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SCIENTIFIC-PRODUCTION
ENTERPRISE VIBROBIT LLC

EQUIPMENT VIBROBIT 300

Module MK40 Setup Manual
(Ver. 1, module software version 3.0)

ВШПА.421412.304 И1

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Module MK40 Setup Manual are meant for introducing to user (consumer) of operating principles and setting methods of MK40 Fixed Signal Monitoring Module of Equipment Vibrobit 300.

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

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CONTENTS

General Information

2-channel MK40 Control Module is designed for measuring of tachometric signals. MK40 is based on high-performance microcontroller, use of which permits to process signals from sensors in real-time mode (measurement periods up to 0.1s) and support, in parallel, digital control interfaces.

Measuring channels operate synchronously but independently of one another. Measuring channels basic functions are:

- Measurement of sensors DC current and monitoring of sensors and communication line functionality;
- Measurement period of rotor speed from 0.1 to 1.0 second (equal for both measuring channels);
- Adjustable number of gear teeth (pulse count per rotor revolution);
- Selection of sensor signal active front (determined by bridge on the module board);
- Repetition of basic tachometric pulses for synchronization of control modules, calculating rotational components and phases (for example, MK20 and M30 modules);
- Rotor stop block detection and rotor stop block alarm testability (“STOP” mode);
- Calculated frequency value comparison with set-points (3 set-points for each channel);
- Calculation of maximum rotor speed;
- Calculated parameter value transfer to standard current output.

Other MK40 Module features include:

- Measuring channels input signals: 0(1) – 5mA; 0(4) – 20mA; 0 – 5V.
- Six logic outputs with adaptable algorithm for alarm and protection circuits implementation;
- Two standard current outputs with programmed range setup option;
- Supported communication interfaces: RS485, CAN2.0B, diagnostic interface;
- Utility software for PC rendering of the module actual state, setting and calibration;
- Module in several design options:
    - ***MK40-DC*** – 20mm 3U narrow front panel, restricted module state alarm system, +24V DC voltage power supply;
    - ***MK40-DC-11*** – 40mm 3U front panel, bright 7-segment digital display with extended module indication and control system, +24V DC voltage power supply;
    - ***MK40-DC-001*** - 40mm 3U front panel, a customized alphanumeric LCD with measurement results displaying capability in all measuring channels simultaneously, +24V DC voltage power supply;
    - ***MK40-AC-11-S*** – 40mm 3U front panel, bright 7-segment digital display with extended module indication and control system, AC 220V 50Hz power supply and power-on toggle-switch, installed on the front panel.
- Transducers (sensors) +24V DC voltage power supply is provided through self-healing 200mA fuse, installed on MK40 Module board.
- 50Hz test signal generation for MK40-AC-11-S design option.

Overall MK40 Module setting up is implemented by PC or dedicated ПН31 setting unit. In order to setup the module by means of PC, MK40_setup.exe software should by run on PC and MK40 Module should be connected to PC via MC01 diagnostic interface board (RS232 PC Interface) or MC01 USB (USB PC interface).

Technical specifications

Table 1. Technical specifications of MK40 Module

Parameter name	Value
Number of measuring channels	2
Measuring range and rotor speed alarm, rotations per minute	1 – 10 000
Measuring ranges and input signal alarm: - Direct current, mA - DC voltage, V	 1-5; 4-20 0.95-4.75
Input resistance, Ohm - Direct current - DC voltage	 953±2; 232±0,5 not less than 10000
Acceptable tolerance limits of standard output mean percentage error of rotor speed measuring channels, %	±1,0
Acceptable tolerance limits of digital display mean absolute error of rotor speed measuring channels, rotations per minute, not greater than	±2,0
Readings updating time, s	0.1 – 1.0
Number of standard DC current signals	2
Output standard DC current signal, mA	0-5;4-20
Output standard DC current signal load resistance, Ohm, not greater than	2000; 500
Number of set-points for each measuring channel	3
Number of digital outputs	6
Output digital signals - type - DC voltage, V, not greater than - output current, mA, not greater than	 open collector 24 100
Number of synchronization outputs	2
Output synchronization signals - type - DC voltage, V, not greater than - output current, mA, not greater than	 open collector 24 100
Supported digital communication interfaces types	RS485 (ModBus) CAN2.0B Diagnostic I2C
Power supply voltage, V - for MK40-AC option - for MK40-DC options	 AC 50Hz 176-242 DC 246-350 +(24±1)
Power consumption, W, not greater than	7
Operating ambient temperature range (inside and out), ºC	+5-+45

Table 2. Additional specifications of MK40 Module

Parameter name	Value
Dimensions, mm - MK40-DC Module - MK40-DC-11, MK40-DC-001 and MK40-AC-11-S Modules	 20.1 x 130 x 190 40.3 x 130 x 190
Weight, kg, not greater than - MK40-DC option - MK40-DC-11, MK40-DC-001 options - MK40-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	Ж3

Indication and control equipment

The front panel features of MK40 Module vary depending on design option. Appearance of MK40 Module front panels is shown in Figure 1.

The following elements are arranged on all front panel types:

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

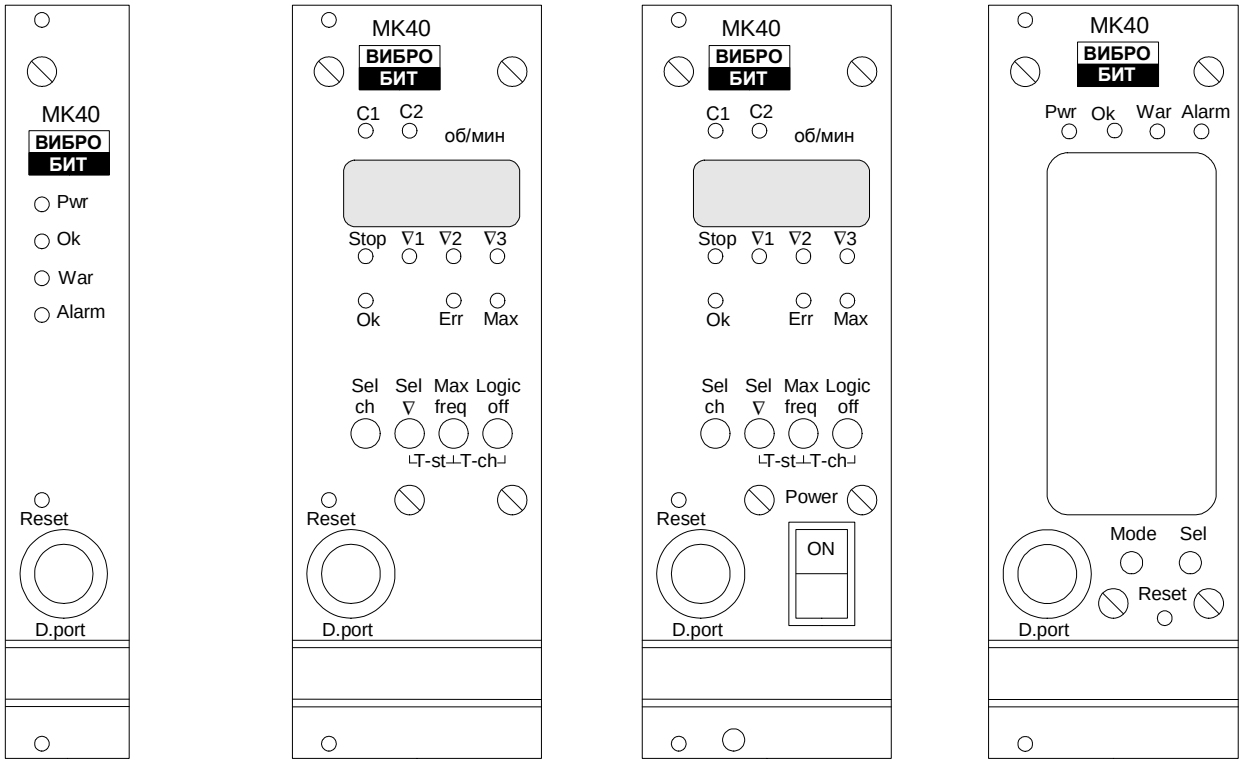
Module state can be assessed based on **Ok** LED emission color:

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

MK40-DC design option

Narrow front panel (width - 20mm) with restricted indication display and control system. Measurement results review is only possible at reading via digital communication interfaces. Additionally, on the module front panel are arranged:

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



а) MK40-DC б) MK40-DC-11 в) MK40-AC-11-S г) MK40-DC-001

Figure 1. MK40 Module front panel appearance

MK40-DC-11, MK40-AC-11-S design option

MK40 Module front panel is provided with 7-segment 4-digit LED display with auxiliary LED's and control keys. In these MK40 Module design options only one measuring channel measurement results can be displayed at a time.

On the module front panel are arranged:

- 7-segment digital display for measurement results displaying.
- Bicolor "***Ok***" LED – module status indication.
    - Yellow LED's "**C1**", "**C2**" - for selected measuring channel displaying. Flashing of "**C1**", "**C2**" LED's indicates test signal generation at relevant measuring channel output;
    - Yellow "**Stop**" LED – "STOP" mode, rotor stop block. At "STOP" alarm testing, "**Stop**" LED starts flashing;
    - Yellow LED's "**V1**", "**V2**" - for indication of parameters overrun of relevant set-points. During displaying of set-point, relevant set-point LED flashes.
    - Red "***Err***" LED – indication of selected measuring channel fault. "***Err***" LED flashes, when measuring channel normalization timeout is being count.
    - Yellow "***Max***" LED – displaying of rotor maximum speed. During sensor DC current displaying, "***Max***" LED starts flashing;
- Control keys:
    - "***Sel ch***" – switching between measuring channels. If measuring channel is disabled (during the module setup), relevant measuring channel information is not displayed;
    - "***Sel V***" – set-points displaying. If set-point is disabled (during the module setup), relevant set-point value is not displayed. At pressing and holding down of "**Sel V**" key, sensor DC current is displayed;
    - "***Max freq***" – rotor maximum speed displaying. At pressing and holding down of "**Max freq**" key, rotor maximum speed is reset;
    - "***Logic off***" – when held down for long duration, disables/enables module logic alarm;
- Power-on toggle-switch "**Power**" (only for MK40-AC-11-S option).

