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ENTERPRISE VIBROBIT LLC

EQUIPMENT VIBROBIT 300

Module MK10 Setup Manual
(Ver. 1, module software version 3.0)

ВШПА.421412.301 И1

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Module MK10 Setup Manual are meant for introducing to user (consumer) of operating principles and setting methods of MK10 Fixed Signal Monitoring Module of Equipment Vibrobit 300.

This Document is an Amendment to
ВШПА.421412.300 РЭ Equipment Vibrobit 300. Operations and Maintenance Manual.

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General Information

MK10 Module is designed for measuring and monitoring of linear shift, direct current signals in 2 independent measuring channels, and offers an alarm and equipment shutoff protection functions.

MK10 basic functions are:

- Measurement of fixed signal level in 4 independent measuring channels, with sensor monitoring function.
- Four set-points for each measuring channel with unique operating mode selection for each set-point;
- Four standard current outputs;
- Twelve logic outputs with direct alarm and shutoff protection relay coil connectivity.
- Support of digital communication interfaces: RS485 with ModBus protocol; CAN2.0B; diagnostic interface.

MK10 is based on high-performance 8-digit microcontroller, use of which permits to process, in parallel, the signals from several measuring channels, combine large number of functions in one module and support sophisticated digital control interfaces.

MK10 Module operates in real-time mode with measurement results update rate of 250ms. MK10 Module fulfills the following basic operations:

- Measures constant signal level in measuring channels;
- Calculates sensor current and controls sensor functionality;
- Calculates actual values of measured parameters;
- Compares calculated parameter value with set-point value and signals overrun;
- Transfers measured values to standard outputs;
- Generates logic alarms;
- Supports data exchange via digital communication interfaces;
- Displays measured values and processes them at key pressing by user.

MK10 Module implements simplified method of input measuring channels and standard outputs calibration, which permits to change parameter measuring range or standard output range without implementation of recalibration (or ratio recalculation).

Twelve logic outputs with open collector (OK – low active level) provides the user with opportunity to setup functionality of each output.

All operation modes setup of MK10 Module is made by means of PC or dedicated ПН31 setting unit. In order to setup MK10 Module by means of PC, MK10_Setup_V3.exe software should by run on PC and MK10 Module should be connected to PC via MC01 diagnostic interface board (RS232 Interface) or MC01 USB (USB interface).

MK10 Module is supplied in several design options:

- ***MK10-DC*** – restricted indication system, 20mm front panel. Setup and review of measured values and module state are only possible via digital communication interfaces;
- ***MK10-DC-11*** – extended indication system, 40mm front panel. A 7-segment digital display, additional LED's and control keys are arranged on module front panel.
- ***MK10-DC-011*** – extended indication system, 40mm front panel. A customized alphanumeric LCD, with measurement results displaying capability in all measuring channels simultaneously, is arranged on module front panel.

Provision is made for sensors +24V DC power supply from MK10 Module through self-healing 200mA fuse.

Structurally, MK10 is designed as a 3U module suitable for 19" "Euromechanica" type framework.

Table 1. Technical specifications of MK10 Module

Parameter name	Value
Number of measuring channels	4
Measuring range and shift alarm (inside and out), (S), mm	Determined by module setup parameters
Measuring ranges and input signal alarm: - Direct current, mA - DC voltage, V	 1 – 5; 4 – 20 0.76 – 3.84
Input resistance, Ohm - Direct current - DC voltage	 768 ± 2; 191 ± 0.5 not less than 10 000
Acceptable tolerance limits of mean percentage error, % - by digital display - by standard signal	 ±1,0 ±1,0
Readings updating time, s	0.5
Number of output standard DC current signals	4
Output standard DC current signal, mA	1 – 5; 4 – 20
Output standard signal load resistance, Ohm, not greater than	500
Number of set-points for each measuring channel	4
Number of module digital outputs	12
Module output digital signals - type - DC voltage, V, not greater than - output current, mA, not greater than	 Open collector (OK) 24 100
Supported digital communication interfaces types	RS485 (ModBus) CAN2.0B Diagnostic I2C
Operating ambient temperature range (inside and out), ºC	+5 – +45
Power supply voltage	+(24 ± 1.0)
MK10 absorbed current at +24V circuit, mA, not greater than (not included sensor and other external circuits absorbed current)	100

Table 2. Additional specifications of MK10 Module

Parameter name	Value
Dimensions, mm - MK10-DC option - MK10-DC-11 and MK10-DC-001 options	 20.1 x 130 x 190 40.3 x 130 x 190
Weight, kg, not greater than - MK10-DC option - MK10-DC-11 and MK10-DC-001 options	 0.15 0.20
Readiness (warm-up) time, min, not greater than	1
Mode of operation	continuous
Average life span, years	10
Mean time between failures (calculated), hours, not less than	100000
Acceptable relative humidity, %	80 at a temperature +35°C
Insulation resistance in circuits, MOhm, not less than - in normal operating conditions - at relative humidity of 80% and temperature of +35ºC	 40 2
Man-made broadcast interference voltage, dB·mkV, not greater than - at frequency range from 0.15 to 0.5 MHz - at frequency range from 0.5 to 2.5 MHz - at frequency range from 2.5 to 30 MHz	 80 74 60
Warranty period, months	24
Handling and transportation conditions in accordance with GOST 23216-78	Ж
Storage conditions in accordance with GOST 15150-69	Ж3

Table 3.Shift measuring channels with VIBROBIT-300 equipment set sensors and convertors

Parameter name	Value
Measuring range, mm	0 – 320[1)]
Acceptable limit of reduced reference error, %	± 2.5
Acceptable limit of reduced measuring error within entire operating temperatures range for sensor, convertor, control module, %	± 6.0

Note 1. Operating range of VIBROBIT-300 equipment set sensors and convertors

Indication and control equipment

The front panel features of MK10 Module vary depending on design option. Appearance of MK10 Module front panels is shown in figure 1 below.

The following elements are arranged on all front panel types:

- handle for module installation/dismantling in framework;
- captured screws;
- diagnostic interface **D.port** connector;
- hidden **Reset** key for the module resetting;
- Module state indication **Ok** LED.

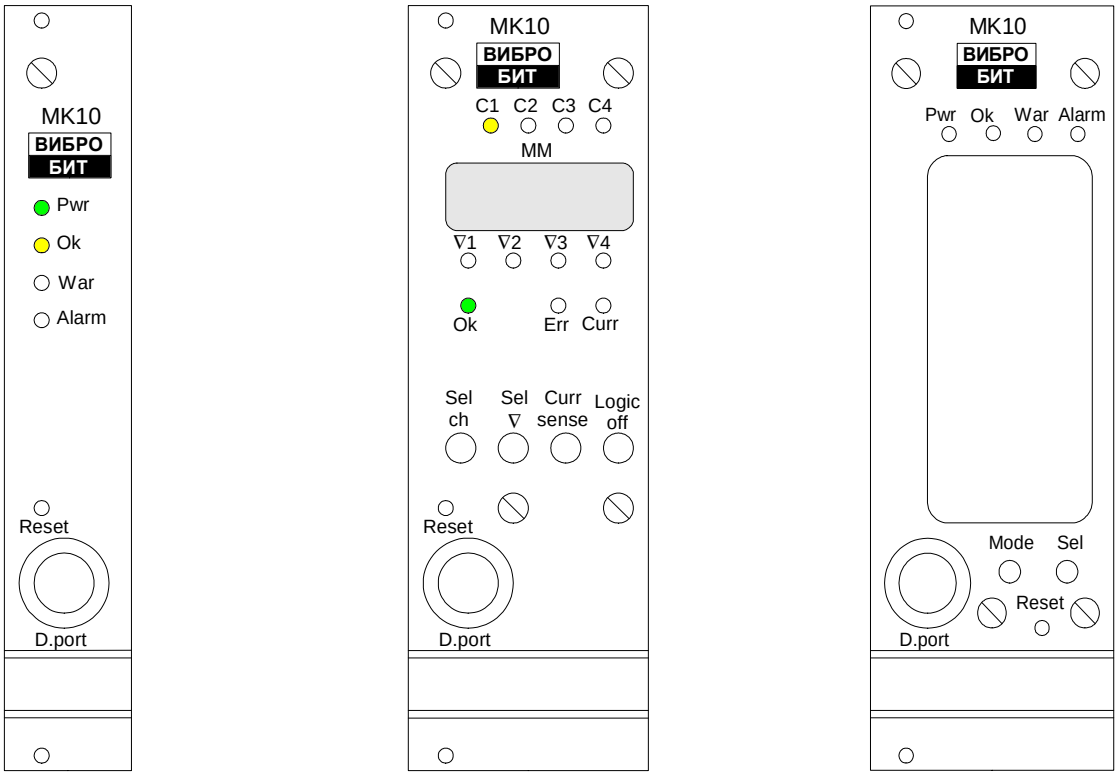
Module state can be assessed based on **Ok** LED emission color:

- Green light – normal module operation;
- Yellow light – output logic alarm is disabled by user or after the module resetting;
- Red light – fatal error in module operation, module operation is disabled;
- Green (yellow) light flashing – sensor test error is detected for one of measuring channels.

MK10-DC design option

Narrow front panel (width - 20mm) with restricted indication display and control system. Review of measurement results is only possible at reading via digital communication interfaces. Additionally, on MK10-DC Module front panel are arranged:

- "***Pwr***" green LED – module switching on;
- "***Ok***" bicolor LED – module status indication;
- "***War***" yellow LED – warning (LED operation logic is defined by user);
- "***Alarm***" red LED – alarm (operation logic is defined by user);



а) MK10-DC б) MK10-DC-11 в) MK10-DC-001

Figure 1. Module front panel appearance

MK10-DC-11 design option

MK10 Module front panel is provided with 4-digit, 7-segment digital display with auxiliary LED's and control keys. In this MK10 Module design option only one measuring channel measurement results can be displayed at a time.

On the module front panel are arranged:

- Four yellow LED's "**C1**", "**C2**", "**C3**" and "**C4**", for displaying of selected measuring channel;
- 4-digit, 7-segment digital display for measured parameters values and messages displaying;
- Four yellow LED's "**V1**", "**V2**", "**V3**" and "V**4**" for indication of parameters overrun of relevant selected measuring channel set-points. During displaying of set-point, relevant set-point LED flashes;
- Bicolor "***Ok***" LED – module status indication. "***Ok***" LED function in "MK10" option is similar to that of "Slim" option;
- Red "***Err***" LED – indication of selected measuring channel fault. "***Err***" LED flashes, if measuring channel function is normalized, but wait timeout has not yet been counted between measuring channel function normalization and start of the parameter value test against set-point;
- Yellow "***Curr***" LED – displaying of sensor current actual value (engineering data). During sensor current indication on selected measuring channel display, "***Curr***" LED flashes;
- Four control keys:
  - "***Sel ch***" – measuring channel selection for displaying of parameter value and measuring channel state (disabled measuring channels are not displayed);
  - "***Sel V***" – set-points displaying (disabled set-points are not displayed);
  - "***Curr sense***" – sensor current displaying;
  - ***"Logic off"*** – logic outputs function disabling;
- Slot for pressing of hidden "**Reset**" key;
- Diagnostic interface connector;
- Handle for convenient dismantling from framework.

Switching between measuring channels is implemented by pressing **"*Sel ch*"** key. At selection of new measuring channel current value of selected measuring channel basic parameter is displayed immediately.

Note. If measuring channel is disabled in MK10 Module settings, this measuring channel won't be displayed. If all channels are disabled in module settings, **"OFF"** will be displayed.

Rolling of set-points values is implemented by pressing **"*Sel V*"** key. Set-point value is displayed, while relevant set-point LED starts flashing. If switching to next value hasn't taken place for preset period of time, the module switched to basic measured parameter display.

Note. If set-point is disabled by module settings, this set-point value won't be displayed. If none of set-points function is enabled, set-points values are not displayed.

In order to display sensor current, it's necessary to press **"*Curr sense*"** key. Sensor current is displayed in ##.## format, even if sensor fault is detected. **"*Curr*"** LED flashed.

Logic outputs on and off switching is implemented by pressing and holding down **"*Logic off*"** key, until logic outputs operation mode is switched. When logic outputs are disabled, **"Ok"** LED glows yellow, and all logic outputs are inactive.

Individual display format for measured parameters value must be set for each measuring channel (see Table 4). When an attempt is made to display value, exceeding acceptable limits, maximum acceptable value will be displayed (for negative values – minimum acceptable value).

Table 4. MK10 Module data display format

Mode code	Display format	Acceptable values
0	#.###	from 0.000 to 9.999
1	##.##	from -9.99 to 99.99
2	###.#	from -99.9 to 999.99
3	####	from -999 to 9999

MK10-DC-001 design option

MK10 Module front panel has customized alphanumeric LCD, signal LED's and control keys. All measuring channel measurement results and measuring channels state can be displayed simultaneously.

On the module front panel are arranged:

- Customized alphanumeric LCD;
- Signal LED's"
  - "***Pwr***" green LED – module switching on;
  - "***Ok***" bicolor LED – module status indication;
  - "***War***" yellow LED – warning (LED operation logic is defined by user);
  - "***Alarm***" red LED – alarm (operation logic is defined by user);

Two control keys

- "**Mode**" key – display mode selection
- "**Sel**" key – displayed data selection

Figure 2. LCD data display example

Controlled parameter overrun of set-point is signaled by "**V1**", "**V2**", "**V3**" and "**V4**" symbols (in frame).

"**Er**" (in frame) symbol indicates sensor fault detected in actual measuring channel; measured parameter value is deemed equal to zero (zero is displayed on LCD), actual measuring channels set-points alarm is inactive.

