ВИБРО
БИТ

SCIENTIFIC-PRODUCTION

ENTERPRISE VIBROBIT LLC

EQUIPMENT VIBROBIT 300

Module MK11 Setup Manual

ВШПА.421412.3011 И1

Rostov-on-Don
2012

Phone/Fax +7 863 218-24-75
Phone/Fax +7 863 218-24-78
E-mail: info@vibrobit.ru
http:// www.vibrobit.ru

Module MK11 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.

Edition 5 of 29.05.2012

CONTENTS

General Information

MK11 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.

MK11 basic functions are:

- Measurement of fixed signal level in 2 independent measuring channels, with sensor monitoring function.
- Automatic switching of the display to basic measured parameter image display (Channel 1).
- Four set-points for each measuring channel with unique operating mode selection for each set-point;
- Two standard current outputs;
- Measuring channels, alarms and shutoff protection test mode;
- Eight logic outputs with direct alarm and shutoff protection relay coil connectivity.
- Support of digital communication interfaces: RS485 with ModBus protocol; CAN2.0B; diagnostic interface;
- +24V DC and 85-240V, 50Hz AC power supply (depending on module design option);

MK11 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.

MK11 Module operates in real-time mode with measurement results update rate of 250ms. MK11 Module fulfills the following basic operations:

- Measures fixed 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;

MK11 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).

MK11 Module structure permits to carry out test functionality of entire module measuring path and logic outputs. Control of MK11 Module measuring channels test is implemented by means of keys, arranged on module front panel or by commands via digital communication interfaces.

Eight 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 MK11 Module is made by means of PC or dedicated ПН31 setting unit. In order to setup MK11 Module by means of PC, mk11_setup.exe software should by run on PC and MK11 Module should be connected to PC via MC01 diagnostic interface board (RS232 Interface) or MC01 USB (USB interface).

MK11 Module is supplied in several design options:

- ***MK11-DC*** – restricted indication system, 20mm front panel. Setup and review of measured values and module state are only possible via digital communication interfaces;
- ***MK11-DC-11*** – extended indication system, 40mm front panel, module power supply from DC +24V power source. A 7-segment digital display, additional LED's and control keys are arranged on module front panel.
- ***MK11-AC-11-S*** – this option is similar to previous one, except power supply is from AC 85-240V, 50Hz power source, and a power-on switch is arranged on module front panel. This design option is especially advantageous, when independent power source is required by project specifications for each measuring channel for measuring of mechanical quantities, for example, control circuit plotting of rotor axial shift.

Provision is made for sensors +24V DC power supply from MK11 Module through self-healing 200mA fuse.

In MK11-AC-11-S option the second measuring channel may be used to control +24V sensor and module supply voltage level.

Structurally, MK11 is designed as a 3U module suitable for 19" "Euromechanica" type framework.

Table 1 Technical specifications of MK11 Module

Parameter name	Value
Number of measuring channels	2
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 10000
Acceptable tolerance limits of mean percentage error, % - by digital display - by standard signal	 ±1,0 ±1,0
Readings updating time, s	0.25
Number of output standard DC current signals	2
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	8
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 - for MK11-AC-11-S option - for other options	 85-240/50Hz +(24±1.0)
MK11 absorbed current at +24V circuit, mA, not greater than (not included sensor and other external circuits absorbed current)	100
Total absorbed current at +24V circuit, mA, not greater than (for MK11-AC-11-S option, with allowance for all connected loads)	320

Table 2. Additional specifications of MK11 Module

Parameter name	Value
Dimensions, mm - MK11-DC option - MK11-DC-11 and MK11-AC-11-S options	20.1 x 130 x190 40.3 x 130 x 190
Weight, kg, not greater than - MK11-DC option - MK11-DC-11 option - MK11-AC-11-S option	0.15 0.20 0.30
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 of +35ºC
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	ЖЗ

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

Switching power on, resetting MK11 Module

Switching power on

When switching power on, MK11 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 7, "Ok" LED glows red.

During standard loading of operating parameters before MK11 Module operation start:

- ***MK11-DC option*** – "Ok" LED glows yellow to indicate module starting initialization.
- ***MK11-DC-11 and MK11-AC-11-S options*** - "Ok" LED glows yellow, module serial number, and then, module year of manufact.

Note. Hot swap of MK11 module in section without disconnection from power supply is not recommended but allowed for all MK11 Module design options.

After switching MK11 Module power on (resetting), logic outputs function is disabled for preset time. If logic outputs function is disabled, "Ok" LED glows yellow.

For MK11-AC-11-S option power supply of MK11 Module and connected sensors, relays, indicating units is provided from in-built AC/DC power source. MK11 Module switching on is implemented by "Power" toggle-switch, located on the front panel.

Module resetting

For Module resetting, microcontroller hand resetting is fulfilled and series of actions is made which corresponds to power switching on. Reasons for MK11 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 MK11 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 MK11 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:

- ***MK11-DC option*** – "Ok" LED starts glowing yellow simultaneously with "War" LED.
- ***MK11-DC-11 and MK11-AC-11-S options*** – "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.

MK11-DC option

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.

MK11-DC-11 and MK11-AC-11-S options

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.

Indication and control equipment

MK11-DC option

In MK11-DC design option status indication of the module is restricted. MK11-DC Module front panel appearance is shown in Figure 1. On MK11-DC Module front panel are arranged:

- Four signal LED's:
  - "***Pwr***" green LED – module switching on;
  - "***Ok***" bicolor LED – module status indication;
    - *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;
    - *Flashing* – sensor test error is detected for one of measuring channels.
  - "***War***" yellow LED – warning (LED operation logic is defined by user);
  - "***Alarm***" red LED – alarm (operation logic is defined by user);
- Slot for pressing of hidden "Reset" key;
- Diagnostic interface connector;
- Handle for convenient dismantling from framework.

In MK11-DC Module design option signal LED's are the unique equipment for module status indication, except for possibility of providing connection of ПН31 setting unit (by PC) to diagnostic interface or access to measurement results via RS485 and CAN2.0B interfaces.

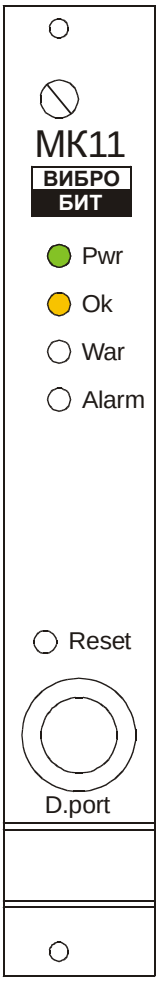


Figure 1. MK11-DC front panel appearance (width 20mm)

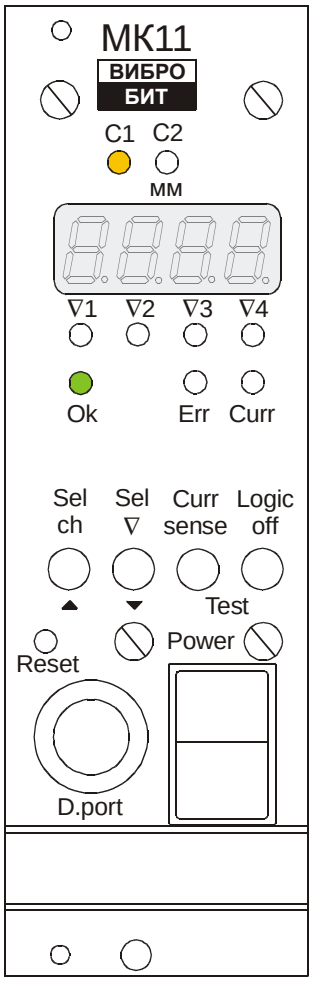


Figure 2. MK11-AC-11-S front panel appearance (width 40mm)

MK 11-DC-11 and MK 11-AC-11-S options

In MK 11-DC-11 and MK 11-AC-11-S options extended indication and control equipment is implemented. MK11-AC-11-S Module front panel appearance is shown in Figure 2. On MK11-AC-11-S Module front panel are arranged:

- Two yellow LED's *"**C1**"* and *"**C2**"* for displaying of selected measuring channel. In measuring channel *'Тест'* mode, selected channel LED starts flashing;
- 4-digit, 7-segment digital display for measured parameters values and messages displaying;
- Four yellow LED's *"**V1**", "**V2**", "**V3**"* and *"**V4**"* - 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 "MK11" 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 measured between measuring channel function normalization and start of the parameter value test against set-point;
- Yellow "***Curr***" LED – indication of sensor current actual value display (engineering data). During sensor current indication on selected measuring channel display, "***Curr***" LED flashes;
- Four control keys:
  - "***Sel ch***" – measuring channel selection for display of parameter value and measuring channel state. In "Test" mode is used for DC increase at measuring channel output;
  - "***Sel V***" – set-points displaying. In "Test" mode is used for DC decrease at measuring channel output;
  - "***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.

In MK11-AC-11-S option, additional ***"Power"*** toggle-switch is installed on MK11 Module front panel for turning of module power on (switching of input line voltage).

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.

While in MK11 Module the 1st measuring channel is primary and the 2nd channel is auxiliary, then module setup can be implemented to enable output automatic switching to 1st measuring channel data display by user's inactivity timeout (user did not press any of the front panel keys for preset period of time, when data was displayed in 2nd measuring channel).

Note. Switching to 2nd measuring channel data display is not implemented, if 2nd measuring channel function is disabled by MK11 Module settings.