At displaying of additional information (maximum rotor speed, set-point values etc.), module automatically switches to rotor speed value displaying after preset timeout is count (30 seconds on default).

2nd measuring channel of MK40 Module can be set up in the module +24V supply voltage measuring mode. After selection of 2nd measuring channel displaying, transition to 1st measuring channel displaying will be implementer automatically upon timeout.

At simultaneous pressing of holding down of "**Sel V**" and "**Max freq**" keys, "STOP" alarm test is switched on/off ("STOP" alarm test must be enabled in the module settings). At enabling of "STOP" alarm test "**Stop**" LED starts flashing. Module automatically resets "STOP" alarm test during preset timeout (TimeOut_TestStop parameter).

At simultaneous pressing of holding down of "**Max freq**" and "**Logic off**" keys, external test signal at measuring channel input is connected/disconnected (test signal connection must be enabled in the module settings). At connection of external test signal relevant measuring channel "**C1**", "**C2**" LED starts flashing. Module automatically disconnects external test signal during preset timeout (TimeOut_TestMode parameter).

MK40-DC-001 design option

MK40 Module front panel is provided with customized alphanumeric LCD, signal LED's and control keys. All measuring channel measurement results and measuring channels state can be displayed simultaneously.

On the module front panel are arranged:

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

Two control keys

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

Figure 2. LCD data display example

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

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

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

In "STOP" mode rotor speed value is deemed equal to zero, nonsignificant decimal point is displayed after "0" symbol At "STOP" alarm testing, nonsignificant decimal point, following rotor speed value, starts flashing.

At test signal connection to measuring channel input, empty frame of non-existing set-point 4 starts flashing on top right panel of measuring channel data display.

In supply voltage measuring mode of 2nd measuring channel, actual supply voltage of the module is displayed on bottom panel of measuring channel data display, while standard 2nd measuring channel data is not displayed.

In order to display maximum rotor speed, press "**Mode**" key until rotor speed value appears on LCD (in two channels simultaneously). During maximum rotor speed displaying, measuring unit symbols "rpm" start flashing on LCD, while symbols of measured parameter value overrun of set-point are not displayed. Return to normal display mode is implemented by repeated pressing of "**Mode**" key or automatically upon timeout.

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

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

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

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

Module operation

Switching power on

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

- Measuring channels parameters;
- Module system parameters 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 MK40 Module operation start:

- ***MK40-DC option*** – "Ok" LED glows yellow to indicate module starting initialization.
- ***MK40-DC-11, MK40-DC-001 and MK40-AC-11-S options*** - "Ok" LED glows yellow, module serial number, and then, module year of manufacture is displayed on 7-segment indication display and MK40 initialization is implemented.

Note. Hot swap of MK40 module in section without disconnection from power supply is not recommended but allowed for all MK40 Module design options.

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

Resetting

For Module resetting, microcontroller hand resetting is fulfilled and series of actions is made which corresponds to power switching on. Reasons for MK40 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 MK40 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 MK40 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:

- ***MK40-DC option*** – “Ok” LED starts glowing yellow simultaneously with “War” LED.
- ***MK40-DC-11, MK40-DC-001 and MK40-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.

MK40-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.

MK40-DC-11, MK40-DC-001 and MK40-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.

Parameters measurement

MK40 Module operates in real-time mode with measurement results update rate of 250ms.

Module implements the following basic operations:

- measures sensor current and monitors sensor functionality;
- measures rotor speed;
- repeats tachometric pulses for control modules synchronization, calculating variable signals (only for “slot” reference surface);
- compares calculated parameter values with set-points and signals overrun;
- transfers measured values to standard outputs;
- generates logic alarms;
- updates data on display equipment;
- supports data exchange via digital communication interfaces.

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.

Both measuring channels function equally, synchronously and independently of one another. Only several parameters are common (for detailed description of parameters, refer to Table 16):

- `PeriodMeasur` - otor speed measurement period from 0.1 to 1.0 second;
- `TestPointSenseOk` - set-points test timeout after sensor function normalization;
- `TimeOut_TestMode` - “Measuring channel test” mode timeout;
- `TimeOut_TestStop` - “STOP” mode test timeout;
- `SynhroPulse` - pulse time of control modules measurements synchronization.

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 5V.

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

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

Sensor current is calculated by formula:

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

where

I_{sense} – calculated value of sensor current;

ADC – averaged ADC value;

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

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

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

Note. If one of calibration value pairs (20% of `RangeCurrMax, RangeCurrMax` 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.

Monitoring of minimum/maximum acceptable sensor current can be disabled in the module settings (`EnaValidMin, EnaValidMax` respectively). If sensor current monitoring is switched off at one of the limits, sensor is deemed functional independent of calculated sensor current.

Enabling of sensor current monitoring can be useful, for example, during MK40 Module operation with sensor signals level 0-5mA; in this case, disabling of sensor current lower limit monitoring is reasonable.

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.

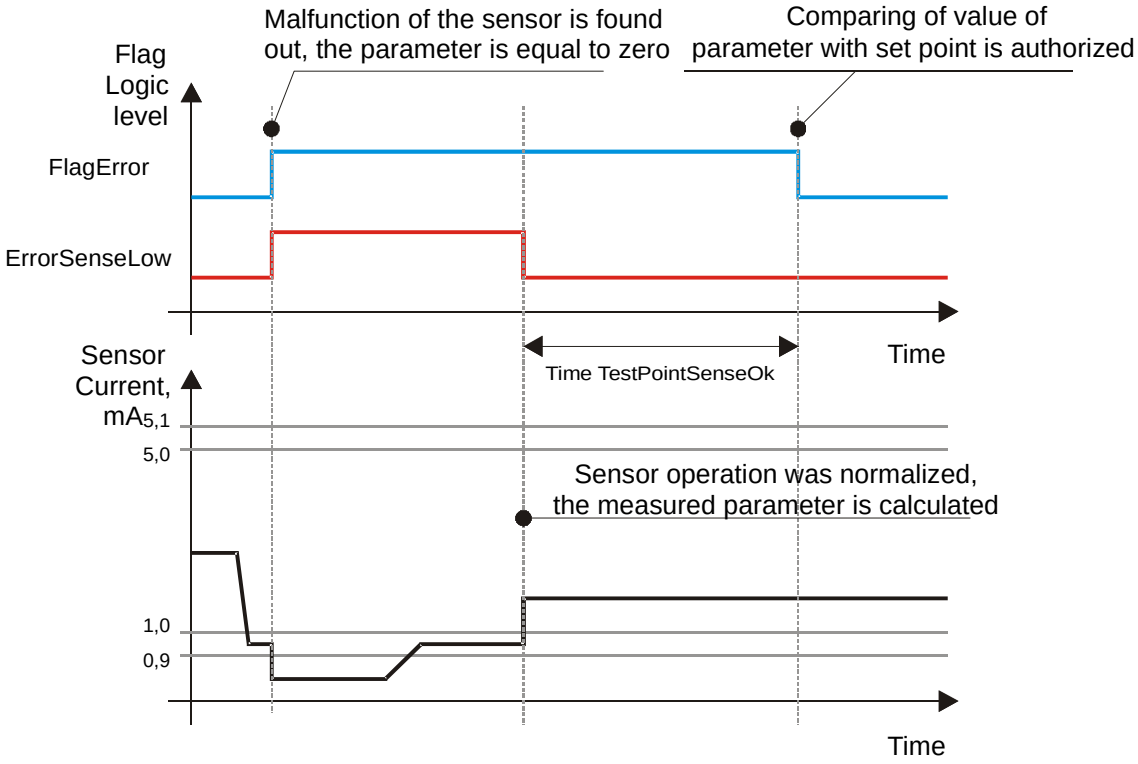


Figure 3. Sensor test algorithm during sensor constant current decrease below acceptable level

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.

Rotor speed measurement

Rotor speed measurement is implemented, providing that sensor fault was not detected (`ErrorSenseLow`, `ErrorSenseHigh` flags are dropped). If sensor fault was detected (one of `ErrorSenseLow`, `ErrorSenseHigh` flags is activated), rotor speed is not calculated and taken as equal to zero.

Note. Synchronizing pulses are generated (if enabled in the module settings), even if sensor fault was detected.

Definition of rotor speed is implemented by measuring of clock cycles, calculation of leading edge of timing signal with frequency 10MHz between two clock cycles active fronts.

Clock cycle value is averaged during measurement cycle (determined by `PeriodMeasur` parameter), then rotor speed is calculated in rpm (with provision for preset number of pulses per rotor revolution).

If only one clock cycle was detected during measurement cycle, non-averaged clock cycle value is used in rotor speed calculation.

Minimum measured rotor speed is set by `FrequencyMin` (not less than 0.9 rpm). If rotor speed is below preset value, synchronization pulses are deemed non-existing (rotor is stopped).