After measuring channel operation is normalized, "**Er**" symbol starts flashing, and the unit counts measuring channel normalization timeout (set by user).

In order to display sensors direct current, press and hold down "**Mode**" key, until sensor current value appears on LCD (in two channels simultaneously). During sensor current displaying, measuring unit symbols "mA" appear on LCD, while symbols of measured parameter value overrun of set-point are not displayed. Return to normal display mode is implemented by repeated pressing and holding down of "**Mode**" key or automatically upon timeout.

For set-points values displaying, press and hold down "**Sel**" key, until 1st measuring channel sign **K1** and first set-point symbol **V1**start flashing. By repeated (and short-term) pressing of "**Sel**" key, all four set-points of actual measuring channel can be reviewed. Set-points values are displayed instead of measurement results. If set-point is disabled (in module settings), lines are displayed instead of set-point.

Review of other measuring channel set-points values can be implemented by pressing "**Sel**" key or automatically upon timeout.

Logic outputs on and off switching is implemented by simultaneous pressing and holding down of "**Mode-Sel**" keys, until logic outputs operation mode is switched. When logic outputs are disabled, "**Ok**" LED glows yellow, and all logic outputs are inactive.

Module Operation

Switching power on

When switching power on, MK10 Module operating parameters are loaded from volatile memory. Operating parameters are divided by sections:

- Measuring channels parameters;
- System and communication interfaces parameter.

Check sum, which permits to ensure validity of loaded data, is added to each operating parameters section of volatile memory. If calculated check sum is not matching sum, written to volatile memory, data is considered as corrupted and can't be used for module operation.

Each section of volatile memory has main and reserve storage. In case, that parameters section of volatile memory is read with error, attempt is being made data reading from volatile memory reserve storage section.

In case of error occurrence in one of parameters sections, module operation is disabled, active signal level is present at logic output 12, "Ok" LED glows red.

During standard loading of operating parameters before MK10 Module operation start:

- ***MK10-DC*** – "Ok" LED glows yellow to indicate module starting initialization;
- ***MK10-DC-11, MK10-DC-001*** - "Ok" LED glows yellow, module serial number, and then, module year of manufacture is displayed and MK10 initialization is implemented.

Note. Hot swap of MK10 module in section without disconnection from power supply is not recommended but allowed for all MK10 Module design options.

After switching MK10 Module power on (resetting), logic outputs function is disabled for preset time. If logic outputs function is disabled, "Ok" LED glows yellow.

Module resetting

For Module resetting, microcontroller hand resetting is fulfilled and series of actions is made which corresponds to power switching on. Reasons for MK10 Module resetting can be:

- Switching the module power on;
- Resetting upon user's command (by means of "Reset" key, located on the front panel or by command via digital communication interfaces);
- Microcontroller supply voltage reduction (power source failure);
- Resetting by watchdog timer due to microcontroller program "hang up".

By pressing hidden "Reset" key, installed on MK10 Module board, through the slot in module front panel, user may implement resetting and "cold start" of the module.

For Module resetting – press "Reset" key for short period of time, and, after that pressing and hold down "Reset" key until the module is reset.

Note. Module resetting can only be implemented after identification information (Module serial number, year of manufacturing) is displayed and MK10 Module initialization cycle is complete.

Module cold start

Cold start is meant for writing default operating parameters to volatile memory. This function is beneficial during initial Module powering on or in the case, when module recalibration is to be carried out or known operating parameters are to be set.

Switching to "Cold start" mode is implemented by pressing and holding down "Reset" key during entire cycle of identification information displaying and module initialization after resetting.

If module transfers to Cold start mode, then:

- ***MK10-DC*** – "Ok" LED starts glowing yellow simultaneously with "War" LED.
- ***MK10-DC-11, MK10-DC-001*** – "Cold" message starts flashing on 7-segment display.

After switching to cold start mode, the module "Cold start" mode must be confirmed. Confirmation of "Cold start" mode is "Reset" key pressing sequence, which is similar to Module resetting sequence in normal operating conditions (short-term pressing, pressing and holding down of "Reset" key).

At confirmation of the module "Cold start" mode, module settings are initialized by default setup and written to volatile memory, after which the module is reset. If "Cold start" mode is not confirmed, module does over to normal operation.

MK10-DC

During settings writing to volatile memory, "War" LED flashes. Writing results can be determined by "Ok" LED glowing color:

- **Green** – writing is successful and error free.
- **Yellow** – one or several data sections has been written to volatile memory at the second attempt.
- **Red** – one or several data sections has been written to volatile memory with error.

MK10-DC-11, MK10-DC-001

During writing, "Load" message is displayed. Writing results can be determined by "Ok" LED glowing color (in the same manner as for "Slim" option) and displayed message:

- `'Good'` – writing is successful and error free;
- `'bad'` – one or several data sections has been written to volatile memory at the second attempt;
- `'Err'` – one or several data sections has been written to volatile memory with error.

Results of operating parameters writing to volatile memory are displayed for 2 seconds, after which the module is reset automatically.

Parameters measurement

MK10 Module operates in real-time mode with measurement results update rate of 500ms.

Module implements the following basic operations:

- measures constant signal level in measuring channels;
- calculates sensor current and controls sensor functionality;
- calculates actual values of measured parameters;
- compares calculated parameter values with set-points and signals overrun;
- transfers measured values to standard outputs;
- generates logic alarms;
- updates data on indication display.

All measuring channels function equally and synchronously. Differ only setup parameters and input signal type, set up by MK10 board jumper (for jumpers application and functionality, refer to annex):

- current 4 – 20mA;
- current 1 – 5mA;
- voltage 0-4.096V.

At measuring channels outputs resettable fuses and protective stabilitrons (triacs) are provided, which prevent damage to module input circuits, caused by impulse interference or hazardous voltage level.

Sensor current measurement

Input current signal must be converted into voltage. For this purpose, precision resistors, corresponding to sensor signal current range, and removable bridge are provided at measurement channels input circuits. Input signals range by voltage is from 0 to 4.096.

Note. During measuring channel function operation with voltage signals, it is recommended to keep margin of valid signal range in order to implement sensor functionality test function.

Input signal (voltage) passes through low-frequency filter (LFF) and arrives at 10-digit analog-digital convertor (ADC) input, built in microcontroller. Within 250ms 521samplings of ADC values are implemented in each measuring channel. ADC mean value is used in further calculations of sensor current. High number of ADC samplings permits to achieve ADC actual DC resolution of 12bit due to averaging.

Sensor current is calculated by formula:

$$I_{sense} = A_I + B_I \cdot ADC;$$

where:

I_{sense} – calculated value of sensor current;

ADC – averaged ADC value;

A_I, B_I – linear equation ratios for sensor current calculation.

Sensor current value I_{sense} can be displayed (by pressing "***Curr sense***" key) and is used in sensor test algorithm for calculation of changing parameter value.

A_I , B_I ratios are automatically calculated during module operation initialization by sensor current range data (20% of `RangeCurrMax, RangeCurrMax`) and saved ADC values (`AdcInMin, AdcInMax`), corresponding to sensor current input range, by which calibration has been carried out.

Note. If one of calibration value pairs (20% of `RangeCurrMax, RangeCurrMax` of `AdcInMin, AdcInMax`) is equal to zero, or they are equal, then A_I , B_I ratios are not calculated and taken equal to zero (sensor current value I_{sense} is always equal to zero).

Sensor functionality test

Sensor test is carried out by I_{sense} calculated value. Sensor is deemed functional, if value falls within acceptable limits (`CurrValidMin, CurrValidMax`), setup during the module settings.

If I_{sense} value is lower than minimum acceptable current level `CurrValidMin`, sensor signal level is deemed too low (`ErrorSenseLow, FlagError flags are activated`). In order to normalize measuring channel function, I_{sense} value must be higher than `CurrValidMax - CurrValidHist` (`ErrorSenceLow` flag is dropped).

If I_{sense} value is higher than maximum acceptable current level `CurrValidMax`, sensor signal level is deemed too high (`ErrorSenseHigh, FlagError` flags are activated). In order to normalize measuring channel function, I_{sense} value must be lower than `CurrValidMin - CurrValidHist` (`ErrorSenceHigh` flag is dropped).

When any abnormal sensor current level flag is activated (`ErrorSenseLow, ErrorSenseHigh`), measured parameter value is taken as equal to zero.

It is not recommended to set sensor current level hysteresis value (`CurrValidHist`) equal to zero, as the alarm frequent switch-over effect may occur.

After normalization of sensor function and `ErrorSenseLow, ErrorSenseHigh` flags are dropped, `FlagError` flag is dropped after definite time interval `TestPointSenseOK`. After `FlagError` flag drop, calculated value of measured parameter is compared with set-point.

In Figure 3 is shown an example of sensor test algorithm during sensor constant current decrease below acceptable level. Sensor current acceptable levels are equal to 0.9mA and 5.1mA respectively, hysteresis – 0.1mA.

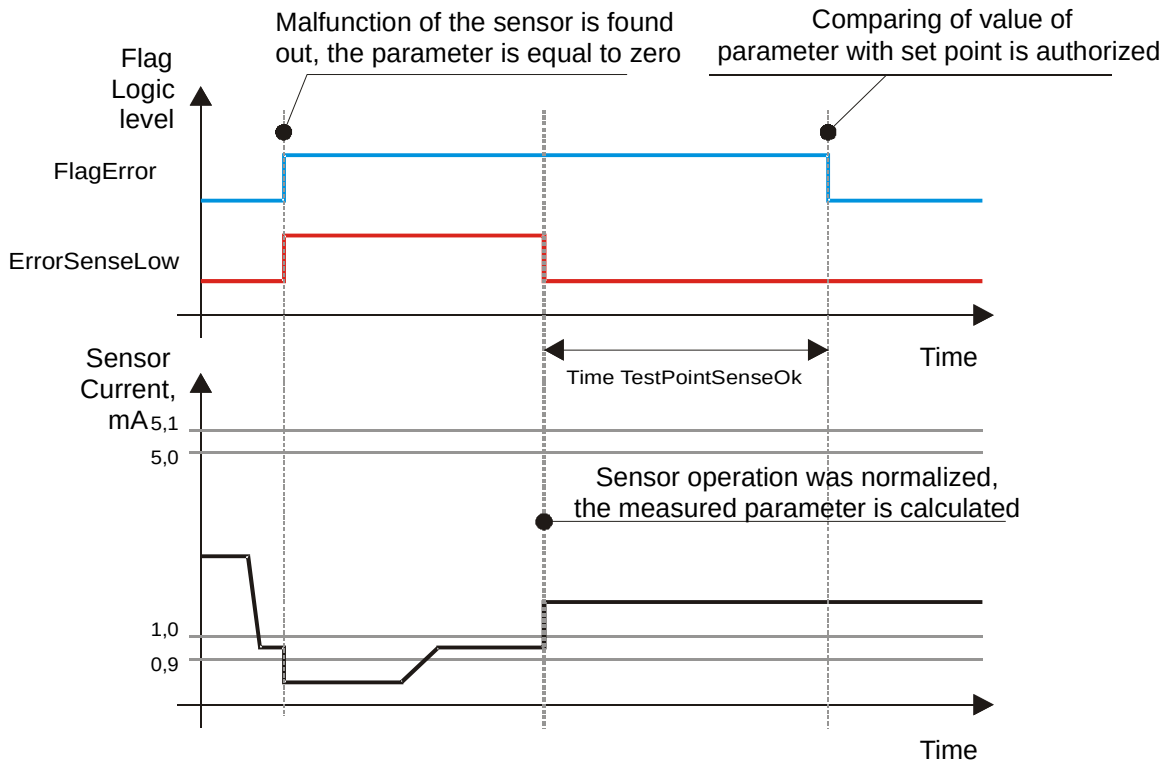


Figure 3. Sensor test algorithm during sensor constant current decrease below acceptable level.

After the module resetting, sensor is deemed functional, however timeout is to be counted before comparing parameter value with set-points value, as FlagError flag is automatically activated after resetting.

Parameter value measurement

Parameter value is calculated from measured sensor current value, if sensor fault was not detected (`ErrorSenseLow`, `ErrorSenseHigh` flags are dropped). If sensor fault was detected (`ErrorSenseLow`, `ErrorSenseHigh` flags are activated), measured parameter value is not calculated and taken as equal to zero.

Calculation of measured parameter value is implemented by linear equation formula:

$$D_{Param} = A_P + B_P \cdot I_{sense};$$

where:

D_{Param} – calculated value of measured parameter;

I_{sense} – calculated value of sensor current;

A_P, B_P – linear equation ratios for sensor current calculation.

D_{Param} value is basic measured parameter, used for:

- Comparison with set-points values;
- Indication display as basic parameter;
- Calculation of digital-analog convertor (DAC) value for standard output.

A_P, B_P ratios are calculated automatically during the module operation initialization by sensor current range data (`RangeCurrMin, RangeCurrMax`) and measuring parameter preset range (`RangeParamMin, RangeParamMax`).

Note. If one of value pairs (`RangeCurrMin, RangeCurrMax` of `RangeParamMin, RangeParamMax`) is equal to zero or they are equal, A_P, B_P ratios are not calculated and taken as equal to zero (measured parameter D_{Param} value is always equal to zero).

Averaging measured parameter value

Before use of measured parameter D_{Param} value (indication display, comparison with set-points values, calculation of DAC value for standard output), value averaging by moving-average method (the last few calculated values of measured parameter are averaged in order to achieve D_{Param} value) is possible.

Depth of averaging is set during the module setup (`AverageData`) and can vary from 1 to 10 (1 – no averaging, 10 – maximum averaging).

Note. Averaging permits to stabilize measured parameter value (during indication display variations of measured parameter value will be minimum), however, increase in averaging depth leads to slow response of alarm and shutoff protection.

