

# USER MANUAL



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## MG15

### MULTI GAUGE CONTROLLER

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# **OPERATING MANUAL**

## **English translation**

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# **MG15**

## **MULTI GAUGE CONTROLLER**

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# 1 INTRODUCTION

Please read this manual carefully to ensure the optimum operating conditions and safety of the user. This user manual handbook contains important information about functionality, installation, start-up and operation of the MG15 device.

## 1.1 INFORMATION ABOUT VERSION - RELEASE NOTE

Information about MG15 device version can be found at [www.prevac.eu](http://www.prevac.eu), in the *DOWNLOAD* tab. There is information about any possible changes in subsequent versions of the device or software.

## 1.2 INTENDED USE

The MG15 multi gauge controller is a universal devices controlled by a microprocessor, able to support several types of pressure gauges in a range of  $2 \cdot 10^5$  mbar to  $2 \cdot 10^{-12}$  mbar (depending on the gauge used). The concept and design of the controller enable stable and reliable integration of the comprehensive process control systems. The MG15 is able to support up to seven gauges, including up to three passive and four active gauges. Optionally, the user may on placing an order choose the number of supported passive (with hot cathode) and an additional communication interface (ProfiNet). In further part of the manual the device will be referred to as the "MG15".

## 1.3 SAFETY

The owner of the device must ensure that all the users have been informed about the safety requirements contained in this manual. In the event of sale or transfer of the device to another owner this manual should be attached.

### 1.3.1 PERSONNEL QUALIFICATIONS

All work described in this document may only be carried out by persons who have suitable technical training and the necessary experience or who have been instructed by the final user of the device.

### 1.3.2 ILLUSTRATION OF RESIDUAL DANGERS

This user manual illustrates safety notes concerning dangers as follows:

1. Information on potential serious accident or personal injury.



**DANGER**

2. Information on possible damage to the device.



**WARNING**

3. Information on correct handling or use. Disregarding safety notes can lead to malfunctions or device damage.



**CAUTION**

4. **Note.** Indicates particularly important, but not safety-relevant information.

### 1.3.3 GENERAL SAFETY INSTRUCTIONS

The MG15 has been designed to maximally protect the user and his environment against burns or electric shocks, mechanical hazards, high temperature and fire spreading out of the device. The environmental conditions different from those specified below may pose a threat to the user and his environment:

- Use inside buildings.
- Elevation above sea level of up to 2000 metres.
- Temperature range of safe operation: 5°C do 40°C.
- Maximum relative humidity: 80% (to 31°C), decreased linearly down to max. 50% at 40°C.
- Fluctuations of supply voltage cannot exceed  $\pm 10\%$  of the rated value.
- Protection class 1.

During all the operations carried out with the use of the device described in this manual, observe the applicable safety regulations. Observe all the safety notes given in this document and forward the information to all other users of the device. Pay particular attention to the following safety notes:

**DANGER**



#### **Supply voltage..**

Contact with live parts is extremely hazardous when any objects are introduced or any liquids penetrate into the device.

Make sure that no objects enter through the vent holes of the device. Keep the device dry.



**DANGER****Fire of device.**

If smoke or flames coming from the device are sighted, disconnect power supply immediately (by unplugging the power cord, or if it is not possible by disconnecting a relevant circuit in the switchboard powering the device). Remove flammable materials at a safe distance. Start extinguishing the fire. If the power supply could not be disconnected use only E-type extinguishers or dry-powder extinguishers designed to extinguish equipment under voltage.

**WARNING****Improper installation, operation or use.**

Improper installation, operation or use may damage the MG15. Strictly adhere to the stipulated installation and operation data.

**Self-configuration of the device.**

Self-configuration of the MG15 by the user through the service application results in waiver of the PREVAC's liability for proper functioning of the device.



Figure 1.1: Make sure that no objects enter through the vent holes of the device. Keep the device dry.

**Failure to observe the general safety instructions may result in potentially dangerous situations.**

### 1.3.4 GROUNDING

The MG15 is the class 1 device. To minimize a risk of electric shock connect the device to the mains with a 3-conductor mains cable. Conductor cross-section should be min. 1 mm<sup>2</sup> (17AWG). Plug the mains cable into wall sockets with protective ground only.

### 1.3.5 INTERNAL CIRCUITS OF DEVICE

The operating personnel cannot remove the device covers. The device does not contain any internal control systems and replaceable elements, which could be operated by unauthorized persons. Replace any attached components only after disconnecting the mains cable. To avoid electric shock always disconnect the mains cable, any external voltage sources and discharge the output circuits.

### 1.3.6 SPARE PARTS AND MODIFICATIONS

Replacement of spare parts, modifications and repairs may be carried out only by the PREVAC's authorized personnel. Therefore, the device must be delivered to the PREVAC's service.

### 1.3.7 VENTILATION

The device has vent holes located on the side panels of the enclosure. Do not cover the vent holes during the operation of the device.

### 1.3.8 OPERATION IN EXPLOSIVE ATMOSPHERES

**DANGER**



**Operation in explosive atmospheres.**

The device cannot be used in the presence of flammable gases or vapours. The device cannot be used in potentially explosive atmospheres.

### 1.3.9 CLEANING

Keep the device dry. For cleaning device's enclosure, use only moistened cloth. Do not use any aggressive or abrasive cleaning agents.

## 1.4 TECHNICAL DATA

### 1.4.1 MECHANICAL DATA

The section describes the external dimensions of the device. Figure 1.2 present the MG15 , which may be rack-mounted or used as a desktop device.

