Position	Mode
Removed	Terminator disconnected from bus
Installed	Terminator connected to bus

Jumper S7 – pull-up resistor 7.23 kOhm to input +24V of the second measurement channel

(can be used to measure power supply voltage at module version 'АС + МИ11')

Position	Mode
Removed	Not connected
Installed	Connected

Jumpers S9, S8 – test signal of channels 1, 2 connection to the connector X4 terminals

Position	Mode
Removed	Not connected
Installed	Connected

E. 4 MK20 control module
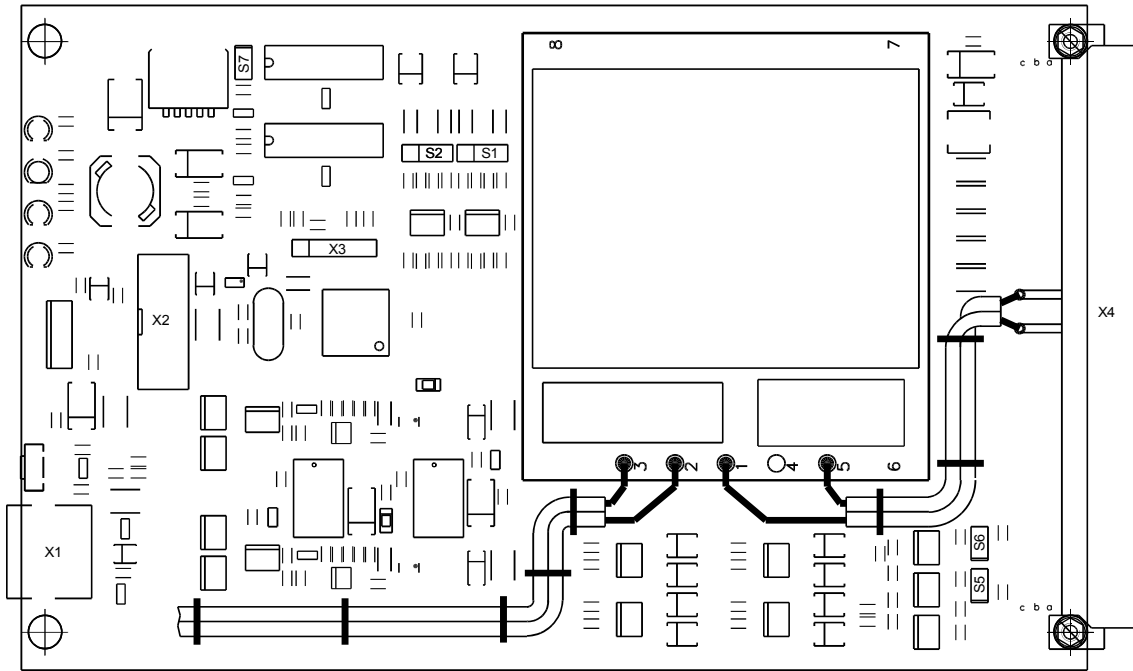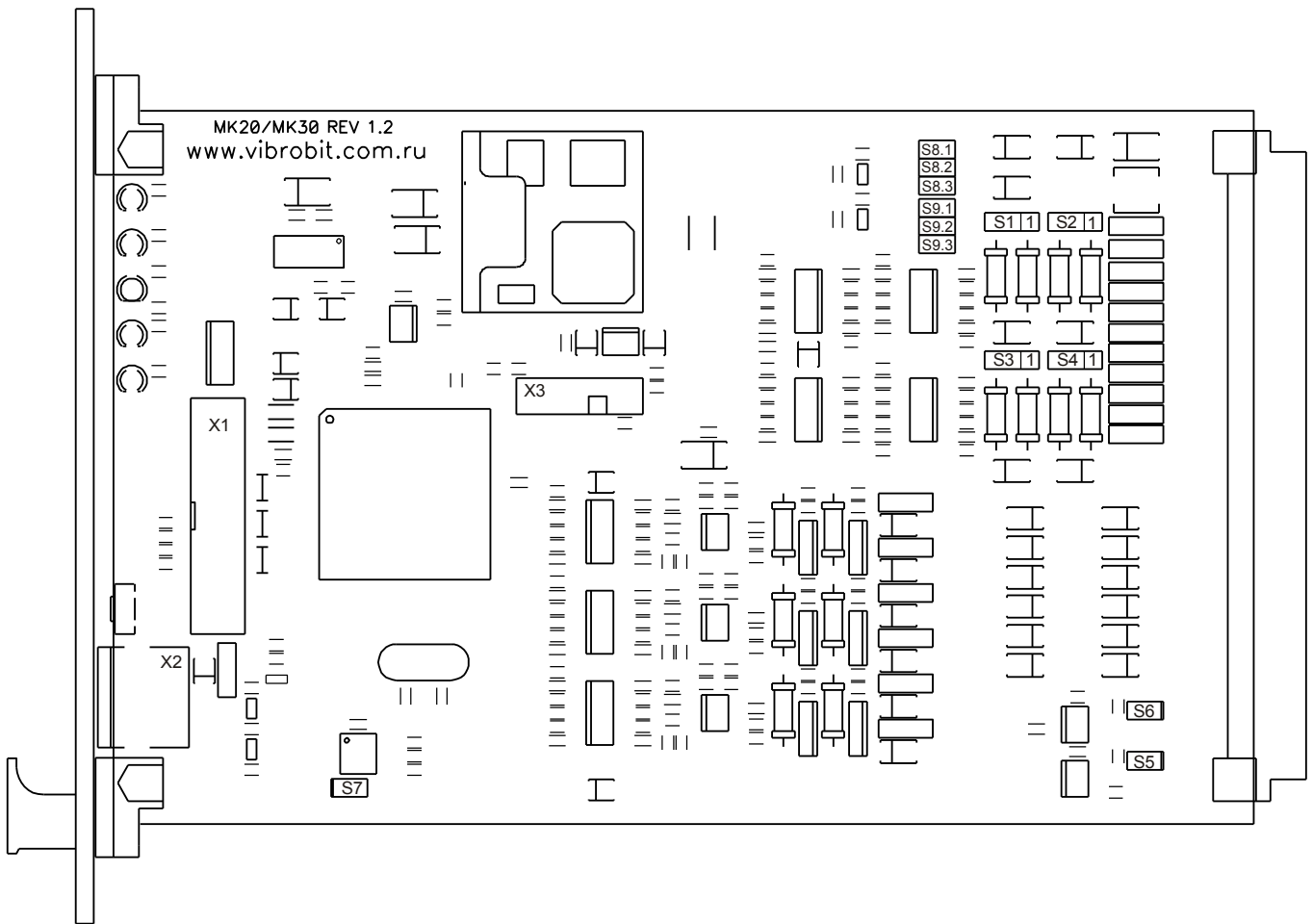

Figure E. 4

Jumpers S1, S2, S3, S4 – measurement channels 1, 2, 3, 4 mode selection correspondingly

Removed	Voltage operating mode
1-2	Current operating mode (4-20) mA
2-3	Current operating mode (1-5) mA

Jumper S5 – terminator 120 Ohm of RS485 bus

Removed	Terminator disconnected from bus
Installed	Terminator connected to bus

Jumper S6 – terminator 120Ohm of CAN bus

Removed	Terminator disconnected from bus
Installed	Terminator connected to bus

Jumper S7 – EEPROM recording protection

Removed	EEPROM recording prohibited
Installed	EEPROM recording permitted

Jumpers S8, S9 – operation mode of pulse inputs 1 (main), 2 (reserve), correspondingly

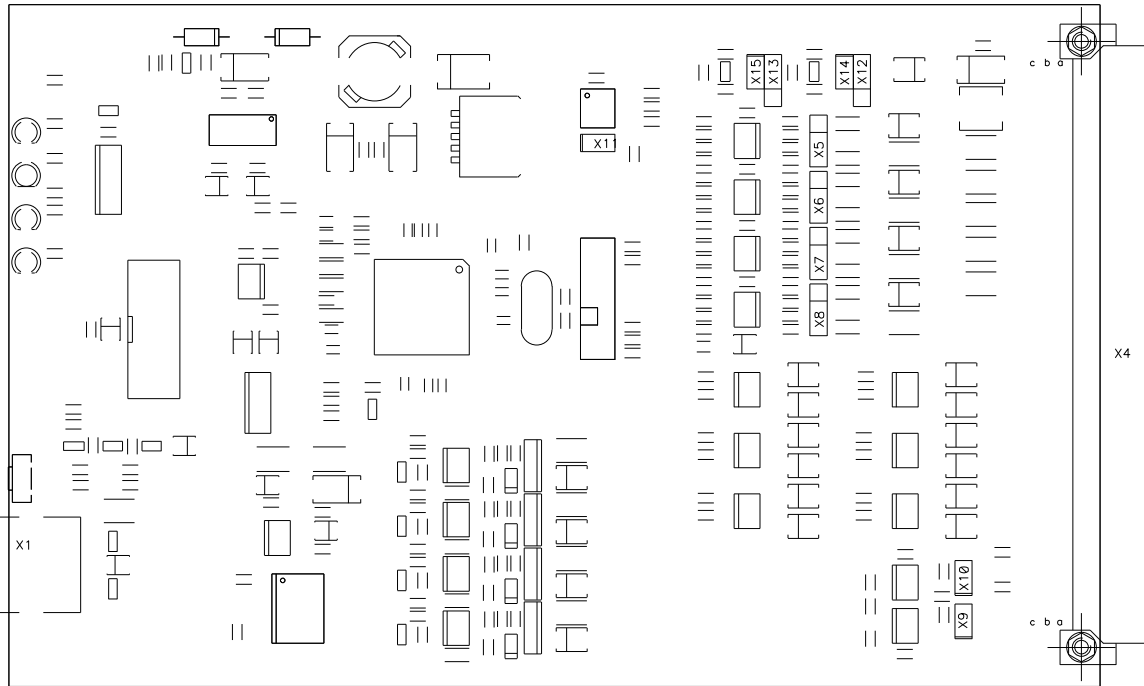| Removed	Voltage operating mode
1	OC signal source, for example, MK40 synchronization outputs
2	Current operating mode (4-20) mA
3	Current operating mode (1-5) mA

E. 5 MK22, MK22-DC-001 control modules

Figure E. 5

Jumpers X5, X6, X7,X8 – measurement channels 1, 2, 3, 4 operation mode selection (correspondingly)

Position	Mode
Removed	Voltage operating mode (0-3) V
1-2	Current operating mode (1–5) mA ((4–20) mA)*
2-3	Current operating mode (4–20) mA ((1–5) mA)*

Jumpers X9, X10 – terminator 120Ohm of RS485, CAN2.0B bus (correspondingly)

Position	Mode
Removed	Terminator disconnected from bus
Installed	Terminator connected to bus

Jumpers X12, X13 – synchronization pulses source selection for measurement channel 1 (2)

Position	Mode
1-2	Synchronization from input Input CH1 (2)
2-3	Synchronization from input Fin 1 (2)

Jumpers X14, X15 – pulse input connection to + 3.3 V via the resistor of 1 kOhm

Position	Mode
Removed	Pull-up disabled (operation with comparator)
Installed	Pull-up enabled (operation as part CVMS)

* For MK22 boards before version 4.