Rolling of set-point 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. MK11 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

"Test" mode

In MK11 Module user can test function of module measuring channels, standard and logic outputs. When "Test" mode is activated, sensor, connected to module input, is disconnected from module input circuits. Signals from internal controlled current generator or external test signals arrive at module measuring inputs (defined by MK11 board jumper).

In order to switch to "Test" mode, it is necessary to simultaneously press and hold down ***"Curr sense"*** and **"*Logic off*"** keys, until current measuring channel transfers to "Test" mode. In "Test" mode, selected measuring channel (***"C1", "C2"***) LED starts flashing. To exit "Test" mode it is necessary to press and hold down ***"Curr sense"*** and "Logic off" keys, until "Test" mode is exited.

Note. "Test" mode for each module channel must be enabled during MK11 setup. If "Test: mode is not enabled, "Test" mode transfer will not be implemented.

If board jumper selects internal test signal generator mode, user can increase (by means of **"*Sel ch*"** key) or decrease (by means of **"*Sel V*"** key test signal fixed level. When mentioned keys are held down, continuous increase/decrease of test signal level takes place.

Note. In "Test" mode, switching to other measuring channel and view of selected channel set-point value is not possible.

In "Test" mode calculated current value is compared with acceptable current rate, set in the module, thus the module may switch to "Sensor fault" mode. Calculated parameter value is compared with set-points and logic alarm for parameter overrun of set-points is generated. User can view actual calculated value of current sensor (by pressing ***"Curr sense"*** key), switch output disabling and enabling (by pressing ***"Logic off"*** key) and alter test signal level (by means of ***"Sel ch"*** and ***"Sel V"*** keys).

Note. Alteration of test signal level must be enabled during module setup for each measuring channel individually.

When switching to "Test" mode, test signal assumes level, set during module setup. Switching "Test" mode on for both channels simultaneously is only possible by commands via communication interfaces.

Module operation

MK11 Module operates in real-time mode with measurement results update rate of 250ms.
Module implements the following basic operations:

- measures fixed 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;
- supports data exchange via digital communication interfaces.

Both measuring channels function equally and synchronously. Differ only setup parameters and input signal type, set up by MK11 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 (`CurrMinCalibr, RangeCurrMax`) and saved ADC values (`AdcInMin, AdcInMax`), corresponding to sensor current input range, by which calibration has been carried out.

Generally, low level of sensor current calibration (`CurrMinCalibr`) and low range of sensor current (`RangeCurrMin`) are equal. If low range of sensor current (`RangeCurrMin`) is equal to zero, calibration of low value is recommended to be carried out at 20% of maximum sensor current value, while minimum calibration value of sensor current is indicated separately (`CurrMinCalibr`).

Note. If one of calibration value pairs (`CurrMinCalibr, RangeCurrMax` or `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 `CurrValidMin + 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.

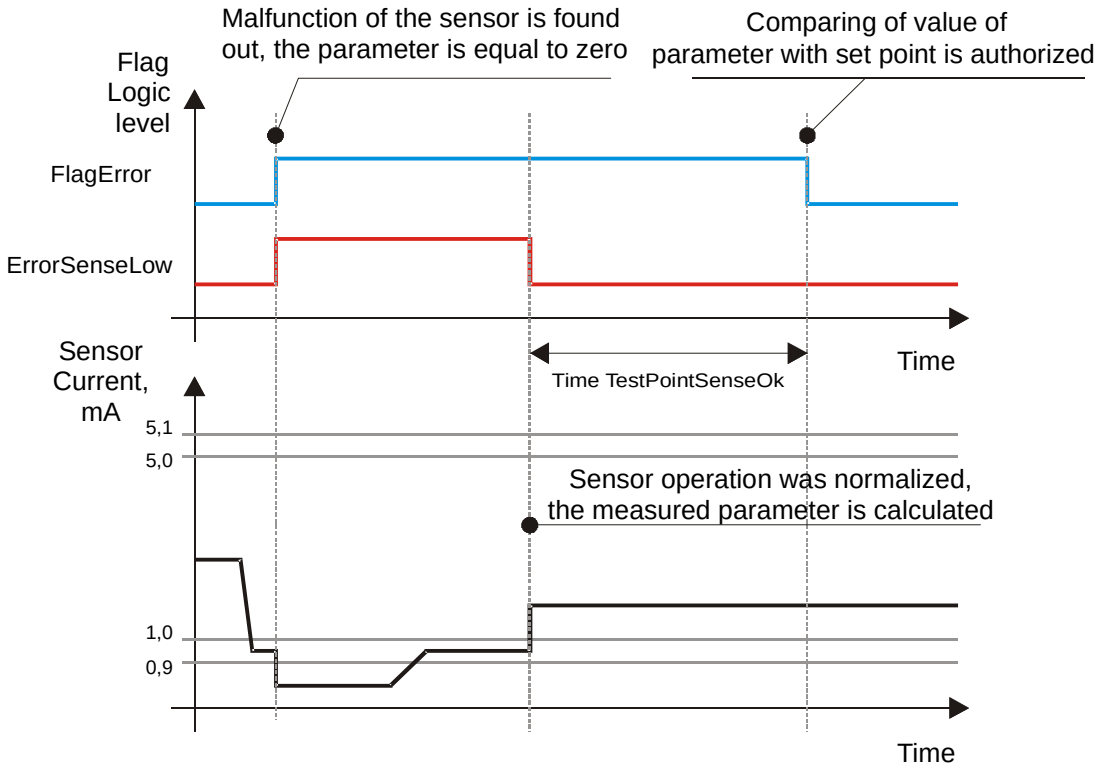


Figure 3. Sensor test algorithm during sensor constant current decrease below acceptable level.

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` parameter) in module memory.

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` time.

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` time.

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.

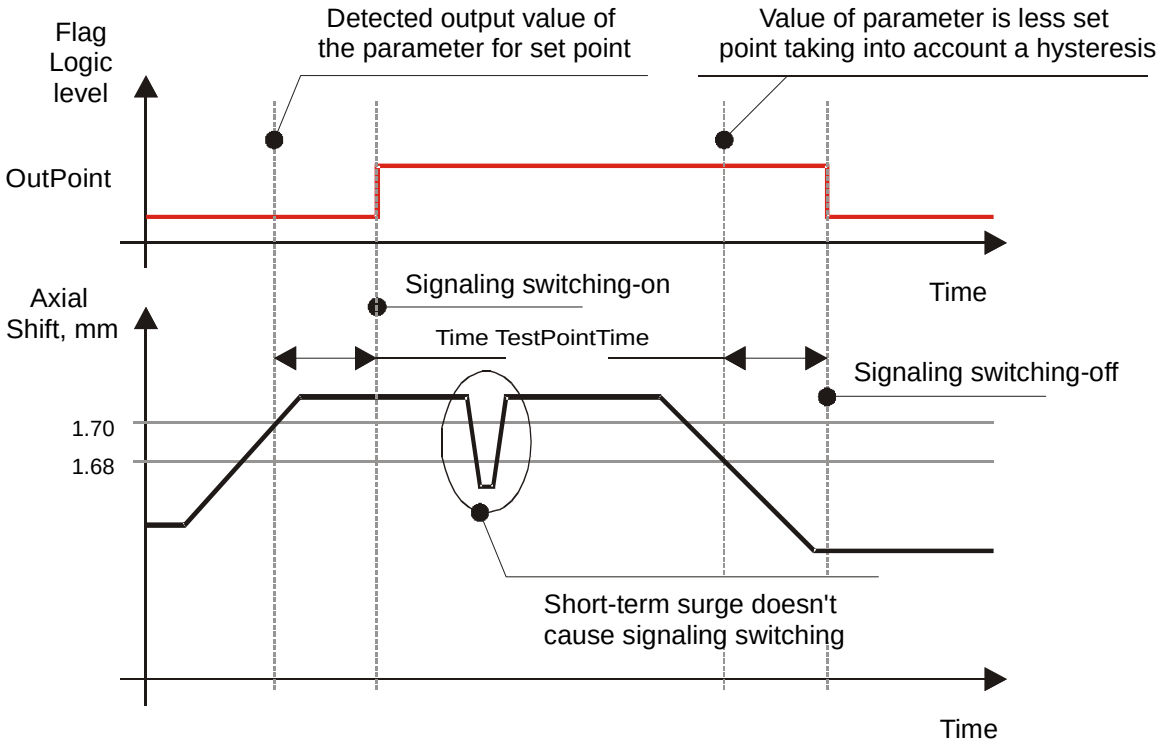


Figure 4.Example of set-point algorithm
(mode – test above set-point level).

Standard output

Standard current output is provided for each MK11 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`), parameter range of standard output (`RangeParamOutMin, RangeParamOutMax`), 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 the values RangeParamOutMin, RangeParamOutMax not specified or equal to zero (by default they have zero value), the coefficients of the A_O, B_O is automatically calculated from the values of the parameters RangeParamMin, RangeParamMax. Parameters RangeParamOutMin, RangeParamOutMax introduced starting with version 1.40 software module. In previous versions of the software modules used in the calculations only the parameters RangeParamMin, RangeParamMax.

Generally, low level of standard output calibration (`CurrMinCalibr`) and low range of standard output (`CurrOutMin`) are equal. If low range of standard output (`CurrOutMin`) is equal to zero, calibration of low value is recommended to be carried out at 20% of maximum standard output value, while minimum calibration value of standard output is indicated separately (`CurrOutMinCalibr`).

Note. If one of calibration value pairs (`CurrOutMinCalibr, 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).

