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SCIENTIFIC PRODUCTION
ENTERPRISE VIBROBIT LCC

EQUIPMENT "VIBROBIT 300"

MK71 Control Module

Setup Instruction

(with module software version from 1.10)

ВШПА.421412.3071 И1

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The MK71 Module Setup Instruction is intended to familiarize users (customers) with main operating principles and setup methods of MK71 safety shutdown logic module of equipment Vibrobit 300.

This document is a supplement to
ВШПА.421412.300 РЭ «Equipment "Vibrobit 300" Operations and Maintenance Manual».

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Contents

1 General

MK71 module is intended to carry out equipment logic signaling and safety shutdown signal generation for the monitored equipment. MK71 module is based upon CPLD (Complex Programmable Logic Device) Altera. The equipment safety shutdown outputs operation logic is determined by position of microswitches on the module board. MK71 module implements majority of logic charts protecting turbine-generators from dangerous vibration level and vibration step.

MK71 main functions:

- 48 logic inputs;
- 3 safety shutdown outputs of OC type;
- up to 4 additional inputs/outputs;
- safety shutdown logic reset and block output;
- outputs response delay from 0 to 3 sec. configured by microswitches;
- input logic signal configurable validity time for vibration step protection logic charts;
- logic outputs status indication;
- logic inputs/outputs status data transfer via digital communication interfaces RS485, CAN2.0B, diagnostic interface;
- discrete signals reception via CAN2.0B interface;
- module status reset by front panel button, external signal or by command via digital communication interfaces.
- test signal generation.

To transfer MK71 module status data via digital communication interfaces, installed on MK71 board is a high-performance 8-bit microcontroller, which enables simultaneous logic inputs/outputs status data gathering, digital communication interfaces support.

Protection logic operation is determined only by microswitches position and is not influenced by microcontroller software.

MK71 module operating modes are setup using personal computer or targeted setup instrument. To setup MK71 module using personal computer, started on computer should be a sofrware ModuleConfigurator, MK71 module should be connected to computer via diagnostic interface board MC01 USB (USB interface).

Table 1 – MK71 module specifications

Parameter description	Value
Number of logic inputs (6 groups 8 inputs each)	48
Number of module operation block logic inputs	1
Number of module reset logic inputs	1
Number of CPLD-based additional inputs	2
Number of microcontroller-based additional inputs	2
VDC signal range on logic inputs, V	0 – 5
Schmitt input buffer switch levels by logic inputs, V - logic 1, max - logic 0, min (active signal)	 3.5 1.5
Logic input pull-up resistance to +5V, Ohm	10 000 ±500
Number of CPLD-based safety shutdown discrete outputs	1
Number of CPLD-based additional outputs	2
Number of microcontroller-based additional outputs	3
Outputs of “OR” signals by groups	6
Variable signal test output	1
Module failure output	1
Module output discrete signals - type - VDC, V, max - output current, mA, max	 Open collector (OC) 24 100
Supported digital communication interfaces types	two RS485 (ModbusRTU)[1)], CAN2.0B I2C diagnostic
Ambient air operating temperature range (from and to inclusive), °C	+5 – +45
Power supply voltage	+(24 ± 1.0)
Consumption current, mA, max	50
[1)] Two RS485 interfaces are implemented in the module version MK71-R2.	

Table 2 – MK71 additional features

Parameter description	Value
Overall dimensions, mm	20.1 x 130 x 190
Mass, kg, max	0.15
Warm-up time, sec, max	10
Operating mode	continuous
Average service life, years, min	10
Mean time between failures (design), hours, min	100,000
Permissible relative humidity at a temperature of +35°C, %	80 at temperature +35°C
Industrial radio interference voltage, dB mkV, max - on frequency from 0.15 to 0.5 MHz - on frequency from 0.5 to 2.5 MHz - on frequency from 2.5 to 30 MHz	 80 74 60
Guarantee service life, months	24
Transportation conditions according to ГОСТ 23216-78	Ж
Storage conditions according to ГОСТ 15150-69	3 (Ж3)

Table 3 – RS485 interface parameters

Parameter description	Value
Number of RS485 interfaces: • ВШПА.421412.3071 МК71 control module • ВШПА.421412.3071-01 МК71-R2 control module	 1 2
Exchange protocol	ModBus RTU (partial implementation)
Data format	without parity bit, 2 stop bits
Pause between messages, byte, min	3.5
Data rate (one speed is set), bit/s	4800; 9600; 19200; 38400; 57600; 115200; 230400
Driver operating mode	semiduplex
Maximum nodes number on bus	256
Driver input resistance, kOhm, min	12
Electrostatic resistance, kV, min	± 16
Galvanic isolation from the module power supply source	none

Table 4 – CAN2.0 interface parameters

Parameter description	Value
Number of CAN2.0 interfaces	1
Operating mode	Active
Data format	Special for equipment Vibrobit 300
Code for indicating units	0x71 (113)
Data rate (one speed is set), kbit/s	1000; 500; 250; 200; 125; 100; 80; 40
Compliance with CAN bus standard	ISO-11898
Maximum nodes number on bus	112
Driver input resistance, kOhm, min	5
Electrostatic resistance, kV, min	± 6
Galvanic isolation from the module power supply source	none

Table 5 – I2C slave interface parameters

Parameter description	Value
MK71 address on I2C interface	0x72
Address format when accessing module registers	16-bit
Data rate, kbit/s, max	400
VDC on diagnostics connector to power matching device, V	5 ± 0.2
Permissible input current in power supply circuit on diagnostics connector, mA, max	50
Galvanic isolation	none

2 Module operation

2.1 Indication and control means

Arranged on MK71 module front panel are (Figure 1):

- four module status LEDs:
  - green LED ***Pwr***' - module power switched on;
  - bi-color LED ***'Ok'*** - module status indication;
    - green color – module normal operation;
    - yellow color - operation of microcontroller-connected logic outputs is blocked;
    - red color – module operation error;
    - blinking - protection logic reset state;
  - yellow LED ***'War'*** – warning (operation logic is determined by user);
  - red LED ***'Alarm'*** - warning (operation logic is determined by user);
- six red LEDs of ***'Input'*** unit - logic inputs status;
- three red LEDs of ***'Output'*** unit - protection outputs status;
- reset button ***'Reset'***;
- ***'D.port'*** diagnostic interface connector;
- handle for the module easy removal from framework.

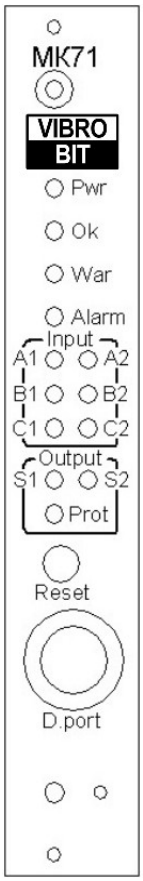


Figure1 – MK71 module front panel

'Input' unit LEDs combined into groups 8 inputs each, signal logic inputs status:

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

'Input' unit LEDs indicate logic inputs status. If ***'Input'*** unit LED illuminates, then active signal is present on one of logic inputs of the corresponding group. ***'Input'*** unit LED blinking indicates, that active level was present on one of logic inputs of the corresponding group, all group inputs have inactive signal level.

Output' unit LEDs indicate status of CPLD-controlled protection logic outputs:

not illuminated - inactive signal level on logic output;

blinks - logic inputs status combination corresponds to safety shutdown logic (set up by microswitches), time out is counted off to switch logic output to active state (protection actuation);

illuminates - logic output is in active state (protection actuated), logic inputs status has no effect on protection output.

Microcontroller, installed on MK71 board, controls ***'Ok', 'War', 'Alarm'*** LEDs operation. ***'War'***, ***'Alarm'*** LEDs can be assigned with additional signaling of logic inputs/outputs status or overall module status.

'Reset' button resets CPLD logic, microcontroller and carry out module "cold start".

MK71 module logic inputs/outputs status, operating mode (microswitches position) and other parameters are available for reading via digital communication interfaces.

2.2 Switching power on

Upon switching power on all safety shutdown outputs are inactive, module operation parameters (service functions) are loaded from non-volatile memory.

Each operating parameters section in non-volatile memory is accompanied with a check sum, permitting to check authenticity of loaded data. If calculated check sum is not the same as recorded sum in non-volatile memory, then data are considered damaged and unfit for module operation.

Each data section in non-volatile memory has main and reserve allocation. If operating parameters section from non-volatile memory is read with an error, then attempt is made to read the data from non-volatile memory reserve area.

If an error is detected in one of operating parameters sections (from main or reserve section), then module service functions operation is blocked, module failure logic signaling is generated, LED **'Ok'** on front panel will light up with red color.

At operating parameters normal loading before operation, LED ***'Ok'*** blinks with yellow color (with frequency about 2 Hz) indicating, that start initialization is in progress. During module start initialization, CPLD is in reset condition.

It is permitted to carry out MK71 module "hot" replacement in section without switching power off.

2.3 Module reset to initial state

There are several types of MK71 module reset:

- protection logic reset (CPLD reset);
- CPLD and microcontroller reset (similar to switching power on);
- module "cold start".

2.3.1 Protection logic reset

Protection logic (CPLD reset) is reset at:

- pressing ***'Reset'*** button, arranged on the module front panel;
- signal active level at L-Res input;
- command via digital communication interfaces;
- module switching power on;
- reset according to user command (by ***'Reset'*** button on front panel or by command via digital communication interfaces);
- changing microswitches positions, setting CPLD operating mode.

To reset CPLD – briefly press ***'Reset'*** button.

CPLD is reset by reset signals edge, not by level, what ensures safety shutdown logic operation restoration even at maintaining reset signals in active state. After detecting reset signal edge, CPLD is in reset status for about 4 seconds (LED ***'Ok'*** blinks at frequency of 1 Hz).

All inputs/outputs in CPLD reset status are inactive. CPLD reset reason is indicated in status bits, available for reading via digital communication interfaces.

2.3.2 CPLD and microcontroller reset

Carried out during CPLD and microcontroller reset is a sequence of actions, corresponding to switching power on. Reset reasons include:

- module switching power on;
- reset according to user command (by ***'Reset'*** button on front panel or by command via digital communication interfaces);
- microcontroller power supply voltage drop (power source malfunction);
- reset according to watchdog timer due to microprocessor program "hang-up".

By pressing ***'Reset'***, button user can reset module and carry out module "Cold start".

To reset microcontroller – briefly press button ***"Reset"***, then press button ***"Reset"*** and hold it until module is reset. Reset can be executed only after completing initialization cycle.

2.3.3 Module "Cold start"

"Cold start" is intended to record default operating parameters into non-volatile memory. This function is useful during module first switching power on after manufacturing or if it is necessary to carry out repeated setup, establishing predetermined operating parameters.

To switch to "Cold start" mode, press and hold button ***'Reset'*** during whole module initialization cycle after its reset. If module has switched to "Cold start" mode, then '***Ok'*** LED will blink with yellow color synchronously with ***'War'*** LED.

After switching to "Cold start" mode, it is necessary to confirm "Cold start". "Cold start" confirmation is a sequence of ***'Reset'*** button pressing similar to reset sequence in normal operating mode (brief pressing, pressing and holding ***'Reset'*** button).

Upon "Cold start" confirmation, module service settings are initialized with default values and are saved in non-volatile memory, then module is reset. If "Cold start" was not confirmed, module switches to normal operating mode.

'War' LED blinks during recording into non-volatile memory. Recording results can be determined by ***'War'*** LED illumination color:

- green - recording completed without errors;
- yellow - one of data sections was correctly recorded into non-volatile memory at the second attempt;
- red - one of data sections was recorded into non-volatile memory with an error.

Results of operation service parameters recording into non-volatile memory are indicated for 2 seconds, then module is reset automatically.

2.4 Logic inputs

MK71 logic inputs are divided into several functional groups:

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

All MK71 module logic inputs have the same circuit engineering and are designed for operation with signal levels of (0 - 5) V (CMOS (Complementary-Symmetry/Metal-Oxide Semiconductor) logic levels) or connection to open collector type outputs.

Provided on logic inputs are overvoltage protecting diodes and pull-up resistor 10 kOhm to circuit +5V (MK71 logic inputs circuit engineering enables voltage supply up to +24V).

Logic input signal passes RC filter (time constant 1 ms) and is supplied to Schmitt trigger input. Schmitt trigger output is connected with CPLD (or microcontroller) input. Provided for each logic signal in CPLD is a digital filter with time constant of 4 ms. Analog and digital filters on logic inputs are intended to filter pulse interferences (e.g. relay switching) which may cause protection false actuation.

Logic inputs status can be read using digital communication interfaces.

2.4.1 Safety shutdown logic inputs

Safety shutdown 48 inputs are grouped into 6 groups 8 inputs each. To indicate each group status on module front panel provided is LED in ***'Input'*** unit.

The following functions are implemented for each of 48 inputs:

- actuation memory;
- active status time validation;

Actuation memory determines which logic inputs had signal active level (memory function has no time marks). Memory is reset at CPLD reset.

Parameter step protection algorithms need logic signal to participate in safety shutdown logic for some time since switching to active status. Implemented in MK71 module are time validation functions with intervals of 4 and 8 seconds (set up by microswitches).

If signal active level is present at input and the established time interval is counted off, then this input doesn't participate in parameter step safety shutdown logic. Input status (with counted off validation interval) is reset at CPLD reset.

Upon step signaling acknowledgment on parameter measurement control module, the step logic signal is switched to inactive state, MK71 module starts counting off the validation time established interval. If during validation time, the logic input has signal inactive level, then corresponding logic input is again ready to participate in parameter step protection logic. Thus it isn't necessary to carry out MK71 module full reset, which may cause skip (false actuation) of parameter step event.

Logic inputs validation status is available for reading using digital communication interfaces.

2.4.2 Safety shutdown logic reset input

CPLD is reset to initial state during L-RES signal switching from inactive to active state. After reset signal detection, CPLD is in reset state for 4 seconds. Signal active level at L-RES input do not keep CPLD in reset status.

It is permitted to reset CPLD using pulse signal with duration of 10 ms min.

2.4.3 Safety shutdown logic block

With signal active level at L-ENA input, the safety shutdown logic is inactive (outputs block), combination at logic inputs may not cause protection actuation.

If one of logic outputs already was in actuated state before safety shutdown block, then it is not affected by block signal.

Safety shutdown logic block doesn't affect logic inputs operating modes, inputs status is available for reading using digital communication interfaces, memory function is operational and counted off are logic signal validation intervals for step algorithms etc.

2.4.4 CPLD additional logic inputs

Implemented in MK71 are two additional logic inputs, which depending on safety shutdown current logic have different operation algorithms:

- signals from logic inputs are supplied to corresponding additional logic outputs, connected to CPLD;
- signals from logic inputs are joined using "OR" circuit and supplied to additional logic output 2, connected to CPLD;
- additional logic inputs are used only to input logic signals into CVMS (Condition and Vibration Monitoring System), which status is available for reading using digital communication interfaces.

For additional inputs operation logic refer to section "Safety shutdown logic".

2.4.5 Microcontroller additional logic inputs (service function)

Additional logic inputs, connected to microcontroller are intended to input logic signals into CVMS, which status is available for reading using digital communication interfaces.

Response delay and logic signal inversion can be set up for microcontroller additional logic inputs.

Additional logic inputs at corresponding setup of MK71 module service functions can participate in logic signals generation at additional logic outputs, connected to microcontroller.