E. 6 MK22-DC-R2, MK22-DC-001-R2 control modules
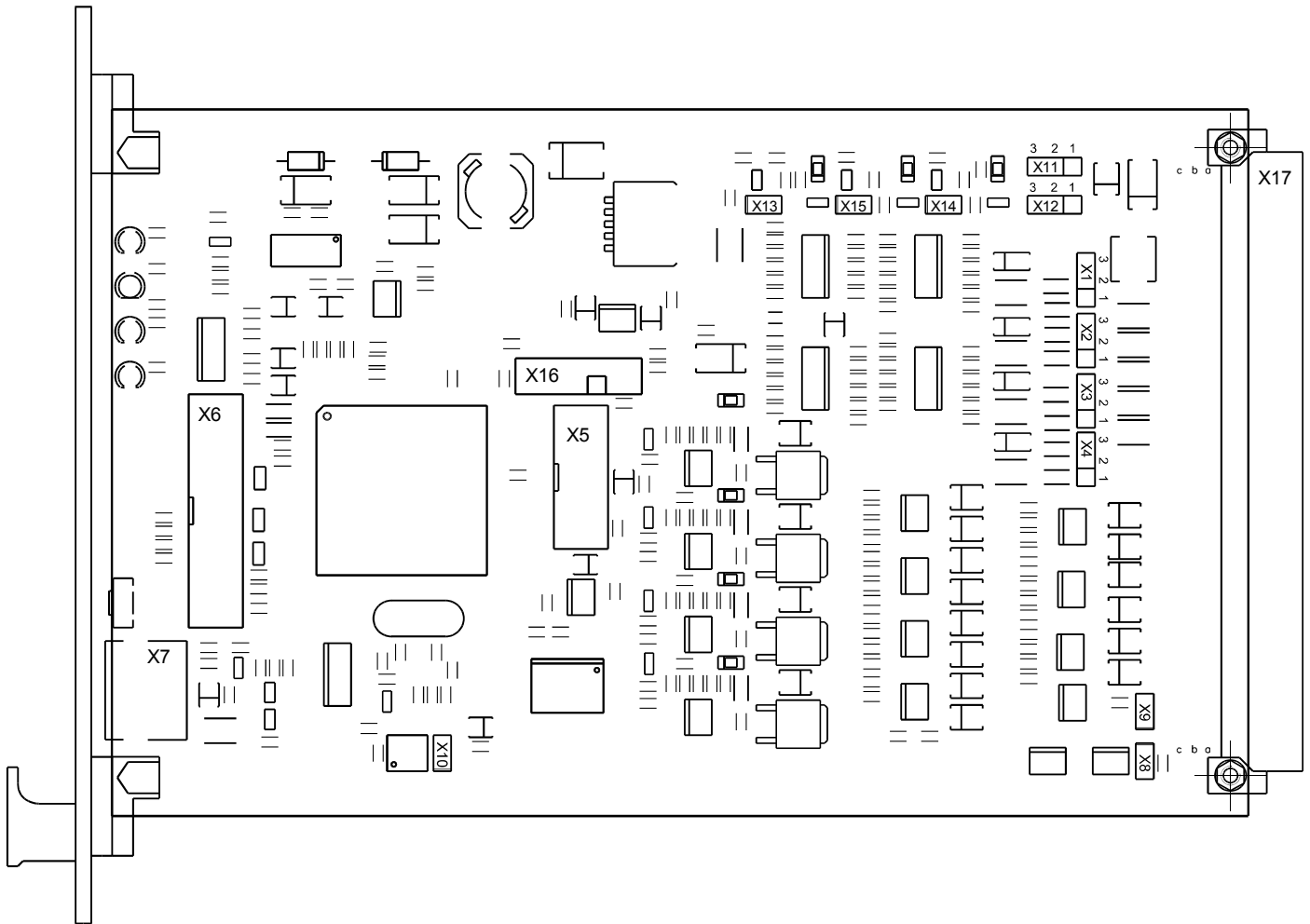
Figure E. 6

Connector purpose

Designation	Purpose
X17	Main switching connector
X5	Module front panel indicator connection serial interface
X6	Parallel interface, reserve
X7	Diagnostic interface, D.port
X16	Microcontroller programming, service

Jumpers X1, X2, X3,X4

Measurement channels 1, 2, 3, 4 operation mode selection (correspondingly)

Position	Mode
Removed	Voltage operating mode 0…3 V
1-2	Current operating mode 4…20 mA
2-3	Current operating mode 1…5 mA

Jumpers X8, X9

Terminator 120Ohm of RS485 No.1, CAN2.0B bus (correspondingly)

Position	Mode
Removed	Terminator disconnected from bus
Installed	Terminator connected to bus

Jumpers X11, X12

Synchronization pulses source selection for measurement channel 1, 2 correspondingly

Position	Mode
1-2	Synchronization from input Input CH1 (2)
2-3	Synchronization from input Fin 1 (2)

Jumpers X13

Pull-up resistor connection to the logic input

Position	Mode
Removed	Pull-up resistor disabled
Installed	Pull-up resistor enabled

Jumpers X14, X15

Pull-up resistor connection to synchronization channels 1, 2 correspondingly

Position	Mode
Removed	Pull-up resistor disabled (synchronization pulses from measurement channel)
Installed	Pull-up resistor enabled (synchronization pulses from input with OC)

Jumper X10
EEPROM recording protection

Removed	EEPROM recording prohibited
Installed	EEPROM recording permitted

Jumpers X20, X21
Internal power supply connection to current outputs board

Position	Mode
Removed	External power supply
Installed	Internal power supply

E. 7 MK30 control module

Figure E. 7

Jumpers X1, X2, X3, X4 – measurement channels 1, 2, 3, 4 mode selection correspondingly

Removed	Voltage operating mode
1-2	Current operating mode (4-20) mA
2-3	Current operating mode (1-5) mA

Jumper X8, X9 – terminator 120Ohm of RS485, CAN2.0B bus correspondingly

Removed	Terminator disconnected from bus
Installed	Terminator connected to bus

Jumper X10 – EEPROM recording protection

Removed	EEPROM recording prohibited
Installed	EEPROM recording permitted

Jumpers X13, X14, X15 – pull-up resistors of logic input, synchronization input 1, synchronization input 2 respectively

Removed	pull-up resistor disabled
Installed	pull-up resistor enabled

Jumpers X11, X12 - signal source for synchronization channels 1, 2 correspondingly

Removed	No synchronization
1-2	Measurement channel input (1 or 2)
2-3	Synchronization signals input (1 or 2)

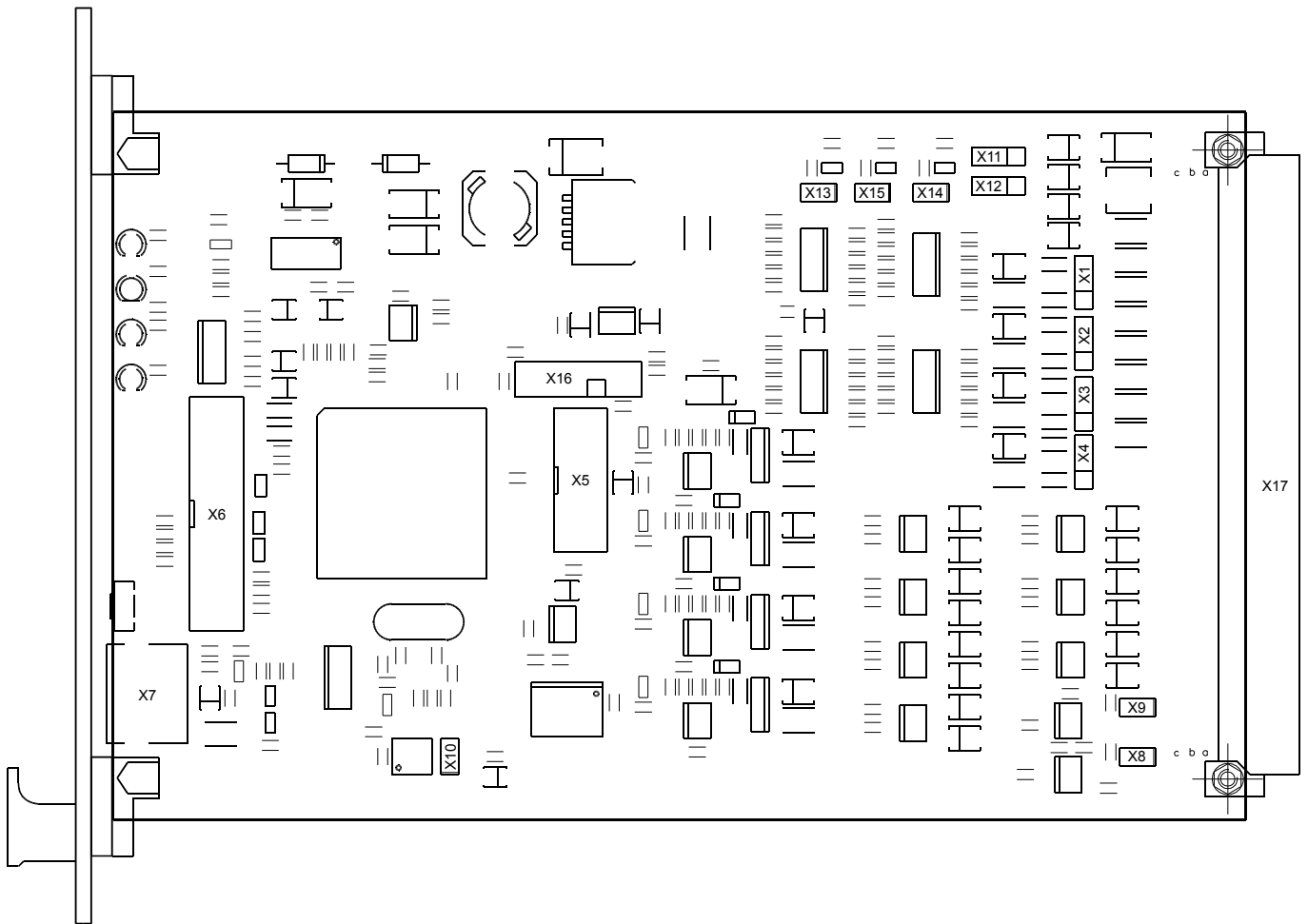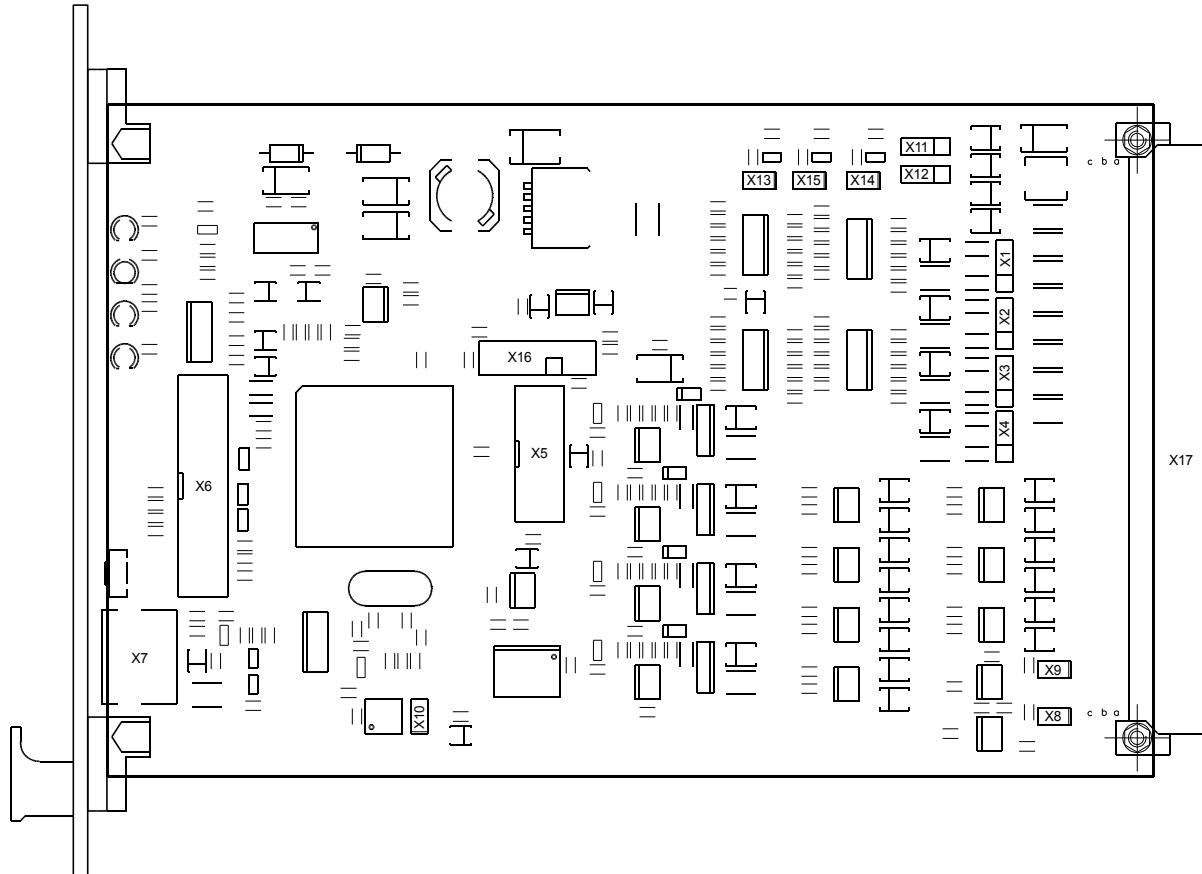E. 8 MK32-DC, MK32-DC-20, MK32-DC-001, MK32-DC-11 control modules

Figure E. 8

Jumpers X1, X2, X3, X4 – measurement channels 1, 2, 3, 4 mode selection correspondingly

Removed	Voltage operating mode
1-2	Current operating mode (4-20) mA
2-3	Current operating mode (1-5) mA

Jumper X8, X9 – terminator 120Ohm of RS485, CAN2.0B bus correspondingly

Removed	Terminator disconnected from bus
Installed	Terminator connected to bus

Jumper X10 – EEPROM recording protection

Removed	EEPROM recording prohibited
Installed	EEPROM recording permitted

Jumpers X13, X14, X15 – pull-up resistors of logic input, synchronization input 1, synchronization input 2 respectively

Removed	pull-up resistor disabled
Installed	pull-up resistor enabled

Jumpers X11, X12 - signal source for synchronization channels 1, 2 correspondingly

Removed	No synchronization
1-2	Measurement channel input (1 or 2)
2-3	Synchronization signals input (1 or 2)