Synchronizing pulses polarity

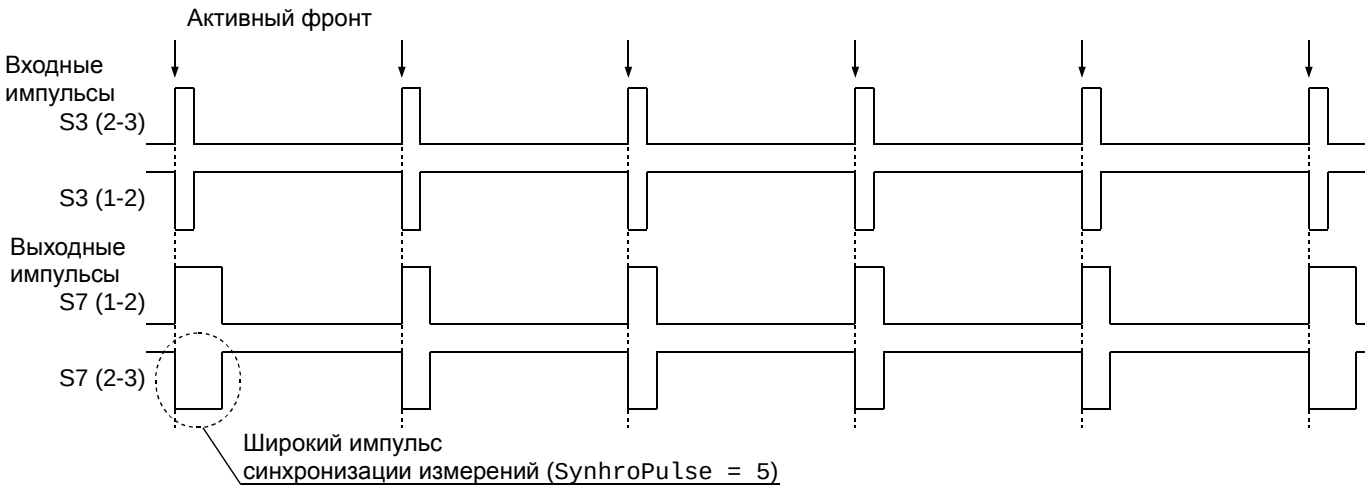
Active front polarity of input pulses and repeated synchronizing pulses is determined by bridges on the module board (see Annex A).

In Figure 4 are shown input/output synchronizing pulses diagrams for 1st measuring channel depending on bridges position on the module board (same for 2nd measuring channel).

Synchronizing pulses are generated only if enabled in the module settings (`PulseEnabled` parameter).

Other ASVM modules synchronization (calculation of rotational components and phases) by MK40 Module input signals must only be implemented at bridges selected active front, as inactive front of repeated synchronizing pulses has jitter not greater than ±200mks (output synchronizing pulse duration 800-1000mks).

In order to synchronize simultaneous results acquisition by ASVM control modules, MK40 Module generates synchronizing pulses with twofold duration and `SynchroPulse` time (if `SynchroPulse` is equal to zero, lengthened synchronizing pulses are not generated).



Note. It is implied, that adjusting resistor is connected to positive supply of pulse output.
Rate of pulse rise is determined by output circuit capacitance and adjusting circuit parameters (resistor resistance, adjustment voltage).
Rate of pulse rise is determined by output circuit capacitance and adjusting circuit parameters (resistor resistance, adjustment voltage).

Figure 4. Polarity of input and output synchronizing pulses

Comparing measured parameter value with set-point value

If `FlagError` flag is dropped (wait timeout is counted after sensor operation normalization), calculated rotor speed value of 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 3. 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

Rotor speed value is not compared with TestPointData set-point, OutPoint flag is always dropped.

Operating mode - test above set-point value

If rotor speed 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), rotor speed value must be lower that TestPointData-TestPointHist within TestPointTime time.

Operating mode - test below set-point value

If rotor speed 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), rotor speed value must be higher that TestPointData+TestPointHist within TestPointTime time.

Figure 5 shows an example of alarm function at set-point 2400rpm and hysteresis of 100prm.

Set-points test enabling in “STOP” mode is determined by StopEnabled parameter. If StopEnabled parameter is equal to zero, in “STOP” mode rotor speed value (equal to 0) is not compared with set-points, rotor speed overrun flags are inactive.

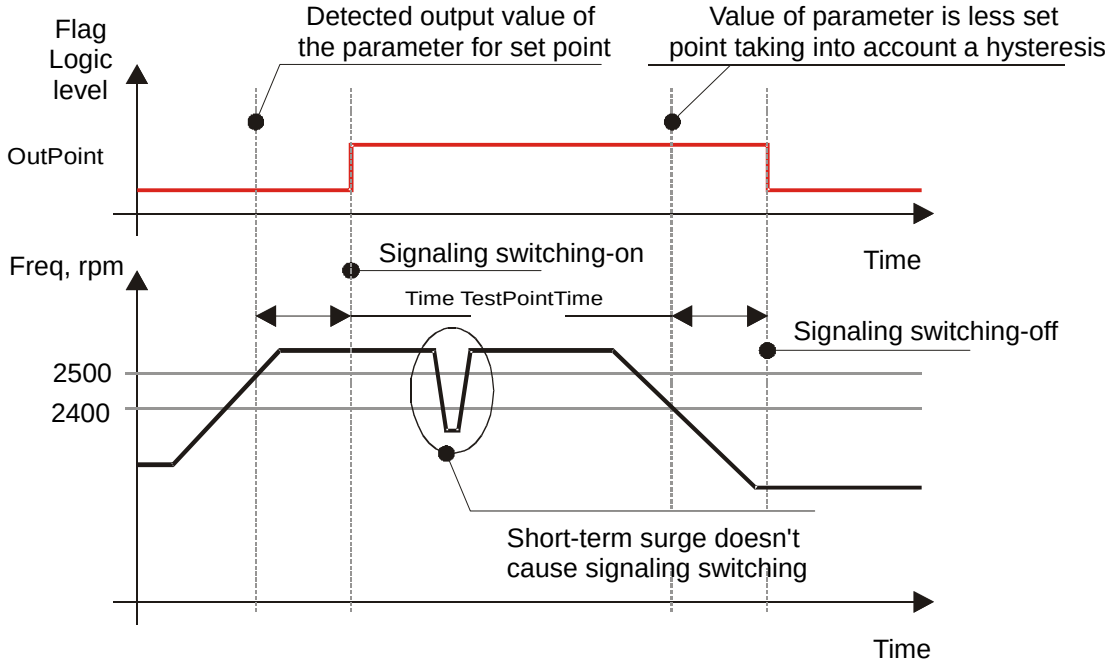


Figure 5. Example of set-point algorithm
(mode – test above set-point level).

Module supply voltage measurement

2nd measuring channel can be setup for measurement and monitoring of module and sensors supply voltage, which power circuits are connected to MK40 Module. It is reasonable to use supply voltage measurement in MK40-AC-11-S Module design option.

Enabling of the module voltage measurement is set during the module setup (ModeWork parameter). In this mode 2nd channel frequency value is taken as equal to zero, all set-points are disabled.

Calculation of the module supply voltage is implemented by sensor current calculation algorithm (voltage value is available in Current parameter). Voltage calculated value can be compared with sensor test set-points with alarm generation at logic outputs.

At module supply voltage measurement in 2nd measuring channel, bridges on the module board must be set in positions as follows (position of S4, S8, S5 is of no concern):

S3 – 1-2, 1-5mA current operating mode; S13 – OFF; S9 – ON

2nd measuring channel calibration is carried out at 1-5mA range.

Table 4. 2nd channel recommended parameters for module supply voltage measurement

Parameter	Label	Value	Notes
Sensor current range lower level	RangeCurrMin	8,27	
Sensor current range higher level	RangeCurrMax	41,36	
Sensor lower limit test enabling	EnaValidMin	1	
Sensor higher limit test enabling	EnaValidMax	1	
Sensor current lower tolerance limit	CurrValidMin	20	
Sensor current upper tolerance limit	CurrValidMax	28	
Sensor test hysteresis	CurrValidHist	0,5	
Standard output current range lower level	CurrOutMin	0	
Standard output current range higher level	CurrOutMax	0	
ADC value of sensor current calibration lower level	AdcInMin		1
ADC value of sensor current calibration higher level	AdcInMax		1
DAC value of standard output calibration lower level	DacOutMin	0	
DAC value of standard output calibration higher level	DacOutMax	0	
Measuring channel enabling	Enabled	1	volt
Measuring channel operating mode	ModeWork	1	
Test signal connection enabling	TestEnabled	0	
“STOP” alarm test enabling	StopEnabled	0	
Generate synchronizing pulses	PulseEnabled	0	
Measured parameter lower range	RangeParamMin	0	
Measured parameter higher range	RangeParamMax	0	
Minimum measured rotor speed, rpm	FrequencyMin	1	
Pulse count per rotor revolution	Tooth	1	
Data display format	FormatOut	0	rpm
Set-points test enabling in “STOP” mode	TestPointStop	0	
Sensor current range lower level	TestPointTime	0	0,5c
Sensor current range higher level	TestPointMode_1	0	
Sensor lower limit test enabling	TestPointMode_2	0	
Sensor higher limit test enabling	TestPointMode_3	0	
Sensor current lower tolerance limit	TestPointData_1	0	
Sensor current upper tolerance limit	TestPointData_2	0	
Sensor test hysteresis	TestPointData_3	0	
Standard output current range lower level	TestPointHist	0	

Note 1. Determined during calibration of measuring channel input

External test signal

External test signal can be connected to measuring channel input. External signal source can be determined by S5, S6 bridges.

For MK40-AC-11-S design option 50Hz test signal is generated from mains AC 220V 50Hz voltage.

Connection/disconnection of external timing signal can be implemented by commands via digital communication interfaces or by user pressing front panel keys for MK40-DC-11 and MK40-AC-11-S design options.

Test signal connection must be enabled during the module setup (`TestEnabled`).

"STOP" mode test

MK40 Module can generate false "STOP" mode alarm signal at logic outputs. This function can be useful for "STOP" alarm circuits test before equipment stop block.

Switching on/off of "STOP" mode test can be implemented by commands via digital communication interfaces or by user pressing front panel keys for MK40-DC-11 and MK40-AC-11-S design options.

"STOP" mode test must be enabled during the module setup (StopEnabled parameter).