2.5 Logic outputs

MK71 module has 12 logic outputs of OC (open collector) type. Used as output keys are powerful MOSFET transistors with parallel-connected protective diode, designed for voltage of +24V. Logic outputs circuit engineering permits direct relay winding connection (with DCV of +24V max).

Logic outputs are functionally divided into two groups:

- logic outputs connected to CPLD;
- logic outputs connected to microcontroller.

Status of logic outputs connected to CPLD is indicated on MK71 module front panel in ***'Output'*** unit:

'Prot' — protection main output;

'S1' — CPLD additional output 1;

'S2' — CPLD additional output 2.

Microcontroller logic outputs status indication can be set up to LEDs ***'War', 'Alarm'***.

Logic outputs status is available for reading using digital communication interfaces.

2.5.1 CPLD logic outputs

Provided in MK71 module are three CPLD logic outputs with buffer circuit, implementing delay to incoming signal for the established time from 0 to 3 seconds (set up by microswitches).

If logic output buffer input has signal active level (logic inputs status corresponds to safety shutdown logic) during the established time, then corresponding output is switched to active status. There is no further (after switching to active state) output status change, until CPLD is reset.

If during output response delay counting off the safety shutdown logic block signal L-ENA will be switched to active state, then the corresponding output will remain in passive state (countdown is reset to initial state).

CPLD logic outputs actuation algorithm is determined by microswitches position (ref. section “Safety shutdown logic”).

Each of logic inputs 6 groups is provided with logic output “OR”, which indicates signal active level if one of the corresponding groups’ eight inputs has signal active level.

“OR” logic outputs has no latching function, they are unaffected by protection logic block signal.

2.5.2 Microcontroller logic outputs (service function)

MK71 module is provided with 3 logic outputs, connected to microcontroller. Operation of each of 3 logic outputs is configured by user with digital communication interfaces.

If check sum error is detected by one of the module operation parameters section, logic output 3 will have signal active level, other logic outputs of MK71 module (connected to microcontroller) will remain inactive.

After module switching on (reset), the logic outputs (connected to microcontroller) operation is blocked for a time `LogicOffStartUp`, counted after completing MK71 module initialization cycle.

User can block logic outputs (connected to microcontroller) operation which can be necessary during the module operation parameters correction or check of its operation, without fear of signaling actuation.

MK71 module includes “OR” matrix (`LogicMatrix`) of status flags switching to logic outputs. If at least one flag assigned to logic output is set, then corresponding logic output will have signal active level, if logic outputs operation is not blocked.

Specified for each flag is logic output number to which it will be assigned. If any flag has assigned logic output number of zero or more than 3, then corresponding flag status doesn’t affect any logic output.

Table 6 – Register flags `CPU_InOutput` and their position in logic outputs matrix `LogicMatrix`

Bit No.	Designation	Description	Code	Matrix position
0	outCPU1	Microcontroller output 1 controlled bit	outCPU1	0
1	outCPU2	Microcontroller output 2 controlled bit	outCPU2	1
2	inCPU1	Microcontroller additional output 1 status	inCPU1	2
3	inCPU2	Microcontroller additional output 2 status	inCPU2	3
4	outCAN1	Logic signal circuit by CAN interface, output 1	outCAN1	4
5	outCAN2	Logic signal circuit by CAN interface, output 2	outCAN2	5
6	outCAN3	Logic signal circuit by CAN interface, output 3	outCAN2	6
7	outF1	Logic formula, output 1	outF1	7

Bits can be `outCPU1`, `outCPU2` set/reset by commands via digital communication interfaces. At corresponding setting of logic signaling this function may be used for remote control of logic outputs, connected to microcontroller (e.g. relay control). After reset bits `outCPU1`, `outCPU2` are equal to 0.

The status inversion (register `LogicOut_Inversion`) can be assigned for microcontroller logic outputs 1, 2. Signal inactive level is set on the inverted logic outputs when the logic outputs blocking and module failure.

Notes

1 The logic chart of the signals received via the CAN interface is implemented in the MK71 module software version 1.10.

2 The logic outputs inversion is implemented in the MK71 module software version 1.14.

3 The logical rule description as an analytical logical formula is implemented in the MK71 module software version 1.14.

Table 7 – Register flags `CPLD_Output` and their position in logic outputs matrix `LogicMatrix`

Bit No.	Designation	Description	Code	Matrix position
0	outADD1	CPLD additional output 1 status	outADD1	8
1	outADD2	CPLD additional output 2 status	outADD2	9
2	outProt	CPLD protection main output status	outPROT	10
3	Reserv_0	Reserve, always equals to 0	-	11
4	outADD1_Wait	CPLD additional output 1 actuation waiting	waitADD1	12
5	outADD2_Wait	CPLD additional output 2 actuation waiting	waitADD2	13
6	outProt_Wait	CPLD protection main output actuation waiting	waitPROT	14
7	Reserv_1	Reserve, always equals to 0	-	15
Note - Actuation waiting means that logic combination at CPLD logic inputs corresponds to safety shutdown logic.				

Table 8 – Register flags `CPLD_Status` and their position in logic outputs matrix `LogicMatrix`

Bit No.	Designation	Description	Code	Matrix position
0	inAdd_1	CPLD additional output 1	inADD1	16
1	inAdd_2	CPLD additional output 2	inADD1	17
2	inEna_Ext	Safety shutdown logic block input	inENA	18
3	inRes_Ext	CPLD reset input	inRES	19
4	inRes_Key	***'Reset'*** button on module front panel	inResKey	20
5	inRes_CPU	CPLD reset signal from microcontroller	inResCPU	21
6	Reset	CPLD in reset state	Reset	22
7	CLK_524ms	CPLD clock signal with period of 524 ms	CLK	23

Table 9 – Register flags `StatusSys` and their position in logic outputs matrix `LogicMatrix`

Bit No.	Designation	Description	Code	Matrix position
0	ErrorLoadData	Operation parameters read error from non-volatile memory	ErrLD	24
1	LoadDataReserv	One or several operating parameters groups read from non-volatile memory reserve section	ResLD	25
2	LogicOffStartUp	Logic outputs operation block after module reset	LgOffSt	26
3	LogicOffUser	Logic outputs operation block by user command	LgOffU	27
4	InterfRS485_Off	RS485 interface disabled	RS_Off	28
5	InterfCAN_Off	CAN2.0B interface disabled	CAN_Off	29
6	PWM_Off	PWM test signal not generated	OneWr	30
7	ErrorCPLD	CPLD failure	Calibr	31

Table 10-Register flags StatusSysAdd

Bit No.	Designation	Description	Code	Matrix position
0	AllowOneWrite	Permission for single recording by RS485 interface No.1	-	-
1	AllowModbusR2	RS485 interface No.2 is implemented on the MK71 module board	-	-
2	InterfRS485_R2_Off	RS485 interface No.2 disabled	-	-
3	AllowOneWrite_R2	Permission for single recording by RS485 interface No.2	-	-
4	ErrorLogicFormula	Logic formula error	-	-
5		Reserve, equals to zero	-	-
6		Reserve, equals to zero	-	-
7		Reserve, equals to zero	-	-

2.5.3 Logic signaling received via CAN interface

The function of receiving signaling from control modules via the CAN interface and generating the safety shutdown signals is implemented in order to duplicate MK71 modules in CVMS sections of the Vibrobit 300.

The received signals from the control modules can be processed with pre-installed logic chart and sent to MK71 module logic outputs. Software logic chart operating principles are extremely simplified and are similar to physical logical signal supplied to MK71 inputs.

The software logic chart has 96 signals and allows for processing logic signals for a 16-support unit.

The logic chart of the signals received via the CAN interface is implemented in the MK71 module software version 1.10.

2.5.3.1 CAN interface setup

CAN interface need to be setup for the logic signaling operation:

- permit the interface operation;
- specify data rate and address.

It is recommended to specify the address after the supports sequential numbers range. The supports sequential numbers will be used in numbering addresses of the source modules.

If it is not required to transfer the MK71 module status information via the CAN interface, then it is permitted not to set up the sending period and messages sending flags.

Figure 2 shows an example of MK71 module CAN interface engagement in the ModuleConfigurator software.

Parameter	Value	Address
01. Permit interface operation	☑	0x1000
02. Data rate, bit/s	1000	0x1001
03. Module address on bus	101	0x1002
04. Message sending period (by 0.1), sec	0.1	0x1004
05.1 Messages about inputs state	☐	0x1005
05.2 Messages about active inputs state by time	☐	0x1006
05.3 Messages about inputs state	☐	0x1007
05.4 Messages about module state	☐	0x1008

Figure 2 – Example of MK71 module CAN interface engagement in the ModuleConfigurator software

2.5.3.2 Registration of message sources

It is necessary to specify from which modules and with which message code the messages will be received. I.e. configure the message sources. Overall, registered can be 16 sources, 16 modules monitoring the corresponding supports.

Figure 3 shows an example of CAN message source setup in ModuleConfigurator software.

Parameter	Value	Address
01. Enabled	☑	0x0800
02. Address CAN. Code SID (Hex)	0632	0x0806
03. Address CAN. Code EID (Hex)	00020001	0x0808
04.1 Use message ID	☑	0x0802
04.2 Message ID (Hex)	80	0x0803
05. Timeout receive data from source, sec	5	0x0801

Figure 3 – Example of CAN message source setup in ModuleConfigurator software

To setup each source it is necessary to specify:

- permit operation – permit source registration;
- specify source SID code. For MK32 module - 0x0632 (Hex format);
- specify source EID code. For MK32 module - 0x02nnnn (Hex format). Where nnn – MK32 module address on CAN bus. For example, if the MK32 module address of support 1 on the CAN bus is 0x0001, then the EID code will be 0x00020001;
- because MK32 modules transmit several messages from one address, separated by message codes, it is necessary to engage the message code recording;

- specify the message code (for example 0x80, corresponding to signaling transfer from MK32 modules);
- messages absence time-out serves to forced signaling reset to inactive state, if there were no messages from the corresponding module for a long time (communication break, failure etc.). Recommended to set 5 seconds.

Carry out similar setup for other sources, by changing the source EID code according to the module addresses. Changing the sources registration settings requires re-initialization of the MK71 module.

2.5.3.3 Message reception setup monitoring

The ModuleConfigurator software provides the ability to monitor the re-initialization of signaling reception via the CAN interface. The following information is available in item “09. Signaling via the CAN interface”.

- normal initialization and signaling operation;
- messages absence detection from at least one of the sources;
- filters and masks of SID, EID codes contain information about the CAN message receiver setup and the messages filtration degree on the CAN bus. Only messages registered during the sources setup will be processed.

Figure 4 shows an example of the CAN interface setup monitoring in ModuleConfigurator software.

Parameter	Value	Address
01.0 Alarm on	☑	0x0500
01.1 No messages from one sources	☑	0x0500
02.1 Filter SID (Hex)	0020	0x0504
02.2 Mask SID (Hex)	01A8	0x0506
03.1 Filter EID (Hex)	00000000	0x0508
03.2 Mask EID (Hex)	0001F3C0	0x050C

Figure 4 – Example of the CAN interface setup monitoring in ModuleConfigurator software

Time-out counters status can be viewed for each source. Value 0 - no messages received. In normal operating mode, the counter value should be close to the value set during the source setup. Message transmission period (in MK32 it is set with an increment of 0.5 s) should be considered when evaluating the counter value.

Figure 5 shows an example of the CAN messages time-out counter monitoring in ModuleConfigurator software.

Parameter	Value	Address
01. Source counter 1, sec	0.0	0x0520
02. Source counter 2, sec	0.0	0x0521
03. Source counter 3, sec	0.0	0x0522
04. Source counter 4, sec	0.0	0x0523
05. Source counter 5, sec	0.0	0x0524
06. Source counter 6, sec	0.0	0x0525
07. Source counter 7, sec	0.0	0x0526
08. Source counter 8, sec	0.0	0x0527
09. Source counter 9, sec	0.0	0x0528

Figure 5 – Example of the CAN messages time-out counter monitoring in ModuleConfigurator software

Messages content can be monitored for each source, it can be viewed in item “02. Source Messages” of the ModuleConfigurator software.

Figure 6 shows an example of CAN messages reception monitoring from source No. 1 in ModuleConfigurator software.

Parameter	Value	Address
01. Message received	☐	0x0600
02. Received bytes length	0	0x0601
03.0 Byte 0 (message code)	00	0x0602
03.1 Byte 1	00	0x0603
03.2 Byte 2	00	0x0604
03.3 Byte 3	00	0x0605
03.4 Byte 4	00	0x0606
03.5 Byte 5	00	0x0607
03.6 Byte 6	00	0x0608
03.7 Byte 7	00	0x0609

Figure 6 – Example of CAN messages reception monitoring from source No. 1 in ModuleConfigurator software

This information can be used during the system setup and signaling monitoring, for example, the structure of messages received from MK32 modules:

- byte 0 - message code 0x80, value that was specified during the source setup;
- byte 1 - always equals to 0x00;
- byte 2 - step signaling flags (active level);
- byte 3 - step signaling flags (latch);
- bytes 4-7 - setpoints flags.

To receive signaling messages from the control modules, it is necessary to setup a corresponding permission for signaling via the CAN interface during the modules setup.

2.5.3.4 Setup of messages processing rules

Rules should be registered to extract useful information from received messages. The following is configured for each rule:

- rule type (logical 'AND' mask, logical 'OR' mask);
- data type (according to the C language rules);
- offset in CAN message (byte);
- bitmask value (32 bits).

Figure 7 shows an example of the rule No. 1 setup for processing CAN messages in ModuleConfigurator software.

Parameter	Value	Address
01. Rule type	Mask by 'AND'	0x0900
02. Data type	UChar (1 byte)	0x0901
03. Offset, byte	2	0x0902
04. Value, mask (Hex)	00000001	0x0904

Figure 7 – Example of the rule No. 1 setup for processing CAN messages in ModuleConfigurator software

Below is an example of the rules setup to implement the vibration step logic.

Step signaling (active flag) is present in CAN message 2-nd byte from MK32 module. Flags in this byte are arranged in the following way:

bit 0 – main parameter step monitoring, channel 1 - vertical component (0x01);
bit 1 – rotational component step monitoring, channel 1 - vertical component;
bit 2 – main parameter step monitoring, channel 2 - transverse component (0x04);
bit 3 – rotational component step monitoring, channel 2 - transverse component;
bit 4 – main parameter step monitoring, channel 3 - axial component (0x10);
bit 5 – rotational component step monitoring, channel 3 - axial component;
bit 6 – main parameter step monitoring, channel 4;
bit 7 – rotational component step monitoring, channel 4.

Three rules need to be created:

1. main parameter step (active signal), vertical component (group SA1);
2. main parameter step (active signal), vertical component (group SB1);
3. main parameter step (active signal), vertical component (group SC1).

Figure 7 shows the 1st rule setup:

- masking by "AND". 04. Value, the mask is applied to the received data bit by bit with "AND" logic. If the result is not null, then "True";
- data type - 1 byte, unsigned;
- offset in the message. 2 - because the second byte is required.

The other two rules (for the transverse and axial components) are configured similarly, only the mask changes.

2.5.3.5 Signaling purpose

For the logic chart operation, it is necessary to assign signaling, similar to switching signals from control modules to the MK32 inputs LA1, LB1, LC1.

Logic signals SA1, SB1, SC1 are software signaling inputs containing 16 signals each. For the parameter step monitoring of the 8-support unit, the following signaling distribution is adopted:

SA1-01 - SA1-8 - vibration step along the supports in the vertical plane;

SB1-01 - SB1-8 - vibration step along the supports in the horizontal plane;

SC1-01 - SC1-8 - vibration step along the supports in the axial plane.

