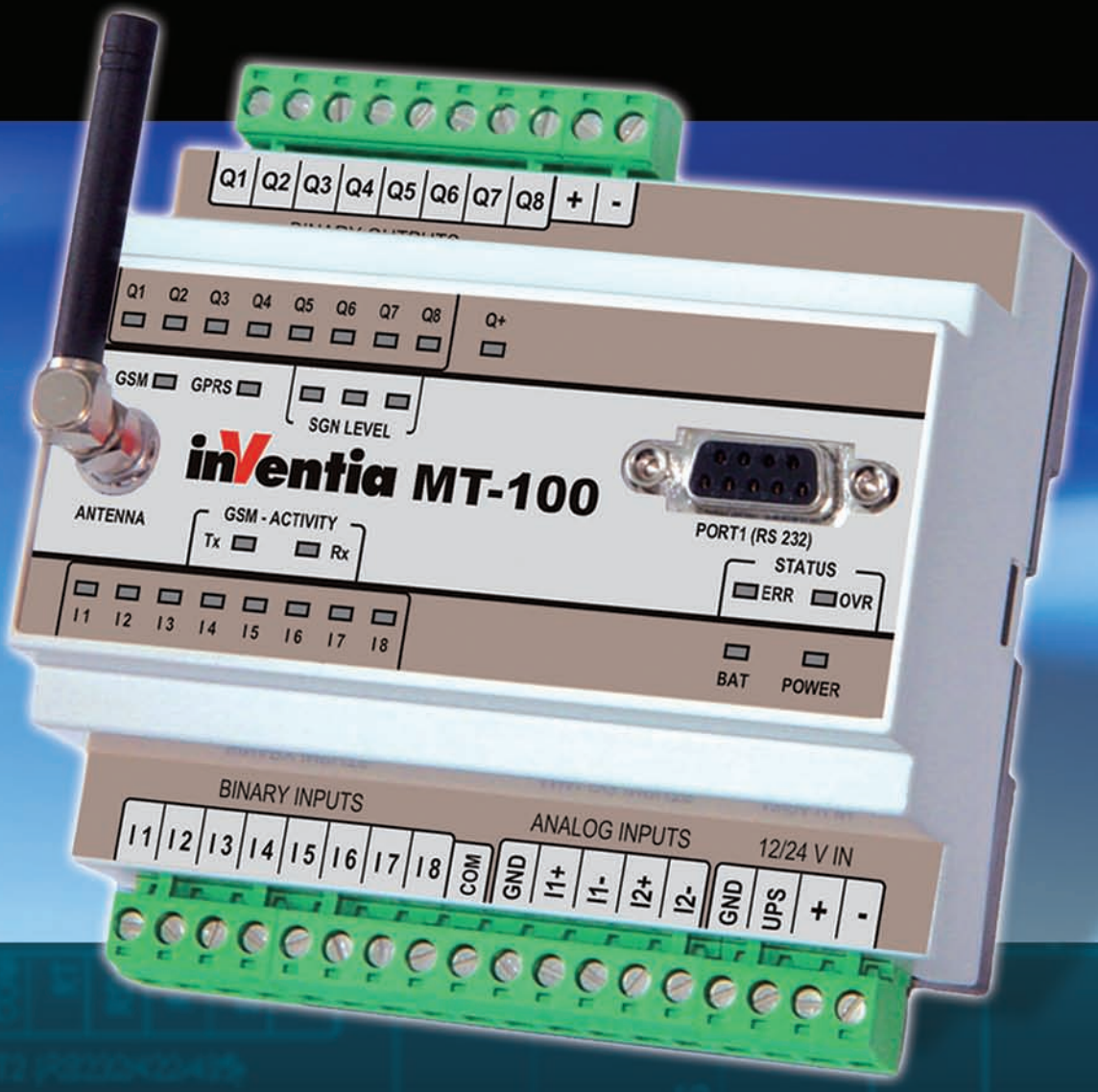
Telemetry Module MT-100

CE

User Manual



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Telemetry Module
MT-100
User Manual

GSM/GPRS Telemetry Module
for monitoring and control

Class 1 Telecommunications Terminal
Equipment for GSM 850/900/1800/1900

MT-100

INVENTIA Sp. z o.o

v1.48

MT-100

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1. Module destination

Telemetry Module MT-100 provides unmatched price to possibilities ratio. It provides the same, known for high quality and reliability input/output resources as MT-101 - binary inputs. The difference is that MT-100 does not have buttons used for manual setting of additional fifth alarm level on analog inputs. It is also equipped with one configuration/communication (Modbus RTU slave) RS-232 port. It provides possibility of creating local autonomous system thanks to PLC functionality. Program limited to 100 lines is enough to create simple control and alarm algorithms.
MT-100 connectors and I/Os position are compatible with MT-101 allowing easy upgrade of created control and monitoring system.

MT-100 allows building modern, wireless alarm systems, monitoring, measurement, diagnosis and control based on GPRS data packet transmission and/or SMS text messaging technologies.
An important feature of MT-100 module is ability to transmit data not only by querying, but also when user defined event occurs (e.g. when logical state of binary input/output changes or value measured by analog input changes significantly). The module is equipped with event recorder with a resolution of 100ms which can be used for data logging. The module is fully configurable and programmable by intuitive, user-friendly software environment MTManager. Both program and configuration can be written locally via the serial port or remotely via GPRS network.

Basic features of MT-100 module:
- compact design
- rich set of integral I/O
- local measurements logging
- possibility of implementation user-written programs (up to 100 lines of code)
- possibility of sending unsolicited messages on user-defined events

We encourage getting acquainted with the modules' configuration and modes of operation along with examples of application in different configurations described in appendices.

2. GSM requirements

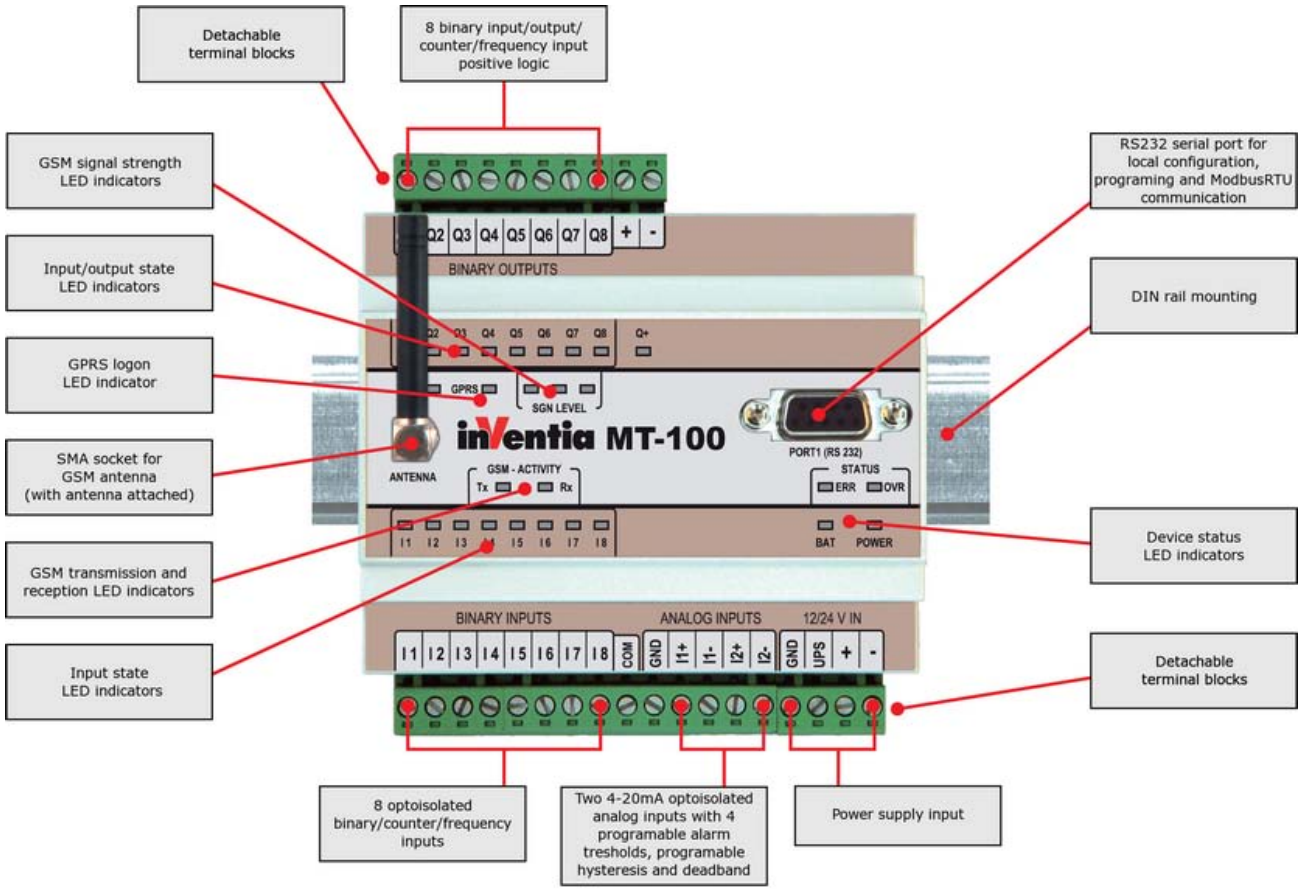
For proper operation, the module needs a SIM card supplied by a GSM operator providing GPRS and/or SMS services.

The GPRS/enabled SIM card has to be registered in the APN with static IP addressing. The unique IP address of the SIM card is identification for the module within the APN. This enables module-to-module and module-to-server communication within the APN structure.

A good and strong GSM signal in the place where the module antenna is located is imperative for the proper function of the module. Using the module in places where the signal is weak may lead to interruptions in transmission and possible loss of transmitted data along with increased costs generated by transmission retries.

3. Module design

3.1. Topography



3.2. Resources

MT-100 module resources

DI - binary inputs	8 (max.16)	working as: • binary input • counter input • analog input F/U
DO - binary outputs	8	working as: • binary output • binary input • counter input • analog input F/U
C - counters	0 (max.16)	each input and output can work as a counter input
AI - analog inputs	2 (+ 16)	• 4 - 20 mA • as analog F/U created of binary inputs and outputs
Serial **PORT 1**	1	standard RS232 - configuration and Modbus RTU Slave (ID1, 9600, 8N1, hardware handshake [CTS/RTS])

3.2.1. Binary inputs

The **MT-100** telemetry Module is equipped with 8 dedicated binary inputs marked as **I1 – I8**. The inputs support both positive and negative logic.

Additionally, up to 8 binary inputs are available if binary outputs, **Q1 – Q8**, are configured to work in the binary input mode. For design-related reasons, those inputs work exclusively in positive logic.

The change of the input signal sets the alarm flag, connected with the corresponding binary input **I1 – I8, Q1 – Q8**, respectively as *BiIn0->1*, *BiIn1->0* and *Bi In Chg .* The flags may be used in rules processing.

Each of the binary inputs, **I1 – I8, Q1 – Q8,** may be configured independently also to work in the counter or analog mode. The use of binary inputs in these additional modes will be presented further in respective sections of this manual.

3.2.2. Analg inputs

The **MT-100** Telemetry Module is equipped with two 4-20 mA analog inputs marked as **AN1** and **AN2**. The inputs are isolated both from each other and from the rest of the device, enabling the easy connectivity of the signal sources with different ground potentials.

Additionally, users may create up to 16 analog inputs by reconfiguring binary inputs **I1-I8** and binary outputs **Q1-Q8** to work in quasi/analog mode. After reconfiguration, all inputs work in input signal frequency-to-analog conversion, so for proper operation, one has to connect analog signal source via analog-to-frequency converter which outputs a square wave of frequency proportional to analog signal. Input signal conversion range is **0-2kHz**.

During configuration of analog inputs, the user can set engineering units and precisely rescale the input signal. The alarm levels and the time of input signal integration are also configurable. The possibility to configure as much as four - and in the case of the **AN1** and **AN2** inputs five - alarm levels guarantees supervision flexibility of monitoring of analog signals.

Analog inputs have two parameters defined. They are Hysteresis and Deadband. The value of hysteresis defines insensitivity of device for signal variations near threshold values preventing excessive generation of events. The range of hysteresis allows generating event only when the signal on the input changes by defined value. Hysteresis is set for all selected analog input alarm thresholds.

Flags *AnLoLo*, *AnLo*, *AnHi*, *AnHiHi*, *An DB* set by analog signal changes may be employed for rules processing.

3.2.3. Binary outputs

MT-100 Telemetry module is equipped with 8 dedicated binary outputs marked **Q1....Q8**. The state of outputs is set by writing desired value into a binary outputs memory register. This record may be performed either remotely via GPRS or locally as the execution of a user-defined program.

For each binary output, the state of forcing signal is compared with actual output state signal. Upon detection of discrepancy, the *BiOutErr* Flag is raised and may be used for rules processing.

As stated before for Binary inputs, any binary output may be individually configured to work either as binary input, counter input or quasi-analog input.
That makes the hardware universal in application.

3.2.4. Serial port

MT-100 Telemetry Module is equipped with one serial port **PORT1**.

PORT1 works only in **RS232** mode and is used for local configuration of parameters. In order to perform local configuration, connect this port to a PC-class computer with running MTM program. Operating parameters of this port are not modifiable and the length of the connecting cable should not exceed 3 m. **This port is not isolated!**

PORT1 can also be used as Modbus RTU Slave port without need of changing modules configuration. Transmission parameters are:
- speed of 9600bps,
- 8 data bits,
- no parity,
- 1 stop bit,
- hardware handshake (RTS/CTS).

This port is ideal for connecting external graphical or text panel supporting Modbus RTU Master.

NOTICE!
The first configuration has to be performed locally, via PORT1 in order to provide the module with basic GPRS communication parameters like PIN code and APN name.

3.2.5. Real time clock

MT-100 Module is equipped with astronomical time clock (**RTC**).

The clock is a base for defining working cycles of module, timers and time stamps for measurement results recorded in registers. Imprecise clock setting results in faulty time stamping and subsequent loss of vital information. For that reason, it is recommended to set the clock to UTC time instead of the local time zone of the module placement.

CAUTION!
The module RTC clock does not automatically adjust to summer/winter time. To avoid loss of data during manual time adjustment, UTC time is recommended .

CAUTION!
The RTC clock is powered from an internal battery, and as long as it is operational there is no need to reset the time after power-off. Since the clock precision is not absolute, periodical time adjustment may be necessary.

Setting the time is described in configuring mode documentation for the **MTM** program.

3.3. Internal resources

3.3.1. Registers

MT-100 Telemetry module has in its internal resources 16 bit input registers and 16 bit internal registers. Remote access to these areas is possible using standard Modbus commands.

Internal Registers are not reset at power off.
Input Registers are reset at power on.

Module 16 bit registers store unsigned values in range 0-65535. In order to increase the range of stored values, pairs of 16 bit registers were reserved to create 32 bit registers storing signed values for use in user/defined internal program.

3.3.2. Virtual registers

MT-100 Telemetry module feature 16 bit Virtual Registers. They reflect input (VREG_BIx) and output (VREG_BOx) bit spaces. Using virtual registers gives easy access to bit groups and copying data between bit spaces and registers. Access to registers is possible through module's internal program using standard programming functions described in the chapter Programming.

3.3.3. Clocks

MT-100 Telemetry Module is equipped with 4 programmatic clocks divided in two groups with different functionalities.
2 programmable **Asynchronous clocks** TMR1, TMR2, enable cyclical time measuring for up to 100 days (8 640 000 s) and 2 programmable **Synchronous clocks** TMR3, TMR4, enable cyclical time measuring from 1 min to 24 h with synchronization with module z RTC clock.

Properly configured clock counts the time setting after each completed period, for one program cycle, a flag in binary inputs space (respective *TMR1, TMR2, TMR3, TMR4*). These flags can be used in internal controlling program or for triggering transmission on event.

3.3.4. Counters

Each of **MT-100** module inputs/outputs is capable of counting pulses and storing the value in 32 bit counter with capacity of 2 147 483 647 (31 bits + counting direction bit) events. The counter can count „up” or „down”, and the range can be freely defined in range of 1 to 2 147 483 647.

Counting "up" means that the counter value is increased by 1 for each detected pulse and after reaching the value set as "counter length-1" is reset to "0". Counting "down" diminishes the counter value by 1 for each detected pulse and after reaching the value set as "counter length-1" is reset to "0" to resume the value of defined maximum.

Crossing the value of counter length sets *Counter* alarm flag for respective input. The flag can be used in the internal controlling program or for triggering transmission on event.

3.3.5. Logger

MT-100 Telemetry Module is equipped with internal **Recorder**, storing state changes on binary inputs/outputs and on analog inputs. The Recorder has a volume of 140 data records. New records are written to memory after change of state on binary inputs/outputs or at crossing of dead band defined for analog inputs. Records are stamped with time stamp from module internal real time clock (RTC). It is recommended to set module RTC compliant to UTC for preserving data integrity.

Data written in the recorder is transmitted accordingly to configured options to defined IP address. Confirmation of reception removes records from the recorder.

NOTICE!
The recorder function is available only in GPRS mode.

3.3.6. MT2MT buffer

MT2MT buffer enables creation of system where MT-100/101/102/202 modules may exchange information (Internal Registers) with each other without any relaying instance.
Data transmission from one module to another goes like this:

1. In sending module the event/triggered sending of the buffer has to be defined.
2. In receiving module switch the **MT2MT** buffer on and define its placement and size so that it encompasses the area of sent registers.
3. Upon reception of event-triggered data frame, registers from event-reporting module are copied into receiving module's registers and MT2MT_x bit informing about modification of MT2MT buffer with data from respective IP is set. (Bit number reflects the index of IP address in GPRS/Authorized numbers in configuration). MT2MT_x bits are set for 1 program cycle immediately after reception and recording it in MT2MT buffer.
4. Data transmission in this system copies registers of sending module into the exact same register in receiving module. When designing communication between larger numbers of modules, separate register areas have to be sent and appropriately large areas define for **MT2MT receiving buffer** in receiving modules**.**

3.3.7. Constant parameters

In **MT-100** module max. 128 constant parameters that are loaded into module memory during initialization of the module can be defined.
These constants are stored in 16 bit registers and have numerical values ranging from 0 – 65535.
Constant parameters may be used for parameterization of user programs.

Defined parameters are preserved after power loss or module reset.

3.3.8. System variables

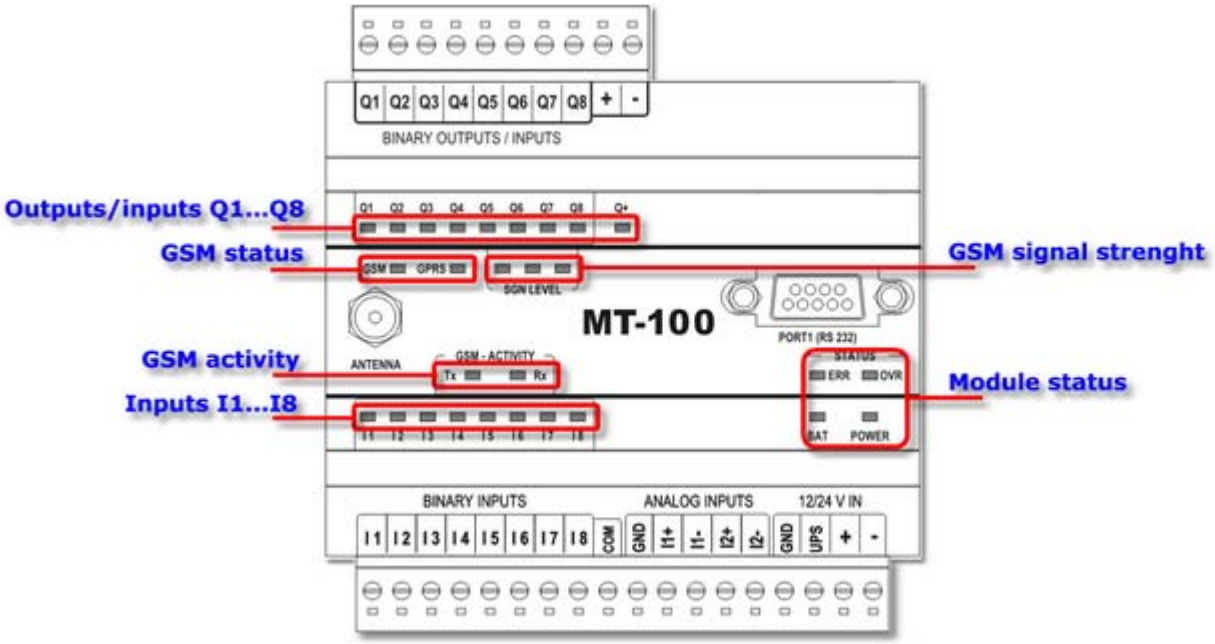
MT-100 has system variables connected to GSM/GPRS connection state and power supply. Variables state is reflected by flags that can be used as transmission triggers or in internal control programs.

FS1_ups = 1 - loss of potential at module UPS pin
FS1_q+ = 1 - loss of power supply for binary outputs Q1..Q8
FS1_gprs = 1 - informs upon log off from GPRS network

Full list of system variables is placed in Memory map chapter in Appendices.

3.4. LED diodes

LED indicators placed on **MT-100** front panel are convenient during module start up phase.



Detailed description of signaling patterns is placed in chapter LED signaling

3.5. SIM card

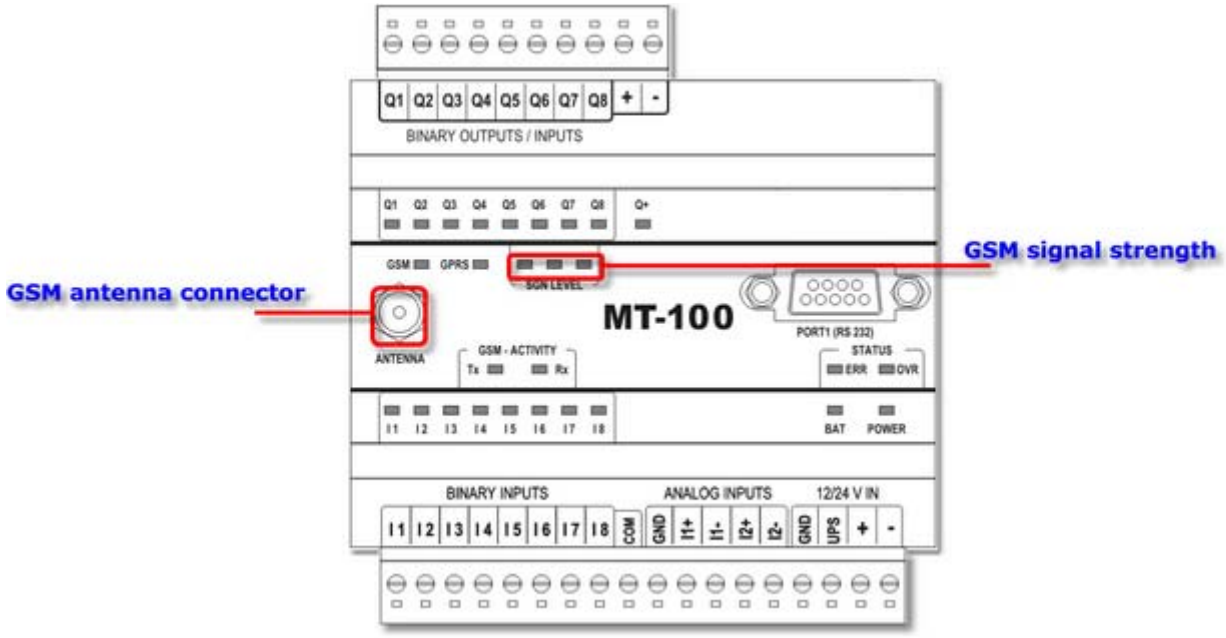
MT-100 telemetry module is equipped with standard miniature SIM card holder for connecting card to GSM modem.

If use of GPRS transmission is intended the SIM card should have GPRS option and possibility of login to APN for assigning static IP addresses activated. In absence of static IP address, use of the module for GPRS transmission is impaired.

Proper placement of the SIM card is imperative for module operation. The module accepts only SIM cards operating in low potential technology 3,3V.

3.6. Antenna

Attachment of antenna is essential for proper operation of MT-100 telemetry module. SMA socket is placed on module front panel. The attached antenna has to secure appropriate radio signal level enabling login to GSM network.
The type and placement of antenna has significant influence on module sender/receiver circuits. GSM signal level is reflected by **SGN LEVEL LEDs** on module front panel . When GSM signal level is not sufficient for reliable operation LED is not lit. In that case the use of a directional antenna should be considered.



3.7. Power supply

MT-100 may be powered by 9…30 V (DC).

NOTICE!
Exceeding the range of power supply may cause faulty operation or damage the module!

The module may work with auxiliary battery supply securing operation for some time after main supply failure. In order to discriminate whether the module is powered from battery or from main supply the module has a binary input marked **UPS**, where the signal informing that main supply has failed. Main supply voltage drop below 10,8 V raises the *FS1_ups* system flag. The flag may be used for rules processing. The input may be used to signal main supply failure and switch over to battery supply.

3.8. Housing

MT-100 module is encapsulated in standard housing made of plastic compliant with safety requirements and protecting the module in standard operating environment.
The applied solution complies with standard industrial requirements for DIN rail mounting.

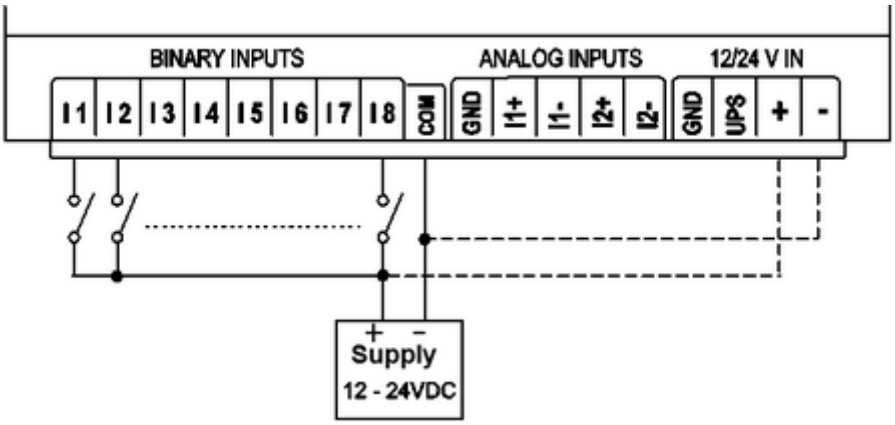
3.9. Connections scheme

This chapter shows standard configurations of connections securing proper operation of MT-100 module integral inputs in all available operating modes.

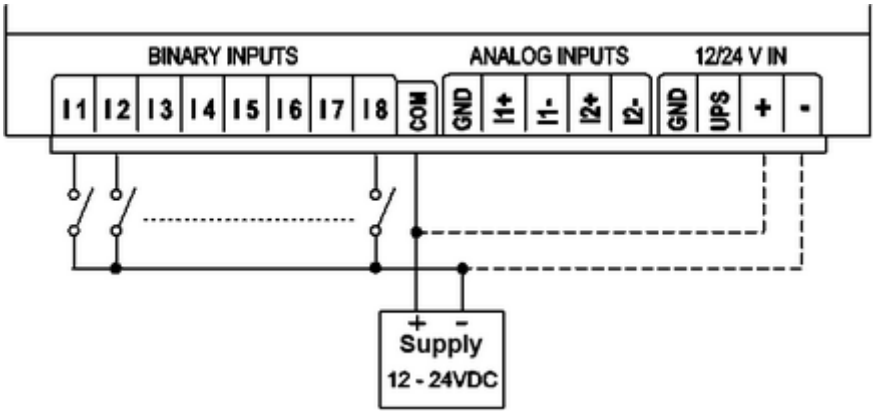
3.9.1. Binary inputs I1....I8

Integral binary inputs marked as **I1....I8** may work in both positive and negative logic making circuit design very easy.

Binary inputs **I1....I8** – in positive logic:



Binary inputs **I1....I8** – in negative logic:

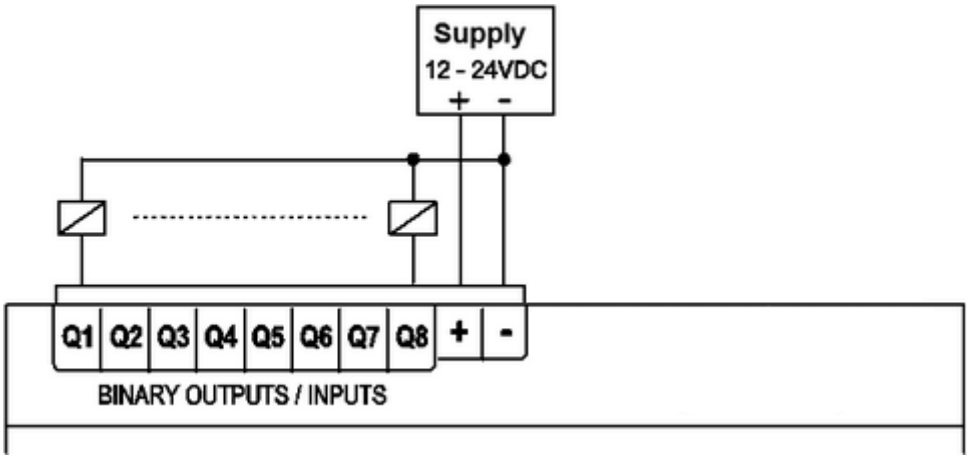


Each of binary inputs I1....I8 may operate as a counter input or analog input with frequency conversion to analog value. The change of input operating mode is done during configuration.

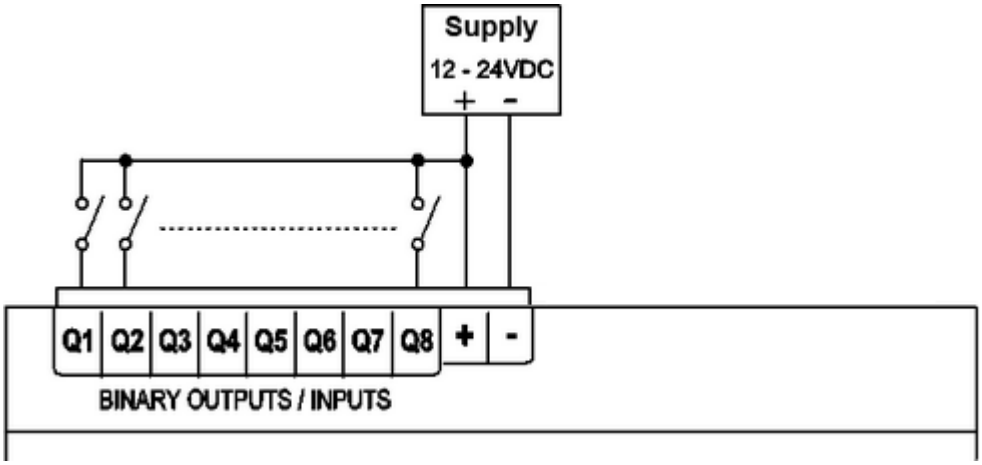
Typical connection for counting input is identical to standard input connection for both negative and positive logic. The only difference lies in counting of pulses appearing on the input and storing the result in a 32 bit register assigned to this input.
Binary input operating in analog mode has slightly different connection. It is assumed that the signal is a square wave with variable frequency in range 0....2kHz, where momentary frequency corresponds to measured analog value. The wave usually comes from a converter exchanging measured analog value to proportional frequency in defined range.

3.9.2. Binary inputs / outputs Q1....Q8

Integral outputs **Q1....Q8** may operate, depending on selected mode as inputs or outputs, In both cases only positive logic applies.
Binary outputs **Q1....Q8** – in positive logic:



Binary inputs **Q1....Q8** – in positive logic:



Any of binary outputs Q1....Q8 may operate as counter input or analog input with frequency conversion to analog value. The change of input operating mode is done during configuration.

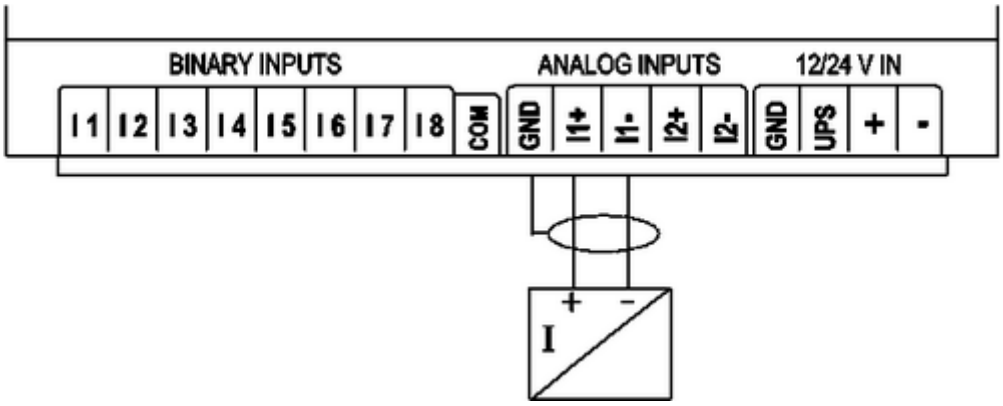
Typical connection for counting input is identical to standard input connection for positive logic. The only difference lies in counting of pulses appearing on the input and storing the result in a 32 bit register assigned to this input.

Binary input operating in analog mode has a slightly different connection. It is assumed that the signal is a square wave with variable frequency in range 0....2kHz, where momentary frequency corresponds to measured analog value. The wave comes usually from a converter that exchanges measured analog value to proportional frequency in defined range.