E. 9 MK32-DC-20-R2 control module
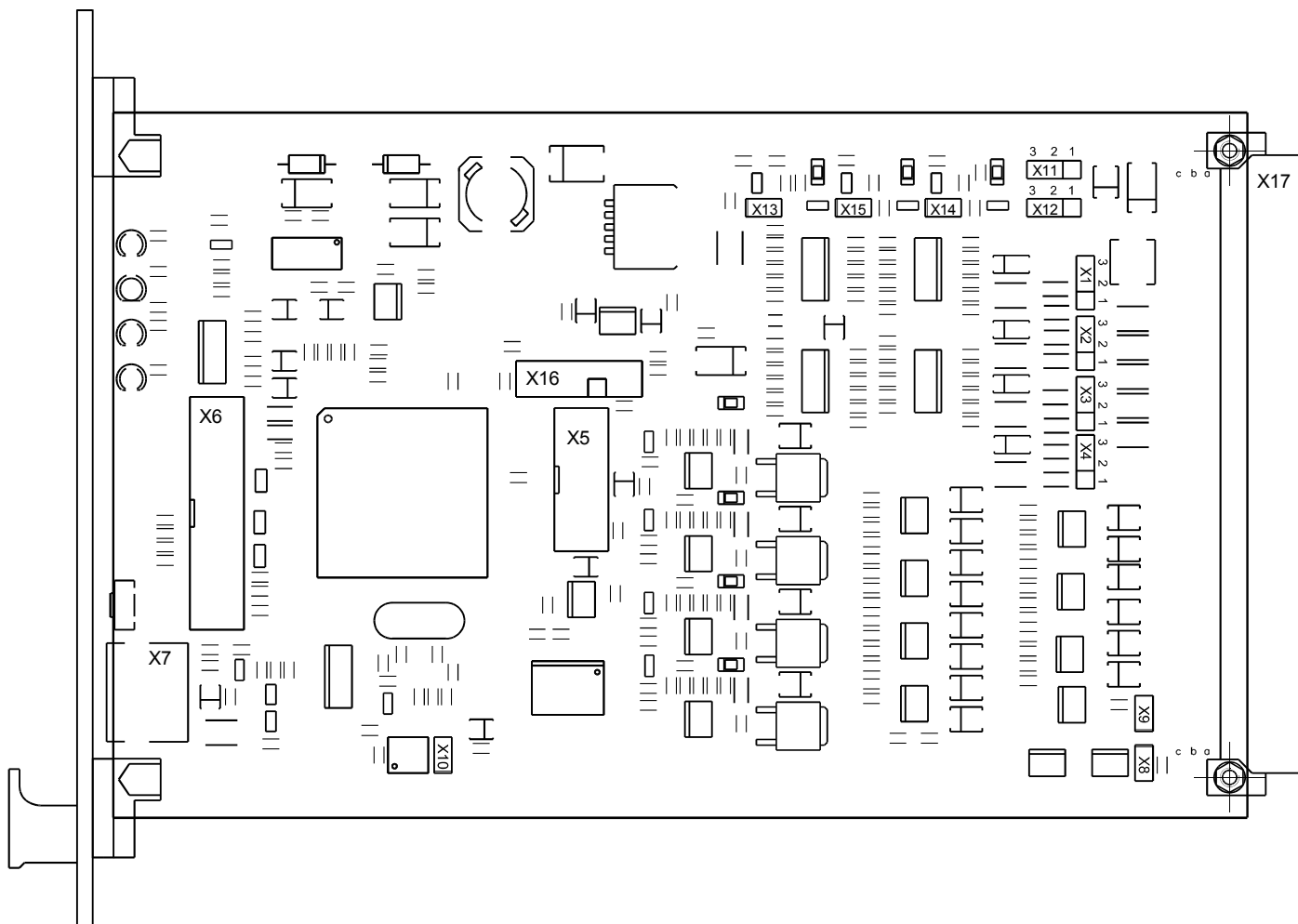
Figure E. 9

Connector purpose

Designation	Purpose
X17	Main switching connector
X5	Module front panel indicator connection serial interface
X6	Parallel interface, reserve
X7	Diagnostic interface, D.port
X16	Microcontroller programming, service

Jumpers X1, X2, X3,X4

Measurement channels 1, 2, 3, 4 operation mode selection (correspondingly)

Position	Mode
Removed	Voltage operating mode (0…3) V
1-2	Current operating mode (4…20) mA
2-3	Current operating mode (1…5) mA

Jumpers X8, X9

Terminator 120Ohm of RS485 No.1, CAN2.0B bus (correspondingly)

Position	Mode
Removed	Terminator disconnected from bus
Installed	Terminator connected to bus

Jumpers X11, X12

Synchronization pulses source selection for measurement channel 1, 2 correspondingly

Position	Mode
1-2	Synchronization from input Input CH1 (2)
2-3	Synchronization from input Fin 1 (2)

Jumpers X13

Pull-up resistor connection to the logic input

Position	Mode
Removed	Pull-up resistor disabled
Installed	Pull-up resistor enabled

Jumpers X14, X15

Pull-up resistor connection to synchronization channels 1, 2 correspondingly

Position	Mode
Removed	Pull-up resistor disabled (synchronization pulses from measurement channel)
Installed	Pull-up resistor enabled (synchronization pulses from input with OC)

Jumper X10
EEPROM recording protection

Removed	EEPROM recording prohibited
Installed	EEPROM recording permitted

Jumpers X20, X21
Internal power supply connection to current outputs board

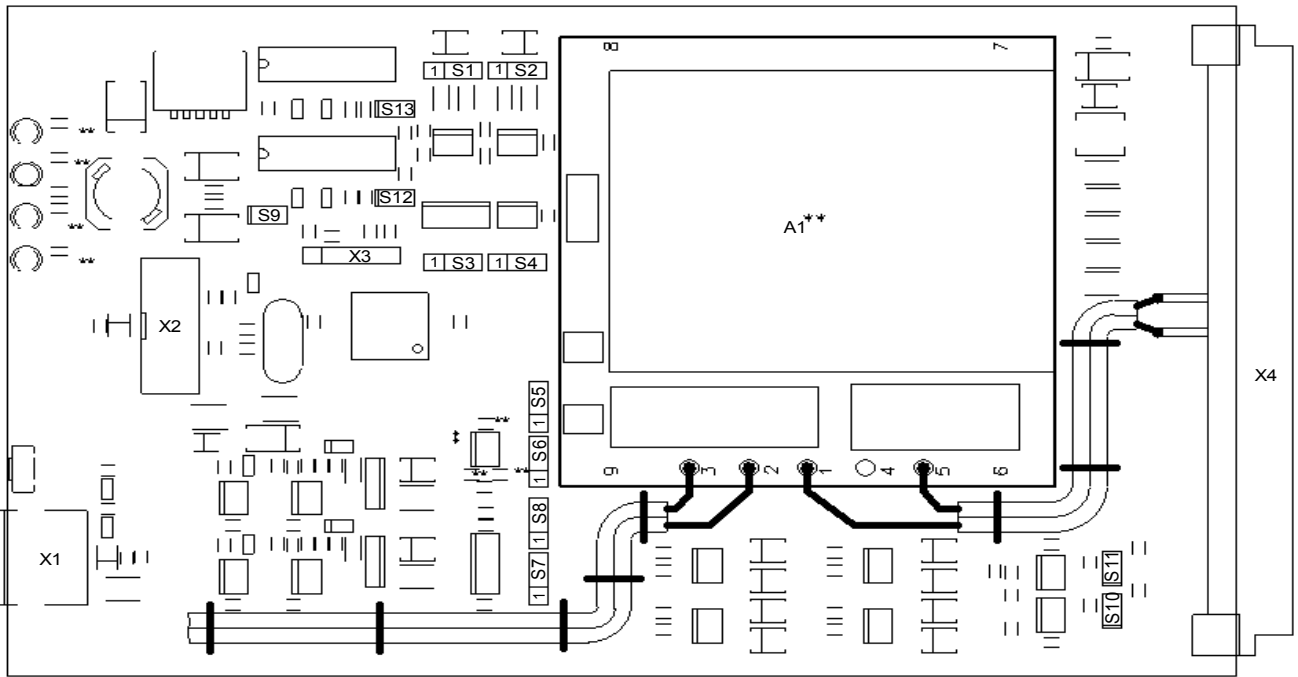| Position	Mode
Removed	External power supply
Installed	Internal power supply

E. 10 MK40 control module

Figure E. 10

Jumpers S1 (S12), S2 (S13) – measurement channels 1, 2 operation mode selection (correspondingly)

S1 (S2)	S12 (S13)	
Removed	Removed	Voltage operating mode (0-5) V
1-2	Removed	Current operating mode (1-5) mA
2-3	Removed	Current operating mode (4-20) mA
Removed	Installed	OC signal source (pull-up resistor 1kOhm at the input to the circuit +5V)

Jumper S9 — measurement channel 2 operation mode selection

Removed	Normal operation mode
Installed	Module supply voltage monitoring +24V

Jumpers S3, S4 — measurement channels 1, 2 pulse active edge selection (correspondingly)

Removed	Not permitted, frequency is not measured
1-2	Trailing edge
2-3	Leading edge

Jumpers S7, S8 — selection of pulses active edge repeated by MK40 module for measurement channels 1, 2 (correspondingly)

Removed	Not permitted, frequency is not measured
1-2	Leading edge
2-3	Trailing edge

Jumpers S6, S5 — measurement channels 1, 2 test signal source selection

Removed	Test signal not connected
1-2	External test signal from the terminals of connector X4
2-3	Internal test signal 50Hz (only for MK40-AC-11-S)

Jumpers S10, S11 – terminator 120Ohm of RS485, CAN2.0B bus (correspondingly)

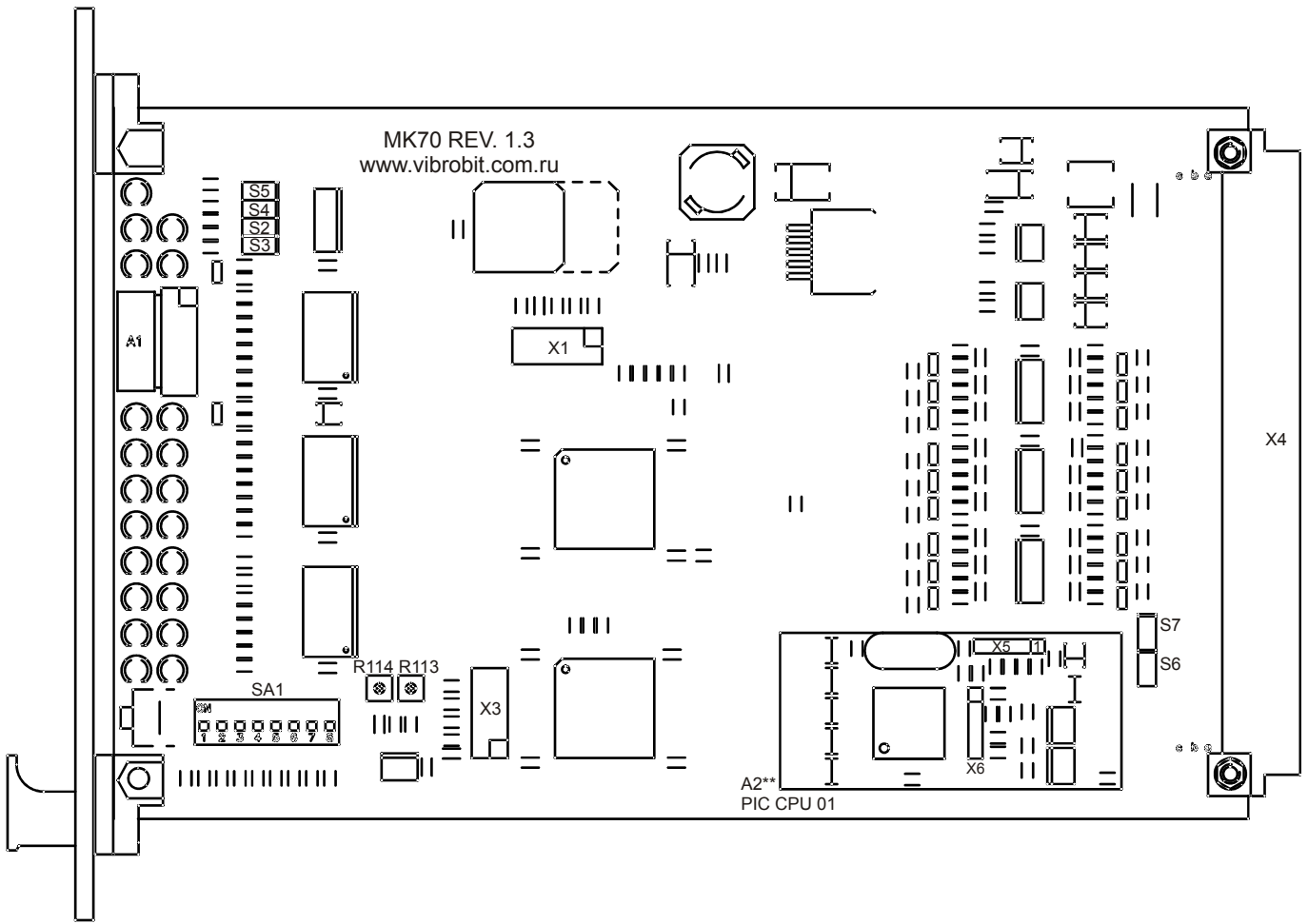| Removed	Terminator disconnected from bus
Installed	Terminator connected to bus

E. 11 MK70 control module

Figure E. 11

Controls purpose

Designation	Purpose
S4	Operation permission (jumper installed) of output 1 LED installed on the MK70 module front panel
S5	Operation permission (jumper installed) of output 2 LED installed on the MK70 module front panel
S3	Operation permission (jumper installed) of output 3 LED installed on the MK70 module front panel
S2	Operation permission (jumper installed) of output 3 LED installed on the MK70 module front panel
S6*	Connection (jumper installed) of the Test out 1 signal to the terminal A28 of connector X4 (support of compatibility with the MK70 zero character)
S7*	Connection (jumper installed) of the Test out 2 signal to the terminal B27 of connector X4 (support of compatibility with the MK70 zero character)
SA1	Unit of 8 microswitches to select the MK70 module operating mode
R114	Adjustment of the test signal 61Hz level
R113	Adjustment of the test signal 61Hz DC component
A2	PIC CPU 01 diagnostic communication interfaces board
X5	PIC CPU 01 diagnostic interface connector
X6	Microcontroller programming connector
* When installing the PIC CPU 01 communication interfaces boards on the MK70 board, the jumpers S6, S7 should be removed.	