It is necessary to specify the source number and the rule number for each signal. Signals are inactive if:

- time-out exceeded for the corresponding source;
- no source or rule assignment.

Figure 8 shows an example of signaling assignment in ModuleConfigurator software.

Parameter	Value	Address
01.1 Signal SA1-01. Source number	01	0x0A00
01.2 Signal SA1-01. Rule number	01	0x0A01
02.1 Signal SA1-02. Source number	02	0x0A02
02.2 Signal SA1-02. Rule number	01	0x0A03
03.1 Signal SA1-03. Source number	03	0x0A04
03.2 Signal SA1-03. Rule number	01	0x0A05
04.1 Signal SA1-04. Source number	04	0x0A06
04.2 Signal SA1-04. Rule number	01	0x0A07
05.1 Signal SA1-05. Source number	05	0x0A08
05.2 Signal SA1-05. Rule number	01	0x0A09
06.1 Signal SA1-06. Source number	06	0x0A0A
06.2 Signal SA1-06. Rule number	01	0x0A0B
07.1 Signal SA1-07. Source number	07	0x0A0C
07.2 Signal SA1-07. Rule number	01	0x0A0D
08.1 Signal SA1-08. Source number	08	0x0A0E
08.2 Signal SA1-08. Rule number	01	0x0A0F
09.1 Signal SA1-09. Source number	09	0x0A10
09.2 Signal SA1-09. Rule number	01	0x0A11

Figure 8 – Example of signaling assignment in ModuleConfigurator software

It is possible to monitor the signaling status in order to check the logic signals reception of and the logic chart operation. Signaling group data is presented in hexadecimal format, 16 signals per group. Group signaling information is available regardless of the configured logic chart.

Figure 9 shows an example of the CAN logic signals monitoring in the ModuleConfigurator software.

Parameter	Value	Address
01. Alarm logic SA1 (Hex)	0000	0x0400
02. Alarm logic SB1 (Hex)	0000	0x0402
03. Alarm logic SC1 (Hex)	0000	0x0404
04. Alarm logic SA2 (Hex)	0000	0x0406
05. Alarm logic SB2 (Hex)	0000	0x0408
06. Alarm logic SC2 (Hex)	0000	0x040A

Figure 9 – Example of the CAN logic signals monitoring in the ModuleConfigurator software

2.5.3.6 Signaling logics

The following should be specified during the signaling logic setup:

- logic chart (two logic charts are supported);
- response delay;
- output mode: direct control, trigger.

Figure 10 shows an example of the CAN signaling logic setup in the ModuleConfigurator software.

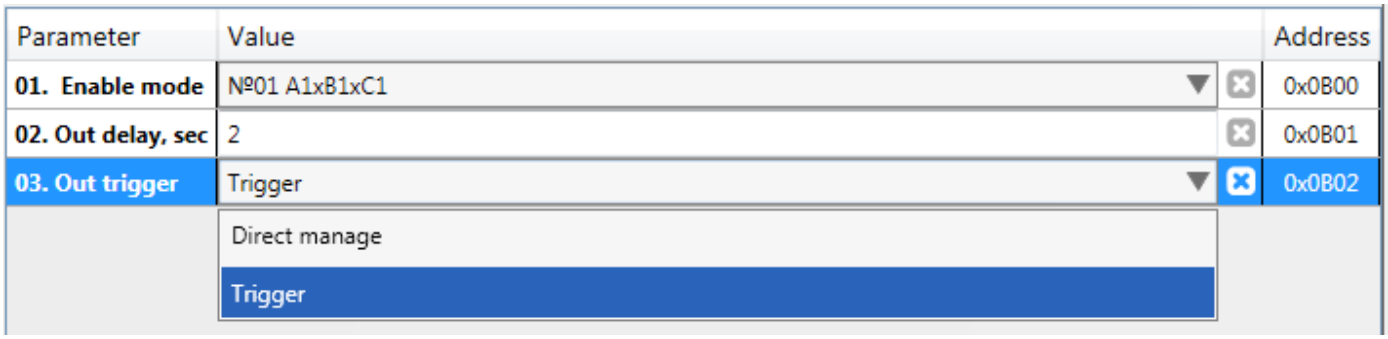


Figure 10 – Example of the CAN signaling logic setup in the ModuleConfigurator software

Software version 1.10 of the MK71 module supports two logic charts:

No.01 A1xB1xC1

The signal active level at the logic output 1 is generated with:

- two components of one support (vertical, transverse, axial);
- any two components of adjacent supports (vertical, transverse, axial).

No.02 A1xB1 - C1

The signal active level at the logic output 1 is generated with:

- two components of one support (vertical, transverse);
- any two components of adjacent supports (vertical, transverse).

The signal active level at the logic output 2 is generated with:

- two signals of axial components of adjacent supports.

Output operating modes:

- direct control - the signal is transmitted to the output during the set delay countdown;
- trigger - the output active state is latched when the logic is active after the set delay countdown. Trigger reset by MK71 module reset signals: button on the front panel, command via communication interfaces, reset logic input.

The signaling logic can be monitored in two sections of the ModuleConfigurator software:

- section “04.09.04. Signaling status. Outputs” available are the signaling browsing after the logic matrix (initial status), output after the trigger (result) and the time-out counter (delay);
- section "04.04 CPU logic inputs/outputs" flags "CAN signaling output status".

Figure 11 shows an example of CAN signaling monitoring after the logic matrix in the ModuleConfigurator software.

Parameter	Value	Address
01. Output logic matrix	0	0x0700
02. "Output of algorithm (result)"	0	0x0701
03 Countdown timeout set value , sec	0.0	0x0702

Figure 11 – Example of CAN signaling monitoring after the logic matrix in the ModuleConfigurator software

Figure 12 shows an example of CAN signaling monitoring at CPU logic inputs/outputs in the ModuleConfigurator software.

Parameter	Value	Address
00. CPU output 1 customizable bit	☐	0x0016
01. CPU output 2 customizable bit	☐	0x0016
02. CPU additional input 1 state	☐	0x0016
03. CPU additional input 2 state	☐	0x0016
04. CAN alarm output state 1	☐	0x0016
05. CAN alarm output state 2	☐	0x0016
06. CAN alarm output state 3	☐	0x0016
07. State of logical formula output 1	☐	0x0016

Figure 12 – Example of CAN signaling monitoring at CPU logic inputs/outputs in the ModuleConfigurator software

2.5.3.7 Assignment to logic output

Signaling logic result via the CAN interface can be assigned to the logic output in the section “02.02.01 Microcontroller” of the ModuleConfigurator software. Specify the logic output and, if necessary, the signal LEDs for the desired signal.

All signals assigned to the MK71 module logic output are combined using the "OR" chart. The microcontroller logic outputs are affected by the logic signaling block.

Figure 13 shows an example of assigning a CAN signaling to a logic output in the ModuleConfigurator software.

Parameter	Value	Address
00. CPU output 1 controlled bit	○ War ● Alarm 1	0x0E07
01. CPU output 2 controlled bit	○ War ● Alarm 2	0x0E08
02. CPU additional input 1 status	○ War ○ Alarm --	0x0E09
03. CPU additional input 2 status	○ War ○ Alarm --	0x0E0A
04. CAN alarm output 1 status	● War ○ Alarm 3	0x0E0B
05. CAN alarm output 2 status	○ War ○ Alarm --	0x0E0C
06. CAN alarm output 3 status	○ War ○ Alarm 1	0x0E0D
07. Status of output 1 logic formula	○ War ○ Alarm 2	0x0E0E
		3

Figure 13 – Example of assigning a CAN signaling to a logic output in the ModuleConfigurator software

2.5.4 Logic signaling configured by logic formula

One logical signal (bit 7 `outF1` of the `CPU_InOutput` register) can be configured analytically using a logical sequence. Used in logical operations are boolean functions on module status flags. Maximum number of operations is 32. Logical operations are performed sequentially from zero to the "END" command or to the last command.

Logical rules command structure is given in Table 50. To setup and edit logical rules, provided in ModuleConfigurator software is a special mean enabling to form logical rules in convenient and simplified form.

Logical operations used in the program to generate logical rules:

" | " - logical operation "OR";
" ^ " - logical operation "exclusive OR";
" & " - logical operation "AND";
" ! " - logical operation "NOT";

Logical operations execution order (top down in order):

1) " ! " - logical operation "NOT";
2) " & " - logical operation "AND";
3) " | " and " ^ " are equivalent, logical operation "OR", logical operation "exclusive OR";
4) " **->** " - calculation results recording.

Figure 14 shows an example of a logical sequence configuring in the ModuleConfigurator software.

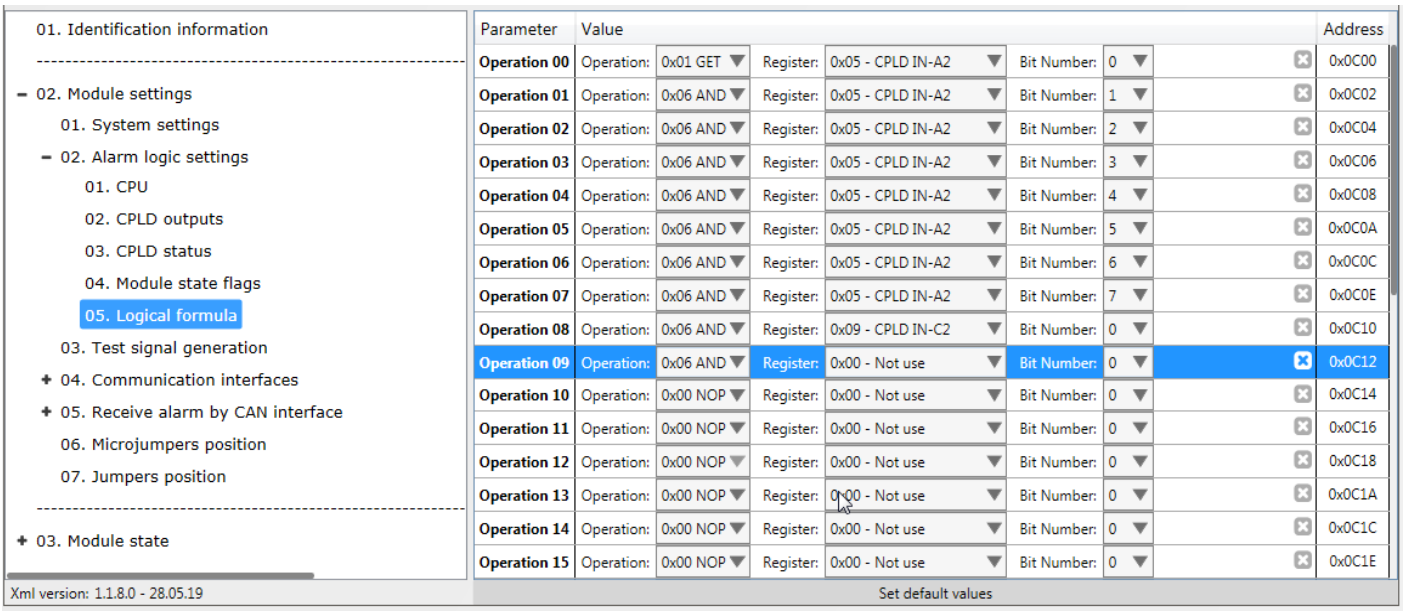


Figure 14 – Example of a logical sequence configuring in the ModuleConfigurator software

The result of the logical sequence execution should be transferred to the physical output in the logical signaling settings.

Figure 15 shows an example of a logic formula assigning to logic output No.1 in ModuleConfigurator software.

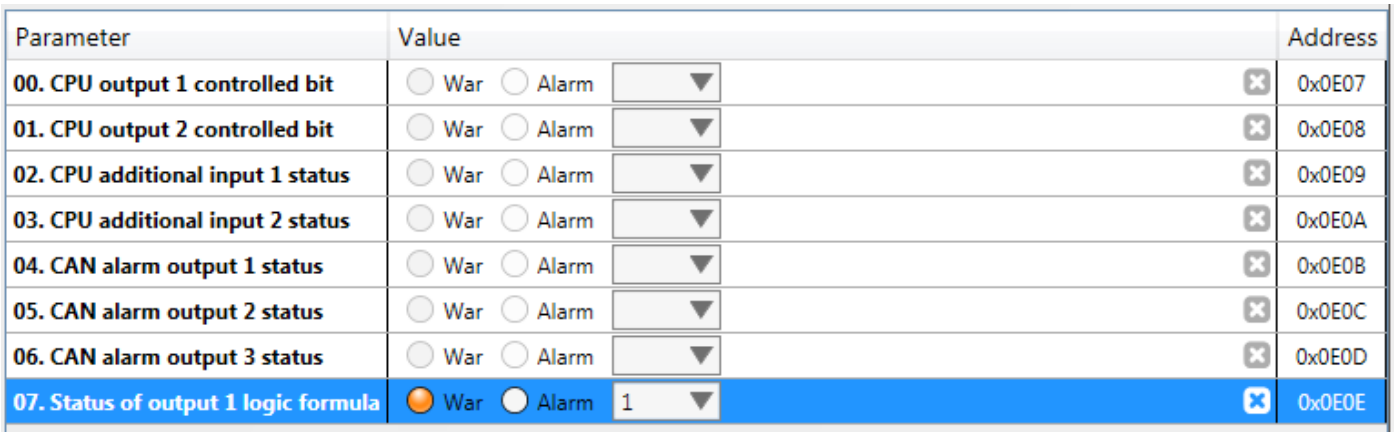


Figure 15 – Example of a logic formula assigning to logic output No.1 in ModuleConfigurator software

2.6 Test signal generation

MK71 module has one test signal output. Test signal can originate from:

- CPLD output, meander with frequency of 61 Hz;
- Microcontroller PWM (Pulse Width Modulation) output, generating test signals of different form and frequency.

Test signal can be used to check serviceability of control modules, measuring variable signal. Test signal permissible voltage range from 0 to +5V, what should be considered during adjustment.

Test signal source is selected using jumpers X5, X7 on MK71 board. Resistors R251 and R252 can be used to set constant component level and test signal excursion (Ref. Appendix A).

CPLD-generated test signal will continue generating even if module CPLD is in reset condition.

2.6.1 Microcontroller PWM output (service function)

Microcontroller PWM output can be used to generate test signal of different form and frequency. Test signal is generated using 8-bit PWM module (maximum sampling number 128) and analog LPF (Low-Pass Filter) with cutoff frequency of 1.5 kHz.

To set up microcontroller-generated test signal proceed as follows:

- Calculate necessary number of 8-bit samplings for module PWM (buffer `PWM_Buffer`)
- Specify sampling number for test signal generation (`PWM_Size` parameter);
- Determine sampling period (parameter `PWM_Period`), minimum sampling period 50 μs.

Samplings number and sampling period can be used to determine generated signal frequency.

If samplings number is less than 1 or sampling frequency is less than 50 μs, test signal is not generated (flag `PWM_Off` is set). PWM test signal is not generated at module initialization.

After the module “Cold start”, PWM is configured for 50 Hz harmonic test signal generation.

Constant component and excursion can be specified in two ways:

- Constant component and excursion are preset in samplings PWM code (X5 in position 1-2);
- Constant component and excursion are set using resistors R251, R252 (X5 in position 2-3);

3 Safety shutdown logic

Safety shutdown logic implemented on CPLD doesn't depend on microcontroller status and operating mode. Logic chart specific implementation is set using eight microswitches, arranged on module board.

MK71 module is optimized for logic chaining of 8 and 16 nods (measurement control modules, generating logic signals). It is permitted to cascade MK71 modules to lengthen safety shutdown logic chains.