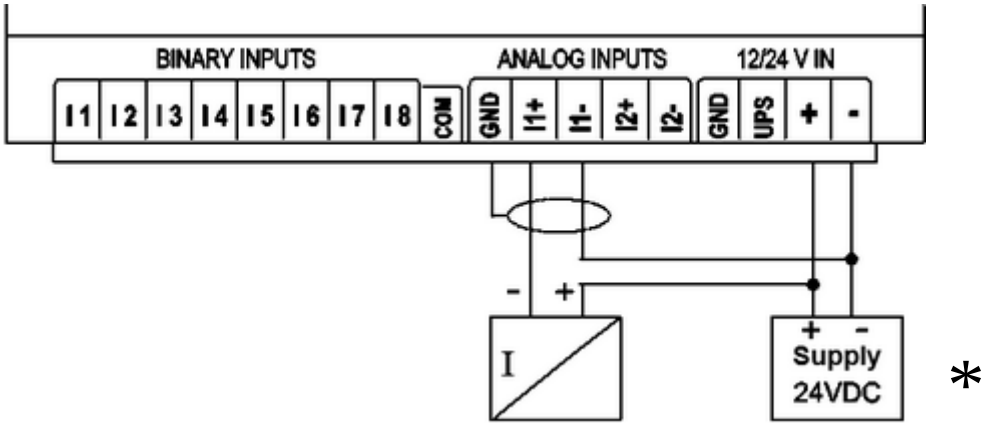
3.9.3. Analog inputs A1, A2

Integral analog inputs **A1**, **A2** cooperate with active as well as passive converters (sensors)

Analog inputs **A1**, **A2** – connection with active output converter



Analog inputs **A1**, **A2** – connection with passive output converter



* in noisy environment, use independent supply for input-output circuits is recommended.

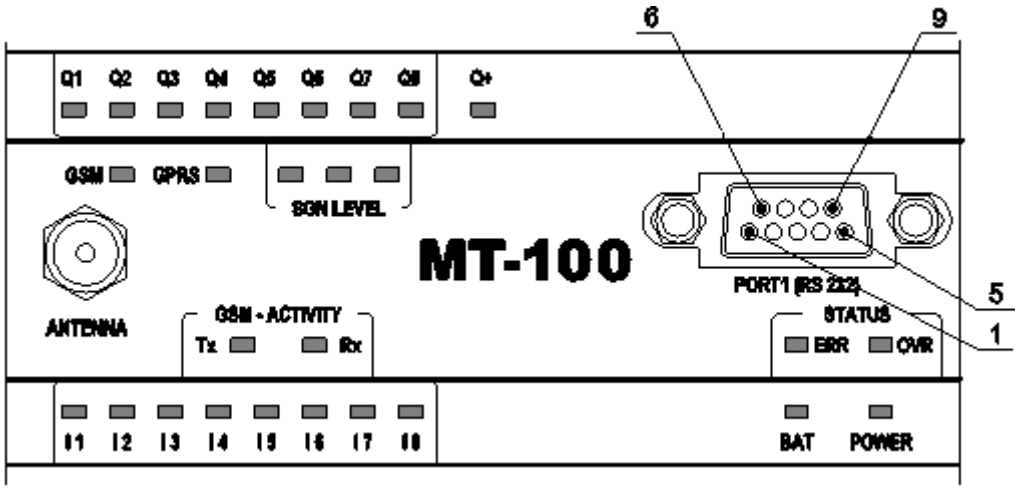
3.9.4. Communication ports

Telemetry module is equipped with 2 communication ports for different applications. They are :

PORT 1 (RS232 – configuration, Modbus RTU Slave [ID1])
- The not optically-isolated Port is used for configuration
- Connection point to point to PC via RS-232

DB-9 connector (female)

Pin	description
1 -	
2 – TXD	transmitter output
3 – RXD	receiver input
4 -	
5 – GND	ground
6 -	
7 – CTS	handshake input
8 – RTS	handshake output
9 -	



NOTICE!

- Supply cables length < 10 m
- Signal cables length < 30 m
- For longer cables it is recommended to use external overvoltage protection.

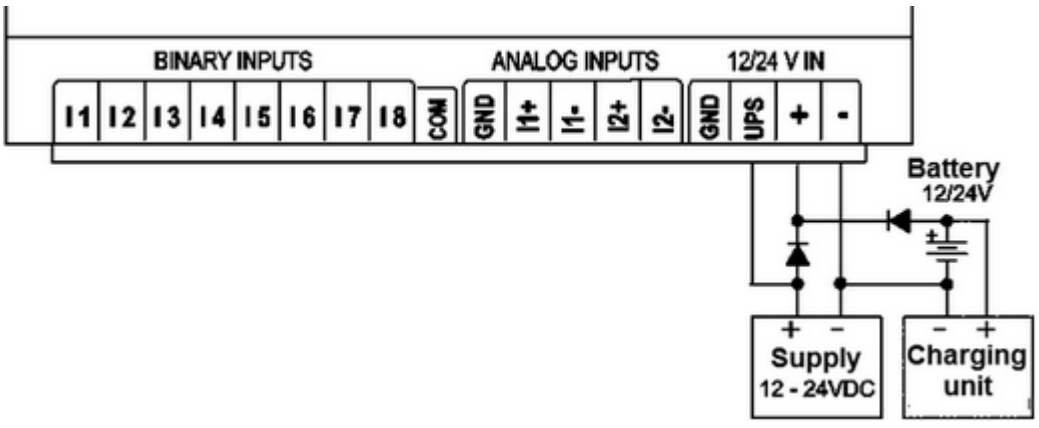
3.9.5. Power supply

The power supply is connected to „+" and „-" terminals (preserving polarization only when supplying direct current).

Pin	Description
GND	Module's ground *
UPS	Input – power supply state signaling. Active state for voltage > 10,8V When not employed , shortcut with +.
+	Positive pole of power supply**
-	Negative pole of power supply**
* - Not recommended in standard appliances since it may increase emitted noise. ** - For AC supply polarization does not apply.	

Example:

Connection diagram with backup battery



NOTICE!
Due to MT-100 module's high momentary current consumption the supply must be capable of delivering >= 2A current.
Improper power supply may result in faulty operation and damage the module!

4. Starting the module

Starting **MT-10** module requires few basic activities.

Recommended sequence:

1. GSM antenna attachment.

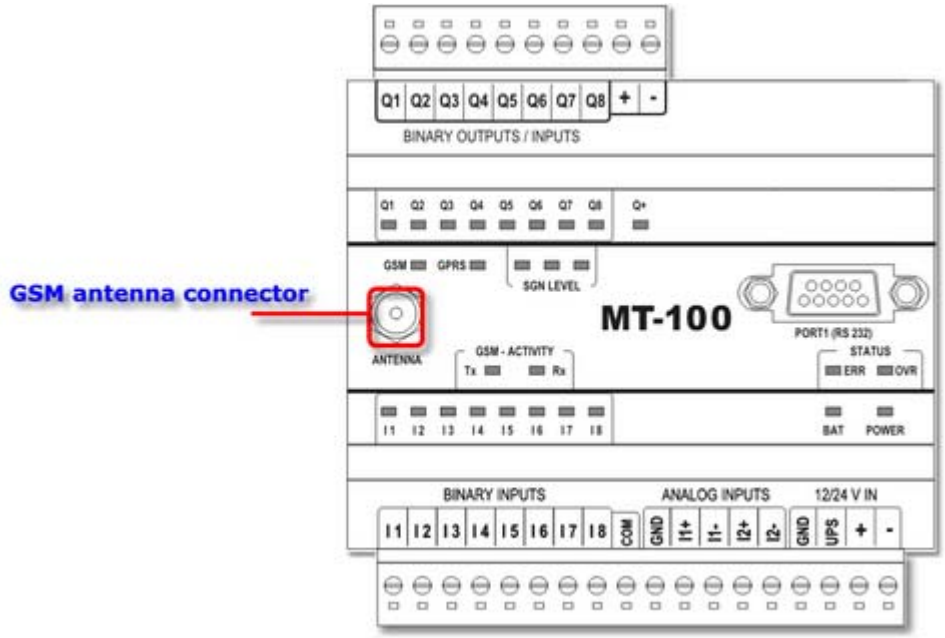
NOTICE!
The antenna has to be attached at every power up since it is a necessary transmitter load.
The module exchanges information with available GSM networks in order to test availability of performing emergency calls (112) even without SIM card

2. Configuration of basic operating parameters
3. Insertion of SIM card
4. Restart of the module

4.1. Connecting antenna

Connecting external GSM antenna is an essential condition for proper module operation. The type of antenna depends on the desired mounting type and power of GSM signal in antenna placement area. As previously mentioned, the antenna has to be attached at every power up because it is a necessary transmitter load and absence endangers the module's transmitter part. Even with no SIM inserted, the module exchanges information with available GSM networks in order to secure possibility of sending emergency calls (112).

The antenna is connected to **MT-100** module via SMA connector placed on the front panel of device.



The choice of antenna type depends on GSM signal propagation at place where the module is installed. In most cases, a standard small size antenna is sufficient. Where GSM signal is weak using multi-segment directional antenna may be necessary.

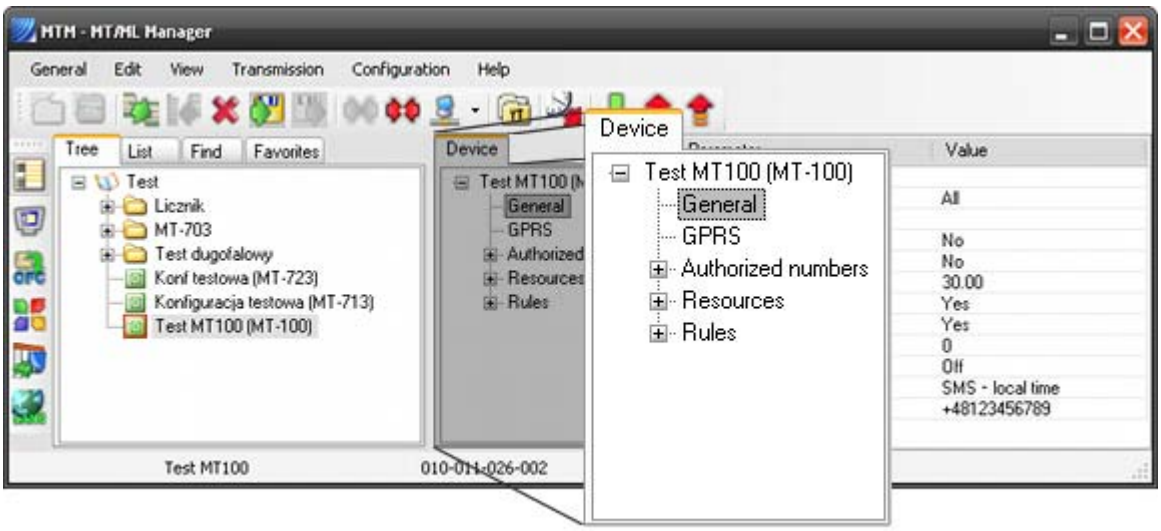
4.2. First configuration

First configuration of **MT-100** is necessary for setting up basic parameters making logging to GSM network possible and, optionally, servicing GPRS.

NOTICE!
Since a new module or a module configured for other circumstances may not have necessary data for proper login to GSM network, it is necessary to perform the first configuration in local mode by serial RS232 cable connected to Port 1

To configure the module, connect it via RS232 cable to a computer running **MTManager.** Comprehensive information about installation, use and attachment of **MTM** program to configured modules can be found in **MTM User Manual.**

Logging into GSM/GPRS network requires basic information about the SIM card in use and optionally about the APN that the module is going to operate within when GPRS mode is turned on.
The parameters are:



In **General** group:

PIN code for SIM card
insert PIN code of the SIM card intended for the module, unless the card is configured not to ask for PIN code.

Use of GPRS
Yes - if SMS and GPRS packet transmission is intended
No - if the module is to work in SMS mode only.

In **GPRS** group - visible if *Use of GPRS* is set to ***Yes***:

APN name
insert name of APN, in which GPRS transmission is to take place.

APN user name
insert user name (if required by Network Operator)

APN login password
insert password (if required by Network Operator)

NOTICE!
Upon each writing of new configuration into MT-100, the module performs full RESET

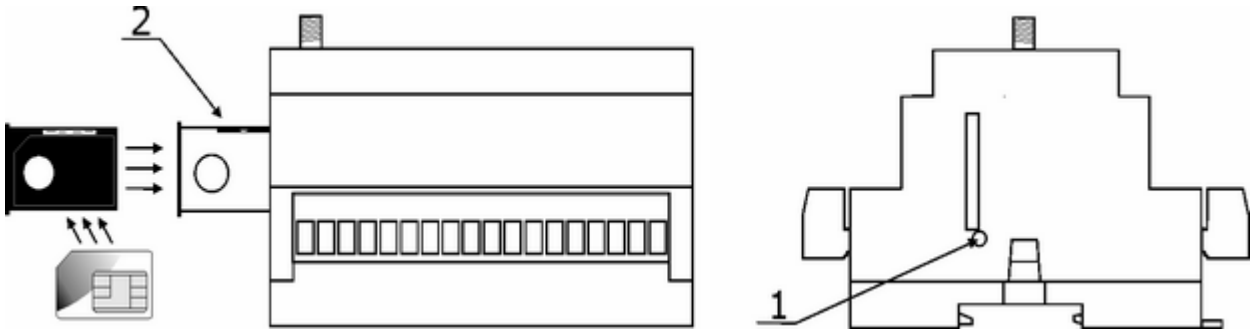
These parameters are all that is needed to be able to log in GSM/GPRS network. One has to remember that modules with basic configuration cannot send any information. Therefore, after verifying that module logs in to GPRS network, one has to perform full configuration of module parameters enabling all full intended functionality of the module.

4.3. Inserting SIM card

One of the fundamental conditions for proper operation of the module is inserting a **SIM** card enabling module to send SMS and/or packet data in GPRS network.

The best way to do it is when the power supply disconnected. Theoretically the SIM card may be inserted into the module before the first configuration is performed, but note that two attempts of entering wrong PIN code the cause module to stop attempting to log into network. Should this happen, the module has to be unlocked.

Insert **SIM** card in cradle and slide it into the slot as depicted below until the gentle click is heard.



Properly inserted **SIM** cards secure reliable connection with module's terminals.

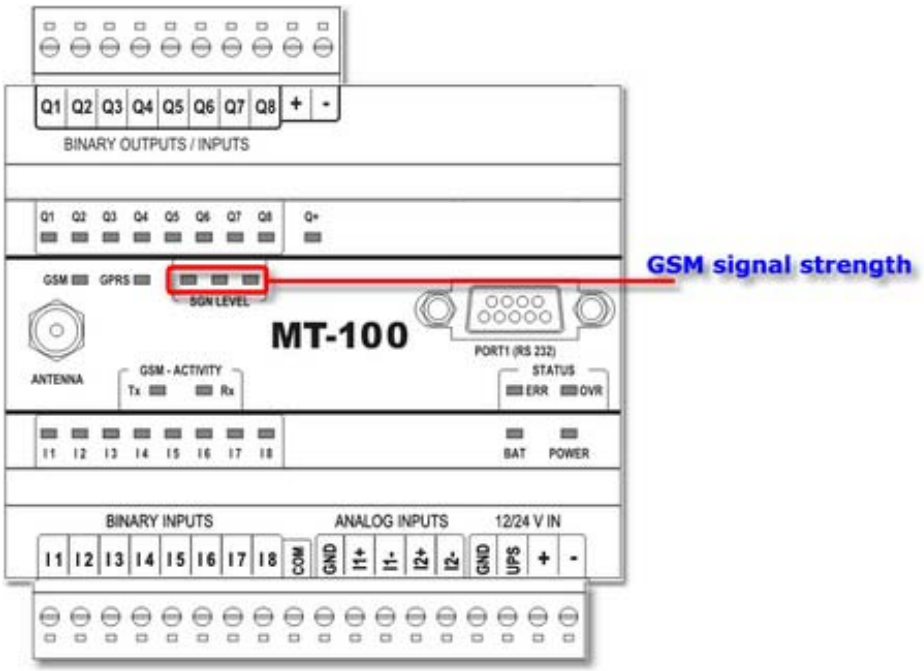
4.4. Start up

After performing the first configuration and inserting SIM card, proceed to start up. Switch the power supply off and on again to reset the module.

NOTICE!
If the SIM card was inserted to the module during first configuration resetting the module is unnecessary as every writing of new configuration forces RESET of the module.

Well/configured MT-100 module logs into GPRS network within 20 -30 seconds. The login sequence is displayed by diagnostic LEDs at the front panel of the module. Explanation of sequence is described in details in LED signaling chapter.

In case of difficulties when logging into GPRS, verify configured parameters and pay attention to LEDs indicating GSM signal level.



To weak GSM signal may render log-in impossible.

5. Configuration

5.1. General informations

The configuration of MT-100 module, as is the case for other modules in the MT series, is carried out using the MTM (MT Manager) program portal, delivered free of charge to users of our telemetry solutions.

The portal is a specialized environment providing full control of the entire telemetry system regardless of the system's size. The possibility of dividing hardware resources into Projects and Folders facilitates efficient management of very complex telemetry systems.
After adding a new module to the environment and selecting it, all module parameters are available for editing. Detailed description of functions and their applications are to be found in MTM user manual.

NOTICE!
Availability of different functions and parameters depends on module's firmware version and the settings of parameters they may be dependent on.

5.2. Parameter groups

For clarity and ease of use, the operating parameters of MT-100 module are divided into logically or functionally connected groups in the following order:

Header group - contains unmodifiable parameters describing the module, its firmware and configuration

General group - contains basic parameters defining module's operating mode

GPRS group - contains necessary parameters to log in to GPRS network and defines parameters vital for transmission reliability

Authorized numbers group - contains lists of phone numbers and IP addresses of other terminals authorized for communication with configured module.

Resources group - defines parameters for hardware and software resources related to reading and processing measurement data.

Rules group - contains lists of transmission tasks to be carried out upon occurrence of activating criteria

5.2.1. Header

Header of parameter structure describes **MT-100** telemetry module. It holds basic information unique to the module, the configuration contained by module and configuration file version. Information displayed is not user editable and solely used for verification and information purpose.

5.2.1.1. Module name

Function	-	displays name assigned to module during configuration
Data type	-	text

Range - n/a, read-only parameter
Comments - n/a

5.2.1.2. Module type

Function - displays the type of configured telemetry module
Data type - text
Range - n/a, read-only parameter
Comments - n/a

5.2.1.3. Module serial number

Function - displays serial number configured telemetry module
Data type - text
Range - n/a, Read-only parameter
Comments - this field displays module serial number assigned during manufacturing. This number is static and unique identifier of the unit.

5.2.1.4. Modem firmware version

Function - displays modem firmware version
Data type - text
Range - n/a, Read-only parameter
Comments - n/a

5.2.1.5. IMEI number

Function - displays GSM modem's IMEI number
Data type - text
Range - n/a, read-only parameter
Comments - n/a

5.2.1.6. Internal program version

Function - displays the identification of actual version of internal telemetry module program (firmware)
Data type - text
Range - n/a, read-only parameter
Comments - the value of this field changes automatically after download of firmware

5.2.1.7. Configuration file version

Function	-	displays version identification of configuration file used for actual configuration
Data type	-	text
Range	-	n/a, Read-only parameter
Comments	-	value depends on module's firmware version. Auxiliary extension character defines the sub-version

5.2.1.8. Configuration identifier

Function	-	displays identification of current configuration
Data type	-	hexadecimal
Range	-	n/a, read-only parameter
Comments	-	the value of this parameter increases automatically by 1 after each successfully stored configuration.

5.2.1.9. Last configuration date

Function	-	displays time and date of last successful configuration change
Data type	-	text
Range	-	n/a, read-only parameter
Comments	-	the value changes automatically with successful configuration change. Useful in tracing unauthorized configuration changes.

5.2.1.10. Last reading time

Function	-	displays internal module time recorded during last configuration reading or during last time setting
Data type	-	text
Range	-	compliant with Date and Time format
Comments	-	this field is useful in verifying last access time and checking internal module clock settings (RTC)

5.2.2. General

Contains data necessary for successful login to GSM network and parameters defining module operating mode.
Note: values set here have impact on module's behavior and in worst case, when chosen improperly may even lock the module.

NOTICE!
Availability of parameters described in following chapters depends on firmware version and the superior parameters they depend on.

5.2.2.1. SIM card PIN number

Function	-	defines PIN access code for SIM module delivered by GSM operator. For SIM modules not protected by PIN code, the value is insignificant.
Data type	-	text
Range	-	letters and numerals, max 8 characters
Default value	-	n/a
Comments	-	wrong pin can cause locking of SIM module

CAUTION!
Caution is vital when setting the PIN code value. Entering faulty PIN code may cause module start-up to be impossible and lock SIM card. In latest versions of the module, attempting to enter wrong PIN code twice renders a third attempt impossible.

Procedure in case of blocked module as the result of the wrong PIN value

5.2.2.2. Access to configuration

Function	-	defines configuration access restrictions. The user can decide whether access to configuration will be allowed for all or only selected IP addresses.
Data type	-	selection list
Range	-	*All* Unrestricted access for any IP address within the APN *List* Access limited to addresses defined in the list of *Authorized numbers, IP* for addresses with *Configuration* option set to *Allowed*.
Default value	-	*All*
Comments	-	Note that access restriction configuration applies only to GPRS connection and when used improperly may block remote access for users that should have the right to configure the module.

5.2.2.3. Configuration password

Function	-	defines the password protecting access to configuration of the module. The password will be required for both local and remote access, thus protecting against unauthorized configuration alterations. The password does not protect against reading current configuration or the module status.
Data type	-	text string
Range	-	letters and numerals, max. 32 characters
Default value	-	n/a
Comments	-	since the only way of unlocking the module is resetting it to factory settings, it is vital that the password is stored in a safe way and available when needed.

5.2.2.4. Configuration read disable

Function - blocks reading of module configuration even when using valid password

Data type - selection list

Range - *Yes*
Reading of configuration from the module is impossible.
No
Module is not protected against reading of configuration

Default value - *No*

Comments - This parameter does not influence writing a new full configuration but prevents writing changes if configuration identifiers in the module and in MTM application do not match

5.2.2.5. Data write protection

Function - blocks writing of data into internal module registers, protecting data significant to proper operation of module.

Data type - selection list

Range - *Yes*
Data writing is possible when password is provided
No
Data writing to internal registers not protected.

Default value - *No*

Comments - This parameter protects the module against accidental or intended intrusion into internal resources without preventing users authorized by password to make changes.

5.2.2.6. Data write protection password

Function - defines password for Data write protection parameter

Data type - text field

Range - letters and numerals, max. 32 characters

Default value - n/a

Comments - when Data write protection parameter is active, writing to module is possible only after providing valid password. The procedure to be followed in this case is to be found in chapter Appendices - Unblocking writing to internal registers

5.2.2.7. Error display time

Function - Defines (in seconds) error display time on Status GSM and SGN LEVEL and on ERR LED groups

Data type - number

Range - 1....60 [s]

Default value - 30 [s]

Comments - setting of too small value makes error code identification difficult while too long value extends the restart time after error code display

5.2.2.8. Use of GPRS

Function - defines means of communication for the module

Data type - selection list

Range - *Yes*

The Module works in GPRS mode. Upon power-up module tries to log in to select APN. This mode requires SIM cards with enabled GPRS access.

No

The Module works in GSM mode. The only way of remote communication is SMS messaging. In this mode, pre-paid type SIM cards with no GPRS work without problems.

Default value - *Yes*

Comments - n/a

5.2.2.9. Use of SMS

Function - defines working sub-mode of module operating in GPRS

Data type - selection list

Range - *Yes*

Module operating in GPRS mode has SMS services active. As a result, the GPRS session is suspended every 12 min. and the module checks for incoming text messages. Event triggered SMS transmission is instantaneous.

No

Module operates in GPRS mode and SMS services are inactive.

Default value - *Yes*

Comments - This parameter is available only in GPRS mode. Setting this parameter to *No* may result in filling the SIM card with received messages that are not processed by internal logic.

5.2.2.10. Monthly SMS limit

Function - Defines maximum amount of SMS messages module may send during 1 month in order to prevent uncontrolled number of sent messages thus saving on running expenses. Setting the parameter to *0* removes the limit.

Data type - number

Range - 0 ... 65.535

Default value - 0

Comments - This parameter is available in no GPRS and in GPRS mode with *Yes* option for use SMS chosen.

CAUTION!
Reaching the limit set by this parameter results in unconditional (without warning) stop of SMS sending. Note that no SMS will be sent until the month is up even in alarm situations!

5.2.2.11. Roaming

Function - defines whether roaming in foreign GSM network is allowed

Data type - selection list

Range - *On*
in case of absence of home network, the module will attempt to login to available operator network.
Off
login to foreign networks is not allowed

Default value - *Off*

Comments - This parameter decides whether the Module will try to login to available foreign network in the absence of home network. This is possible only when the SIM card in module has roaming service enabled.

5.2.2.12. Time synchronization

Function - defines automatic time synchronization method used by device

Data type - selection list

Range - *None*
Automatic time synchronization is disabled. However you still can used manual time synchronization using MTManager (both locally and via GPRS) or time synchronization tools delivered with MTDataProvider
SMS - local time
Module synchronizes RTC clock with local time using SMS transmission.
SMS - UTC time
Module synchronizes RTC clock with UTC time using SMS transmission.

Default value - *None*

Comments - Time synchronization uses time provided by GSM provider.
If SMS synchronization is used device sends one SMS to itself (requires entering correctly Module phone number parameter) every Sunday at 3:30AM.

5.2.2.13. Module phone number parameter

Function - enables entering of telephone number of SIM card inserted into device used during time synchronization via SMS.

Data type - phone number field

Range - 0-23 digits

Default value -

Comments - This parameter is visible only if Time synchronization parameter is different from *None*.

5.2.3. GPRS

GPRS Group encompasses parameters connected to login and data transmission in GPRS system. Some parameters defined within this group are mandatory for establishing GPRS connection. Optional parameters are convenient for transmission optimization.

5.2.3.1. APN name

Function	-	defines APN name selected for GPRS transmission
Data type	-	text
Range	-	letters, numerals, special characters - max. 32 characters
Default value	-	empty
Comments	-	absence of APN name disables login to GPRS network

5.2.3.2. APN user name

Function	-	defines APN user name
Data type	-	text
Range	-	letters, numerals, special characters - max. 32 characters
Default value	-	empty
Comments	-	Optional parameter used only if required by GSM network operator

5.2.3.3. APN password

Function	-	defines password for APN user account
Data type	-	text
Range	-	letters, numerals, special characters - max. 32 characters
Default value	-	empty
Comments	-	Optional parameter used only if required by GSM network operator

5.2.3.4. Module IP

Function	-	allows user to define IP number for newly created module definition and displays IP number read from the module configuration that was assigned to the module during last login to GPRS network
Data type	-	IP number field
Range	-	0.0.0.0 - 255.255.255.255
Default value	-	0.0.0.0
Comments	-	if the number is not read in nor written manually after local configuration, remote configuration of the module via GPRS will not be possible.

5.2.3.5. IP assignment

Function	-	selects IP address assignment mode during login to GPRS network procedure
Data type	-	selection list

Range - *DHCP*
IP address is assigned by GSM network according to operator policy. It may be static or dynamic address.
Manual
IP address is assigned by GSM network to the value set in Force IP field by user. This mode is applicable only when operator policy allows forcing IP address by the user.

Default value - *DHCP*

Comments - *Manual* mode is allowed only in few GSM networks

5.2.3.6. Force IP

Function - enables manual entering of IP when parameter IP assignment is set to *Manual*

Data type - IP number field

Range - 0.0.0.0 - 255.255.255.255

Default value - 0.0.0.0

Comments - forcing of IP address mode assigned by operator is serviced only in few GSM networks

5.2.3.7. Virtual static IP address

Function - defines IP address that will be placed in internal data header of frames sent by the module.

Data type - IP number field

Range - 0.0.0.0 - 255.255.255.255

Default value - 0.0.0.0

Comments - Parameter mandatory in case of operating MT-100 module in GSM networks where operator uses dynamic address translation of internal addresses to static external addresses visible to external users. The parameter enables placing the external IP address under which the internal network node is visible in the header for sent data frame. As a result, external recipients will experience match of sender's IP with IP address written in data header. It is necessary due to double authentication of received data employed by MTDataProvider (MTDP).

5.2.3.8. GPRS transmission retries number

Function - defines number of retries of GPRS transmission in case of not receiving confirmation in time defined by Transmission timeout parameter

Data type - number

Range - 0....255
Setting this parameter to 0 results in sending data without waiting for confirmation of error-free reception.

Default value - 3

Comments - In normal conditions, it is not recommended to set this value to higher than 3. This effectively secures against loss of transmitted data without hampering processing following rules. Note that consecutive data will be sent after successful conclusion of current transmission.

5.2.3.9. Transmission timeout

Function	-	Defines waiting time (in seconds) for confirmation of reception of sent data frame.
Data type	-	number
Range	-	0....655 [s]
Default value	-	12 [s]
Comments	-	This value in connection with declared Number of GPRS transmission retries defines max. time of one data packet transmission, described by formula: *MaxT* = (*number* of *GPRS transmission retries* +1)*transmission *Timeout* For default values: MaxT = (3 + 1) * 12 = 48s. Please notice that calculated value does not define the time of delivery but the time to elapse before the module considers that transmission to appointed IP address is not possible (the data will be lost due to unavailability of recipient) and moves to sending next data frame awaiting transmission.

5.2.3.10. Idle time

Function	-	Defines the interval (in seconds) for sending data frame (ping) controlling the ability to communicate with the network in case of transmission inactivity
Data type	-	number
Range	-	0....86400 [s] (24h)
Default value	-	240 [s]
Comments	-	in case of inactivity longer than the value defined in this parameter the module sends a control frame in order to check whether transmission is still possible. During network check, control data frame is sent to module's own IP address, respecting timeout and number of retries parameters. The length of the frame is 45B+length of the module's name. The frame is sent to module's own IP address or to the address defined in parameter GPRS testing IP address, if different than 0.0.0.0. In „Proxy” mode, the frame is sent to Proxy server IP address. No reply to sent frame after exercising defined timeout and number of retries is considered as transmission failure and sets triggering input FS1_gprs 0--> 1, which can be used for Rules processing (SMS sending). As a consequence, after elapsing of time defined in Wait time after disconnection, the module performs RESET and commences GSM/GPRS login sequence. Reduction of this parameter increases the frequency of testing GPRS network state. This shortens possible disruptions of control due to network failures but increases "unproductive" data transmission.

5.2.3.11. GPRS testing IP

Function	-	sets IP address where data frames testing GPRS network state are sent.
Data type	-	IP address field
Range	-	0.0.0.0 - 255.255.255.255
Default value	-	0.0.0.0

Comments - This parameter sets recipient's address for data frames testing GPRS transmission channel sent after defined Idle time elapses.
Leaving recipient address at *0.0.0.0* sends data frames to module's own IP address. Any other valid address (within the APN) is accepted as the recipient.

5.2.3.12. Number of login retries

Function - Defines max. number of login to GPRS network retries. Each unsuccessful attempt changes the state of triggering input FS1_gprs from 0 to 1 and increases the failure counter by 1. After reaching declared value the module displays error code and awaits user action.
Successful login resets failure counter.

Data type - number

Range - 0....255

Default value - 0

Comments - Setting the value to "**0**" results in endless retries

5.2.3.13. Wait time after disconnection

Function - Defines interval (in seconds) before resuming after failed login attempt.

Data type - number

Range - 0....60 [s]

Default value - 5 [s]

Comments - Setting the value to *0* results in immediate retries.

5.2.3.14. Data frame format

Function - This parameter selects data frame type used by module for GPRS communication, and indirectly the operating mode.

Data type - selection list

Range -

Standard
Standard mode. Modules communicate using the protocol and transmission protection created by the manufacturer.

Proxy
mode allowing application in GPRS networks with dynamic IP assignment. This mode requires special communication software running on computer with static public address. Currently not supported.

Open
Configuration and operating modes as for Standard type frames. The only difference is lack of frame protection and opened UDP frame header format allowing creation of user's own access system.

UDP Standard
Data is sending in form of ModbusRTU command encapsulated in standard UDP data frame. Data reception control is not available when using that data format.

Default value - *Standard*

Comments - More info about data formats employed in MT series can be found in chapter Appendices - Data formats

5.2.3.15. Proxy server IP address

Function - inserts Proxy server IP for selected *Proxy* Data frame format.

Data type - IP address field

Range - 0.0.0.0 - 255.255.255.255

Default value - 0.0.0.0

Comments - inserted IP is public static address of communication server serving modules working in GSM/GPRS network with dynamic IP assignment.

5.2.3.16. CRC compatibility

Function - This parameter sets CRC calculation for systems requiring full Modbus RTU compatibility.

Data type - selection list

Range - *Yes*

For compatibility of Modbus RTU Slave mode, Modbus RTU Master mode and Modbus RTU Mirror mode with remaining modes, enabling the creation of systems consisting of modules working in transparent modes and Modbus RTU modes. This mode ensures compatibility with MT-DP communication software .

No

for maintaining compatibility when expanding existent systems operating in MODBUS modes or cooperating with old versions of OPC driver.

Default value - *Yes*

Comments - in new systems, it is recommended to leave the option at default value *Yes*

5.2.3.17. UDP port (data)

Function - Defines number of UDP port used for data transmission excluding configuration data frames. Configuration data frames are send on the same port which was used to write or read configuration.

Data type - number

Range - 1024....65535

Default value - 7110

Comments -

5.2.4. Authorized numbers

This group holds lists of telephone numbers and IP addresses authorized to communicate with the Module.

Lists form the basis for assignment of privileges for configuring, receiving data and sending commands.
Numbers on lists are the only ones allowed to be used for Rules processing.

5.2.4.1. Number of phone numbers

Function	-	Defines length of phone number list that will receive SMS messages. Each phone number has defined privileges for SMS querying.
Data type	-	number
Range	-	0....32
Default value	-	1
Comments	-	The range value defines required volume of phone numbers used in SMS Rules processing. See more in Phone

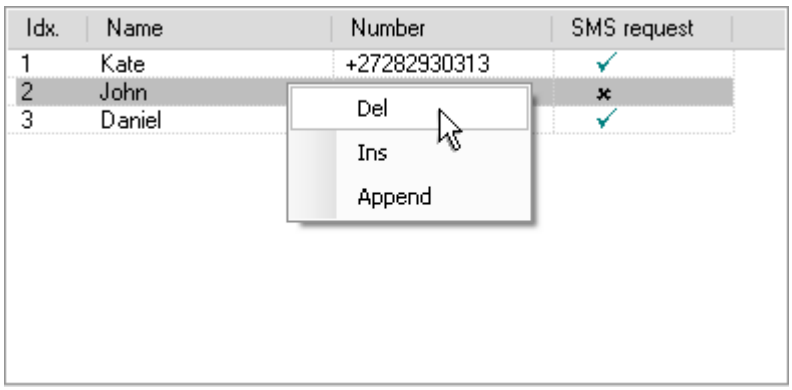
5.2.4.2. Number of IP numbers

Function	-	Defines length of IP numbers list authorized to communicate with the module via GPRS. Particular IP addresses have defined privileges for access to configuration and sending data queries.
Data type	-	number
Range	-	0....128
Default value	-	1
Comments	-	The range value defines required volume of IP addresses used in Rules for Data transmission. See more in IP

5.2.4.3. Phone

Idx	-	list index number
Name	-	friendly name of the number facilitating identification in Rules processing. Max length - 16 characters.
Number	-	phone number assigned to index and name. Max 23 characters. Phone number may be a stored in the internal registers which allows dynamic changes of SMS recipient number. Number should be stored in the form of ASCII characters string. Characters are stored only on the younger byte of register. String should be ended with NULL character (0x0000). In MTManager you should put decimal address of first register of string instead of telephone number, e.g. 64 for number stored in REG1 and following registers.
SMS request	-	depending on check mark incoming SMS requests will be processed or ignored

The list may be edited using context menu activated by right mouse click. Available operations depend on the cursor placement. When cursor rests on an entry, all options are available, while only Append is available with cursor resting on active window's background.