E. 12 MK71, MK71-R2 control modules
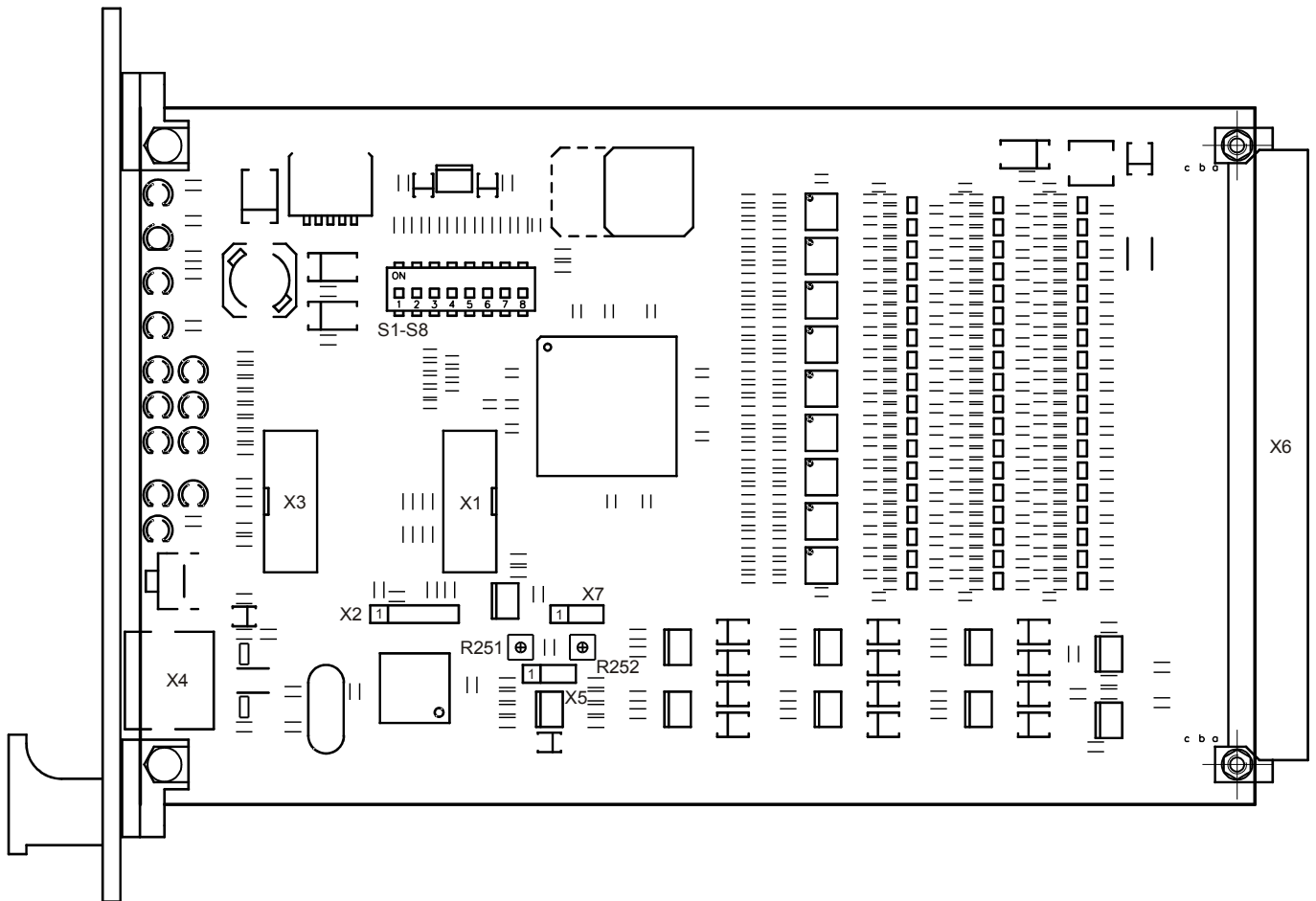
Figure E. 12

Purpose of controls on the MK71 module board

Designation	Description
S1-S8	Safety shutdown logic selection microswitches
X5, X7	Test signal source selection
R251	Test signal excursion adjustment (only when X5 is in position 2-3)
R252	Test signal DC component adjustment (only when X5 is in position 2-3)

Test signal source selection

X5	X7	The test signal source
1-2	1-2, 2-3	Microcontroller PWM without adjustment of DC component (R252) and excursion (R251)
2-3	1-2	Microcontroller PWM with adjustment of DC component (R252) and excursion (R251)
2-3	2-3	CPLD 61 Hz meander with adjustment of DC component (R252) and excursion (R251)

E.13 MK90 control module
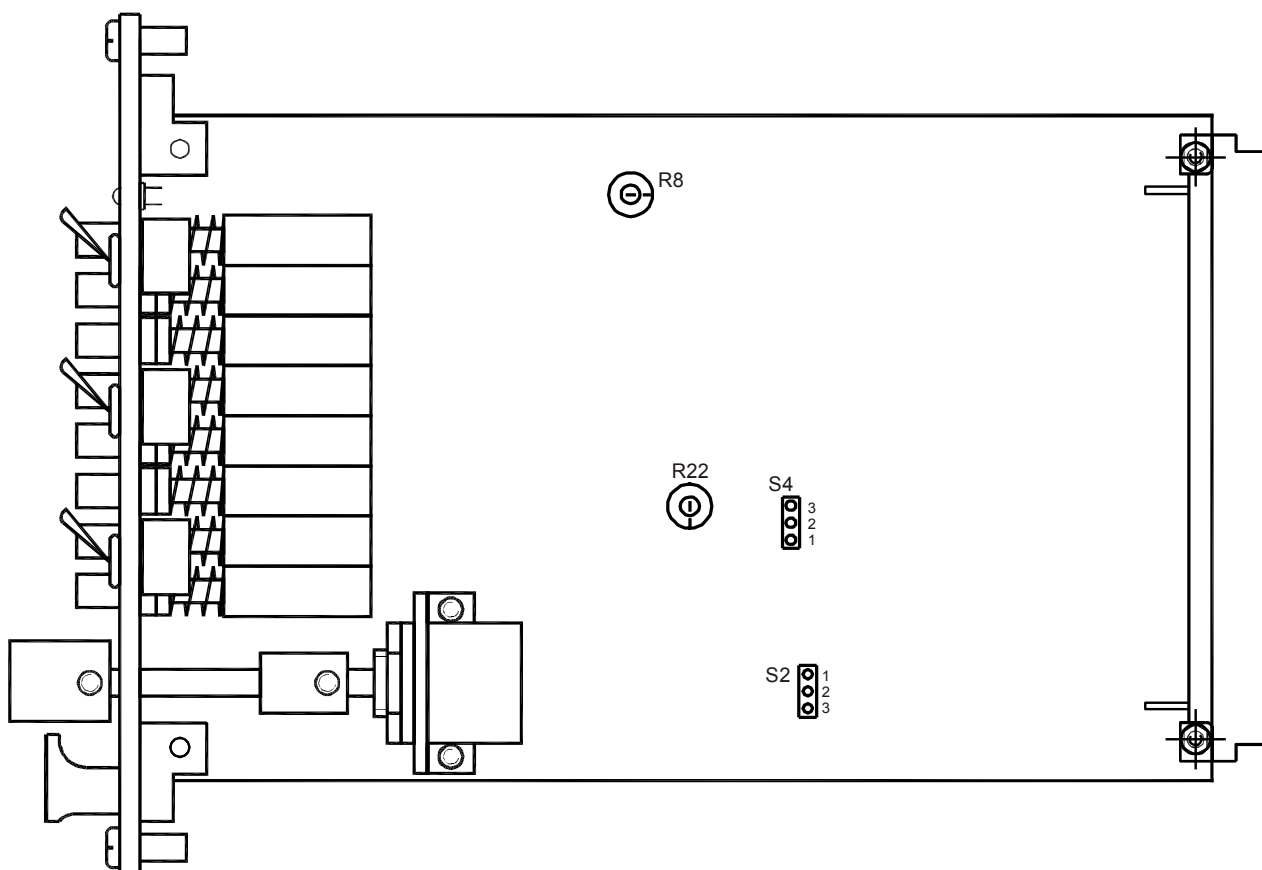
Figure E.13

Adjustment resistors

Designation	Purpose
R8	Sinusoidal voltage generator start
R22	Signal amplitude in pulse mode

Jumpers S2, S4 – MK90 operating mode selection

Version	S2	S4	The mode
1	1-2	1-2	(1-170) Hz; «groove»; negative polarity
2	1-2	3-2	(1-170) Hz; «groove»; positive polarity
3	3-2	1-2	(60-10000) Hz; «pinion»; negative polarity
4	3-2	3-2	(60-10000) Hz; «pinion»; positive polarity

E.14 MK91 control module
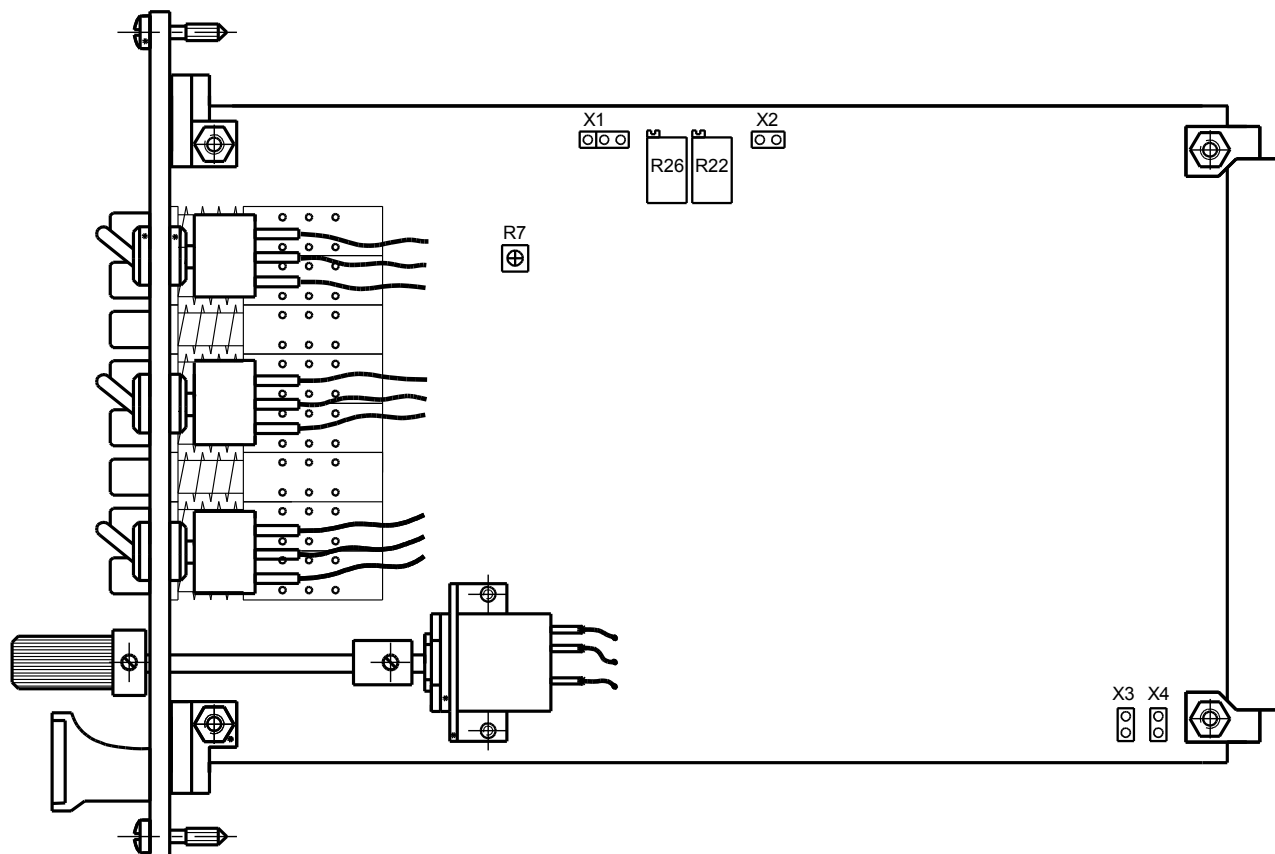
Figure E.14

Adjustment resistors

Designation	Purpose
R7	Sinusoidal voltage generator start
R22	Adjustment of signal excursion in pulse mode
R26	Adjustment of pulse signal DC offset

Jumpers

Designation	Position	The mode
X1	1-2	Pulse signal frequency range (1 – 170) Hz ("groove").
	2-3	Pulse signal frequency range 60 Hz – 10 kHz ("pinion").
X2	1-2	Enabling of signal offset in pulse mode (adjustment by R26 resistor).
X3	1-2	Enabling the output "7" voltage operating mode.
X4	1-2	Enabling the output "8" voltage operating mode.