3.1 Logic inputs/outputs grouping

All logic inputs/outputs are grouped, simplifying MK71 module description and implementation for equipment safety shutdown logic building.

Table 11 – Logic inputs groups and "OR" outputs by groups

Signaling	Inputs designation	Terminal No.
Vertical component (L1A group)	L1A-1, L1A-2, L1A-3, L1A-4 L1A-5, L1A-6, L1A-7, L1A-8	A8, A10, A12, A14, A16, A18, A20, A22
"OR" output by L1A group	OUT-L1A	A24
Transverse component (L1B group)	L1B-1, L1B-2, L1B-3, L1B-4 L1B-5, L1B-6, L1B-7, L1B-8	B7, B9, B11, B13, B15, B17, B19, B21
"OR" output by L1B group	OUT-L1B	B23
Axial component (L1C group)	L1C-1, L1C-2, L1C-3, L1C-4 L1C-5, L1C-6, L1C-7, L1C-8	C8, C10, C12, C14, C16, C18, C20, C22
"OR" output by L1C group	OUT-L1C	C24
Vertical component (L2A group)	L2A-1, L2A-2, L2A-3, L2A-4 L2A-5, L2A-6, L2A-7, L2A-8	A7, A9, A11, A13, A15, A17, A19, A21
"OR" output by L2A group	OUT-L2A	A23
Transverse component (L2B group)	L2B-1, L2B-2, L2B-3, L2B-4 L2B-5, L2B-6, L2B-7, L2B-8	B8, B10, B12, B14, B16, B18, B20, B22
"OR" output by L2B group	OUT-L2B	B24
Axial component (L2C group)	L2C-1, L2C-2, L2C-3, L2C-4 L2C-5, L2C-6, L2C-7, L2C-8	C7, C9, C11, C13, C16, C17, C19, C21
"OR" output by L2C group	OUT-L2C	C23

For example, dangerous vibration level (11.2 mm/s) setpoint exceeding signals can be supplied to logic inputs of groups L1A, L1B, L1C and warning level (7.1 mm/s) setpoint exceeding signal – to logic inputs of groups L2A, L2B, L2C.

Table 12 – Control signals, additional inputs/outputs, safety shutdown main output

Signaling	Inputs designation	Terminal No.
CPLD additional input 1	L-ADD1	C4
CPLD additional output 1	OUT-ADD1	C26
CPLD additional input 2	L-ADD2	C3
CPLD additional output 2	OUT-ADD2	C25
Safety shutdown logic block	L-ENA	B2
Protection logic reset	L-RES	A4
Protection main output	OUT-PR	A26

3.2 Microswitches purpose

Microswitches are used to set:

- Safety shutdown logic operating mode;
- Interaction between input logic groups;
- Safety shutdown logic;
- Input signals validation time for safety shutdown logic by parameter value step;
- Safety shutdown outputs response delay time.

Table 13 – Module operating mode (switch S3)

S3	Description
OFF	Dangerous vibration level protection
ON	Dangerous vibration step protection

Table 14 – Interaction between input groups (switches S1, S2)

Mode	S1	S2	Description
0	OFF	OFF	All groups (6 groups 8 inputs each) operate independently
1	OFF	ON	Inputs are united into 3 independent units Unit 1 – groups L1A, L2A (vertical component) Unit 2 – groups L1B, L2B (transverse component) Unit 3 – groups L1C, L2C (axial component)
2	ON	OFF	Inputs are united into 2 independent units Unit 1 – groups L1A, L2A (vertical component), groups L1B, L2B (transverse component) Unit 2 – groups L1C, L2C (axial component)
3	ON	ON	All input groups operate interacting with each other

Table 15 - Response delay of outputs OUT_PR, OUT_ADD1, OUT_ADD2 (switches S7, S8)

S7	S8	Description
OFF	OFF	Delay 0 seconds
OFF	ON	Delay 1 second
ON	OFF	Delay 2 seconds
ON	ON	Delay 3 seconds

Microswitches S4, S5, S6 determine specific safety shutdown logic implementation for different interaction types between input groups and protection modes.

3.3 Dangerous vibration level protection

In dangerous vibration level protection mode, the S3 switch should be in position OFF. For not implemented logic charts, the output OUT-PR is inactive.

3.3.1 Interaction mode 0 (S1=OFF, S2=OFF, S3=OFF)

This operating mode can be used to control dangerous vibration level (11.2 mm/s) on adjacent bearing supports. Operation logic is determined by switches S4, S5. Microswitch S6 determines additional outputs operating mode.

Table 16 – Protection logic for interaction mode 0 (S1=OFF, S2=OFF, S3=OFF)

S4	S5	Description
OFF	OFF	All 8 signals of each group are gathered in “AND” logic serial chain. **S6 = OFF** Groups output signals are joined by “OR” and supplied to protection output OUT-PR (Figure 16). OUT_ADD1, OUT_ADD2 - operate in normal mode **S6 = ON** Homonymous groups output signals are joined by “OR” and supplied to protection output OUT-PR, OUT_ADD1, OUT_ADD2 correspondingly.
OFF	ON	Signals of homonymous groups (L1A-L2A; L1B-L2B; L1C-L2C) are joined in “AND” serial chains consisting of 16 inputs. **S6 = OFF** Groups output signals are joined by “OR” and supplied to protection output OUT-PR. OUT_ADD1, OUT_ADD2 - operate in normal mode **S6 = ON** Homonymous groups output signals are joined by “OR” and supplied to protection output OUT-PR, OUT_ADD1, OUT_ADD2 correspondingly (Figure 17).
ON	OFF	Groups L1A-L2A are intended for alarm setpoints (16 inputs), groups L1B-L2B are intended for warning setpoints. OUT-PR output has signal active level at any two warning setpoints signals and at least one alarm setpoint. **S6 = OFF** OUT_ADD1, OUT_ADD2 - operate in normal mode **S6 = ON** (Figure 18) OUT_ADD1 - L1C-L2C groups signals are joined in “AND” serial chains consisting of 16 inputs. OUT_ADD2 – Additional outputs signals are joined by “OR” circuit.
ON	ON	***Change for code version CPLD 1.1 (dated 23.04.2009) and above.*** Groups L1A, L1B, L1C are intended for alarm setpoints (vertical, transverse and axial component accordingly). OUT-PR output has signal active level at any two alarm setpoints signals (vertical, transverse, axial) of one support or two similar components of adjacent supports. Groups L2A, L2B, L2C outputs can receive warning setpoint logic signals for vertical, transverse and axial components accordingly. Warning setpoints signaling doesn’t participate in protection logic. **S6 = OFF** OUT_ADD1, OUT_ADD2 - operate in normal mode **S6 = ON** OUT_ADD1, OUT_ADD2 - always inactive

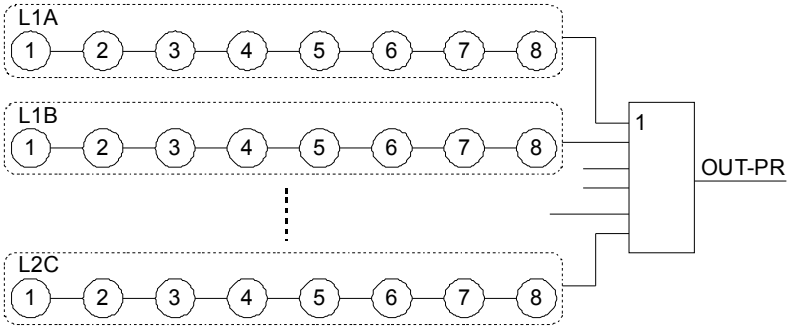


Figure 16 – Logic chart (S1=OFF, S2=OFF, S3=OFF, S4=OFF, S5=OFF, S6=OFF)

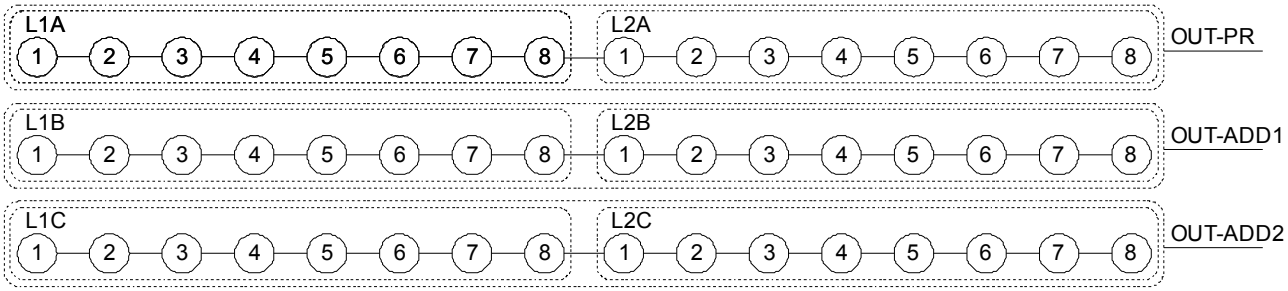


Figure 17 – Logic chart (S1=OFF, S2=OFF, S3=OFF, S4=OFF, S5=ON, S6=ON)

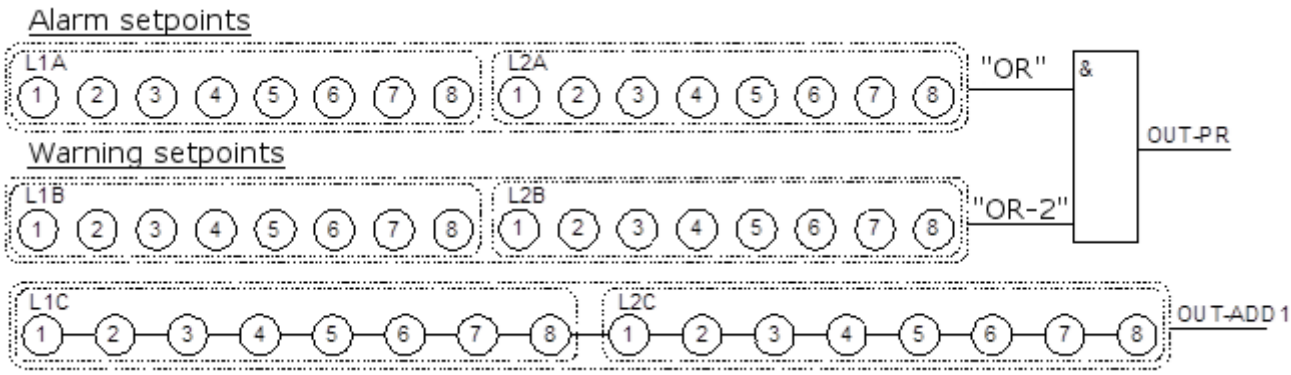


Figure 18 – Logic chart (S1=OFF, S2=OFF, S3=OFF, S4=ON, S5=OFF, S6=ON)

3.3.2 Interaction mode 1 (S1=OFF, S2=ON, S3=OFF)

Input groups are joined into 3 units.

Table 17 – Purpose of input groups units for interaction mode 1 (S1=OFF, S2=ON, S3=OFF)

Unit	Purpose	Used inputs	Protection output
A	Vertical component	L1A-1:L1A-8 — alarm setpoint (11.2 mm/s) L2A-1:L2A-8 — warning setpoint (7.1 mm/s)	determined by S6
B	Transverse component	L1B-1:L1B-8 — alarm setpoint (11.2 mm/s) L2B-1:L2B-8 — warning setpoint (7.1 mm/s)	
C	Axial component	L1C-1:L1C-8 — alarm setpoint (11.2 mm/s) L2C-1:L2C-8 — warning setpoint (7.1 mm/s)	

S6 switch determines additional outputs usage (unless otherwise specified)

Table 18 – S6 switch positions for interaction mode 1 (S1=OFF, S2=ON, S3=OFF)

S6	Description
OFF	All signaling by units is joined by “OR” at OUT-PR output Additional inputs L-ADD1, L-ADD2 and outputs OUT-ADD1, OUT-ADD2 operate in normal mode.
ON	Unit A to output OUT-PR Unit B to output OUT-ADD1 Unit C to output OUT-ADD2 Additional outputs OUT-ADD1, OUT-ADD2 operate in protection algorithm. Additional inputs can be used to transfer logic signals to CVMS.

Table 19 – Protection logic for interaction mode 1 (S1=OFF, S2=ON, S3=OFF)

S4	S5	Description
OFF	OFF	Participated in protection logic is only alarm setpoint signaling, protecting by vibration dangerous level at adjacent supports. (Figure 19) Connection of warning setpoints signaling can be used to transfer corresponding logic outputs status of control modules to CVMS.
OFF	ON	Unit protection signaling actuates provided there is active status of two warning signaling signals (7.1 mm/s) and one alarm signaling signal (11.2 mm/s). (Figure 20)
ON	OFF	Unit protection signaling actuates provided there is alarm signaling (11.2 mm/s) and warning setpoint (7.1 mm/s) on adjacent support (Figure 21)
ON	ON	***Change for code version CPLD 1.1 (dated 23.04.2009) and above.*** Only alarm setpoint signaling participate in protection logic. Unit protection signaling actuates provided there is alarm signaling active status of support vibration any component (vertical, transverse) and alarm signaling active status of adjacent support vibration any component (vertical, transverse). Unit protection signaling actuates provided there is alarm signaling active status of support vibration axial component and alarm signaling active status of adjacent support vibration axial component. Connection of warning setpoints signaling can be used to transfer corresponding logic outputs status of control modules to CVMS. **S6 = OFF** OUT-PR – signaling by vertical, transverse or axial component OUT_ADD1, OUT_ADD2 - operate in normal mode **S6 = ON** OUT-PR – signaling by vertical and transverse component OUT_ADD1 – signaling by axial component OUT_ADD2 – always inactive

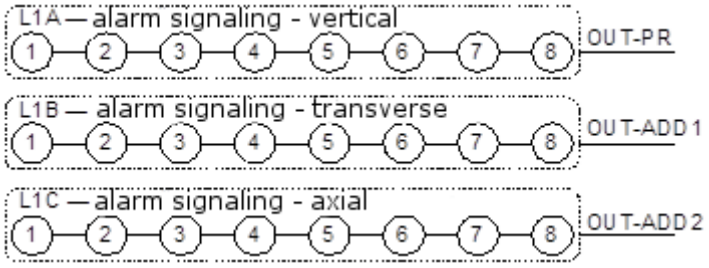


Figure 19 – Logic chart (S1=OFF, S2=ON, S3=OFF, S4=OFF, S5=OFF, S6=ON)

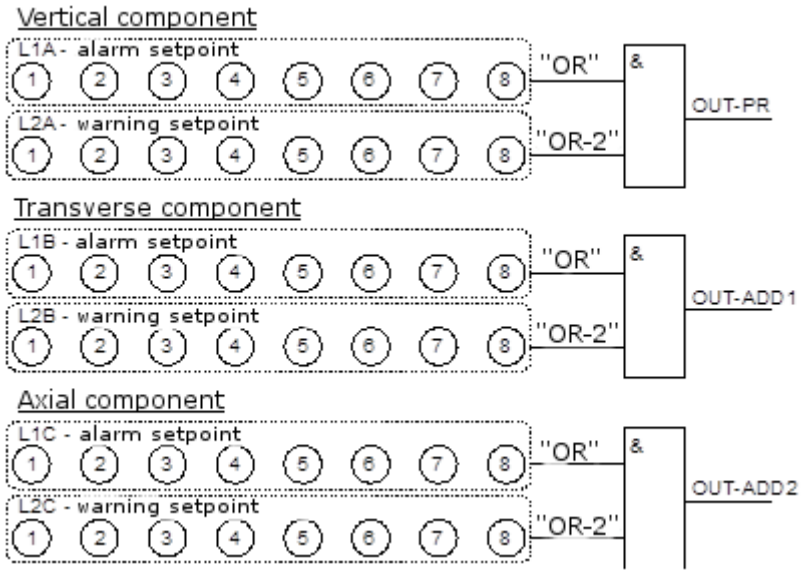


Figure 20 – Logic chart (S1=OFF, S2=ON, S3=OFF, S4=OFF, S5=ON, S6=ON)