5.2.4.4. IP

Idx - list index number

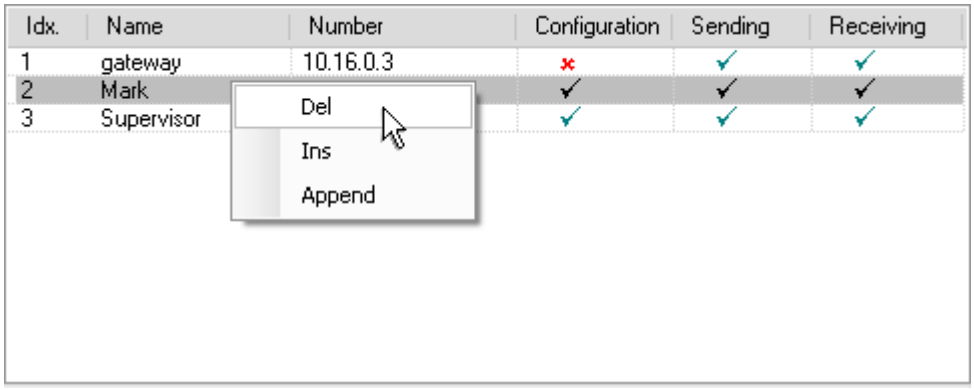
Name - friendly name of the IP number facilitating identification in Rules processing. Max length - 16 characters.

Number - number IP assigned to index and Name

Configuration - grants or denies right to perform remote configuration by this IP number

Receiving - depending on this setting, data incoming from this IP will be accepted or rejected

The list may be edited using context menu activated by right mouse click. Available operations depend on the cursor placement. When cursor rests on an entry, all options are available, while only Append is available with cursor resting on active window's background.



5.2.5. Resources

Group **Resources** encompasses a list of hardware and software resources available to users. Sub-groups hold configurable parameters for Inputs/outputs, asynchronous and synchronous timers, Datalogger, MT2MT Buffer and Constant parameters.

5.2.5.1. Internal resources Modbus ID number (GPRS)

Function - Defines Modbus ID number for internal resources of the module for GPRS communication.

Data type - number

Range - *0...254*
Default value - *1*
Comments - setting Modbus ID to *0* (*zero*) makes access to module internal module resources impossible

5.2.5.2. Internal resources Modbus ID number (Port 1)

Function - Defines Modbus ID number for internal resources of the module on Port 1
Data type - number
Range - *0...254*
Default value - *1*
Comments - setting Modbus ID to *0* (*zero*) makes access to module internal resources impossible

5.2.5.3. Terminals

Subgroup Terminals gathers all inputs and outputs. Depending on type of accepted input, they are binary and analog. Final functionality of each input depends on settings and configuration parameters connected.

5.2.5.3.1. Binary inputs I1...I8

Module **MT-100** has eight identical Binary inputs. Inputs can operate in one of three functional modes:

- standard binary input
- counter input
- analog input with conversion of frequency to analog value

Each mode has a set of specific configuration parameters.

5.2.5.3.1.1. Name

Function - Enables entering a friendly input name e.g. connected to the function performed. The name is displayed on list of terminals.
Data type - text
Range - letters and numerals, max.16 characters
Default value - Name of resource (I1....I8)
Comments - Using friendly names facilitates recognition of destination and appropriate settings.

5.2.5.3.1.2. Input type

Function - defines operating mode for inputs I1....I8
Data type - selection list
Range - *Binary input*
the input acts as typical binary input accepting positive and negative logic.

Analog input
the input acts as analog input, measuring frequency of incoming signal in range from 0....2 kHz.
Counter input
the input acts as counter input. Each pulse appearing on input increments value of corresponding 32 bit register

Default value - *Binary input*

Comments - selecting appropriate operating mode is the basis for taking full advantage of module capabilities. It has an influence on available configuration parameters optimizing module performance.

5.2.5.3.1.2.1. Binary input

5.2.5.3.1.2.1.1. Filtering constant

Function - Defines (in seconds) value of min. duration of altered state on input in order to consider state to be stable.

Data type - number

Range - *0,00…163 [s]*

Default value - *0,00 [s]*

Comments - Setting value appropriate to contact characteristics eliminates disturbance caused by contact bounce thus preventing multiple registration of what is in reality one pulse.

5.2.5.3.1.2.2. Analog input

Function - Defines filter filtering constant

Data type - number

Range - *0,0…25,5 [s]*

Default value - *0*

Comments - for *0* (*zero*) value filtering is off.
Setting high time value influences stabilizing of result after signal value change, but allows better precision of measuring noisy signal. It is recommended to set filtering constant to value *6,4* and higher to provide satisfying precision of measurements.
Assuming that measured value will raise from minimum to maximum value (unit step), value from measurement will achieve X% of real value within time specified by table:

Time of measurement	Percent of real value
1 filtering constant	63,2%
2 filtering constants	86,5%
3 filtering constants	95,0%
4 filtering constants	98,2%
5 filtering constants	99,3%

5.2.5.3.1.2.2.1. Engineering units

Function - Defines name for engineering units

Data type - text

Range	-	letters and numerals, max 16 characters
Default value	-	*x*
Comments	-	inserted text does not have any influence on the value of measured analog signal

5.2.5.3.1.2.2.2. Low reference - internal units

Function	-	used along with other reference parameters for rescaling input signal range to engineering units range.
Data type	-	number
Range	-	*0....65535*
Default value	-	*0*
Comments	-	low reference point for internal units

5.2.5.3.1.2.2.3. Low reference - engineering units

Function	-	used along with other reference parameters for rescaling input signal range to engineering units range.
Data type	-	number
Range	-	*0....65535*
Default value	-	*400*
Comments	-	low reference point for engineering units

5.2.5.3.1.2.2.4. High reference - internal units

Function	-	used along with other reference parameters for rescaling input signal range to engineering units range.
Data type	-	number
Range	-	*1....65535*
Default value	-	*65535*
Comments	-	high reference point for internal units

5.2.5.3.1.2.2.5. High reference - engineering units

Function	-	used along with other reference parameters for rescaling input signal range to engineering units range.
Data type	-	number
Range	-	*1....65535*
Default value	-	*2000*
Comments	-	high reference point for engineering units

5.2.5.3.1.2.2.6. Alarm HiHi

Function	-	Defines **HiHi** alarm level in engineering units for analog input signal.
Data type	-	number
Range	-	*0....65535* [engineering units]
Default value	-	*0* [engineering units]

Comments - Sets *A HiHi* flag used for rules processing. The level of reset for this flag depends on Alarm hysteresis value.

5.2.5.3.1.2.2.7. Alarm Hi

Function - Defines **Hi** alarm level in engineering units for analog input signal.
Data type - number
Range - *0....65535* [engineering units]
Default value - *0* [engineering units]
Comments - Sets *A Hi* flag used for rules processing. The reset level for this flag depends on Alarm hysteresis value.

5.2.5.3.1.2.2.8. Alarm Lo

Function - Defines **Lo** alarm level in engineering units for analog input signal.
Data type - number
Range - *0....65535* [engineering units]
Default value - *0* [engineering units]
Comments - Sets *An Lo* flag used for rules processing. The reset level for this flag depends on Alarm hysteresis value.

5.2.5.3.1.2.2.9. Alarm LoLo

Function - Defines **LoLo** alarm level in engineering units for analog input signal.
Data type - number
Range - *0....65535* [engineering units]
Default value - *0* [engineering units]
Comments - Sets *An Lo* flag used for rules processing. The reset level for this flag depends on Alarm hysteresis value.

5.2.5.3.1.2.2.10. Alarm hysteresis

Function - Defines hysteresis for analog input alarm thresholds. The value is in engineering units.
Data type - number
Range - *1....65535* [engineering units]
Default value - *10* [engineering units]
Comments - setting proper hysteresis value for variable signal source prevents frequent activation of alarm flag when signal source is unstable.

5.2.5.3.1.2.2.11. Deadband

Function - Defines size of dead band for value of analog input in engineering units.
Data type - number
Range - *0....65534* [engineering units]
Default value - *10* [engineering units]

Comments - Insensitivity band spans symmetrically with last recorded value in center. Upon crossing this value, the new value is recorded and insensitivity band is moved. The An DB flag in binary inputs space is raised and may be used for rules processing.

5.2.5.3.1.2.3. Counter input

5.2.5.3.1.2.3.1. Counting direction

Function - defines counting direction
Data type - selection list
Range - *Up*
A pulse on input increases value of counter register
Down
A pulse on input decreases value of counter register
Default value - *Up*
Comments - The counting process is valid only within range of Counting range parameter.

5.2.5.3.1.2.3.2. Counting range

Function - defines max. value assumed by the counter
Data type - number
Range - *0....2 147 483 647* (31 bits + counting direction bit)
Default value - *0*
Comments - when counting up the counter is zeroed by next appearing pulse upon reaching declared value. When counting down, next pulse writes declared value into the counter upon reaching 0.
Setting *0* (*zero*) value switches counting off.

5.2.5.3.1.2.3.3. Active edge

Function - selects counting direction
Data type - selection list
Range - *Rising*
The change of counter state occurs upon signal change from 0 --> 1
Falling
The change of counter state occurs upon signal change from 1 --> 0
Default value - *Rising*
Comments - n/a

5.2.5.3.1.2.3.4. Filtering constant

Function - Defines (in seconds) value of min. duration of altered state on input in order to consider state to be stable.
Data type - number
Range - *0,00....163,83 [s]*
Default value - *0,00 [s]*

Comments	-	Setting value appropriate to contact characteristics eliminates disturbance caused by contact bounce thus preventing multiple registration of what is in reality one pulse.

5.2.5.3.2. Binary outputs Q1....Q8

MT-100 Module has eight functionally identical Binary outputs. These inputs can operate in one of four modes:

- standard binary input
- analog input with conversion of frequency to analog value
- counter input
- standard binary output

Each mode has a set of specific configuration parameters.

5.2.5.3.2.1. Name

Function	-	Enables entering friendly name of input e.g. connected to the function performed. The name is displayed on terminals list.
Data type	-	text
Range	-	letters and numerals, max.16 characters
Default value	-	Name of resource (Q1....Q8)
Comments	-	Using friendly names facilitates recognition of destination and appropriate settings.

5.2.5.3.2.2. Operating modes

Function	-	defines operating mode for outputs Q1....Q8
Data type	-	selection list
Range	-	*Binary input* the input acts as typical binary input accepting positive and negative logic. *Analog input* the input acts as analog input, measuring frequency of incoming signal in range from 0....2 kHz. *Counter input* the input acts as counter input. Each pulse appearing on input increments value of corresponding 32 bit register *Binary output* the output acts as typical binary output in positive logic.
Default value	-	*Binary output*
Comments	-	selecting appropriate operating mode is the basis for taking full advantage of module capabilities. It has an influence on available configuration parameters optimizing module performance.

5.2.5.3.2.2.1. Binary input

Function	-	Defines (in seconds) value of min. duration of altered state on input in order to consider state to be stable.
Data type	-	number
Range	-	0,00....163,83 [s]

Default value - 0,1 [s]
Comments - Setting value appropriate to contact characteristics eliminates disturbance caused by contact bounce thus preventing multiple registration of what is in reality one pulse.

5.2.5.3.2.2.2. Analog inputs

Function - Defines filter filtering constant
Data type - number
Range - 0,0…25,5 [s]
Default value - 0
Comments - for *0* (*zero*) value filtering is off.
Setting high time value influences stabilizing of result after signal value change, but allows better precision of measuring noisy signal.
It is recommended to set filtering constant to values *6,4* and higher to provide satisfying precision of measurements.
Assuming that measured value will raise from minimum to maximum value (unit step), value from measurement will achieve X% of real value within time specified by table:

Time of measurement	Percent of real value
1 filtering constant	63,2%
2 filtering constants	86,5%
3 filtering constants	95,0%
4 filtering constants	98,2%
5 filtering constants	99,3%

5.2.5.3.2.2.2.1. Engineering units

Function - Defines a name for engineering units
Data type - text
Range - letters and numerals, max 16 characters
Default value - x
Comments - inserted text does not have any influence on the value of measured analog signal

5.2.5.3.2.2.2.2. Low reference - internal units

Function - used along with other reference parameters for rescaling input signal range to engineering units range.
Data type - number
Range - 0....65535
Default value - 0
Comments - low reference point for internal units

5.2.5.3.2.2.2.3. Low reference - engineering units

Function - used along with other reference parameters for rescaling input signal range to engineering units range.

Data type - number
Range - 0....65535
Default value - 400
Comments - low reference point for engineering units

5.2.5.3.2.2.2.4. High reference - internal units

Function - used along with other reference parameters for rescaling input signal range to engineering units range.
Data type - number
Range - 1....65535
Default value - 65535
Comments - high reference point for internal units

5.2.5.3.2.2.2.5. High reference - engineering units

Function - used along with other reference parameters for rescaling input signal range to engineering units range.
Data type - number
Range - 1....65535
Default value - 2000
Comments - high reference point for engineering units

5.2.5.3.2.2.2.6. Alarm HiHi

Function - Defines **HiHi** alarm level in engineering units for analog input signal.
Data type - number
Range - 0....65535 [engineering units]
Default value - 0 [engineering units]
Comments - Sets *An HiHi* flag used for rules processing. The reset level for this flag depends on Alarm hysteresis value.

5.2.5.3.2.2.2.7. Alarm Hi

Function - Defines **Hi** alarm level in engineering units for analog input signal.
Data type - number
Range - 0....65535 [engineering units]
Default value - 0 [engineering units]
Comments - Sets *An Hi* flag used for rules processing. The reset level for this flag depends on Alarm hysteresis value.

5.2.5.3.2.2.2.8. Alarm Lo

Function - Defines **Lo** alarm level in engineering units for analog input signal.
Data type - number
Range - 0....65535 [engineering units]
Default value - 0 [engineering units]

Comments - Sets *An Lo* flag used for rules processing. The reset level for this flag depends on Alarm hysteresis value.

5.2.5.3.2.2.2.9. Alarm LoLo

Function - Defines **LoLo** alarm level in engineering units for analog input signal.
Data type - number
Range - 0....65535 [engineering units]
Default value - 0 [engineering units]
Comments - Sets *An LoLo* flag used for rules processing. The reset level for this flag depends on Alarm hysteresis value.

5.2.5.3.2.2.2.10. Alarm hysteresis

Function - Defines hysteresis for analog input alarm thresholds. The value is in engineering units.
Data type - number
Range - 1....65535 [engineering units]
Default value - 10 [engineering units]
Comments - setting proper hysteresis value for variable signal source prevents frequent activation of alarm flag when signal source is unstable.

5.2.5.3.2.2.2.11. Deadband

Function - Defines size of deadband for values of analog input in engineering units.
Data type - number
Range - 0....65534 [engineering units]
Default value - 10 [engineering units]
Comments - Insensitivity band spans symmetrically with last recorded value in center. Upon crossing this value, the new value is recorded and insensitivity band is moved. The An DB flag in binary inputs space is raised and may be used for rules processing.

5.2.5.3.2.2.3. Counter inputs

5.2.5.3.2.2.3.1. Counting direction

Function - defines counting direction
Data type - selection list
Range - *Up*
A pulse on input increases value of counter register
Down
A pulse on input decreases value of counter register
Default value - *Up*
Comments - The counting process is valid only within range of Counting range parameter.

5.2.5.3.2.2.3.2. Counting range

Function	-	defines max. value assumed by the counter
Data type	-	number
Range	-	0....2 147 483 647 (31 bits + counting direction bit)
Default value	-	0
Comments	-	when counting up, the counter is zeroed by next appearing pulse upon reaching declared value. When counting down, next pulse writes declared value into the counter upon reaching 0. *0* (*zero*) value switches counting off.

5.2.5.3.2.2.3.3. Activating slope

Function	-	selects counting direction
Data type	-	selection list
Range	-	*Raising* The change of counter state occurs upon signal change from 0 --> 1 *Falling* The change of counter state occurs upon signal change from 1 --> 0
Default value	-	*Raising*
Comments	-	n/a

5.2.5.3.2.2.3.4. Filtering constant

Function	-	Defines (in seconds) value of min. duration of altered state on input in order to consider state to be stable.
Data type	-	number
Range	-	0,00....163,83 [s]
Default value	-	0,00 [s]
Comments	-	Setting value appropriate to contact characteristics eliminates disturbance caused by contact bounce thus preventing multiple registration of what is in reality one pulse.

5.2.5.3.2.2.4. Binary outputs

Binary outputs do not require any configuration.

5.2.5.3.3. Analog inputs AN1, AN2

MT-100 Module is equipped with two identical Analog inputs operating in 4-20mA standard.

5.2.5.3.3.1. Name

Function	-	allows setting a friendly name for the input usually connected with performed function. Assigned name appears on the terminals list
Data type	-	text
Range	-	letters and numerals, max. 16 characters

Default value - Resource Name (A1, A2)
Comments - entering a friendly name facilitates distinguishing destination, performed function and required settings.

5.2.5.3.3.2. Operating mode

Function - defines analog inputs operating mode
Data type - selection list
Range - *Analog input*
the input operates as 4-20 mA standard input
Default value - *Analog input*
Comments - Parameter preserved for legacy support, not important for operating analog inputs A1, A2

5.2.5.3.3.3. Filtering constant

Function - Defines filter filtering constant
Data type - number
Range - 0,0…25,5 [s]
Default value - 0
Comments - for *0* (*zero*) value filtering is off.
Setting high time value influences stabilizing of result after signal value change, but allows better precision of measuring noisy signal. Assuming that measured value will raise from minimum to maximum value (unit step), value from measurement will achieve X% of real value within time specified by table:

Time of measurement	Percent of real value
1 filtering constant	63,2%
2 filtering constants	86,5%
3 filtering constants	95,0%
4 filtering constants	98,2%
5 filtering constants	99,3%

5.2.5.3.3.4. Engineering units

Function - Defines a name for engineering units for measured values.
Data type - text
Range - letters and numerals, max 16 characters
Default value - x
Comments - inserted text does not have any influence on the value of measured analog signal

5.2.5.3.3.5. Low reference - internal units

Function - used along with other reference parameters for rescaling input signal range to engineering units range.
Data type - number

Range - 0....65535
Default value - 0
Comments - low reference point for internal units

5.2.5.3.3.6. Low reference - engineering units

Function - used along with other reference parameters for rescaling input signal range to engineering units range.
Data type - number
Range - 0....65535
Default value - 400
Comments - low reference point for engineering units

5.2.5.3.3.7. High reference - internal units

Function - used along with other reference parameters for rescaling input signal range to engineering units range.
Data type - number
Range - 1....65535
Default value - 65535
Comments - high reference point for internal units

5.2.5.3.3.8. High reference - engineering units

Function - used along with other reference parameters for rescaling input signal range to engineering units range.
Data type - number
Range - 1....65535
Default value - 2000
Comments - high reference point for engineering units

5.2.5.3.3.9. Alarm HiHi

Function - Defines **HiHi** alarm level in engineering units for analog input signal.
Data type - number
Range - 0....65535 [engineering units]
Default value - 0 [engineering units]
Comments - Sets *An HiHi* flag used for rules processing. The reset level for this flag depends on Alarm hysteresis value.

5.2.5.3.3.10. Alarm Hi

Function - Defines **Hi** alarm level in engineering units for analog input signal.
Data type - number
Range - 0....65535 [engineering units]
Default value - 0 [engineering units]
Comments - Sets *An Hi* flag used for rules processing. The reset level for this flag depends on Alarm hysteresis value.

5.2.5.3.3.11. Alarm Lo

Function	-	Defines **Lo** alarm level in engineering units for analog input signal.
Data type	-	number
Range	-	0....65535 [engineering units]
Default value	-	0 [engineering units]
Comments	-	Sets *An Lo* flag used for rules processing. The reset level for this flag depends on Alarm hysteresis value.

5.2.5.3.3.12. Alarm LoLo

Function	-	Defines **LoLo** alarm level in engineering units for analog input signal.
Data type	-	number
Range	-	0....65535 [engineering units]
Default value	-	0 [engineering units]
Comments	-	Sets *An LoLo* flag used for rules processing. The reset level for this flag depends on Alarm hysteresis value.

5.2.5.3.3.13. Alarm hysteresis

Function	-	Defines alarm thresholds for hysteresis value of analog signal (in engineering units).
Data type	-	number
Range	-	1....65535 [engineering units]
Default value	-	10 [engineering units]
Comments	-	setting hysteresis value appropriate to signal source variations prevents overly frequent activation of alarm flags when signal source is unstable.

5.2.5.3.3.14. Deadband

Function	-	Defines the range of insensitivity for analog input signal changes in engineering units
Data type	-	number
Range	-	0....65534 [engineering units]
Default value	-	10 [engineering units]
Comments	-	the range of insensitivity stretches symmetrically around previously noted signal value. Upon signal crosses range, new signal value is noted so that it is in mid range and an An DB flag is set high in binary outputs space. This flag can be used for rules processing or trigger recording in Datalogger .

5.2.5.4. Asynchronous clocks

Two **Asynchronous clocks** can cyclically count time for up to 8640000 s (100 days). Counting starts immediately after module starts up and goes on until switched off. Asynchronous clocks have two Triggering outputs T1, T2, that can be used for rules processing.

5.2.5.4.1. Clocks TMR1, TMR2

5.2.5.4.1.1. Period

Function	-	Defines (in seconds) asynchronous timer counting period
Data type	-	number
Range	-	0....8640000 [s]
Default value	-	0 [s]
Comments	-	*0* (*zero*) value switches the clock off

5.2.5.5. Synchronous clocks

Synchronous clocks group contains parameters set for two clocks capable of cooperating with module real time (RTC) clock thus enabling triggering of events synchronized with defined time.

5.2.5.5.1. Clock TMR3, TMR4

5.2.5.5.1.1. Start

Function	-	synchronizes timer's clock setting start point and counting period.
Data type	-	time [HH:mm]
Range	-	0:00 - 23:59
Default value	-	0:00
Comments	-	n/a

5.2.5.5.1.2. Period

Function	-	defines **synchronous clock** counting period in minutes.
Data type	-	number
Range	-	*0...1440 [min]*
Default value	-	*0 [min]*
Comments	-	*0* (*zero*) value switches the clock off

5.2.5.6. Datalogger

This section's parameters define operation of internal **Datalogger**, recording state changes on binary inputs/outputs and analog inputs state. The capacity of internal buffer is 140 records. New records are written into memory after changes of state on binary inputs/outputs or at crossing of dead band for analog inputs.

5.2.5.6.1. Active

Function	-	defines Datalogger status
Data type	-	selection list
Range	-	*Yes* Datalogger active *No*

Datalogger inactive

Default value - *No*

Comments - During MT-100 module operation, the state of Datalogger may be remotely altered by *MLOG_act* bit in binary outputs space. *1* – active, *0* – inactive.
Upon start of the datalogger, the first record of actual state is created. Switching the Datalogger off triggers transmission of datalogger content to defined recipient but only when it holds records with data.

5.2.5.6.2. Sampling interval

Function - Defines (in seconds) the interval of checking module inputs state

Data type - number

Range - 0....1500 [s]

Default value - 0 [s]

Comments - *0* (*zero*) value results in sampling interval of 100ms

5.2.5.6.3. Buffer flush mode

Function - defines Datalogger buffer flush mode

Data type - selection list

Range - *Auto*
Data collected in Datalogger are sent automatically upon filling the buffer up or after Buffer flush interval time. The datalogger is zeroed after transmission.
Upon request
Flushing Datalogger buffer is possible only by forcing

Default value - *Auto*

Comments - Flushing of Datalogger buffer may be remotely forced by setting *MLOG_rd bit* to *1* (one) in binary outputs space. Note that when forcing, some data may get lost if querying is too slow compared to object's dynamics. If the buffer gets filled between readings, new data will replace oldest data so the latest 140 records are preserved.

5.2.5.6.4. Buffer flush interval

Function - Defines (in seconds) the interval of buffer flushing in automatic mode

Data type - number

Range - 0....65535 [s]

Default value - 0 [s]

Comments - *0* (*zero*) disables timed flushing. In any case, the Datalogger is emptied upon buffer filling. Note that in timed flushing, frames are sent only when buffer has at least 1 record.

5.2.5.6.5. Recipient IP address

Function	-	defines IP address of device to send Datalogger buffer to.
Data type	-	selection list
Range	-	friendly names of IP of devices declared as Authorized to communicate with module
Default value	-	IP1 - first number on the list of authorized numbers
Comments	-	since IP address of recipient is selected from list of friendly names, assigning unambiguous unique descriptive names is beneficial

5.2.5.7. MT2MT Buffer

MT2MT Buffer enables creation of system where modules may exchange information (internal registers) with each other. Using buffer requires activation and defining register space where exchange is going to take place. More in chapter Internal Resources/MT2MT Buffer.

5.2.5.7.1. Active

Function	-	defines state of employing MT2MT Buffer
Data type	-	selection list
Range	-	*Yes* MT2MT Buffer active *No* MT2MT Buffer inactive
Default value	-	*No*
Comments	-	n/a

5.2.5.7.2. Buffer address

Function	-	Defines start address of internal register space used for events reception.
Data type	-	number
Range	-	0...8191
Default value	-	64
Comments	-	received events registers laying outside defined space are not copied.

5.2.5.7.3. Buffer size

Function	-	Defines the size of internal registers space used for events reception.
Data type	-	number
Range	-	1...700
Default value	-	16
Comments	-	received events registers laying outside defined space are not copied.

5.2.5.8. Constant parameters

An option of defining Constant parameters under configuration was added for the user's convenience. Parameters are loaded to module memory during initialization of the module. More in chapter Internal Resources/Constant parameters.

5.2.5.8.1. Number of parameters

Function	-	Defines number of available constant parameters
Data type	-	number
Range	-	0...128
Default value	-	0
Comments	-	n/a

5.2.5.8.2. Parameter 1...128

Parameters are defined as numbers ranging from 0...65535.

5.2.6. Rules

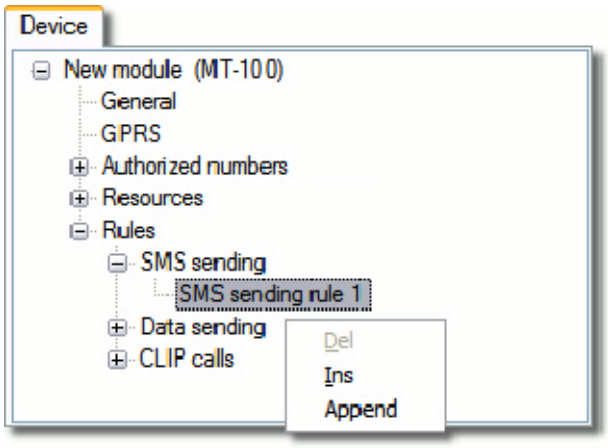
Rules group contains lists of transmission tasks performed by internal program when criteria defined in rules are met. Tasks are divided into two groups:

- rules concerning transmission of SMS messages
- rules concerning transmission of data

In both cases, the criteria are defined by using same resources and conditions of application of the rule.

5.2.6.1. SMS sending

List of SMS sending rules can hold max. 32 entries defining short text message transmission conditions. Adding a new position is done in the context menu by right-clicking mouse while one of positions on the list is highlighted.



Adding more rules is done by setting the parameter number of SMS sending rules to desired value.

5.2.6.1.1. Number of SMS sending rules

Function	-	declares number of SMS sending rules
Data type	-	number
Range	-	1....32
Default value	-	1
Comments	-	diminishing the number of rules does not delete settings until the configuration is written to the module.

5.2.6.1.2. SMS sending rule

Each of the rules residing on the list is defined by following parameters:

- Trigger input
- Trigger flag
- SMS text
- Recipient number
- Sending additional information

5.2.6.1.2.1. Trigger input

Function	-	defines resource to observe
Data type	-	selection list
Range	-	*None* the rule is inactive *I1....I8* binary inputs *Q1....Q8* binary outputs *A1, A2* analog inputs *FS1_ups, FS1_q+, FS1_gprs* system trigger inputs *P1...P32* user program inputs *TMR1, TMR2, TMR3, TMR4* synchronous and asynchronous clocks trigger inputs
Default value	-	*None*
Comments	-	more about trigger inputs and flags in chapter Appendices

5.2.6.1.2.2. Trigger flag

Function	-	defines event-triggering flag associated with selected trigger input
Data type	-	selection list
Range	-	*None* rule inactive *Bi In 0->1, Bi In 1->0 Bi In Chg* binary input state change *Bi Out Err* discrepancy between the forcing and output state *Counter* counter flip over (up or down)

An LoLo, An Lo, An Hi, An HiHi, An DB
alarm threshold flags for analog inputs signals

Default value	-	*None*
Comments	-	more about trigger inputs and flags in chapter Appendices

5.2.6.1.2.3. SMS text

Function	-	allows entering text sent in message triggered by defined rule
Data type	-	text
Range	-	letters, numerals, special characters - max. length: 160 characters
Default value	-	.
Comments	-	if the message will include the status of the module, total length of SMS text and the status may not exceed 160 characters. If the length is greater, the text will be truncated so that full status is sent.

5.2.6.1.2.4. Recipient number

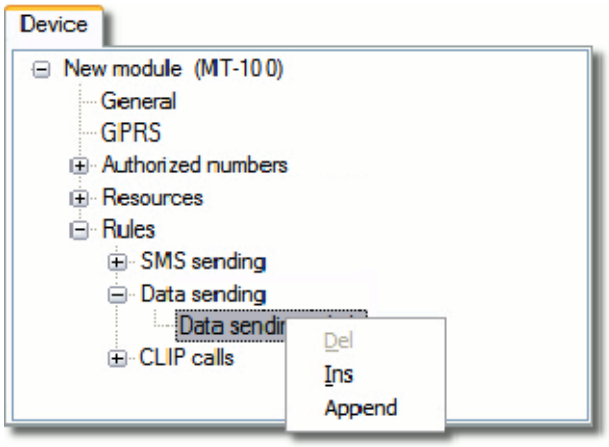
Function	-	selects message recipient number
Data type	-	selection list
Range	-	friendly names of recipients associated with phone numbers in Authorized numbers list
Default value	-	NUM 1 - first number on the list
Comments	-	since recipient's phone number is selected from the list of friendly names, it is important to enter unique, unambiguous names facilitating identification.

5.2.6.1.2.5. Sending additional information

Function	-	selects whether module status is to be attached to the message.
Data type	-	List
Range	-	*Status and timestamp* Status and timestamp attached to SMS *Timestamp* Timestamp attached to SMS *None* Only SMS text is send
Default value	-	*Status and timestamp*
Comments	-	Total length of SMS text and additional information may not exceed 160 characters. If the length is greater, the text defined by user will be truncated so that additional information will be sent.

5.2.6.2. Data sending

List of SMS sending rules can hold max. 32 entries defining data transmission conditions. A defined data block or Status will be sent to appointed IP address. Adding a new position is done in the context menu by right-clicking mouse while one of positions on the list is highlighted.



Adding more rules is done by setting the parameter number of data sending rules to desired value.

5.2.6.2.1. Number of data sending rules

Function	-	declares number of SMS sending rules
Data type	-	number
Range	-	1....32
Default value	-	1
Comments	-	diminishing the number of rules does not delete settings until the configuration is written to the module.

5.2.6.2.1.1. Data sending rule

Each of rules residing on the list is defined by following parameters:

- Trigger input
- Trigger flag
- IP Address
- Send
- Buffer address
- Buffer size

5.2.6.2.1.1.1. Trigger input

Function	-	defines resource to observe
Data type	-	selection list
Range	-	*None* the rule is inactive *I1....I8* binary inputs *Q1....Q8* binary outputs *A1, A2* analog inputs *FS1_ups, FS1_q+, FS1_gprs* system trigger inputs *P1...P32* user program inputs

TMR1, TMR2, TMR3, TMR4
synchronous and asynchronous clocks trigger inputs

Default value	-	*None*
Comments	-	more about trigger inputs and flags in chapter Appendices

5.2.6.2.1.1.2. Trigger flag

Function	-	defines event triggering flag associated with selected trigger input
Data type	-	selection list
Range	-	*None* rule inactive *Bi In 0->1, Bi In 1->0 Bi In Chg* binary input state change *Bi Out Err* discrepancy between the forcing and output state *Counter* counter flip over (up or down) *An LoLo, An Lo, An Hi, An HiHi, An DB* alarm threshold flags for analog inputs signals
Default value	-	*None*
Comments	-	more about trigger inputs and flags in chapter Appendices

5.2.6.2.1.1.3. IP address

Function	-	selects recipient's IP address
Data type	-	selection list
Range	-	friendly names of recipients associated with IP addresses in Authorized numbers list
Default value	-	IP1 - first number on the list
Comments	-	since recipient's IP address is selected from the list of friendly names, it is important to enter unique, unambiguous names facilitating identification.

5.2.6.2.1.1.4. Send

Function	-	defines data type sent in transmission triggered by defined rule
Data type	-	List
Range	-	*Status* Module Status will be sent *Buffer Hold. Reg.* Registers from modules' internal registers' space will be sent. Defining the transmitted space is required. *Buffer Inp. Reg.* Registers from module input registers' space will be sent. Defining the transmitted space is required.
Default value	-	*Status*
Comments	-	n/a

5.2.6.2.1.1.5. Buffer address

Function	-	Defines start address of internal registers space sent in transmission triggered by defined rule
Data type	-	number
Range	-	0...8191
Default value	-	64
Comments	-	n/a

5.2.6.2.1.1.6. Buffer size

Function	-	Defines size of internal registers space sent in transmission triggered by defined rule
Data type	-	number
Range	-	1...700
Default value	-	16
Comments	-	n/a

5.3. Configuration writing

After required modifications and parameter settings, the configuration is stored on the configuring PC's hard disk only. In order to write it to the module memory, it has to be transmitted to the module.