E.15 MK95 control module
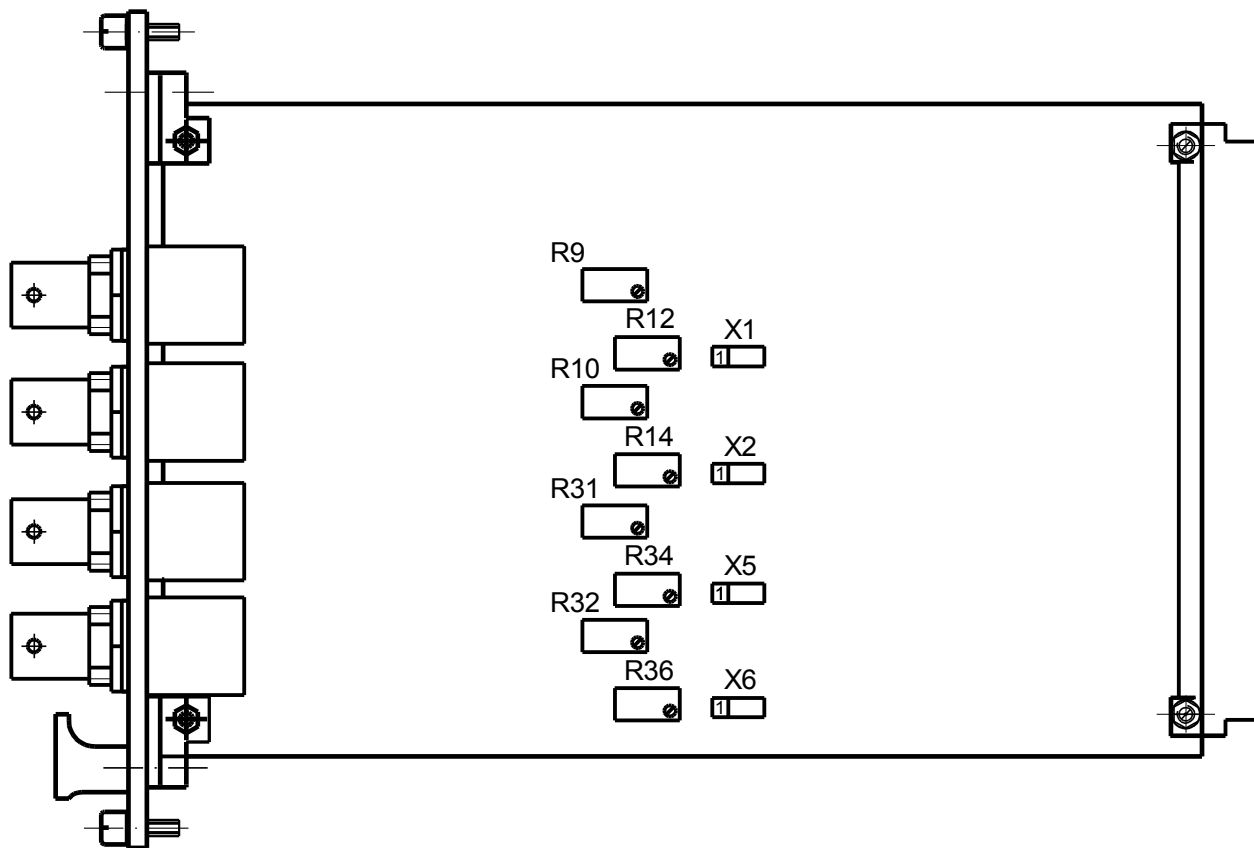
Figure E.15

Position of jumpers on X1,X2,X5,X6 - channels 1,2,3,4 operating mode version selection respectively

Channels 1...4 operating mode version selection respectively

Version	Position of jumpers on X1, X2, X5, X6	Note
A	2-3	current input (1–5) mA
B	1-2	current input (4–20) mA
U	removed	voltage input

Adjustment resistors in channels 1,2,3,4 correspondingly

Designation	Purpose
R9, R10, R31, R32	Range start adjustment (offset)
R12, R14, R34, R36	Range end adjustment (gain)

E.16 БИ24 indication unit
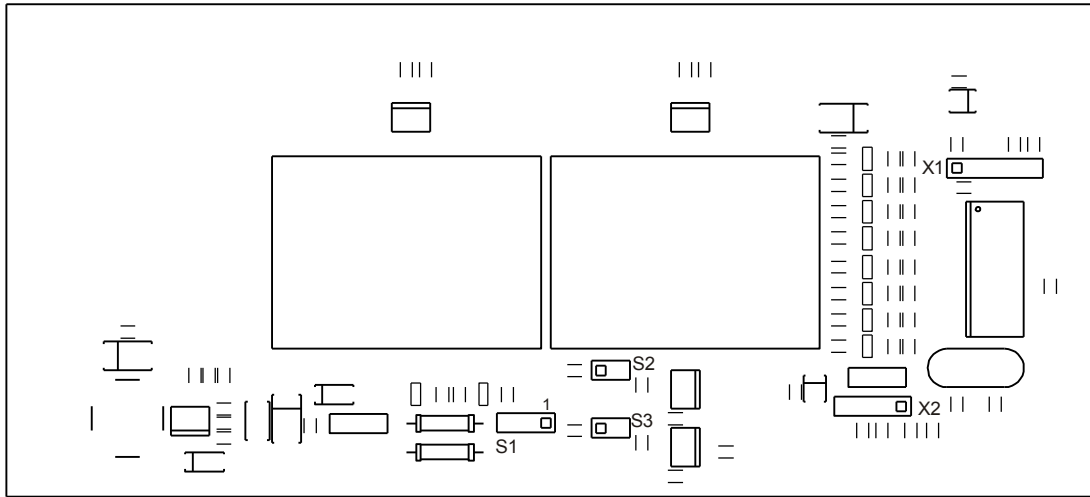
Figure E.16

Jumper S1 – pulse input operating mode selection

Removed	Voltage input
1-2	Positive current pulse
2-3	Active level zero

Jumper S2 – terminator 120 Ohm of RS485 bus

Removed	Terminator disconnected from bus
Installed	Terminator connected to bus

Jumper S3 – terminator 120 Ohm of CAN bus

Removed	Terminator disconnected from bus
Installed	Terminator connected to bus

E.17 БИ34 indication unit
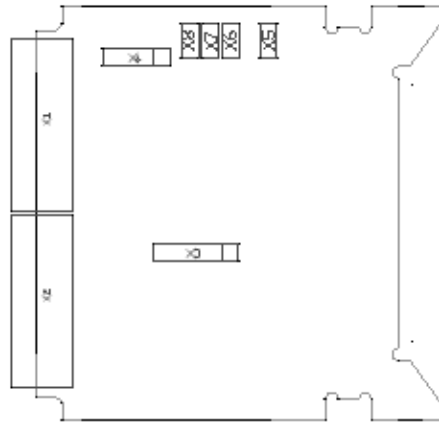
Figure E.17

Description of jumpers installation on БИ34 board

Jumper	Voltage input	Current input (4-20) mA	Current input (0-5) mA
X6	removed	installed	installed
X7	removed	installed	installed
X8	removed	installed	installed

E.18 МП24 power supply module
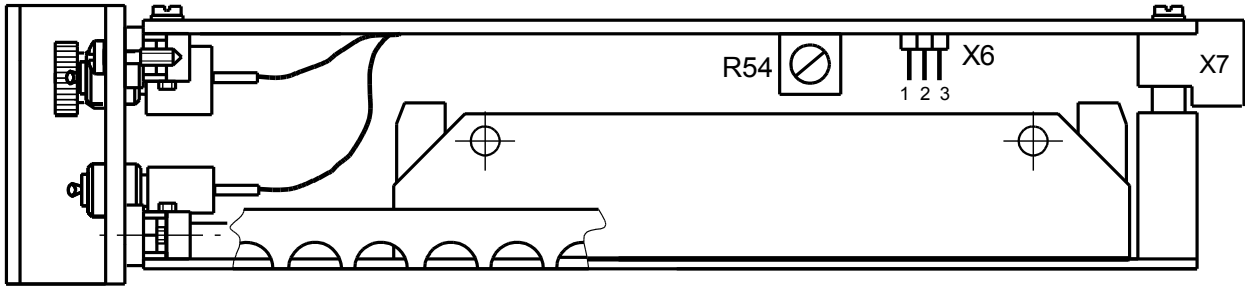
Figure E.18

Jumper X6 position

Position	Note
1-2	OC output (relay output) active status holding time after МП24 energizing — 1 sec.
2-3	OC output (relay output) active status holding time after МП24 energizing — 10 sec.

R54 resistor – OC threshold actuation adjustment in case of supply voltage of +24 V deviation from permissible level.

E.19 МП24.1 power supply module
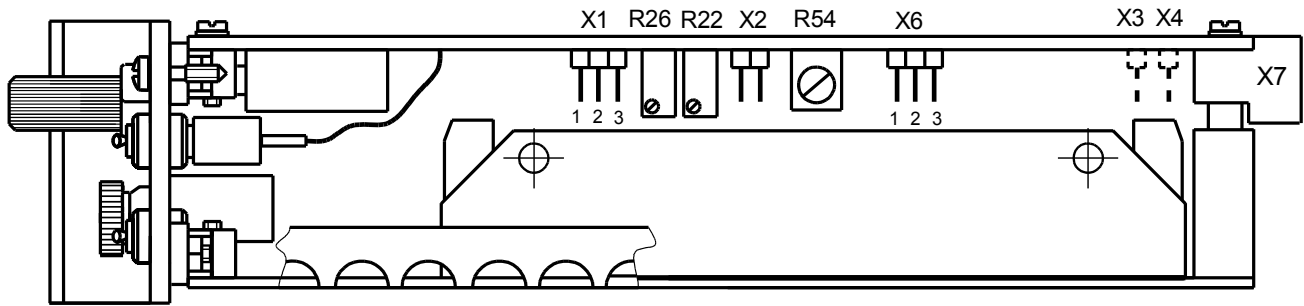
Figure E.19

Adjustment resistors

Designation	Purpose
R22	Adjustment of signal excursion in pulse mode
R26	Adjustment of pulse signal DC offset
R54	OC threshold actuation adjustment in case of supply voltage of +24 V deviation from permissible level

Jumpers

Designation	Position	Mode
X1	1-2	Pulse signal frequency range (1 – 170) Hz ("groove").
	2-3	Pulse signal frequency range 60 Hz – 10 kHz ("pinion").
X2	1-2	Enabling of signal offset in pulse mode (adjustment by R26 resistor).
X3 *	1-2	Enabling the output "7" voltage operating mode.
X4 *	1-2	Enabling the output "8" voltage operating mode.
X6	1-2	OC output (relay output) active status holding time after МП24.1 energizing — 1 sec.
	2-3	OC output (relay output) active status holding time after МП24.1 energizing — 10 sec.
* Jumpers X3 and X4 are located on the module bottom side.		