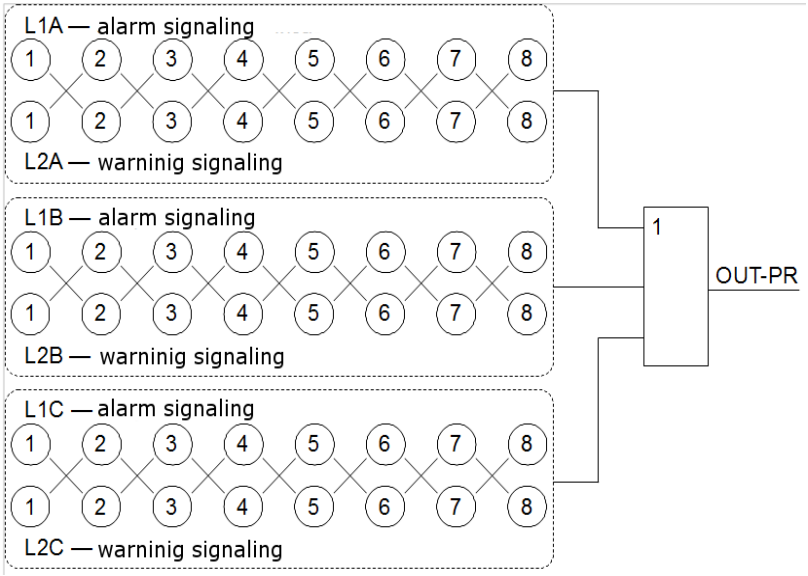


Figure 21 – Logic chart (S1=OFF, S2=ON, S3=OFF, S4=ON, S5=OFF, S6=OFF)

3.3.3 Interaction mode 2 (S1=ON, S2=OFF, S3=OFF)

Input groups are joined into two units vertical + transverse components, axial component.

Table 20 – Purpose of input groups units for interaction mode 2 (S1=ON, S2=OFF, S3=OFF)

Unit	Purpose	Used inputs	Protection output
A	Vertical component	L1A-1:L1A-8 — alarm setpoint (11.2 mm/s) L2A-1:L2A-8 — warning setpoint (7.1 mm/s)	OUT-PR
	Transverse component	L1B-1:L1B-8 — alarm setpoint (11.2 mm/s) L2B-1:L2B-8 — warning setpoint (7.1 mm/s)	
C	Axial component	L1C-1:l1C-8 — alarm setpoint (11.2мм/с) L2C-1:L2C-8 — warning setpoint (7.1 mm/s)	determined by S6

Signaling output assignment for axial component

Table 21 – S6 switch position for interaction mode 2 (S1=ON, S2=OFF, S3=OFF)

S6	Description
OFF	Axial component signaling is joined by “OR” with vertical and transverse component signaling and is transferred to OUT-PR output
ON	Axial component signaling is transferred to OUT-ADD1 output. Additional signals L-ADD1, L-ADD2 are joined using “OR” circuit and supplied to additional output OUT-ADD2.

Table 22 – Protection logic for interaction mode 2 (S1=ON, S2=OFF, S3=OFF)

S4	S5	Description
OFF	OFF	Vibration increase of any component (vertical, transverse) of any bearing above 11.2 mm/s and adjacent bearing vibration value of any component (vertical, transverse) 7.1 mm/s. Vibration axial component increase of any bearing above 11.2 mm/s and adjacent bearing vibration value of axial component 7.1 mm/s.
OFF	ON	Vibration increase of any component (vertical, transverse) of any bearing above 11.2 mm/s and adjacent bearing vibration value of any component (vertical, transverse) 7.1 mm/s. Vibration increase of any component (vertical, transverse) of any bearing above 11.2 mm/s and other component (vertical, transverse) value of the same bearing 7.1 mm/s. Vibration axial component increase of any bearing above 11.2 mm/s and adjacent bearing vibration value of axial component 7.1 mm/s.
ON		Corresponding alarm setpoints (11.2 mm/s) are supplied to inuts of groups L2A, L2B, L2C. Logic chain length is increased up to 16 inputs. At S5 = OFF ant S5 = ON (any position) 1. Vibration increase of any component (vertical, transverse) of any bearing above 11.2 mm/s and adjacent bearing vibration value of any component (vertical, transverse) 11.2 mm/s. 2. Vibration axial component increase of any bearing above 11.2 mm/s and adjacent bearing vibration value of axial component 11.2 mm/s. Only at S5 = ON 3. Vibration increase of any component (vertical, transverse) of any bearing above 11.2 mm/s and other component (vertical, transverse) value of the same bearing above 11.2 mm/s.
ON		

3.3.4 Interaction mode 3 (S1=ON, S2=ON, S3=OFF)

Input groups are joined into one unit vertical + transverse + axial components.

Table 23 – Purpose of input groups units for interaction mode 3 (S1=ON, S2=ON, S3=OFF)

Unit	Purpose	Used inputs	Protection output
	Vertical component	L1A-1:L1A-8 — alarm setpoint (11.2 mm/s) L2A-1:L2A-8 — warning setpoint (7.1 mm/s)	
A	Transverse component	L1B-1:L1B-8 — alarm setpoint (11.2 mm/s) L2B-1:L2B-8 — warning setpoint (7.1 mm/s)	OUT-PR
	Axial component	L1C-1:L1C-8 — alarm setpoint (11.2 mm/s) L2C-1:L2C-8 — warning setpoint (7.1 mm/s)	

Additional inputs L-ADD1, L-ADD2 and outputs OUT-ADD1, OUT-ADD2 operate in normal mode (repeating logic signals from input to output).

Table 24 – Protection logic for interaction mode 3 (S1=ON, S2=ON, S3=OFF)

S4	S5	S6	Description
OFF	OFF	OFF	Vibration increase of any component (vertical, transverse, axial) of any bearing above 11.2 mm/s and adjacent bearing vibration value of any component (vertical, transverse, axial) 7.1 mm/s.
OFF	ON	OFF	Vibration increase of any component (vertical, transverse, axial) of any bearing above 11.2 mm/s and adjacent bearing vibration value of any component (vertical, transverse, axial) 7.1 mm/s. Vibration increase of any component (vertical, transverse) of any bearing above 11.2 mm/s and other component (vertical, transverse, axial) value of the same bearing 7.1 mm/s.
ON	OFF	OFF	Corresponding alarm setpoints (11.2 mm/s) are supplied to inputs of groups L2A, L2B, L2C. Logic chain length is increased for 16 inputs. Vibration increase of any component (vertical, transverse, axial) of any bearing above 11.2 mm/s and adjacent bearing vibration value of any component (vertical, transverse, axial) 11.2 mm/s.
ON	ON	OFF	Corresponding alarm setpoints (11.2 mm/s) are supplied to inputs of groups L2A, L2B, L2C. Logic chain length is increased for 16 inputs. Vibration increase of any component (vertical, transverse, axial) of any bearing above 11.2 mm/s and adjacent bearing vibration value of any component (vertical, transverse, axial) 11.2 mm/s. Vibration increase of any component (vertical, transverse, axial) of any bearing above 11.2 mm/s and other component (vertical, transverse, axial) value of the same bearing 11.2 mm/s.
OFF	OFF	ON	***Change for code version CPLD 1.2 (dated 23.04.2009) and above.*** Vibration increase of any component (vertical, transverse, axial) of any bearing above 11.2 mm/s and adjacent bearing vibration value of any component (vertical, transverse, axial) 11.2 mm/s. Vibration increase of any component (vertical, transverse, axial) of any bearing above 11.2 mm/s and other component (vertical, transverse, axial) value of the same bearing above 7.1 mm/s.

3.4 Vibration level step protection

This mode is intended to implement vibration step protection logic together with equipment Vibrobit 300 control modules. Switch S3 should be in ON position.

Switch S4 determines validity time of appeared logic signal.

Table 25 – Switch S4 positions

S4	Input signal validity time
OFF	4 seconds
ON	8 seconds

For logic signal to participate further in step protection logic, the corresponding signal should be inactive (step signal acknowledgment) for not less than time established by S4.

Specific vibration step safety shutdown logic implementation is determined by switches S5, S6.

3.4.1 Interaction mode 0 (S1=OFF, S2=OFF, S3=ON)

Protection logic combined operating mode:

- Dangerous vibration level control
- Vibration level step control

Table 26 – Outputs purpose for interaction mode 0 (S1=OFF, S2=OFF, S3=ON)

Purpose	Used inputs
Vertical component	L1A-1:L1A-8 — alarm setpoint (11.2 мм/с) L2A-1:L2A-8 — vibration level step
Transverse component	L1B-1:L1B-8 — alarm setpoint (11.2 мм/с) L2B-1:L2B-8 — vibration level step
Axial component	L1C-1:L1C-8 — alarm setpoint (11.2 мм/с) L2C-1:L2C-8 — vibration level step

Table 27 – Protection logic for interaction mode 0 (S1=OFF, S2=OFF, S3=ON)

S5	S6	Description	Protection output
OFF	OFF	***Dangerous vibration level protection*** 1. Dangerous vibration level on two adjacent supports of any components (vertical, transverse)	OUT-PR
		Dangerous vibration level protection 1. Dangerous vibration level on two adjacent supports of axial component	OUT-ADD2
		Vibration step protection 1. Unexpected and irreversible simultaneous vibration change of any component (vertical, transverse) of two adjacent bearing supports. 2. Unexpected and irreversible simultaneous vibration change of axial component of two adjacent bearing supports.	OUT-ADD1
OFF	ON	***Dangerous vibration level protection*** 1. Dangerous vibration level on two adjacent supports of any components (vertical, transverse) 2. Dangerous vibration level of two components (vertical, transverse) on one support.	OUT-PR
		Dangerous vibration level protection 1. Dangerous vibration level on two adjacent supports of axial component	OUT-ADD2
		Vibration step protection 1. Unexpected and irreversible simultaneous vibration change of any component (vertical, transverse) of two adjacent bearing supports. 2. Unexpected and irreversible simultaneous vibration change of two components (vertical, transverse) of one support. 3. Unexpected and irreversible simultaneous vibration change of axial component of two adjacent bearing supports.	OUT-ADD1

S5	S6	Description	Protection output
ON	OFF	***Dangerous vibration level protection*** 1. Dangerous vibration level on two adjacent supports of any component (vertical, transverse, axial).	OUT-PR
		Vibration step protection 1. Unexpected and irreversible simultaneous vibration change of any component (vertical, transverse, axial) of two adjacent bearing supports.	OUT-ADD1
ON	ON	***Dangerous vibration level protection*** 1. Dangerous vibration level on two adjacent supports of any component (vertical, transverse, axial). 2. Dangerous vibration level of any two components (vertical, transverse, axial) on one support.	OUT-PR
		Vibration step protection 1. Unexpected and irreversible simultaneous vibration change of any component (vertical, transverse, axial) of two adjacent bearing supports. 2. Unexpected and irreversible simultaneous vibration change of any two components (vertical, transverse, axial) of one support.	OUT-ADD1

If OUT_ADD2 is not used in protection algorithm, then signals L-ADD1, L-ADD2 are joined using “OR” circuit and supplied to additional output OUT-ADD2.

3.4.2 Interaction mode 1 (S1=OFF, S2=ON, S3=ON)

At S5 = OFF the input groups are divided in the following way (serial “AND” chains of 8 inputs)

Table 28 – Purpose of input groups units for interaction mode 1 (S1=OFF, S2=ON, S3=ON) at S5 = OFF

Unit	Purpose	Used inputs	Protection output
A	Vibration general level step		determined by S6
	Vertical component	L1A-1:L1A-8	
	Transverse component	L1B-1:L1B-8	
	Axial component	L1C-1:L1C-8	
B	Vibration 1-st rotational step (vibration displacement)		
	Vertical component	L2A-1:L2A-8	
	Transverse component	L2B-1:L2B-8	
	Axial component	L2C-1:L2C-8	

At S5 = ON the input groups are divided in the following way (serial “AND” chains of 16 inputs)

Table 29 – Purpose of input groups units for interaction mode 1 (S1=OFF, S2=ON, S3=ON) at S5 = ON

Unit	Purpose	Used inputs	Protection output
A	Vertical component	L1A-1:L1A-8 - L2A-1:L2A-8 — vibration step	determined by S6
B	Transverse component	L1B-1:L1B-8 - L2B-1:L2B-8 — vibration step	
C	Axial component	L1C-1:L1C-8 - L2C-1:L2C-8 — vibration step	

Table 30 – Protection logic for interaction mode 1 (S1=OFF, S2=ON, S3=ON)

S6	Description
OFF	Step signaling of all components is joined by “OR” and supplied to output OUT-PR. Additional inputs L-ADD1, L-ADD2 and outputs OUT-ADD1, OUT-ADD2 operate in normal mode (logic signal delay for a time, established by switches S7, S8).
ON	**At S5 = OFF** OUT-PR - vibration general level step signaling output OUT-ADD1 - vibration general level step signaling output Signals L-ADD1, L-ADD2 are joined using “OR” circuit and supplied to additional output OUT-ADD2. **At S5 = ON** OUT-PR - vibration vertical component step signaling output OUT- ADD1 - vibration transverse component step signaling output OUT- ADD2 - vibration axial component step signaling output

3.4.3 Interaction mode 2 (S1=ON, S2=OFF, S3=ON)

At S5 = OFF the input groups are divided in the following way

Table 31 – Purpose of input groups units for interaction mode 2 (S1=ON, S2=OFF, S3=ON) at S5 = OFF

Unit	Purpose	Used inputs	Protection output
A	Vibration general level step Vertical component Transverse component	 L1A-1:L1A-8 L1B-1:L1B-8	OUT-PR
B	Vibration 1-st rotational step (vibration displacement) Vertical component Transverse component	 L2A-1:L2A-8 L2B-1:L2B-8	OUT-ADD1
C	Axial component Vibration general level step Vibration 1-st rotational step (vibration displacement)	 L1C-1:L1C-8 L2C-1:L2C-8	OUT-ADD2

At S5 = ON the input groups are divided in the following way

Table 32 – Purpose of input groups units for interaction mode 2 (S1=ON, S2=OFF, S3=ON) at S5 = ON

Unit	Purpose	Used inputs	Protection output
A	Vibration general level step Vertical component Transverse component	 L1A-1:L1A-8 - L2A-1:L2A-8 L1B-1:L1B-8 - L2B-1:L2B-8	OUT-PR
B	Vibration general level step Axial component	 L1C-1:L1C-8 - L2C-1:L2C-8	OUT-ADD1

Signals L-ADD1, L-ADD2 are joined using “OR” circuit and supplied to additional output OUT-ADD2.

Table 33 – Protection logic for interaction mode 2 (S1=ON, S2=OFF, S3=ON)

S6	Description
OFF	Unexpected and irreversible simultaneous vibration change of any component (vertical, transverse) of two adjacent bearing supports. Unexpected and irreversible simultaneous vibration change of axial component of two adjacent bearing supports.
ON	Unexpected and irreversible simultaneous vibration change of any component (vertical, transverse) of two adjacent bearing supports. Unexpected and irreversible simultaneous vibration change of any two components (vertical, transverse) of one support. Unexpected and irreversible simultaneous vibration change of axial component of two adjacent bearing supports.