Starting with version 1.20 software module at fault measurement channel (active state flag FlagError) on the corresponding logical output current is set equal to 0 mA. In previous versions of software modules for fault measurement channel was set the current value corresponding to the value zero.

"Test" mode

In order to implement "Test" mode, in MK111 Module are provide separate current generators for each measuring channel, which are connected to measuring channel output instead of sensor. Control of test current generators is implemented by means of 12-digit DAC.

With a jumper on the board (see Appendix A) can be selected signal to the inputchannel measurement, the internal oscillator current / voltage or an external test signal.

Table 6. "Test" mode operation options (`TestEnabled` parameter)

Mode code	Description
`0`	"Test" mode is denied
`1`	"Test" mode is enabled, internal test signal level measurement is denied
`2`	"Test" mode is enabled, internal test signal level measurement is enabled

When switching "Test" mode on, `TestMode` flag is activated and signal level at test output settles equal to `CurrTestOn`. "Test" mode exit is implemented by user's command or automatically, upon `TimeOut_TestMode` timeout– acceptable user's inactivity time in "Test" mode.

Test signal current value is calculated by linear equation formula:

$$DAC_{TEST} = A_T + B_T \cdot I_{TEST};$$

where:

DAC_{TEST} – DAC calculated value;

I_{TEST} – test signal setup current (voltage);

A_T, B_T – linear equation ratios for calculation of test signal DAC value.

A_T, B_T ratios are calculated automatically during the module operation initialization by sensor current range data (`CurrMinCalibr, RangeCurrMax`) and DAC saved values (`DacTestMin, DacTestMax`), corresponding sensor current input range, at which calibration was carried out.

Generally, low level of sensor current calibration (`CurrMinCalibr`) and low range of sensor current (`RangeCurrMin`) are equal. If low range of sensor current (`RangeCurrMin`) is equal to zero, calibration of low value is recommended to be carried out at 20% of maximum sensor current value, while minimum calibration value of standard output is indicated separately (`CurrOutMinCalibr`).

Note. If one of calibration value pairs (`CurrMinCalibr, RangeCurrMax` of `DacTestMin, DacTestMax`) is equal to zero, or they are equal, then A_T, B_T ratios are not calculated and taken equal to zero (DAC_{TEST} value is always equal to zero).

Test signal level variation is implemented by varying of `CurrTest` variable value. Variation of `CurrTest` parameter value is possible at pressing of **"*Sel ch*"**, **"*Sel V*"** keys for test signal level increment/decrement, as well as writing of test signal level value by commands via digital communication interfaces.

Acceptable test signal variation range `CurrTest` is set during the module setup (`CurrTestMin`, `CurrTestMax` parameters).

Module calibration recommendations

МК11 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).

МК11 Module connection set-up for calibration and test calibration is shown in Figure 5. МК11 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 of БП17 ***B*** – МК11 ***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.

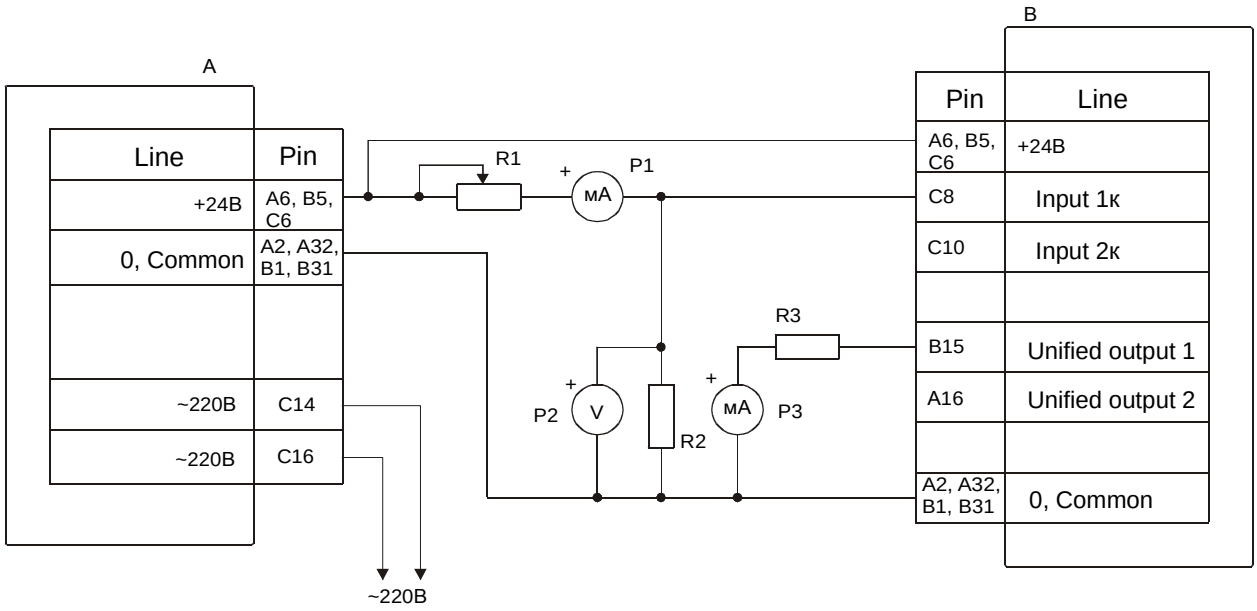


Figure 5. МК11 Module connection set-up for calibration and test calibration

Measuring channel input calibration

1. Measuring channel input calibration sequence is simple enough:
2. Indicate measuring channel current range value (`CurrMinCalibr, RangeCurrMin, RangeCurrMax`);
3. Indicate measured parameter range (`RangeParamMin, RangeParamMax`);
4. Set `CurrMinCalibr` current at channel input;
5. Rewrite `AdcData` value to `AdcInMin`;
6. Set `RangeCurrMax` current at channel input;
7. Rewrite `AdcData` value to `AdcInMax`;
8. Transfer calibration results to MK11 Module;
9. 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 MK11 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 (`CurrOutMinCalibr, CurrOutMin, CurrOutMax`);
2. Switch on standard output calibration mode (`CalibrateMode` flag is activated);
3. By writing of value to `DacDirectData` select current (by means of microammeter), equal to `CurrOutMinCalibr`, at standard output;
4. Rewrite `DacDirectData` value to `DacOutMin`;
5. By writing of value to `DacDirectData` select current (by means of microammeter), equal to `CurrOutMax`, at standard output;
6. Rewrite `DacDirectData` value to `DacOutMax`;
7. Switch off standard output calibration mode;
8. Transfer calibration results to MK11 Module;
9. Implement ratios recalculation.

Alteration of input measured parameter range (`RangeParamMin, RangeParamMax`) automatically changes parameter range at standard output. Calibration wizard is provided in MK11 setup software for module calibration, which considerably simplifies calibration process.

Test signal output calibration

Calibration of test output is carried out by measuring channel current range (`CurrMinCalibr`, `RangeCurrMin`, `RangeCurrMax`). Test signal calibration is carried out in following sequence:

1. Indicate test signal parameters (`CurrTestOn, CurrTestMin, CurrTestMax, TestEnabled`);
2. Switch on test signal calibration mode (`CalibrateMode` flag is activated);
3. By writing of value to `DacDirectData` select current (by means of microammeter), equal to `CurrMinCalibr`, at test output;
4. Rewrite `DacDirectData` value to `DacTestMin`;
5. By writing of value to `DacDirectData` select current (by means of microammeter), equal to `RangeCurrMax`, at test output;
6. Rewrite `DacDirectData` value to `DacTestMax`;
7. Switch off standard output calibration mode;
8. Transfer calibration results to MK11 Module;
9. Implement ratios recalculation.

Note. Writing of calibration results to MK11 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 MK11 Module 8 logic outputs with open collector (active 0) are provided.

Logic outputs circuit design provides for possibility of direct relay coils connection.

Operation of each logic output is setup by user via digital communication interfaces, except for output 8. Logic output 8 is always inverted to output 7. Assignment of MK11 Module fault alarm to logic output 7 is recommended.

If check sum error has been detected in one of the module operation parameters section, active signal level is present at logic output 7, while other MK11 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.

When logic outputs are disabled by user and outputs disabling wait timeout has been counted after module resetting, active level is present at logic output 8. Logic output 8 can be used as the module functionality active alarm, while logic output 7 – as module fault alarm.

Note. In subsequent versions of the software module changes were made in the work of logic outputs: Starting with version 1.30 software module added a new feature - the inversion of logic outputs from the 1 st to 6 th. Starting with version 1.40 software module 8th logic output works as a normal logic output with adjustable inversion. On the inversion of the logic output 7 can not be assigned. When you lock a logical output of the module and module faults on inverted logic outputs an inactive signal level is set.

MK11 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 7 (greater than 8, for the version of the module above 1.40), state of relevant assigned flag will not affect any of logic outputs.

Table 7. 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
0	`ErrorSenseLow`	Sensor current below acceptable level	xSH	0	8
1	`ErrorSenseHigh`	Sensor current above acceptable level	xSL	1	9
2	`TestMode`	“Test” mode on	xTM	2	10
3	`FlagError`	Measuring channel general fault flag	xFE	3	11
4	`OutPoint_1`	Parameter value overrun of set-point 1	xS1	4	12
5	`OutPoint_2`	Parameter value overrun of set-point 2	xS2	5	13
6	`OutPoint_3`	Parameter value overrun of set-point 3	xS3	6	14
7	`OutPoint_4`	Parameter value overrun of set-point 4	xS4	7	15

Note. In alarm code instead of “x” symbol, channel number should be indicated.