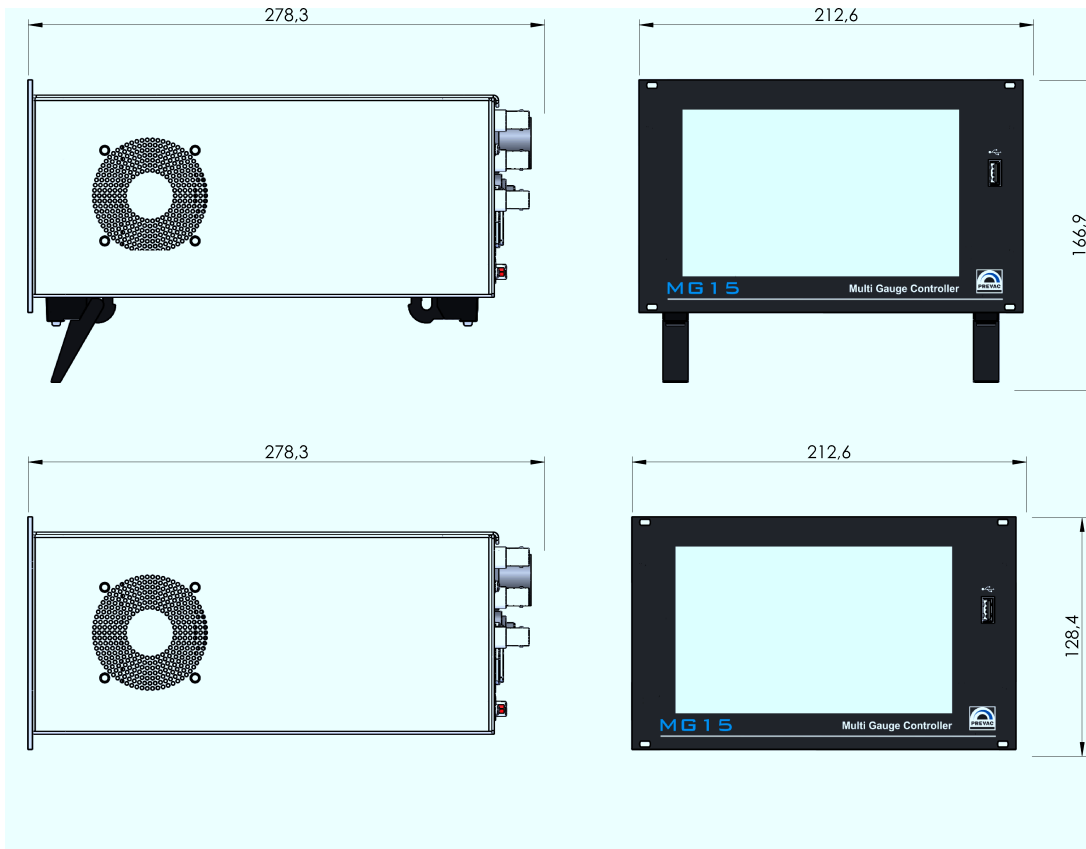


Figure 1.2: Dimensions

## 1.5 SPECIFICATION

### 1.5.1 TECHNICAL DATA

| PARAMETER                                | DESCRIPTION  |
|--|--|
| <b>ELECTRICAL PARAMETERS</b>             |  |
| Power supply                             | 100-240 VAC  |
| Frequency                                | 50 - 60 Hz   |
| Current consumption                      | 1.8A (110V)<br>0.85A (230V)  |
| Maximum power consumption                | 200 W  |
| Protection class                         | I  |
| Overvoltage category                     | II   |
| Power supply connection socket           | European connection socket IEC 60 320 C13  |
| Fuse                                     | 3.15A (250V)<br>6.3A (125V)  |
| <b>MEASUREMENT CHANNELS</b>              |  |
| Measurement channels                     | 4 active channels<br>up to 3* passive channels   |
| Supported active gauges**                | CTR90, TTR91, TTR211, PTR225, PKR251, PCR280, PTR90, ITR90, ITR100, Baratron, ANALOG IN, PG105, ATMION |
| Supported passive gauges**               | IE414, IE514, UHV-24, UHV-24p, MKS Series 274, NUDE-UHV-8A, NR-F-UHV, G8130                            |
| <b>MEASUREMENT RANGE</b>                 |  |
| Active gauges                            | $5 \times 10^{-10}$ mbar (depending on type)   |
| Passive gauges                           | $2 \times 10^{-12}$ mbar (depending on type)   |
| <b>VOLTAGE MEASUREMENT SPECIFICATION</b> |  |
| Resolution of converter                  | $0.6 \mu\text{V}$  |
| Accuracy of measurement                  | $2 \mu\text{V}$  |
| Sampling frequency                       | 12 sps   |
| <b>CURRENT MEASUREMENT SPECIFICATION</b> |  |
| Resolution of converter                  | 0.1fA  |
| continued on next page                   |  |

| continued from previous page  |   |
|---|---|
| PARAMETER   | DESCRIPTION   |
| Accuracy of measurement   | 3fA***  |
| Sampling frequency  | 10sps   |
| Screen refreshment  | 10 sps  |
| Temperature drift   | Automatically adjusted by internal temperature control            |
| <b>GAUGE CONNECTION</b>   |   |
| Active gauge  | RJ45  |
| Passive gauge   | UTG0187SVDEU + BNC  |
| <b>COMMUNICATION</b>  |   |
| Communication interfaces  | RS232/485, Ethernet, PROFINET*                                    |
| <b>I/O</b>  |   |
| Digital inputs  | 4   |
| Digital outputs   | 4   |
| Analogue outputs  | 4 (0-10V)   |
| <b>AMBIENCE</b>   |   |
| Operating temperature range   | +5 °C - +40 °C  |
| Storage temperature range   | 0 °C - +70 °C   |
| Relative humidity   | Max. 80% (to 31°C), decreased linearly down to max. 50% (at 40°C) |
| <b>MECHANICAL PARAMETERS</b>  |   |
| Dimensions  | Width: 212.6 mm<br>Height: 128.4 mm<br>Depth: 260.3 mm            |
| Weight  | 4.2 kg  |
| Installation  | Rack mounted or Desktop device                                    |
| <b>(*) - optional</b>   |   |
| <b>(**) - additional gauges can be defined, see section 3.6.1.3 or 3.6.1.5.</b> |   |
| <b>(***) - at lowest range (highest vacuum).</b>                                |   |

Table 1.1: Device specification

## 1.5.2 OPERATION

The device can be controlled in two ways:

- Manually on the display with touch panel.
- Remotely via RS232, RS485 or Ethernet, see chapter 2.5.3.

## 1.5.3 STANDARDS

- The MG15 conforms to the following standards and harmonised standards:
  - PN-EN 61326-1:2013-06 (EN 61326-1:2013) - Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements.
  - PN-EN 61000-6-4:2008/A1:2012 (EN 61000-6-4:2007/A1:2011) - Electromagnetic compatibility (EMC) – Part 6-4: General standards – Emission standard for industrial environments.
  - PN-EN 61010-1:2011 (EN 61010-1:2010) - Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements.
- Conforms to the essential requirements of the following directives
  - EMC 2014/30/EU - Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility
  - LVD 2014/35/EU - Directive 2014/35/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits.

## 2 INSTALLATION

This chapter describes the procedures for unpacking, mechanical installation and electrical installation. Take care when lifting the unit that the weight and position do not exceed comfortable limits.

### 2.1 UNPACKING

1. Visually inspect the transport packaging for signs of external damage.
2. Unpack the MG15 .  
**Note: Retain the packaging materials for later use. The MG15 must be stored and transported in the original packaging material only.**
3. Examine the MG15 for completeness.
4. Visually inspect the MG15 for signs of damage.

#### DANGER



#### Damaged product.

Using the destroyed or damaged device or connection cables can result in electric shock. Never attempt to put a damaged product into operation. Secure the damaged product from unintended operation. Send a damage report to the courier company or the insurer.

### 2.2 MECHANICAL INSTALLATION

The MG15 device can be mounted in a DIN 41 494 (19", 3 HU) cabinet/rack, occupying half of its width. In each of these cases you must pay attention to the following safety note.

#### WARNING



#### Ambient temperature.

Exceeding the maximum permitted ambient temperature may damage the device.

Before switching on the device, make sure that the maximum permitted ambient temperature is not exceeded and that the air can flow freely through the vent holes.

Do not expose the device to direct sun.

**DANGER****Protection class of the rack.**

If the product is installed in a rack, the protection class of the rack (protection from foreign bodies and water) is likely to be lowered, e.g. according to the EN 60204-1 regulations for switching cabinets.

Take appropriate measures to restore the required protection class of the rack.

## 2.3 COOLING

The MG15 is equipped with a cooling system. The power unit is equipped with a suction fan. Air is supplied from the panels located by the power unit enclosure. Hot air outlet is located on the rear panel. At least 15mm should be ensured to let air get inside from the side panels. The MG15 should not be operated at temperatures exceeding 40°C.

## 2.4 ELECTRICAL INSTALLATION

### 2.4.1 POWER SUPPLY

The main mains connection is an IEC 320 socket on the rear wall of the device. The MG15 enclosure is grounded to protect the user against electric shock. Always connect the device to a socket with protective ground. If necessary, contact an electrician before connecting the device. A suitable mains cable is supplied with the device. If the plug is not compatible with the socket, use a suitable mains cable:

- Three-conductor cable with protective ground.
- Conductor cross-section should be min. 1mm<sup>2</sup> (17AWG).

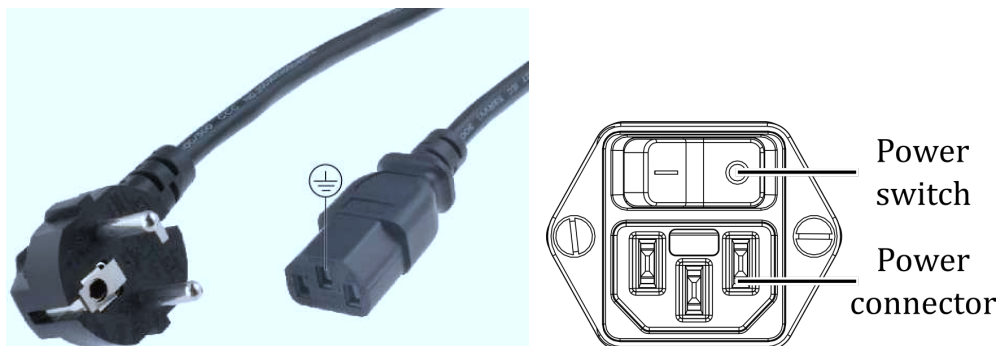


Figure 2.1: Three-conductor cable with protective ground and mains connection



**DANGER****Main power supply.**

Improperly grounded devices can be extremely dangerous in the event of a fault. Use three-conductor mains or extension cables with protective ground only supplied with the MG15 . Plug the mains cable into wall sockets with protective ground only.