The method of transmission depends on whether we configure it locally or remotely via GPRS. For local configuration, it is enough to secure a connection via RS232 cable.
Detailed description of local configuration is to be found in the MTM user manual.

For remote configuration, it is vital that the computer running the configuration application has access to the APN where the configured module resides. Detailed description of remote configuration is to be found in the MTM user manual.

5.4. Verification of configuration

Despite high reliability of both local and remote module configuration, verify of it is important. It is relevant if the modules behavior does not comply in accordance with the performed configuration.
For verification, please read the configuration from the module and check parameters settings.
Reading of module configuration is described in details in MTM users manual.

6. Programming

6.1. General information

Modules from the MT-10x and MT-202 series and EX-101 expansion allow downloading user-defined internal programs, thereby expanding module functionality with non-standard algorithms of data processing and module control. Programming is accomplished by using the

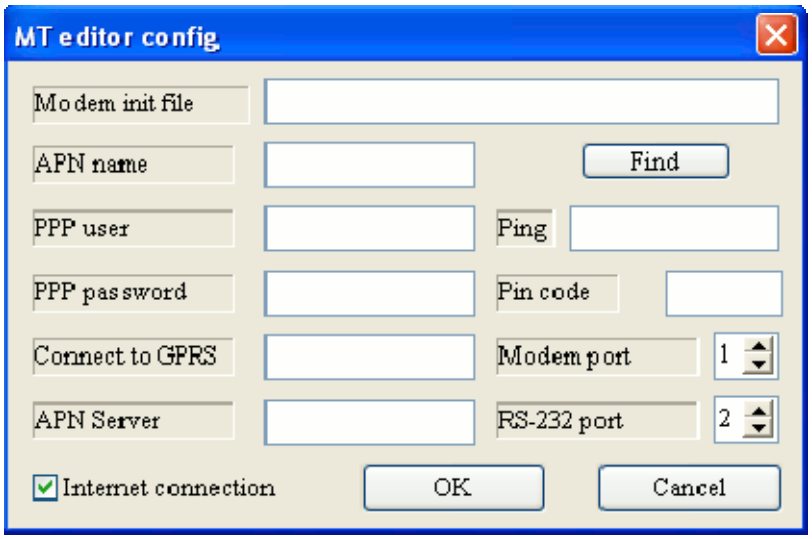
MTProg application delivered free of charge to our customers, giving them the possibility of programming in integrated environments.

Basic information regarding user programs functionality:

- The program is executed cyclically every 100ms.
- If the particular program cycle does not complete execution within 100ms, the next cycle will not start immediately but at the next 100ms round. The omission of the program cycle is signaled by flashing of OVR LED. In such cases, the user program should use RTC register values or clock blocks instead of measuring the time by incrementing a register value for each cycle.
- The user program can consist of max. 1024 instructions (100 for MT-100)
- Max. number of instructions carried out in one cycle is limited to 2000. Upon reaching this value, the program is automatically disrupted and restarted at the next 100ms round.
- The program is capable of carrying approx. 750 instructions in 100ms.
- The function of copying the buffers copies approx. 1500 registers in 100ms.
- The function of fast copying of blocks copies approx. 7000 registers in 100ms.

6.2. Starting to work

It is recommended to set up the working environment during the first run of the program. For this purpose, select menu item Help/Settings or activate  icon from the Toolbar and the following dialog window will appear. Fill in the relevant data for parameters.



Modem init file

Finds and selects the file holding initialization parameters for the GPRS modem used to communicate with remote module.

APN name

States name of the APN where programmed module resides.

PPP user

Parameter has to be defined only if network operator requires it.

PPP password

Parameter has to be defined only if network operator requires it.

Connect to GPRS

Parameter has to be defined only if network operator requires it.

APN server

IP address of the computer routing data packets sent via internet.

Internet connection

When selected in conjunction with "RS-232 port", it sets up the communication via dial up GPRS connection or via routed Ethernet connection.
This is the optimal way of communication between MTProg and remote modules.
When unselected, it leaves the connection to GPRS modem and MTProg takes care of initializing modem and establishing connection.

Ping

IP address pinged by application in order to maintain internet connection session. This address must belong to the same APN as programmed module. (Can be the programmed module's IP). If used, leave it at default „0.0.0.0".

PIN code

Contains PIN code of the SIM card placed in the modem employed to communicate with APN.

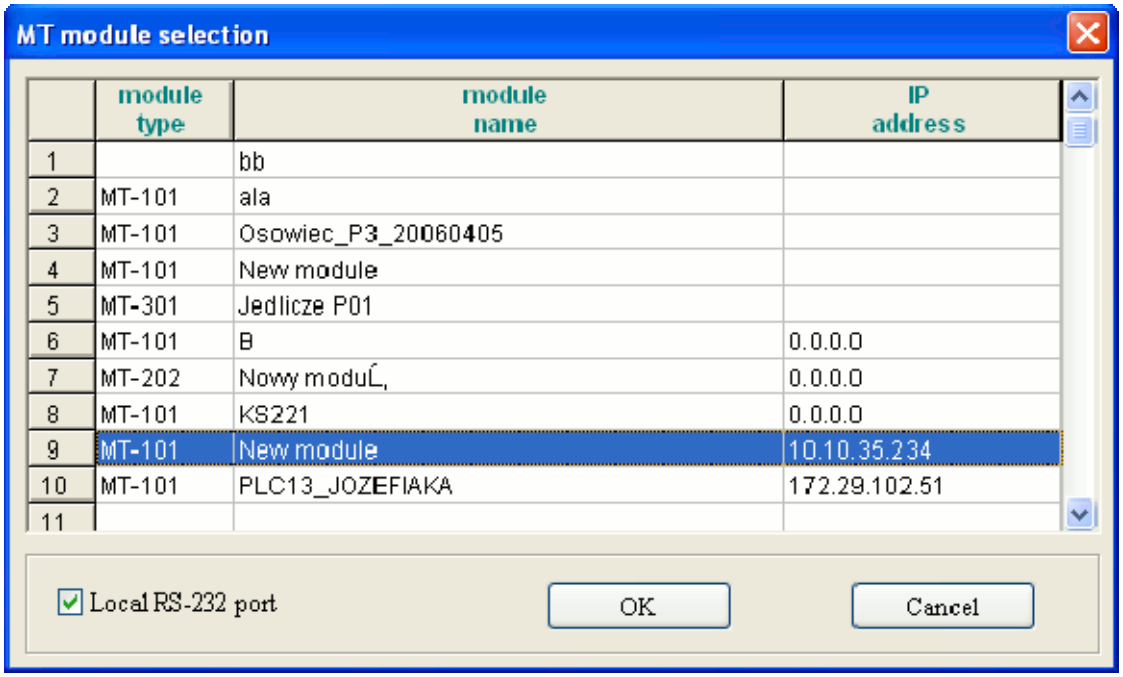
Modem port

Contains number of the com port the GPRS modem is connected to.

RS-232 Port

Contains number of the com port the programmed module is connected to via serial cable.

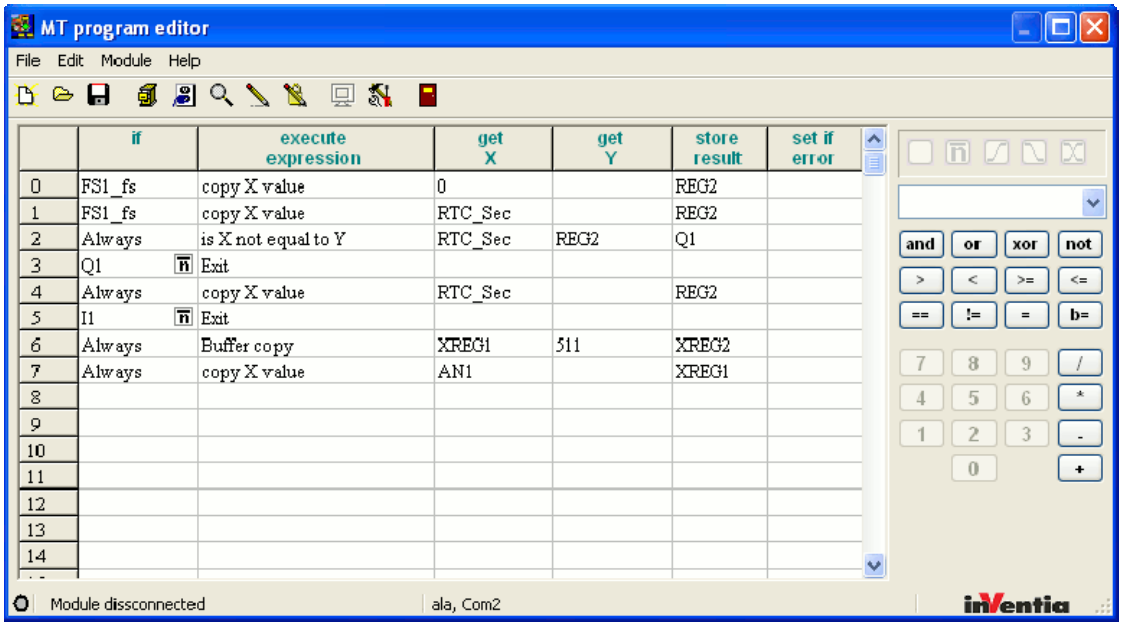
Select the chosen module and connection type. In order to do so activate parameter „Select" from menu „Module" or click the icon  on the toolbar. The selection window will open and present all available options.



Notice that only modules defined and configured by MTManager application in active Project are selectable.
When Local port RS 232 is checked in, serial transmission via RS 232 takes place. When Local port RS 232 is unchecked, GPRS transmission is employed and module IP address is used.
„OK" button stores the choice for connecting MTprog.exe application with selected module and opens program editing table.

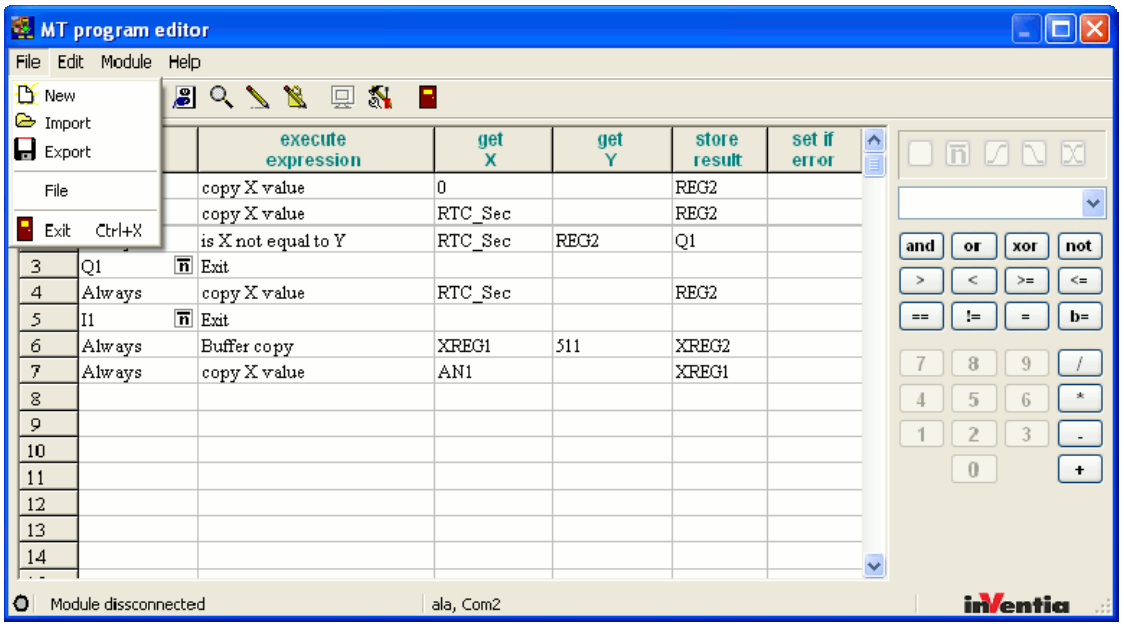
6.3. Main window layout

Main program window displays a table containing the program to be executed by module's command interpreter. Right side of the window contains a field with button groups dedicated to defining operations and constants. On top, there is a system menu and a toolbar with icons for frequently used functions. At the bottom, a status bar displays from the left: status of command interpreter, selected module's name and selected communication channel.



6.3.1. Menu items

6.3.1.1. File



- **Function "New"**

Erases the program visible in the table and the table is ready for editing of a new program. The icon  on the toolbar performs same function.

- **Function "Import"**

Writes a program previously stored on the hard disc into the table. Programs have a default extension ".MTp".

The icon  on the toolbar performs same function.

- **Function "Export"**

Stores the program from the table on the hard disc with default extension ".MTp".

The icon  on the toolbar performs same function.

- **Function "File"**

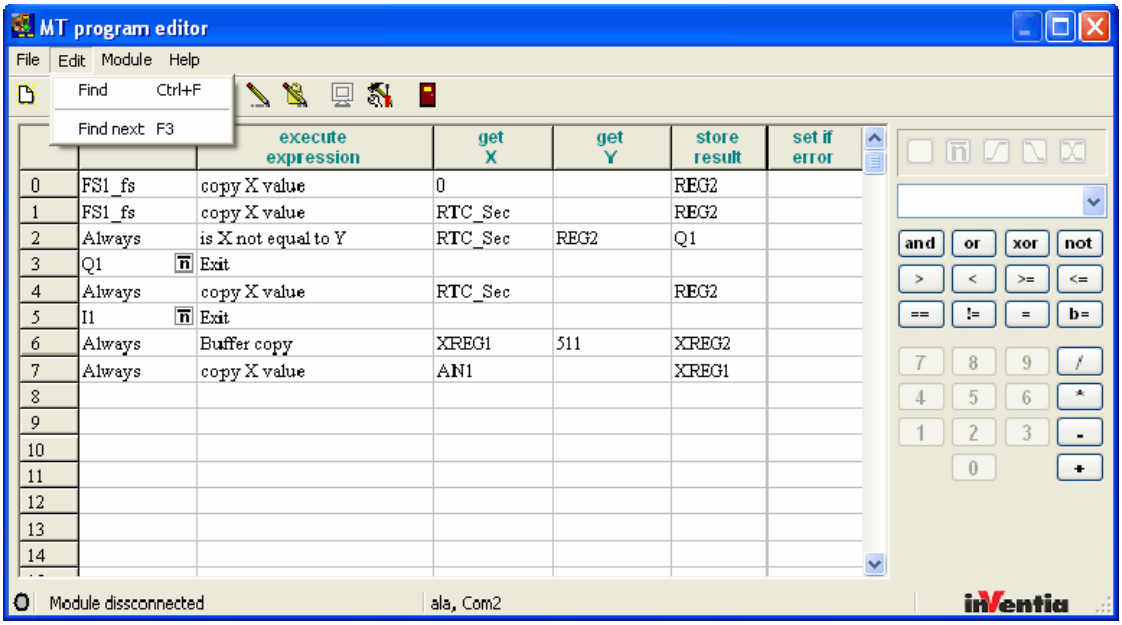
Stores the program from the table on the hard disc in clear text, creating good documentation.

- **Function "Exit"**

Closes the application after confirmation. The keyboard shortcut for this function is "Ctrl-X".

The icon  on the toolbar performs same function.

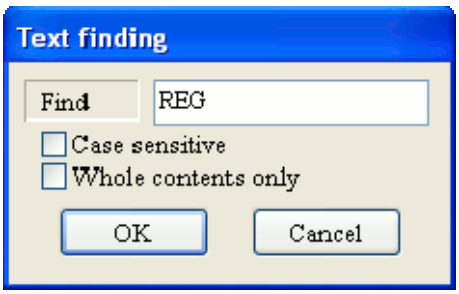
6.3.1.2. Edit



- **Function "Find"**

Allows searching the program for defined text (eg. register name). Text that you want to look for is entered in the window opened just after clicking this menu position. It is possible to choose if the search phrase is case sensitive and if search phrase is a complete "word" or only part of it (whole contents only). After selecting OK cursor in main window will move to first cell with found search phrase.

Search area begins from firs cell after selected and ends where program ends.



Function can also be started by using keyboard shortcut **Ctrl+F**.

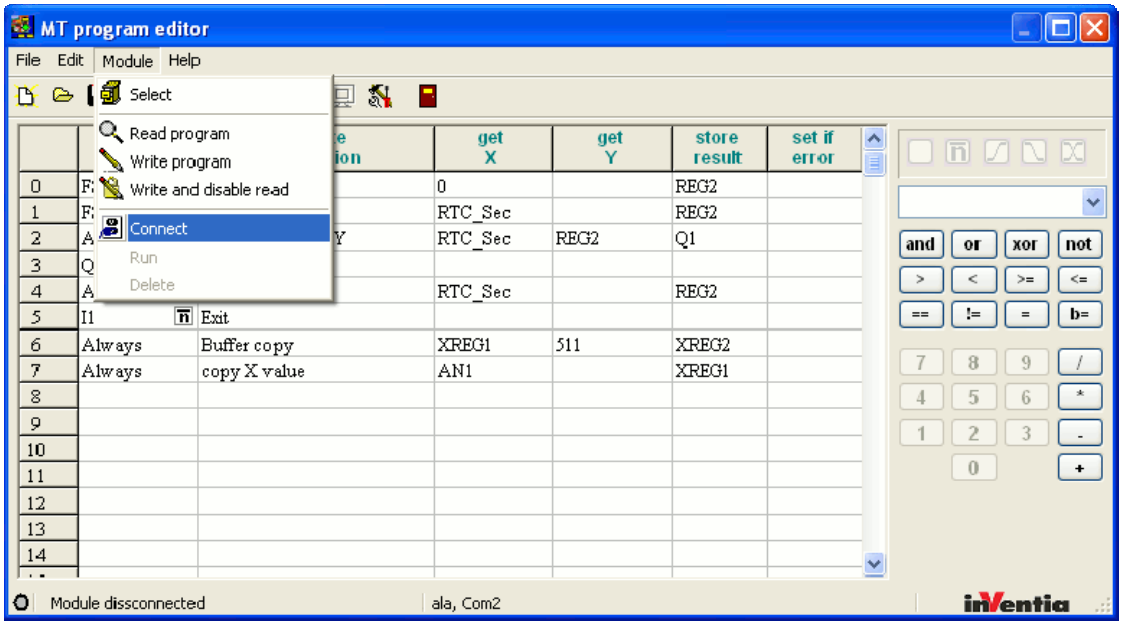
- **Function "Find next"**

Moves cursor to next cell with searched phrase.
Function can also be started by using keyboard shortcut **F3**.

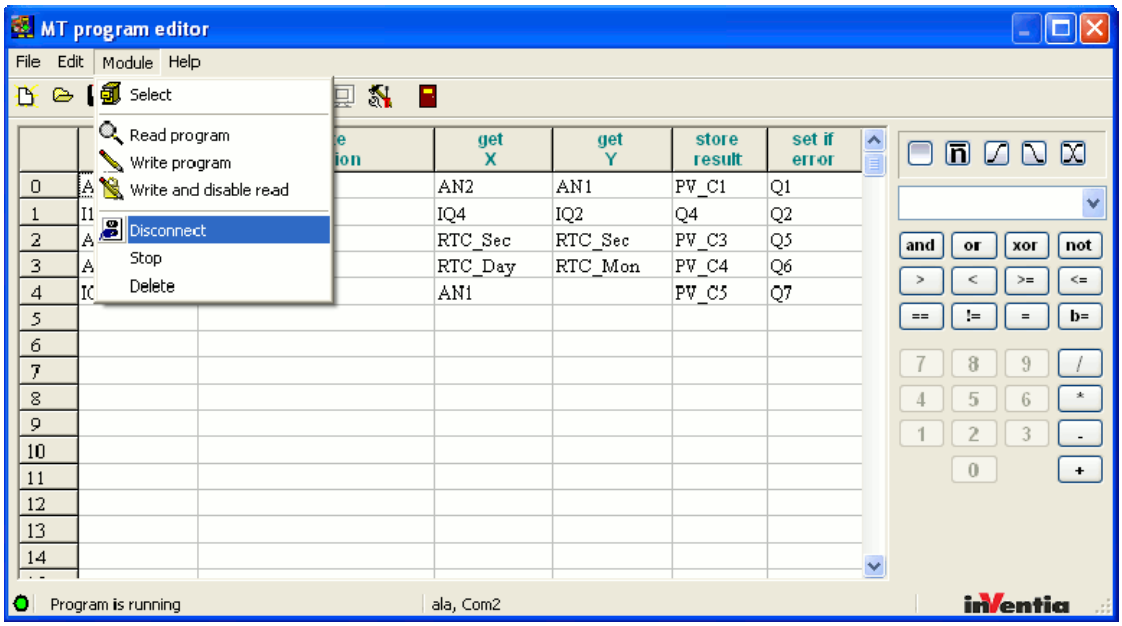
6.3.1.3. Module

Module Menu consists of functions governing the state of programmed module. Functions of this menu item change dynamically depending on the state of connection with the module and the state of the module's internal program.

Active functions of the menu when program is disconnected from the module....

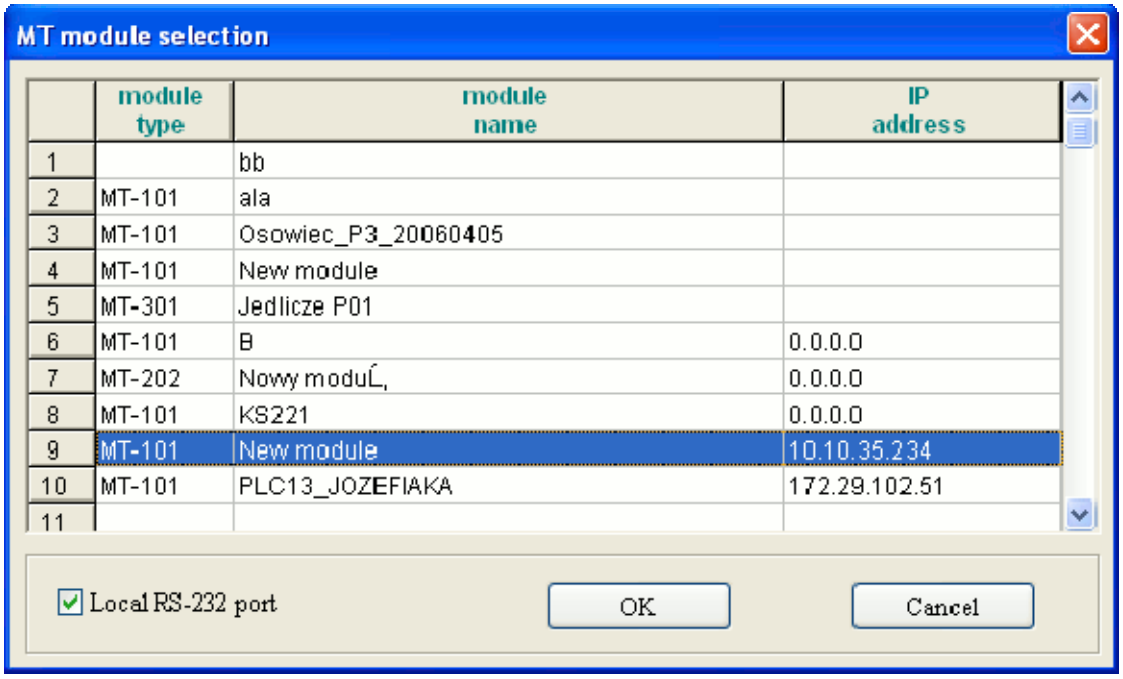


and after connecting to the module with internal program running. Notice the green dot in lower left corner of the status bar.



- **Function "Select"**

Presents the list of defined modules for selection of the desired module. The list has the option of selecting transmission mode via either RS232 cable or wireless (GPRS) connection using the module's IP address.



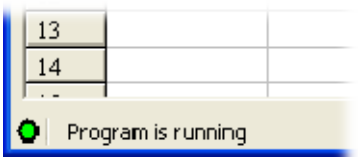
The table shows data written in system registers by MTManager application. MTProg application can only access modules previously defined and configured in active Project by MTManager.

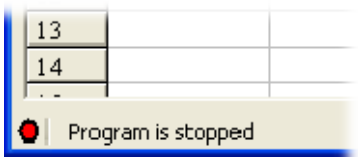
The icon  on the toolbar performs same function.

- **Function "Read program"**

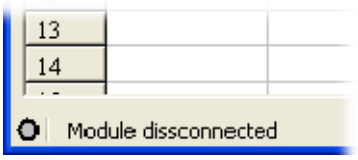
Reads the content of module's program interpreter into the table.

If the application is connected to the module, the control in the left side of the status bar is lit in red or green depending on the state of the program interpreter. The text displayed close to the control reflects the actual state and the function "Read program" is active.





If the connection is not established or broken the control is gray and reading from the module is impossible.



In case of serial cable connection the queries about sequential program lines are sent. Lines are continuously read and displayed in the table. In GPRS mode there is a couple of seconds delay between the query and response arrival. In order to speed the function up queries are sent without waiting for response. Upon arrival of response the value is displayed in the table.

The icon  on the toolbar performs same function.

- **Function "Writing to module"**

This function writes the program from the table to the module. If the table is empty, the effect of using this function will be erasing a program existing in the module.

All introductory remarks concerning the connection and password protection of Read function are valid in this case as well. The process of writing program into module's interpreter is similar. The only difference appears in GPRS mode. After verification of privileges all lines of program are sent and the application waits for confirmations.

The icon  on the toolbar performs same function.

- **Function "Write and disable read"**

This function writes the program from the table into the module disabling the reading function. The only way of modifying the program in the module is to write it again or import previously stored programs and modify it.

The icon  on the toolbar performs same function.

Function "Connect"

This function toggles between ON-Line and OFF-Line mode.

In first case, MTprog.exe application sends cyclically queries about module's interpreter state and on the base of received response displays status information in lower left corner of main window. The menu item Help/Transmission opens transmission window displaying sent commands and replies.

ON-Line/OFF-Line differentiation is important during connection via modem in GPRS mode. Leaving the application connected with the module for longer time results in higher costs of transmission since transfer may be roughly estimated to 2 kB per minute.

In ON-Line mode, the serial port connecting the computer with the module or GPRS modem is occupied by MTprog.exe application and cannot be used by other applications. In OFF-Line mode, serial port is released and may be used by any other application.

The icon  on the toolbar performs same function.

- **Function "Start"**

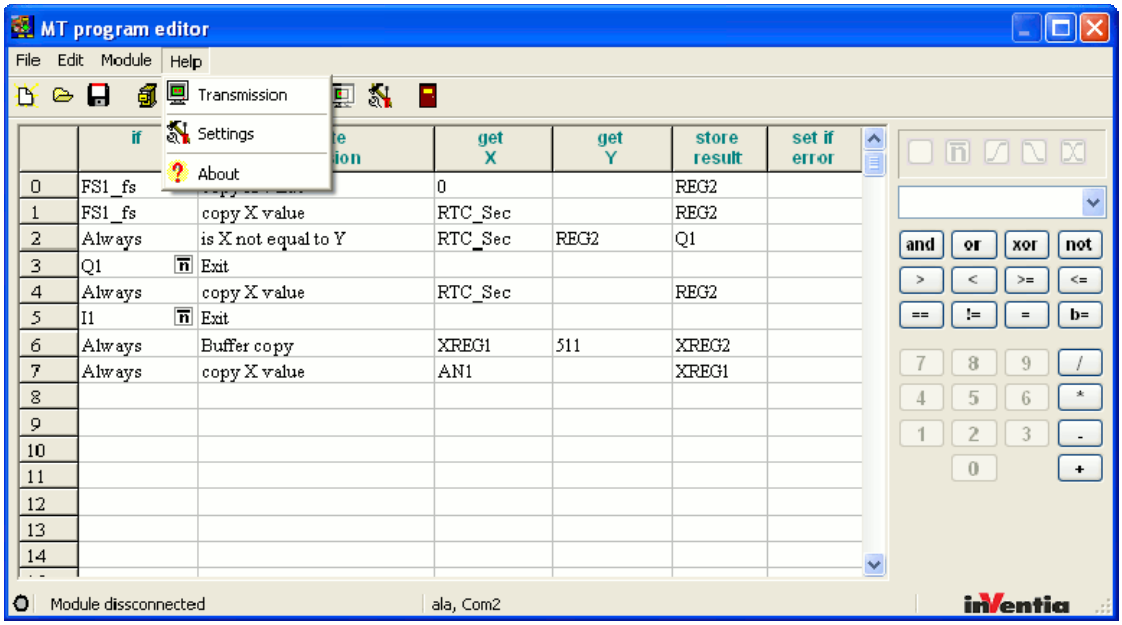
This function starts the command interpreter of the module.
To start the interpreter the module has to be in ON-Line mode. This function does not have a corresponding icon on the toolbar.

- **Function "Delete"**

This function deletes data from the module's data memory space.

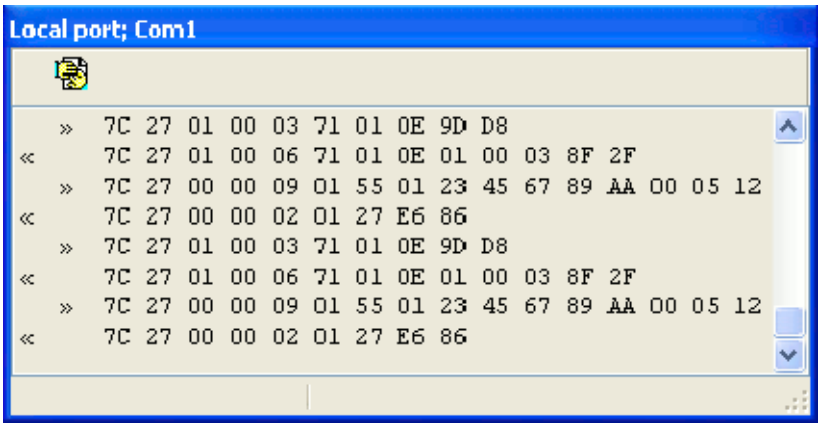
The areas selected for deletion should be checked in. Pressing the OK button resets selected areas.

6.3.1.4. Help



- **Function "Transmission"**

toggles transmission preview window



The title bar displays transmission type and recipient address while status bar displays connection status. The tool bar displays the icon closing the window.

The main window's tool bar icon  toggles transmission window display.

- **Function "Settings"**

opens environment configuration window described in "Starting to work" section.

The icon  on the toolbar performs same function

- **Function "About"**

opens window displaying version number and Manufacturer's address data.

6.3.1.5. Toolbar

The main window's toolbar holds icons corresponding to following menu functions:

menu item "File" Function "New"
menu item "File" Function "Red"
menu item "File" Function "Write"
menu item "Module" Function "Select"
menu item "Module" Function "Connect/Disconnect"
menu item "Module" Function "Read program"
menu item "Module" Function "Write program"
menu item "Module" Function "Write and block reading"
menu item "Help" Function "Transmission"
menu item "Help" Function "Settings"
menu item "File" Function "Exit"

6.4. Program editor table

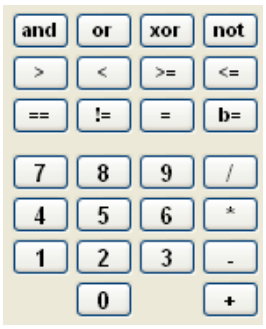
The table has six columns. Each column has specific role assigned to be performed by the command interpreter:

	if	execute expression	get X	get Y	store result	set if error
0						
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						

“If” – defines the condition for the table row to be executed. If not met, the line will be skipped.
“Execute expression” – defines the function to be performed,
“Get X” - holds the first argument of interpreted function,
“Get Y” - holds the second argument of interpreted function,
“Store Result” - points to where to store the result of the function,
“Set if error” - holds the optional flag to be set if the function fails due to e.g. division by zero or overflow.

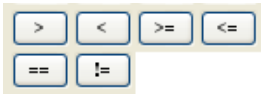
6.5. Standard functions

Most commonly used functions are grouped with numeric keyboard on the right side of the main window.



Top button row groups 4 logical operations of true/false type.

Next group represents 6 functions comparing arithmetical values.

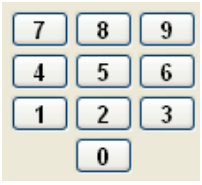


Next 2 buttons represent assignment of arithmetical and logical values.

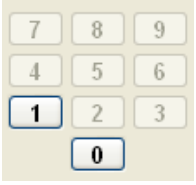
Right column of numerical keyboard represent 4 standard arithmetical operations.

6.6. Numeric keyboard

Numerical keyboard has all keys active only when selected function allows arithmetic input.



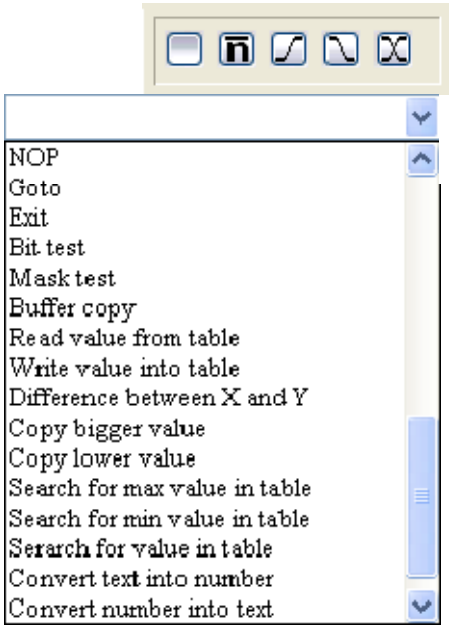
If selected function allows only logical input only keys "0" and "1" meaning respectively False/Never and True/Always.



When selected function does not allow numerical input the keyboard is grayed out (inactive).