3.4.4 Interaction mode 3 (S1=ON, S2=ON, S3=ON)

Input groups are joined into 2 units (at S5 = OFF).

Table 34 – Purpose of input groups units for interaction mode 3 (S1=ON, S2=ON, S3=ON) at S5 = OFF

Unit	Purpose	Used inputs by components	Protection output
A	General level	L1A-1:L1A-8 — vertical component L1B-1:L1B-8 — transverse component L1C-1:L1C-8 — axial component	OUT-PR
B	1-st rotational (vibration displacement)	L2A-1:L2A-8 — vertical component L2B-1:L2B-8 — transverse component L2C-1:L2C-8 — axial component	OUT-ADD1

Input groups are joined into 1 unit by 16 inputs for each component (at S5 = ON).

Table 35 – Purpose of input groups units for interaction mode 3 (S1=ON, S2=ON, S3=ON) at S5 = ON

Unit	Purpose	Used inputs by components	Protection output
A	General level	L1A:L2A — vertical component L1B:L2B — transverse component L1C:L2C — axial component	OUT-PR

S6 jumper determines protection at irreversible simultaneous vibration level change (step) by any two components (vertical, transverse, axial) of one support.

Table 36 – Protection logic for interaction mode 3 (S1=ON, S2=ON, S3=ON)

S6	Description
OFF	Unexpected and irreversible simultaneous vibration change of any component (vertical, transverse, axial) of two adjacent bearing supports.
ON	Unexpected and irreversible simultaneous vibration change of any component (vertical, transverse, axial) of two adjacent bearing supports. Unexpected and irreversible simultaneous vibration change of any two components (vertical, transverse, axial) of one support.

4 Digital control interfaces

MK71 module supports three independent control interfaces:

- Two interfaces RS485 with partial implementation of ModBus RTU protocol;
- Interface CAN2.0B (only extended messages exchange);
- Slave interface I2C to set up module operation parameters.

All interfaces can operate simultaneously without interfering one another. Power supply source, driver microchips of RS485 and CAN2.0B interfaces, diagnostic interface **have no galvanic isolation.** MK71 module with galvanic isolation of communication interfaces and power supply is manufactured upon separate agreement.

4.1 RS485 interface

RS485 bus semiduplex driver microchip is provided for operation by RS485 interface. Data exchange by RS485 interface is carried out according to ModBus RTU protocol with data rate choice from several standard speeds and bus module address.

4.1.1 Module operation parameters setup by ModBus protocol

Module is set up by recording values into the corresponding configuration registers if recording is permitted. If recording into configuration registers is prohibited, a message is returned with error code NEGATIVE ACKNOLEDGE.

Configuration registers recording is carried out only using ModBus protocol command **Preset Multiple Regs**.

Module control commands are executed by ModBus protocol command **Preset Single Registers.**

Upon receiving incorrect command, generated is an error message, if request address matched with module address and check sum is correct.

Error message format (5 bytes):

- Device address
- Function code with high bit set to “1”
- Error code
- Check sum, low byte
- Check sum, high byte

Table 37 – ModBus protocol possible error codes

Code	Designation	Description	Notes
0x01	ILLEGAL FUNCTION	Incorrect function code	
0x02	ILLEGAL DATA ADRESS	Unacceptable register address	
0x03	ILLEGAL DATA VALUE	Unacceptable recorded value	
0x07	NEGATIVE ACKNOWLEDGE	Command can’t be executed	
0x09	ILLEGAL SIZE COMMAND	Function code and length of received message are not applicable	Unusual ModBus code

4.1.2 Check sum calculation in messages

Check sum CRC consists of two bytes. Check sum CRC is calculated by transmitting device and added into each message end. Receiving device calculates check sum during reception and compares with received message CRC filed. CRC counter is preliminary initialized with value of 0xFFFF. Only 8 data bits are used to calculate check sum (start, stop and parity bits are not used when calculating check sum).

4.1.3 ModBus protocol MK71 module control features

Addressing of operation parameters and module status registers is not aligned by 16-bit words.

Maximum number of recorded/read bytes per one transaction is 64 bytes.

4.1.4 ModBus protocol supported commands

Table 38 – Implemented commands of ModBus protocol in MK70 module

Code	Description	Request	Response	Note
0x03	Read Holding Registers Setup registers reading	Device address Function (0x03) Start address, high byte Start address, low byte Register number, high byte Register number, low byte CRC, low byte CRC, high byte	Device address Function (0x03) Bytes counter Data, high byte Data, low byte CRC, low byte CRC, high byte	Used to read measurement results and module operation parameters
0x06	Preset Single Registers Register recording	Device address Function (0x06) Address, high byte Address, low byte Data, high byte Data, low byte CRC, low byte CRC, high byte	Device address Function (0x06) Address, high byte Address, low byte Data, high byte Data, low byte CRC, low byte CRC, high byte	Used to record into control registers (commands execution)
0x10	Preset Multiple Regs Several registers recording	Device address Function (0x10) Start address, high byte Start address, low byte Register number, high byte Register number, low byte Bytes counter Data, high byte Data, low byte CRC, low byte CRC, high byte	Device address Function (0x10) Start address, high byte Start address, low byte Register number, high byte Register number, low byte CRC, low byte CRC, high byte	Used to record operation parameters into module
0x11	Report Slave ID Identifier reading	Device address Function (0x11) CRC, low byte CRC, high byte	Device address Function (0x11) Bytes counter Identifier (0x0B) Start indicator (0xFF) Software version, high byte Software version, low byte Module number, high byte Module number, low byte Manufacturing year, high byte Manufacturing year, low byte CRC, low byte CRC, high byte	
0x08	Diagnostics Diagnostic commands	Device address Function (0x08) Subfunction, high byte Subfunction, low byte Data, high byte Data, low byte CRC, low byte CRC, high byte	Device address Function (0x08) Subfunction, high byte Subfunction, low byte Data, high byte Data, low byte CRC, low byte CRC, high byte	List of supported diagnostic commands is given in Table 39

Table 39 – List of ModBus protocol supported diagnostic commands

Command code	Description
0x0000	Echo response
0x0001	ModBus protocol counters reset and Listen Only mode exit
0x0004	Engage Listen Only mode
0x000A	ModBus protocol counters reset
0x000B	Send number of received messages without errors
0x000C	Send number of received messages with check sum errors
0x000D	Send number of received messages with errors (excluding check sum errors)

4.2 CAN2.0B interface

CAN2.0B interface enables MK71 module status data transmission to indicating units and statistics gathering module. Module setup is not provided using CAN2.0B interface.

CAN2.0B interface can be used to receive logic signals from control modules to arrange additional logic charts (ref. section 2.5.3).

Module CAN controller operates in active mode, i.e. generates dominant confirmation of received messages and can generate active reset messages into CAN bus (e.g. In case of incorrectly specified data rate).

All nodes on CAN bus should have the same data rate. When data rate increasing, CAN bus physical maximum length decreases. Maximum permissible CAN bus length at data rate of 1000 kbit/s is 40 meters, and for speed 40 kbit/s – 1000 meters.

For CAN2.0B interface operation it is necessary to set up the following parameters:

- CAN2.0B interface operation permission (CanEnabled):
- Data rate (`CanSpeed`);
- Module address (`CanBasicAddress`);
- Messages sending periodicity (`CanBasicTime`);
- Data sending permission (`BasicDataOut`);

MK71 module status data are sent with periodicity `CanBasicTime`. If current message can't be sent during 200 ms, its send is canceled.

Module generates normal message sending confirmation of other modules, connected to CAN2.0B bus.

Byte number in message							
0	1	2	3	4	5	6	7
Code	CPLD status	Inputs L1A-L2A		Inputs L1B-L2B		Inputs L1C-L2C	
0x20	`CPLD_Status`	`Input_A`		`Input_B`		`Input_C`	

Figure 22 – Inputs status message format

Byte number in message							
0	1	2	3	4	5	6	7
Code	CPLD version	Inputs L1A-L2A		Inputs L1B-L2B		Inputs L1C-L2C	
0x21	`CPLD_Version`	`TimeValid_A`		`TimeValid_B`		`TimeValid_C`	

Figure 23 – Inputs time active status message format

Byte number in message							
0	1	2	3	4	5	6	7
Code		Inputs L1A-L2A		Inputs L1B-L2B		Inputs L1C-L2C	
0x22	`0x00`	`Memory_A`		`Memory_B`		`Memory_C`	

Figure 24 – Inputs status memory message format

Byte number in message							
0	1	2	3	4	5	6	7
Code		CPLD outputs	Microswitch	Microcontroller inputs	Microcontroller outputs		Module status
0x23	`0x00`	`CPLD_Output`	`CPLD_KeySetup`	`CPU_InOutput`	`LogicOutStatus`		`StatusSys`

Figure 25 – Module status message format

4.3 I2C slave interface

I2C slave interface is intended to control module operation and set up its operation parameters. I2C interface connector is arranged on MK71 module front panel. I2C slave interface parameters are predetermined, therefore regardless of module current status, the I2C interface is always available for module control.

Module can be set up by setup instrument ПН31 or personal computer. To setup using personal computer, started should be a software ModuleConfigurator, and module should be connected to personal computer via diagnostic interface module MC01 USB (PC USB interface).

When module setup using MC01 USB, installed on personal computer should be drivers of virtual COM port.

Module provides “hot” connection/disconnection of setup instrument and MC01 USB diagnostic interface module.

4.4 Setting parameters and module current status (address tables)

4.4.1 Communication interfaces

Table 40 – List of RS485 No.1 interface parameters

Description	Designation	Type (bytes)	Address (Hex)	Default value	Note
Interface operation permission 0 – Disabled 1 – VibrobitRTU mode 2 – ModbusRTU mode	RSEnabled	UChar (1)	0x0F00	0	
Module operation parameters change permission by commands and RS485 interface 0 – prohibited 1 – permitted	RSChangeEnabled	UChar (1)	0x0F01	0	
Single recording operation permission 0 – prohibited 1 – permitted	RSOneWriteCommand	UChar (1)	0x0F02	0	
Device address on RS485 bus (from 1 to 247)	RSAddress	UChar (1)	0x0F03	1	
Data rate, bit/s: 0 – 4800; 1 – 9600; 2 – 19200; 3 – 38400; 4 – 57600; 5 – 115200; 6 - 230400	RSSpeed	UChar (1)	0x0F04	0	
Notes 1 RS485 interface parameters take effect only after the interface repeated initialization. 2 Default value – value assigned to parameter after “Cold start”					

Table 41 – List of RS485 No.2 interface parameters

Description	Designation	Type (bytes)	Address (Hex)	Default value	Note
Interface operation permission 0 – Disabled 1 – VibrobitRTU mode 2 – ModbusRTU mode 10 – Apply setup of RS485 No.1 interface	RSEnabled	UChar (1)	0x1100	0	
Module operation parameters change permission by commands and RS485 interface 0 – prohibited 1 – permitted	RSChangeEnabled	UChar (1)	0x1101	0	
Single recording operation permission 0 – prohibited 1 – permitted	RSOneWriteCommand	UChar (1)	0x1102	0	
Device address on RS485 bus (from 1 to 247)	RSAddress	UChar (1)	0x1103	1	
Data rate, bit/s: 0 – 4800; 1 – 9600; 2 – 19200; 3 – 38400; 4 – 57600; 5 – 115200; 6 - 230400	RSSpeed	UChar (1)	0x1104	0	
Note – RS485 interface parameters take effect only after the interface repeated initialization.					

Table 42 – List of CAN2.0B interface parameters

Description	Designation	Type (bytes)	Address (Hex)	Default value	Note
Interface operation permission 0 – interface disabled 1 – interface enabled	CANEnabled	UChar (1)	0x1000	0	
Data rate, kbit/s: 0 – 1000; 1 – 500; 2 – 250; 3 – 200; 4 – 125; 5 – 100; 6 – 80; 7 - 40	CANSpeed	UChar (1)	0x1001	0	
Module address on bus	CANBasicAddress	Uint (2)	0x1002	0	
Message sending period by 0.1 s	CANBasicTime	UChar (1)	0x1004	0	
CAN messages sending permission for codes 0x20 - 0x23 correspondingly: 0 - message not sent 1 - message is sent	CANBasicDataOut	UChar (4)	0x1005	0	
Note – CAN2.0B interface parameters take effect only after the interface repeated initialization.					

Table 43-Parameter list CAN2.0B messages sources

Description	Designation	Type (bytes)	Address (Hex)	Default value	Note
Source No.1	SourceID_01	STR (12)	0x0800		
Source enabling 0 – disabled 1 — enabled	Enabled	UChar (1)	0x0800	0	
Message reception time-out by 0.1 s	TimeOutReceiveData	UChar (1)	0x0801	0	
Execute message code monitoring: 0 - do not execute monitoring 1 - check message code	UseMessageID	UChar (1)	0x0802	0	
Equipment Vibrobit 300 control modules code	MessageID	UChar (1)	0x0803	0	
Reserve, equals to zero	Reserv	Uint (2)	0x0804	0	
SID code of CAN message	SID	Uint (2)	0x0806	0	
EID code of CAN message	EID	Ulong(4)	0x0808	0	
Source No.2	SourceID_02	STR (12)	0x080C		
Source No.3	SourceID_03	STR (12)	0x0818		
Source No.4	SourceID_04	STR (12)	0x0824		
Source No.5	SourceID_05	STR (12)	0x0830		
Source No.6	SourceID_06	STR (12)	0x083C		
Source No.7	SourceID_07	STR (12)	0x0848		
Source No.8	SourceID_08	STR (12)	0x0854		
Source No.9	SourceID_09	STR (12)	0x0860		
Source No.10	SourceID_10	STR (12)	0x086C		
Source No.11	SourceID_11	STR (12)	0x0878		
Source No.12	SourceID_12	STR (12)	0x0884		
Source No.12	SourceID_13	STR (12)	0x0890		
Source No.14	SourceID_14	STR (12)	0x089C		
Source No.15	SourceID_15	STR (12)	0x08A8		
Source No.16	SourceID_16	STR (12)	0x08B4		
Note - Source interface parameters take effect only after the module reset.					