Table 8. 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	16
1	`LoadDataReserv`	One or several operating parameters groups are readout from volatile memory reserve storage	ResLD	17
2	`LogicOffStartUp`	Logic outputs are disabled after module resetting	LgOffSt	18
3	`LogicOffUser`	Logic outputs are disabled by user command	LgOffU	19
4	`InterfRS485_Off`	RS485 Interface is off	RS_Off	20
5	`InterfCAN_Off`	CAN2.0B Interface is off	CAN_Off	21
6	`AllowOneWrite`	Single write access is obtained	OneWr	22
7	`CalibrateMode`	Calibration mode is on for one of standard outputs	Calibr	23

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

MK11 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**. MK11 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 MK11 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 9. RS485 interface parameters

Parameter name	Value
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 10. Possible ModBus protocol error codes

Code	Symbol	Description	Notes
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 11. Implemented ModBus protocol commands in MK11 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 12.

Table 12. 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).

MK11 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 MK11 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 MK11 Module status data transfer to indicating units and statistics gathering module. MK11Module does not receive any data via CAN2.0B interface, possibility of module setup by means of CAN2.0B interface is not provided either.

Table 13. 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
MK11 Module indicating units code	0xC1 (193)
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 MK11 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.

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
0x30, 0x31	`ParamData`				`StatusCh`	`StatusSys`

Figure 6. MK11 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 14. I2C driven interface parameters

Parameter name	**Value**
MK11 address on I2C interface	0x26
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 15. List of measuring channels calibration parameters

Name	Label	Type (byte)	Address (Hex)		Note
			Channel 1	Channel 2	
Sensor current range lower level	RangeCurrMin	Float (4)	0x0600	0x0700	
Sensor current range higher level	RangeCurrMax	Float (4)	0x0604	0x0704	
Sensor current range lower level, at which calibration was carried out	CurrMinCalibr	Float (4)	0x0608	0x0708	
Sensor current lower tolerance limit	CurrValidMin	Float (4)	0x060C	0x070C	
Sensor current upper tolerance limit	CurrValidMax	Float (4)	0x0610	0x0710	
Sensor test hysteresis	CurrValidHist	Float (4)	0x0614	0x0714	
Standard output current range lower level	CurrOutMin	Float (4)	0x0618	0x0718	
Standard output current range higher level	CurrOutMax	Float (4)	0x061C	0x071C	
Standard output current range lower level, at which calibration was carried out	CurrOutMinCalibr	Float (4)	0x0620	0x0720	
Current level, set at test signal during “Test” mode activation	CurrTestON	Float (4)	0x0624	0x0724	
Test signal current control lower tolerance level	CurrTestMin	Float (4)	0x0628	0x0728	
Test signal current control higher tolerance level	CurrTestMax	Float (4)	0x062C	0x072C	
ADC value of sensor current calibration lower level	AdcInMin	Uint (2)	0x0630	0x0730	
ADC value of sensor current calibration higher level	AdcInMax	Uint (2)	0x0632	0x0732	
DAC value of standard output calibration lower level	DacOutMin	Uint (2)	0x0634	0x0734	
DAC value of standard output calibration higher level	DacOutMax	Uint (2)	0x0636	0x0736	
DAC value of internal test signal calibration lower level	DacTestMin	Uint (2)	0x0638	0x0738	
DAC value of internal test signal calibration higher level	DacTestMax	Uint (2)	0x063A	0x073A	
“Test” mode operation enabling	TestEnabled	Uchar (1)	0x063C	0x073C	1

Notes:

1. For TestEnabled parameter description, refer to Table 6.

Table 16. List of measuring channels basic parameters

Name	Label	Type (byte)	Address (Hex)		Note
			Channel 1	Channel 2	
Measured parameter lower range	RangeParamMin	Float (4)	0x0800	0x0900	
Measured parameter higher range	RangeParamMax	Float (4)	0x0804	0x0904	
Measuring units label	MeasurUnit	Char (8)	0x0808	0x0908	
Measurement results display format	FormatOut	UChar (1)	0x0810	0x0910	1
Measured parameter averaging depth	AverageData	UChar (1)	0x0811	0x0911	2
Set-point overrun response time	TestPointTime	UChar (1)	0x0812	0x0912	3
Set-point 1 operating mode	TestPointMode_1	UChar (1)	0x0813	0x0913	4
Set-point 2 operating mode	TestPointMode_2	UChar (1)	0x0814	0x0914	4
Set-point 3 operating mode	TestPointMode_3	UChar (1)	0x0815	0x0915	4
Set-point 4 operating mode	TestPointMode_4	UChar (1)	0x0816	0x0916	4
Set-point 1	TestPointData_1	Float (4)	0x0817	0x0917	
Set-point 2	TestPointData_2	Float (4)	0x081B	0x091B	
Set-point 3	TestPointData_3	Float (4)	0x081F	0x091F	
Set-point 4	TestPointData_4	Float (4)	0x0823	0x0923	
Set-point hysteresis	TestPointHist	Float (4)	0x0827	0x0927	

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 0.25s (0 = 0.25s)
4. For parameters description, refer to Table 5.

Table 17. List of module system settings

Name	Label	Type (byte)	Address (Hex)	Note
Channel 2 operation enabling: 0-channel 2 is OFF 1-channel 2 is ON	ActivChannel	UChar (1)	0x0A00	1
1 second timeout of indication display switching from channel 2 (auxiliary) to channel 1 (main)	TimeOut_ChannelTwo	UChar (1)	0x0A01	2
“Test” mode 1 second timeout.	TimeOut_TestMode	UChar (1)	0x0A02	2
Logic outputs disabling timeout after the module resetting	LogicOffStartUp	UChar (1)	0x0A03	3
Set-point test timeout after sensor function normalization	TestPointSenseOk	UChar (1)	0x0A04	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 (24)	0x0A05	4
Inversion of logic outputs bits 0 ... 5 - to activate the inversion, respectively, on the logical output from the 1 st to 6 th bit 7 - to activate inversion at the 8th logic output	LogicInvert	UChar (1)	0x0A1D	5

Notes:

1. Comes into effect only after the module resetting.
2. When value is equal to zero, function is OFF.
3. Time by 0.25s (0 = 0.25s)
4. For logic alarm bytes assignment, refer to Tables 7, 8.
5. Default value — 0 .

Communication interfaces

Table 18. 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)	0x0B00	
Operating parameters change by commands and via RS485 interface: 0 – denied 1 - enabled	RSChangeEnabled	UChar (1)	0x0B01	
Single write operation: 0 – denied 1 - enabled	RSOneWriteCommand	UChar (1)	0x0B02	
Unit address on RS485 bus (from 1 to 247)	RSAddress	Uint (2)	0x0B03	
Data rate, bit/s: 0 – 4800; 1 – 9600; 2 – 19200; 3 – 38400; 4 – 57600; 5 – 115200; 6 – 230400	RSSpeed	UChar (1)	0x0B05	

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

Table 19. 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)	0x0C00	
Data rate, bit/s: 0 – 1000; 1 – 500; 2 – 250; 3 – 200; 4 – 125; 5 – 100; 6 – 80; 7 - 40	CANSpeed	UChar (1)	0x0C01	
Unit address on the bus	CANBasicAddress	Uint (2)	0x0C02	
Message sending interval by 0.25s	CANBasicTime	UChar (1)	0x0C04	
Data sending in channel 1 (0 – not to send)	CANBasicDataOut_1	UChar (1)	0x0C05	
Data sending in channel 2 (0 – not to send)	CANBasicDataOut_2	UChar (1)	0x0C06	

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

Identification information

Table 20. List of identification information registers

Name	Label	Type (byte)	Address (Hex)	Note
Module software version	VerProg	Uint (2)	0x0D00	
Module serial number	Number	Uint (2)	0x0D02	
Module year of manufacture	Year	Uint (2)	0x0D04	
Assembler code	Assembler	UChar (1)	0x0D06	
Adjuster code	Adjuster	UChar (1)	0x0D07	
Additional text string	TextString	Char (32)	0x0D08	

Note. Identification information is read-only.

Information on the location of the jumpers on the board

Table 21. List of registers of information on the location of jumpers on MK11

Name	Label	Type (byte)	Address (Hex)	Note
Jumpers: bits 0:1 – S1 (0 - removed; 1 - «1-2»; 2 - «2-3»;) bits 2:3 – S2 (0 - removed; 1 - «1-2»; 2 - «2-3»;) bits 4:5 – S3 (0 - removed; 1 - «1-2»; 2 - «2-3»;) bits 6:7 – S4 (0 - removed; 1 - «1-2»; 2 - «2-3»;) bit 8 – S5 (0 - removed; 1 - set;) bit 9 – S6 (0 - removed; 1 - set;) bit 10 – S7 (0 - removed; 1 - set;) bit 11 – S8 (0 - removed; 1 - set;) bit 12 – S9 (0 - removed; 1 - set;)	Jumpers	Uint (2)	0x0A1E	

Note. This register is only available in modules with software version 1.30 or higher.

Measurement results

Table 22. 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	
Module status flags	StatusSys	UChar (1)	0x0016	2
Reserved	Reserv	UChar (1)	0x0017	
Logic outputs state bits 0-7 – logic output state bits 13-8– reserved, equal to zero bit 14 – “War” LED state bit 15 – “Alarm” LED state	LogicOutStatus	Uint (2)	0x0018	3

Notes:

1. For flags assignment, refer to Table 7.
2. For flags assignment, refer to Table 8.
3. During logic outputs disabling, logic outputs state after enabling can be determined from LogicOutStatus parameter.
4. Measurement results registers are read-only.