6.7. Auxiliary functions

Some modules types and versions may implement auxiliary functions. Access to these functions is possible via the drop-down menu just above numerical keyboard:



Detailed description of standard and auxiliary functions is located at chapter Description of program functions

6.8. Description of Program functions

Boolean AND X ,Y

get X (bit)	get Y (bit)	store result (bit)
0	0	0
0	1	0
1	0	0
1	1	1

Boolean OR X , Y

get X (bit)	get Y (bit)	store result (bit)
0	0	0
0	1	1
1	0	1
1	1	1

Boolean XOR X , Y

get X (bit)	get Y (bit)	store result (bit)
0	0	0
0	1	1
1	0	1
1	1	0

Boolean NOT X

get X (bit)	get Y	store result (bit)
0	-	1
1	-	0

Is X greater than Y

get X (register)	get Y (register)	store result (bit)
get X > get Y		1
get X <= get Y		0

Is X lower than Y

get X (register)	get Y (register)	store result (bit)
get X < get Y		1
get X >= get Y		0

Is X greater or equal Y

get X (register)	get Y (register)	store result (bit)
get X >= get Y		1
get X < get Y		0

Is X lower or equal Y

get X (register)	get Y (register)	store result (bit)
get X <= get Y		1
get X > get Y		0

Is X equal Y

get X (register)	get Y (register)	store result (bit)
get X equal get Y		1
get X not equal get Y		0

Is X not equal Y

get X (register)	get Y (register)	store result (bit)
get X not equal get Y		1
get X equal get Y		0

Copy X value
store result (register) = get X (register)

Copy Boolean X
store result (bit) = get X (bit)

NOTICE!!!
When copying register DREG to a 16 bit register the function returns an error, since the copied value is not in the range of 0-65535.

Divide X by Y
store result (register) = get X (register) / get Y (register)

NOTICE !!!
The function operates on integers. The result is truncated to integer.
Crossing the valid range sets an error flag.
Examples:
10 / 3 = 3
-15 / 4 = -3

Multiply X by Y
store result (register) = get X (register) * get Y (register)
Crossing the valid range sets an error flag.

Subtract Y from X
store result (register) = get X (register) - get Y (register)
Crossing the valid range sets an error flag.

Add X to Y
store result (register) = get X (register) + get Y (register)
Crossing the valid range sets an error flag.

Modulo
The function assigns the modulus of the division of X by Y. For proper functioning, it is required that get X >= 0 and get Y > 0. When any of preconditions are not met, the function returns an error which sets an error flag.
Examples:
10 / 3 = 1
-15 / 4 = error
15 / 5 = 0

Negation
store result (register) = -get X (register)

CAUTION!!!
Note that all registers store unsigned values. Only DREG registers can hold 32 bit signed values. Using this function on DREG registers in will in most cases return an error.

Bitwise OR
The function calculates logical sum of corresponding bits in 2 registers.
Example:

	decimal	hexadecimal	binary
get X (register)	= 1234	= 04D2	= 0000 0100 1101 0010
get Y (register)	= 4991	= 137F	= 0001 0011 0111 1111
store result (register)	= 6143	= 17FF	= 0001 0111 1111 1111

Bitwise AND
The function calculates the product of corresponding bits in 2 registers.

Example:

	decimal	hexadecimal	binary
get X (register)	= 1234	= 04D2	= 0000 0100 1101 0010
get Y (register)	= 4991	= 137F	= 0001 0011 0111 1111
store result (register)	= 82	= 0052	= 0000 0000 0101 0010

Bitwise XOR

The function calculates symmetrical difference of corresponding bits in 2 registers.

Example:

	decimal	hexadecimal	binary
get X (register)	= 1234	= 04D2	= 0000 0100 1101 0010
get Y (register)	= 4991	= 137F	= 0001 0011 0111 1111
store result (register)	= 6061	= 17AD	= 0001 0111 1010 1101

Bitwise NOT

The function negates bits in the register.

Example:

	decimal	hexadecimal	binary
get X (register)	= 1234	= 04D2	= 0000 0100 1101 0010
store result (register)	= 64301	= FB2D	= 1111 1011 0010 1101

Bit copy

The function copies selected bits from a register (get X) to register (store result). Only bits from positions where there are values of 1 in register (get Y). Other bits remain intact.

Example:

	decimal	hexadecimal	binary
get X (register)	= 1039	= 040F	= 0000 0100 0000 1111
get Y (register)	= 4915	= 1333	= 0001 0011 0011 0011
store result (register before operation)	= 3925	= 0F55	= 0000 1111 0101 0101
store result (register after operation)	= 3143	= 0C47	= 0000 1100 0100 0111

This function is very handy when copying values between register space and bit addressed memory space. Virtual registers from bit addressed memory spaces (VREG_BIx - binary inputs, and VREG_BO - binary outputs) enable access from functions operating on registers to bit variables. Virtual register mapping is sequential: first register holds first 16 bits, the next following 16 and so on...

For example:

register	bit 0	bit 1	bit 2	bit 3	bit 4	bit 5	bit 6	bit 7
VREG_BI0	IQ1	IQ2	IQ3	IQ4	IQ5	IQ6	IQ7	IQ8
VREG_BO 0	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
VREG_BO 1	P9	P10	P11	P12	P13	P14	P15	P16

register	bit 8	bit 9	bit 10	bit 11	bit 12	bit 13	bit 14	bit 15
VREG_BI0	I1	I2	I3	I4	I5	I6	I7	I8
VREG_BO 0	P1	P2	P3	P4	P5	P6	P7	P8
VREG_BO 1	CLK_C1	CLK_C2	CLK_C3	CLK_C4	CLK_C5	CLK_C6	CLK_C7	CLK_C8

NOP

No operation performed.

Goto
The function jumps to specified in parameter (get X) location (program line).

CAUTION!!!
The number of instructions carried out in one program cycle is limited to 2000. Upon reaching limit, the execution stops. Next cycle starts from line number 0. Reaching the limit is signaled by ERR LED for diagnostic purposes.

Exit
The function ends the program execution for a particular cycle.

Bit test
This function verifies whether at least one bit in get X register is set according to mask defined by get Y register. If confirmed, the function returns value 1 in store result column, else 0.
Example:

	hexadecimal	binary
get X (register) (value)	04D2	= 0000 0100 1101 0010
get Y (register) (mask)	1820	= 0001 1000 0010 0000
store result (bit)	0	= 0
get X (register) (value)	04F2	= 0000 0100 1111 0010
get Y (register) (mask)	1820	= 0001 1000 0010 0000
store result (bit)	1	= 1

Mask test
This function verifies whether all bits in get X register defined in mask get Y are set. If confirmed, the function returns value 1 in store result column, else 0.

Example:

	hexadecimal	binary
get X (register) (value)	04D2	= 0000 0100 1101 0010
get Y (register) (mask)	1820	= 0001 1000 1110 0010
store result (bit)	0	= 0
get X (register) (value)	04F2	= 0001 1100 1111 0010
get Y (register) (mask)	1820	= 0001 1000 1110 0010
store result (bit)	1	= 1

Buffer copy
This function copies value of source buffer starting at register (get X) to destination buffer defined in store result. The length of copied buffer depends on the value in (get Y) register. The function stops when:
- buffer length value is negative,
- writing attempted beyond the buffer space,
- copied value exceeds allowed value of destination buffer. (For instance, an attempt to copy -1 from 32 bit register to 16 bit register).Example:

get X (register) = XREG10
get Y (register) = REG1
store result (register) = DREG2

If REG1 = 4, to function copies 4 values:
DREG5 = XREG13,
DREG4 = XREG12,
DREG3 = XREG11,
DREG2 = XREG10

CAUTION!!!
The function starts copying from the last buffer register and ends at the first register. It creates an easy way to create a logger keeping the history of selected resources in internal registers. In section "Examples of programs" a „Logger program" illustrates using this function.

Copy block quickly
The function copies data among blocks in internal registers space. Following parameters are used:
register (get X) – source block address
register (get Y) – block size
register (store result) – destination block address
Destination and source block may overlap.
When block size exceeds the size of internal register space the data is not copied and the function rises an error flag.

Example:
REG1 = 0x60, REG2 = 0x100, REG3 = 0x600

get X (register) = REG1
get Y (register) = REG2
store result (register) = REG3

The function copies data from source block 0x060…0x15F (XREG1…XREG256) to destination block 0x600…0x6FF (P2SND_B1…P2SND_B256)

Read value from table
This function takes the numerical value from table starting with (get X) register. The value from table cell defined by index register (get Y) is copied to store result register. Table cells are indexed from 0.
store result = get X [get Y].
The function rises error flag when copied value exceeds the range of destination register or cell address lays beyond the space.
Example:

get X (register) = XREG10
get Y (register) = REG1
store result (register) = DREG2

If REG1 = 4, than function performs the operation:
DREG2 = XREG14

Write value to table
The function writes numeric value to table starting with register (store result). The value from register (get X) is copied to table cell defined by index register (get Y). Table cells are indexed from 0.
store result [get Y] = get X.

The function rises error flag when copied value exceeds the range of destination register or cell address lays beyond the space.
Example:

get X (register)	=	REG2
get Y (register)	=	DREG1
store result (register)	=	XREG100

If DREG1 = -5, than function performs the operation:
XREG95 = REG2

Difference between X and Y
This function calculates the integer difference between X and Y, no matter which value is higher.
Exceeding the valid range rises the error flag.

store result (register) = integer value of (get X (register) - get Y (register))

Copy bigger value
The function verifies which value, X or Y is higher and copies the higher one.

If	get X > get Y	than	store result = get X
If	get X <= get Y	than	store result = get Y

Copy lower value
The function verifies which value, X or Y is lower and copies the lower one.

If	get X < get Y	than	store result = get X
If	get X >= get Y	than	store result = get Y

Search for max value in table
The function scans the table beginning with register (get X) for length defined by register (get Y). The highest value found in search is written to (store result) register.
Both 16 and 32 bit registers can be searched. If the value found exceeds the range of (store result) register, the error flag is set.
Example 1:
Table from XREG1 = 1, 5, 0, 100, 23, 340, 1, 25, 340, 5, 560, 23

get X (register)	=	XREG1
get Y (register)	=	10
store result (register)	=	REG1

The result is REG1 = 340
Example 2:
Table from DREG1 = 1, 5, 0, -12000, 23, 340, 1, 25, 340, 5, 65000, 23, 100000, -65000

get X (register)	=	DREG1
get Y (register)	=	12
store result (register)	=	REG1

The result is REG1 = 65000.
If register had the value of 13 for (get Y), the function would have returned REG1 value equal to 100000.

Search for min. value in table

The function scans the table beginning with register (get X) for length defined by register (get Y). The lowest value found in the search is written to (store result) register.
Both 16 and 32 bit registers can be searched. If the value found exceeds the range of (store result) register, the error flag is set.
Example 1:
Table from XREG1 = 1, 5, 6, 100, 23, 340, 1, 25, 340, 5, 560, 0

```
get X (register)        =  XREG1
get Y (register)        =  10
store result (register) =  REG1
```

The result is REG1 = 1
Example 2:
Table from DREG1 = 1, 5, 0, -12000, 23, 340

```
get X (register)        =  DREG1
get Y (register)        =  4
store result (register) =  REG1
```

The result is since REG1 cannot hold the value of -12000.

Search for value in table
The function scans the table (buffer) starting with register (get X) searching for value defined in (get Y) register. The table is searched for first occurrence of searched value or to the end of the memory space. If the value is found, the function returns an index to the register. Indices are calculated from 0. If not found, the function sets an error flag.

NOTICE!!!
The function can search tables of 32 bit registers though one has to be aware that index returned is a 32 table index and not equal to the offset in the address space, as is the case for 16 bit tables.

Example 1:
Table from XREG1 = 1, 5, 0, 100, 23, 340, 1, 100, 340, 5, 560, 23

```
get X (register)        =  XREG1
get Y (register)        =  100
store result (register) =  REG1
```

The result is REG1 = 3

Example 2:
Table from DREG1 = 1, 5, 0, -12000, 23, 340, 1, -100

```
get X (register)        =  DREG2
get Y (register)        =  DREG1
store result (register) =  REG1
```

The result is REG1 = 5

Convert text to number
The function converts decimal value from text to binary. Get X defines start of the text buffer to convert. Text characters are written to low order bytes of 16 bit registers. Get Y defines max number of characters (registers) to convert. The function after successful conversion writes the result in (store result) register. The result is always an integer value. If converted value had a decimal fraction, the decimal separator is omitted and function writes the number of digits after comma to AUX_RET2 register. This allows handling of scaled floating point values. Recognized delimiters are '.' and ','.
Furthermore, the function writes the length of converted value. The converted value may be a negative number provided that result storing register is a 32 bit register.
Examples:

get X	get Y	store result		AUX_RET1	AUX_RET2
		REG1	DREG1		
0abc	4	0	0	1	0
0.000abc	8	0	0	5	3
1234.56789	3	123	123	3	0
-1234.56789	7	Error	-12345	7	1
+0.1234abc	10	1234	1234	7	4
abc	3	Error – number format			
1234.5678900	12	Error – value too big			
1234.56	7	Error	123456	7	2
0,00000012	10	12	12	10	8
.123	4	Error – number format			
123.456.789.000	15	Error	123456	7	3
+000111.2	9	1112	1112	9	1
12.0000	7	Error	120000	7	4
12.0000	6	12000	12000	6	3

Convert number to text

This function converts a binary value from register (get X) to text. The result is written into buffer starting with (store result) register. Separate text characters are stored in low order bytes of 16 bit registers. Get Y defines converted number's format.

get Y:

- unit number defines the number of digits after comma in resultant format.
- tens number defines number of digits before comma , 0 – automatically

+ 100 – sets delimiter to ‘,’ instead of ‘.’

+ 200 – forces adding a sign before positive value.

Furthermore, the function writes the resultant number's length in characters to AUX_RET1 register.

If the converted number is larger then allowed range, the function does not perform the conversion and raises an error flag.

Examples:

get X	get Y	store result	AUX_RET1
0	0	0	1
123	0	123	3
-1234	0	-1234	5
12345	2	123.45	6
123456	103	123,456	7
123456	23	Error	---
0	323	+00,000	7
-15	323	-00,015	7
-15	50	-00015	6

Logical shift left

Function shifts left bits in argument X. Number positions to shifts is defined by parameter Y. The bits that are shifted out are discarded, and zeros are shifted in. Get Y should be ≥ 0, otherwise operation will not be completed and error bit will be set. Error bit will be set also when bit set high (1) will be shifted out.

Examples:

get X	get Y	store result	set if error
0x0000	1	0x0000	0
0x1234	-2	undefined	1
0x0001	15	0x8000	0
0x0003	15	REG=0x8000	1
0x0003	15	DREG=0x00018000	0
0x0003	31	REG=0x0000	1
0x0003	31	DREG=0x80000000	1
0x0001	≥32	0x0000	1
0x0000	≥32	0x0000	0
0x00010000	0	DREG=0x00010000	0
0x00010000	0	REG=0x0000	1

Logical shift right

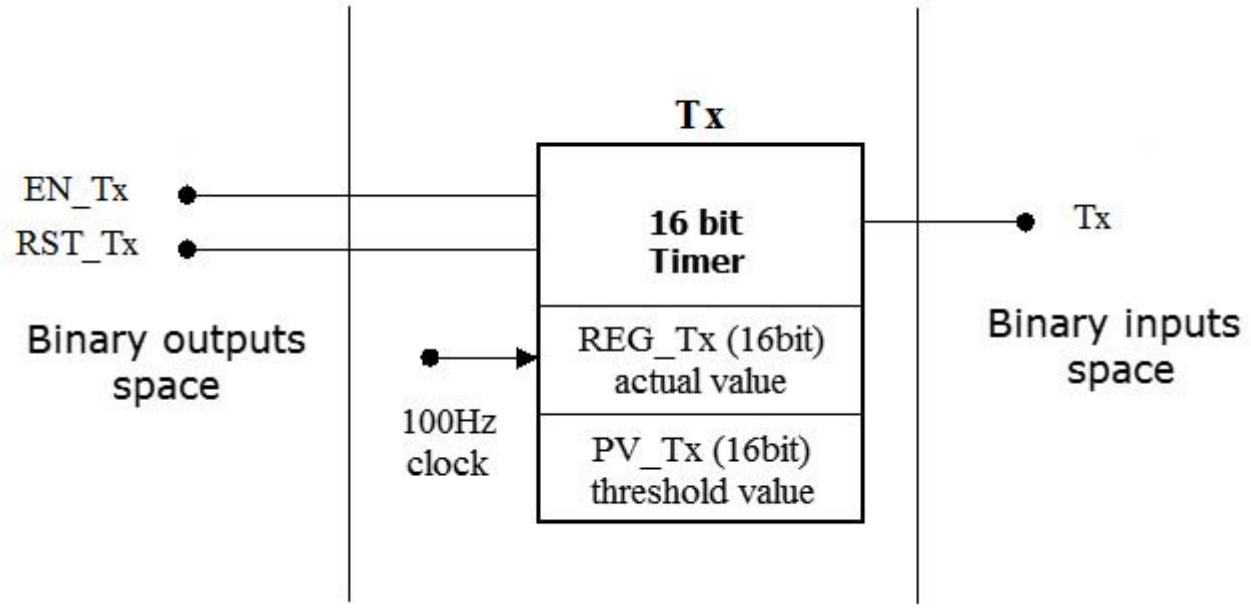
Function shifts right bits in argument X. Number positions to shifts is defined by parameter Y. The bits that are shifted out are discarded, and zeros are shifted in. Get Y should be ≥ 0, otherwise operation will not be completed and error bit will be set. Error bit will be set also when bit set high (1) will be shifted out.

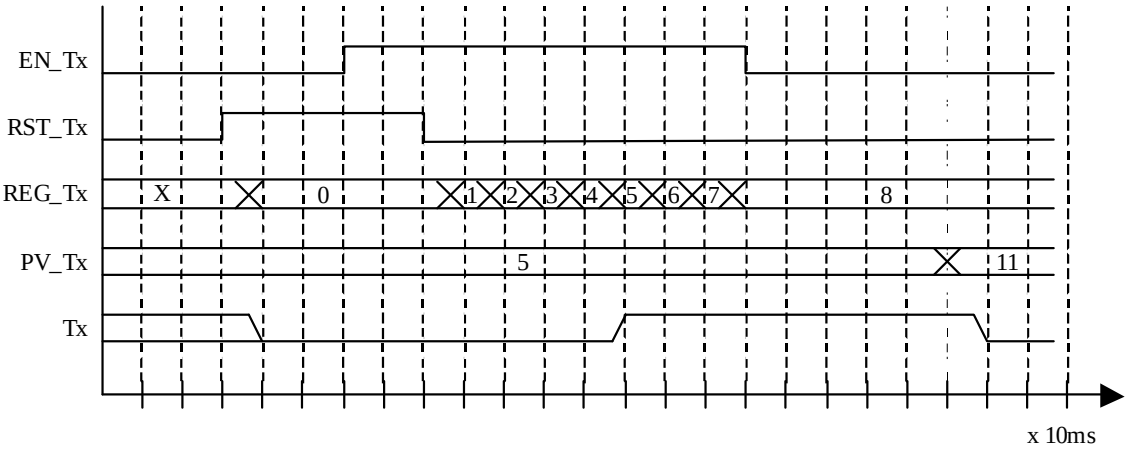
Examples:

get X	get Y	store result	set if error
0x0000	1	0x0000	0
0x1234	-2	undefined	1
0x1112	1	0x0889	0
0x1111	1	0x0888	1
0x01118000	15	0x0223	0
0x81118000	15	REG=0x0223	1
0x81118000	15	DREG=0x00010223	0
0xC0000000	31	0x0001	1
0x80000000	≥32	0x0000	1
0x0000	≥32	0x0000	0
0x00010000	0	DREG=0x00010000	0
0x00010000	0	REG=0x0000	1

6.9. Description of internal function blocks

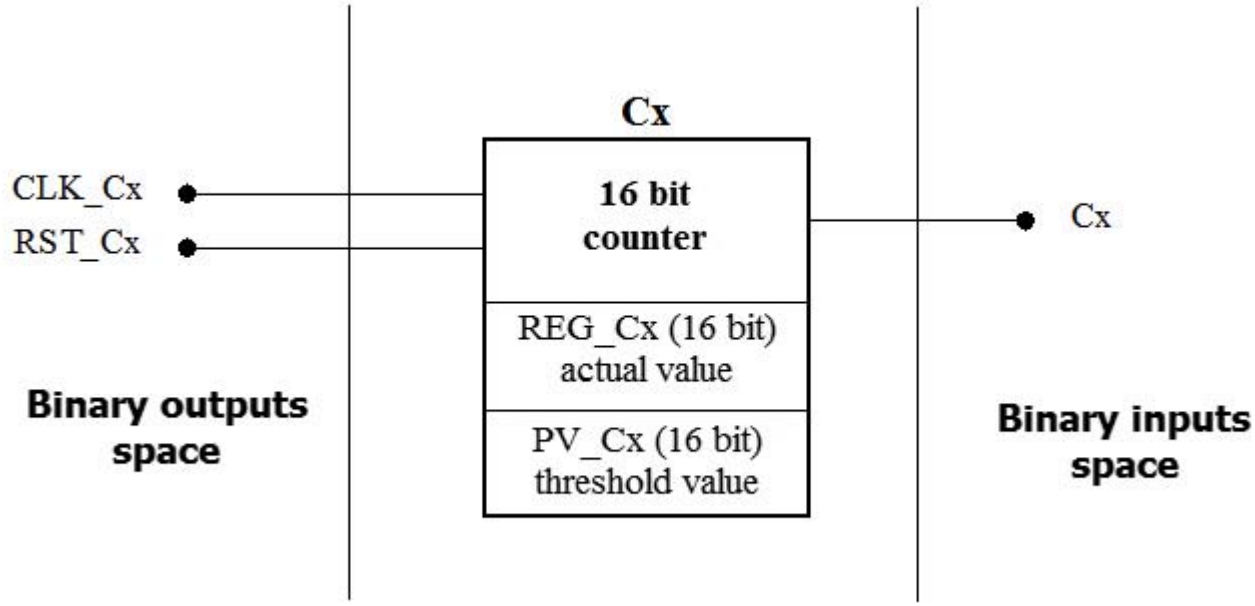
6.9.1. Timers T1...T8

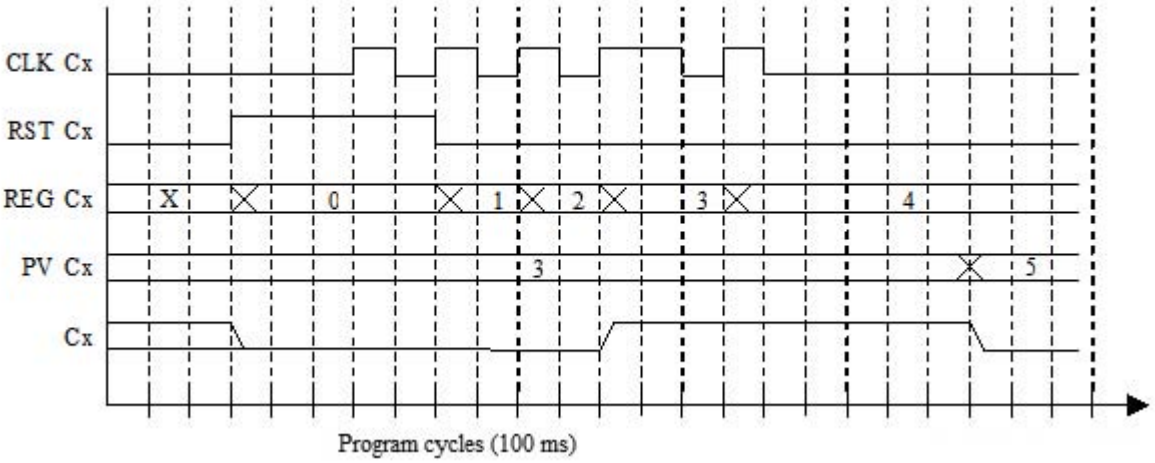




CAUTION!
All variables in Modbus address space are updated after every cycle of internal program execution - that is every 100ms.

6.9.2. Counters C1...C8





6.10. Signal levels or edges

All logical input values may be additionally affected by a level or edge condition.

The default value is a positive signal level. However, the user can change each of the input signals (Condition, Parameter X or Parameter Y) so that the program reacts to inverted value, rising edge, falling edge or change of state.

6.11. Filling and modifying program table

The program table has to be filled out with subsequent lines starting with the left column and moving towards the right column. Double-clicking on any given field in the table unfolds a list of variables or functions available to the given column.
In the “Condition” column, double-clicking unfolds a list of logical variables whose state can be checked. The name of the variable can also be entered directly by keyboard or by clicking on

the 0/1 values on the numerical keypad. After selecting the name of the variable, it is also possible to define the level or edge condition the execution of the function.

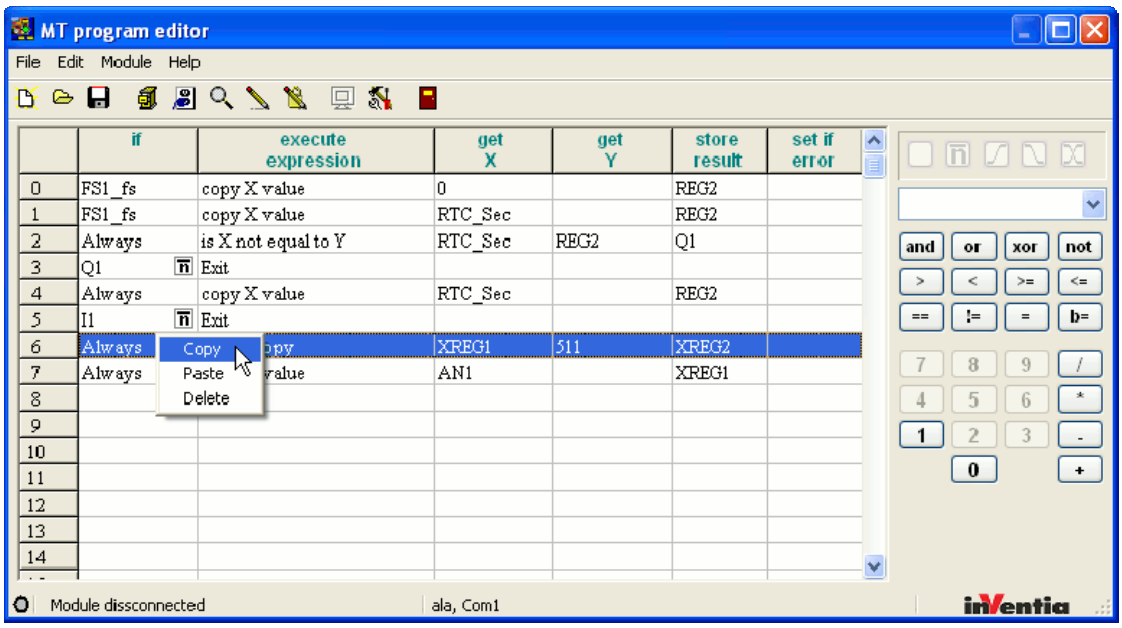
Double-clicking with left mouse button causes a list of available functions to drop down. However, the function can also be selected from standard functions grouped around the numerical keypad, from the list placed above the numerical keypad or by entering the name of the function manually. In case of manual entering, a warning message will appear if the name entered manually is not identical to one of the available functions.

For the columns “Take X” or “Take Y”, double-clicking with the left mouse button unfolds a box with a list of variables which may be used as arguments of the function selected earlier. These will be either arithmetic or logical variables. The same discrimination will be visible on the numerical keypad in the right side of the window. In case of logical variables, only the “0” and “1” buttons will be active. Of course, the names of variables or values can be entered from the computer keyboard. If the function can only accept one argument, it will be impossible to select and enter a second one.

The “Store result” column is filled out in a similar way. A list of modifiable variables drops down after double-clicking on the column with left mouse button. Logical and analog inputs will not be displayed. The type of variables is correlated with the previously selected function.

The optional selection in the “If error” column is limited to logical variables whose modification is possible.

Manipulation of program rows is possible after activating context menu by clicking with right mouse button.



Functions of Context Menu apply for the selected table row. Copied rows are pasted above the highlighted row.

6.12. Downloding the program

After completed editing of program, data can be sent to the module.

The method of transmission depends on selected means of communication. When programming locally, it is necessary to establish RS232 cable connection.

For remote programming, it is necessary that the computer on which MTProg is running has a network connection to the APN where the module resides.
Next step is selecting "Connect" and "Write Program" or "Write and block reading". The command description can be found in section Menu Module.

6.13. Verifying the program

Despite the high reliability of both local and remote programming, it is recommended to verify the program written into the module. Especially in cases where the module does not seem to be acting according to the controlling algorithm.

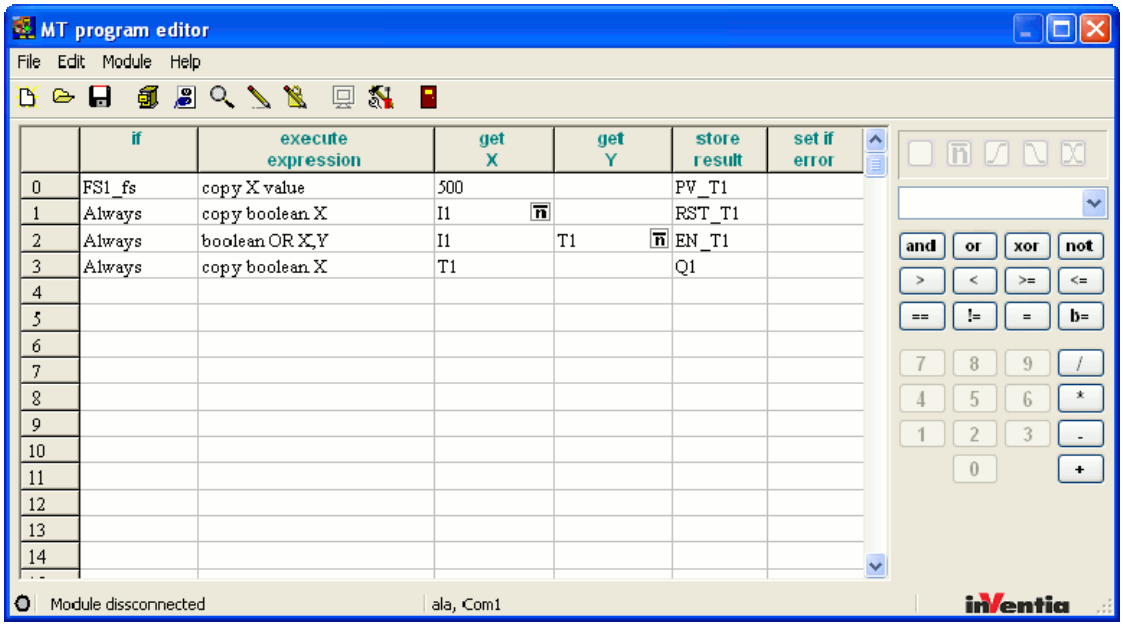
The device status LED which displays possible problems resulting from errors in processing of downloaded internal programs has to be verified.

6.14. Program examples

This chapter aims at acquainting the user with common methods of defining algorithms. Programs included in this chapter are built on simple premises and do not take the fact that they are all made for purely educational purposes into consideration. The authors renounce any liability for faults resulting from using programs without prior analysis of circumstances.

6.14.1. The timer

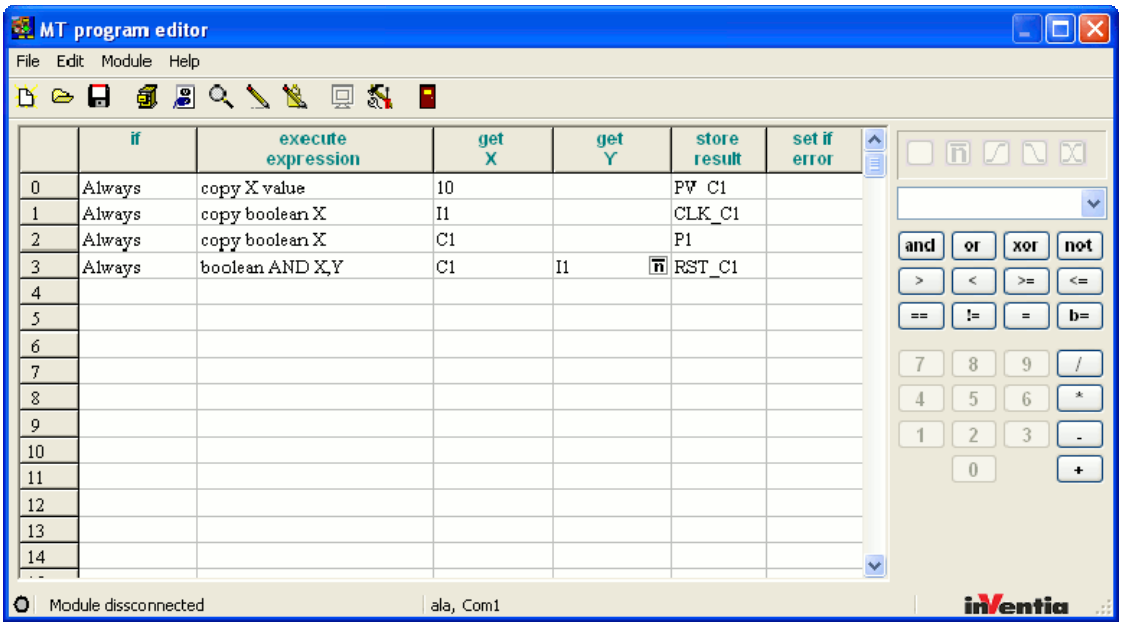
This program illustrates the use of the typical timer (1 of 8 available in MTProg), activated by I1 going high (third program line). The preset value PV_T1 that the timer counts up to is 5s (clock frequency is 100Hz) - the line is executed only by first program cycle. When preset value is reached, T1 flag is raised and output Q1 is set to high. The timer can be stopped before 5 seconds lapse by setting I1 low.