E.20 МП26 power supply module
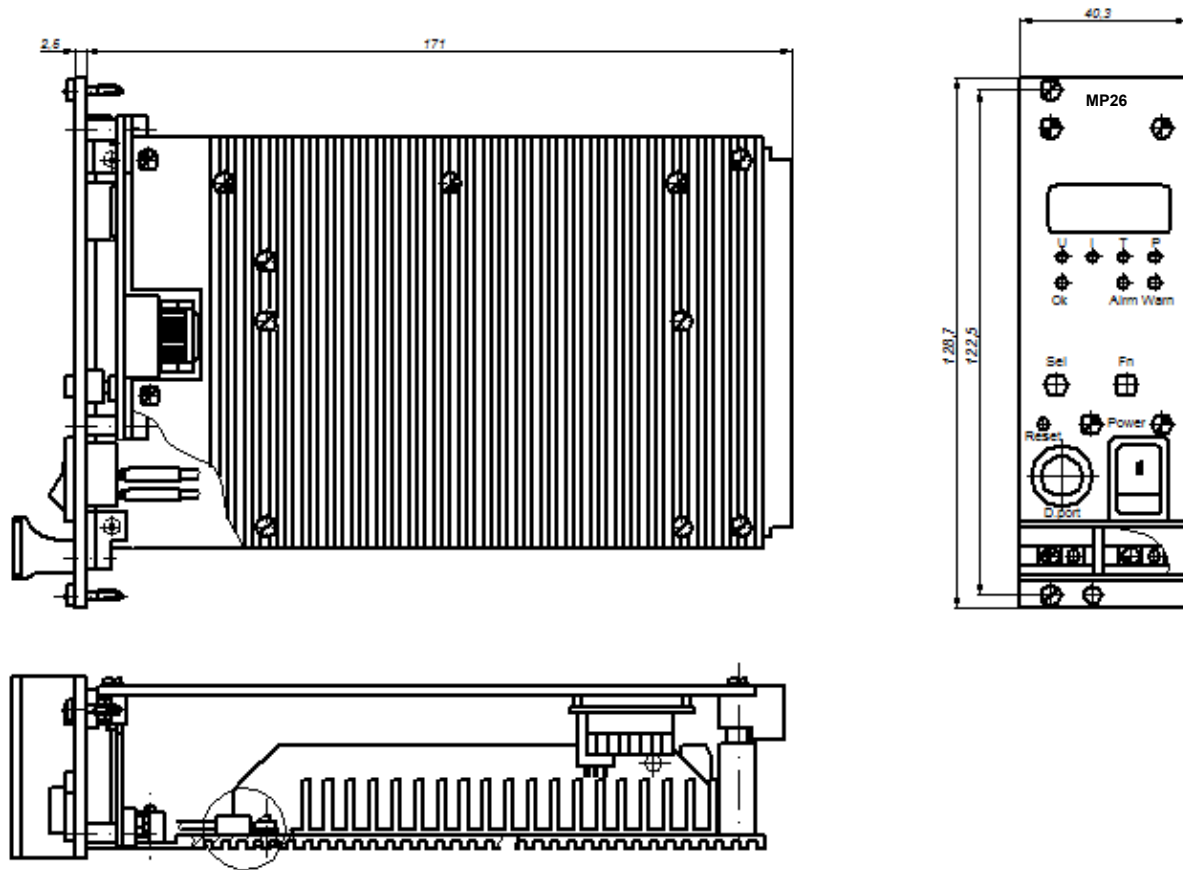
Figure E.20

Control and adjustment elements:

Switch SW1 — sets the delay time for the power supply to ACDC converter.

Jumpers

Designation	Position	Mode
X10, X12	installed	Enabling CAN-1 and CAN-2 bus terminator
X11, X13	installed	Enabling RS485-1 and RS485-2 bus terminator

Annex F

(informative)

Order specification form for the Vibrobit 300 equipment assembly units

Description (type)	Quantity, pcs	Comment

Annex G

(informative)

Electric schematic diagrams

G.1 БИ24 connection to the control modules via the CAN2.0B interface

Control module

Terminal	Designation
A6, B5, C6	+24V
A2, A32, B1, B31	0, Common
B27	CAN-H
C28	CAN-L
A28	CAN-GND

МП24 power supply module

Designation	Terminal
+24V	A6, B5, C6
0, Common	A2, A32, B1, B31

БИ24 indication unit

Цепь	Terminal
+24V	5
0, Common	6
CAN-H	1
CAN-L	2
CAN-GND	7
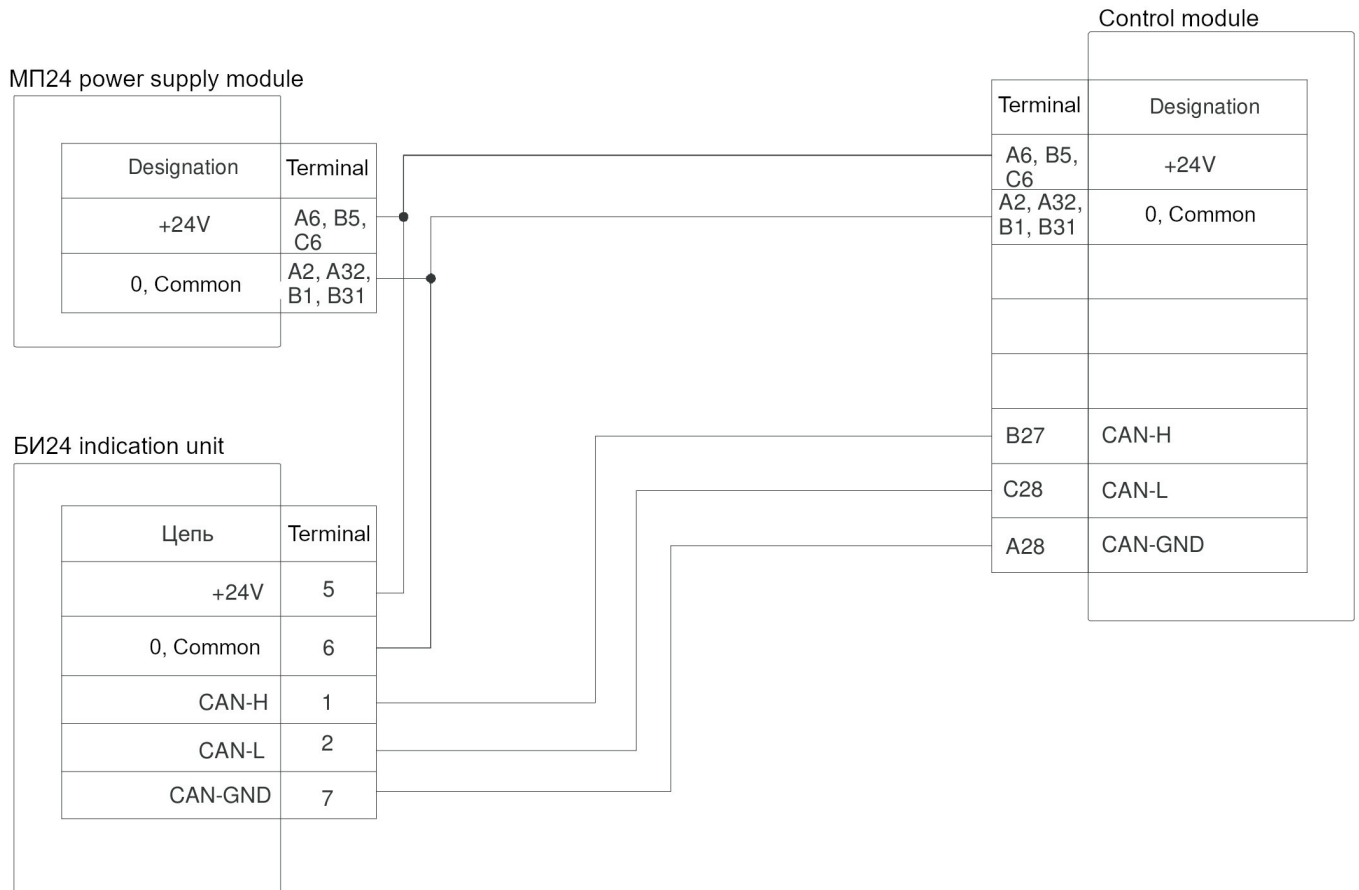
Figure G.1

G.2 Mechanical values sensor (converter) connection to MK10, MK11, MK22, MK32, MK40 module

МП24, МП24.1 power supply module

Circuit	Terminal
+24 V	A6, B5, C6
0, Common	A2, A32, B1, B31

Sensor (converter)

Terminal	Circuit	
1	Output	
2	0, Common	
3	+	18-36 V
4	–	

MK95 control module

Terminal	Circuit
A6, B5, C6	+24 V
A2, A32, B1, B31	0, Common
C8	Input 1+
A8	Input 1-

VD1

MK10, MK11, MK22, MK32, MK40 control module

Circuit	Terminal
+24 V	A6, B5, C6
0, Common	A2, A32, B1, B31
+24 V, supply converter ch1	B7
Input 1ch	C8

MK90, MK91 control module

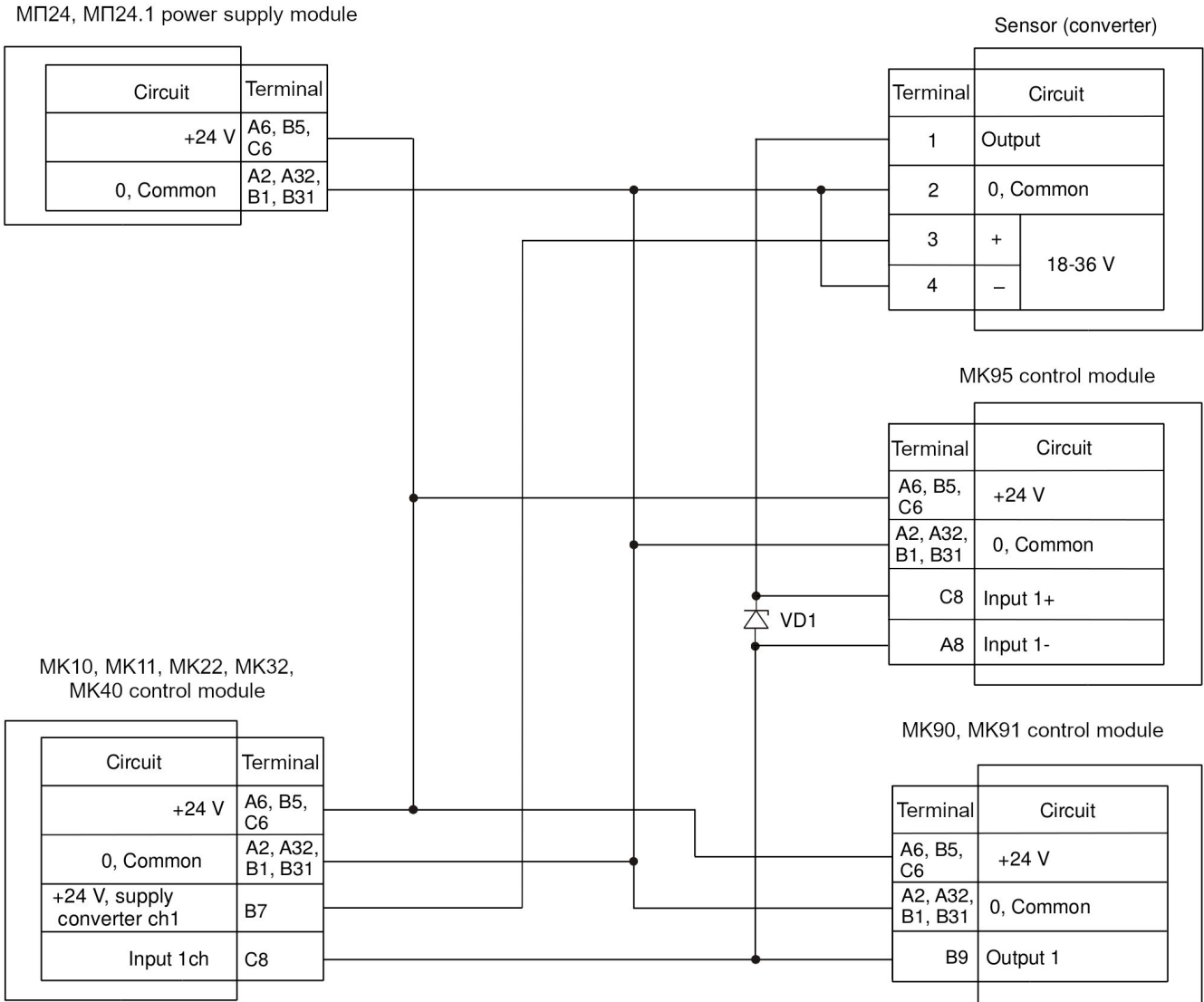| Terminal	Circuit
A6, B5, C6	+24 V
A2, A32, B1, B31	0, Common
B9	Output 1

Figure G.2

Notes

1 Sensor (converter) from the line of Vibrobit 100 equipment.

2 MK90, MK91, MK95 modules are used if necessary.

3 When using the MK95 module, the stabilitron of 5.6 V is installed in a circuit break according to the diagram (Recommended type: BZX84-C5V6).