Standard output

Standard current output is provided for each 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`, `CurrOutMax`), measured parameter range (`RangeParamMin, RangeParamMax`) and DAC saved value (`DacOutMin, DacOutMax`), corresponding to standard output range, at which calibration was carried out (20% of `CurrOutMax, CurrOutMax`).

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

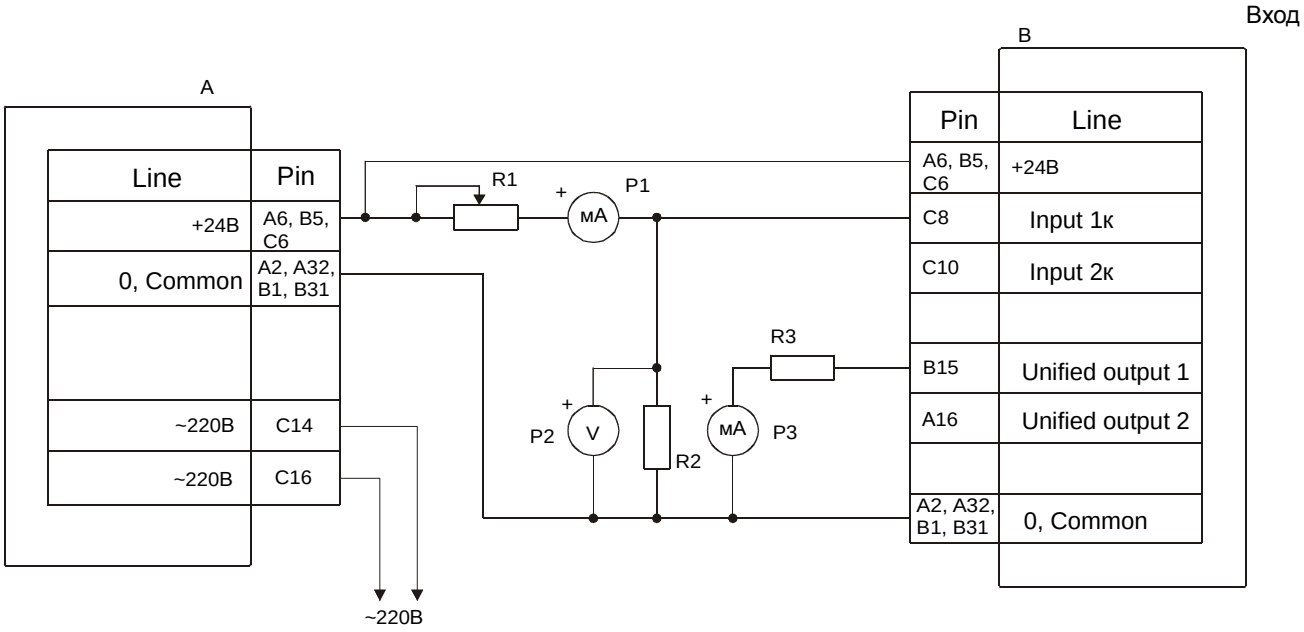
Calibration recommendations

МК40 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).

МК40 Module connection set-up for calibration and test calibration is shown in Figure 6. МК40 Module calibration is recommended on СП43 calibration bench, which permits to establish indicated test set-up.

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



A – МП24 or БП17
B – МК40
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 6. МК40 Module connection set-up for calibration and test calibration

Measuring channel input calibration

Measuring channel input calibration sequence is simple enough:

1. Indicate measuring channel current range value (`RangeCurrMin`, `RangeCurrMax`);
2. Indicate measured parameter range (`RangeParamMin, RangeParamMax`);
3. Set 20% of `RangeCurrMax` current at channel input;
4. Rewrite `AdcData` value to `AdcInMin`;
5. Set `RangeCurrMax` current at channel input;
6. Rewrite `AdcData` value to `AdcInMax`;
7. Transfer calibration results to MK40 Module;
8. Implement ratios recalculation.

Alteration of measured parameter range consists in alteration of `RangeParamMin, RangeParamMax` parameters.

Calibration wizard is provided in dedicated MK40 Module setting software, which considerably simplifies calibration process.

Standard output calibration

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

1. Indicate standard output current range value (`CurrOutMin, CurrOutMax`);
2. By writing of value to `DacDirectData` select current (by means of microammeter), equal to 20% of `CurrOutMax`, at standard output;
3. Rewrite `DacDirectData` value to `DacOutMin`;
4. By writing of value to `DacDirectData` select current (by means of microammeter), equal to `CurrOutMax`, at standard output;
5. Rewrite `DacDirectData` value to `DacOutMax`;
6. Write zero to `DacDirectData` (switch on calibration mode);
7. Transfer calibration results to MK40 Module;
8. Implement ratios recalculation.

Alteration of input measured parameter range (`RangeParamMin, RangeParamMax`) automatically changes parameter range at standard output. Calibration wizard is provided in MK40 setup software for module calibration, which considerably simplifies calibration process.

Note. Writing of calibration results to MK40 Module and recalculation of ratios can be carried out once after all calibration steps (input, standard output) are completed.

Logic outputs

In MK40 Module 6 logic outputs with open collector (active 0) are provided.

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

Operation of each of 6 logic output is setup by user via digital communication interfaces.

If check sum error has been detected in one of the module operation parameters section, active signal level is present at logic output 6, while other MK40 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.

MK40 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 6, state of relevant assigned flag will not affect any of logic outputs.

Table 5. 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	`OffMode`	Measuring channel is off	Off	8	16
1	`ErrorSenseLow`	Sensor current below acceptable level	xSL	9	17
2	`ErrorSenseHigh`	Sensor current above acceptable level	xSH	10	18
3	`FlagError`	Measuring channel general fault flag	xFE	11	19
4	`StopMode`	“STOP” mode	xSM	12	20
5	`OutPoint_1`	Parameter value overrun of set-point 1	xS1	13	21
6	`OutPoint_2`	Parameter value overrun of set-point 2	xS2	14	22
7	`OutPoint_3`	Parameter value overrun of set-point 3	xS3	15	23

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

Table 6. Module status flags `StatusSys` and their position if logic outputs matrix `LogicMatrix`

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

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

Digital Control Interfaces

MK40 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**. MK40 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 MK40 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 7. 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 8. 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 9. Implemented ModBus protocol commands in MK40 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 10.

Table 10. 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).

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 MK40 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 MK40 Module status data transfer to indicating units and statistics gathering module. MK40Module does not receive any data via CAN2.0B interface, possibility of module setup by means of CAN2.0B interface is not provided either.

Table 11. CAN2.0B interface parameters

Parameter name	Value
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
MK40 Module indicating units code	0xC4 (196)
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 MK40 Module board. If the module is last to be connected to RS485 bus and standard 120 Ohm bus terminator is missing, bridge with bus terminator must be installed on the module board for normal operation of RS485 interface.

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

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

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

0x30(48) – 1st measuring channel message;

0x31(49) – 2nd measuring channel message.

0x32(50) – Combined message. In normal state, message with 1st channel measurement result is transferred. In case of 1st channel fault, message 2nd channel measurement is transferred. In case of both channels fault, message is not transferred (implemented in module software version 3.40 and newer).

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	Data				StatusCH	StatusSys

Byte number in message						
0	1	2	3	4	5	6
Code	Parameter measured value (4 bytes float)					
0x32	Data					

Figure 7. Measuring results CAN message format

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

Table 12. I2C driven interface parameters

Parameter name	**Value**
MK40 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 13. List of measuring channels calibration parameters

Name	Label	Type (byte)	Address (Hex)		Default value	Note
			Channel 1	Channel 2		
Sensor current range lower level	RangeCurrMin	Float (4)	0x0600	0x0700	1.0	
Sensor current range higher level	RangeCurrMax	Float (4)	0x0604	0x0704	5.0	
Sensor lower limit test enabling	EnaValidMin	Uchar (1)	0x0608	0x0708	1	
Sensor higher limit test enabling	EnaValidMax	Uchar (1)	0x0609	0x0709	1	
Sensor current lower tolerance limit	CurrValidMin	Float (4)	0x060A	0x070A	0.7	
Sensor current upper tolerance limit	CurrValidMax	Float (4)	0x060E	0x070E	5.3	
Sensor test hysteresis	CurrValidHist	Float (4)	0x0612	0x0712	0.1	
Standard output current range lower level	CurrOutMin	Float (4)	0x0616	0x0716	4.0	
Standard output current range higher level	CurrOutMax	Float (4)	0x061A	0x071A	20.0	
ADC value of sensor current calibration lower level	AdcInMin	Uint (2)	0x061E	0x071E	0	1
ADC value of sensor current calibration higher level	AdcInMax	Uint (2)	0x0620	0x0720	0	1
DAC value of standard output calibration lower level	DacOutMin	Uint (2)	0x0622	0x0722	0	1
DAC value of standard output calibration higher level	DacOutMax	Uint (2)	0x0624	0x0724	0	1

Notes:

1. Calibration data is missing, all measuring parameters will be equal to zero.
2. Default value – value assigned to parameter after the module cold start.