Table 23. Test signal and standard output control registers

Name	Label	Type (byte)	Address (Hex)	Note
Channel 1 test signal current level	CurrTest_1	Float (4)	0x0500	1, 2
Channel 2 test signal current level	CurrTest_2	Float (4)	0x0504	1, 2
DAC value of Channel 1 standard output direct control	DacDirectData_1	Uint (2)	0x0508	3
DAC value of Channel 2 standard output direct control	DacDirectData_2	Uint (2)	0x050A	3
DAC value of Channel 1 test signal direct control	DacDirectData_1T	Uint (2)	0x050C	3
DAC value of Channel 2 test signal direct control	DacDirectData_2T	Uint (2)	0x050E	3

Notes:

1. During “Test” mode activation, assumes a value, equal to CurrTestON.
2. Kept within CurrTestMin, CurrTestMax range even during writing via digital communication interfaces.
3. Used in calibration. DAC range from 0 to 4095. Does not participate in normal operation.
4. All registers of the group are writable in all operating modes of the module.

Control commands

In MK11 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 24. 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
	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	
0xFF04	0x10	Switch off “Test” mode for both channels	4
	0x11	Switch on “Test” mode for channel 1	4, 5
	0x12	Switch on “Test” mode for channel 2	4, 5
0xFF05	0x40	Switch on all standard outputs and test signals calibration mode	4
	0x41	Switch on standard output 1 calibration mode	4
	0x42	Switch on test signal 1 calibration mode	4
	0x43	Switch on standard output 2 calibration mode	4
	0x44	Switch on test signal 2 calibration mode	4
0xFF06	Writing of module operating parameters to volatile memory		4, 6
	0x81	Channel 2 calibration data	
	0x82	Channel 1 basic parameters	
	0x83	Channel 2 basic parameters	
	0x84	Module system parameters	
	0x85	RS485 interface parameters	
	0x86	CAN2.0B interface parameters	
	0x87	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 25. Measuring channels calibration parameters values after cold start

Parameter	Label	Value	Note
Sensor current range lower level	RangeCurrMin	1.0	
Sensor current range higher level	RangeCurrMax	5.0	
Sensor current range lower level, at which calibration was carried out	CurrMinCalibr	1.0	
Sensor current lower tolerance limit	CurrValidMin	0.8	
Sensor current upper tolerance limit	CurrValidMax	5.2	
Sensor test hysteresis	CurrValidHist	0.1	
Standard output current range lower level	CurrOutMin	4.0	
Standard output current range higher level	CurrOutMax	20.0	
Standard output current range low level, at which calibration was carried out	CurrOutMinCalibr	4.0	
Current level, set at test signal during “Test” mode activation	CurrTestON	1.0	
Test signal current control lower tolerance level	CurrTestMin	0.6	
Test signal current control higher tolerance level	CurrTestMax	5.4	
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	
DAC value of internal test signal calibration lower level	DacTestMin	0	3
DAC value of internal test signal calibration higher level	DacTestMax	0	
“Test” mode operation enabling	TestEnabled	2	

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).
3. Test signal is disabled, test signal level is 0 (or as low as possible).

Table 26. Measuring channels basic parameters values after cold start

Parameter	Label	Value	Note
Measured parameter lower range	RangeParamMin	0	
Measured parameter higher range	RangeParamMax	0	
Measuring units label	MeasurUnit	void	
Measurement results display format	FormatOut	3	####
Measured parameter averaging depth	AverageData	5	
Set-point value overrun response time	TestPointTime	5	1.5c
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 27. Module system parameters values after cold start

Parameter	Label	Value	Note
Channel 2 operation enabling	ActivChannel	1	both
Timeout of indication display switching from channel 2 (auxiliary) to channel 1 (main)	TimeOut_ChannelTwo	5	
“Test” mode timeout.	TimeOut_TestMode	0	OFF
Logic outputs disabling timeout after the module resetting	LogicOffStartUp	31	8c
Set-point test timeout after sensor function normalization	TestPointSenseOk	31	8c
Logic alarm matrix	LogicMatrix	0	1

Notes:

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

Table 28. RS485 interface parameters after cold start

Parameter	Label	Value	Note
Interface operation enabling	RSEnabled	0	OFF
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 29. RCAN2.0B interface parameters values after cold start

Parameter	Label	Value	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 0.25s	CANBasicTime	0	0.25c
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

Software

Dedicated software for MK11 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 MK11 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 and test signal calibration.

Note. Some of the listed options are not available to read and change described in the setup program module MK11. Working with these and other parameters of the module MK11 available in the specialized program - ModulConfigurator. Description on how to use ModulConfigurator given in the instructions on the proper software.

In the Setup module MK11 no access to the following parameters: inversion of logic outputs, adjustment of the 8th logic output (for modules software version higher than 1.40), as well as to register the location of jumpers on MK11.

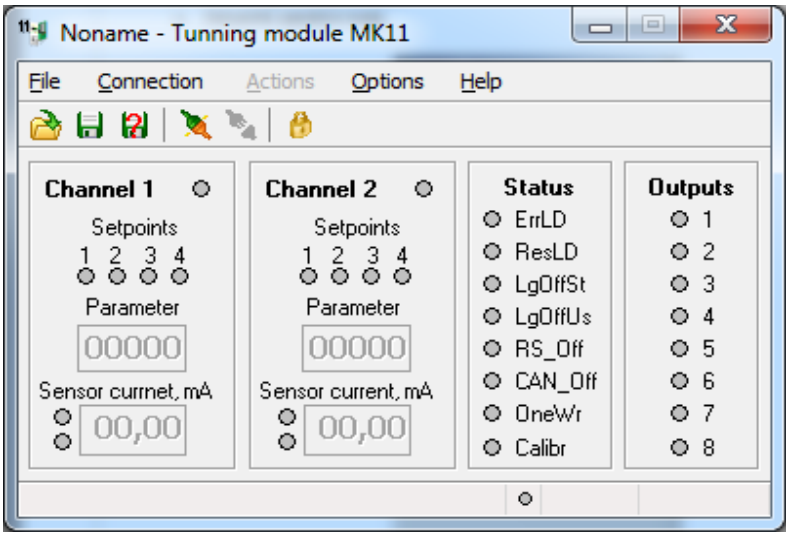


Figure 7. MK11 setting software configuration

Getting started

In order to get started, connection to MK11 is required. For this purpose, COM-port must be selected, to which MK11 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 MK11, 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.

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.

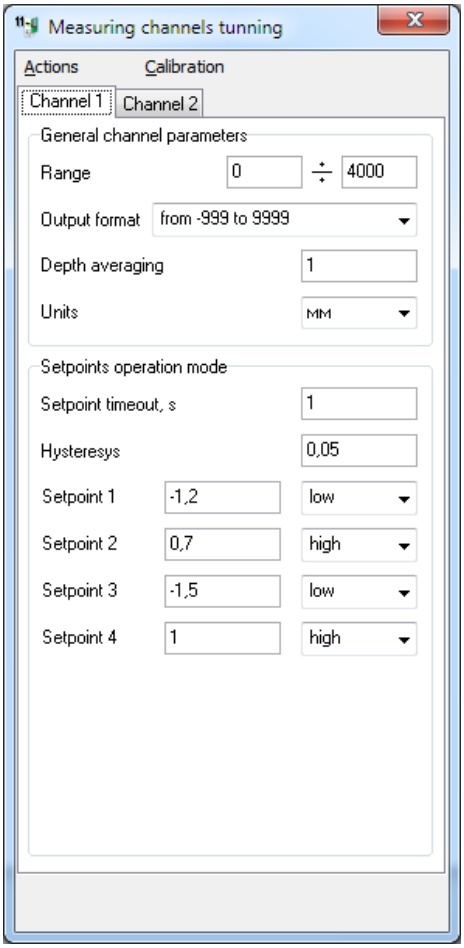


Figure 8. Measuring channel parameters setup window.

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, select ***Read settings from module*** option in ***Actions*** Menu. This option is active when MK11 is connected.

For writing of selected channel settings, select ***Write settings to module*** **options** in ***Actions*** Menu. This option is active when MK11 is connected and logic outputs are disabled.

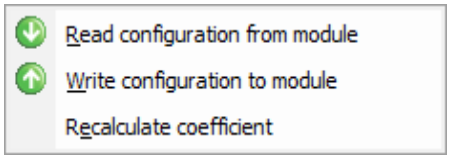


Figure 9. Shortcut menu of measuring channels parameters

Channel general parameters

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

- Set parameter range (minimum and maximum parameter values, maximum number of characters - 4);
- 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;
- Select from list or enter new parameter measuring unit.

Set-points operating mode

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

- Set set-point values overrun time (discreteness – 0.25s);
- Set hysteresis;
- For each of 4 set-points, set:
  - Set-point preset value;
  - Set-points operating mode:
    - OFF
    - above preset value
    - below preset value

When pressing >> push button, additional window opens with input and output signals calibration. Calibration is considered in ***Calibration*** section.