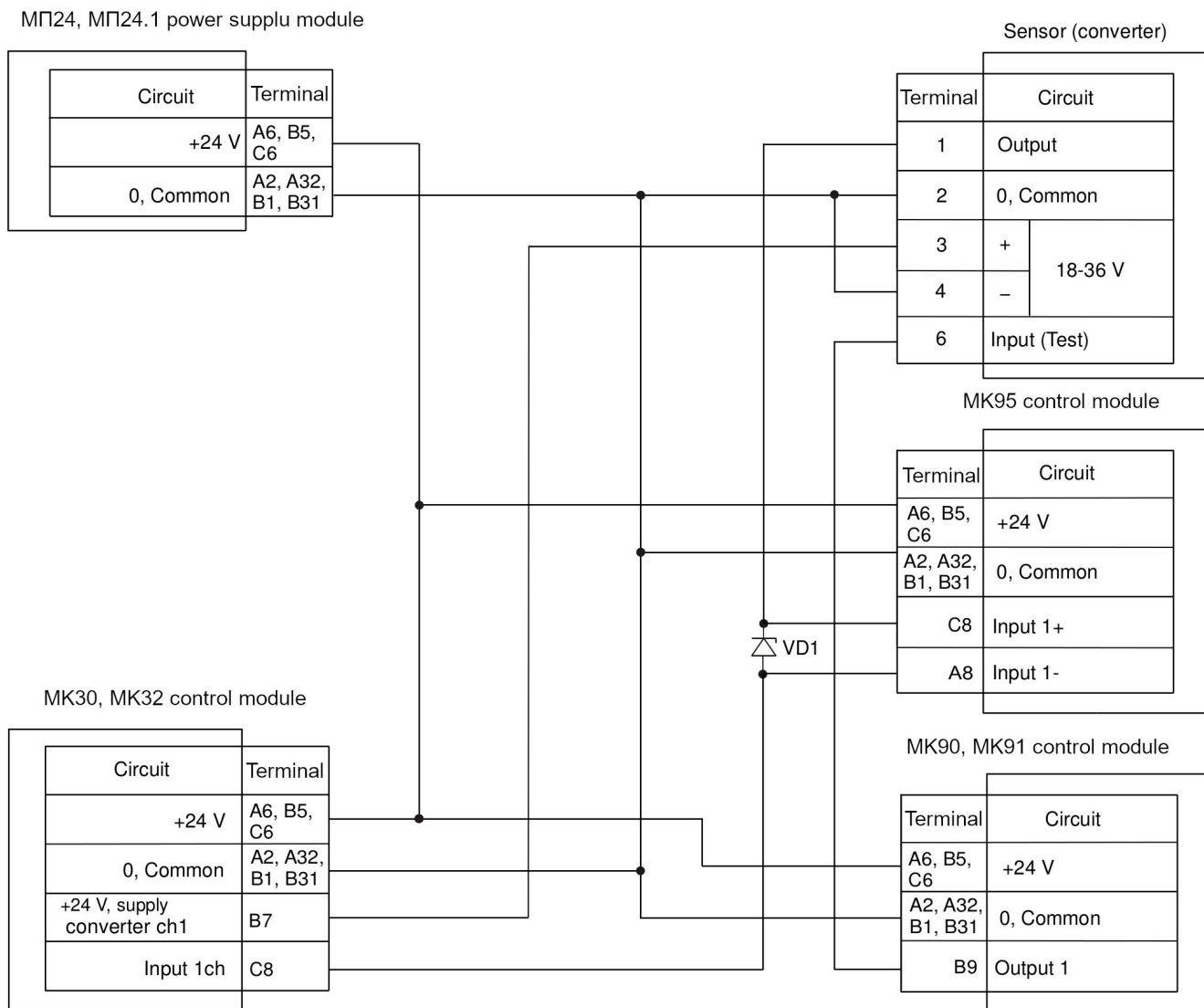G.3 Vibration velocity sensor (converter) connection to the MK30, MK32 module

МП24, МП24.1 power supplu module

Sensor (converter)

Circuit	Terminal
+24 V	A6, B5, C6
0, Common	A2, A32, B1, B31

Terminal	Circuit	
1	Output	
2	0, Common	
3	+	18-36 V
4	–	
6	Input (Test)	

MK95 control module

Terminal	Circuit
A6, B5, C6	+24 V
A2, A32, B1, B31	0, Common
C8	Input 1+
A8	Input 1-

VD1

MK30, MK32 control module

Circuit	Terminal
+24 V	A6, B5, C6
0, Common	A2, A32, B1, B31
+24 V, supply converter ch1	B7
Input 1ch	C8

MK90, MK91 control module

Terminal	Circuit
A6, B5, C6	+24 V
A2, A32, B1, B31	0, Common
B9	Output 1

Figure G.3

Notes

1 Sensor (converter) from the line of Vibrobit 100 equipment.

2 MK90, MK91, MK95 modules are used if necessary.

3 When using the MK95 module, the stabilitron of 5.6 V is installed in a circuit break according to the diagram (Recommended type: BZX84-C5V6).

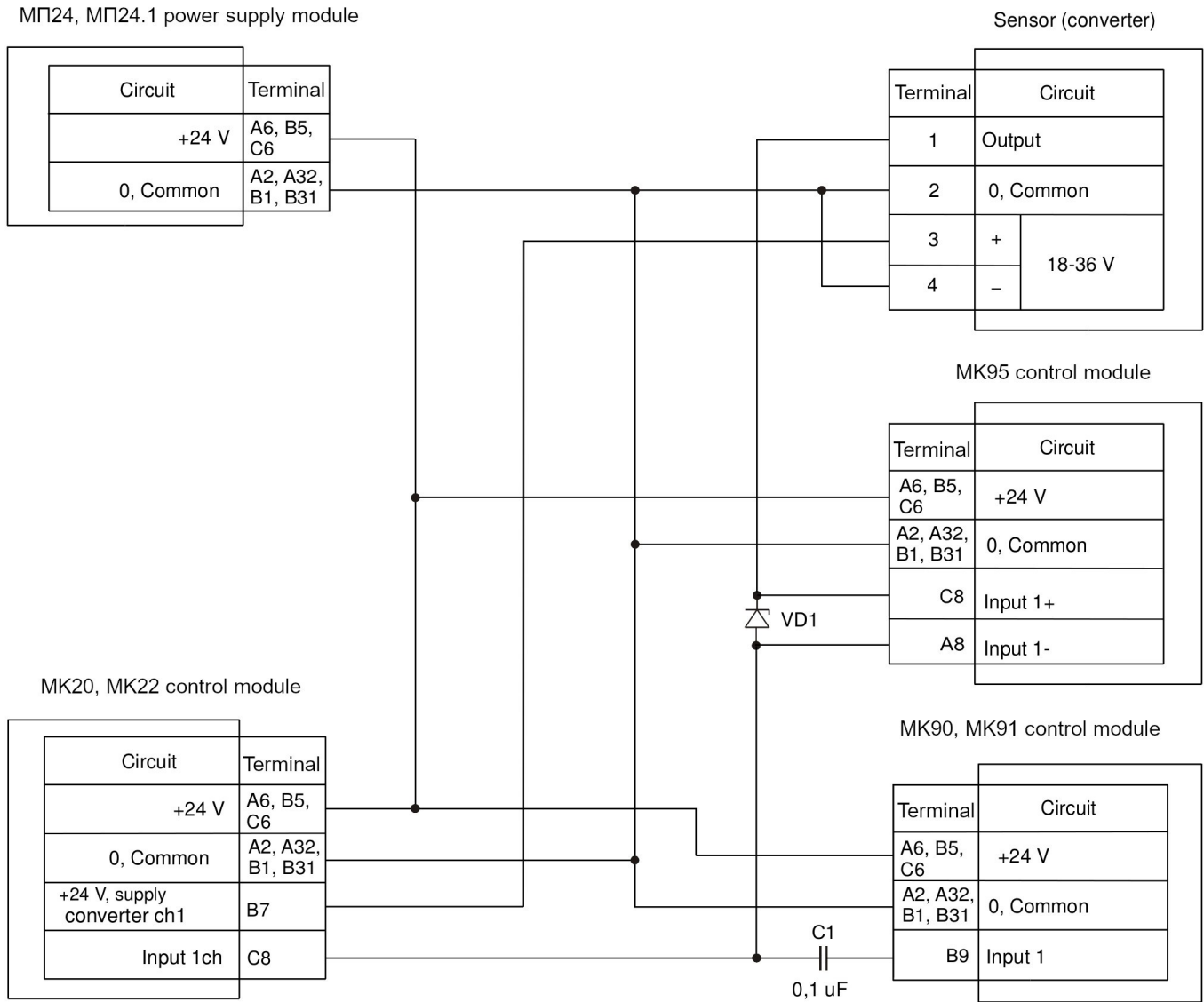G.4 Vibration displacement sensor (converter) connection to the MK20, MK22 module

МП24, МП24.1 power supply module

Sensor (converter)

Circuit	Terminal
+24 V	A6, B5, C6
0, Common	A2, A32, B1, B31

Terminal	Circuit	
1	Output	
2	0, Common	
3	+	18-36 V
4	−	

MK95 control module

Terminal	Circuit
A6, B5, C6	+24 V
A2, A32, B1, B31	0, Common
C8	Input 1+
A8	Input 1-

VD1

MK20, MK22 control module

Circuit	Terminal
+24 V	A6, B5, C6
0, Common	A2, A32, B1, B31
+24 V, supply converter ch1	B7
Input 1ch	C8

MK90, MK91 control module

Terminal	Circuit
A6, B5, C6	+24 V
A2, A32, B1, B31	0, Common
B9	Input 1

C1

0,1 uF

Figure G.4

Notes

1 Sensor (converter) from the line of Vibrobit 100 equipment.

2 MK90, MK91, MK95 modules are used if necessary.

3 When using the MK95 module, the stabilitron of 5.6 V is installed in a circuit break according to the diagram (Recommended type: BZX84-C5V6).

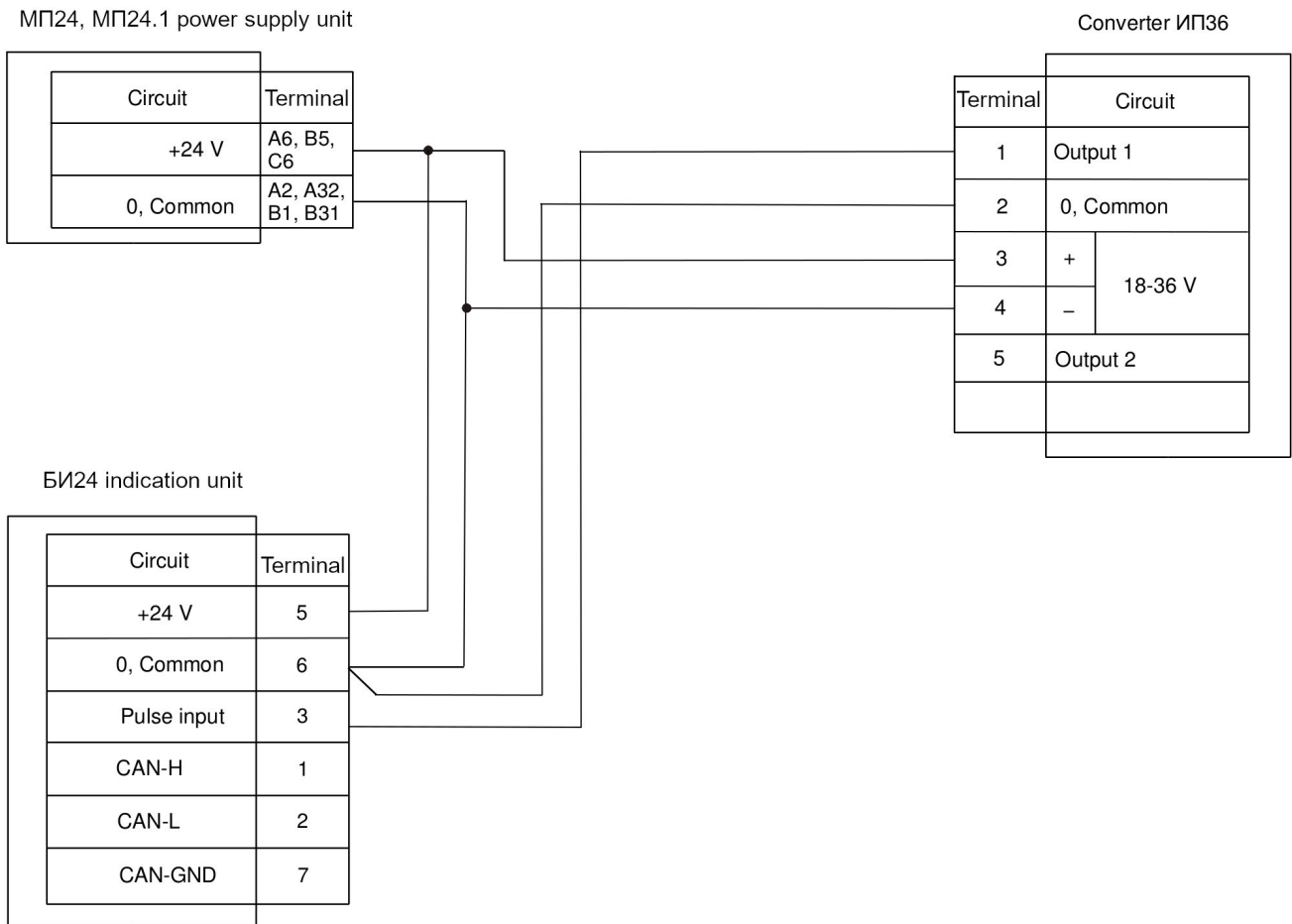G.5 ИП36 converter connection to the БИ24 indication unit (version I)

МП24, МП24.1 power supply unit

Circuit	Terminal
+24 V	A6, B5, C6
0, Common	A2, A32, B1, B31

Converter ИП36

Terminal	Circuit	
1	Output 1	
2	0, Common	
3	+	18-36 V
4	–	
5	Output 2	

БИ24 indication unit

Circuit	Terminal
+24 V	5
0, Common	6
Pulse input	3
CAN-H	1
CAN-L	2
CAN-GND	7

Figure G.5

Note – ИП36 converter from the line of Vibrobit 100 equipment.