Table 14. List of measuring channels basic registers

Name	Label	Type (byte)	Address (Hex)		Default value	Note
			Channel 1	Channel 2		
Measuring channel enabling (0-channel OFF)	Enabled	Uchar (1)	0x0A00	0x0B00	1	
Measuring channel operating mode (0-starndard; 1 – voltage measurement)	ModeWork	Uchar (1)	0x0A01	0x0B01	0	1
Test signal connection enabling (0 – disabled)	TestEnabled	Uchar (1)	0x0A02	0x0B02	1	
“STOP” alarm test enabling (0 – disabled)	StopEnabled	Uchar (1)	0x0A03	0x0B03	1	
Generate synchronizing pulses (0 – generate)	PulseEnabled	Uchar (1)	0x0A04	0x0B04	0	
Measured parameter lower range	RangeParamMin	Float (4)	0x0A05	0x0B05	0	
Measured parameter higher range	RangeParamMax	Float (4)	0x0A09	0x0B09	4000	
Minimum measured rotor speed, rpm	FrequencyMin	Float (4)	0x0A0D	0x0B0D	2.5	
Pulse count per rotor revolution	Tooth	Uchar (1)	0x0A11	0x0B11	1	
Data display format (0-rpm; 1 – 1000rpm)	FormatOut	Uchar (1)	0x0A12	0x0B12	0	1
Set-points test enabling in “STOP” mode (0 – disabled)	TestPointStop	Uchar (1)	0x0A13	0x0B13	0	
Set-point overrun response time (measurement cycles)	TestPointTime	Uchar (1)	0x0A14	0x0B14	1	
Set-point 1 operating mode	TestPointMode_1	Uchar (1)	0x0A15	0x0B15	0	2
Set-point 2 operating mode	TestPointMode_2	Uchar (1)	0x0A16	0x0B16	0	2
Set-point 3 operating mode	TestPointMode_3	Uchar (1)	0x0A17	0x0B17	0	2
Set-point 1	TestPointData_1	Float (4)	0x0A18	0x0B18	0	
Set-point 2	TestPointData_2	Float (4)	0x0A1C	0x0B1C	0	
Set-point 3	TestPointData_3	Float (4)	0x0A20	0x0B20	0	
Set-point hysteresis	TestPointHist	Float (4)	0x0A24	0x0B24	0	

Notes:

1. Only for MK40-DC-11, MK40-AC-11-S design options.
2. All set-points are disabled, for parameters description, refer to Table 3.
3. Default value – value assigned to parameter after the module cold start.

Table 15. List of standard output control registers

Name	Label	Type (byte)	Address (Hex)		Default value	Note
			Channel 1	Channel 2		
DAC value for direct control of measuring channel standard output	AnalogDirectData	Uint (2)	0x500	0x502	0	

Notes:

1. Used in standard outputs calibration. DAC range from 0 to 4096.
2. Do not participate in channels normal operation.
3. Automatically resets to 0, if register value has not changed for 30 seconds.
4. Writable in any operating mode.

Table 16.List of system registers

Name	Label	Type (byte)	Address (Hex)	Default value	Notes
Logic alarm disabling time after module resetting	LogicOffStartUp	Uchar (1)	0x0E00	15	1, 3
Set-points test timeout after sensor function normalization	TestPointSenseOk	Uchar (1)	0x0E01	59	2, 3
“Measuring channel test” mode timeout.	TimeOut_TestMode	Uchar (1)	0x0E02	59	2, 3
“STOP” mode test timeout	TimeOut_TestStop	Uchar (1)	0x0E03	59	2, 3
Control modules measurement clock cycle	SynhroPulse	Uchar (1)	0x0E04	50	
Set-point test timeout after sensor function normalization	PeriodMeasur	Uchar (1)	0x0E05	4	4
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 for this option bit 7 – “Alarm” LED is enabled for this option	LogicMatrix	Uchar (24)	0x0E06	0	
Signal inversion at logic output	LogicOutMode	Uchar (6)	0x0E1F	0	4

Notes:

1. In case of data read error from volatile memory, always equal to 15 (8 seconds).
2. When value is equal to zero, function is OFF.
3. Time by 0. 5s.
4. Time by 0. 1s (0 = 0.01s).
5. This parameter does not cover logic output 6.
6. Default value – value assigned to parameter after the module cold start.

Communication interfaces

Table 17. List of RS485 interface registers

Name	Label	Type (byte)	Address (Hex)	Default value	Notes
Interface operation enabling: (not 0 – interface enabled)	Enabled	Uchar (1)	0x0F00	0	
Operating parameters change by commands and via RS485 interface: (not 0 –enabled)	ChangeData	Uchar (1)	0x0F01	0	
Single write operation: (not 0 –enabled)	OneWrite	Uchar (1)	0x0F02	0	
Unit address on RS485 bus (from 1 to 247)	Address	Uchar (1)	0x0F03	1	
Data rate, bit/s: 0 – 4800; 1 – 9600; 2 – 19200; 3 – 38400; 4 – 57600; 5 – 115200; 6 – 230400	Speed	Uchar (1)	0x0F04	0	

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

Table 18. List of CAN2.0B interface registers

Name	Label	Type (byte)	Address (Hex)	Default value	Notes
Interface operation enabling (not 0 – interface enabled)	Enabled	Uchar (1)	0x1000	0	
Data rate, bit/s: 0 – 1000; 1 – 500; 2 – 250; 3 – 200; 4 – 125; 5 – 100; 6 – 80; 7 - 40	Speed	Uchar (1)	0x1001	0	
Unit address on the bus	BasicAddress	Uint (2)	0x1002	0	
Message sending interval by 0. 5s	BasicTime	Uchar (1)	0x1004	0	
Data sending in channel 1 bit 0 – measurement results bit 1 – combined message bits 2-7 – reserved, must be equal to 0	BasicDataOut_1	Uchar (1)	0x1005	0	1
Data sending in channel 2 bit 0 – measurement results bits 1-7 – reserved, must be equal to 0	BasicDataOut_2	Uchar (1)	0x1006	0	

Notes:

1. Implemented in module software version 3.40 and newer.
2. Default value – value assigned to parameter after the module cold start.
3. CAN2.0B interface parameters come into effect only after the module re-initialization.

Table 19. List of CAN2.0B interface additional registers

Name	Label	Type (byte)	Address (Hex)	Default value	Notes
Extended functions enabling (not 0 – interface enabled)	EnabledAdd	Uchar (1)	0x1100	0	2
Module bus address for extended messages	AddressAdd	Uchar (1)	0x1101	0	
Enabling the module parameters change via CAN2.0B interface (not 0 – enabled)	ChangeEna	Uchar (1)	0x1102	0	
Single write command enabling (not 0 – enabled)	OnWriteEna	Uchar (1)	0x1103	0	
Message sending interval 0	PeriodSend_M0	Uchar (1)	0x1104	0	3
Message length 0	LenSend_M0	Uchar (1)	0x1105	0	4
Address in module message memory 0	AddressData_M0	Uint (2)	0x1106	0	5
Message sending interval 1	PeriodSend_M1	Uchar (1)	0x1108	0	3
Message length 1	LenSend_M1	Uchar (1)	0x1109	0	4
Address in module message memory 1	AddressData_M1	Uint (2)	0x110A	0	5

Notes:

1. CAN2.0B interface parameters come into effect only after the module re-initialization.
2. CAN2.0B interface operation must be enabled (register 0x1000).
3. Time by 0.1s (0 = 0.1s).
4. From 1 to 8. If message length is 0 or greater than 8, message is not sent.
5. If inquired address does not match address in MK40 Module.
6. Default value – value assigned to parameter after the module cold start.
7. CAN2.0B interface extended functions are provided on additional agreement.

Identification information

Table 20. List of module identification information registers

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

Note. Identification information is read-only, not initialized by cold start.

Table 21. List of module software identification information registers

Name	Label	Type (byte)	Address (Hex)	Default value	Notes
Microcontroller software version	Version	Char (6)	0x1300		
Microcontroller software release date	Date	Char (12)	0x1306		
Microcontroller software release time	Time	Char (10)	0x1312		

Note. Identification information is read-only

Measurement results

Table 22. List of measurement results registers

Name	Label	Type (byte)	Address (Hex)	Default value
Rotor speed, channel 1	Data	Float (4)	0x000	
Maximum rotor speed, channel 1	DataMax	Float (4)	0x004	
Channel 1 status flags	StatusCh	Uint (2)	0x008	
Channel 1 sensor DC current	Current	Float (4)	0x00A	1
Channel 1 ADC constant value (used for calibration0	AdcConst	Uint (2)	0x00E	
Rotor speed, channel 2	Data	Float (4)	0x010	
Maximum rotor speed, channel 2	DataMax	Float (4)	0x014	
Channel 2 status flags	StatusCh	Uint (2)	0x018	
Channel 2 sensor DC current	Current	Float (4)	0x01A	1
Channel 2 ADC constant value (used for calibration0	AdcConst	Uint (2)	0x01E	
Module system flags	StatusSys	UChar (1)	0x020	2
Additional system flags	StatusSysAdd	UChar (1)	0x021	
Logic outputs state bits 0-5 – 1-6 logic outputs state bits 6-13– reserved, equal to zero bit 14 – “War” LED state bit 15 – “Alarm” LED state	LogicOutStatus	Uint (2)	0x022	3

Notes:

1. For flags assignment, refer to Table 5.
2. For flags assignment, refer to Table 6.
3. During logic outputs disabling, logic outputs state after enabling can be determined.

Control commands

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 23. List of control registers

Register address (Hex)	Written value (Hex)	Action	Notes
0xFF00	0x55	Module resetting (the same as module switching on)	
0xFF01	0x61	Recalculate Channel 1 ratios	1, 3
	0x62	Recalculate Channel 2 ratios	1, 3
	0x93	Implement RS485 interface re-initialization	2, 3
	0x98	Implement CAN2.0B interface re-initialization	2, 3
0xFF02	0x33	Logic alarm disabling	
	0xCC	Logic alarm normal operation	
0xFF03	0x3C	Single write query	
0xFF04	0x10	Switch off test signal for both channels	
	0x11	Switch on test signal for channel 1	
	0x12	Switch on test signal for channel 2	
	0x50	Switch off “STOP” alarm test for channels 1, 2	
	0x51	Switch on “STOP” alarm test for channels 1	
	0x52	Switch on “STOP” alarm test for channels 2	
0xFF06		Writing of module operating parameters to volatile memory	3, 4
	0x81	Channel 1 calibration data	
	0x82	Channel 2 calibration data	
	0x85	Channel 1 basic parameters	
	0x86	Channel 2 basic parameters	
	0x89	Module system parameters	
	0x8A	RS485 interface parameters	
	0x8B	CAN2.0B interface parameters	
0xFF07	0x21	Writing of all module setting parameters to volatile memory	3

Notes:

1. Can be used after module calibration for measurements check without module resetting.
2. If command is received at the time of data transfer, data is transferred completely, and then re-initialization is implemented.
3. Logic alarm must be disabled.
4. Module resetting is not implemented after writing.
5. During writing, module operation is stopped. After writing, module resetting is implemented automatically.