Data display format is defined during the module setup (`FormatOut` parameter). For display format codes refer to Table 4.

Additionally, user can save channel measurement units in ASCII code symbols (up to 7 symbols, `MeasurUnit`) in module memory (up to 7 symbols, `MeasurName`).

Comparing measured parameter value with set-point value

If `FlagError` flag is dropped (timeout is counted after sensor operation normalization), calculated D_{Param} value of measured parameter is compared with set-points values, set during the module setup.

If sensor fault has been detected (one of `ErrorSenseLow`, `ErrorSenseHigh` flags is activated) or `FlagError` flag is activated, comparison of calculated D_{Param} value with set-points values is not implemented, and all measured parameter value overrun flags are dropped.

Four set-points are provided for each measuring channel (`TestPointData`) with individually setup operating modes (`TestPointMode`), general hysteresis level (`TestPointHist`) and overrun response time (`TestPointTime`).

Table 5. Set-points operating modes

Mode code	Description
`0`	Set-point is disabled, test is not carried out
`1`	Test above set-point value
`2`	Test below set-point value

Operating mode – set-points are disabled

Measured parameter D_{Param} value is not compared with `TestPointData` set-point, `OutPoint` flag is always dropped.

Operating mode - test above set-point value

If D_{Param} value is higher than `TestPointData` set-point within `TestPointTime` time, parameter level is deemed too high and `OutPoint` flag is activated. In order to drop `OutPoint` flag (normal level), D_{Param} value of measured parameter must be lower that `TestPointData-TestPointHist` within `TestPointTime`.

Operating mode - test below set-point value

If D_{Param} value is lower than `TestPointData` set-point value within `TestPointTime` time, parameter level is deemed too low and `OutPoint` flag is activated. In order to drop `OutPoint` flag (normal level), D_{Param} value of measured parameter must be higher that `TestPointData+TestPointHist` within `TestPointTime`.

Figure 4 below shows an example of sensor test algorithm during sensor constant current decrease below acceptable level. Sensor current acceptable levels are equal to 0.9mA and 5.1mA respectively, hysteresis – 0.1mA.

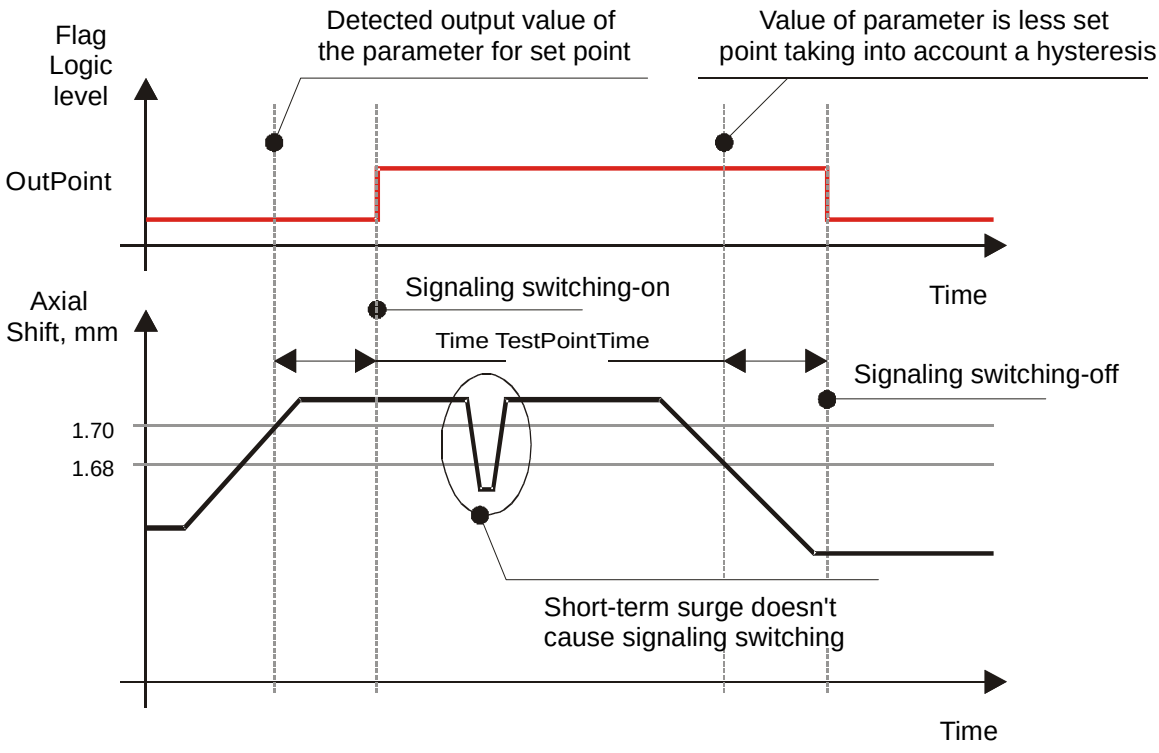


Figure 4. Example of set-point algorithm
(mode – test above set-point level).

Standard output

Standard current output is provided for each MK10 Module measuring channel. Signal level at standard output is proportional to measured parameter value. Standard output current range, corresponding to measured parameter range, can be selected randomly during the module setup.

Current setting at standard output is implemented by 12-bit DAC and dynamic current amplifier, designed for grounded load connection. Protective stabilitrons (breakdown voltage 27V) and 200mA resettable fuse for standard output circuit protection.

DAC value of standard output is calculated by linear equation formula:

$$DAC_{OUT} = A_O + B_O \cdot D_{Param};$$

where:

DAC_{OUT} – DAC calculated value;

D_{Param} – calculated value of measured parameter;

A_O, B_O – linear equation ratios for calculation of standard output DAC value.

A_O, B_O ratios are calculated automatically during the module operation initialization by standard output current range data (`CurrOutMin, CurrOutMinCalibr, CurrOutMax`), measured parameter range (`RangeParamMin, RangeParamMax`) and DAC saved value (`DacOutMin, DacOutMax`), corresponding to standard output range, at which calibration was carried out (`CurrOutMinCalibr, CurrOutMax`).

Note. If one of calibration value pairs (20% of `CurrOutMax, CurrOutMax` or `RangeParamMin, RangeParamMax` or `DacOutMin, DacOutMax`) is equal to zero, or they are equal, then A_O, B_O ratios are not calculated and taken equal to zero (DAC_{OUT} value is always equal to zero).

Module calibration recommendations

MK10 Module calibration technique permits to implement recalibration without cold start of the module, and implement measuring channel range variation without recalibration of measuring channels and standard outputs. If measuring channel or standard output current range variation is implemented, recalibration is required.

After the module calibration, calibration data must be loaded to module and stored in volatile memory, and the module must be reset (or ratios recalculation command to be fulfilled).

MK10 Module connection set-up for calibration and test calibration is shown in Figure 5. MK10 Module calibration is recommended on СП43 calibration bench, which permits to establish indicated test set-up.

Note. The module calibration is carried out by commands via digital communication interfaces by means of dedicated software.

A – МП24 or БП17 ***B*** – МК10 ***R1*** – resistance box 100kOhm

R2, R3 – 500±10 Ohm, 0.5V resistors ***P1, P2*** – DC microammeters 0-20mA, Class 0.2

P2 – DC voltmeter, Class 0.1

Note. P2, R2 are used for voltage measuring channels test.

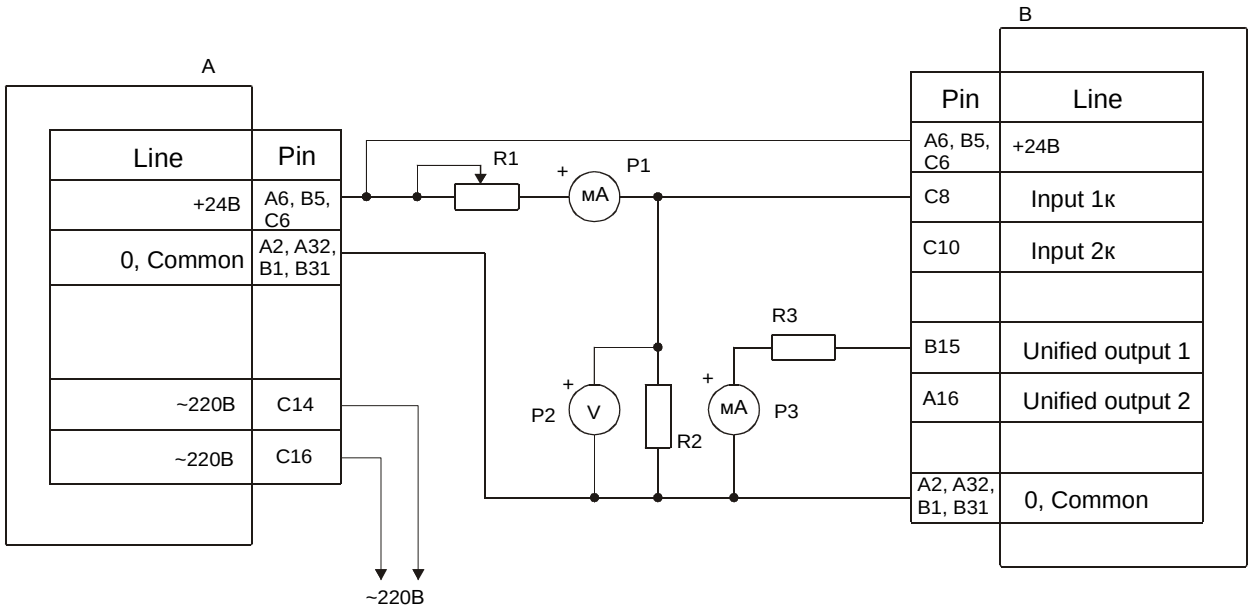


Figure 5. MK10 Module connection set-up for calibration and test calibration

Measuring channel input calibration

Measuring channel input calibration sequence is simple enough:

1. Indicate measuring channel current range value (RangeCurrMin, RangeCurrMax);
2. Indicate measured parameter range (RangeParamMin, RangeParamMax);
3. Set 20% of CurrMinCalibr current at channel input;
4. Rewrite AdcData value to AdcInMin;
5. Set RangeCurrMax current at channel input;
6. Rewrite AdcData value to AdcInMax;
7. Transfer calibration results to MK10 Module;
8. Implement ratios recalculation.

Alteration of measured parameter range consists in alteration of `RangeParamMin`, `RangeParamMax` parameters. At alteration of measured parameter range, alteration of data display format may be required (`FormatOut`).

Calibration wizard is provided in dedicated MK10 Module setting software, which considerably simplifies calibration process.

Standard output calibration

By measured parameter, standard output range corresponds to input range (`RangeParamMin`, `RangeParamMax`). Standard output calibration consists of the following steps:

1. Indicate standard output current range value (`CurrOutMin, CurrOutMax`);
2. By writing of value to `DacDirectData` select current (by means of microammeter), equal to 20% of `CurrOutMax`, at standard output;
3. Rewrite `DacDirectData` value to `DacOutMin`;
4. By writing of value to `DacDirectData` select current (by means of microammeter), equal to `CurrOutMax`, at standard output;
5. Rewrite `DacDirectData` value to `DacOutMax`;
6. Write “zero” to `DacDirectData` (switch calibration mode on)
7. Transfer calibration results to MK10 Module;
8. Implement ratios recalculation.

Alteration of input measured parameter range (`RangeParamMin, RangeParamMax`) automatically changes parameter range at standard output. Calibration wizard is provided in MK10 setup software for module calibration, which considerably simplifies calibration process.

Note. Writing of calibration results to MK10 Module and ratios recalculation can be implemented once, after all calibration steps (input, standard output, test output of both measuring channels) are complete.

Logic outputs

In MK10 Module 12 logic outputs with open collector (active 0) are provided.Logic outputs circuit design provides for possibility of direct relay coils connection.

Operation of each of 12 logic output is setup by user via digital communication interfaces.

If check sum error has been detected in one of the module operation parameters section, active signal level is present at logic output 12, while other MK10 Module logic outputs remain in dormant state.

After module resetting, logic outputs are disabled for `LogicOffStartUp` period of time, counted after module initialization cycle termination.

Logic outputs operation can be disabled by user, which may be required during module operating parameters correction or functionality test of the module, without risk of alarm or shutoff protection trip.

MK10 Module includes “OR” matrix (`LogicMatrix`) for switching of status flags (of measuring channels and general module status) to logic outputs. If at least one flag, assigned for logic output, is activated, active signal level will be present at relevant logic output, unless logic outputs are disabled.

Number of logic output, to which it will be assigned, is indicated for each flag. If number of logic output is equal to o or greater than 12, state of relevant assigned flag will not affect any of logic outputs.

Table 6. Measuring channels status flags `StatusCh` and their position if logic outputs matrix `LogicMatrix`

Bit No.	Label	Description	Code	Position in matrix			
				Channel 1	Channel 2	Channel 3	Channel 4
0	`OffMode`	Channel is off	xOff	8	16	24	32
1	`ErrorSenseLow`	Sensor current below acceptable level	xSH	9	17	25	33
2	`ErrorSenseHigh`	Sensor current above acceptable level	xSL	10	18	26	34
3	`FlagError`	Measuring channel general fault flag	xFE	11	19	27	35
4	`OutPoint_1`	Parameter value overrun of set-point 1	xS1	12	20	28	36
5	`OutPoint_2`	Parameter value overrun of set-point 2	xS2	13	21	29	37
6	`OutPoint_3`	Parameter value overrun of set-point 3	xS3	14	22	30	38
7	`OutPoint_4`	Parameter value overrun of set-point 4	xS4	15	23	31	39

Note. In alarm code instead of “x” symbol, channel number should be indicated (for example 1SH).