- Connect the mains cable with the mains connection on the rear wall of the device.
- Connect the plug of the mains cable with the wall socket.

**NOTE: If the device is installed in a switching cabinet, the mains power can be supplied via a switchable central power distributor.**

### 2.4.2 MAINS SWITCH

The mains switch is installed on the rear panel of the MG15 . The switch has two positions marked as **I** i **O** (see fig. 2.1). The switch in the position **I** (ON) supplies power to the device. The switch in the position **O** (OFF) disconnects power from the device. However, it possible that the mains switch does not remove voltage from the separate components of the device. Therefore, always disconnect the mains cable to remove residual voltage of the device modules.

**DANGER****Risk of electric shock.**

Do not use the mains switch as an element to disconnect the device from the mains. Disconnect the mains cable from the mains connection to remove completely dangerous voltage from the inside of the MG15.

### 2.4.3 GROUNDING TERMINAL

The ground terminal is installed on the rear panel next to mains connection. It is used to connect the device directly with the protective ground of the structure through an additional conductor to provide protection against electric shock.

**DANGER****Screw for internal protective conductor.**

The internal protective conductor is connected with the enclosure through a screw.

Do not turn or loosen this screw.

## 2.5 DEVICE REAR PANEL

This section describes the sockets and connections of the rear panel. Read this section to properly connect the accessories available for the device.

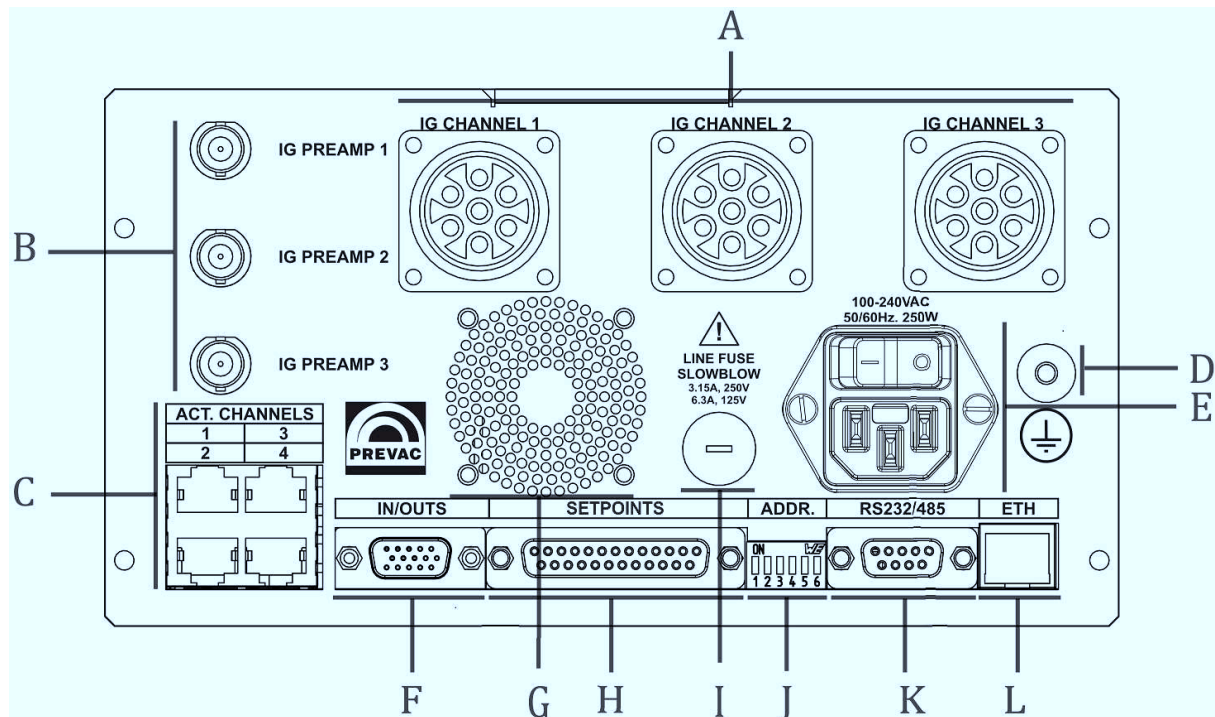


Figure 2.2: View of the rear panel of the standard MG15 .

The following connections are installed on the rear panel:

- **A** - Passive gauges connections
- **B** - Connections for passive gauges measuring signal
- **C** - Active gauges connections
- **D** - Ground terminal
- **E** - Mains connection
- **F** - I/O interface
- **G** - Air outlet
- **H** - Connection for relay outputs
- **I** - Fuse socket
- **J** - Address DIP switch
- **K** - RS232/485 communication interface
- **L** - Ethernet communication interface

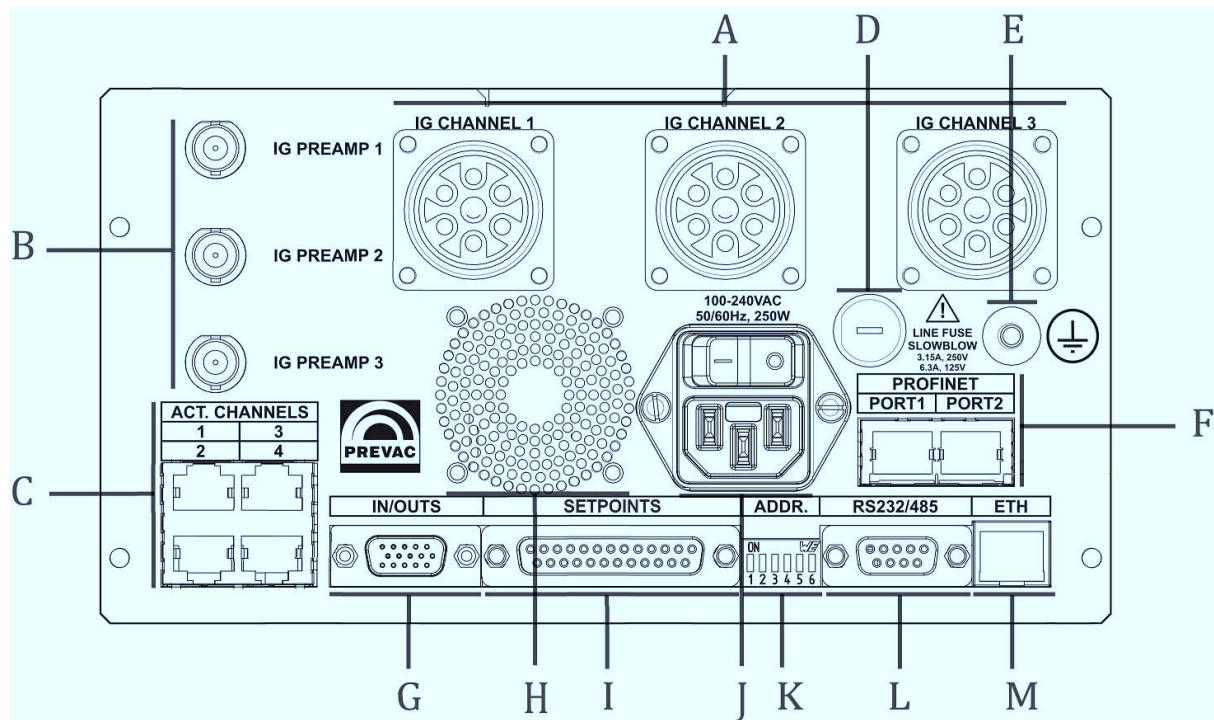


Figure 2.3: View of the rear panel of the MG15 with optional PROFINET interface.

The following connections are installed on the panel:

- **A** - Passive gauges connections
- **B** - Connections for passive gauges measuring signal
- **C** - Active gauges connections
- **D** - Fuse socket
- **E** - Ground terminal
- **F** - ProfiNet communication interface
- **G** - I/O interface
- **H** - Air outlet
- **I** - Connection for relay outputs
- **J** - Mains connection
- **K** - Address DIP switch
- **L** - RS232/485 communication interface
- **M** - Ethernet communication interface

### 2.5.1 ACTIVE CHANNELS

The active channels connections are used to connect gauges. The active channels use an 8-pin RJ45 connector.