Software

Dedicated software for MK40 Module operation 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 MK40 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.

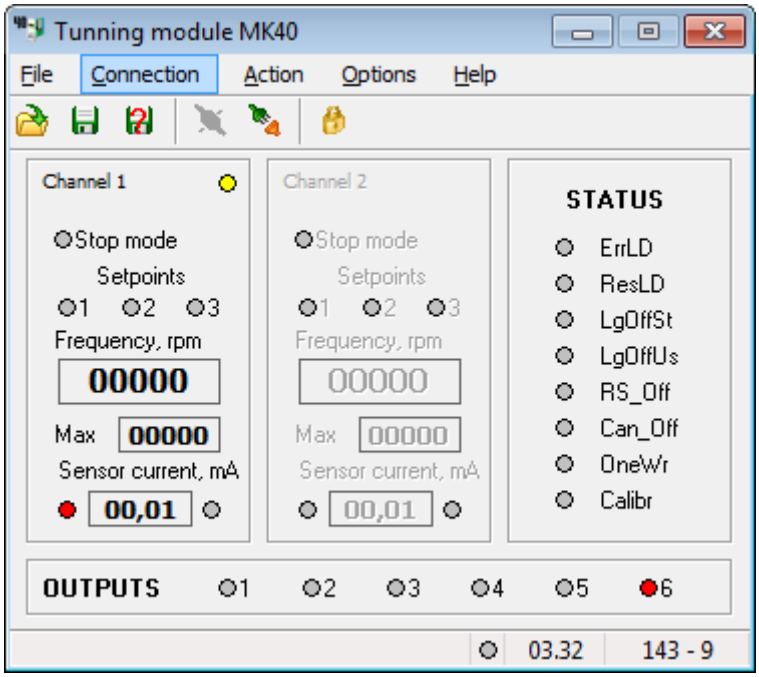


Figure 8. Program primary window

Getting started

In order to get started, connection to MK40 is required. For this purpose, COM-port must be selected, to which MK40 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*** command or press  push button. If connection is successful, ***Actions*** Menu is activated.

For reading settings from MK40, select ***Read module settings*** option. Current settings state can be saved to file on PC drive. Later on these files can be used as template files.

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

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

Measuring channels parameters

For measuring channels parameters setup, select ***Measuring channels*** option in ***Parameters*** Menu.

Parameters include the following sections:

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

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 MK40 is connected.

For writing of selected channel settings, select ***Write settings to module*** **options** in ***Actions*** Menu. This option is active when MK40 is connected and logic outputs are disabled.

Set-points operating mode

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

- Activate “Set-points test in “STOP” mode” flag;
- Set set-point values overrun time (discreteness – 0.5s);
- Set hysteresis;
- For each of 3 set-points, set:
    - Switch set-point on/off
    - Operating mode (H or B) selection by pressing relevant push button;
    - Set-point value.

Channel general parameters

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

- Enable/disable measuring channel;
- Set measuring channel operating mode (standard or voltage measurement), for 1st channel operating mode cannot be changed;
- Select “Enable measuring channels test” checkbox;
- Select “Enable “STOP” mode test” checkbox;
- Select “Generate synchronizing pulses” checkbox;
- Set parameter range (maximum and minimum parameter value);
- Set minimum measured rotor speed;
- Set pulse count per rotor revolution;
- Select parameter display format (only for MK40-DC-11, MK40-AC-S options):
    - Rotations per second.
    - 1000 rotations per second.

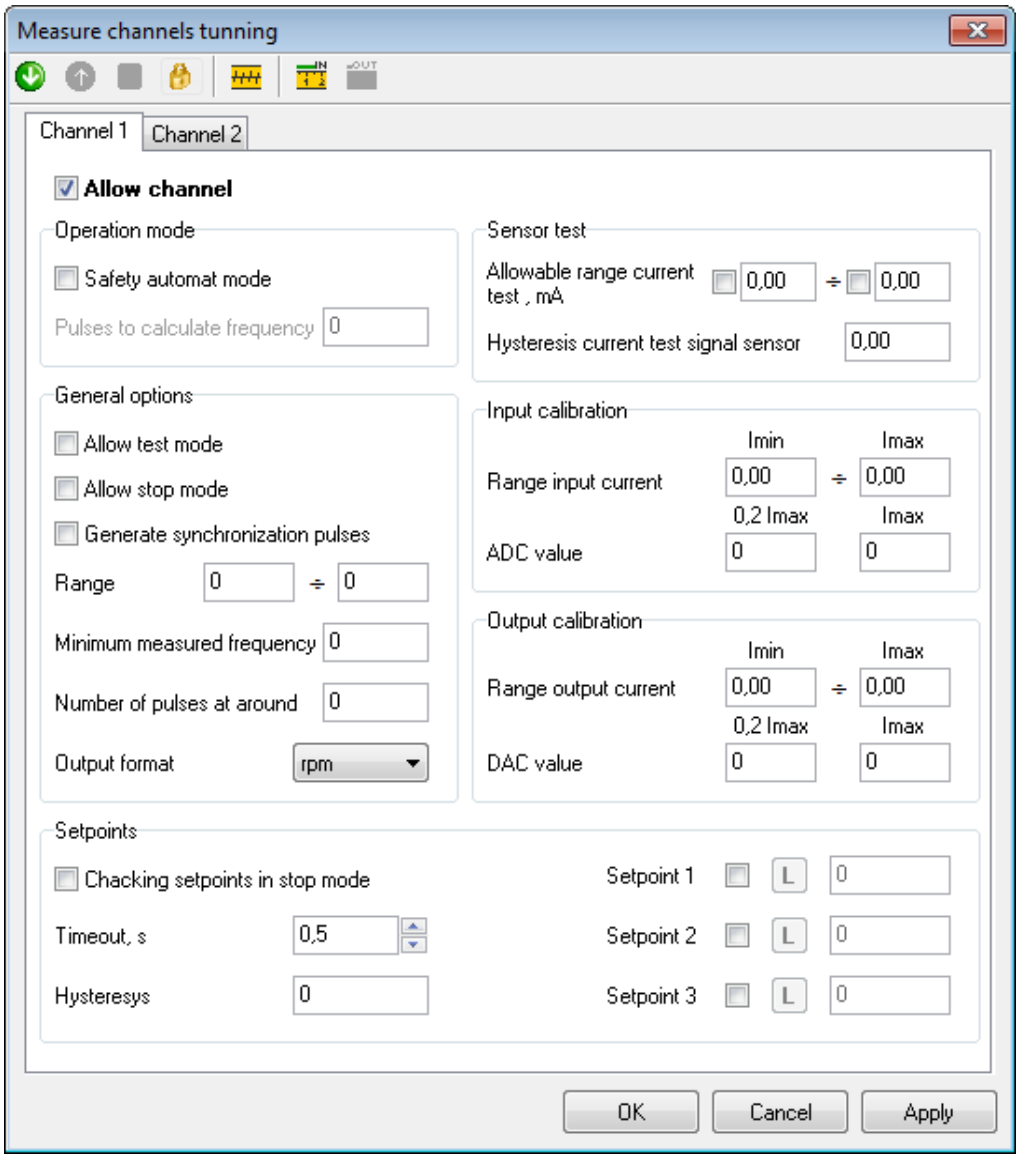


Figure 9. Measuring channels setup window

Calibration

Input and standard output calibration is carried out by means of calibration wizard. Calibration operations are accessible when MK40 Module is connected and logic outputs are disabled.

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

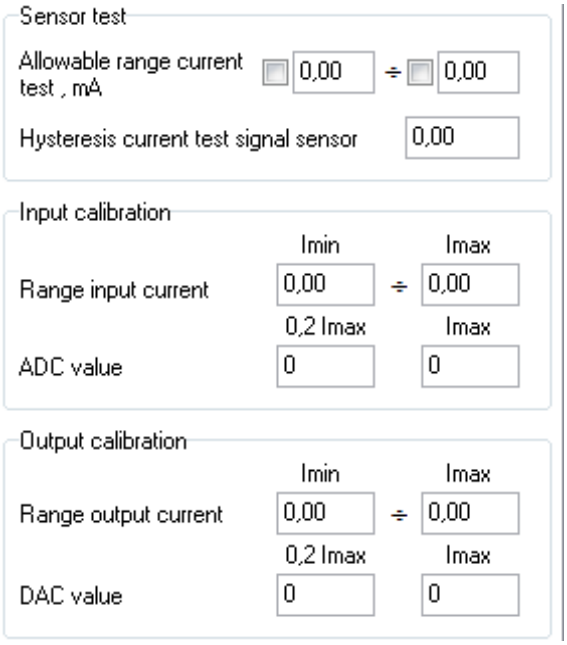


Figure 10. Measuring channel calibration parameters

For calibration parameters setup, act as follows:

- Enable/disable sensor current higher/lower range test;
- Set acceptable sensor current range;
- Set sensor current hysteresis.