Table 7. Module status flags StatusSys and their position if logic outputs matrix `LogicMatrix`

Bit No.	Label	Description	Code	Position in matrix
0	`ErrorLoadData`	Operating parameter readout from volatile memory error	ErrLD	0
1	`LoadDataReserv`	One or several operating parameters groups are readout from volatile memory reserve storage	ResLD	1
2	`LogicOffStartUp`	Logic outputs are disabled after module resetting	LgOffSt	2
3	`LogicOffUser`	Logic outputs are disabled by user command	LgOffU	3
4	`InterfRS485_Off`	RS485 Interface is off	RS_Off	4
5	`InterfCAN_Off`	CAN2.0B Interface is off	CAN_Off	5
6	`AllowOneWrite`	Single write access is obtained	OneWr	6
7	`CalibrateMode`	Calibration mode is on for one of standard outputs	Calibr	7

Note. For changing module operating parameters, logic outputs must be disabled or permit for single write in operating parameters must be gained.

Digital Control Interfaces

MK10 Module supports there independent control interfaces:

- RS485 interface with ModBus RTU protocol partial implementation (sufficient for control);
- CAN2.0B interface (only expanded messages exchange is fulfilled);
- I2C driven interface for setting of module operating parameters.

All interfaces can operate simultaneously, without interfering.

Attention. Power supply, integrated circuits of RS485 and CAN2.0B interfaces drivers do not have **galvanic isolation**. MK10 Module with galvanic isolation of communication interfaces and power supply is manufactured on additional agreement basis.

RS485 interface

Half-duplex RS485 bus driver integrated circuit is provided on MK10 board for operation via RS485 interface. Data exchange via RS485 interface is fulfilled according to ModBus RTU protocol with possibility of data rate selection from several standard speed values and module address on the bus.

Table 8. RS485 interface parameters

Parameter name	Definition
Exchange protocol	ModBus RTU (partial implementation)
Data format	no parity, 2 stop-bits
Interval between messages, byte, not less than	3.5
Date rate (one of speed values is setup), bit/c	4800; 9600; 19200; 38400; 57600; 115200; 230400
Driver operating mode	half-duplex
Maximum number of bus cross-points	128(1)
Driver input resistance, kOhm, not less than	12(1)
Electrical endurance, kV, not less than	±15(1)
Galvanic isolation	no(1)

Note 1. On condition that MAX487ESA driver is used.

Setting module operating parameters by ModBus protocol

Module setup is implemented by writing of the values to relevant configuration registers, provided that writing is enabled. When writing to configuration registers is denied, NEGATIVE ACKNOLEDGE error code message returns.

Writing to configuration registers is only implemented by **Preset Multiple Regs** command of ModBus protocol.

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

At reception of wrong (incorrect) command, error report is generated, provided that address in query matches the module address and checksum is correct.

Error report format (5 byte):

Unit address
Function code with high-order bit set to “1”
Error code
Checksum, low-order byte
Checksum, high-order byte

Table 9. Possible ModBus protocol error codes

Code	Label	Description	Note
0x01	ILLEGAL FUNCTION	Incorrect function code	
0x02	ILLEGAL DATA ADRESS	Illegal register address	
0x03	ILLEGAL DATA VALUE	Illegal written value	
0x07	NEGATIVE ACKNOWLEDGE	Command can’t be executed	
0x09	ILLEGAL SIZE COMMAND	Function code and received message length don’t match	No a standard ModBus code

ModBus protocol supported commands

Table 10. Implemented ModBus protocol commands in MK10 Module.

Code	Name, description	Query	Response	Notes
0x03	**Read Holding Registers** Setting registers reading	Unit address Function (0x03) High-order byte initial address Low-order byte initial address Number of high-order byte registers Number of low-order byte registers Low-order byte CRC High-order byte CRC	Unit address Function (0x03) Byte counter High-order byte data Low-order byte data Low-order byte CRC High-order byte CRC	Used for measurement results and module operating parameters reading
0x06	**Preset Single Registers** Writing to register	Unit address Function (0x06) High-order byte address Low-order byte address High-order byte data Low-order byte data Low-order byte CRC High-order byte CRC	Unit address Function (0x06) High-order byte address Low-order byte address High-order byte data Low-order byte data Low-order byte CRC High-order byte CRC	Used for writing to control registers (execution of commands)
0x10	**Preset Multiple Regs** Writing to multiple registers	Unit address Function (0x10) High-order byte initial address Low-order byte initial address Number of high-order byte registers Number of low-order byte registers Byte counter High-order byte data Low-order byte data Low-order byte CRC High-order byte CRC	Unit address Function (0x10) High-order byte initial address Low-order byte initial address Number of high-order byte registers Number of low-order byte registers Low-order byte CRC High-order byte CRC	Used for operating parameters writing to the module
0x11	**Report Slave ID** Identification code reading	Unit address Function (0x11) Low-order byte CRC High-order byte CRC	Unit address Function (0x11) Byte counter Identification code (0x0B) Start indicator (0xFF) Software version, high-order byte Software version, low-order byte Module number, high-order byte Module number, low-order byte Year of manufacture, high-order byte Year of manufacture, low-order byte Low-order byte CRC High-order byte CRC	
0x08	**Diagnostics** Diagnostic commands	Unit address Function (0x008) High-order byte subfunction Low-order byte subfunction High-order byte data Low-order byte data Low-order byte CRC High-order byte CRC	Unit address Function (0x008) High-order byte subfunction Low-order byte subfunction High-order byte data Low-order byte data Low-order byte CRC High-order byte CRC	For the list of supported diagnostic commands refer to Table 11.

Table 11. List of ModBus protocol supported diagnostic commands

Command code	Description
0x0000	Echo response
0x0001	ModBus protocol counters resetting and “Listen Only” mode exit
0x0004	Switching on “Listen Only” mode
0x000A	ModBus protocol counters resetting
0x000B	Transfer number of received messages without errors
0x000C	Transfer number of received messages with checksum errors
0x000D	Transfer number of received messages with errors (except for checksum errors)

Checksum calculation in messages

CRC checksum consists of two bytes. CRC checksum is calculated by transmission unit and appended to each message. Receiver calculates checksum during receive and compares with CRC field of received message. CRC counter is pre-initialized by 0xFF value. Only 8 data bits are used for checksum calculation (start-, stop- and parity bits are not used for checksum calculation).

MK10 Module ModBus protocol control features

Operating parameters and module status register addressing is not aligned by 16-bit words. “Number of registers” parameter in ModBus commands is indicated in bytes.

During operating parameters and module status writing/reading, data is transferred according to C-based data storage in memory (low-order bit, then – high-order bit), but not according to ModBus standard requirements.

If odd number of bytes is acquired during reading, response will contain even number of bytes (per unit greater, than acquired). During writing of odd number of bytes, even number of bytes must always be transferred (per unit greater, than required), as virtually indicated number of bytes is written to module parameters.

Maximum size of writable/readable bytes in one transaction is 64 bytes.

Note. RS485 bus terminator is provided on MK10 Module board. If the module is last to be connected to RS485 bus and standard 120 Ohm bus terminator is missing, bridge with bus terminator must be installed on the module board for normal operation of RS485 interface.

CAN2.0B interface

CAN2.0B interface provides for possibility of MK10 Module status data transfer to indicating units and statistics gathering module. MK10 Module does not receive any data via CAN2.0B interface, possibility of module setup by means of CAN2.0B interface is not provided either.

Table 12. CAN2.0B interface parameters

Parameter name	Definition
Operating mode	data transfer in active mode with possibility of bus reset generation
Message format	only extended
Exchange protocol	unified for operation as part of “VIBROBIT 300” equipment set
MK10 Module indicating units code	0xC2 (194)
Data rate (one of speed values is setup), Kbit/c	1000; 500; 250; 200; 125; 100; 80; 40
CAN bus standards compliance	ISO-11898(1)
Maximum number of bus cross-points	112(1)
Driver input resistance, kOhm, not less than	5(1)
Electrical endurance, kV, not less than	±6(1)
Galvanic isolation	no(1)

Note 1. On condition that MCP2551 driver is used.

Module CAN controller operates in active mode, i.e. generates dominant acknowledgement of received data and can generate active reset message to CAN bus (for example, in case of incorrect indication of data rate)

All CAN bus cross-points must have equal data rate. At increase of data rate, CAN bus physical maximum light decreases. CAN bus maximum allowed length at 1000Kbit/s data rate is 40 meters, and at 40Kbit/s data rate – 1000 meters.

Note. CAN2.0B bus terminator is provided on MK10 Module board. If the module is last to be connected to RS485 bus and standard 120 Ohm bus terminator is missing, bridge with bus terminator must be installed on the module board for normal operation of RS485 interface.

The following parameters must be set up for CAN2.0B interface operation:

- CAN2.0B operation enabling (CanEnabled);
- Data rate (CanSpeed);
- Module address (CanBasicAddress);
- Message transfer intervals (CanBasicTime);
- Data transfer enabling via measuring channels (CanBasicDataOut).

Measuring results data are transferred with CanBasicDataOut intervals. Individual message with unique message code is generated or each of measuring channels:

0x30(48) – 1st measuring channel message;
0x31(49) – 2nd measuring channel message.
0x32(50) – 3rd measuring channel message;
0x33(51) – 4th measuring channel message

Messages are transferred sequentially: 1st measuring channel messages, then – 2ng measuring channel messages. New message is not transferred to bus, until previous message is transferred. If current message is not sent within 200ms, sending is cancelled.

If `CanBasicDataOut` flag is not equal to zero, relevant measuring channel message is transferred via CAN2.0B interface. If all `CanBasicDataOut` flags are equal to zero, no messages are transferred from the module via CAN 2.0B interface, however, the module generates acknowledgment of successful message transfer of other modules, connected to CAN2.0B bus.

Byte number in message						
0	**1**	**2**	**3**	**4**	**5**	**6**
Code	Parameter measured value (4 bytes float)				Measuring channel status register	Module status register
0x3x	`ParamData`				`StatusCh`	`StatusSys`

Figure 6. MK10 Module message format on CAN bus

I2C driven interface

I2C driven interface is designed for control of module operation and operating parameters setup. I2C interface connector is located on the module front panel (data link connector). I2C driven interface parameters are strictly defined, thus, independently from module current state, I2C interface is always accessible for module control.

Module setup can be implemented by means ПН31 setting unit, or PC. In order to setup by PC, dedicated software should by run on PC and the module must be connected to PC via MC01 diagnostic interface board (RS232 Interface) or MC01 USB (USB interface).

Note. During the module setup by means of MC01 USB, virtual COM port drivers must be installed on PC (see Annex D).

Table 13. I2C driven interface parameters

Parameter name	**Definition**
MK10 (version 3.0) address on I2C interface	0x24
Address format for module registers reference	16 bit
Data rate, Kbit/c, not greater than	400
DC voltage at data link connector for adaptor supply, V	5 ± 0.2
Permissible power circuit absorbed current at data link connector, mA, not greater than	50
Galvanic isolation	no

Note. Module is provided with hot swap option of setting unit and MC01, MC01 USB diagnostic interface boards

Module settings and current state (address tables)

Module measuring channels parameters and system settings

Table 14. List of measuring channels calibration parameters

Name	Label	Type (byte)	Address (Hex)				Note
			Channel 1	Channel 2	Channel 3	Channel 4	
Sensor current range lower level	RangeCurrMin	Float (4)	0x0600	0x0700	0x0800	0x0900	
Sensor current range higher level	RangeCurrMax	Float (4)	0x0604	0x0704	0x0804	0x0904	
Sensor current lower tolerance limit	CurrValidMin	Float (4)	0x0608	0x0708	0x0808	0x0908	
Sensor current upper tolerance limit	CurrValidMax	Float (4)	0x060C	0x070C	0x080C	0x090C	
Sensor test hysteresis	CurrValidHist	Float (4)	0x0610	0x0710	0x0810	0x0910	
Standard output current range lower level	CurrOutMin	Float (4)	0x0614	0x0714	0x0814	0x0914	
Standard output current range higher level	CurrOutMax	Float (4)	0x0618	0x0718	0x0818	0x0918	
ADC value of sensor current calibration lower level	AdcInMin	Uint (2)	0x061C	0x071C	0x081C	0x091C	
ADC value of sensor current calibration higher level	AdcInMax	Uint (2)	0x061E	0x071E	0x081E	0x091E	
DAC value of standard output calibration lower level	DacOutMin	Uint (2)	0x0620	0x0720	0x0820	0x0920	
DAC value of standard output calibration higher level	DacOutMax	Uint (2)	0x0622	0x0722	0x0822	0x0922	

Table 15. List of measuring channels basic parameters

Name	Label	Type (byte)	Address (Hex)				Note
			Channel 1	Channel 2	Channel 3	Channel 4	
Measuring channel enabling (0 - enabled)	Enabled	Uchar(1)	0x0A00	0x0B00	0x0C00	0x0D00	
Measured parameter lower range	RangeParamMin	Float (4)	0x0A01	0x0B01	0x0C01	0x0D01	
Measured parameter higher range	RangeParamMax	Float (4)	0x0A05	0x0B05	0x0C05	0x0D05	
Measuring units label	MeasurUnit	Char (8)	0x0A09	0x0B09	0x0C09	0x0D09	
Parameter name text string	MeasurName	Char (8)	0x0A11	0x0B11	0x0C11	0x0D11	
Measurement results display format	FormatOut	UChar (1)	0x0A19	0x0B19	0x0C19	0x0D19	1
Measured parameter averaging depth	AverageData	UChar (1)	0x0A1A	0x0B1A	0x0C1A	0x0D1A	2
Set-point overrun response time	TestPointTime	UChar (1)	0x0A1B	0x0B1B	0x0C1B	0x0D1B	3
Set-point 1 operating mode	TestPointMode_1	UChar (1)	0x0A1C	0x0B1C	0x0C1C	0x0D1C	4
Set-point 2 operating mode	TestPointMode_2	UChar (1)	0x0A1D	0x0B1D	0x0C1D	0x0D1D	4
Set-point 3 operating mode	TestPointMode_3	UChar (1)	0x0A1E	0x0B1E	0x0C1E	0x0D1E	4
Set-point 4 operating mode	TestPointMode_4	UChar (1)	0x0A1F	0x0B1F	0x0C1F	0x0D1F	4
Set-point 1	TestPointData_1	Float (4)	0x0A20	0x0B20	0x0C20	0x0D20	
Set-point 2	TestPointData_2	Float (4)	0x0A24	0x0B24	0x0C24	0x0D24	
Set-point 3	TestPointData_3	Float (4)	0x0A28	0x0B28	0x0C28	0x0D28	
Set-point 4	TestPointData_4	Float (4)	0x0A2C	0x0B2C	0x0C2C	0x0D2C	
Set-point hysteresis	TestPointHist	Float (4)	0x0A30	0x0B30	0x0C30	0x0D30	

Notes:

1. For FormatOut parameter description, refer to Table 4.
2. Value from 0 to 9. At AverageData equal to zero – no averaging. At AverageData equal to 9 – averaging depth 10 (maximum).
3. Time by 0.5s (0 = 0.5s)
4. For parameters description, refer to Table 5.