Table 44-Parameter list of CAN2.0B messages rules

Description	Designation	Type (bytes)	Address (Hex)	Default value	Note
Rule No.1	Rule_01	STR (8)	0x0900		
Source enabling 0 – disabled 1 - logic ‘AND’;	TypeOfRule	UChar (1)	0x0900	0	
Data type 0 - Not specified 1 - Char (1) 2 - Uchar (1) 3 - Short (2) 4 - UShort (2) 5 - Long (4) 6 - Ulong (4) 7 - Float (4)	TypeOfData	UChar (1)	0x0901	0	
Offset in message, byte	Offset	UChar (1)	0x0902	0	
Reserve, should be equal to zero	ucReserv	UChar (1)	0x0903	0	
Rule argument, bitmask	Value	Ulong(4)	0x0904	0	
Rule No.2	Rule_02	STR (8)	0x0908		
Rule No.3	Rule_03	STR (8)	0x0910		
Rule No.16	Rule_16	STR (8)	0x0978		

Table 45 – Parameter list of CAN2.0B logic signaling assignment

Description	Designation	Type (bytes)	Address (Hex)	Default value	Note
Signal SA1-01	CrossTableSA1-01	STR (2)	0x0A00		
Message source number (from 1 to 16)	SourceIndex	UChar (1)	0x0A00	0	
Rule number (from 1 to 16)	RuleIndex	UChar (1)	0x0A01	0	
Signal SA1-02	CrossTableSA1-02	STR (2)	0x0A02		
Signal SA1-03	CrossTableSA1-03	STR (2)	0x0A04		
Signal SA1-16	CrossTableSA1-16	STR (2)	0x0A1E		
Signal SB1-01	CrossTableSB1-01	STR (2)	0x0A20		
Signal SB1-02	CrossTableSB1-02	STR (2)	0x0A22		
Signal SB1-16	CrossTableSB1-16	STR (2)	0x0A3E		
Signal SC1-01	CrossTableSC1-01	STR (2)	0x0A40		
acc. to SC1-16					
Signal SA2-01	CrossTableSA1-01	STR (2)	0x0A60		
acc. to SA2-16					
Signal SB2-01	CrossTableSA1-01	STR (2)	0x0A80		
acc. to SB2-16					
Signal SC2-01	CrossTableSA1-01	STR (2)	0x0AA0		
acc. to SC2-16					

Table 46 – Parameter list of CAN2.0B signaling logic rule

Description	Designation	Type (bytes)	Address (Hex)	Default value	Note
Logic chart 0 - not specified (disabled) 1 - No.1 A1xB1xC1 2 - No.2 A1xB1 - C1	EnableMode	UChar (1)	0x0B00	0	
Output response delay by 0.1 s.	OutDelay	UChar (1)	0x0B01	0	
Output mode 0 - Direct control 1 - Trigger	IsOutTrigger	UChar (1)	0x0B02	0	
Reserve, should be equal to zero	ucReserv	UChar (1)	0x0B03	0	

4.4.2 Module system setup

Table 47 – List of system registers

Description	Designation	Type (bytes)	Address (Hex)	Default value	Note
Logical outputs block time after module reset	LogicOffStartUp	Uchar (1)	0x0E00	79	1, 3
Number of PWM samplings for test signal generation	PWM_Size	Uchar (1)	0x0E01	120	2
PWM sampling period (by 0.1 μs)	PWM_Period	Uint (2)	0x0E02	1667	
Inputs status switching delay (by 0.1 s)	LogicIn_Delay	Uchar (1)	0x0E04	0	2, 3
Input 1 active status 0 - low 1 - high	LogicIn_Inver_1	Uchar (1)	0x0E05	0	
Input 2 active status 0 - low 1 - high	LogicIn_Inver_2	Uchar (1)	0x0E06	0	
Logic signaling matrix (48 words) bits 0:1 – input number to which signaling is assigned bits 4:5 – reserved, should be zero bit 6 - LED ‘War’ engagement bit 7 - LED ‘Alarm’ engagement bits 8:15 – reserved, should be zero	LogicMatrix	Uchar (32)	0x0E07	0	
Information about microswitches	InfoSwitch	Uchar (1)	0x0E27	0	4
Information on jumpers, installed on module board	InfoJumpers	Uint (2)	0x0E28	0	4
Logic output 1 mode 0 - Normal 1 - Inverted	Out_Inversion_1	Uchar (1)	0x0E2A	0	5
Logic output 1 mode 0 - Normal 1 - Inverted	Out_Inversion_2	Uchar (1)	0x0E2B	0	5
Notes 1 In case of data reading error from non-volatile memory always equals to 79 (8 seconds) 2 If value is 0, function is disabled. 3 Time by 0.1 s (0 = 0.1 s). 4 Information values, do not affect the module operation 5 Implemented in MK71 module software version 1.14.					

Table 48 – PWM samplings buffer for test signal generation

Description	Designation	Type (bytes)	Address (Hex)	Default value	Note
PWM buffer	PWM_Buffer	Uchar (128)	0x1500		
Note - Default value corresponds to harmonic signal with frequency of 50 Hz, signal excursion - 5V.					

Table 49 – List of logical sequence setup registers (logic formula)

Description	Designation	Type (bytes)	Address (Hex)	Default value	Note
Output 1 logical rule (32 comands)	LogicRules[0]	Uint(2)x32	0x0C00	0	

Table 50 – Logical rules command structure

Description	Designation	Bits
Operation code 0x00 - empty operation NOP 0x1F - logic formula completion END 0x01 - place memory value to storage battery GET 0x02 - save storage battery value to memory SET 0x03 - reset storage battery to zero CLR 0x04 - invert storage battery value NOT 0x05 - logical OR of storage battery and memory OR 0x06 - logical AND of storage battery and memory AND 0x07 - logical exclusive OR of storage battery and memory XOR	Operation	11 : 15 (5)
Memory (register) code 0x00 - no memory reference 0x01 - no memory reference 0x02 - local memory (16 bit) cleared before execution 0x03 - global memory (16 bit) cleared by module reset 0x04 - CPLD IN-A1 0x05 - CPLD IN-A2 0x06 - CPLD IN-B1 0x07 - CPLD IN-B 0x08 - CPLD IN-C1 0x09 - CPLD IN-C2 0x0C - CPU Status 0x0D - CPLD Status 0x0E - CPLD Output 0x0F - CPU InOutput 0x10 - CAN SA1 (2 bytes) 0x11 - CAN SB1 (2 bytes) 0x12 - CAN SC1 (2 bytes) 0x13 - CAN SA2 (2 bytes) 0x14 - CAN SB2 (2 bytes) 0x15 - CAN SC2 (2 bytes)	Memory	6 : 10 (5)
Memory address (bin number in register)	Address	0 : 5 (6)

4.4.3 Identification information

Table 51 – List of module identification information registers

Description	Designation	Type (bytes)	Address (Hex)	Default value	Note
Module factory number	Number	Uint (2)	0x1200	0	
Module manufacturing year	Year	Uint (2)	0x1202	0	
Order number	Order	Uint (2)	0x1204	0	
Assembler’s code	Assembler	UChar (1)	0x1206	0	
Adjuster’s code	Adjuster	UChar (1)	0x1207	0	
Additional text information	TextString	Char (32)	0x1208		
Note - Identification information is available read-only, not changed by “Cold start”.					

Table 52 – List of module software identification information registers

Description	Designation	Type (bytes)	Address (Hex)	Default value	Note
Microcontroller software version line	Version	Char (6)	0x1300		
Microcontroller software compilation date	Date	Char (12)	0x1306		
Microcontroller software compilation time	Time	Char (10)	0x1312		
Note - Identification information is available read-only.					

4.4.4 Control commands

Several reserved registers are provided for control commands execution in МК71 module. Control commands are executed only during individual recording into each register (it is impossible to execute several control commands per one transaction).

Table 53 – List of control registers

Register address (Hex)	Recorded value (Hex)	Action	Note
0xFF00	0x55	Module reset (similar to module power-up)	1
0xFF01	0x93	Execute RS485 No.1 interface repeated initialization	1
	0x94	Execute RS485 No.2 interface repeated initialization	1
	0x98	Execute CAN2.0B interface repeated initialization	
	0xE2	Execute safety shutdown logic reset	2
	0x41	Execute generator PWM repeated initialization	
0xFF02	0x33	Microcontroller logical signaling block	
	0xCC	Logical signaling normal operation	
0xFF03	0x3C	Request for single recording	3
0xFF04	0xD1	Set bit outCPU1 in register CPU_InOutput	
	0xD2	Set bit outCPU2 in register CPU_InOutput	
	0xC1	Reset bit outCPU1 in register CPU_InOutput	
	0xC2	Reset bit outCPU2 in register CPU_InOutput	
0xFF06	0x84	Write logic formula to ROM	
	0x85	Write CAN interface message sources to ROM	
	0x86	Write CAN interface message processing rules to ROM	
	0x87	Write CAN logic signaling assignment to ROM	
	0x88	Write PWM buffer to ROM	
	0x89	Write system settings to ROM	
	0x8A	Write the RS485 interface No.1 parameters to ROM	
	0x8B	Write CAN interface parameters to ROM	
	0x8C	Write the RS485 interface No.2 parameters to ROM	
	0x8D	Write CAN signaling logic parameters to ROM	
0xFF07	0x21	Writing all module setup parameters to ROM	4, 5

Notes

1 If command was received during response transfer, response is transferred in full, then repeated initialization is carried out.

2 Similar to pressing button on МК71 module front panel, the reset signal in maintained in active state for 1 second.

3 Recording permission is active for 8 seconds after command receipt.

4 It is necessary to preliminary execute command “Request for single recording” or block logic signaling.

5 Module service functions operation is stopped during recording. Module automatically reboots after recording.

4.4.5 Module inputs/outputs status

Table 54 – List of module inputs/outputs status registers

Description	Designation	Type (bytes)	Address (Hex)	Note
CPLD logic version	CPLD_Version	UChar (1)	0x0000	1
CPLD status bits	CPLD_Status	UChar (1)	0x0001	2
Logic inputs L2A1-L2A8, L1A1-L1A8 status	Input_A	Uint (2)	0x0002	3
Logic inputs L2B1-L2B8, L1B1-L1B8 status	Input_B	Uint (2)	0x0004	3
Logic inputs L2C1-L2C8, L1A1-L1C8 status	Input_C	Uint (2)	0x0006	3
Active signal availability flags on logic inputs L2A1-L2A8, L1A1-L1A8 to participate in step algorithm	TimeValid_A	Uint (2)	0x0008	3
Active signal availability flags on logic inputs L2B1-L2B8, L1B1-L1B8 to participate in step algorithm	TimeValid_B	Uint (2)	0x000A	3
Active signal availability flags on logic inputs L2C1-L2C8, L1C1-L1C8 to participate in step algorithm	TimeValid_C	Uint (2)	0x000C	3
Logic input active status memory elements L2A1-L2A8, L1A1-L1A8	Memory_A	Uint (2)	0x000E	3
Logic input active status memory elements L2B1-L2B8, L1B1-L1B8	Memory_B	Uint (2)	0x0010	3
Logic input active status memory elements L2C1-L2C8, L1C1-L1C8	Memory_C	Uint (2)	0x0012	3
CPLD outputs status bits	CPLD_Output	UChar (1)	0x0014	4
Microswitches position status bits	CPLD_KeySetup	UChar (1)	0x0015	5
Microcontroller outputs status bits	CPU_InOutput	UChar (1)	0x0016	6
Microcontroller logic outputs status bits: bits 0-2 - logic outputs status from 1 to 3 bits 3-13 – reserved, always are zero bit 14 - LED ‘War’ status bit 15 - LED ‘Alarm’ status	LogicOutStatus	Uint (2)	0x0017	
Module status bits	StatusSys	UChar (1)	0x0019	7
Module status additional bits	StatusSysAdd	UChar (1)	0x001A	8

Notes

1 If CPLD logic version is zero, then CPLD microchip is faulty.

2 For bits purpose refer to Table 8.

3 Bit 15 – input 8 groups L2A, L2B or L2C. Bit 0 – input 1 groups L1A, L1B, L1C.

4 For bits purpose refer to Table 7.

5 Bit 7 - corresponds to switch S8.

6 For bits purpose refer to Table 6.

7 For bits purpose refer to Table 9.

8 For bits purpose refer to Table 10.

4.4.6 Logic signaling status from CAN interface

Table 55 – Signaling status by CAN interface

Description	Designation	Type (bytes)	Address (Hex)	Note
Signaling status bits bit 0 - signaling enabled bit 1 - no data from one of the sources bits 2-15 – reserve, equal to zero	Status	Uint (2)	0x0500	
Reserve, equals to zero	Status	Uint (2)	0x0502	
CAN message SID address filter	usReserv	Uint (2)	0x0504	
CAN message SID address mask	FilterSID	Uint (2)	0x0506	
CAN message EID address filter	MaskSID	Ulong (2)	0x0508	
CAN message EID address mask	FilterEID	Ulong (2)	0x050C	
Reserve, equals to zero	MaskEID	Ulong (2) x 4	0x0510	
Time-out for accepting messages from source No.01, by 0.1 s	ulReserv	UChar (1)	0x0520	
Time-out for accepting messages from source No.02, by 0.1 s	MessageTimeOut_01	UChar (1)	0x0522	
	MessageTimeOut_02			
Time-out for accepting messages from source No.16, by 0.1 s		UChar (1)	0x052F	

Table 56 – CAN messages from data sources

Description	Designation	Type (bytes)	Address (Hex)	Note
Source No.01 message	MessageSource_01	STR (10)	0x0600	
Flag, data are authentic	FlagOk	UChar (1)	0x0600	
Number of data bytes	Count	UChar (1)	0x0601	
Data (message code), byte 01	Byte_0	UChar (1)	0x0602	
Data, byte 02	Byte_1	UChar (1)	0x0603	
Data, byte 03	Byte_2	UChar (1)	0x0604	
Data, byte 04	Byte_3	UChar (1)	0x0605	
Data, byte 05	Byte_4	UChar (1)	0x0606	
Data, byte 06	Byte_5	UChar (1)	0x0607	
Data, byte 07	Byte_6	UChar (1)	0x0608	
Data, byte 07	Byte_7	UChar (1)	0x0609	
Source No.02 message	MessageSource_02	STR (10)	0x060A	
Source No.03 message	MessageSource_03	STR (10)	0x0614	
Source No.16 message	MessageSource_16	STR (10)	0x0696	

Table 57 – Status of logic signals received by CAN interface

Description	Designation	Type (bytes)	Address (Hex)	Note
Logic signals SA1	SA1	Uint (2)	0x0400	
Logic signals SB1	SB1	Uint (2)	0x0402	
Logic signals SC1	SC1	Uint (2)	0x0404	
Logic signals SA2	SA2	Uint (2)	0x0406	
Logic signals SB2	SB2	Uint (2)	0x0408	
Logic signals SC2	SC2	Uint (2)	0x040A	

5 Software

Specialized ModuleConfigurator software to setup MK71 has convenient interface and access to all module parameters. For the setup program operation it is necessary to connect MK71 module to personal computer via diagnostic interface module MC01 USB.

Main program features:

- Viewing module logic inputs/outputs status;
- Setup parameters of communication interfaces RS485, CAN2.0B, microcontroller logic outputs parameters and test signal generation;
- Saving settings into module non-volatile memory.

ModuleConfigurator software is available for loading from the official website of SPE Vibrobit LLC www.vibrobit.ru, section "Support".

A detailed description of the ModuleConfigurator software operation is given in the “ВШПА.421412.300.001 34 Vibrobit Module Configurator. Operator's Manual”.

Before connecting to MK71 module in ModuleConfigurator software, you need to select the MK71 settings, as shown in Figure 26.