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:

- Set input current range; calibration minimum calibration current is set automatically (0.2 I_{max});
- Minimum calibration current must be supplied at actual channel input;
- After setting ADC value, maximum range current must be supplied at the input;
- After pressing of ***Continue*** push button, acquired data is saved in actual channel setup window;
- For ratios recalculation in module, actual channel settings must be saved to MK40 Module and press ratios recalculation push button;

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

Standard output calibration

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

- Standard output current range must be set; calibration minimum calibration current is set automatically (0.2 I_{max});
- Milliammeter must be connected to measuring channel standard output;
- 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 MK40 Module);
  - actual value entry in input box and press ***Load to module*** push button;
- After setting minimum input current, DAC value must be selected for maximum calibration current;
- After pressing of ***Done*** push button, acquired data is saved in actual channel setup window;
- For ratios recalculation in module, actual channel settings must be loaded to MK40 Module and press ratios recalculation push button/

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.

Communication interfaces parameters

For measuring channels parameters setup, select ***Communication interfaces*** option in ***Parameters*** Menu.

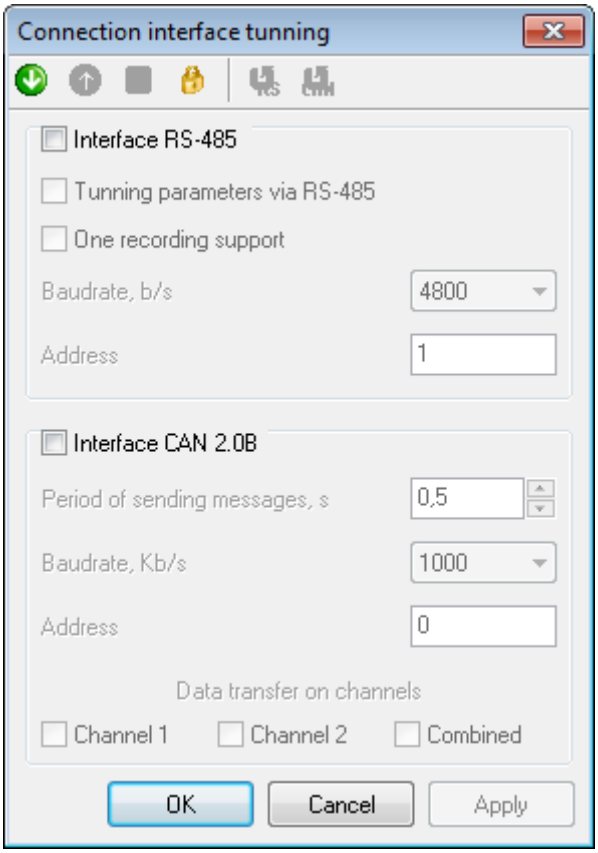


Figure 11. Communication interfaces setup window

For reading settings from the module, select ***Read interfaces settings from module*** option. This option is active when MK40 is connected.

For writing settings to the module, select ***Write interface settings to module*** option in shortcut menu. This option is active when MK40 is connected and logic outputs are disabled.

For saving RS485 and CAN2.0B interfaces settings, written to the module, to volatile memory, select relevant *Saving* ***settings to memory*** menu option. This option is active when MK40 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 MK40 is connected and logic outputs are disabled.

RS485 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 – 0.5s);
- Select one of possible interface data rates;
- Set module address on interface bus (acceptable address range 0÷255);
- Enable/disable data transfer in channels.

General parameters

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

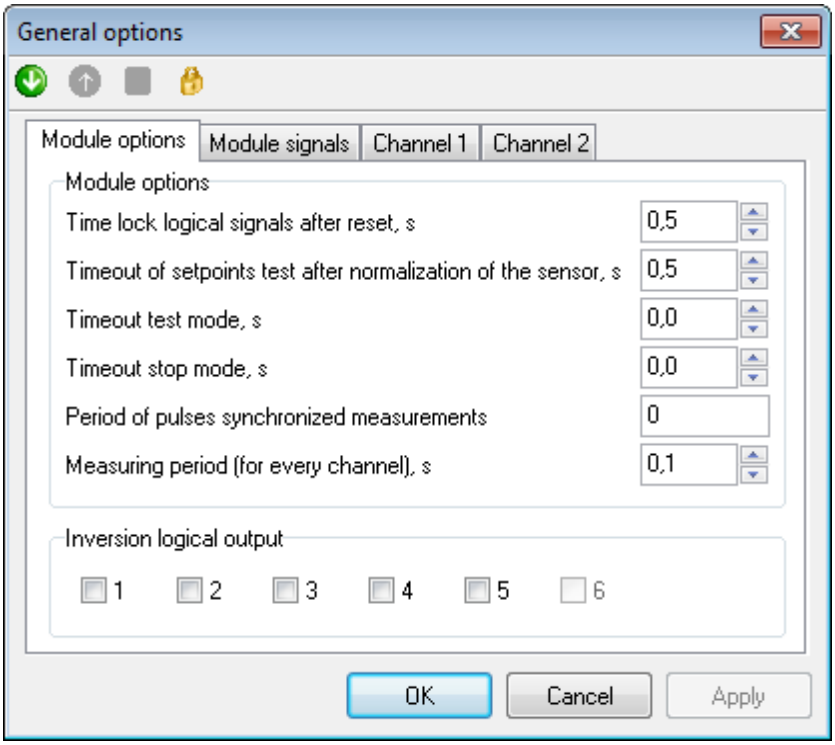


Figure 12. Module general parameters window

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 MK40 is connected.

For writing settings to the module, select ***Write settings to module*** option in shortcut menu. This option is active when MK40 is connected and logic outputs are disabled.

Measuring channels logic alarm

For measuring channels logic alarm setup, act as follows:

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

Module logic alarm

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

Module parameters

For module parameters setup, act as follows:

- Set logic alarm disabling period after resetting (discreteness – 0.5s);
- Set set-points disabling period after measuring channel normalization (discreteness – 0.5s);
- Set set-points test timeout after sensor resetting (discreteness – 0.5s);
- Set stop mode test timeout (discreteness – 0.5s);
- Set measurements clock cycle;
- Set measurements period for both channels (discreteness – 0.1s).

Logic outputs inversion

For each logic output (except for output 6) select, whether to implement signal inversion or not.

Program close-down

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

For parameters saving to MK10 volatile memory, select ***Save actual setting to memory*** command or press push button.

Selection of ***Parameters comparison*** command in ***Actions*** Menu is recommended to compare settings, saved to module memory and setting in PC setup software; test report on comparison results will be displayed.

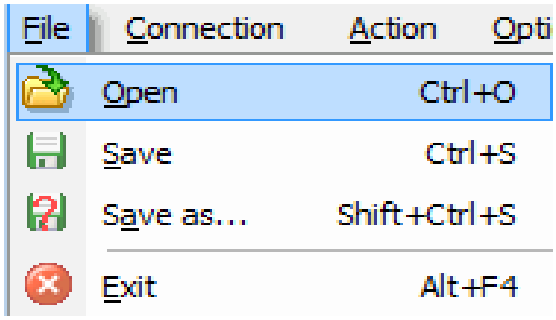
Next, select ***Disconnect*** command in ***Connection*** Menu or press push button.

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

Program menu description

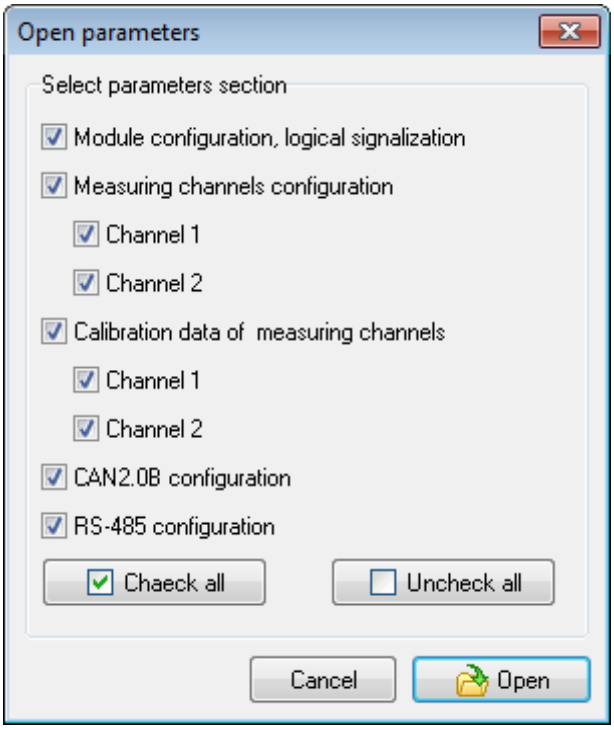
File Menu

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



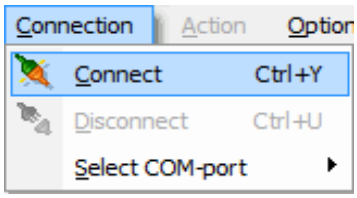
Command	Description
Open **[Ctrl+O]**	Open previously created file with settings. When this command is run, file opening dialog box opens, then selected file consistency is checked. In case of file error, relevant warning is issued.
Save **[Ctrl+S]**	Save changes, made to open file with settings
Save 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 MK40 current settings.
Exit **[Alt+F4]**	Exit program

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



Connection Menu

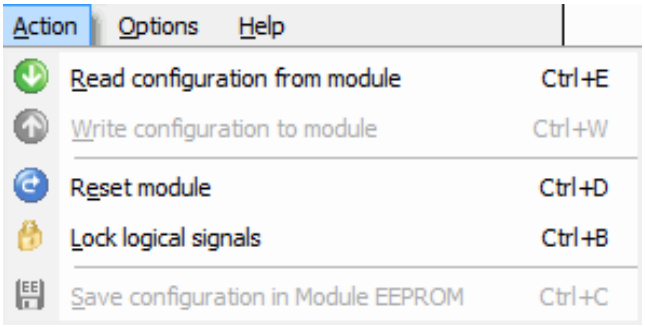
Connection Menu contains commands for working with COM-port.