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

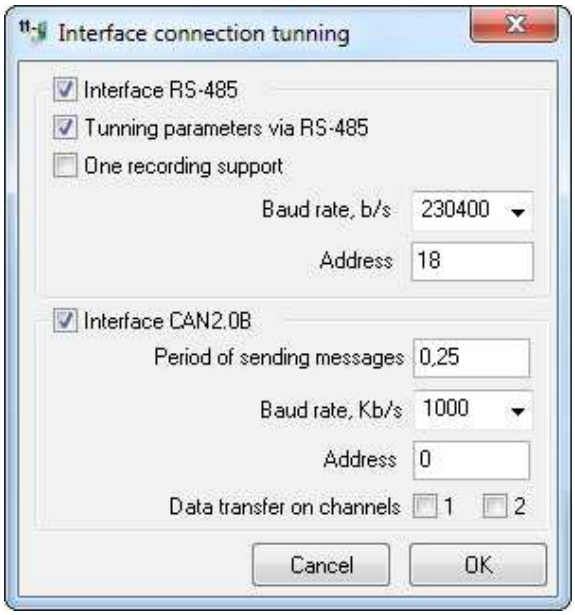


Figure 10. Communication interfaces parameters setup window

For reading settings from the module, select ***Read interfaces settings from module*** option. This option is active when MK11 is connected.

For writing settings to the module, select ***Write interface settings to module*** option in shortcut menu. This option is active when MK11 is connected and logic outputs are disabled.

For saving RS485 and CAN2.0B interfaces settings, written to the module, to volatile memory, select relevant option in ***Saving RS485 settings to memory*** or ***Saving CAN settings to memory*** Menu. This option is active when MK11 is connected and logic outputs are disabled.

For RS485 interface re-initialization in case of settings change, select ***RS485 initialization*** option in shortcut menu. This option is active when MK11 is connected and logic outputs are disabled.

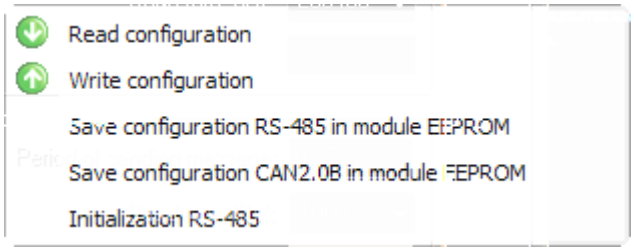


Figure 11. Communication interfaces parameters shortcut menu

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.

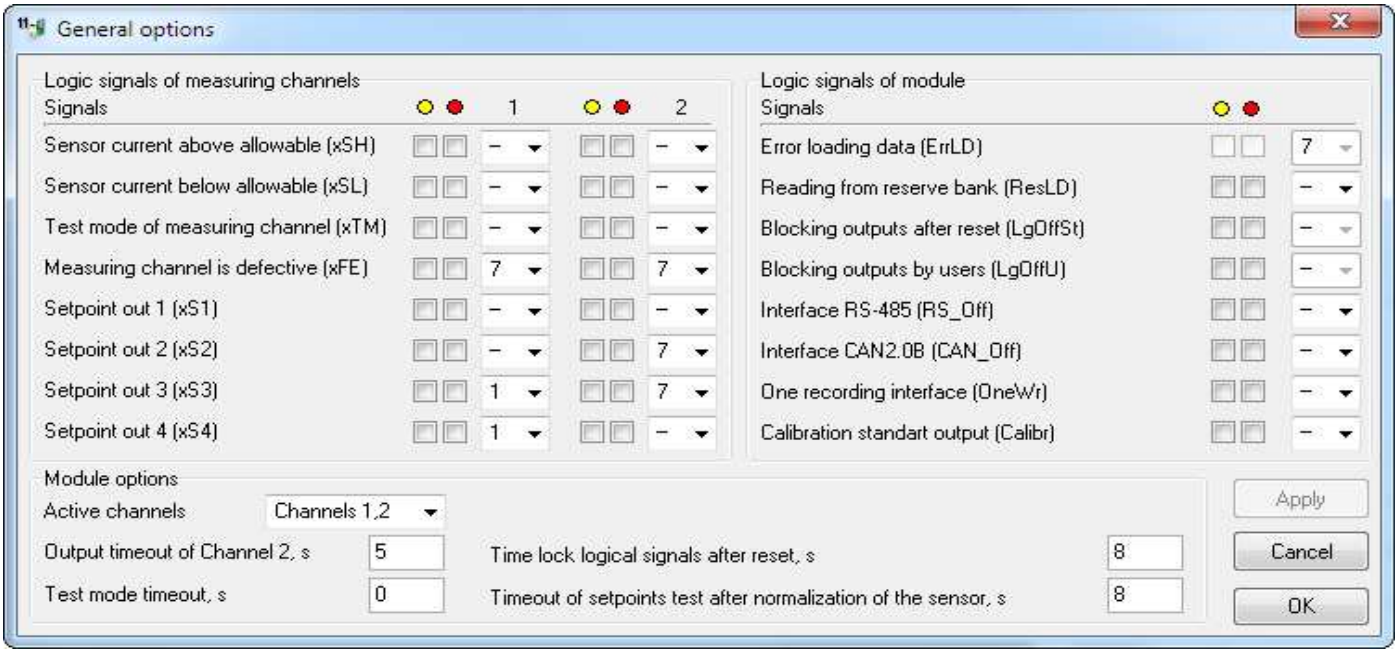


Figure 12. General (system) parameters window.

For logic alarm text report generation, select ***Test report*** option in shortcut menu. At this, 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, select ***Read settings from module*** option. This option is active when MK11 is connected.

For writing settings to the module, select ***Write settings to module*** option in shortcut menu. This option is active when MK11 is connected and logic outputs are disabled.

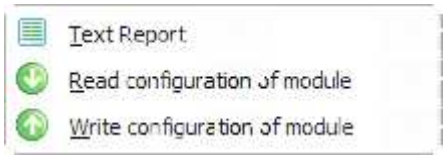


Figure 13. General parameters shortcut menu

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:

- Select number of operating channels: 1 or 2;
- Set channel 2 data display timeout;
- Set “Test” mode timeout;
- Set logic alarm disabling wait timeout after resetting (discreteness – 0.25s);
- 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 MK11 Module is connected and logic outputs are disabled.

- Input calibration;
- Output calibration.

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

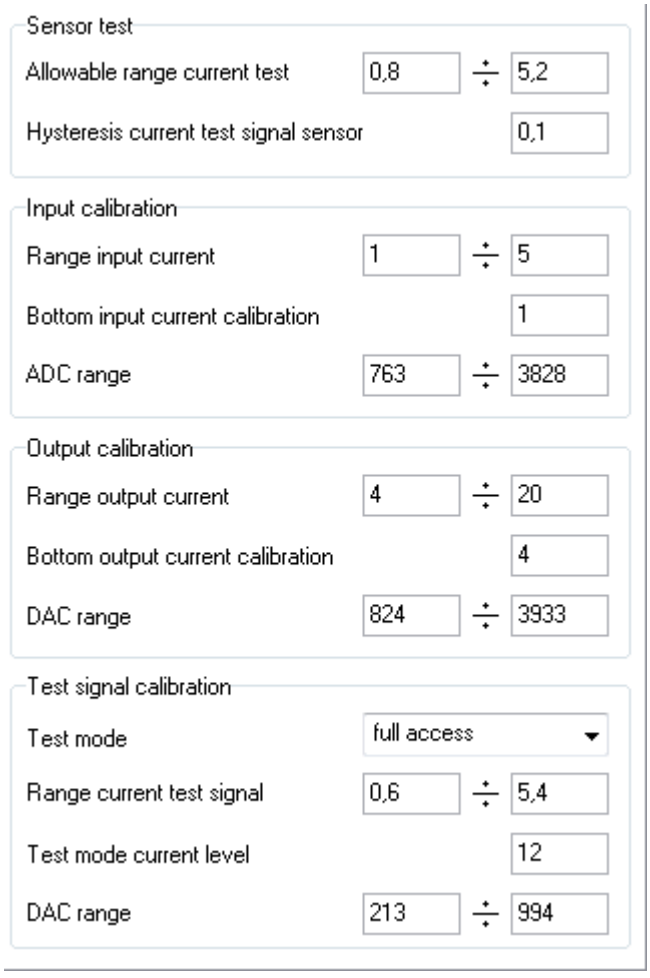


Figure 14. Calibration parameters window

Input calibration

In order to launch input calibration wizard, select ***Input calibration*** option in ***Calibration*** Menu of ***Measuring channels*** window. Then, following the hints, act as follows:

- If test mode of the measuring channel is switched on, wizard switches it off.
- 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.

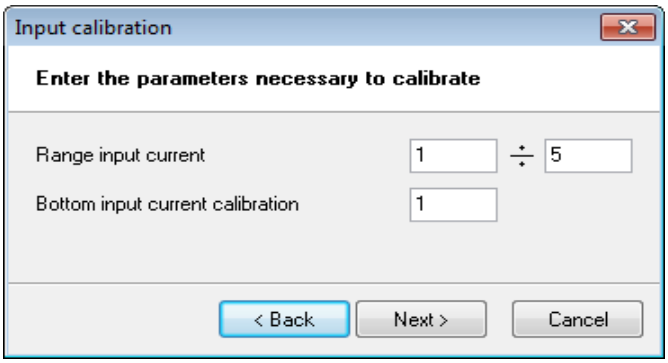


Figure 15. Measuring channel input calibration window.

Standard output calibration (basic mode)

In order to launch output signal (basic mode) calibration wizard, select ***Output calibration (basic mode)*** option in ***Calibration*** Menu of ***Measuring channels*** window. Then, following the hints, act as follows:

- If standard outputs calibration mode is switched off, wizard switches it on.
- If test mode of the measuring channel is switched on, wizard switches it off.
- Current range at standard output and minimum calibration current must be set;
- 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 MK11 Module);
  - actual value entry in input box and press ***Load to module*** 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.