Table 16. List of module system settings

Name	Label	Type (byte)	Address (Hex)	Note
Logic outputs disabling timeout after the module resetting	LogicOffStartUp	UChar (1)	0x0E00	3
Set-point test timeout after sensor function normalization	TestPointSenseOk	UChar (1)	0x0E01	3
Logic alarm matrix bits 0:3 – output number, to which alarm is assigned bits 4:5– reserved, must be equal to zero bit 6 – “War” LED is enabled bit 7 – “Alarm” LED is enabled	LogicMatrix	UChar (40)	0x0E02	4

Notes:

1. Comes into effect only after the module resetting.
2. When value is equal to zero, function is OFF.
3. Time by 0. 5s (0 = 0. 5s)
4. For logic alarm bytes assignment, refer to Tables 6, 7.

Communication interfaces

Table 17. List of RS485 interface parameters

Name	Label	Type (byte)	Address (Hex)	Note
Interface operation enabling: 0 – interface is OFF 1 – interface is ON	RSEnabled	UChar (1)	0x0F00	
Operating parameters change by commands and via RS485 interface: 0 – denied 1 – enabled	RSChangeEnabled	UChar (1)	0x0F01	
Single write operation: 0 – denied 1 – enabled	RSOneWriteCommand	UChar (1)	0x0F02	
Unit address on RS485 bus (from 1 to 247)	RSAddress	Uint (2)	0x0F03	
Data rate, bit/s: 0 – 4800; 1 – 9600; 2 – 19200; 3 – 38400; 4 – 57600; 5 – 115200; 6 - 230400	RSSpeed	UChar (1)	0x0F05	

Note. RS485 interface parameters come into effect only after the module re-initialization.

Table 18. List of CAN2.0B interface parameters

Name	Label	Type (byte)	Address (Hex)	Note
Interface operation enabling: 0 – interface is OFF 1 – interface is ON	CANEnabled	UChar (1)	0x1000	
Data rate, bit/s: 0 – 1000; 1 – 500; 2 – 250; 3 – 200; 4 – 125; 5 – 100; 6 – 80; 7 - 40	CANSpeed	UChar (1)	0x1001	
Unit address on the bus	CANBasicAddress	Uint (2)	0x1002	
Message sending interval by 0. 5s	CANBasicTime	UChar (1)	0x1004	
Data sending in channel 1 (0 – not to send)	CANBasicDataOut_1	UChar (1)	0x1005	
Data sending in channel 2 (0 – not to send)	CANBasicDataOut_2	UChar (1)	0x1006	
Data sending in channel 3 (0 – not to send)	CANBasicDataOut_3	UChar (1)	0x1007	
Data sending in channel 4 (0 – not to send)	CANBasicDataOut_4	UChar (1)	0x1008	

Note. CAN2.0B interface parameters come into effect only after the module re-initialization.

Identification information

Table 19. List of identification information registers

Name	Label	Type (byte)	Address (Hex)	Note
Module software version	Number	Uint (2)	0x1200	
Module serial number	Year	Uint (2)	0x1202	
Module year of manufacture	Order	Uint (2)	0x1204	
Assembler code	Assembler	UChar (1)	0x1206	
Adjuster code	Adjuster	UChar (1)	0x1207	
Additional text string	TextString	Char (32)	0x1208	

Note. Identification information is read-only.

Measurement results

Table 20. List of measurement results registers

Name	Label	Type (byte)	Address (Hex)	Note
Channel 1 measurement results	ParamData_1	Float (4)	0x0000	
Channel 1 status flags	StatusCh_1	UChar (1)	0x0004	1
Channel 1 sensor current	Current_1	Float (4)	0x0005	
Channel 1 ADC value (used in calibration)	AdcData_1	Uint (2)	0x0009	
Channel 2measurement results	ParamData_2	Float (4)	0x000B	
Channel 2 status flags	StatusCh_2	UChar (1)	0x000F	1
Channel 2 sensor current	Current_2	Float (4)	0x0010	
Channel 2 ADC value (used in calibration)	AdcData_2	Uint (2)	0x0014	
Channel 3 measurement results	ParamData_3	Float (4)	0x0016	
Channel 3 status flags	StatusCh_3	UChar (1)	0x001A	1
Channel 3 sensor current	Current_3	Float (4)	0x001B	
Channel 3 ADC value (used in calibration)	AdcData_3	Uint (2)	0x001F	
Channel 4 measurement results	ParamData_4	Float (4)	0x0021	
Channel 4 status flags	StatusCh_4	UChar (1)	0x0025	1
Channel 4 sensor current	Current_4	Float (4)	0x0026	
Channel 4 ADC value (used in calibration)	AdcData_4	Uint (2)	0x002A	
Module status flags	StatusSys	UChar (1)	0x002C	2
Reserved	Reserv	UChar (1)	0x002D	
Logic outputs state bits 0-11 – logic output state bits 13-12– reserved, equal to zero bit 14 – “War” LED state bit 15 – “Alarm” LED state	LogicOutStatus	Uint (2)	0x002E	3

Notes:

1. For flags assignment, refer to Table 6.
2. For flags assignment, refer to Table 7.
3. During logic outputs disabling, logic outputs state after enabling can be determined from LogicOutStatus parameter/
4. Measurement results registers are read-only.

Table 21. Test signal and standard output control registers

Name	Label	Type (byte)	Address (Hex)	Note
DAC value of Channel 1 standard output direct control	DacDirectData_1	Uint (2)	0x0500	
DAC value of Channel 2 standard output direct control	DacDirectData_2	Uint (2)	0x0502	
DAC value of Channel 3 standard output direct control	DacDirectData_3	Uint (2)	0x0504	
DAC value of Channel 4 standard output direct control	DacDirectData_4	Uint (2)	0x0506	

Notes:

1. Used in calibration. DAC range from 0 to 4095. Does not participate in normal operation.
2. All registers of the group are writable in all operating modes of the module.

Control commands

In MK10 Module several reserved registers are provided for control commands implementation. Control commands are only implemented by individual writing to each register (implementation of several commands during one transaction is not possible).

Table 22. List of control registers

Register address (Hex)	Written value (Hex)	Action	Note
0xFF00	0x55	Module resetting (the same as module switching on)	
0xFF01	0x61	Recalculate Channel 1 ratios	1, 4
	0x62	Recalculate Channel 2 ratios	1, 4
	0x63	Recalculate Channel 3 ratios	1, 4
	0x64	Recalculate Channel 4 ratios	1, 4
	0x93	Implement RS485 interface re-initialization	2, 4
	0x98	Implement CAN2.0B interface re-initialization	3, 4
0xFF02	0x33	Logic alarm disabling	
	0xCC	Logic alarm normal operation	
0xFF03	0x3C	Single write query	
0xFF06	Writing of module operating parameters to volatile memory		4, 6
	0x81	Channel 2 calibration data	
	0x82	Channel 3 calibration data	
	0x83	Channel 4 calibration data	
	0x84	Channel 1 basic parameters	
	0x85	Channel 2 basic parameters	
	0x86	Channel 3 basic parameters	
	0x87	Channel 4 basic parameters	
	0x88	Module system parameters	
	0x89	RS485 interface parameters	
	0x8A	CAN2.0B interface parameters	
	0x8B	Writing of all module setting parameters to volatile memory	
0xFF07	0x21	Channel 1 calibration data	7

Notes:

1. Can be used after module calibration for measurements check without module resetting.
2. If command is received at the time of response transfer, response is transferred completely, and then re-initialization is implemented.
3. If command is received at the time of message sending, message is sent completely, and then re-initialization is implemented.
4. Alarm logic outputs must be disabled.
5. Mode must be enabled in module settings.
6. Module resetting is not implemented after writing.
7. During writing, module operation is stopped. After writing, module resetting is implemented automatically.

Parameters value after module cold start

After module cold start, module parameters are reset:

- Calibration information is deleted;
- Logic alarm is not assigned;
- RS485, CAN2.0B interfaces are switched off;
- Part of the parameters is initialized on default.

Table 23. Measuring channels calibration parameters values after cold start

Parameter	Label	Definition	Note
Sensor current range lower level	RangeCurrMin	1.0	
Sensor current range higher level	RangeCurrMax	5.0	
Sensor current lower tolerance limit	CurrValidMin	0.7	
Sensor current upper tolerance limit	CurrValidMax	5.3	
Sensor test hysteresis	CurrValidHist	0.1	
Standard output current range lower level	CurrOutMin	4.0	
Standard output current range higher level	CurrOutMax	20.0	
ADC value of sensor current calibration lower level	AdcInMin	0	1
ADC value of sensor current calibration higher level	AdcInMax	0	
DAC value of standard output calibration lower level	DacOutMin	0	2
DAC value of standard output calibration higher level	DacOutMax	0	

Notes:

1. Sensor current and measured parameter values are not calculated.
2. Standard output is disabled, current at the output is always 0 (or as low as possible).

Table 24. Measuring channels basic parameters values after cold start

Parameter	Label	Definition	Note
Measuring channel mode	Enabled	1	Вкл.
Measured parameter lower range	RangeParamMin	0	
Measured parameter higher range	RangeParamMax	0	
Measuring units label	MeasurUnit	void	
Parameter name text string	MeasurName	void	
Measurement results display format	FormatOut	3	####
Measured parameter averaging depth	AverageData	0	No
Set-point overrun response time	TestPointTime	0	0.5c
Set-point 1 operating mode	TestPointMode_1	0	
Set-point 2 operating mode	TestPointMode_2	0	
Set-point 3 operating mode	TestPointMode_3	0	
Set-point 4 operating mode	TestPointMode_4	0	
Set-point 1	TestPointData_1	0	
Set-point 2	TestPointData_2	0	
Set-point 3	TestPointData_3	0	
Set-point 4	TestPointData_4	0	
Set-point hysteresis	TestPointHist	0	

Table 25. Module system parameters values after cold start

Parameter	Label	Definition	Note
Logic outputs disabling timeout after the module resetting	LogicOffStartUp	15	8c
Set-point test timeout after sensor function normalization	TestPointSenseOk	15	8c
Logic alarm matrix	LogicMatrix	0	1

Notes:

1. Logic alarm is not determined, all logic outputs are inactive.

Table 26. RS485 interface parameters after cold start

Parameter	Label	Definition	Note
Interface operation enabling	RSEnabled	0	Выкл.
Operating parameters change by commands and via RS485 interface	RSChangeEnabled	0	
Single write operation enabling	RSOneWriteCommand	0	
Unit address on RS485 bus (from 1 to 247)	RSAddress	1	
Data rate, bit/s	RSSpeed	0	4800

Table 27. RCAN2.0B interface parameters values after cold start

Parameter	Label	Definition	Note
Interface operation enabling	CANEnabled	0	Выкл.
Data rate, bit/s	CANSpeed	0	1000
Unit address on the bus	CANBasicAddress	0	
Message sending interval by 0. 5s	CANBasicTime	0	0.5c
Data sending in channel 1 (0 – not to send)	CANBasicDataOut_1	0	no
Data sending in channel 2 (0 – not to send)	CANBasicDataOut_2	0	no
Data sending in channel 3 (0 – not to send)	CANBasicDataOut_3	0	no
Data sending in channel 4 (0 – not to send)	CANBasicDataOut_4	0	no

Software

Dedicated software for MK10 Module setup has a user friendly interface and access to all module parameters. In order to operate setting software, the module must be connected to PC by means of MC01 diagnostic interface board or MC01 USB.

Software basic features:

- Real-time viewing of current display readings and MK10 alarm;
- Setting of all measuring channels parameters, communication interfaces and module general parameters;
- Generation of logic alarm and module general parameters setting text report;
- Loading/saving settings to file;
- Input calibration;
- Standard output calibration.