Command	Description
Connect **[Ctrl+V]**	Create connection to MK40. *Actions* Menu is activated
Disconnect **[Ctrl+U]**	Break connection to MK40. *Actions* Menu is deactivated
Select Com-port	Assign COM-port for MK40 connection

Actions Menu

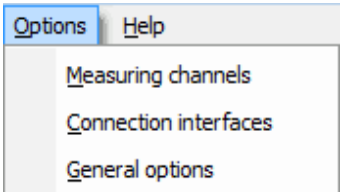
Actions Menu contains commands for working with MK40.



Command	Description
Read settings from module **[Ctrl+E]**	Read all settings from MK40. 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 MK40. 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 MK40. Query is being sent to confirm action. At resetting, communication with MK40 persists.
Logic outputs disabling **[Ctrl+B]**	Disable output logic signals. At disabling, menu options, such as ***Write settings to module***, ***Save current setting to memory*** etc., corresponding to writing to MK40 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 MK40 on settings saving to module volatile memory. At saving, communication with MK40 persists, and after saving, MK40 automat resetting is implemented.
Parameters comparison **[Shift+Ctrl+C]**	Comparison of module operating parameters in the module with operating parameters in the opened program.

Parameters Menu

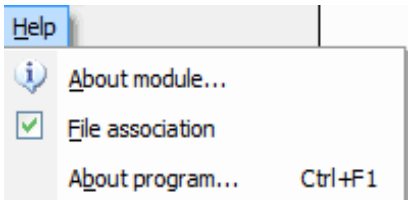
Parameters Menu contains parameters setting and MK40 calibration commands.



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 MK40 module and program help information



Command	Action
Work instructions **[F1]**	The instruction on operation with the program of adjustment of MK40 unit
File association	Association of files with .mk40 extension with the given program. If the tick is installed, the association is led.
About module	The software version information, unit number, year of release and so on
About program **[Ctrl+F1]**	The information on a title, the version, date of creation and authors of the program

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 “ЖЗ” 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 on MK40 Module board

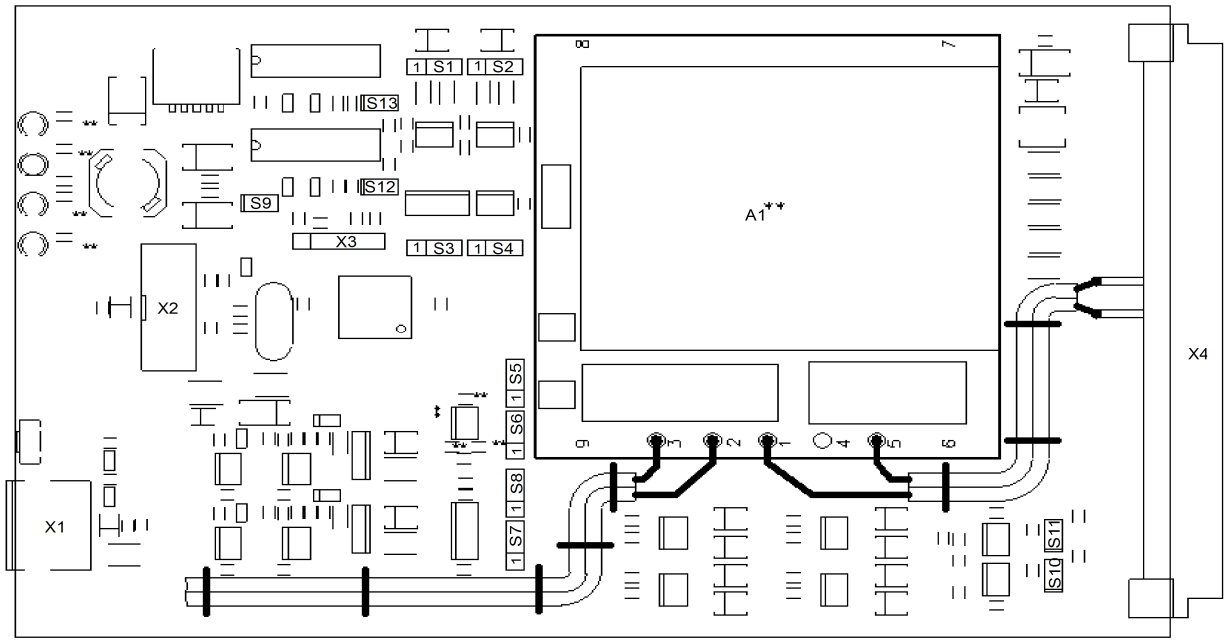


Figure 13. Elements arrangement on MK40 Module board

S1(S12), S2(S13) bridges – operating mode selection for measuring channels 1, 2 (respectively)

Position		Mode
S1 (S2)	**S12 (S13)**	
OFF	OFF	Operating mode by voltage 0…5V
1-2	OFF	Operating mode by current 1…5mA
2-3	OFF	Operating mode by current 4…20mA
OFF	ON	OK signal source (1KOhm +5V circuit adjusting resistor at channel output)

Note. Other bridge positions combination is not recommended.

S9 bridge – Channel 2 operating mode selection

Position	Mode
OFF	Standard operating mode
ON	+24V module supply voltage monitoring

Note. In supply voltage monitoring mode S13bridge must be OFF, S2 bridge must be in 1-2 position.

S3, S4 bridges –active front selection for measuring channels 1, 2 (respectively) tachometric pulses

Position	Mode
OFF	Not allowed, rotor speed measurement is not implemented
1-2	Falling edge
2-3	Leading edge

S7, S8 bridges – active front selection for MK40 Module measuring channels 1, 2 (respectively) repeated tachometric pulses

Position	Mode
OFF	Not allowed, rotor speed measurement is not implemented
1-2	Falling edge
2-3	Leading edge

Note. Given the existence of the outputs of the synchronization pull-up resistor

S6, S5 bridges – test signal source selection for measuring channels 1, 2 (respectively)

Position	Mode
OFF	Test signal is not connected
1-2	External test signal from X4 connector terminals
2-3	50Hz internal test signal (only for MK40-AC-11-S option)

S10, S11 bridges – 120 Ohm bus terminator of RS485 and CAN2.0B interfaces (respectively)

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

MK40 board connectors assignment

Position	Mode
X1	Diagnostic interface
X2	Display connection at the module front panel
X3	Microcontroller programming (service)
X4	Module main connector for section circuits connection

B. Connector terminals assignment

Table 24. MK40 Module X4 connector terminals assignment

Terminal number	Label	Assignment	Notes
A2, B1, C2 A32, B31, C32	GND	General	
A6, B5, C6	Power +24V	+24V supply voltage input/output	
B7	+24V sense CH1	+24V voltage output for measuring channel 1 convertor supply	1
B9	+24V sense CH2	+24V voltage output for measuring channel 2 convertor supply	1
C8	Input CH1	Measuring channel 1 input	
C10	Input CH2	Measuring channel 2 input	
B15	Analog out 1	Measuring channel 1 standard output	
A16	Analog out 2	Measuring channel 2 standard output	
A20, A22	Strob 1	Measuring channel 1 synchronizing pulses input	
A24, A26	Strob 2	Measuring channel 2 synchronizing pulses input	
B17	Test 1	Measuring channel 1 test pulse input	2
A18	Test 2	Measuring channel 2 test pulse input	2
B19	Logic out 1	Logic output 1	3
B21	Logic out 2	Logic output 2	3
B23	Logic out 3	Logic output 3	3
B25	Logic out 4	Logic output 4	3
C20, C22	Logic out 5	Logic output 5	3
C24, C26	Logic out 6	Logic output 6	3, 4
A12, B11, C12, C18	FG	Faraday grounding of AC/DC converter **Must be connected to cabinet ground.**	5
C14	L220V	Mains voltage AC 220V 50Hz	5
C16	N220V		5
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. +24V circuit is connected though 200mA self-healing fuse.
2. Test signal parameters must correspond to selected measuring channel input mode.
3. Operation logic is determined during module setup.
4. 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.
5. MK40-AC-11-S option only.
6. Terminals A4, A8, A10, A14, B3, B13, C4 are not in use and must be left unconnected for compatibility with succeeding versions of MK10.

C. Module labeling

Module labeling comprises:

- МК40 Module type and design option (DC, DC-11, DC-001, 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

МК40 DC-11	Module No. -	Mode	Assemble.	Adjust.	Order

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

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

Example of basic settings label on the module board.

Channel	1	2	3	4
Unit	rpm	rpm		
Range	0-6000	0-6000		
Set-point1				
Set-point2				
Set-point3				
RS485	Address 014	Rate 115200	Address 014	
CAN2.0B	Address	Rate	Address	

D. Module (Setup) Order Form example

MK40 Module (Setup) Order Form

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

1. Measuring channels parameters

Channel No.	Brief description	Sensor/ transducer	Parameter range	Set-points parameters			Additional parameters	
1.				1			Teeth	
				2			Set-point hysteresis	
				3			Standard output	
							Minimum rotor speed	
2.				1			Teeth	
				2			Set-point hysteresis	
				3			Standard output	
							Minimum rotor speed	

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

Channel No.	Logic formula	Channel No.	Logic formula	Channel No.	Logic formula
1.		3.		5.	
2.		4.		6.	
War		Alarm			

Operations : ‘()’ – group selection «OR» ‘+’ – operation “OR”
'!' – logical inversion

3. RS485, CAN interfaces parameters

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

4. Module additional parameters (values different from default values)

Parameter	Value	Parameter	Value	Parameter	Value

5. Bridges position on MK40 board (OFF, ON, 1-2, 3-4)

	Bridge	Position	Bridge	Position	Bridge	Position	Bridge	Position	Bridge	Bridge
Channel 1	**S1**		**S12**		**S3**		**S7**		**S6**	
Channel 2	**S2**		**S13**		**S4**		**S8**		**S5**	
Common	**S9**		**S10**		**S11**					

Prepared by _____ Date _____

List of Tables