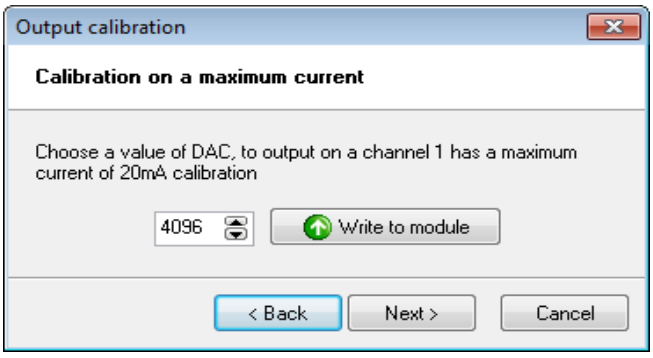


Figure 16. Measuring channel input calibration window.

Test signal output calibration (test mode)

In order to launch output signal (test mode) calibration wizard, select ***Output calibration (test mode)*** option in ***Calibration*** Menu of ***Measuring channels*** window.

Output calibration (test mode) can be carried out in two ways:

- Manual calibration;
- Automatic calibration.

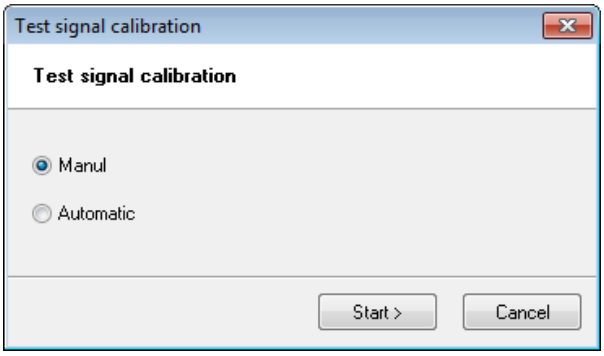


Figure 17. Test output calibration
(calibration mode selection).

Manual calibration

Following the hints, act as follows:

- If standard outputs calibration mode is switched off, wizard switches it on.
- If test mode of the measuring channel is switched on, wizard switches it off.
- Test current range and output current at “Test” mode activation must be set;
- Milliammeter must be connected to measuring channel current output;
- DAC value must be selected to ensure range maximum current on milliammeter by means of:
  - Up/ Down arrows (DAC value is increased or decreased and automatically written to MK11 Module);
  - actual value input in input box and pressing *Load to module* push button;
- After setting range maximum current, DAC value must be selected for output current at “Test” mode activation;
- 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.

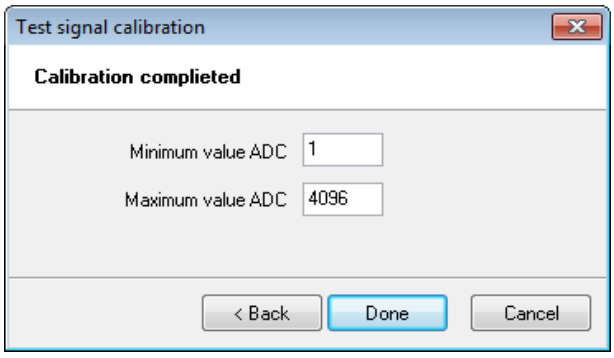


Figure 18. Test output calibration
(manual mode)

Automatic calibration

Following the hints, act as follows:

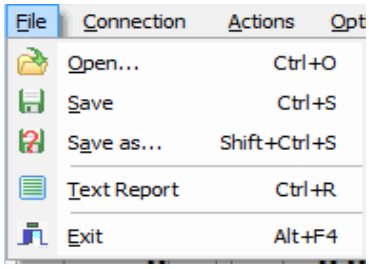
- If standard outputs calibration mode is switched off, wizard switches it on.
- If test mode of the measuring channel is switched on, wizard switches it off.
- Calibration is carried out at input range, thus, input signal calibration must be carried out prior to automatic calibration.
- At pressing 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 menu options description

File Menu

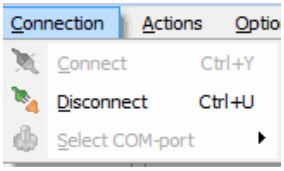
File Menu contains file commands, such as, ***Open settings file, Save settings file*** etc.



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 MK11 current settings.
Exit **[Alt+F4]**	Exit program

Connection Menu

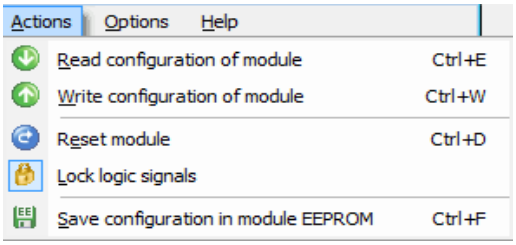
Connection Menu contains commands for working with COM-port.



Command	Description
Connect **[Ctrl+V]**	Create connection to MK11. *Actions* Menu is activated
Disconnect **[Ctrl+U]**	Break connection to MK11. *Actions* Menu is deactivated
Select Com-port	Assign COM-port for MK11 connection

Actions Menu

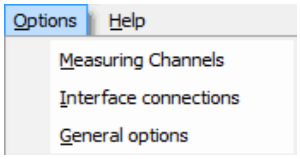
Actions Menu contains commands for working with MK11.



Command	Description
Read settings from module **[Ctrl+E]**	Read all settings from MK11. 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 MK11. 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 MK11. Query is being sent to confirm action. At resetting, communication with MK11 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 MK11 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 MK11 on settings saving to module volatile memory. At saving, communication with MK11 persists, and after saving, MK11 automat resetting is implemented.

Parameters Menu

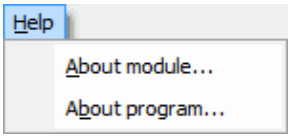
Parameters Menu contains parameters setting and MK11 calibration commands.



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 MK11 module and program help information



Command	Description
Work instructions **[F1]**	Work instructions for MK11 Module setup program
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

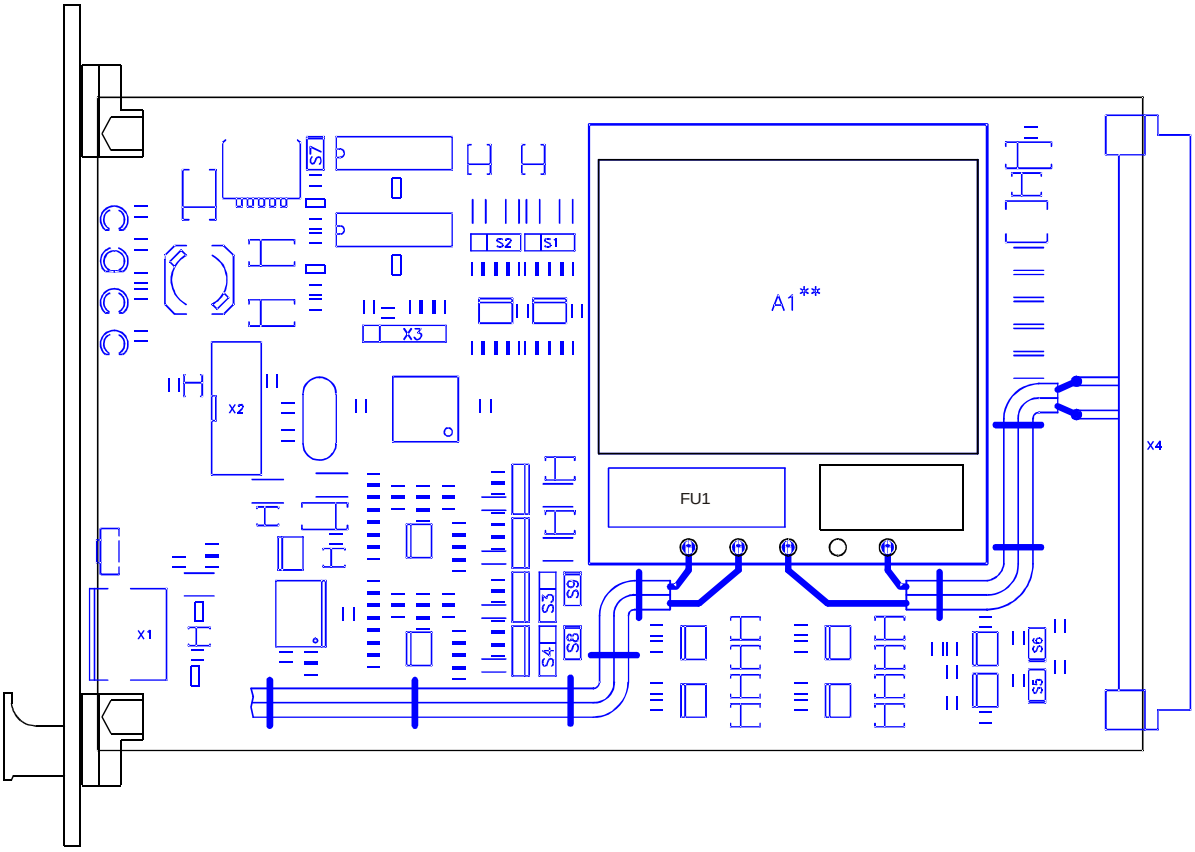
Manufacturer warranties compliance of equipment set with technical conditions, provided that operation, storage, transportation, handling and assembly conditions are met.