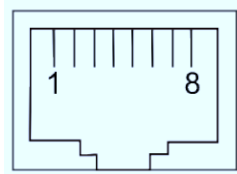


Figure 2.4: Active channel socket (RJ45)

| PIN NUMBER | FUNCTION        | DESCRIPTION                         |
|------------|-----------------|-------------------------------------|
| 1          | 24 VDC          | Voltage 24VDC (max. 1A)             |
| 2          | GND             | Power supply ground                 |
| 3          | Analogue input  | Analogue signal input               |
| 4          | Identification  | Gauge identification resistor input |
| 5          | AGND            | Analogue ground                     |
| 6          | Emission status | Emission status                     |
| 7          | Degas           | Degassing on/off signal             |
| 8          | Emission        | Emission on/off signal              |

Table 2.1: Description of pins of active channel socket.

**CAUTION**



**Improper gauge.**

Gauges which are not designed for use with the MG15 may damage the device. Operate the MG15 with proper gauges only - see chapter 1.5.1.

## 2.5.2 PASSIVE CHANNELS

The passive channels connections are used to connect passive gauges with hot cathode. 7-pin UTG (Metalok Bantam) sockets are available for the passive channels.

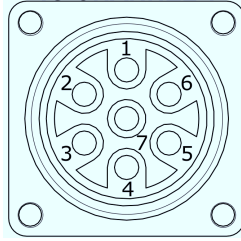


Figure 2.5: Passive channel socket (UTG-type)

| PIN NUMBER | FUNCTION  | DESCRIPTION                      |
|------------|-----------|----------------------------------|
| 1          | Filament  | Filament 1 supply (max. 6.5V 6A) |
| 2          | Filament  | Common ground for filaments      |
| 3          | Anode     | Anode pin                        |
| 4          | Reflector | Reflector (extractor) pin        |
| 5          | Not used  | Pin not used                     |
| 6          | Filament  | Filament 2 supply (max. 6.5V 6A) |
| 7          | PE        | Ground                           |

Table 2.2: Description of pins of passive channel socket

### MEASURING SIGNALS

The measuring signals, i.e. the ion currents are transferred via a coaxial cable (IG PREAMP).  
Pin arrangement:

- inner conductor - signal conductor
- outer conductor – shielding

**DANGER**



#### **Dangerous voltage.**

As soon as the emission is switched on, both connections carry hazardous levels of voltage.

The device must be switched off before any work related to connecting a gauge is performed. After switching off, wait approx.15 seconds before starting the work.

### 2.5.3 REMOTE CONTROL

The device is equipped with the following interfaces:

- Serial RS232/RS485 (Selected in menu),
- Ethernet (compliant with IEEE 802),
- ProfiNet (option).

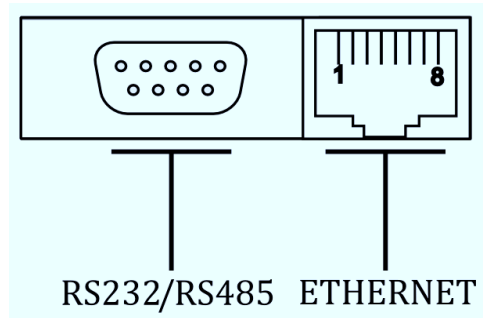


Figure 2.6: Modbus RTU and TCP remote control module

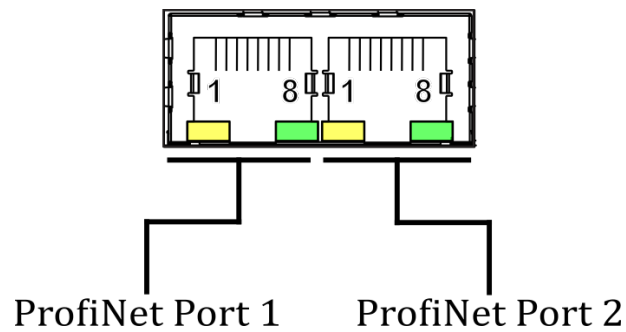


Figure 2.7: ProfiNet remote control module (option)

The parameters of the device can be read via the remote control interfaces at any time. To control/set the parameters switch the device in the remote control mode.

Detailed description of the connections - see fig. 6.3, 6.4 or 6.5.

The configuration of the remote control interfaces is shown in chapter 6.

### 2.5.4 I/O INTERFACE

The I/O connections contains the following signal pins:

- digital inputs
- relay outputs
- analogue outputs

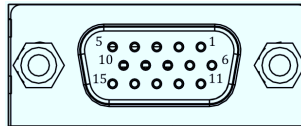


Figure 2.8: I/O socket (D-sub HD 15-pin female)

| PIN NUMBER | FUNCTION | DESCRIPTION  |
|------------|----------|--|
| 1          | DIN1     | Digital input 1 (24 V voltage activated, type 5mA) |
| 2          | DIN2     | Digital input 2 (24 V voltage activated, type 5mA) |
| 3          | DIN3     | Digital input 3 (24 V voltage activated, type 5mA) |
| 4          | DIN4     | Digital input 4 (24 V voltage activated, type 5mA) |
| 5          | GND      | Common ground for digital inputs 1..4              |
| 6          | REL1_NO  | Relay output 1, contact normally open              |
| 7          | REL2_NO  | Relay output 2, contact normally open              |
| 8          | REL3_NO  | Relay output 3, contact normally open              |
| 9          | REL4_NO  | Relay output 4, contact normally open              |
| 10         | REL_COM  | Common pin for relay outputs 1..4                  |
| 11         | AOUT1    | Analogue output 1 (0-10V)                          |
| 12         | AOUT2    | Analogue output 2 (0-10V)                          |
| 13         | AOUT3    | Analogue output 3 (0-10V)                          |
| 14         | AOUT4    | Analogue output 4 (0-10V)                          |
| 15         | GND2     | Common ground for analogue outputs 1..4            |

Table 2.3: Description of pins of I/O connection

**2.5.5 RELAY OUTPUTS CONNECTION (SETPOINTS)**

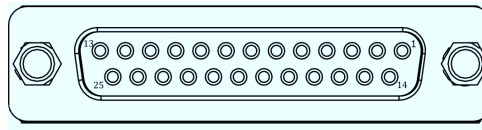


Figure 2.9: Setpoints socket (D-Sub 25 female)

| PIN NUMBER | FUNCTION | DESCRIPTION                         |
|------------|----------|-------------------------------------|
| 1          | SP1_NC   | Setpoint 1, normally closed contact |
| 2          | SP1_NO   | Setpoint 1, normally open contact   |
| 3          | SP2_COM  | Setpoint 2, common contact          |
| 4          | SP3_NC   | Setpoint 3, normally closed contact |
| 5          | SP3_NO   | Setpoint 3, normally open contact   |
| 6          | SP4_COM  | Setpoint 4, common contact          |
| 7          | SP5_COM  | Setpoint 5, common contact          |
| 8          | SP6_COM  | Setpoint 6, common contact          |
| 9          | SP7_COM  | Setpoint 7, common contact          |
| 10         | SP8_COM  | Setpoint 8, common contact          |
| 11         | SP9_COM  | Setpoint 9, common contact          |
| 12         | SP10_COM | Setpoint 10, common contact         |
| 13         | NC       | Not connected                       |
| 14         | SP1_COM  | Setpoint 1, common contact          |
| 15         | SP2_NC   | Setpoint 2, normally closed contact |
| 16         | SP2_NO   | Setpoint 2, normally open contact   |
| 17         | SP3_COM  | Setpoint 3, common contact          |
| 18         | SP4_NC   | Setpoint 4, normally closed contact |
| 19         | SP4_NO   | Setpoint 4, normally open contact   |
| 20         | SP5_NO   | Setpoint 5, normally open contact   |
| 21         | SP6_NO   | Setpoint 6, normally open contact   |
| 22         | SP7_NO   | Setpoint 7, normally open contact   |
| 23         | SP8_NO   | Setpoint 8, normally open contact   |
| 24         | SP9_NO   | Setpoint 9, normally open contact   |
| 25         | SP10_NO  | Setpoint 10, normally open contact  |

Table 2.4: Description of Setpoints connector pins



## 2.5.6 ADDRESS DIP SWITCH

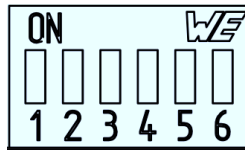


Figure 2.10: Address DIP Switch

To communicate with the MG15 controller the device must be assigned with a unique address set via the address DIP switch.