6.14.2. The counter

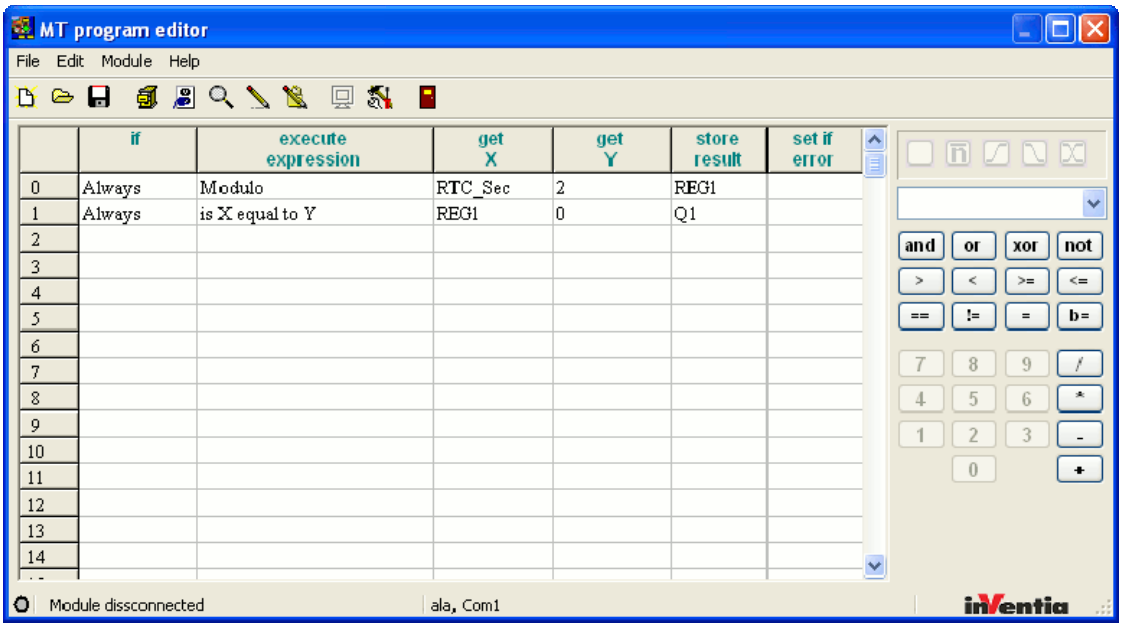
MTProg has 8 counters of this type. The example illustrates a counter counting 10 activations of I1. Upon reaching the count of PV_C1 the flag C1 rises. Line 2 copies the state of C1 to

output Q1. Change of Q1 may be used in the rule defining the data or sms transmission or in further programming. The counter is reset (line 3) upon reaching the preset value of 10.



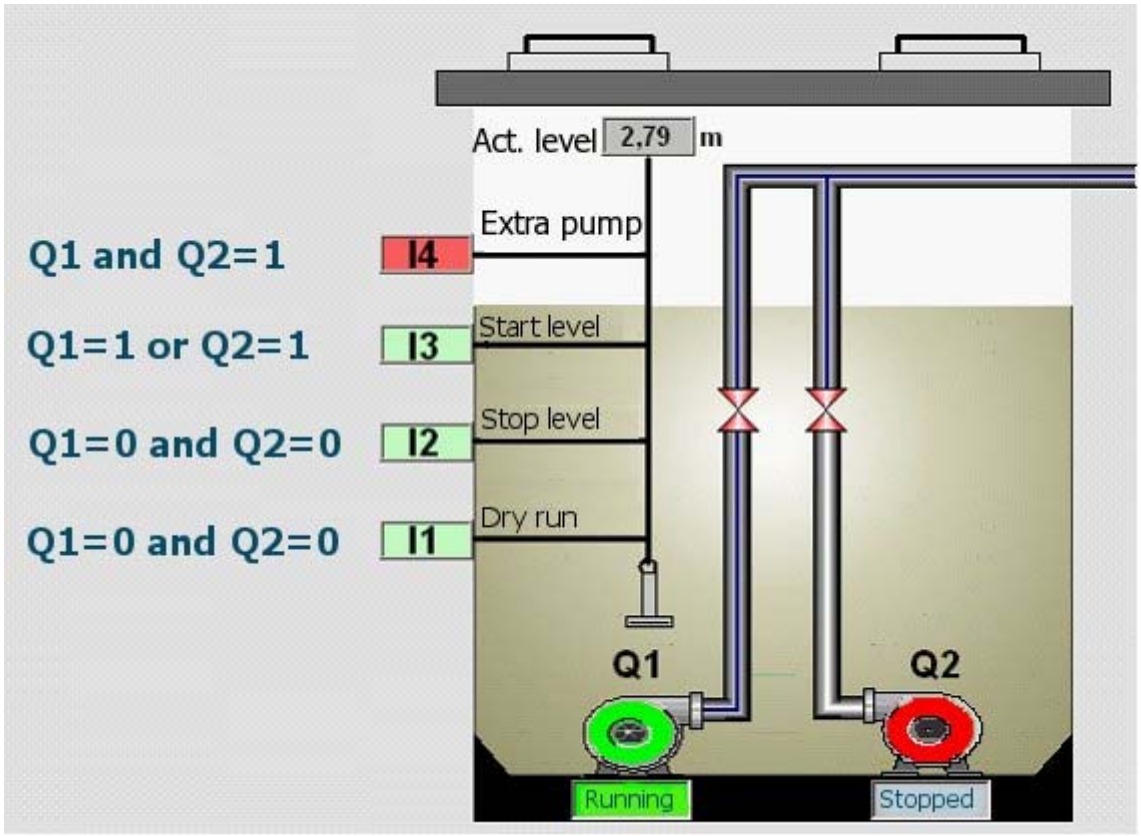
6.14.3. Pulse generator

Simple example of pulsing output Q1. The interval of switching on/off is 1 second.



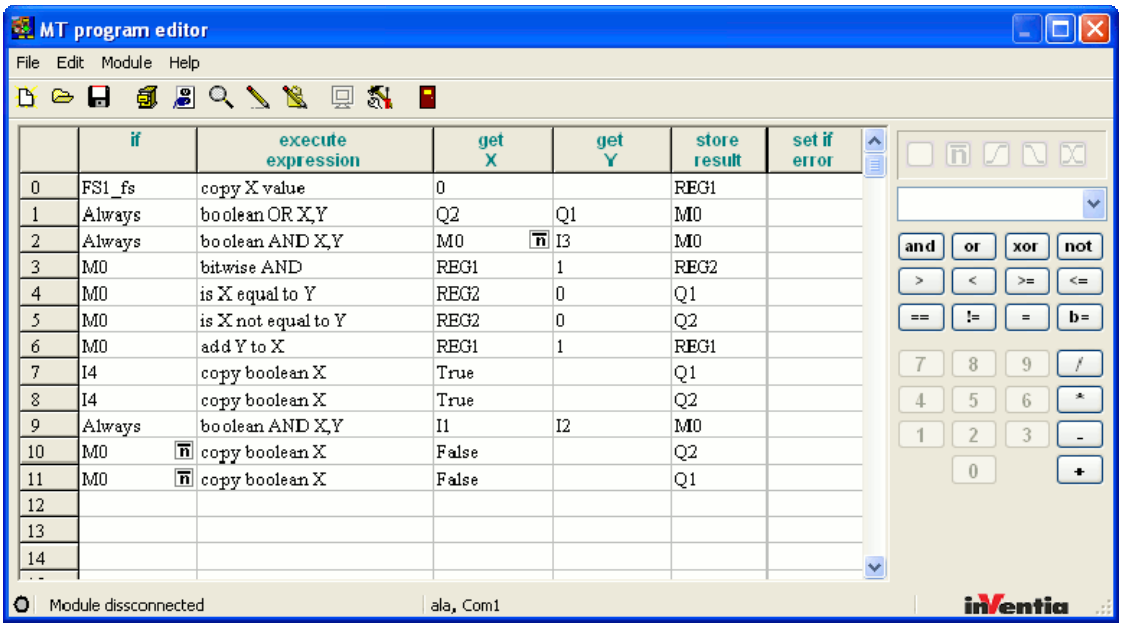
6.14.4. 2 pumps alternating action

Next example illustrates alternating work of 2 pumps activated by respective Q1 and Q2 output. When water level makes sensor on input I3 close (start level), the program turns resting output Qx on. If the water level does not decrease and the sensor on I4 gets activated, the resting pump is switched on and stays on until the level drops to under stop level (I2). There is an auxiliary security measure in the program in case of the I2 sensor hanging, where the program turns both pumps off if Dry run (I1) level is crossed.
Note that in order to start the pump, I1 and I2 have to be ON when I3 gets activated.



* - value 1 shifts between Q1 and Q2 depending on their state in last working cycle (if Q1=1 and Q2=0 then in next cycle it will shift to Q1=0 and Q2=1

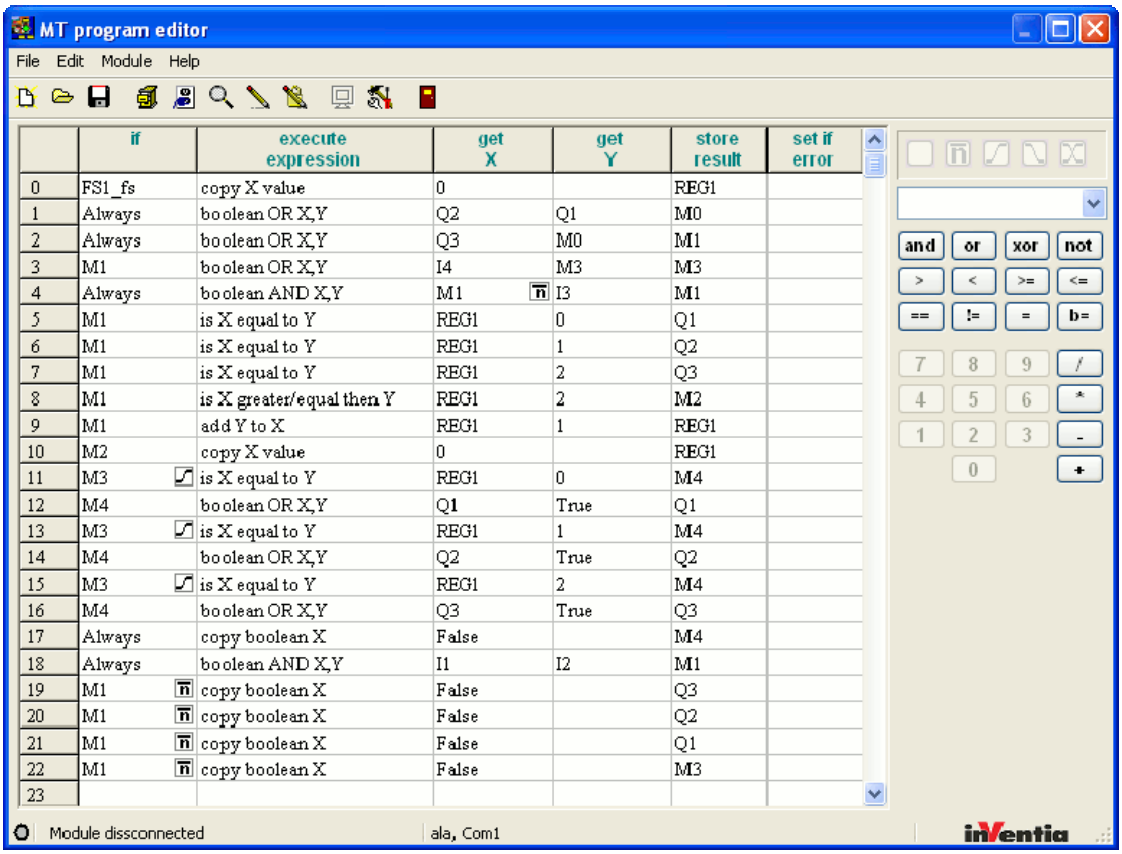
The first program line resets REG1 to 0 (executed only on first scanning of program- later on omitted since the condition is not met). Operations on REG1 and M0 flag prepare tasks for the next sequence of pumping using Q1 and Q2. Altering functionality is based on checking the value of the first bit in REG1. The bit changes its value for each change of M0 marker).



	if	execute expression	get X	get Y	store result	set if error
0	FS1_fs	copy X value	0		REG1	
1	Always	boolean OR X,Y	Q2	Q1	M0	
2	Always	boolean AND X,Y	M0	I3	M0	
3	M0	bitwise AND	REG1	1	REG2	
4	M0	is X equal to Y	REG2	0	Q1	
5	M0	is X not equal to Y	REG2	0	Q2	
6	M0	add Y to X	REG1	1	REG1	
7	I4	copy boolean X	True		Q1	
8	I4	copy boolean X	True		Q2	
9	Always	boolean AND X,Y	I1	I2	M0	
10	M0	copy boolean X	False		Q2	
11	M0	copy boolean X	False		Q1	
12						
13						
14						

6.14.5. 3 pumps toggle action

In this example, the levels of starting and stopping of 3 binary outputs are designed exactly as the previous example for two pumps (I1,I2,I3,I4). The pumps alternate between Q1 Q2 and Q3. The difference is that when I4 is activated, the auxiliary pump goes into action. For instance when Q3 is running Q1 serves as auxiliary pump and so on..

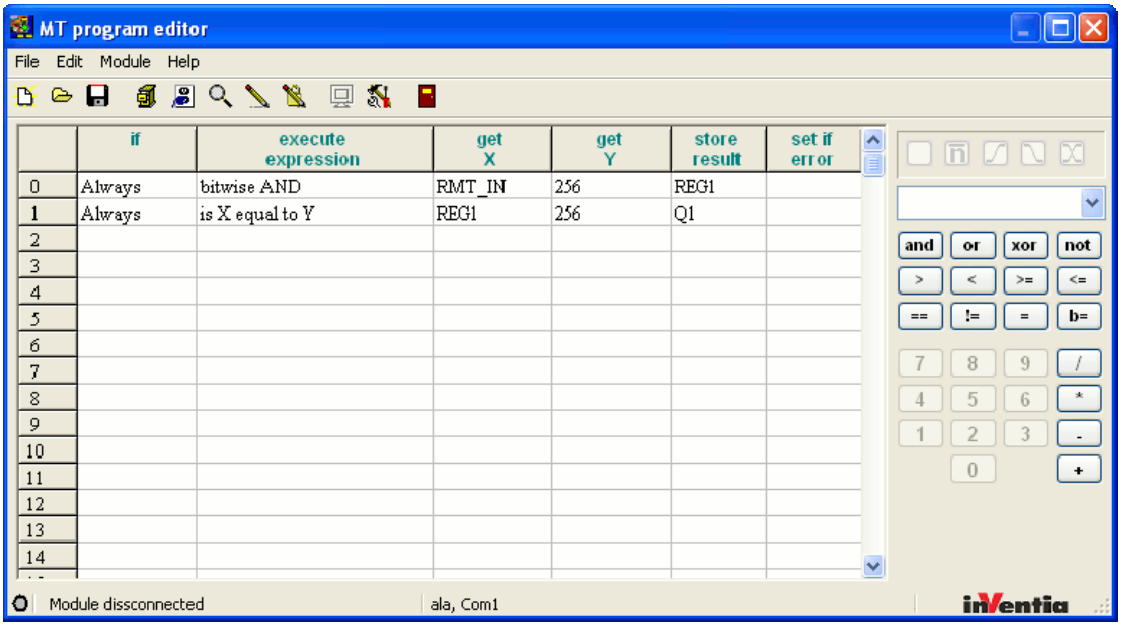


	if	execute expression	get X	get Y	store result	set if error
0	FS1_fs	copy X value	0		REG1	
1	Always	boolean OR X,Y	Q2	Q1	M0	
2	Always	boolean OR X,Y	Q3	M0	M1	
3	M1	boolean OR X,Y	I4	M3	M3	
4	Always	boolean AND X,Y	M1	I3	M1	
5	M1	is X equal to Y	REG1	0	Q1	
6	M1	is X equal to Y	REG1	1	Q2	
7	M1	is X equal to Y	REG1	2	Q3	
8	M1	is X greater/equal then Y	REG1	2	M2	
9	M1	add Y to X	REG1	1	REG1	
10	M2	copy X value	0		REG1	
11	M3	is X equal to Y	REG1	0	M4	
12	M4	boolean OR X,Y	Q1	True	Q1	
13	M3	is X equal to Y	REG1	1	M4	
14	M4	boolean OR X,Y	Q2	True	Q2	
15	M3	is X equal to Y	REG1	2	M4	
16	M4	boolean OR X,Y	Q3	True	Q3	
17	Always	copy boolean X	False		M4	
18	Always	boolean AND X,Y	I1	I2	M1	
19	M1	copy boolean X	False		Q3	
20	M1	copy boolean X	False		Q2	
21	M1	copy boolean X	False		Q1	
22	M1	copy boolean X	False		M3	
23						

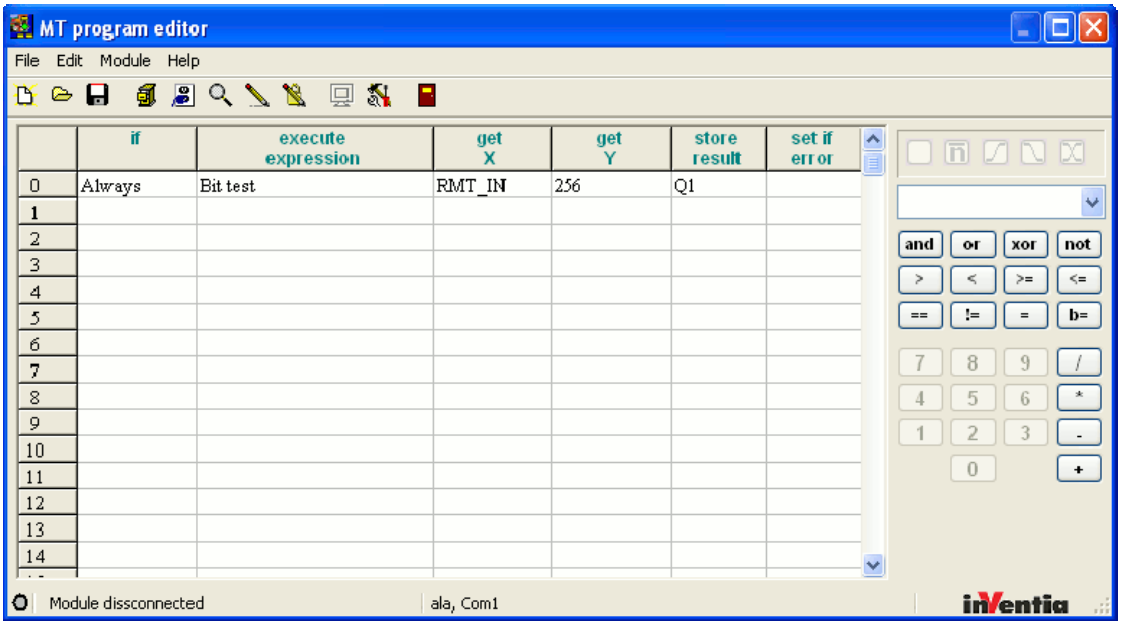
6.14.6. Checking bit value in the registry

In case of MT-10X to MT-10X communication (cascade communication system), it is necessary to test values of receiving module registers holding status received last via GPRS from sending module. MTProg recognizes it as: RMT_IN (input space), RMT_ID_OUT (sender's ID + output space), RMT_AN1 and RMT_AN2 (input AN1 respectively AN2).

As the result, the value of binary input I1 at sending module will be mirrored by receiving module's binary output Q1.
Line 0 copies the bit 9 of RMT_IN into REG1. Line 1 compares REG1 to 256 (value of bit 9) and sets Q1 accordingly to the actual value.



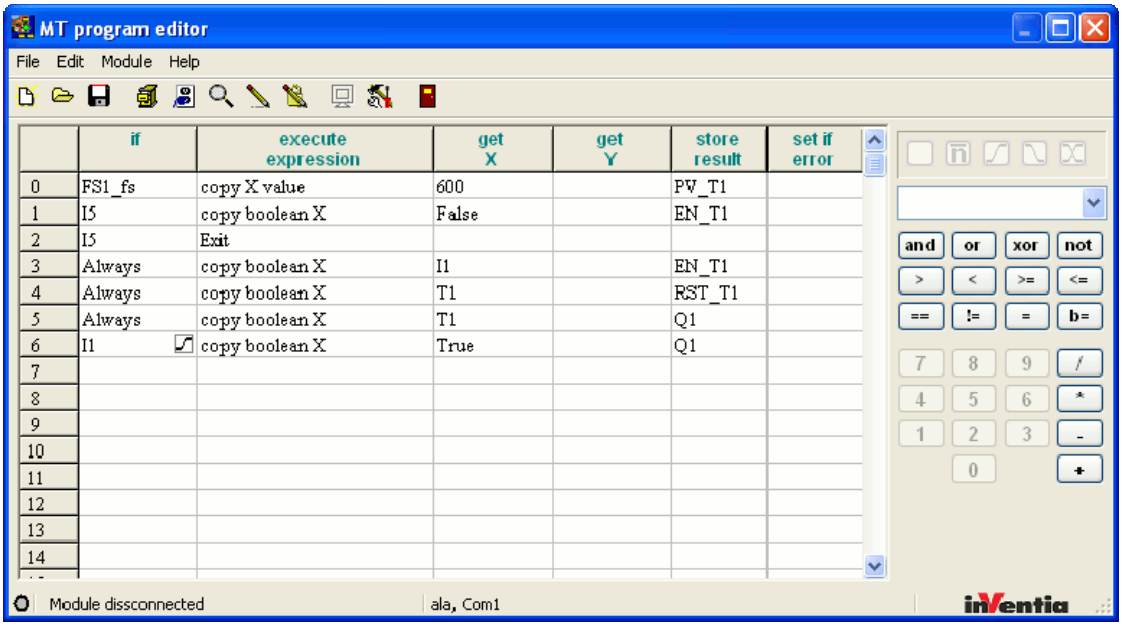
The same effect can be obtained in more elegant way employing function "Bit test":



6.14.7. Alarm with confirmation

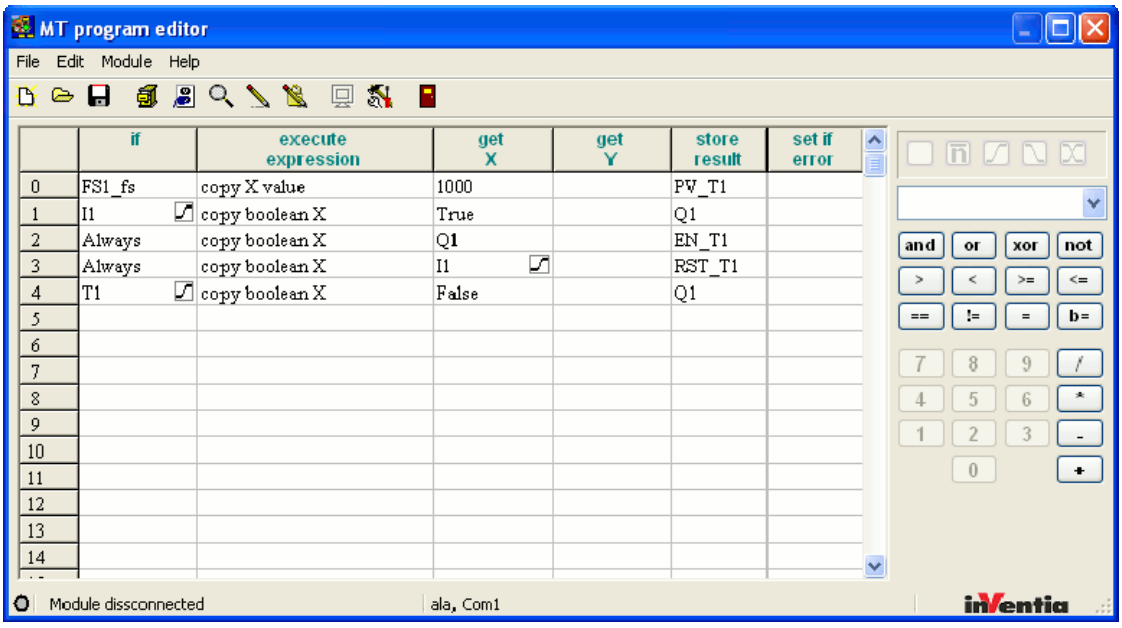
The program generates cyclic transmission of SMS messages until I5, declared as alarm confirmation, is activated or the alarm condition ceases (I1=0)

When binary input I1 is activated, output Q1 is set high. (In MTManager - the rule triggered by Q1 sending SMS is defined). Simultaneous to I1 going high, the timer 1 is activated and counts to PV_T1 amounting 600 (6 seconds) starts. Upon reaching PV_T1, the flag T1 is set and subsequently Q1 is set. As a result of the rule, an SMS message is dispatched. Until I5 is activated or I1 deactivated, SMS messages will be regularly dispatched.



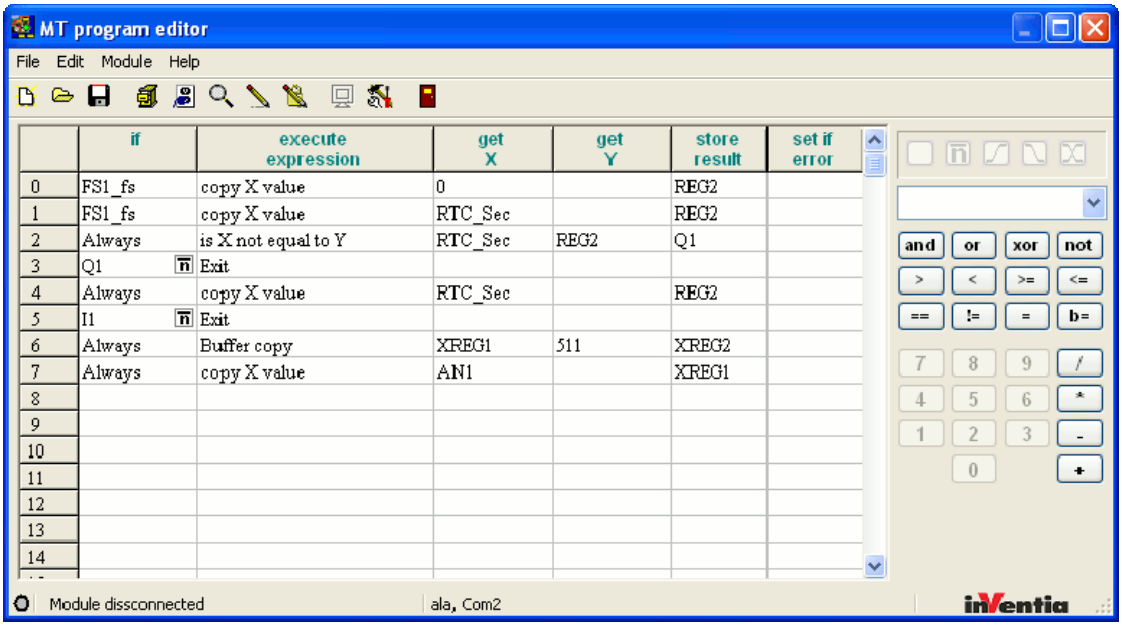
6.14.8. Motion detector

The motion detector is connected to I1 and light source to Q1. When I1 is activated, the module turns the light on for 10 seconds. Repeated activation of I1 resets the time count back to 100 seconds.



6.14.9. Logger program

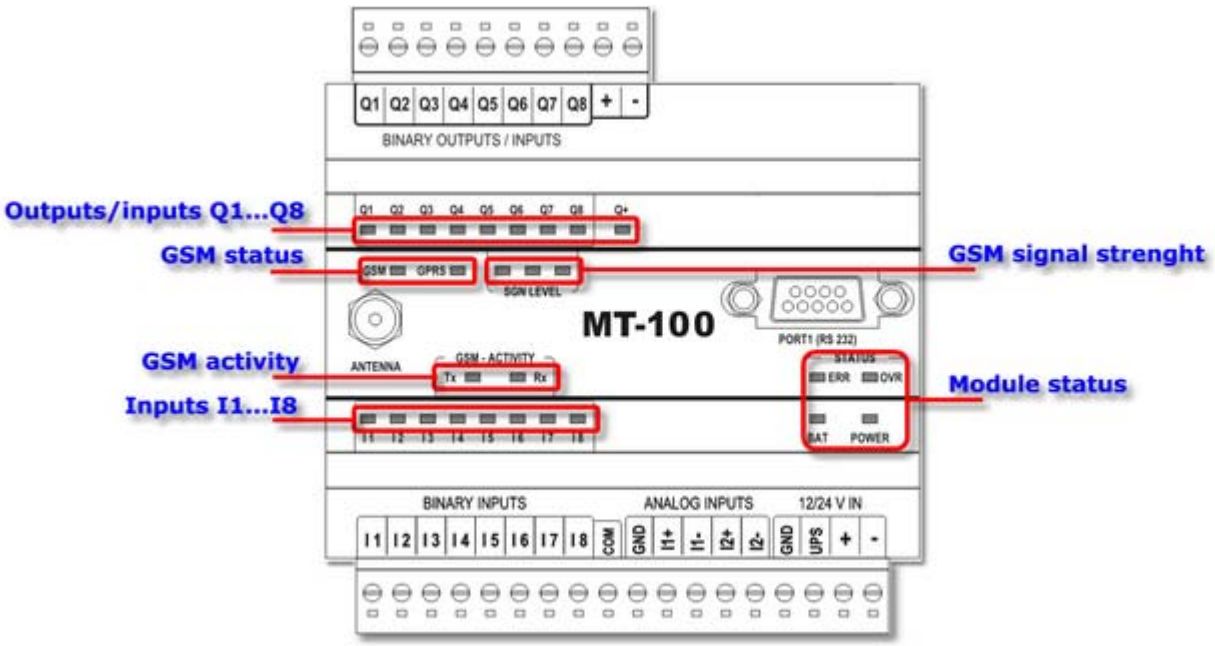
An example of creating 512 elements logger for AN1 with 1 sec interval activated when I1 = 1.



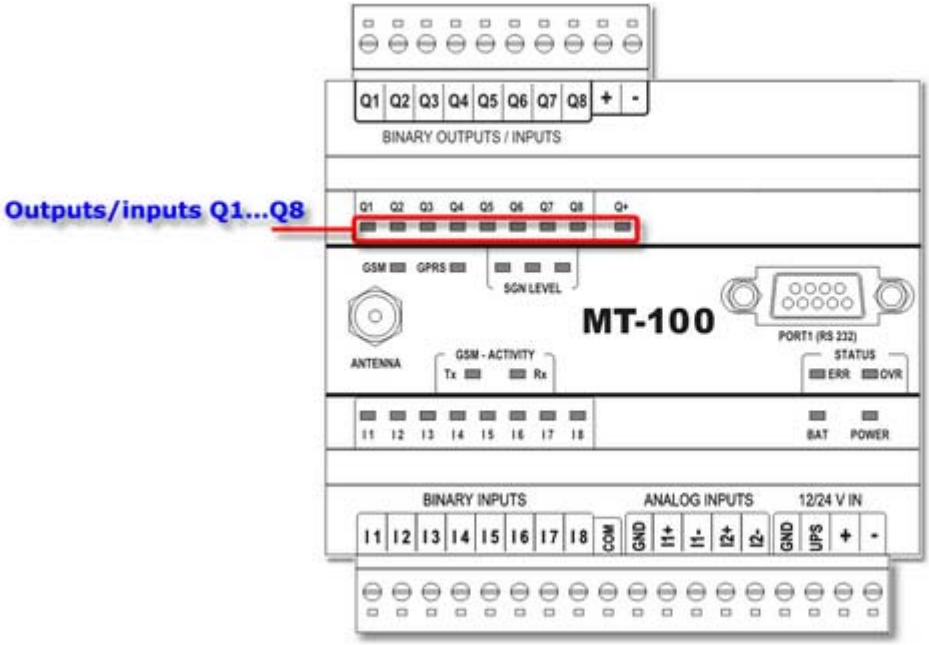
7. Problem solving

7.1. LED signalling

LED indicators placed on front panel of the **MT-100** module are very convenient during start-up procedure. In order to understand their message please get acquainted with error codes.



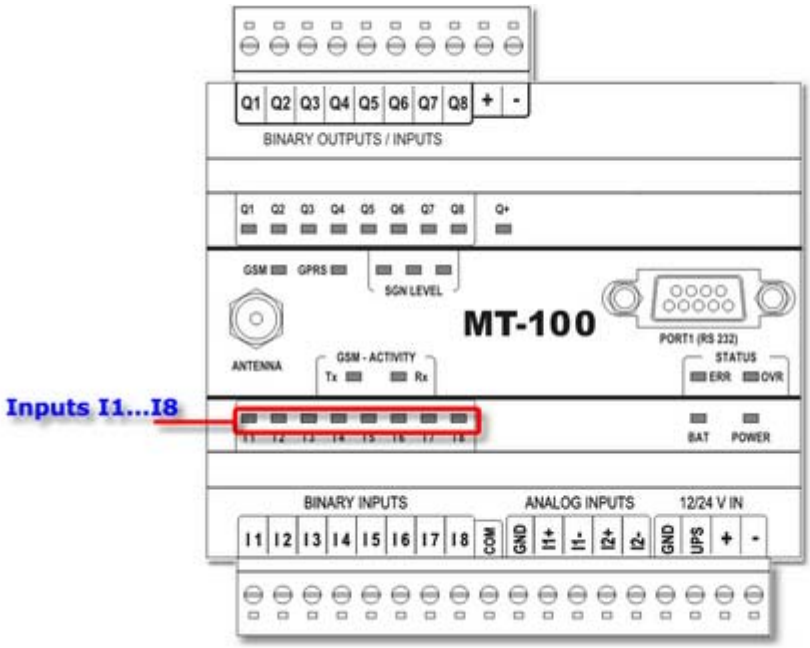
7.1.1. Inputs/Outputs Q1....Q8



LED indicators for *outputs/inputs Q1....Q8* group signal both High state of forced output signal and High state of input signal in cases where output Q1...Q8 operates as binary input. Visual evaluation of current input/output state makes working with the module much easier.

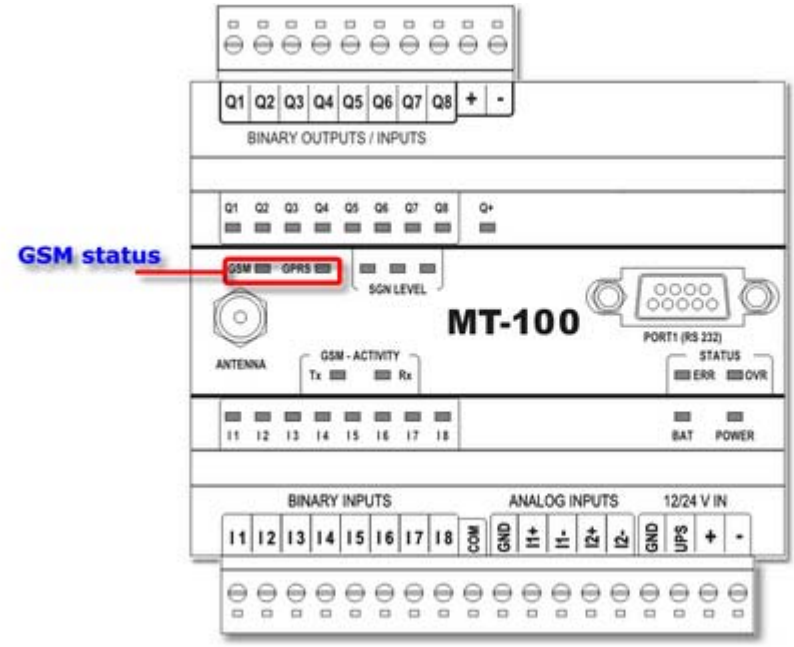
Flashing 2 Hz. output LED signifies that there is a discrepancy between intended output state and its actual state. This usually occurs when the load is missing or the circuit is shorted.