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 (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

S3, S4 bridges – operating mode selection for measuring channels 1, 2 (respectively) test signal

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

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

S7 bridge – 7.23KOhm resistor to +24V 2nd measuring channel input
(can be used for supply voltage measuring in “AC+МИ11” module design option)

Position	Mode
OFF	Not connected
ON	Connected

S9, S8 bridges – channels 1, 2 test signal connection to connector terminals x4

Position	Mode
OFF	Not connected
ON	Connected

B. 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	1
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	
C8	Input CH1	Measuring channel 1 input	
C10	Input CH2	Measuring channel 2 input	2
A12, B11, C12, C18	FG	Faraday grounding of AC/DC switched mode power supply	3
C14	~L220V	Mains voltage AC 220V 50Hz	3
C16	~N220V		
A16	Analog out 2	Measuring channel 2 standard output	
B15	Analog out 1	Measuring channel 1 standard output	
A18	Test 2	Measuring channel 2 test signal input/output (if S8 bridge is ON)	4
B17	Test 1	Measuring channel 1 test signal input/output (if S9 bridge is ON)	4
A20	LG_OUT_1	Logic output 1	5
A22	LG_OUT_2	Logic output 2	5
A24	LG_OUT_3	Logic output 3	5
A26	LG_OUT_4	Logic output 4	5
B19	LG_OUT_5	Logic output 5	5
B21	LG_OUT_6	Logic output 6	5
B23	LG_OUT_7	Logic output 7	5, 6
B25	LG_OUT_8	Logic output 8	7
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. In MK11-AC-11-S option is +24V voltage output. Can be used for external load connection (indicating units) and alarm logic and protection relay coils.
2. If channel 2 is not in use, terminal can be left unconnected; channel 2 operation must be switched off in module settings.
3. Only for MK11-AC-11-S design option, in other options terminals are not connected.
4. Used in output mode for test signal circuit calibration. In “Test” mode is connected to measuring channel input. In Input mode of this terminal the bridge of test signal operating mode selection must be taken off (S3, S4 respectively).
5. Operation logic is determined during module setup.
6. 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.
7. Signal is inverted to logic output 7. Terminal can be used as active module functionality alarm.
8. Terminals A4, A8, A10, A14, B3, B13, C4, C20, C22, C24, C26 are not in use.

C. Module labeling

Module labeling comprises:

- MK11 Module type and design option (DC, DC-11, AC-11-S);
- 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

МК11 AC-11-S	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.

D. Module setting up example for rotor axial shift measurement

Normally, measurement of rotor axial shift is taken by three independent of one another measuring channels with generation of shutoff protection signaling based on “two out of three” logic. In order to fulfill indicated condition, it is necessary to provide, in continuous vibration monitoring system design, unique secondary transducers (control units) with unique power supply of the module and primary transducer.

Use of 2-channel module for fixed signals measurement in MK11-AC-11-S permits to effectively implement rotor axial shift protection circuit with minimum used space in storage section. In MK11-AC-11-S includes digital indicator, which permits to display measurement results, and AC/DC power supply with wide range of input voltages. Considering, that MK11 module is provided with built-in measuring channels test, alarm and shutoff protection actuation function which permit to implement complete measuring circuit and rotor axial shift protection circuits, using only three MK11 modules.

Consider MK11 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).

MK11 Module 1st measuring channel is used for rotor axial shift measurement. Recommended measuring channel 1 setting parameters are shown in table below.

Measuring channel 1 calibration parameters (rotor axial shift measurement)

Parameter	Value	Note
Sensor current range lower level	1.0	1
Sensor current range higher level	5.0	1
Sensor current range lower level, at which calibration was carried out	1.0	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
Standard output current range lower level, at which calibration was carried out	4.0	1
Current level, set at test signal during “Test” mode activation	3.0	
Test signal current control lower tolerance level	0.6	1
Test signal current control higher tolerance level	5.4	1
ADC value of sensor current calibration lower/higher level		2
DAC value of standard output calibration lower/higher level		2
DAC value of internal test signal calibration lower/higher level		2
“Test” mode operation enabling	2	1

Notes:

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

Measuring channel 1 basic parameters (rotor axial shift measurement)

Parameter	Value	Note
Measured parameter lower range	-2	
Measured parameter higher range	2	
Measuring units label	mm	
Measurement results display format	1	##.##
Measured parameter averaging depth	1	
Set-point overrun response time	3	1.0c
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), S3 bridge must be set to position 1-2 (0-20mA current test signal operating mode), and S9 bridge is must not be set (external test signal is not used).

2hd measuring channel is used for +24V voltage regulation (module and primary transducer power supply), generated by AC/DC convertor (AC/DC convertor is installed on MK11 board). For +24V supply voltage regulation, S2 bridge must be set to position 2-3 (1-5mA current operating mode), S7 bridge must be set (connecting shift to measuring channel 2 input), bridges S4 and S8 must not be set (test signal is disabled).

At supply voltage of +24V, 2nd measuring channel input current is approximately equal to 3mA. Supply voltage quality can be assessed by input current deviation from 3mA.

Measuring channel 2 calibration parameters (+24V supply voltage regulation)

Parameter	Value	Note
Sensor current range lower level	8.09	1
Sensor current range higher level	40.44	1
Sensor current range lower level, at which calibration was carried out	8.09	1
Sensor current lower tolerance limit	20	2
Sensor current upper tolerance limit	24	2
Sensor test hysteresis	0.2	2
Standard output current range lower level	0	3
Standard output current range higher level	0	3
Standard output current range lower level, at which calibration was carried out	0	3
Current level, set at test signal during “Test” mode activation	0	3
Test signal current control lower tolerance level	0	3
Test signal current control higher tolerance level	0	3
ADC value of sensor current calibration lower/higher level		4
DAC value of standard output calibration lower/higher level	0	3
DAC value of internal test signal calibration lower/higher level	0	3
“Test” mode operation enabling	0	OFF

Notes:

1. Customized range for setting measuring channel operation to supply voltage measuring mode.
2. Acceptable supply voltage range at its discontinuous jump. Sensor test algorithm is free of averaging and pickup delay.
3. Functions are not in use and must be disabled.
4. Determined during calibration. Low value is determined during calibration at 1mA current, high value – at 5mA current.

Measuring channel 1 basic parameters (rotor axial shift measurement)

Parameter	Value	Note
Measured parameter lower range	8.09	1
Measured parameter higher range	40.44	1
Measuring units text string	B	
Measurement results display format	1	##.##
Measured parameter averaging depth	3	
Set-point overrun response time	3	1.0c
Set-point 1 operating mode	0	OFF
Set-point 2 operating mode	2	below
Set-point 3 operating mode	1	above
Set-point 4 operating mode	0	OFF
Set-point 1	22	
Set-point 2	1.0	2
Set-point 3	26	2
Set-point 4	0	
Set-point hysteresis	0.2	2

Notes:

1. Customized range for setting measuring channel operation to supply voltage measuring mode.
2. Acceptable supply voltage range at its smooth variation. Sensor test algorithm is free of averaging and pickup delay.

2nd measuring channel is auxiliary, thus, the module must switch automatically to axial shift measurement results display (channel 1). Recommended module system settings are shown in table below.

Parameter	Value	Note
Channel 2 operation enabling	1	both
Timeout of indication display switching from channel 2 (auxiliary) to channel 1 (main)	5	
“Test” mode timeout.	0	OFF
Logic outputs disabling timeout after the module resetting	31	8c
Set-points test timeout after sensor function normalization	31	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 7:
  - Abnormal sensor current in rotor axial shift measuring channel (channel 1);
  - Abnormal supply voltage at sensor current algorithm (channel 2);
  - Abnormal supply voltage at set-pointss test algorithm (channel 2);
- Logic output 8 is always inverted to Logic output 7 and signals module and measuring channels functionality.

Alarm is not assigned to unused logic outputs, which are always inactive.

In MK11-AC-11-S option, 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`
7.	Module fault	`ErrLD + 1FE + 2FE + 2S2 + 2S3`
8.	Module operating functionality	

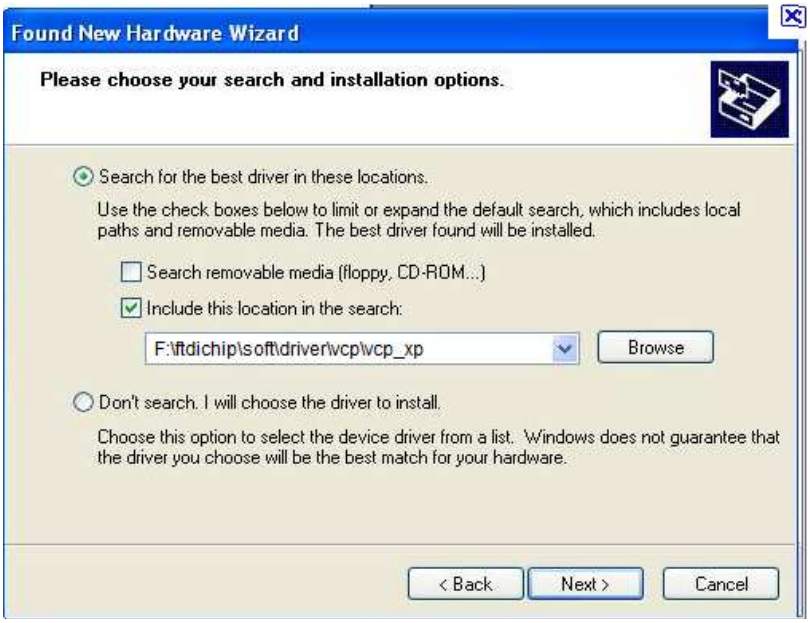
Note. `ErrLD` signal is always assigned to Logic output 7.

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.

E. 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.

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.

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 MK11 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