### 1. MG15 controller with LCD display

To set an address use switches 1 - 6. They encode the device address in the binary code. Weights and values of individual switches are described in table 2.5.

| DIP    | 1 | 2 | 3 | 4 | 5 | 6 |
|--------|---|---|---|---|---|---|
| WEIGHT | 0 | 1 | 2 | 3 | 4 | 5 |

Table 2.5: Weight of individual switches

#### Example:

To assign address with a value of 38 to the device change the position of switches 2, 3, 6 to ON (upwards).

$$2^1 + 2^2 + 2^5 = 38$$

Possible settings of addresses are shown in table 9.1.

### 2. MG15 BlackBox version

- with ProfiNet communication socket

| DIP | FUNCTION    |
|-----|-------------|
| 1-4 | Address     |
| 5   | ProfiNet    |
| 6   | RS232/RS485 |

Table 2.6: DIP switches functions

To set an address use switches 1 - 4. Refer to table 2.5 for weights of switches.

Communication interface can be selected as shown below:

|         |         |          |
|---------|---------|----------|
| 5 - OFF | 6 - OFF | RS232    |
| 5 - OFF | 6 - ON  | RS485    |
| 5 - ON  | 6 - X   | ProfiNet |

Table 2.7: Interface selection

- without ProfiNet communication socket

| DIP | FUNCTION    |
|-----|-------------|
| 1-5 | Address     |
| 6   | RS232/RS485 |

Table 2.8: DIP switches functions

To set an address use switches 1 - 5. Refer to table 2.5 for weights of switches.  
Communication interface can be selected as shown below:

|         |       |
|---------|-------|
| 6 - ON  | RS485 |
| 6 - OFF | RS232 |

Table 2.9: Interface selection

## 3 OPERATION

The MG15 multi gauge controller can be interacted via the touch panel.

### 3.1 SWITCHING ON THE DEVICE

In order to turn on the device make sure that all of the connections on the rear panel are made correctly and that the AC connection meets the AC source requirements. If these conditions are met, set **Power Switch** into **ON** position on the rear panel. The instrument is on when the logo appears. The Introduction screen displays and the main application will start. The instrument is ready to use. After connecting and switching on the MG15 the outputs are not active.

### 3.2 FRONT PANEL - STANDARD

Fig. 3.1. below shows the front panel of the MG15 . The user interface of the MG15 consists of the following elements:



Figure 3.1: Front panel

- A - Touch panel display
- B - USB port
- C - Mounting holes

### 3.2.1 DISPLAY WITH TOUCH PANEL

The device is equipped with a 800x480 TFT 7" colour display with a 16:10 format. The display has an integrated touch panel enabling communication with the user.



#### CAUTION

The touch panel can record only a single press at a time. It is forbidden to touch the panel at several points simultaneously.



#### CAUTION

Do not use any indicators or sharp objects. Using inappropriate objects for pressing may damage the foil resulting in entering incorrect data.

### 3.2.2 USB PORT CONNECTOR

Allows removable media to be used for e.g. update the software. . It also enables copying videos and logs from/to the user's activity records.

### 3.3 FRONT PANEL - BLACK BOX

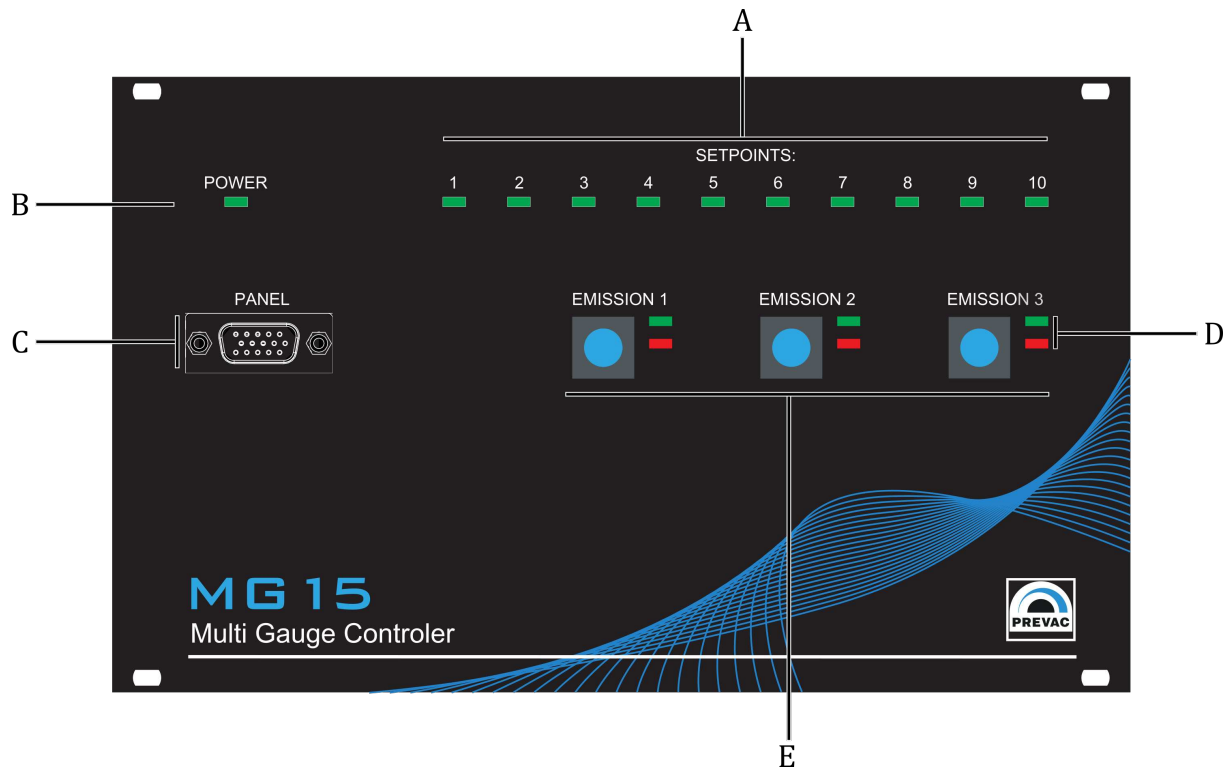


Figure 3.2: Front panel in BlackBox version

- **A** - Diodes signalling active Setpoints
- **B** - Diode signalling that power is ON
- **C** - Socket to connect the panel with a graphic display
- **D** - Diodes signalling that emission is ON or passive gauges errors
- **E** - Buttons activating emission for individual passive gauges

### 3.4 USER INTERFACE

The MG15 is equipped with a colour display with touch screen. All control operations, entering settings and data are carried out only via the touch screen.

Information displayed by the device are grouped in three separate windows:

- main window
- chart window (option)
- timer window

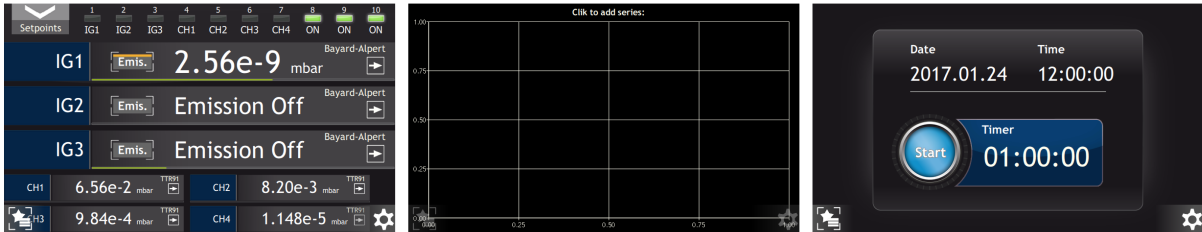


Figure 3.3: Three main device windows

Navigation between the screens is done via the scroll buttons located at the side edges of the device. These buttons are hidden during normal operation.

To move to the next screen press the display near the left or right edge. The scrolling between the screens is looped - it means that from the last screen we move to the first one and, analogically, the other way round.