7.1.2. Inputs I1....I8



LED indicators of *Inputs I1....I8* signal high state of binary signal connected to I1....I8 inputs. It takes place regardless of whether the module operates in positive or negative logic. Visual evaluation of current input state makes working with the module much easier.

7.1.3. GSM status



GSM Status LEDs indicate:

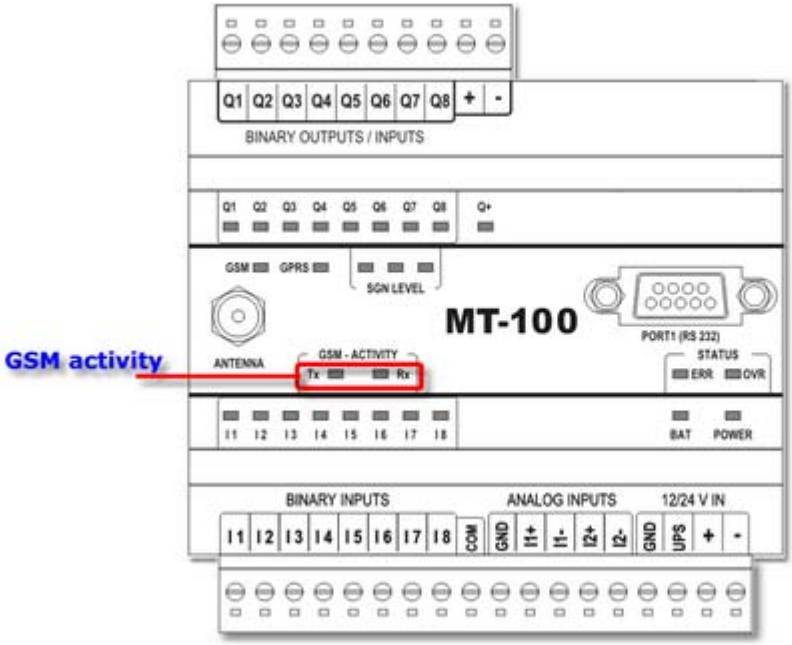
GSM LED- reflects current GSM network login state.

- single long pulses, LED on for 0.6s and off for 0.6s - the module not logged into GSM (no SIM, searching for network, wrong PIN)
- single short pulses, LED on for 0.075s in 3s period - module logged into GSM
- double short pulses, LED on two times for 0.075s with 0.075s gap between pulses in 3s period - module logged into GPRS
- long pulses, LED on for 0.5s with 0.05 gaps between pulses - GPRS data transmission in progress

GPRS LED - when lit, signifies proper login to APN.

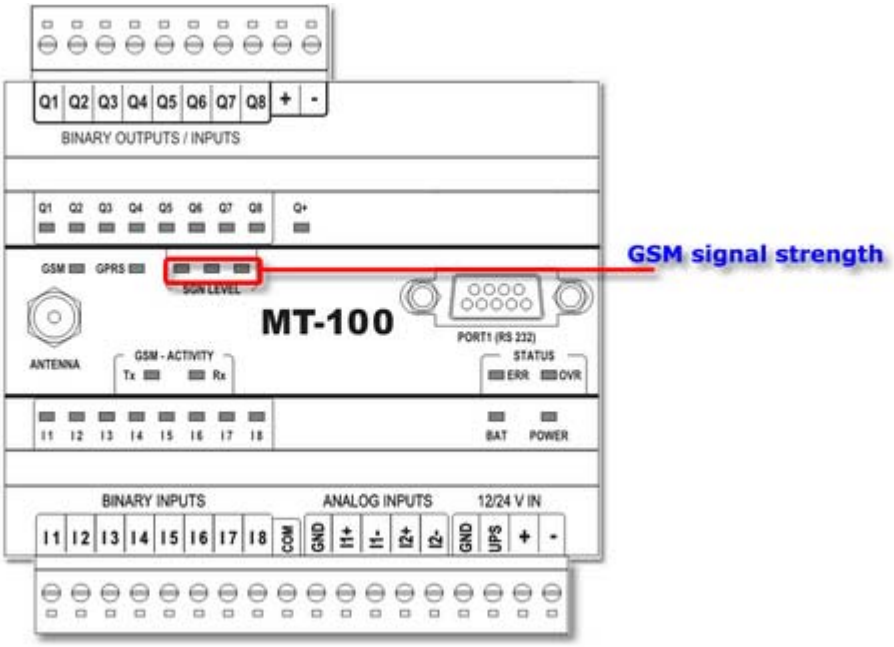
LED indicators for *GSM Status* group reflect module's readiness to perform its duties. Modules not logged in GSM/GPRS network are not able to transmit data and performs cyclic resets and retries to log in.

7.1.4. GSM activity



LED indicators **Tx** and **Rx** of *GSM activity* signal, respectively, transmitting and receiving of data via GPRS. Since SMS sending is a form of data transmission, both data frame transmission and SMS transmission cause short flashes of **Tx** LED. Short flashes of **Rx** LED indicate either SMS or data frame reception. This is an easy way of detecting transmission activities.

7.1.5. GSM signal level

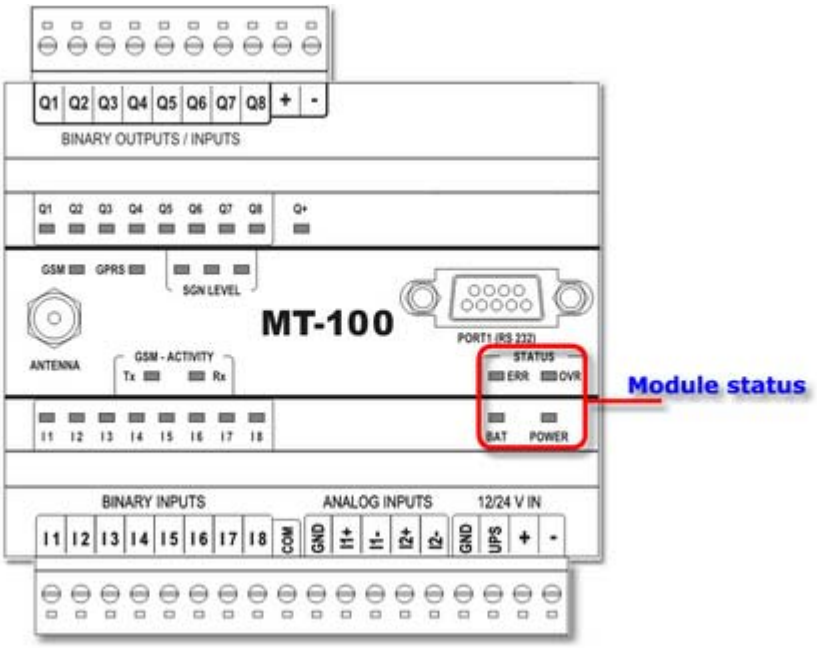


LED indicators of *GSM Signal level* display information received from GSM network on signal level in the place where the antenna is mounted.

It is presumed that for reliable operation at least one LED is lit. Lower level signal does not guarantee reliable operation and means that antenna placement should be changed or the antenna should be replaced with one securing higher signal level.

Reading of signal level happens in the moment of login to network and every 12 minutes, if the module operates in SMS mode. Selection of GPRS mode only means that signal level is investigated only during login procedure, typically at power up. That does not pose any danger since no disturbances in module's operation mean that the signal strength is sufficient.

7.1.6. Module status



Module status group encompasses four LED indicators displaying the state of the circuit controlling the module's operation and with execution of user-defined program.

Significance of LED indicators:

- **Err** LED - when lit, the **Err** LED indicates an error forcing automatic reboot. The reason may be lack of GPRS communication disabling transmission of awaiting data.
  Triple flash of Err LED indicates that current firmware does not support the function used in the program. In this situation, one solution is updating the firmware.
- **Ovr** LED - when lit, the **Ovr** LED indicates that execution of the program cycle took over 100ms and the next cycle was delayed as the result and may render improper execution of the program.
  The LED is lit in following cases:
  - the program loaded is stopped,
  - a new configuration or firmware is loaded and internal program was automatically stopped in order avoid interference. In that case make sure not to disrupt the power supply until the module restarts automatically. It may take couple of minutes.
- **Bat** LED - is lit when the potential on UPS input falls below 13,8V. Since this input is used to signal main supply failure, the system flag FS1_ups is raised simultaneously. The FS1_ups flag may be used in rules processing.
- **Power** LED - is lit all the time the module is supplied with power.

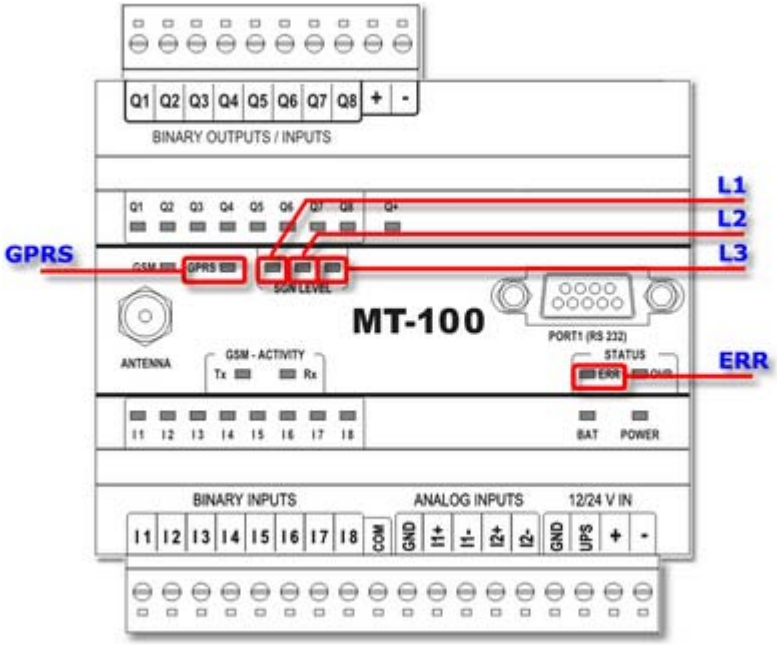
Indicators of *Module status* group are the main sources of visual information about correct operation of the module.

7.1.7. Error signalling

Despite the efforts of module designers and users errors in function do occur. It is often imperative to diagnose and remove the cause of error. Error signaling is a tool for solving problems.

LED indicators on module's front panel interpret errors:

- **ERR**
- **GPRS**
- **L1**, **L2**, **L3** of **SGN LEVEL** group



Depending on type, errors are classified as standard or critical. Standard errors are a result of faulty configuration or reasons independent of the module. Critical errors are usually connected to physical damage or faults in internal program.

7.1.7.1. Standard errors

A sign of **Standard error** occurrence is a lit **ERR** LED. Error code numbers are displayed on signal level and **GPRS** LEDs.

ERR	***State***
○	lit

GPRS	***L1***	***L2***	***L3***	***Error no***	***Description***
●	○	●	●	1	Modem error
●	●	○	●	2	GSM network error - check antenna connection and SIM card activation in GSM network.
●	○	○	●	3	GPRS network error - check SIM card activation in GPRS network
●	●	●	○	4	Wrong user name or password for GPRS network
●	○	●	○	5	Log in to GPRS error
●	●	○	○	6	Connection interrupted
●	○	○	○	7	Other error
○	●	●	●	8	
○	○	●	●	9	SIM card error (locked or missing)
○	●	○	●	10	
○	○	○	●	11	
○	●	●	○	12	
○	○	●	○	13	Number of log into GPRS trials exceeded
○	●	○	○	14	Module blocked
○	○	○	○	15	Wrong PIN for SIM card

○	LED flashing (0,5Hz)
●	LED off

When GPRS LED is off the module is automatically trying reinitiate transmission.
When GPRS LED is flashing user intervention is required. Remove the reason for error and recycle the power.

7.1.7.2. Critical errors

A sign of **Critical error** is the flashing of **ERR LED.** Error code numbers are displayed on signal level and **GPRS** LEDs.

ERR	***State***
○ ●	flashes (0,5Hz)

GPRS	***L1***	***L2***	***L3***	***Error nr***	***Description***
●	○	●	●	1	BOOT module error
●	●	○	●	2	Main program error
●	○	○	●	3	Update error
●	●	●	○	4	RAM_N error in CPU
●	○	●	○	5	External RAM error
●	●	○	○	6	
●	○	○	○	7	Stack overflow
○	●	●	●	8	
○	○	●	●	9	
○	●	○	●	10	
○	○	○	●	11	
○	●	●	○	12	
○	○	●	○	13	
○	●	○	○	14	
○	○	○	○	15	Undefined error
All LED indicators are flashing					RAM_T memory error in CPU

○	flashing LED (0,5Hz)
●	LED off

Occurrence of any errors described above indicates either a fault in program or a module defect. If a critical error occurs, please note the error code and contact the manufacturer.

7.2. Unblocking of SIM card

Three failed attempts of entering PIN code locks the SIM card and requires entering the PUK code. In order to prevent this, the module controls the number of failed attempts written into SIM card by allowing only two attempts making a third attempt impossible even if the third attempt was correct.
A double unsuccessful attempt is perceived as a fault requiring user intervention. An attempt to unlock the module may be performed only when the right PIN code is known.

Necessary procedure:

- turn the power supply off
- remove SIM card from the module
- insert SIM to ordinary mobile phone accepting cards from the operator that issued actual SIM
- start the phone and enter proper PIN code
- if not accomplished before...
  - start the module
  - insert appropriate PIN into configuration
  - power the module off
- remove the SIM from the phone and place it in the module
- start the module

The described procedure reset SIM card's fault counter and allow using the card in **MT-100** module.

In older versions of GSM modems without implemented protection procedures the SIM card may get blocked after 3 failed attempts and the only method of unblocking it is to supply the right PUK code. Unfortunately this cannot be performed in the MT-100 module.

The PUK code may by inserted only after taking the SIM card out of MT-100 module and placing it in a standard GSM mobile phone. The phone will demand entering of PUK code at power-up.
Entering correct PUK-code unblocks the card and resets PIN fault counter making the card operational.

8. Technical data

8.1. General

Dimensions (height x width x length)	105x86x60 mm
Weight	300 g
Mounting method	DIN rail 35mm
Operating temperature	-20^0 ... $+50^0$C
Protection class	IP40
Max. potential on any connector referenced to GND	60Vrms max.
Humidity	5 ... 95% non condensing

8.2. Modem GSM/GPRS

Modem type	CINTERION TC63i
GSM	Multiband GSM module (900/1800 or 850/1900)MHz
GPRS	Class 10
Frequency range (EGSM 900 MHz)	Transmitter: from 880 MHz to 915 MHz Receiver: from 925 MHz to 960 MHz
Frequency range (GSM 850 MHz)	Transmitter: from 824 MHz to 849 MHz Receiver: from 869 MHz to 894 MHz
Peak transmitting power (EGSM 900 MHz & GSM 850 MHz)	33 dBm (2W) – class 4 station
Frequency range (EGSM 1800 MHz)	Transmitter: from 1710 MHz to 1785 MHz Receiver: from 1805 MHz to 1880 MHz
Frequency range (PCS 1900 MHz)	Transmitter: from 1850 MHz to 1910 MHz Receiver: from 1930 MHz to 1990 MHz
Peak transmitting power (EGSM 1800 MHz & PCS 1900 MHz)	30 dBm (1W) – class 1station
Modulation	0,3 GMSK
Channel spacing	200 kHz
Antenna	50Ω

8.3. Power supply

Direct Current DC (12V, 24V)	9 ... 30V
Input current (A) (for 12V DC)	Idle 0,07 Active 0,40 Max 1,90
Input current (A) (for 24V DC)	Idle 0,04 Active 0,18 Max 1,00

CAUTION!
Due to high momentary current consumption the power supply must be capable of delivering >= 2A of current.
Inappropriate power supply may result in faulty operation or cause damage to MT-100 module!

8.4. Binary inputs I1....I8

Input voltage range	-36 ... 36V
Input resistance	5,4 kΩ
Input voltage ON (1)	> 9V or < -9V
Input voltage OFF (0)	-3V ... 3V
Frequency range in analog mode	0....2kHz
Min pulse length "1"	5ms

8.5. Binary outputs Q1....Q8

Operating as binary output

Recommended mean current for single output	50mA
Single output current	350mA max.
Mean current for all outputs	400mA max.
Voltage drop for 350mA	< 3,5V max.
OFF state current	< 0,2mA max.

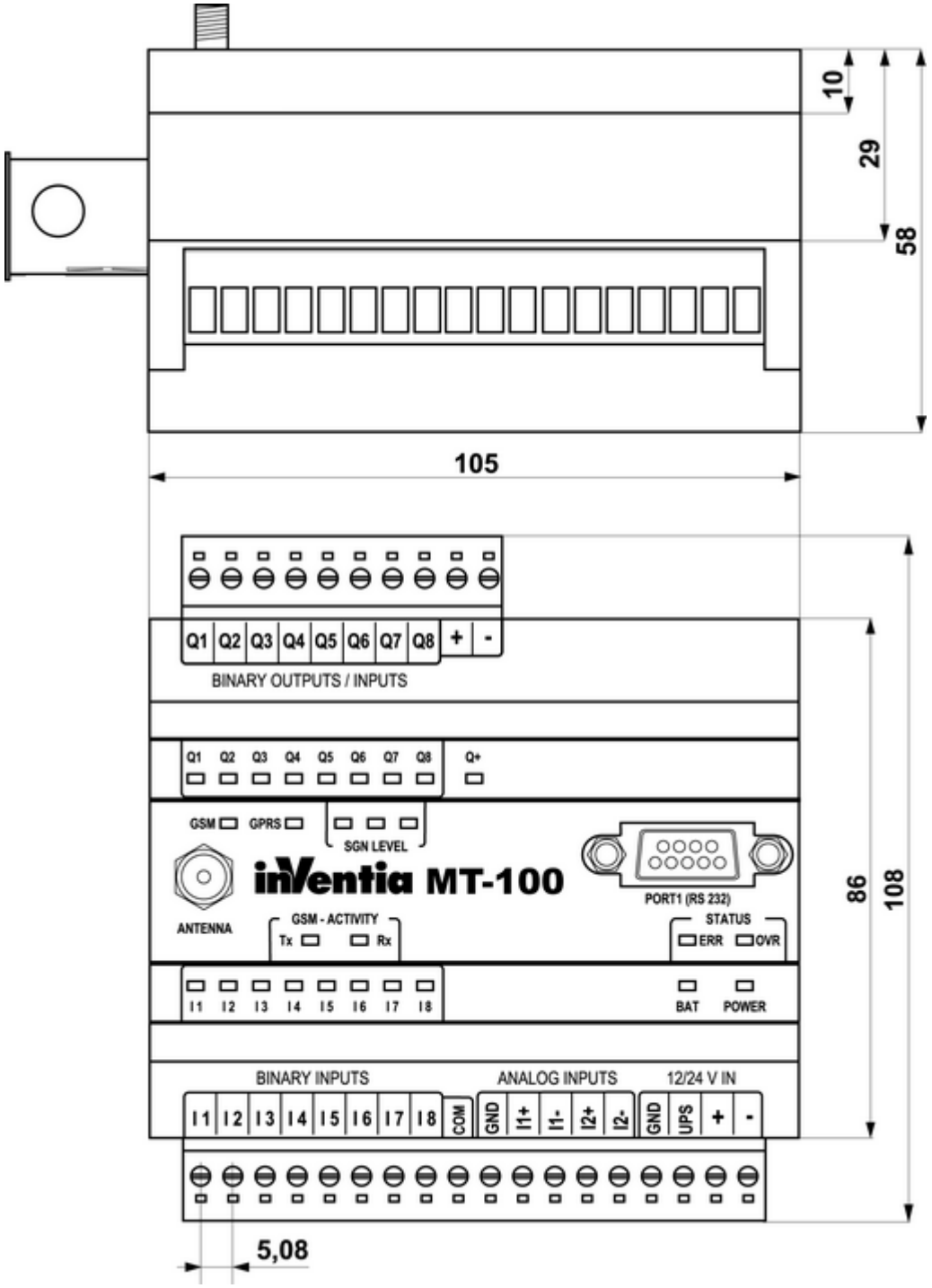
Operating as binary input/counter

Input voltage range	0 ... 36V
Input resistance	5,4 kΩ
Input voltage ON (1)	> 9V
Input voltage OFF (0)	< 3V max
Frequency range in analog mode	0....2kHz
Min pulse length "1"	5ms

8.6. Analog inputs A1, A2

Measuring range	4 ... 20 mA
Max input current	50 mA max.
Dynamic input impedance	25Ω typ.
Voltage drop for 20mA	< 5V max.
A/D converter	10 bits
Accuracy	±1,5% max.
Non linearity	±1% max.

8.7. Drawings and dimensions



NOTE!
All dimensions in millimeters

9. Safety information

9.1. Working environment

When deploying telemetry modules one has to observe and comply to local legislation and regulations. Using the telemetry module in places where it can cause radio noise or other disturbances is strictly prohibited.

9.2. Electronic equipment

Thou most of modern electrical equipment is well RF (Radio Frequency) shielded there is no certainty that radio waves emitted by the telemetry module's antenna may have negative influence on its function.

9.2.1. Heart pacemakers

It is recommended that the distance between the antenna of telemetry module and the Heart Pacemaker is greater than 20 cm.
This distance is recommended by manufacturers of Pacemakers and in full harmony with results of studies conducted independently by Wireless Technology Research.

9.2.2. Hearing aids

In rare cases the signal emitted by the telemetry module's antenna may disturb hearing aids functions. Should that occur, one has to study detailed operating instructions and recommendations for that particular product.

9.2.3. Other medical equipment

Any radio device including the telemetry module may disturb the work of electronic medical equipment.
When there is a need of installing telemetry module in vicinity of medical equipment one has to contact the manufacturer of this equipment in order to make sure that the equipment is adequately protected against interference of radio frequency waves (RF).

9.2.4. RF Marked equipment

The restriction against installing telemetry modules in areas marked as radio frequency (RF) prohibition zones must be unconditionally observed.

9.3. Explosive environment

Installation of telemetry modules in the environment where explosion hazard is present is not permitted. Usually, but not always, these places are marked with warning signs. Where there is no marking do not install telemetry modules at liquid or gas fuels stores, inflammable materials stores, nor places contaminated with metal or wheat dust.

10. Appendices

10.1. Data transmission in GSM systems

At the moment, a subscriber to GSM services has 3 technologies of sending data at his disposal besides voice communication. These are: SMS, CSD and GPRS. Since they offer different functionalities a short description is necessary.

10.1.1. SMS

„Short Message Service" - the technology of sending text messages. The length of the message is 160 characters. Permitted characters are letters and numbers. Despite of its popularity it is not an optimal service for telemetry. The cost of an SMS is constant regardless of information length (within 160 characters limit).

In telemetric applications, using the text mode would require dedicated formatting and special programming for reception. The conclusion is simple. This service was not created for telemetry applications but may be an attractive supplement.
Suppose that along with monitoring current values, it is possible to receive perfectly readable textual information containing a warning about alarm situation.

It is quite a useful supplement.

10.1.2. CSD (HSCSD)

„Circuit Switched Data" - a technology for sending data via commuted communication channel set up on subscriber demand. Despite using a digital telephony technology the data transmission is analogical to traditional telephone modem.
The user establishes a connection with a defined subscriber number and carries out a transmission of data stream sent to the serial port connected to the GSM modem. It is a point-to-point transmission where only 2 data sources are connected. After transmission, the connection is broken and the subscriber charged for the time occupying the channel.
This type of data transmission justifiable when large amounts of data are to be transmitted but would be extremely expensive in real time monitoring since it occupies the channel all of the time.

10.1.3. GPRS

„**General Packet Radio Services**" – a technology of transmitting data as addressed digital packets. Seen from user's point of view it is identical to Internet technology. The technology uses packet data protocols, particularly UDP/IP and TCP/IP.

This technology is radically different from technologies employed by standard modems using GSM/CSD commuted mode.
The main difference is the inability to transmit the stream of data directly in traditional serial protocols.
For transmission by GSM/GPRS modem it is necessary to "package" data in frames compatible with employed protocol.
All procedures necessary for login to GPRS have to be completed, so connecting GSM/GPRS modem to the data source operating in serial protocol (MODBUS, PPI, SNP, M-Bus....) incompatible with packet transmission specification is impossible - even if it has a serial interface.
After completing login sequence we have a connection equal to virtual "wired connection" available all of the time.

10.1.3.1. Advantages of GPRS technology

The absolutely greatest advantage of GPRS technology is the possibility for maintaining a permanent connection with the network while paying only for the volume of transmitted data with no charge for maintaining the connection. This makes establishing of "on line" services for minimal expenses possible. An additional advantage is potentially high transmission speed (up to ~170kb/s), facilitating high data volume transmission.
GPRS standard supports four channel encoding schemes named respectively CS1 to CS4 with throughput of
9.05 kb/s, 13.4 kb/s, 15.6 kb/s and 21.4 kb/s.
Reached this way, maximal transmission rates though rigidly defined are different depending on the number of connected channels and limited usually to max throughput of 115.2 kb/s (typically 8x13.4kb/s = 107,2 kb/s), and in particular situations even up to 171.2 kb/s (8x21.4=171.2).

10.1.3.2. GPRS in telemetry applications

GSM/GPRS technology is possibly the ideal solution for telemetry and control of dispersed objects.

The undisputable advantages are:

- Use of an existing advanced structure of GSM transmission structure.
- The gigantic range of the network – works everywhere!
- Low cost of establishing and utilizing the system
- No need for specialized antenna systems
- The possibility of building networked systems
- No necessity for retransmission
- Full access protection on operator and hardware level
- Cost of transmission system maintenance rests with network operator
- Easy rescaling and reconfiguration of the system
- Great availability of various receiving terminals
- Easy setup of temporary systems
- Only transmitted data volume is charged

For proper operation of terminals - GSM/GPRS network nodes, one needs a SIM card with GPRS service enabled, permission to log in to existing APN and a static IP assignment.
A static IP address is the base for addressing terminals in packet transmission GPRS networks.
Note that when using GPRS for real time monitoring, packet transmission networks add a delay dependent of the route the addressed packet has to go between the sender and recipient terminal. Usually this delay does not exceed a few seconds and is insignificant from a monitoring perspective. In turn, the possibility of creating networks independent of terrain topography and territorial size of the system is gained.

10.1.4. EDGE

EDGE (Enhanced Data rates for GSM Evolution) is a technology for data transmission employed in GSM networks.

This is an extension of GPRS technology (EDGE is also called for EGPRS - Enhanced GPRS), with enhanced radio interface allowing triple throughput (in most of current systems up to 236.8 kbit/s) and dynamic adjustment of packet transmission speed depending on transmission conditions.

10.1.5. UMTS

Universal Mobile Telecommunications System (**UMTS**) is a system of third generation cellular phone networks following 2G systems like GSM. The new radio interface significantly improved data transfer between the subscriber and the network boosting the quality of service (384 kbit/s throughput).

10.1.6. HSDPA

HSDPA (High Speed Downlink Packet Access) is a technology based on shared transmission channel. The main feature is dynamic adaptation to changes in radio environment and quick retransmission of faulty data. The HSDPA technology allows transmission from the network to device with 14.4 Mb/s speed.

10.2. Syntax for reading and writing data in SMS mode

Basic syntax:

Reading

#[representation][internal resource]/[% space address]

Writing

#[representation][internal resource]/[% space address]=value

The value may be variable or constant. It is for example possible to send an SMS resulting in assigning the state of I1 to Q1 (#Q1=I1 or #Q1=#I1). Using second form replaces #I1 with the current value eg. #Q1=1. In first version the proper execution will be confirmed with identical syntax.

Value representation (the way of displaying or interpreting of the value)

D or none	decimally
H	hexadecimally (for registers always in four digits f.e. 002F)
B	binary (for registers always in 16 digits f.e. 0000000000010111)
S	string (read only). Presents ASCII text stored in registers. NULL (0x0000) character should be used as end of string marker.

Internal resource

Qx	state of output Qx,	x in range 1...8
Anx	analog input,	x in range 1...6

% space address - access to internal variables

I	-	bits in binary inputs space
Q	-	bits in binary outputs space
AI	-	Input Registers (16 bit)
R	-	Internal Registers (16 bit)
M	-	internal flags (Not deleted and zeroed during module reset)
S	-	internal flags (deleted and zeroed during module reset)

Examples of syntax that may along with simple text be a part of the SMS.

#DQ5	state of terminal Q5
#AN1	value of analog input AN1 decimally
#BAN2	value of analog input AN2 in binary format
#%R15	value of Register 15 decimally
#H%AI4	value of Input Register 4
#%M123	value of M123 flag
#H%R80#H%R81	value of 32 bit Register DREG1 (memory map) 16 bit
#Q1=1	activation of output Q1
#%R70=255	setting Register R70 to value of 255
#H%R70=FF	setting Register R70 to value 255
#%R1000=2	faulty resource address, replay „Err”
#%R70=100000	faulty value, reply #%R70=Err
#S%R64	text coded in ASCII beginning in internal register which address is 64 decimally and ending in first following register with NULL sign (0x0000).

An example of SMS composed by the user may look as follows:
„Coolant temperature - #AN1”
or take other form, consisting of fixed and variable content dependent on variable registers values.

Notice:
- Valid syntax will be replaced in received SMS with current value of particular variable or else unchanged text will be returned.
- One SMS may read several variables.
- If length of received SMS (text + length of variables replacing mnemonics) exceeds 160 characters, (along with time stamp and optional status) the SMS will be truncated so that it ends with time stamp and optional status.
- Syntax is not case sensitive.
- Addresses in commands should be in decimal notation.
- 32 bit Registers occupy two cells in 16 bit register space. Access to 32 bit registers goes through 16 bit Registers.
- Commands modifying internal resources values are executable only for received SMS.
- Upon reception of SMS starting with $ sign activates "silent mode" and no confirmation is sent to originator.
- Confirmation SMS starts with '>' sign.

10.3. Unlocking writing to internal registers

Procedure when data writing protection is set to Yes :

When data overwriting protection option is set, the module does not process frames trying to change internal resources. Unblocking requires sending data along with password. If received frame contents a valid password, the module allows remote modification of internal resources for 5 minutes or until it receives a frame with empty or invalid password.

Command format:

module's ID (1 byte)	command code (3 bytes)	Password (n bytes)	Password end (1 byte)	Modbus CRC (2 bytes)
ID	0x71, 0x06 0x00	Password text	0x00	CRC_L, CRC_H

Example:

Module settings

ID	5
Password	"ABCDE"
HEX	0x05, 0x71, 0x06, 0x00, 'A', 'B', 'C', 'D', 'E', 0x00, 0x98, 0x70
Decimally	5, 113, 6, 0, 'A', 'B', 'C', 'D', 'E', 0, 152, 112

10.4. Working with dynamic IP addressing

In order to configure MT-100 module to work in Proxy mode do following:

- In MTManager select Data frame format: Proxy
- Set Proxy server IP: has to be static, public IP address of central (receiving) computer
- In Authorized IP numbers type the serial number 255.255.255.255

The structure of configuration file for MT DataProvider for Proxy mode:

```
<?xml version="1.0"?>
<opc>

<configure net_mode="dynamic" udp_port="7110" timestamp="system"
csv_log="true" csv_path="C:\" debug="true"/>

<network name="mt100"
udp_port=""
ip_receiver=""
ip_header_receiver="010.004.006.002"
ip_header_sender="255.255.255.255"
timeout="10" retries="4" add_crc="true"
csv_msg_log="true" debug="false" enable="true">

<modbus name="id13" id="13" type="registers" address="0"
size="5" interval="25" debug="false" enable="true"/>

<modbus name="id13" id="13" type="binary_inputs" address="8"
size="8" interval="25" debug="false" enable="true"/>

<modbus name="id13" id="13" type="binary_outputs" address="0"
size="8" interval="25" debug="false" enable="true"/>

</network>

</opc>

<!-- ip_header_receiver="010.004.006.002" remote device serial number-->
<!-- ip_header_sender="255.255.255.255" MTDataProvider identifier-->
```

10.5. Data formats

MT-100 module gives the user a choice of data frame format :

- Standard - standard operating mode. The units communicate directly with each other in the APN using static IP addresses allocated permanently to used SIM cards. In this mode, IP addresses of communicating modules are written into authorized units' lists.

- Open - The only difference from Standard is lack of frame protection and opened header format of UDP frame allowing the user to create his own user access system.

UDP data frame format (port 7110)

Header			**Data block**
4 bytes 00H marker	Frame identifier 16 bit, 2 bytes (H,L)	Data block size in bytes, 2 bytes (H,L)	Data

1. Frame identifier is used for data flow control, f.e. elimination of repeated frames. When sending consecutive data frames, this number shall be incremented.
2. Max. data block size is 1408 bytes.
3. For access to the module MODBUS frames are used. They are placed in data block without ending CRC.

Data block (MODBUS frame)		
Unit ID (1 byte)	Function (1 byte)	data

4. Upon reception of correct data frame the sender has to be informed by a receipt in a form of an UDP frame bearing only the header of received frame.

- Proxy - In this configuration, units communicate with each other through an external server. The server IP is written in Proxy server IP configuration variable. This mode allows using modules with SIM cards without assigned static address. Modules receive a randomly selected IP address during network login procedure. The Module establishes communication (sends and receives packets) only with Proxy server. Since modules in this mode are identified by serial numbers tables and lists describing, other modules in the network hold serial numbers instead of IP addresses. Dynamically addressed modules do not have the possibility of remote configuration or remote programming.