Annex H

(recommended)

MC01 USB driver Installation on Windows XP PC

When connecting MC01 USB to PC via USB port, the operating system will detect new device on USB bus and offer to install the software for it. MC01 USB drivers are included in the software set supplied with Vibrobit 300 equipment.
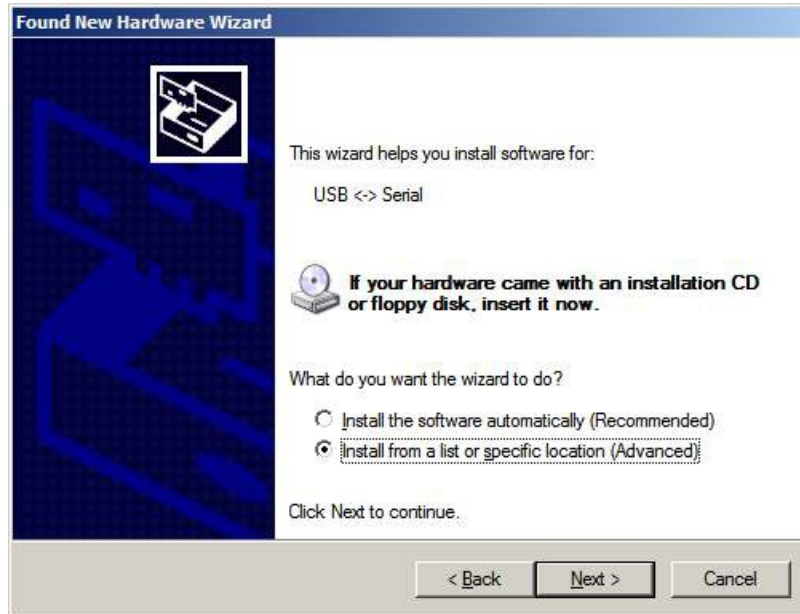

Choose "Install from a list or specific location" and click "Next" button. The window appears where you should specify the path to the folder containing MC01 USB drivers.
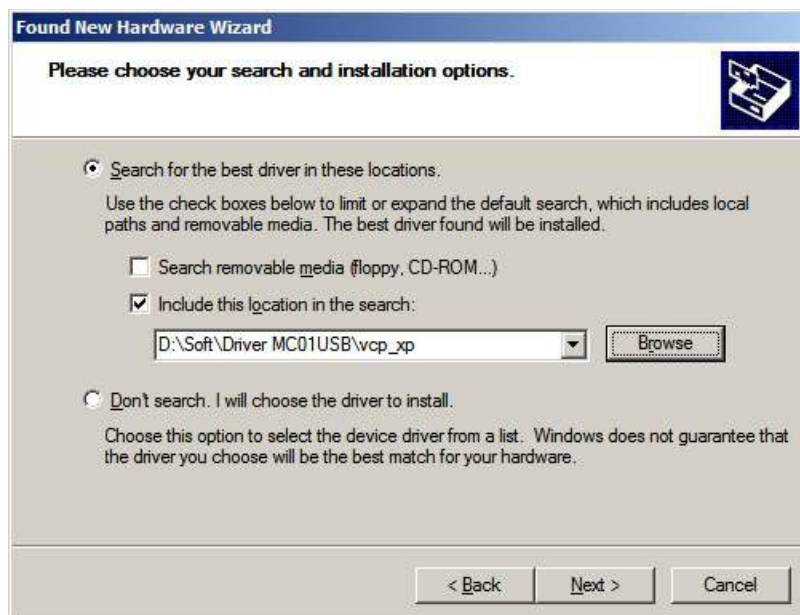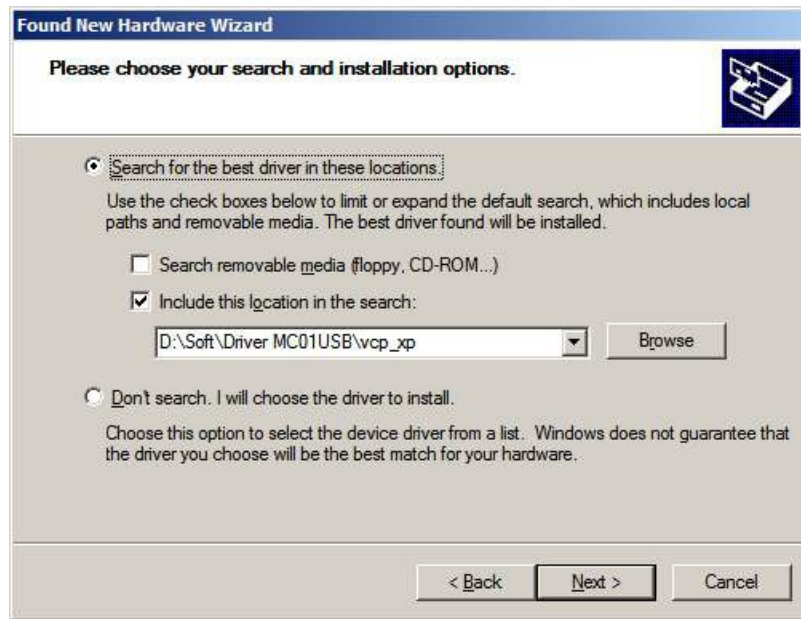

Select "Include this location in the search", click "Browse" button to specify the path to MC01 USB driver. Then click "Next" button.

Windows XP OS will install the required USB Serial Converter drivers. Upon completion push "Finish" button.

Then virtual COM port drivers will be installed. The window informing of driver installation necessity will appear.
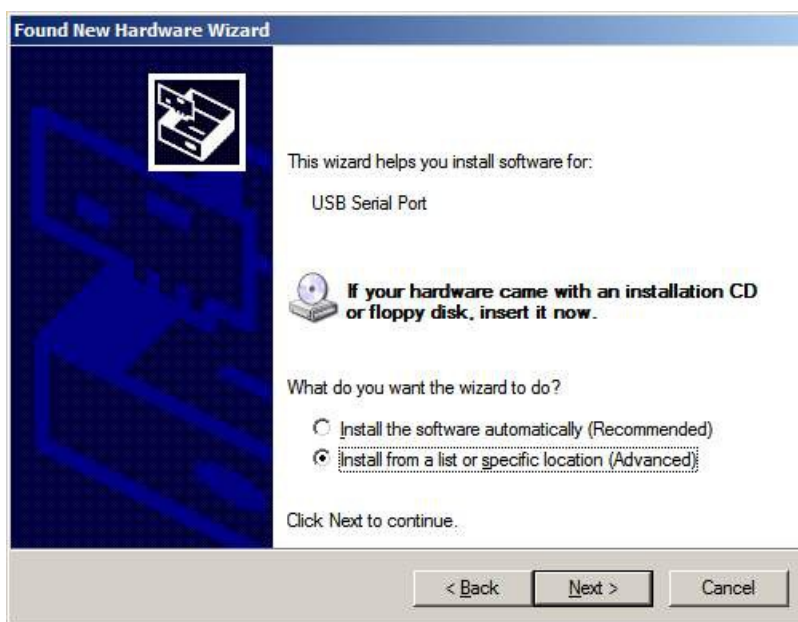
Select "Include this location in the search", click "Browse" button to specify the path to MC01 USB drivers. Then click "Next" button.

Select "Include this location in the search", click "Browse" button to specify the path to MC01 USB drivers. Then click "Next" button.

The required files will be copied and OS will be setup for virtual COM port operation. Click "Finish" button upon completion.

Upon launching the control module setup program, a search will be carried out for the available COM ports in the system. All available COM ports will be added to the list of the "COM Port Number" of setup program.

Annex J

(informative)

Determination of the conversion factors

J.1 Conversion factor K for the MK95 module

Table J.1 – Determination of parameter conversion factor K

Measurement parameter	Measurement range	Input signal, mA	Conversion factor	Meas. unit
Relative displacement, mm	S	Direct current 1-5	10/S	V/mm
		Direct current 4-20	10/S	
Relative vibration displacement, mm	0-0.05 (offset 0-2)	Alternate current 1-5[1]	1.77	V/mm
		Direct current 4-20[2]	20	
Vibration velocity RMS, mm/sec	0-15	Alternate current 1-5[1]	0.13	V/mm/sec
		Direct current 4-20[2]	0.66(6)	
	0-30	Alternate current 1-5[1]	0.0625	
		Direct current 4-20[2]	0.33(3)	
Speed, Hz; rpm	f; N	Direct current 1-5	10/f; 10/N	V/Hz
		Direct current 4-20	10/f; 10/N	V/rpm
		Pulse current 1-5	1[3]	
		Pulse current 4-20	1[3]	
[1] - With DC component 3 mA.				
[2] - Unified signal (detected).				
[3] - By frequency.				

Annex K

### Recommendations for setup of the module from SPTA

(recommended)

MK22 and MK32 modules are setup using the ModuleConfigurator software, delivered on CD together with the Vibrobit 300 equipment.

To prepare the control module taken from SPTA for operation, it is necessary to set its operation parameters. The control module in SPTA is delivered calibrated by inputs and unified outputs, therefore it should be setup with care to prevent the module calibration parameters change.

To prepare the pre-calibrated module for operation, the following sequence of steps is offered:

1. Prepare configuration file for the corresponding control module. The configuration file can be received by reading settings from the existing control module and saving them as a file on a disk (File-> Save), or by using the pre-made file recorded on the CD, included in the Vibrobit 300 equipment delivery.

2. Connect to the module by clicking the button .

3. Read all settings from module using the button .

4. Import the prepared configuration file: File->Import.

5. In the resulting window select categories of parameters to be loaded into the program.
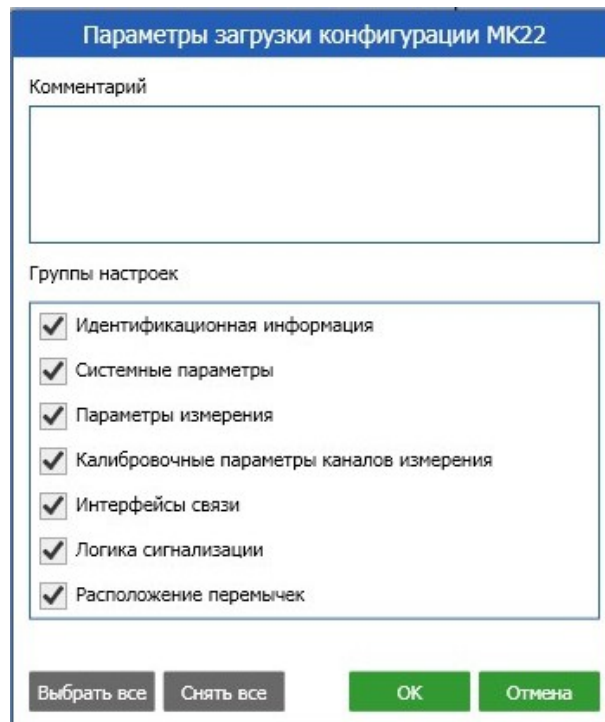
Please note that marks near the items "Calibration data..." (for MK32 only) and "Others" should be removed, for the module calibration data to remain unchanged.

6. Press «OK» button.

7. Change module settings at your own discretion. For example, set the module address via the RS485 interface.

8. Block the module logical signaling by button.

9. Record all settings into the module, by button.

10. Save module settings into the non-volatile memory by button. After saving the settings into non-volatile memory, the module will reset, at the same time the connection with module will be lost.

Record of revisions

Rev.	Sheet (page) number				Total sheets (pages) in document	Document No.	Accompanying document reference number and date	Signature	Date
	changed	replaced	new	revoked					
31		All			—	2907-21 ИИ	—		