The main view contains 3 elements:



Figure 3.4: Description of main window

- **A** - Main view
- **B** - Menu shortcut - list of favourite positions of the main setup menu (see chapter 3.4.7). The shortcut icon appears after adding at least one shortcut.
- **C** - Main menu - access button to main setup menu.

### 3.4.1 MAIN WINDOW

The device has one main view on which the most important parameters controlled by the device are displayed.



Figure 3.5: Description of main window

- **A** - Setpoints configuration button
- **B** - Diodes indicating active Setpoints
- **C** - Single large vacuum channel
- **D** - Single small vacuum channel

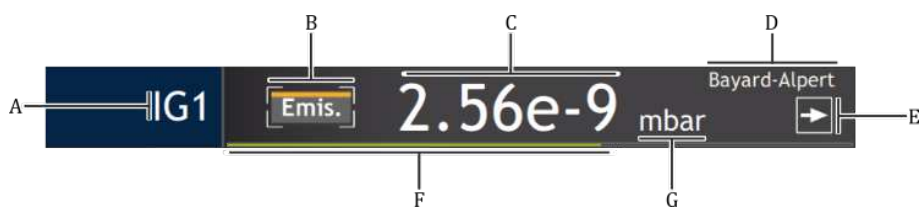


Figure 3.6: Description of single vacuum channel

- **A** - Name of vacuum channel
- **B** - Emission activation button
- **C** - Vacuum value
- **D** - Type of vacuum gauge
- **E** - Trend indicator
- **F** - Graphic indicator of gauge range
- **G** - Vacuum value unit

### 3.4.1.1 SETPOINTS MENU

This parameter group allows you to configure the switching of relays functions. The MG15 is equipped with 10 relays which are switched depending on the measured pressure. Fig. 3.7 shows the setpoints behaviour:

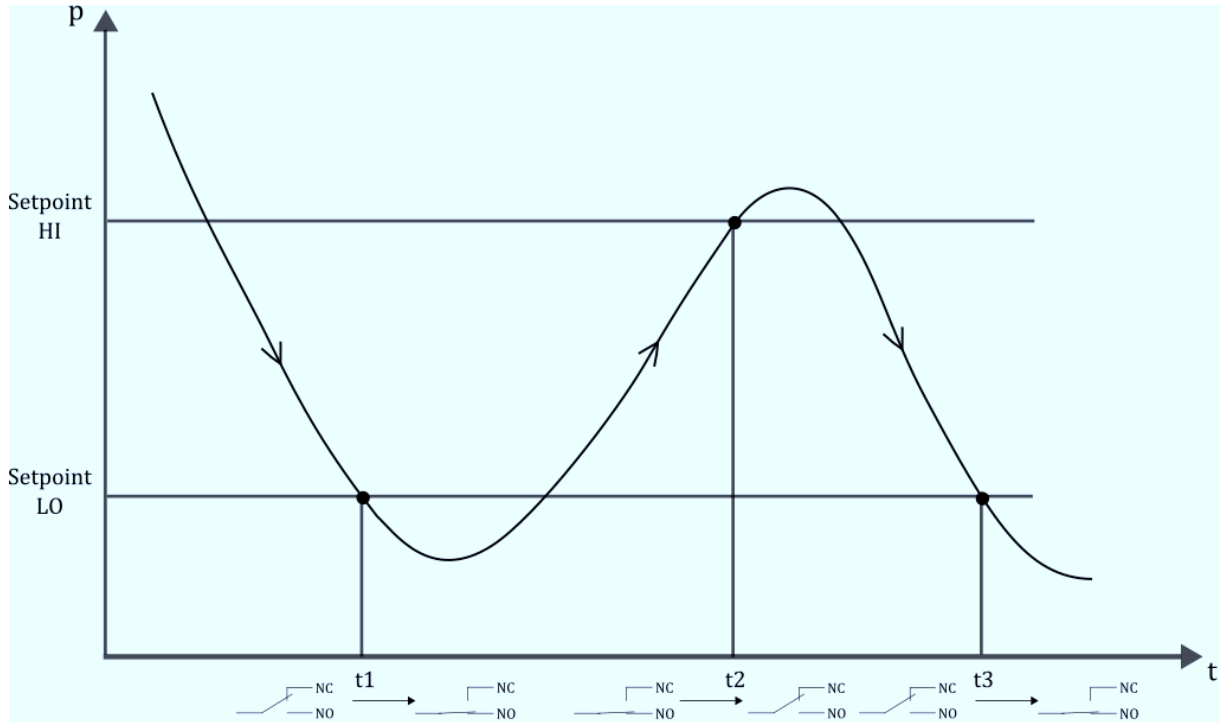


Figure 3.7: Setpoints behaviour

Opisy przekaźników:

- **NO** - Normally Open contact (**N**ormal **O**pen)
- **NC** - Normally closed contact (**N**ormal **c**lose)

Refer to chapter 2.5.5 to configure connections.

To prevent multiple changes of the setpoint status when vacuum reaches the setpoint, hysteresis has been introduced which width is controlled by the Setpoint HI and Setpoint LO parameters:

- **Setpoint HI** – the level of vacuum which will be signalled by switching off the Setpoint diode connected with a given measurement channel. If a vacuum measurement channel has been connected with a given Setpoint (device relay output), then after reaching that value the relay contacts at the output will be opened.
- **Setpoint LO** – the level of vacuum which will be signalled by switching on the Setpoint diode connected with a given measurement channel. If a vacuum measurement channel has been connected with a given Setpoint (device relay output), then after reaching that value the relay contacts at the output will be closed.





Figure 3.8: Setpoints settings

### 3.4.1.2 GAUGE CHANGE

To change a gauge in the main view click on the gauge name. The gauge selection menu will appear, see chapter 3.6.1

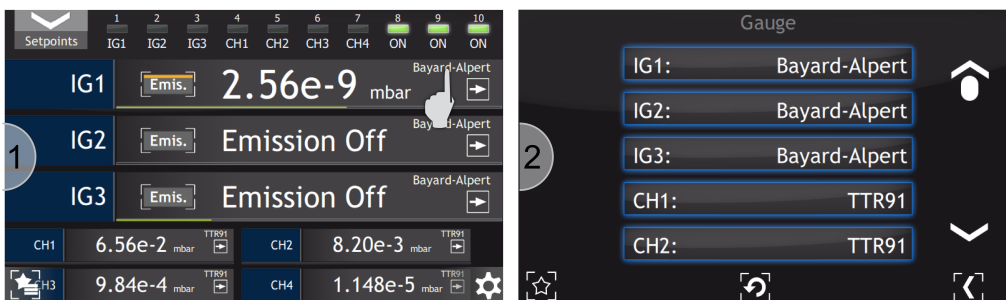


Figure 3.9: Gauge change

### 3.4.1.3 MEASUREMENT UNIT CHANGE

The MG15 enables defining a unit of measurement for pressure values displayed for each channel separately.

The following pressure units can be chosen:

- mbar - pressure unit milibar
- Pa - pressure unit Pascal
- Torr - pressure unit Torr
- psia - pressure unit Pound per square inch



Figure 3.10: Pressure unit change

### 3.4.1.4 ENLARGING OF PRESSURE VALUE/INFORMATION WINDOW

To enlarge the pressure value/information window press this field, see fig. 3.11. To return to the normal view of the main window, press again the displayed information.



Figure 3.11: Enlargement of pressure value window

### 3.4.2 CHART WINDOW

The additional window contains a chart module. The module is used to visualise graphically the behaviour of a chosen physical quantity in time. In the further part of the manual a single physical quantity in time will be called data series.

The time axis is scaled in minutes for the time of recording of charts up to one hour. Above one hour the time axis is scaled in hours.