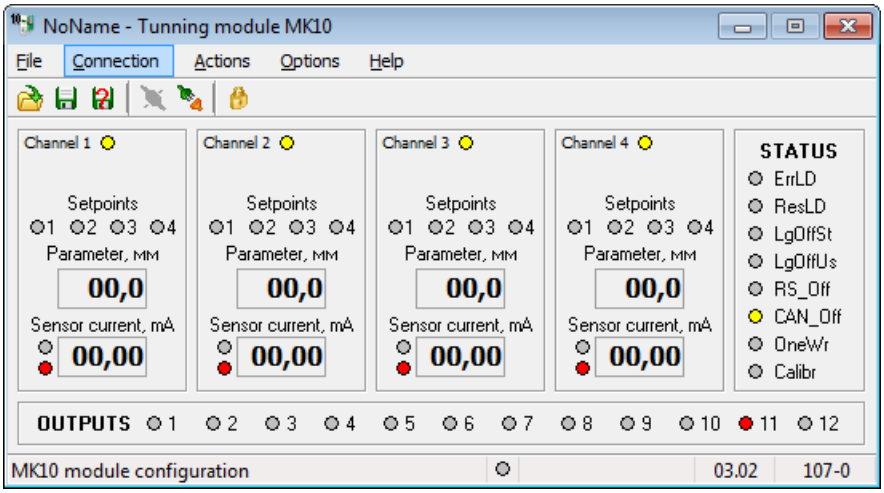


Figure 7. MK10 setting software configuration

Getting started

In order to get started, connection to MK10 is required. For this purpose, COM-port must be selected, to which MK10 is connected by means of MC01 board. Software implements system scan for active COM-ports. COM1 port is selected on default. This setting is saved to program INI-file. In order to create or save to INI-file, software must be stored on hard disc drive or other media, but not on CD.

In ***Connection*** menu, select ***Connect*** or press push button.

If connection is successful, ***Actions*** Menu is activated.

For reading settings from MK10, select ***Read module settings*** option. Current settings state can be saved to file on PC drive. Later on these files can be used as template files.

In order to open existing file with settings, select ***Open…*** in ***File*** Menu or press push button.

Software supports dragging function, which allows to simply drag existing files with settings to program primary window. Besides, program can associate files with **.mk10** extension, which allows to further open such files without initial program run. For this, select ***File association*** in ***Help*** Menu.

Measuring channels parameters

For measuring channels parameters setup, select ***Measuring channels*** option in ***Parameters*** Menu.
Parameters include the following sections:

- Channel general parameters;
- Set-points operation mode;
- Calibration.

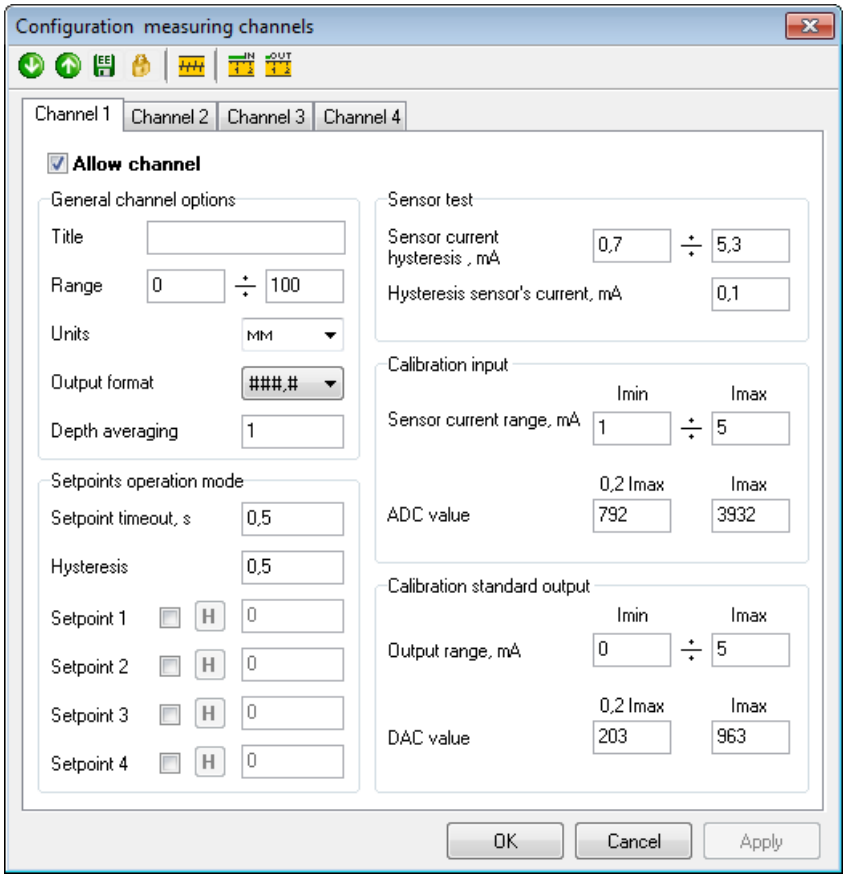


Figure 8. Measuring channel parameters setup window.

Setup configuration is the same for all measuring channels. Change of parameter activates ***Apply*** push button, which helps to save performed changes. When switching tabs with channels, if change has been made, program will ask to save them or not.

For reading of selected channel settings, press push button on command panel. This option is active when MK10 is connected.

For writing of selected channel settings, press push button on command panel. This option is active when MK10 Module is connected and logic outputs are disabled.

For saving settings, written to the module, to volatile memory, press push button on command panel. This option is active when MK10 Module is connected.

For logic alarm disabling, press push button on command panel. This option is active when MK10 Module is connected.

For the changes of calibration data and parameter range (written to the module) to come into effect, command must be sent to the module to implement recalculation of ratios by pressing push button. This option is active when MK10 Module is connected.

Channel general parameters

For selected measuring channel general parameters setup, act as follows:

- Enable/disable measuring channel operation.
- Set measuring parameter name (maximum number of characters – 8)
- Set parameter range (minimum and maximum parameter values);
- Select from list or input new parameter measuring unit;
- Select data display format:
  - from -999 to 9999;
  - from -99.9 to 999.9;
  - from -9.99 to 99.99;
  - from 0.000 to 9.999;
- Set parameter averaging depth.

Set-points operation mode

For selected measuring channel set-points operating mode setup, act as follows:

- Set set-point values overrun time (discreteness – 0. 5s);
- Set hysteresis;
- For each of 4 set-points, set:
  - Set-point preset value;
  - Set-points operation mode:
    - OFF;
    - set value;
    - below preset value.

Communication interfaces parameters

For measuring channels parameters setup, select ***Communication interfaces*** option in ***Parameters*** Menu. Parameters include the following sections:

- RS485 interface
- CAN2.0B interface

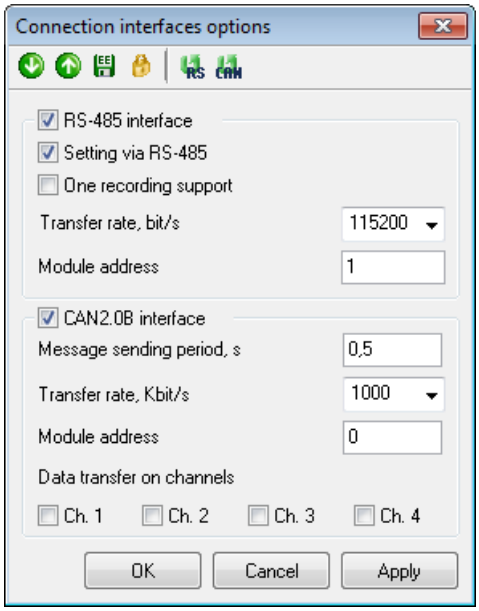


Figure 9. Communication interfaces parameters setup window

For reading settings from the module, press push button on command panel. This option is active when MK10 Module is connected.

For writing settings to the module, press push button on command panel. This option is active when MK10 Module is connected and logic outputs are disabled.

For saving settings, written to the module, to volatile memory, press push button on command panel. This option is active when MK10 Module is connected and logic outputs are disabled.

For logic alarm disabling, press push button on command panel. This option is active when MK10 Module is connected.

For RS485 interface re-initialization in case of settings change, press push button on command panel. This option is active when MK10 Module is connected and logic outputs are disabled.

For CAN2.0B interface re-initialization in case of settings change, press push button on command panel. This option is active when MK10 Module is connected and logic outputs are disabled.

RS-485 Interface

For interface parameters setup, act as follows:

- Enable/disable interface operation by selecting/deselecting *RS485 Interface* option check box;
- Enable/disable interface operating parameters setup;
- Switch on/off single write command support;
- Select one of possible interface data rates;
- Set module address on interface bus (acceptable address range: 1÷247).

CAN2.0B Interface

For interface parameters setup, act as follows:

- Enable/disable interface operation by selecting/deselecting *CAN2.0B5 Interface* option check box;
- Set message sending interval (discreteness – 0.25s);
- Select one of possible interface data rates;
- Set module address on interface bus;
- Enable/disable data transfer in channels.

General parameters

For general (system) parameters setup, select *General* ***parameters*** option in ***Parameters*** Menu.

Parameters include the following sections:

- Measuring channels logic alarm;
- Module logic alarm;
- Module parameters.

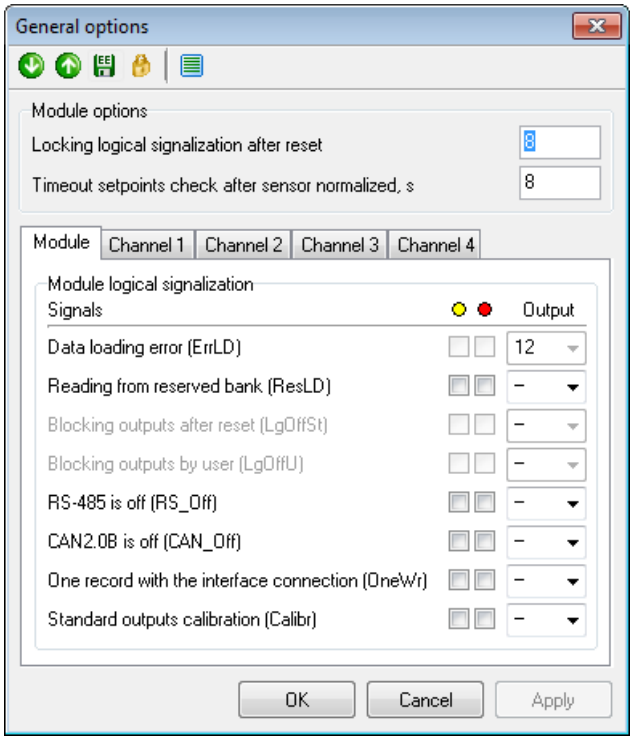


Figure 10. General (system) parameters window

For logic alarm text report generation, press push button on the command panel. At this, the report is saved to folder, from which program was launched, if it is possible, and then is opened by TXT-files reader program. Thus, for text report generation, program must not be launched from read-only media.

For reading settings from the module, press push button on the command panel. This option is active when MK10 Module is connected.

For writing settings to the module, press push button on the command panel. This option is active when MK10 is connected and logic outputs are disabled.

For saving settings, written to the module, to volatile memory, press push button on command panel. This option is active when MK10 Module is connected and logic outputs are disabled.

For logic alarm disabling, press push button on command panel. This option is active when MK10 Module is connected.

Measuring channels logic alarm

For measuring channels logic alarm setup, act as follows:

- Set signals to be indicated by yellow LED by means of selecting/deselecting of relevant option check box under the yellow LED sign.
- Set signals to be indicated by red LED by means of selecting/deselecting of relevant option check box under the yellow LED sign.
- Set logic output for each signal.

Module logic alarm

Module logic alarm setup is implemented in the same manner as measuring channels logic alarm setup.

Module parameters

For module parameters setup, act as follows:

- Set logic alarm disabling wait timeout after resetting (discreteness – 0.5s);
- Specify set-points test timeout after sensor normalization.

Calibration

Input and output signals calibration in basic and test modes is carried out by means of calibration wizard. Calibration operations are accessible when MK10 Module is connected and logic outputs are disabled.

- Input calibration;
- Output calibration.

For input and output calibration, select ***Measuring channels*** option in ***Parameters*** Menu. Calibration will be carried out for selected measuring channel.

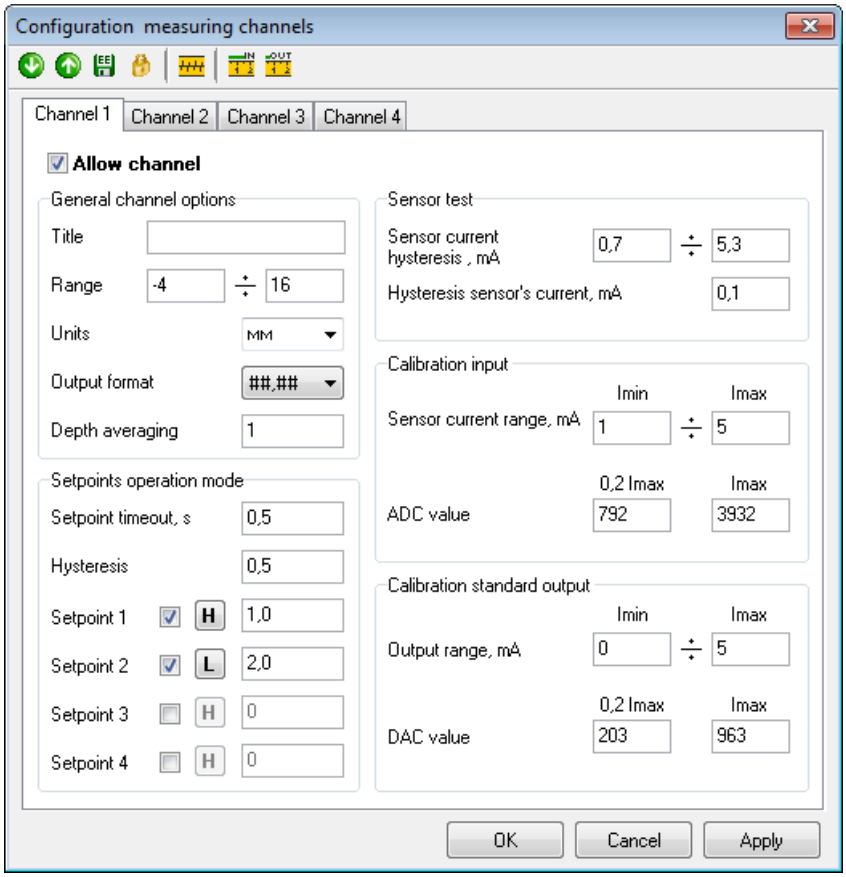


Figure 11. Measuring channels setup window

Input calibration

In order to launch input calibration wizard, press push button on the command panel of ***Measuring channels*** window. Then, following the hints, act as follows:

- Current range and minimum calibration current must be set;
- Minimum calibration current must be supplied at measuring channel input;
- After setting ADC value, press ***Continue*** push button;
- Range maximum current must be supplied at the input;
- After setting ADC value, ***Continue*** push button must be pressed;
- At pressing of ***Done*** push button, results are loaded to the module and ratios are recalculated.