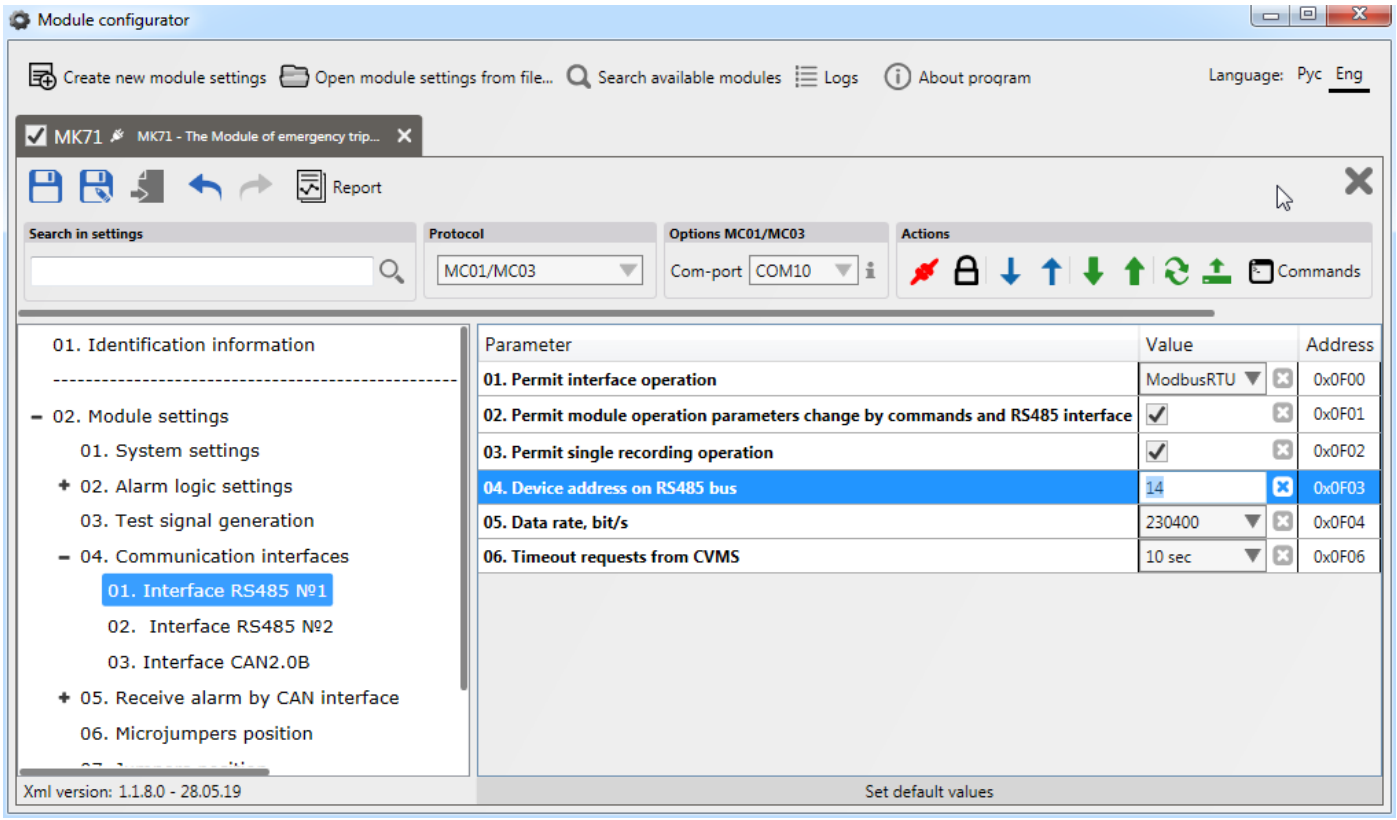


Figure 26 – Setup appearance of MK71 moduleRS485 interface in ModuleConfigurator software

6 Maintenance

For maintenance information refer to document ВШПА.421412.300 РЭ «Equipment Vibrobit 300 Operation and Maintenance Manual»:

- equipment maintenance;
- routine repair;
- equipment check.

Appendix A

(mandatory)

Controls arrangement

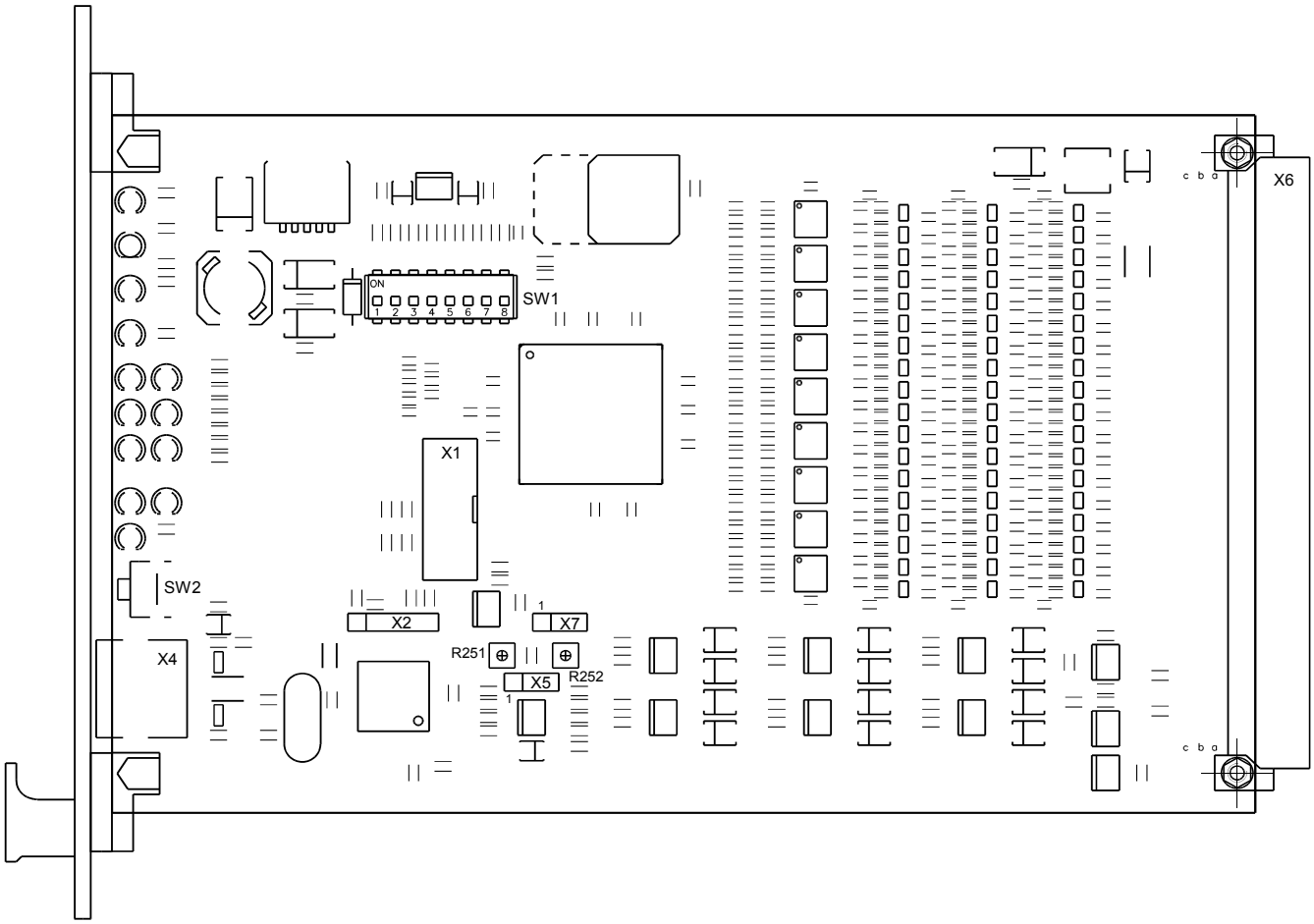


Figure 27 – Controls arrangement on MK71-R2 module board

Table A.1 – Purpose of connectors on MK71 module board

Connector	Purpose
X1	CPLD programming (service)
X2	Microcontroller programming (service)
X4	Diagnostics connector
X6	Main switching connector

Table A.2 – Purpose of connectors on 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 constant component adjustment (only when X5 is in position 2-3)

Table A.3 – Purpose of connectors on MK71 module board

X5	X7	Test signal source
1-2	1-2, 2-3	Microcontroller PWM without adjustment of constant component (R252) and excursion (R251)
2-3	1-2	Microcontroller PWM with adjustment of constant component (R252) and excursion (R251)
2-3	2-3	CPLD 61 Hz meander with adjustment of constant component (R252) and excursion (R251)

Appendix B

(mandatory)

Connector terminals purpose

Table B.1 – Purpose of connectors on MK71 module board

Terminal number	Designation	Purpose	Note
A2, B1, C2 A32, B31, C32	GND	COM	
A6, B5, C6	Power +24V	Power supply voltage input +24V	
A4	L-RES	CPLD (safety shutdown logic) reset input	1, 2
B3	L-ENA	Safety shutdown logic block	1
C4	L-ADD1	CPLD additional logic input 1	1
A8	L1A-1	L1A-1 logic input	1
A10	L1A-2	L1A-2 logic input	1
A12	L1A-3	L1A-3 logic input	1
A14	L1A-4	L1A-4 logic input	1
A16	L1A-5	L1A-5 logic input	1
A18	L1A-6	L1A-6 logic input	1
A20	L1A-7	L1A-7 logic input	1
A22	L1A-8	L1A-8 logic input	1
B7	L1B-1	L1B-1 logic input	1
B9	L1B-2	L1B-2 logic input	1
B11	L1B-3	L1B-3 logic input	1
B13	L1B-4	L1B-4 logic input	1
B15	L1B-5	L1B-5 logic input	1
B17	L1B-6	L1B-6 logic input	1
B19	L1B-7	L1B-7 logic input	1
B21	L1B-8	L1B-8 logic input	1
C8	L1C-1	L1C-1 logic input	1
C10	L1C-2	L1C-2 logic input	1
C12	L1C-3	L1C-3 logic input	1
C14	L1C-4	L1C-4 logic input	1
C16	L1C-5	L1C-5 logic input	1
C18	L1C-6	L1C-6 logic input	1
C20	L1C-7	L1C-7 logic input	1
C22	L1C-8	L1C-8 logic input	1
A24	OUT-L1A	L1A group “OR” logic output	3
B23	OUT-L1B	L1B group “OR” logic output	3
C24	OUT-L1C	L1C group “OR” logic output	3
A26	OUT-PR	Safety shutdown logic main output	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 No.1 interface, line B	
C30	1-RS485-A(+)	RS485 No.1 interface, line A	

Table B.1 continued

Terminal number	Designation	Purpose	Note
B30	2-RS485-B(-)	RS485 No.2 interface, line B	
C29	2-RS485-A(+)	RS485 No.2 interface, line A	
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	L2A-1 logic input	1
A9	L2A-2	L2A-2 logic input	1
A11	L2A-3	L2A-3 logic input	1
A13	L2A-4	L2A-4 logic input	1
A15	L2A-5	L2A-5 logic input	1
A17	L2A-6	L2A-6 logic input	1
A19	L2A-7	L2A-7 logic input	1
A21	L2A-8	L2A-8 logic input	1
B8	L2B-1	L2B-1 logic input	1
B10	L2B-2	L2B-2 logic input	1
B12	L2B-3	L2B-3 logic input	1
B14	L2B-4	L2B-4 logic input	1
B16	L2B-5	L2B-5 logic input	1
B18	L2B-6	L2B-6 logic input	1
B20	L2B-7	L2B-7 logic input	1
B22	L2B-8	L2B-8 logic input	1
C7	L2C-1	L2C-1 logic input	1
C9	L2C-2	L2C-2 logic input	1
C11	L2C-3	L2C-3 logic input	1
C13	L2C-4	L2C-4 logic input	1
C15	L2C-5	L2C-5 logic input	1
C17	L2C-6	L2C-6 logic input	1
C19	L2C-7	L2C-7 logic input	1
C21	L2C-8	L2C-8 logic input	1
A23	OUT-L2A	L2A group “OR” logic output	3
B24	OUT-L2B	L2B group “OR” logic output	3
C23	OUT-L2C	L2C group “OR” logic output	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 (failure)	3, 5

Notes

1 Not connected inputs are logically inactive due to pull-up resistors.

2 Reset input doesn’t effect service functions (of microcontroller).

3 Logic outputs status is not latched by trigger.

4 Logic output active status is latched by trigger. Switching to passive state is executed during safety shutdown logic reset (CPLD).

5 Microcontroller-controlled.

Appendix C

(informative)

Logic charts use recommendations

Table C.1 – Microswitches position for charts of equipment protection from dangerous vibration level.

Microswitches position						Requirements	Explanations
S1	S2	S3	S4	S5	S6		
OFF	OFF	OFF	ON	ON	X	KTW [1)]	Dangerous vibration level on two components (vertical, transverse, axial) of one support or two similar components of adjacent supports.
OFF	OFF	OFF	ON	OFF	X	LMZ [2)]	Dangerous vibration level of one support and warning vibration level on any other support (maximum 16 supports). It is necessary to join logic signaling by components.
OFF	ON	OFF	OFF	ON	X	LMZ	Dangerous vibration level of one support and warning vibration level on any other support (maximum 8 supports). All components are supplied separately.
ON	OFF	OFF	ON	OFF	X	IS [3)], UTW [4)]	Vibration increase of any component (vertical, transverse) of any bearing above 11.2 mm/s and adjacent bearing vibration value of any component (vertical, transverse) 11.2 mm/s. Vibration axial component increase of any bearing above 11.2 mm/s and adjacent bearing vibration value of axial component 11.2 mm/s. (maximum 16 supports)
OFF	ON	OFF	ON	ON	X	IS, UTW	Vibration increase of any component (vertical, transverse) of any bearing above 11.2 mm/s and adjacent bearing vibration value of any component (vertical, transverse) 11.2 mm/s. Vibration axial component increase of any bearing above 11.2 mm/s and adjacent bearing vibration value of axial component 11.2 mm/s. (maximum 8 supports)
ON	ON	OFF	OFF	ON	X	KTW [5)]	Vibration increase of any component (vertical, transverse, axial) of any bearing above 11.2 mm/s and adjacent bearing vibration value of any component (vertical, transverse, axial) 7.1 mm/s. Vibration increase of any component (vertical, transverse, axial) of any bearing above 11.2 mm/s and other component (vertical, transverse, axial) value of the same bearing 7.1 mm/s. (maximum 8 supports)

[1)] KTW – Kaluga Turbine Works PJSC
[2)] LMZ – Leningradsky Metallichesky Zavod OJSC
[3)] IS – industry standard
[4)] UTW – Ural Turbine Works
[5)] KTW – Kharkov Turbine Works

Table C.2 – Microswitches position for charts of equipment protection from vibration level step.

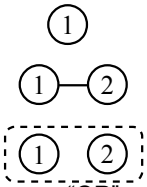
Microswitches position						Requirements	**Explanations**
S1	S2	S3	S4	S5	S6		
ON	OFF	ON	X	X	OFF	UTW [1)]	Unexpected and irreversible simultaneous vibration change of any component (vertical, transverse) of two adjacent bearing supports. Unexpected and irreversible simultaneous vibration change of axial component of two adjacent bearing supports.
ON	OFF	ON	X	X	ON	MR[2)], ГОСТ[3)]	Unexpected and irreversible simultaneous vibration change of any component (vertical, transverse) of two adjacent bearing supports. Unexpected and irreversible simultaneous vibration change of any two components (vertical, transverse) of one support. Unexpected and irreversible simultaneous vibration change of axial component of two adjacent bearing supports.
ON	ON	ON	X	X	ON	MR, ГОСТ	Unexpected and irreversible simultaneous vibration change of any component (vertical, transverse, axial) of two adjacent bearing supports. Unexpected and irreversible simultaneous vibration change of any two components (vertical, transverse, axial) of one support.

[1)] UTW – Ural Turbine Works
[2)] MR – Maintenance rules
[3)] ГОСТ – State standard

Appendix D

(informative)

Agreed notations on logic charts



- Input number of corresponding logic group (L1A, L2A, L1B etc.)
solid line between inputs
Logic “AND” between corresponding inputs
dotted line, joining several inputs
Joining all logic circuits inside selected unit by logic chart “OR”
Group active output at any active input
Group active output at any 2 active inputs

Appendix E

(informative)

List of figures

Appendix F

(informative)

List of tables

Notes