The charts module in some devices is available optionally at an additional charge. The user may order the device with an activated charts module or activate it later - refer to chapter 3.4.2.7

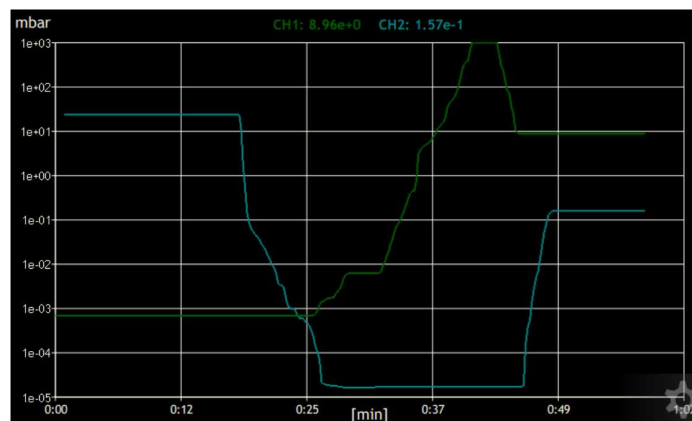


Figure 3.12: Chart module

#### 3.4.2.1 ADDING OF DATA SERIES

To add or remove data series follow the procedure presented in fig. 3.13:

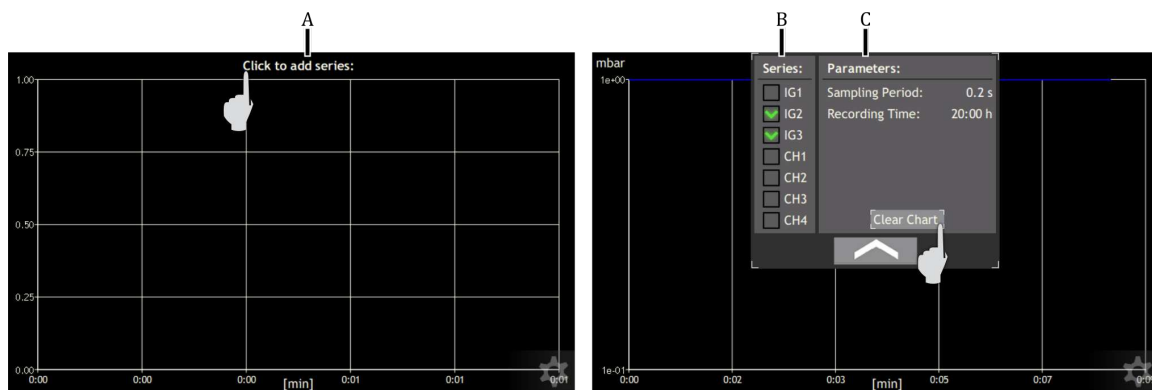


Figure 3.13: Adding data series and editing chart parameters

- **A** - Click on top field, with currently drawn data series
- **B** - Define the data series to be drawn

### 3.4.2.2 EDITING OF CHART PARAMETERS

To change the chart drawing parameters follow the procedure presented in fig. 3.13:

- **A** - Click on top field, with currently drawn data series
- **B** - Click on a selected parameter to be edited

*Parameters that can be edited:*

- **Sampling period** - the parameter determines time intervals at which another data is added to the chart. Increasing this parameter extends the maximum time of recording but simultaneously decreases precision.
- **Recording time** - the parameter determines time window during which data are recorded.

### 3.4.2.3 CLEARING OF CHART

To clear all to date recorded data and start recording from scratch press the **Clear chart** shown in fig. 3.13.

Remember that pressing the button **Clear chart** deletes all the data recorded so far.

### 3.4.2.4 VIEW OF PART OF CHART

The chart module enables viewing a selected part of the chart on full screen. For this purpose, as shown in fig. 3.14 (marker **A**), press the screen at a given place and mark the selected part to view by dragging.

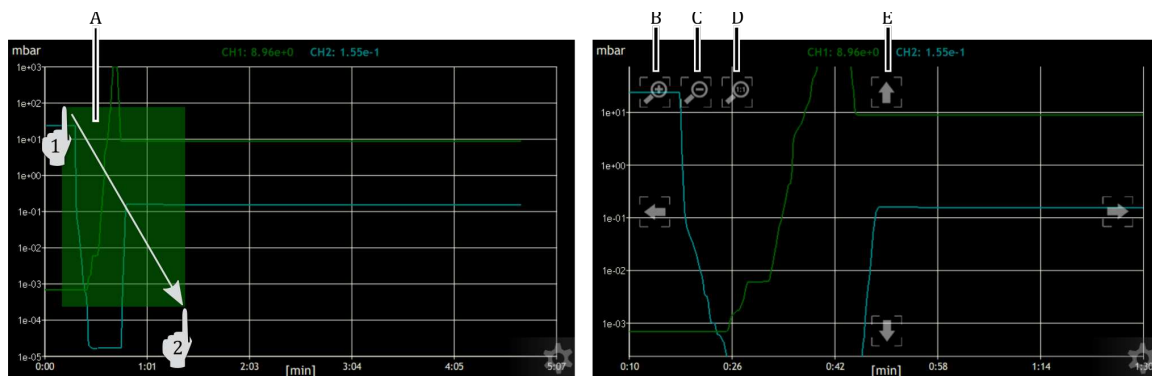


Figure 3.14: View of selected fragment of chart

After enlarging the selected fragment of the chart additional buttons will appear to perform other manipulations:

- **B** - Enlarging the current chart area
- **C** - Reducing the current chart area
- **D** - Returning to normal recording mode
- **E** - Four arrows to scroll the chart in any direction.

### 3.4.2.5 CHANGE OF CHART UNITS

To change the unit, in which the chart is being drawn, click on this unit and select the item on the list.

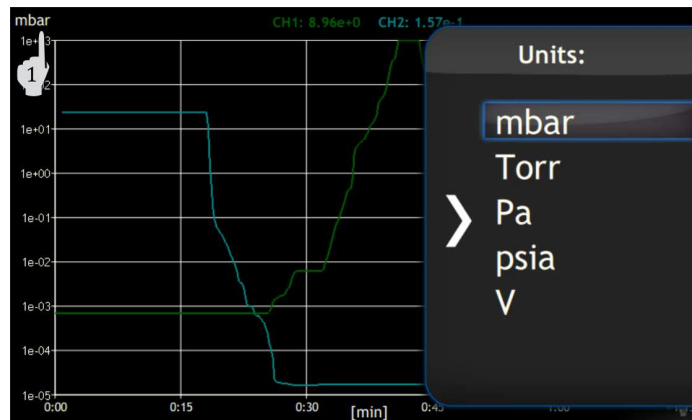


Figure 3.15: Change of chart units

### 3.4.2.6 SAVING CHART DATA ON USB

All the chart data can be saved on a pen drive. To save data connect a USB mass storage device . A new icon and information about detecting a new USB device will appear on the screen: **New USB device detected**. After pressing the icon, the USB menu will be displayed.

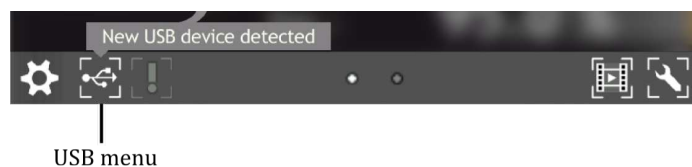


Figure 3.16: Notification about detecting USB

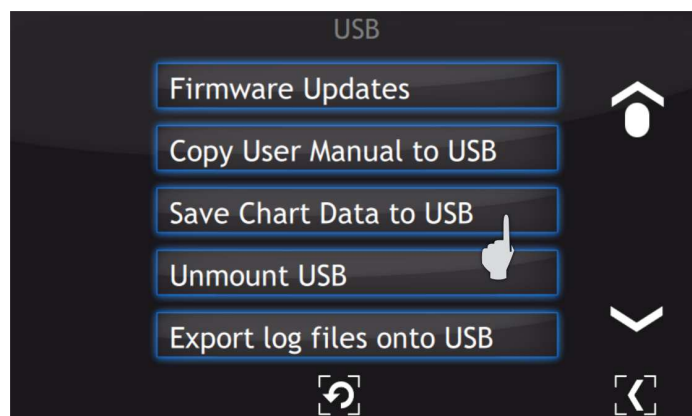


Figure 3.17: USB menu - chart data saving

In the USB menu select the position **Save Chart Data to USB** and wait for the message informing about completion of the saving. Before removing the memory stick, unmount it by clicking **Unmont USB**.

The data of each session are stored in files named ChartData\_ *series\_name*.csv. The file contains information about the time and value of each point. The time is compatible with the system date ??.