At latter stage of calibration, obtained ADC values can be edited. ***Cancel*** push button can be pressed at any stage in order to abort calibration.

Standard output calibration (basic mode)

In order to launch output signal (basic mode) calibration wizard, press push button on the command panel of ***Measuring channels*** window. Then, following the hints, act as follows:

- Current range at standard output and minimum calibration current must be set (0.2Imax);
- Milliammeter must be connected to measuring channel standard output (see Figure 5);
- DAC value must be selected to ensure range maximum output current on milliammeter by means of:
  - Up/ Down arrows (DAC value is increased or decreased and automatically written to MK10 Module);
  - actual value entry in input box and press ***Load to module*** or ***Enter*** push button;
- After setting maximum input current, DAC value must be selected for minimum calibration current;
- At pressing of ***Done*** push button, ratios are recalculated.

At latter stage of calibration, obtained DAC values can be edited. ***Cancel*** push button can be pressed at any stage in order to abort calibration.

Program close-down

On completion of MK10 required parameters entry, parameters must be written to the module, for which, select Write ***parameters to module*** in ***Actions*** Menu or press push button.

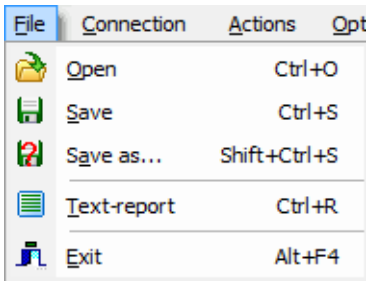
For parameters saving to MK10 volatile memory, select ***Save actual setting to memory*** command or press push button. Selection of ***Parameters comparison*** command in ***Actions*** Menu is recommended to compare settings, saved to module memory and setting in PC setup software; test report on comparison results will be displayed.

Next, select ***Disconnect*** command in ***Connection*** Menu or press push button.

On setup completion, text report must be generated. For this, select ***Text report*** command in ***File*** menu .

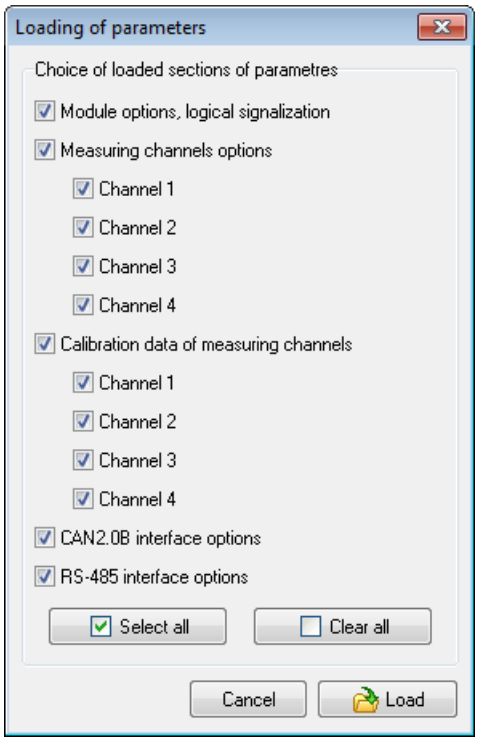
Program menu options description

File Menu
File Menu contains file commands, such as ***Open settings file, Save settings file*** etc.



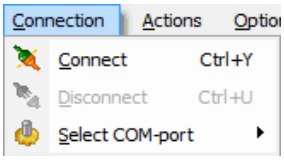
Command	Description
Open **[Ctrl+O]**	Open previously created file with settings. When this command is run, file opening dialog box opens, then selected file consistency is checked. In case of file error, relevant warning is issued.
Save **[Ctrl+S]**	Save changes, made to open file with settings
Save as **[Shift+Ctrl+O]**	Save current settings under different name. When this command is run, file saving dialog box opens. If selected file already exists program issues relevant warning and asks to replace existing file.
Text report **[Ctrl+R]**	Generate text file with MK10 current settings.
Exit **[Alt+F4]**	Exit program

At opening of settings file, program asks to select parameters to be read from file.



Connection Menu

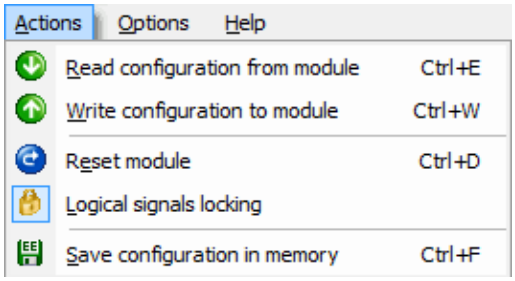
Connection Menu contains commands for working with COM-port.



Command	Description
Connect **[Ctrl+V]**	Create connection to MK10. *Actions* Menu is activated
Disconnect **[Ctrl+U]**	Break connection to MK10. *Actions* Menu is deactivated
Select Com-port	Assign COM-port for MK10 connection

Actions Menu

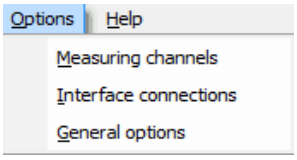
Actions Menu contains commands for working with MK10.



Command	Description
Read settings from module **[Ctrl+E]**	Read all settings from MK10. Query is being sent to confirm action. After operation is complete, message is displayed on successful settings readout. At this, all settings are being replaced by read settings.
Write settings to module **[Ctrl+W]**	Transfer current settings to MK10. Query is being sent to confirm action. After operation is complete, message is displayed on successful settings readout.
Module resetting **[Ctrl+D]**	Transfer reset command to MK10. Query is being sent to confirm action. At resetting, communication with MK10 persists.
Logic outputs disabling	Disable output logic signals. At disabling, menu options, such as ***Write settings to module***, ***Save current setting to memory*** etc., corresponding to writing to MK10 Module, become active. Disabling can also be implemented by shortcut menu command on ***Outputs*** panel.
Save current setting to memory **[Ctrl+F]**	Transfer command to MK10 on settings saving to module volatile memory. At saving, communication with MK10 persists, and after saving, MK10 automat resetting is implemented.
Parameters comparison	Comparison of module operating parameters in the module with operating parameters in the opened program.

Parameters Menu

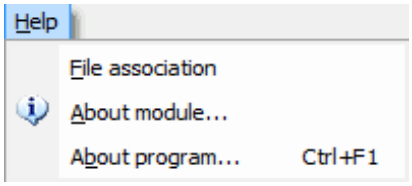
Parameters Menu contains parameters setting and MK10 calibration commands.



Command	Description
Measuring channels	Measuring channels parameters, input and output calibration in basic and test modes
Communication interfaces	RS485 and CAN2.0B interfaces parameters
General parameters	Logic alarm parameters and other module parameters

Help Menu

Help Menu contains MK10 module and program help information.



Command	Description
Work instructions **[F1]**	Work instructions for MK10 Module setup program
File association	Association for files with Mk10 with this program. If the checkbox is set, the association held.
About module	Information on Software version, module serial number, year of manufacture etc.
About program **[Ctrl+F1]**	Information on program name, version, release date and authors

Maintenance

For maintenance information, refer to document ВШПА.421412.300 “VIBROBIT 300 Equipment set. User’s Manual”:

- Equipment set servicing;
- Maintenance;
- Test calibration.

Handling and storage

Transportation can be carried out by any vehicle, upon condition of protection from atmospheric precipitation and water splashes, in accordance with transportation conditions, effective for all transportation vehicles.

At carriage by air freight, equipment set must be placed in heated and sealed compartments.

Transportation conditions – Group “Ж” according to GOST 23216-78.

Storage of equipment set in reference to climatic factors influence must be in compliance with Group “Ж3” according to GOST 15150-69-78.

Shelf life is not longer than 6 months from delivery date.

Manufacturer’s warranty

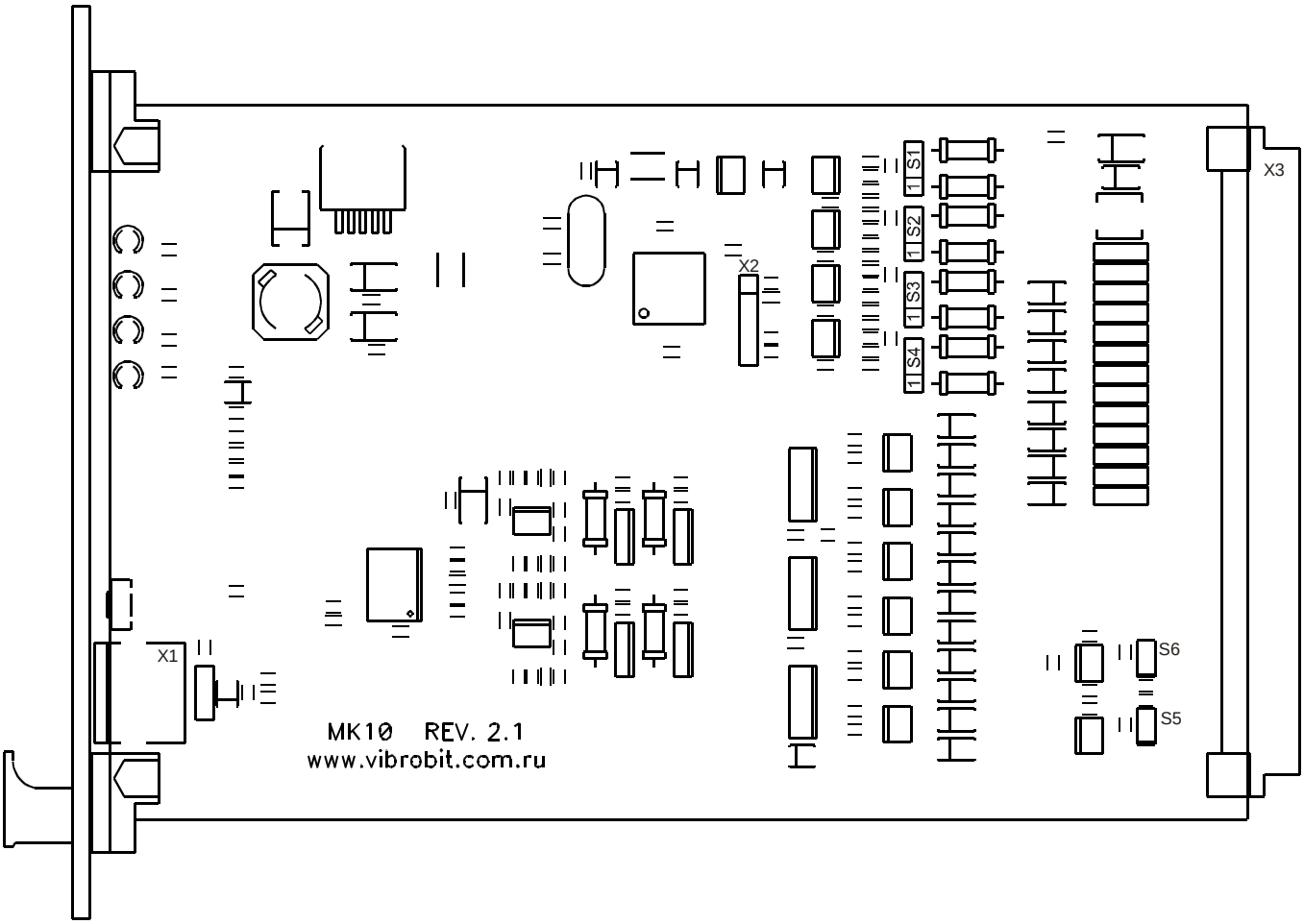
Manufacturer warranties compliance of equipment set with technical conditions, provided that operation, storage, transportation, handling and assembly conditions are met.

Warranty period is 24 month from start-up date, but not longer than 30 months from the date of manufacture.

When sending equipment for repair at manufacturer’s premises, revealed faults should be indicated.