- UDP Standard - in this data module communicates using the Modbus frame encapsulated in standard UDP frame. This allows user to use Modbus/UDP drivers provided from other companies, but disables data delivery control system (confirmation of correct data frame reception mechanism). GPRS transmission retries numer and GPRS transmission timeout parameters are unavailable in that operating mode.

10.6. Format of module Status

Status frame of MT-100 module is a sequence of four 16 bit registers from internal registers space (read command 03H, write 06H or 10H).

0x03E4	Inputs space	MT_IN	I8..I1	IQ8..IQ1
0x03E5	Outputs space	MT_OUT	0..0	Q8..Q1
0x03E6	Input AN1 (copy of input register 0x0004)	MT_AN1	16 bit value	
0x03E7	Input AN2 (copy of input register 0x0005)	MT_AN2	16 bit value	

A call upon this coherent area in memory gives optimal access to all physical inputs/outputs of MT-100.

This information about modules I/O resources is used when sending SMS with status information (defined by sending additional information parameter). It should be noticed that SMS text length including device's status and time stamp should not exceed 160 characters. If overall SMS text length exceeds this value, module will truncate SMS text typed by user to send complete timestamp and status.

<message text>
<module status>
<time stamp>

where status is:
I1...I8=01101011
Q1...Q8=01101011
AN1=143
AN2=1780

Binary values are represented bitwise.
Analog values are represented in engineering units

10.7. Trigger inputs

During operation, the internal system of **MT-100** module creates a number of variables related to its inputs/outputs and to module diagnostics. Triggering inputs and triggering flags in conjunction with rules processing enable instantaneous reaction in occurring states .

User has access to following triggering inputs:

input	**Description**
Q1...Q8	binary inputs/outputs Q1...Q8, can operate as analog input with external Analog/frequency converter
I1...I8	binary inputs I1...I8, can operate as analog input with external Analog/frequency converter
A1...A2	Analog inputs A1...A2
FS1_ups	= 1, no voltage on UPS pin
FS1_q+	= 1, no supply for binary outputs Q1...Q8
FS1_gprs	= 1, information of logging out of GPRS network
P1...P32	Program flags P1...P32 (definable in user program)
TMR1...TMR4	flags from Asynchronous clocks TMR1,TMR2 and synchronous TMR3, TMR4

10.8. Flags

During operation **MT-100** module governs a number of binary flags (assuming value *True* or *False*) that trigger rules processing and remote diagnostics.

The User has access to following flags:

Flag	Resources attached	Description
Bi In 0->1	Binary inputs and outputs Q1...Q8 I1...I8	Flag assuming value *True* after change of binary input from 0 to 1
Bi In 1->0	Binary inputs and outputs Q1...Q8 I1...I8	Flag assuming value *True* after change of binary input from 1 to 0
Bi In Chg	Binary inputs and outputs Q1...Q8 I1...I8	Flag assuming value *True* after any change of binary input
Bi Out Err	Binary outputs. Q1....Q8	Flag assuming value *True* if read outputs state does not comply with set state
Counter	Binary inputs I1...I8 Q1...Q8	Flag assuming value *True* when counter reaches set value or zero value (depending on counting direction)
An LoLo	Analog inputs Q1...Q8 I1...I8 A1...A2	Flag assuming value *True* if value of analog input is lower than value set as Alarm LoLo (preserving relation to hysteresis)
An Lo	Analog inputs I1...I8 Q1...Q8 A1...A2	Flag assuming value *True* if value of analog input is lower than value set as Alarm Lo (preserving relation to hysteresis)
An Hi	Analog inputs I1...I8 Q1...Q8 A1...A2	Flag assuming value *True* if value if value of analog input is higher than value set as Alarm Hi (preserving relation to hysteresis)
An HiHi	Analog inputs I1...I8 Q1...Q8 A1...A2	Flag assuming value *True* if value of analog input is higher than value set as Alarm HiHi (preserving relation to hysteresis)
An DB	Analog inputs I1...I8 Q1...Q8 A1...A2	Flag assuming value *True* if value of analog input crosses defined deviation of previous central value

10.9. Memory map

10.9.1. Binary inputs space

Binary inputs (bit addressable - command 02)

Address	+ 0	+ 1	+ 2	+ 3	+ 4	+ 5	+ 6	+ 7	Description	Virtual Registers
0x0000	IQ1	IQ2	IQ3	IQ4	IQ5	IQ6	IQ7	IQ8	Pin state Q1...Q8	VREG_BI0
0x0008	I1	I2	I3	I4	I5	I6	I7	I8	Pin state I1...I8	
0x0010	ERR_Q1	ERR_Q2	ERR_Q3	ERR_Q4	ERR_Q5	ERR_Q6	ERR_Q7	ERR_Q8	Error messages for outputs Q1..Q8	VREG_BI1
0x0018	AN1_LoLo	AN1_Lo	AN1_Hi	AN1_HiHi	---	---	AN1_Dbd	0	Threshold bits for analog input AN1 + dead band cross over	
0x0020	AN2_LoLo	AN2_Lo	AN2_Hi	AN2_HiHi	---	---	AN2_Dbd	0	Threshold bits for analog input AN2 + dead band cross over	VREG_BI2
0x0028	FS1_fs	FS1_ovr	FS1_ups	FS1_q+	FS1_prog	FS1_gprs	FS1_event	FS1_sms	**FS1_fs = 1 -** first cycle of the program **FS1_ovr = 1 -** delayed cycle start (previous cycle longer than 100ms) **FS1_ups = 1 -** no supply on UPS pin **FS1_q+ = 1 -** no supply for binary outputs Q1..Q8 **FS1_prog = 1 -** error detected in user's program, program stopped. **FS1_gprs = 1 -** module logged out of GPRS. On logon the bit is reset. On power on FS1_gprs = 0 **FS1_event = 1 -** event queue overflow - data **FS1_sms = 1 -** event queue overflow - SMS	

0x0030	F_CNT_Q1	F_CNT_Q2	F_CNT_Q3	F_CNT_Q4	F_CNT_Q5	F_CNT_Q6	F_CNT_Q7	F_CNT_Q8	Counter flip over for inputs Q1..Q8	VREG_BI3
0x0038	F_CNT_I1	F_CNT_I2	F_CNT_I3	F_CNT_I4	F_CNT_I5	F_CNT_I6	F_CNT_I7	F_CNT_I8	Counter flip over for inputs I1..I8	
0x0040	C1	C2	C3	C4	C5	C6	C7	C8	Counter outputs C1 .. C8	VREG_BI4
0x0048	T1	T2	T3	T4	T5	T6	T7	T8	Timer outputs T1 .. T8	
0x0050	AQ1_LoLo	AQ1_Lo	AQ1_Hi	AQ1_HiHi	AI1_LoLo	AI1_Lo	AI1_Hi	AI1_HiHi	Threshold bits for frequency analog inputs AQ1 and AI1	VREG_BI5
0x0058	AQ2_LoLo	AQ2_Lo	AQ2_Hi	AQ2_HiHi	AI2_LoLo	AI2_Lo	AI2_Hi	AI2_HiHi	Threshold bits for frequency analog inputs AQ2 and AI2	
0x0060	AQ3_LoLo	AQ3_Lo	AQ3_Hi	AQ3_HiHi	AI3_LoLo	AI3_Lo	AI3_Hi	AI3_HiHi	Threshold bits for frequency analog inputs AQ3 and AI3	VREG_BI6
0x0068	AQ4_LoLo	AQ4_Lo	AQ4_Hi	AQ4_HiHi	AI4_LoLo	AI4_Lo	AI4_Hi	AI4_HiHi	Threshold bits for frequency analog inputs AQ4 and AI4	
0x0070	AQ5_LoLo	AQ5_Lo	AQ5_Hi	AQ5_HiHi	AI5_LoLo	AI5_Lo	AI5_Hi	AI5_HiHi	Threshold bits for frequency analog inputs AQ5 and AI5	VREG_BI7
0x0078	AQ6_LoLo	AQ6_Lo	AQ6_Hi	AQ6_HiHi	AI6_LoLo	AI6_Lo	AI6_Hi	AI6_HiHi	Threshold bits for frequency analog inputs AQ6 and AI6	
0x0080	AQ7_LoLo	AQ7_Lo	AQ7_Hi	AQ7_HiHi	AI7_LoLo	AI7_Lo	AI7_Hi	AI7_HiHi	Threshold bits for frequency analog inputs AQ7 and AI7	VREG_BI8
0x0088	AQ8_LoLo	AQ8_Lo	AQ8_Hi	AQ8_HiHi	AI8_LoLo	AI8_Lo	AI8_Hi	AI8_HiHi	Threshold bits for frequency analog inputs AQ8 and AI8	
0x0090	AQ1_Dbd	AQ2_Dbd	AQ3_Dbd	AQ4_Dbd	AQ5_Dbd	AQ6_Dbd	AQ7_Dbd	AQ8_Dbd	Dead band cross over bits for frequency analog inputs. AQ1..AQ8	VREG_BI9
0x0098	AI1_Dbd	AI2_Dbd	AI3_Dbd	AI4_Dbd	AI5_Dbd	AI6_Dbd	AI7_Dbd	AI8_Dbd	Dead band cross over bits for frequency analog inputs. AI1..AI8	
0x00A0	TMR1	TMR2	TMR3	TMR4	0	0	0	0	User defined timer flip over info	VREG_BI10
0x00A8	---	---	---	---	---	---	---	---		

...										...
0x02B0	---	---	---	---	---	---	---	---		VREG_BI43
0x02B8	MT2MT_1	MT2MT_2	MT2MT_3	MT2MT_4	MT2MT_5	MT2MT_6	MT2MT_7	MT2MT_8	Bits informing about MT2MT buffer modification with values received with unsolicited messages. The bit number corresponds to the sender's index in Authorized numbers table in the module's configuration, thus referring to the sending module's IP address. Bits are set for one program cycle.	
0x02C0	MT2MT_9	MT2MT_10	MT2MT_11	MT2MT_12	MT2MT_13	MT2MT_14	MT2MT_15	MT2MT_16		VREG_BI44
0x02C8	MT2MT_17	MT2MT_18	MT2MT_19	MT2MT_20	MT2MT_21	MT2MT_22	MT2MT_23	MT2MT_24		
0x02D0	MT2MT_25	MT2MT_26	MT2MT_27	MT2MT_28	MT2MT_29	MT2MT_30	MT2MT_31	MT2MT_32		VREG_BI45
0x02D8	MT2MT_33	MT2MT_34	MT2MT_35	MT2MT_36	MT2MT_37	MT2MT_38	MT2MT_39	MT2MT_40		
0x02E0	MT2MT_41	MT2MT_42	MT2MT_43	MT2MT_44	MT2MT_45	MT2MT_46	MT2MT_47	MT2MT_48		VREG_BI46
0x02E8	MT2MT_49	MT2MT_50	MT2MT_51	MT2MT_52	MT2MT_53	MT2MT_54	MT2MT_55	MT2MT_56		
0x02F0	MT2MT_57	MT2MT_58	MT2MT_59	MT2MT_60	MT2MT_61	MT2MT_62	MT2MT_63	MT2MT_64		VREG_BI47
0x02F8	MT2MT_65	MT2MT_66	MT2MT_67	MT2MT_68	MT2MT_69	MT2MT_70	MT2MT_71	MT2MT_72		
0x0300	MT2MT_73	MT2MT_74	MT2MT_75	MT2MT_76	MT2MT_77	MT2MT_78	MT2MT_79	MT2MT_80		VREG_BI48
0x0308	MT2MT_81	MT2MT_82	MT2MT_83	MT2MT_84	MT2MT_85	MT2MT_86	MT2MT_87	MT2MT_88		
0x0310	MT2MT_89	MT2MT_90	MT2MT_91	MT2MT_92	MT2MT_93	MT2MT_94	MT2MT_95	MT2MT_96		VREG_BI49
0x0318	MT2MT_97	MT2MT_98	MT2MT_99	MT2MT_100	MT2MT_101	MT2MT_102	MT2MT_103	MT2MT_104		
0x0320	MT2MT_105	MT2MT_106	MT2MT_107	MT2MT_108	MT2MT_109	MT2MT_110	MT2MT_111	MT2MT_112		VREG_BI50
0x0328	MT2MT_113	MT2MT_114	MT2MT_115	MT2MT_116	MT2MT_117	MT2MT_118	MT2MT_119	MT2MT_120		
0x0330	MT2MT_121	MT2MT_122	MT2MT_123	MT2MT_124	MT2MT_125	MT2MT_126	MT2MT_127	MT2MT_128		VREG_BI51
0x0338	MT2MT_129	MT2MT_130	MT2MT_131	MT2MT_132	MT2MT_133	MT2MT_134	MT2MT_135	MT2MT_136		
0x0340	MT2MT_137	MT2MT_138	MT2MT_139	MT2MT_140	MT2MT_141	MT2MT_142	MT2MT_143	MT2MT_144		VREG_BI52
0x0348	MT2MT_145	MT2MT_146	MT2MT_147	MT2MT_148	MT2MT_149	MT2MT_150	MT2MT_151	MT2MT_152		
0x0350	MT2MT_153	MT2MT_154	MT2MT_155	MT2MT_156	MT2MT_157	MT2MT_158	MT2MT_159	MT2MT_160		VREG_BI53
0x0358	MT2MT_161	MT2MT_162	MT2MT_163	MT2MT_164	MT2MT_165	MT2MT_166	MT2MT_167	MT2MT_168		
0x0360	MT2MT_169	MT2MT_170	MT2MT_171	MT2MT_172	MT2MT_173	MT2MT_174	MT2MT_175	MT2MT_176		VREG_BI54
0x0368	MT2MT_177	MT2MT_178	MT2MT_179	MT2MT_180	MT2MT_181	MT2MT_182	MT2MT_183	MT2MT_184		
0x0370	MT2MT_185	MT2MT_186	MT2MT_187	MT2MT_188	MT2MT_189	MT2MT_190	MT2MT_191	MT2MT_192		VREG_BI55
0x0378	MT2MT_193	MT2MT_194	MT2MT_195	MT2MT_196	MT2MT_197	MT2MT_198	MT2MT_199	MT2MT_200		
0x0380	MT2MT_201	MT2MT_202	MT2MT_203	MT2MT_204	MT2MT_205	MT2MT_206	MT2MT_207	MT2MT_208		VREG_BI56
0x0388	MT2MT_209	MT2MT_210	MT2MT_211	MT2MT_212	MT2MT_213	MT2MT_214	MT2MT_215	MT2MT_216		
0x0390	MT2MT_217	MT2MT_218	MT2MT_219	MT2MT_220	MT2MT_221	MT2MT_222	MT2MT_223	MT2MT_224		VREG_BI57
0x0398	MT2MT_225	MT2MT_226	MT2MT_227	MT2MT_228	MT2MT_229	MT2MT_230	MT2MT_231	MT2MT_232		
0x03A0	MT2MT_233	MT2MT_234	MT2MT_235	MT2MT_236	MT2MT_237	MT2MT_238	MT2MT_239	MT2MT_240		VREG_BI58
0x03A8	MT2MT_241	MT2MT_242	MT2MT_243	MT2MT_244	MT2MT_245	MT2MT_246	MT2MT_247	MT2MT_248		
0x03B0	MT2MT_249	MT2MT_250	MT2MT_251	MT2MT_252	MT2MT_253	MT2MT_254	MT2MT_255	MT2MT_256		VREG_BI59

0x03B8	---	FS2_apn	0	0	0	0	FS2_new	FS2_stop	**FS2_new** - informs on downloading of new program. This flag is reset at every program stop or power up. **FS2_stop** - Informs that program was stopped. This flag is reset only on power up or download of new program. **FS2_apn** - 1 reflects APN login state, 0 - logged out	

10.9.2. Binary outputs space

Binary outputs (bit addressable - command read 01, write 05 or 0F)

Address	+ 0	+ 1	+ 2	+ 3	+ 4	+ 5	+ 6	+ 7	Description	Virtual Registers
0x0000	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	bits controlling outputs Q1..Q8	VREG_BO0
0x0008	P1	P2	P3	P4	P5	P6	P7	P8	Program flags enabling rule based data transmission on event.	
0x0010	P9	P10	P11	P12	P13	P14	P15	P16		VREG_BO1
0x0018	CLK_C1	CLK_C2	CLK_C3	CLK_C4	CLK_C5	CLK_C6	CLK_C7	CLK_C8	Counting inputs C1..C8 (raising edge)	
0x0020	RST_C1	RST_C2	RST_C3	RST_C4	RST_C5	RST_C6	RST_C7	RST_C8	Counter resetting inputs C1..C8 (active state 1)	VREG_BO2
0x0028	EN_T1	EN_T2	EN_T3	EN_T4	EN_T5	EN_T6	EN_T7	EN_T8	Strobe inputs for timers T1..T8 (active state 1)	
0x0030	RST_T1	RST_T2	RST_T3	RST_T4	RST_T5	RST_T6	RST_T7	RST_T8	Reset inputs for timers T1..T8 (active state 1)	VREG_BO3
0x0038	PS1_stop	MLOG_act	GPRS_data	MLOG_rd	---	---	---	---	**PS1_stop** = 1 - Program stop **MLOG_act** = 1 - activate MiniLogger **GPRS_data** - bit set at every reception of a data frame via GPRS **MLOG_rd** = 1 - force MiniLogger readout, reset after readout	
0x0040	P17	P18	P19	P20	P21	P22	P23	P24	Program flags enabling rule based data transmission on event.	VREG_BO4
0x0048	P25	P26	P27	P28	P29	P30	P31	P32		
0x0050	BU80	BU81	BU82	BU83	BU84	BU85	BU86	BU87	General purpose user fags	VREG_BO5
0x0058	BU88	BU89	BU90	BU91	BU92	BU93	BU94	BU95	General purpose user fags	
…	….	….	….	….	….	….	….	….	….	
0x00F0	BU240	BU241	BU242	BU243	BU244	BU245	BU246	BU247	General purpose user fags	VREG_BO15
0x00F8	BU248	BU249	BU250	BU251	BU252	BU253	BU254	BU255	General purpose user fags	
0x0100	---	---	---	---	---	---	---	---		VREG_BO16
0x0108	---	---	---	---	---	---	---	---		

10.9.3. Analog inputs space

Input Registers (16 bit - command 04H)

Address	Description	Symbol
0x0000	analog input AN1 (converter directly after averaging)	
0x0001	analog input AN2 (converter directly after averaging)	
0x0002	analog input AN1 (calibrated value in range 4..20 mA - 16 bit value)	16 bit value
0x0003	analog input AN2 (calibrated value in range 4..20 mA - 16 bit value)	16 bit value
0x0004	analog input AN1 (engineering units)	AN1
0x0005	analog input AN2 (engineering units)	AN2
0x0006	RTC - seconds (00..59)	RTC_Sec
0x0007	RTC - minutes (00..59)	RTC_Min
0x0008	RTC - hours (00..23)	RTC_Hour
0x0009	RTC - day of week (1 - Sunday, 7 - Saturday)	RTC_DofW
0x000A	RTC - day of month (1..31)	RTC_Day
0x000B	RTC - month (1..12)	RTC_Mon
0x000C	RTC - year (2000 ... 2099)	RTC_Year
0x000D	Number of sent bytes for GPRS since power up (32 bit unsigned value)	(high 16 bit)
0x000E		(low 16 bit)
0x000F	Number of received bytes for GPRS since power up (32 bit unsigned value)	(high 16 bit)
0x0010		(low 16 bit)
0x0011	Converter F/U - 0...2kHz - Pin Q1	16 bit value
0x0012	Converter F/U - 0...2kHz - Pin Q2	16 bit value
0x0013	Converter F/U - 0...2kHz - Pin Q3	16 bit value
0x0014	Converter F/U - 0...2kHz - Pin Q4	16 bit value
0x0015	Converter F/U - 0...2kHz - Pin Q5	16 bit value
0x0016	Converter F/U - 0...2kHz - Pin Q6	16 bit value
0x0017	Converter F/U - 0...2kHz - Pin Q7	16 bit value
0x0018	Converter F/U - 0...2kHz - Pin Q8	16 bit value
0x0019	Converter F/U - 0...2kHz - Pin I1	16 bit value
0x001A	Converter F/U - 0...2kHz - Pin I2	16 bit value
0x001B	Converter F/U - 0...2kHz - Pin I3	16 bit value
0x001C	Converter F/U - 0...2kHz - Pin I4	16 bit value
0x001D	Converter F/U - 0...2kHz - Pin I5	16 bit value
0x001E	Converter F/U - 0...2kHz - Pin I6	16 bit value
0x001F	Converter F/U - 0...2kHz - Pin I7	16 bit value
0x0020	Converter F/U - 0...2kHz - Pin I8	16 bit value
0x0021	Converter F/U - 0...2kHz - Pin Q1 (engineering units)	AQ1
0x0022	Converter F/U - 0...2kHz - Pin Q2 (engineering units)	AQ2
0x0023	Converter F/U - 0...2kHz - Pin Q3 (engineering units)	AQ3
0x0024	Converter F/U - 0...2kHz - Pin Q4 (engineering units)	AQ4
0x0025	Converter F/U - 0...2kHz - Pin Q5 (engineering units)	AQ5
0x0026	Converter F/U - 0...2kHz - Pin Q6 (engineering units)	AQ6
0x0027	Converter F/U - 0...2kHz - Pin Q7 (engineering units)	AQ7
0x0028	Converter F/U - 0...2kHz - Pin Q8 (engineering units)	AQ8
0x0029	Converter F/U - 0...2kHz - Pin I1 (engineering units)	AI1
0x002A	Converter F/U - 0...2kHz - Pin I2 (engineering units)	AI2
0x002B	Converter F/U - 0...2kHz - Pin I3 (engineering units)	AI3

0x002C	Converter F/U - 0...2kHz - Pin I4 (engineering units)	AI4
0x002D	Converter F/U - 0...2kHz - Pin I5 (engineering units)	AI5
0x002E	Converter F/U - 0...2kHz - Pin I6 (engineering units)	AI6
0x002F	Converter F/U - 0...2kHz - Pin I7 (engineering units)	AI7
0x0030	Converter F/U - 0...2kHz - Pin I8 (engineering units)	AI8
0x0031	---	---
...	...	
0x0070	---	---
0x0072	GPRS statistics- Transmission	(high 16 bits)
0x0073	Number of frames Type 0 (retries not accounted)	(low 16 bits)
0x0074	GPRS statistics - Reception	(high 16 bits)
0x0075	Number of retries	(low 16 bits)
0x0076	GPRS statistics- Transmission	(high 16 bits)
0x0077	Number of not delivered (not confirmed) frames	(low 16 bits)
0x0078	GPRS statistics - Reception	((high 16 bits)
0x0079	Frames Type 0	(low 16 bits)
0x007A	GPRS statistics - Reception	(high 16 bits)
0x007B	Frames Type 1	(low 16 bits)
0x007C	GPRS statistics - Reception	(high 16 bits)
0x007D	Rejected frames (Type 0) - module busy	(low 16 bits)
0x007E	Number of attempts since power up	informing on failed access attempts due to invalid password
0x007F	Last attempt time - Year	
0x0080	Last attempt time - Month	
0x0081	Last attempt time - Day	
0x0082	Last attempt time - hours	
0x0083	Last attempt time - minutes	
0x0084	GSM signal strength (Max value 188)	M_SGN_LEV (word)
0x0085	Firmware version (y.xx) y - High byte, xx - Low byte	MWARE_VER (word)
0x0086	---	
...	...	
0x00A7	---	
0x00BB	Reserved	
0x00BC	Number of program lines executed in previous cycle	PRG_CLINE (word)
0x00BD	Elapsed program execution time in previous cycle	PRG_CTIME (word)
0x00BE	Help register for function in user program	K_RET1 (word)
0x00BF	Help register for function in user program	K_RET2 (word)
0x00C0	Parameter 1	PAR_1 (word)
...	...	...
0x00FF	Parameter 64	PAR_64 (word)
0x0100	---	---
...	...	...
0x01FF	---	---
...	...	...
0x0500	Parameter 65	PAR_65 (word)
...	...	...
0x053F	Parameter 128	PAR_128 (word)

10.9.4. Internal registers space

Internal registers space (read command 03H, write 06H or 10H) (Not zeroed at reset)

Address	Description	Symbol	HIGH byte	LOW byte
0x0000	32 bit counter - input Q1	CNT_Q1	(High 16 bits)	
0x0001	32 bit counter - input Q1		(Low 16 bits)	
0x0002	32 bit counter - input Q2	CNT_Q2	(High 16 bits)	
0x0003	32 bit counter - input Q2		(Low 16 bits)	
0x0004	32 bit counter - input Q3	CNT_Q3	(High 16 bits)	
0x0005	32 bit counter - input Q3		(Low 16 bits)	
0x0006	32 bit counter - input Q4	CNT_Q4	(High 16 bits)	
0x0007	32 bit counter - input Q4		(Low 16 bits)	
0x0008	32 bit counter - input Q5	CNT_Q5	(High 16 bits)	
0x0009	32 bit counter - input Q5		(Low 16 bits)	
0x000A	32 bit counter - input Q6	CNT_Q6	(High 16 bits)	
0x000B	32 bit counter - input Q6		(Low 16 bits)	
0x000C	32 bit counter - input Q7	CNT_Q7	(High 16 bits)	
0x000D	32 bit counter - input Q7		(Low 16 bits)	
0x000E	32 bit counter - input Q8	CNT_Q8	(High 16 bits)	
0x000F	32 bit counter - input Q8		(Low 16 bits)	
0x0010	32 bit counter - input I1	CNT_I1	(High 16 bits)	
0x0011	32 bit counter - input I1		(Low 16 bits)	
0x0012	32 bit counter - input I2	CNT_I2	(High 16 bits)	
0x0013	32 bit counter - input I2		(Low 16 bits)	
0x0014	32 bit counter - input I3	CNT_I3	(High 16 bits)	
0x0015	32 bit counter - input I3		(Low 16 bits)	
0x0016	32 bit counter - input I4	CNT_I4	(High 16 bits)	
0x0017	32 bit counter - input I4		(Low 16 bits)	
0x0018	32 bit counter - input I5	CNT_I5	(High 16 bits)	
0x0019	32 bit counter - input I5		(Low 16 bits)	
0x001A	32 bit counter - input I6	CNT_I6	(High 16 bits)	
0x001B	32 bit counter - input I6		(Low 16 bits)	
0x001C	32 bit counter - input I7	CNT_I7	(High 16 bits)	
0x001D	32 bit counter - input I7		(Low 16 bits)	
0x001E	32 bit counter - input I8	CNT_I8	(High 16 bits)	
0x001F	32 bit counter - input I8		(Low 16 bits)	
0x0020	16 bit counter - C1 (threshold value)	PV_C1	16 bit value	
0x0021	16 bit counter - C2 (threshold value)	PV_C2	16 bit value	
0x0022	16 bit counter - C3 (threshold value)	PV_C3	16 bit value	
0x0023	16 bit counter - C4 (threshold value)	PV_C4	16 bit value	
0x0024	16 bit counter - C5 (threshold value)	PV_C5	16 bit value	
0x0025	16 bit counter - C6 (threshold value)	PV_C6	16 bit value	
0x0026	16 bit counter - C7 (threshold value)	PV_C7	16 bit value	
0x0027	16 bit counter - C8 (threshold value)	PV_C8	16 bit value	
0x0028	16 bit Timer - T1 (threshold value)	PV_T1	16 bit value	
0x0029	16 bit Timer - T2 (threshold value)	PV_T2	16 bit value	
0x002A	16 bit Timer - T3 (threshold value)	PV_T3	16 bit value	
0x002B	16 bit Timer - T4 (threshold value)	PV_T4	16 bit value	
0x002C	16 bit Timer - T5 (threshold value)	PV_T5	16 bit value	
0x002D	16 bit Timer - T6 (threshold value)	PV_T6	16 bit value	
0x002E	16 bit Timer - T7 (threshold value)	PV_T7	16 bit value	
0x002F	16 bit Timer - T8 (threshold value)	PV_T8	16 bit value	

0x0030	16 bit counter - C1 (current value)	REG_C1	16 bit value
0x0031	16 bit counter - C2 (current value)	REG_C2	16 bit value
0x0032	16 bit counter - C3(current value)	REG_C3	16 bit value
0x0033	16 bit counter - C4 (current value)	REG_C4	16 bit value
0x0034	16 bit counter - C5 (current value)	REG_C5	16 bit value
0x0035	16 bit counter - C6 (current value)	REG_C6	16 bit value
0x0036	16 bit counter - C7 (current value)	REG_C7	16 bit value
0x0037	16 bit counter - C8 (current value)	REG_C8	16 bit value
0x0038	16 bit Timer - T1 (current value)	REG_T1	16 bit value
0x0039	16 bit Timer - T2 (current value)	REG_T2	16 bit value
0x003A	16 bit Timer - T3 (current value)	REG_T3	16 bit value
0x003B	16 bit Timer - T4 (current value)	REG_T4	16 bit value
0x003C	16 bit Timer - T5 (current value)	REG_T5	16 bit value
0x003D	16 bit Timer - T6 (current value)	REG_T6	16 bit value
0x003E	16 bit Timer - T7 (current value)	REG_T7	16 bit value
0x003F	16 bit Timer - T8 (current value)	REG_T8	16 bit value
0x0040	16 bit Program register (unsigned value)	REG1	16 bit value
0x0041	16 bit Program register (unsigned value)	REG2	16 bit value
0x0042	16 bit Program register (unsigned value)	REG3	16 bit value
0x0043	16 bit Program register (unsigned value)	REG4	16 bit value
0x0044	16 bit Program register (unsigned value)	REG5	16 bit value
0x0045	16 bit Program register (unsigned value)	REG6	16 bit value
0x0046	16 bit Program register (unsigned value)	REG7	16 bit value
0x0047	16 bit Program register (unsigned value)	REG8	16 bit value
0x0048	16 bit Program register (unsigned value)	REG9	16 bit value
0x0049	16 bit Program register (unsigned value)	REG10	16 bit value
0x004A	16 bit Program register (unsigned value)	REG11	16 bit value
0x004B	16 bit Program register (unsigned value)	REG12	16 bit value
0x004C	16 bit Program register (unsigned value)	REG13	16 bit value
0x004D	16 bit Program register (unsigned value)	REG14	16 bit value
0x004E	16 bit Program register (unsigned value)	REG15	16 bit value
0x004F	16 bit Program register (unsigned value)	REG16	16 bit value
0x0050	32 bit Program register (signed value)	DREG1	(High 16 bits)
0x0051			(Low 16 bits)
0x0052	32 bit Program register (signed value)	DREG2	(High 16 bits)
0x0053			(Low 16 bits)
0x0054	32 bit Program register (signed value)	DREG3	(High 16 bits)
0x0055			(Low 16 bits)
0x0056	32 bit Program register (signed value)	DREG4	(High 16 bits)
0x0057			(Low 16 bits)
0x0058	32 bit Program register (signed value)	DREG5	(High 16 bits)
0x0059			(Low 16 bits)
0x005A	32 bit Program register (signed value)	DREG6	(High 16 bits)
0x005B			(Low 16 bits)
0x005C	32 bit Program register (signed value)	DREG7	(High 16 bits)
0x005D			(Low 16 bits)
0x005E	32 bit Program register (signed value)	DREG8	(High 16 bits)
0x005F			(Low 16 bits)
0x0060	16 bit Program register (unsigned value)	XREG1	16 bit value
...	...	...	...
0x025F	16 bit Program register (unsigned value)	XREG512	16 bit value
0x0260	Dead band threshold AQ1	RDBD_AQ1	16 bit value
...	...	...	...
0x0267	Dead band threshold AQ8	RDBD_AQ8	16 bit value
0x0268	Dead band threshold AI1	RDBD_AI1	16 bit value

...	...	...	...	
0x026F	Dead band threshold AI8	RDBD_AI8	16 bit value	
0x0270	Dead band threshold AN1	RDBD_AN1	16 bit value	
0x0271	Dead band threshold AN2	RDBD_AN2	16 bit value	

Registers holding last received via GPRS status of remote module

0x0272	Input space	RMT_IN	I8..I1	IQ8..IQ1
0x0273	Remote module ID + output space	RMT_ID_OUT	ID	Q8..Q1
0x0274	Input AN1	RMT_AN1	16 bit value	
0x0275	Input AN2	RMT_AN2	16 bit value	

Counter of sent SMS

0x0276	Counter of sent SMS	CNT_SMS	16 bit value

Activity time counters on module's inputs

0x0280	32 bit activity time counter on input Q1 [s]	CNT_ON_Q1	(High 16 bits)	
0x0281	32 bit activity time counter on input Q1 [s]		(Low 16 bits)	
0x0282	32 bit activity time counter on input Q2 [s]	CNT_ON_Q2	(High 16 bits)	
0x0283	32 bit activity time counter on input Q2 [s]		(Low 16 bits)	
...	...	...	...	
0x028E	32 bit activity time counter on input Q8 [s]	CNT_ON_Q8	(High 16 bits)	
0x028F	32 bit activity time counter on input Q8 [s]		(Low 16 bits)	
0x0290	32 bit activity time counter on input I1 [s]	CNT_ON_I1	(High 16 bits)	
0x0291	32 bit activity time counter on input I1 [s]		(Low 16 bits)	
...	...	...	...	
0x029E	32 bit activity time counter on input I8 [s]	CNT_ON_I8	(High 16 bits)	
0x029F	32 bit activity time counter on input I8 [s]		(Low 16 bits)	

Device status - Mirror

0x03E4	Inputs space	MT_IN	I8..I1	IQ8..IQ1
0x03E5	Outputs space	MT_OUT	0..0	Q8..Q1
0x03E6	Input AN1 (copy of input register 0x0004)	MT_AN1	16 bit value	
0x03E7	Input AN2 (copy of input register 0x0005)	MT_AN2	16 bit value	

Additional registers (can be used e.g. for logger program - see example in Programming chapter)

0x0800	Additional registers	---	16 bit value
...	...		
0x1FFF	Additional registers	---	16 bit value

Registers for module time modification (for block writing only, command 0x10)

0x2700	RTC - seconds (00..59)	16 bit value
0x2701	RTC - minutes (00..59)	16 bit value
0x2702	RTC - hours (00..23)	16 bit value
0x2703	RTC - day of week (1 - Sunday, 7 - Saturday)	16 bit value
0x2704	RTC - day of month (1..31)	16 bit value
0x2705	RTC - month (1..12)	16 bit value
0x2706	RTC - year (2000 ... 2099)	16 bit value
0x2707	RTC - bit negation + 1 RTC registers sum (preventing unintended time modification)	16 bit value