ANNEXES

A. Controls arrangement



S1, S2 bridges – operating mode selection for measuring channels 1, 2, 3, 4 (respectively)

Position	Mode
OFF	Operating mode by voltage 0…4.096V
1-2	Operating mode by current 4…20mA
2-3	Operating mode by current 1…5mA

S5, S6 bridges – 120Ohm bus terminator of RS485 and CAN2.0B interfaces (respectively)

Position	Mode
OFF	Terminator disconnected from bus
ON	Terminator connected to bus

MK10 board connectors assignment

Position	Mode
X1	Diagnostic interface
X2	Microcontroller programming (service)
X3	Module main connector for section circuits connection

B. X3 connector terminals assignment

Terminal number	Label	Assignment	Note
A2, B1, C2 A32, B31, C32	GND	General	
A6, B5, C6	Power +24V	+24V supply voltage input/output	
B7	+24V sense CH1	+24V voltage output for measuring channel 1 convertor supply	
B9	+24V sense CH2	+24V voltage output for measuring channel 2 convertor supply	
B11	+24V sense CH3	+24V voltage output for measuring channel 3 convertor supply	
B13	+24V sense CH4	+24V voltage output for measuring channel 4 convertor supply	
C8	Input CH1	Measuring channel 1 input	1
C10	Input CH2	Measuring channel 2 input	1
C12	Input CH3	Measuring channel 3 input	1
C14	Input CH4	Measuring channel 4 input	1
B15	Analog out 1	Measuring channel 1 standard output	
C16	Analog out 2	Measuring channel 2 standard output	
B17	Analog out 3	Measuring channel 3 standard output	
C18	Analog out 4	Measuring channel 4 standard output	
A20	LG_OUT_1	Logic output 1	2
A22	LG_OUT_2	Logic output 2	2
A24	LG_OUT_3	Logic output 3	2
A26	LG_OUT_4	Logic output 4	2
B19	LG_OUT_5	Logic output 5	2
B21	LG_OUT_6	Logic output 6	2
B22	LG_OUT_7	Logic output 7	2
B23	LG_OUT_8	Logic output 8	2
C20	LG_OUT_9	Logic output 9	2
C22	LG_OUT_10	Logic output 10	2
C24	LG_OUT_11	Logic output 11	2
C26	LG_OUT_12	Logic output 12	2, 3
A28	CAN-GND	CAN2.0B interface	
B27	CAN-H		
C28	CAN-L		
A30	RS485-GND	RS485 interface	
B29	RS485-B(-)		
C30	RS485-A(-)		

Notes:

1. If channel is not in use, terminal can be left unconnected; channel operation must be switched off in module settings.
2. Operation logic is determined during module setup.
3. At read error during parameters reading from volatile memory, certain active level will be present. It is recommended to assign all module fault signals (sensor test etc.) to this output.
4. Terminals A4, A8, A10, A14, B3, B13, C4, C20, C22, C24, C26 are not in use and must be left unconnected for compatibility with succeeding versions of MK10.

C. Module labeling

Module labeling comprises:

- MK10 Module type and design option (DC, DC-11, DC-001);
- Module serial number and year of manufacture;
- Standard outputs operating mode (A – 1-5mA; B – 4-20mA);
- Assembler number;
- Adjuster number;
- Order number.

Example of module labeling

МК10 DC-11	Module No. -	Mode	Assemble.	Adjust.	Order

Detailed information on module setting up (measuring ranges, set-points levels in measuring channels, communication interfaces parameters, logic alarm setup etc.) is stipulated in relevant module Setting up report.

Additionally, a label with module basic settings is attached to module board.

Example of basic settings label on the module board.

Channel	1	2	3	4
Parameter	ОРР ВД	ОРР НД	Wa	OFF
Unit	mm	mm	MW	
Range	-5-0-+5	-5-0-+5	0-60	
Set-point1	-1.5	-1.5		
Set-point2	+2.5	+2.5		
Set-point3	-2	-2		
Set-point4	+3	+3		
RS485	Address 014	Rate 115200	RS485	Address 014
CAN2.0B	Address	Rate	CAN2.0B	Address

D. Module (Setup) Order Form example

MK10 Module (Setup) Order Form

Module design option (DC, DC-11, DC-001)_____ Quantity of modules with actual setup _____

1.Measuring channels parameters

Channel No.	Brief description	Sensor/ transducer	Parameter range	Set-points parameters			Additional parameters	
1.				1			Display format	
				2			Averaging	
				3			Set-point hysteresis	
				4			Standard output	
2.				1			Display format	
				2			Averaging	
				3			Set-point hysteresis	
				4			Standard output	
3.				1			Display format	
				2			Averaging	
				3			Set-point hysteresis	
				4			Standard output	
4.				1			Display format	
				2			Averaging	
				3			Set-point hysteresis	
				4			Standard output	

2. Logic alarm parameters and “War”, “Alarm” LED’s on the module front panel

Channel No.	Logic formula	Channel No.	Logic formula	Channel No.	Logic formula
1.		5.		9.	
2.		6.		10.	
3.		7.		11.	
4.		8.		12.	
War			Alarm		

Codes in measuring channels *(instead of “x” indicate c*

xOff – channel switched off
xSL – sensor current low level
xSH – sensor current high level
xFE – set-points test not implemented
xS1 – Set-point 1 overrun
xS2 – Set-point 2 overrun
xS3 – Set-point 3 overrun
xS4 – Set-point 4 overrun

System codes: ErrLD – parameters read error; ResLD – read parameters from reserve section

Operations: ‘()’ – “OR” group marking; ‘+’ – logic “OR”

3. RS485, CAN interfaces parameters

Parameter	RS485 interface	CAN interface
Enable interface operation		
Module address (RS485 – from 1 to 247; CAN – from 0 to 65535)		
Date exchange rate RS485 – 4800, 9600, 19200, 38400, 57600, 115200, 230600 bit/s CAN – 40, 80, 100, 125, 200, 250, 500, 1000 Kbit/s		
Enable changes by commands from communication interfaces (Yes/No)		
Enable single write command support (Yes/No)		
Message sending interval, s (CAN only)		
Enable data transfer in measuring channels		

Prepared by _____ Date _____

E. Module setting up example for rotor axial shift measurement

Consider MK10 Module setting up example for rotor axial shift measurement. ДВТ20 primary element with ИП34А transducer (measuring range 2-0-2mm, sensor current range 1-5mA).

MK10 Module 1st measuring channel is used for rotor axial shift measurement, while other measuring channels are switched off. Recommended measuring channel 1 setting parameters are shown in table below.

Measuring channel 1 calibration parameters (rotor axial shift measurement)

Parameter	Definition	Note
Sensor current range lower level	1.0	1
Sensor current range higher level	5.0	1
Sensor current lower tolerance limit	0.7	1
Sensor current upper tolerance limit	5.3	1
Sensor test hysteresis	0.1	1
Standard output current range lower level	4.0	1
Standard output current range higher level	20.0	1
ADC value of sensor current calibration low/high level		2
DAC value of standard output calibration low/high level		2
DAC value of internal test signal calibration low/high level		2

Notes:

1. Value corresponds to the module cold start.
2. Defined during calibration.

Measuring channel 1 basic parameters (rotor axial shift measurement)

Parameter	Definition	Note
Measuring channel enabling	Yes	
Measured parameter lower range	-2	
Measured parameter higher range	2	
Measuring units test string	mm	
Measuring channel name text string	OCP	
Measurement results display format	1	##.##
Measured parameter averaging depth	0	no
Set-point overrun response time	0	0.5s
Set-point 1 operating mode	2	below
Set-point 2 operating mode	1	above
Set-point 3 operating mode	2	below
Set-point 4 operating mode	1	above
Set-point 1	-1.5	Corr.
Set-point 2	1.0	Corr.
Set-point 3	-1.7	Emerg.
Set-point 4	1.2	Emerg.
Set-point hysteresis	0.05	

Note. Set-points values must be set in accordance with set-points log

For 1st measuring channel S1 bridge must be set to position 2-3 (1-5mA current operating mode).

Other measuring channels are not in used in this particular case and must be switched off (installation of external resistors for disabling measuring channel logic alarm is not required). It is recommended to carry out calibration of unused measuring channels, in order to be used without field calibration.

General parameters of switched off measuring channels

Parameter	Definition	Note
Measuring channel enabling	No	
Measured parameter lower range	0	
Measured parameter higher range	0	
Measuring units test string		
Measuring channel name text string		
Measurement results display format	3	##.##
Measured parameter averaging depth	0	no
Set-point overrun response time	0	0.5s
Set-point 1 operating mode	0	OFF
Set-point 2 operating mode	0	OFF
Set-point 3 operating mode	0	OFF
Set-point 4 operating mode	0	OFF
Set-point 1	0	
Set-point 2	0	0
Set-point 3	0	0
Set-point 4	0	
Set-point hysteresis	0	

Module general parameters

Parameter	Definition	Note
Logic outputs disabling timeout after the module resetting	15	8c
Set-points test timeout after sensor function normalization	15	8c

Note. All table values correspond to the module cold start.

Logic alarm can be set up in a manner as follows:

- Rotor axial shift alerting set-points (set-points 2, 3 of channel 1) are assigned to Logic output 1;
- Rotor axial shift emergency set-points (set-points 1, 4 of channel 1) are assigned to Logic output 2;
- All fault conditions (module abnormal state alarms) are assigned to Logic output 12:
    - Abnormal sensor current in rotor axial shift measuring channel (channel 1);
    - Abnormal sensor current in other measuring channels (alarm is not generated as the channels are disabled);
    - Parameters read error from volatile memory.

Alarm is not assigned to unused logic outputs, which are always inactive.
In MK10-DC-11 and MK10-DC-001 options, assignment of “War” and “Alarm” LED’s logic is not required.

Output number	Assignment	Logical formula
1.	Rotor axial shift is above one of alerting set-point values	`1S1 + 2S1`
2.	Rotor axial shift is above one of emergency set-point values	`3S1 + 4S1`
12.	Module fault	`ErrLD + 1FE + 2FE + 3FE + 4FE`

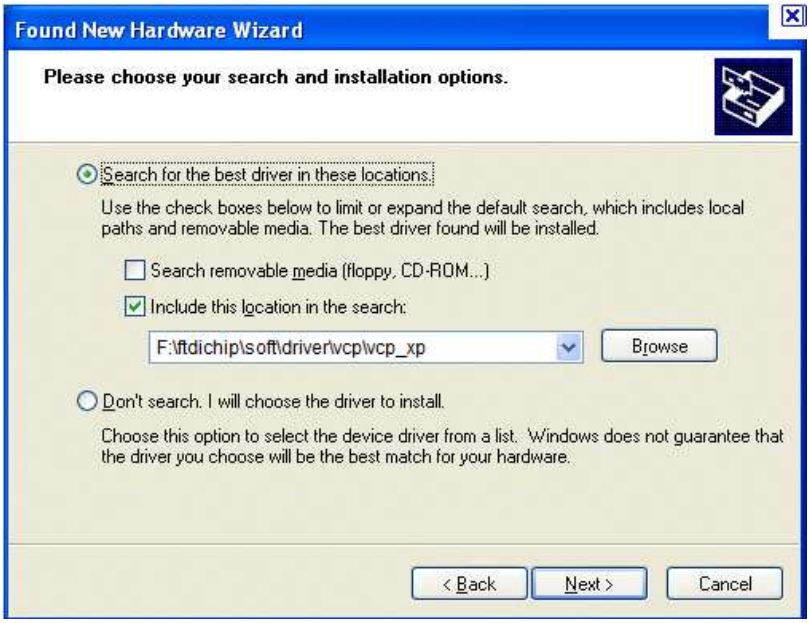
Note. ErrLD signal is always assigned to Logic output 12.

RS845 and CAN2.0B interfaces setting parameters are determined by the project requirements and Automated System of Vibration Monitoring (ASVM) upper level. After the module cold start RS485 and CAN2.0B interfaces are switched off.

F. MC01 USB driver installation for PC with Windows XP Operating System

At MC01 driver connection to PC through USB port, Operating System detects new device on USB bus and asks to install software. MC01 USB drivers are supplied with “VIBROBIT 300” equipment set software.

Select “Install from specified location”, press “Continue”; window appears in which MC01 USB drivers location on disc must be selected.

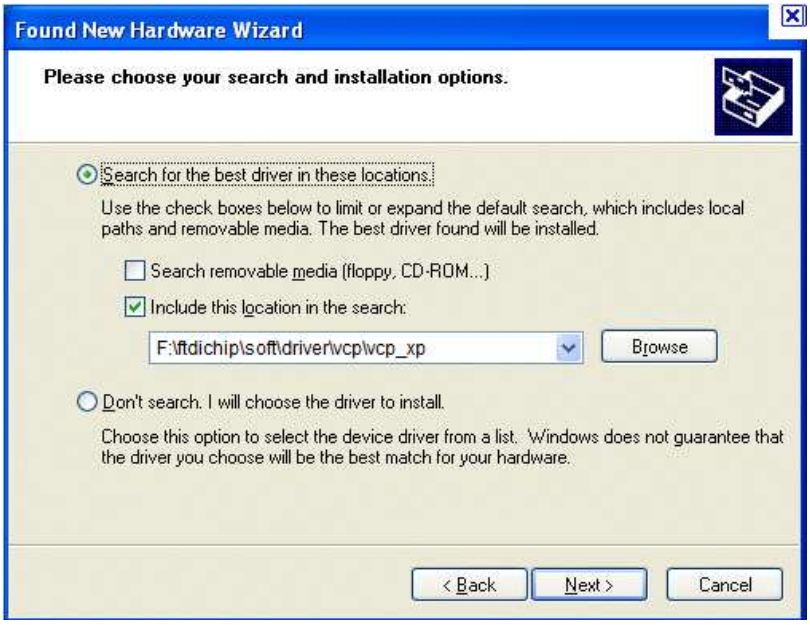


Select “Specify the following search location”, press “Browse” to select MC01 USB drivers location. Press “Continue”.

Windows XP Operation System will install suitable drivers for USB Serial Convertor. After completion, press “Done”.

Next, drivers for virtual COM-port will be installed. Window will appear on the screen, that will inform about necessity of drivers installation.

Select “Install from specified location”, press “Browse” to specify MC01 USB drivers location. Then press ”Continue”.



Select “Specify the following search location”, press “Browse” to select MC01 USB drivers location. Press “Continue”.

Required files will be copied and Operation System setup will be implemented for virtual COM-port operation. After completion, press “Done”.

At launch of MK10 setup software, system search for available COM-ports will be executed. All available COM-ports will be added to “Select COM-port” list of setup software.

Notes