Example content of the data file:

```
Time;data[mbar]
2017-01-01 11:59:46.816;1.50e+3
2017-01-01 11:59:47.028;8.36e+2
```

### 3.4.2.7 ACTIVATION OF CHART MODULE

To activate the module:

1. Read the product and serial numbers from the **Information** menu
2. Read the product key from the **Device Settings** → **Chart Activation**
3. Contact the sales department (+48 32 459 2130 lub sale@prevac.pl) and provide both numbers and the product key.
4. After completing the procedure a licence key will be provided, which should be entered after clicking on the **License key** 3.18

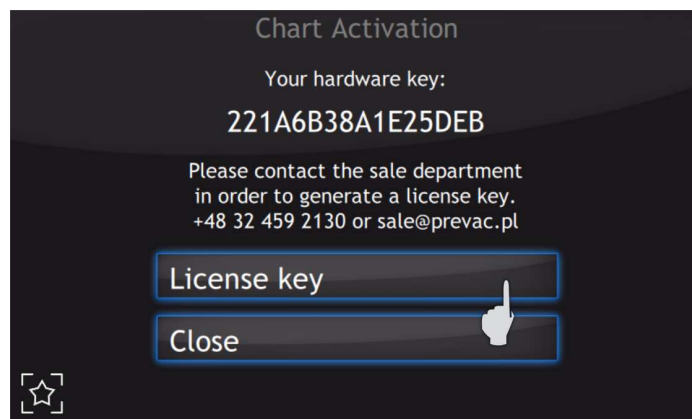


Figure 3.18: Chart activation menu

After correct completion of the activation of the chart module, the message shown below in fig. 3.19 should appear.

### 3.4.3 TIMER WINDOW

An additional window contains a timer and information on the current time and date. Elapsing time is connected with the progress bar located around the Start/Stop button. The value of the timer can be set in a range from 23h:59m:59s to 00h:00m:01s. After pressing the **Start** button time is counted down from the set value to zero. The counting ends with an acoustic signal. When the counting ends the timer is stopped and the value of the time which has been counted is displayed.

#### 3.4.3.1 3.4.3.1 TIMER SETTING

To set the timer carry out the following operations:

1. Press the **timer field**.

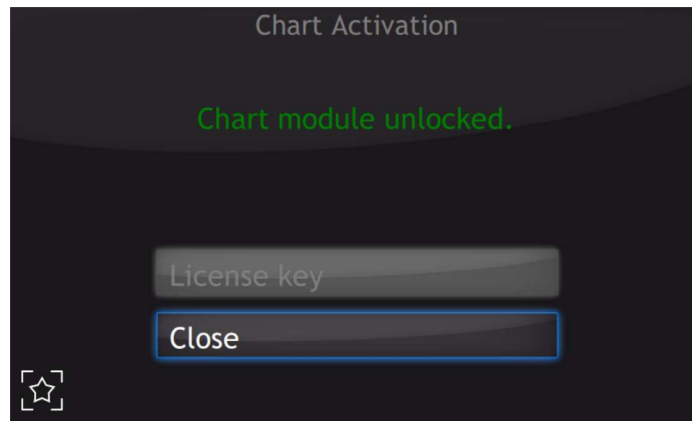


Figure 3.19: Correct activation of chart module

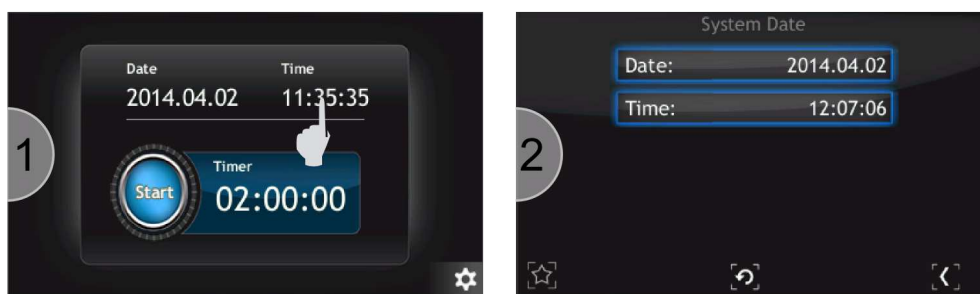


Figure 3.20: Entering system date

2. Enter a start value of the timer using the number keys **from 0 to 9** and symbol **“:”** as a separator. Confirm the value by pressing the **Enter** button.
3. The new value has been set and displayed in the **timer field**. Press **Start** to activate the timer.
4. The timer will start counting time.

Time can also be entered in seconds. Then, the value entered is automatically converted to the **hh:mm:ss** format

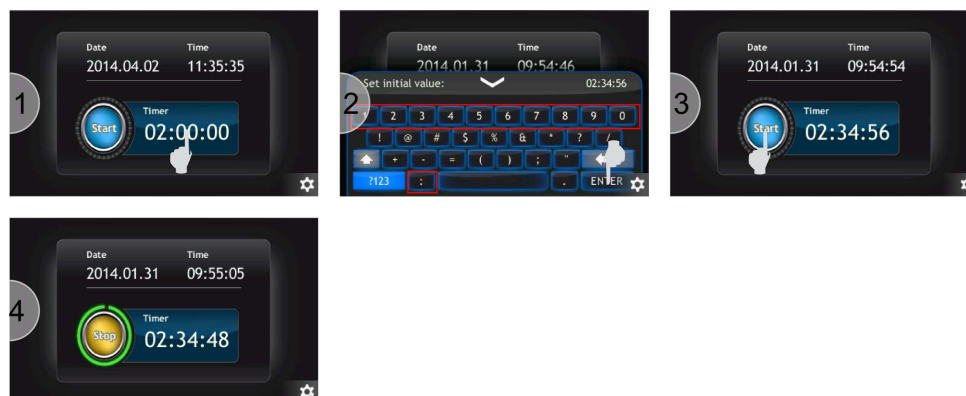


Figure 3.21: Timer setting

### 3.4.4 NUMERIC KEYPAD

Numerical values in the device can be edited via the numeric keypad. It consists of basic numbers from 0 to 9 and function keys to enter new data and update the existing ones. The numeric keypad is shown in fig. 3.22.

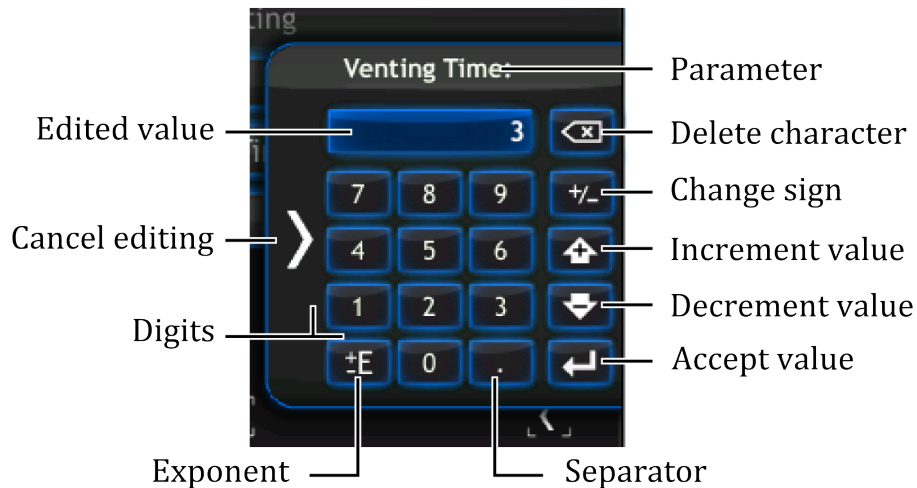


Figure 3.22: Numeric keypad

Data can be entered directly from the numeric keypad by entering and confirming the value entered using the following three methods:

- by entering data as decimal values.
- by entering data as a mantisaa and exponent.
- by increasing/decreasing the current value by a given step.

To increase/decrease the current value:

1. Select the value for edition (e.g. Venting Time).
2. Press **1** and **2**, to increase the value by 12.
3. Press the **Increment value** key (every press of this key increase the value by 12).
4. The value has been increased.
5. To decrease the value press the **Decrement value** key (every press of this key decreases the value by 12).
6. Value is decrement.
7. Confirm the value with the **Confirm value** key.



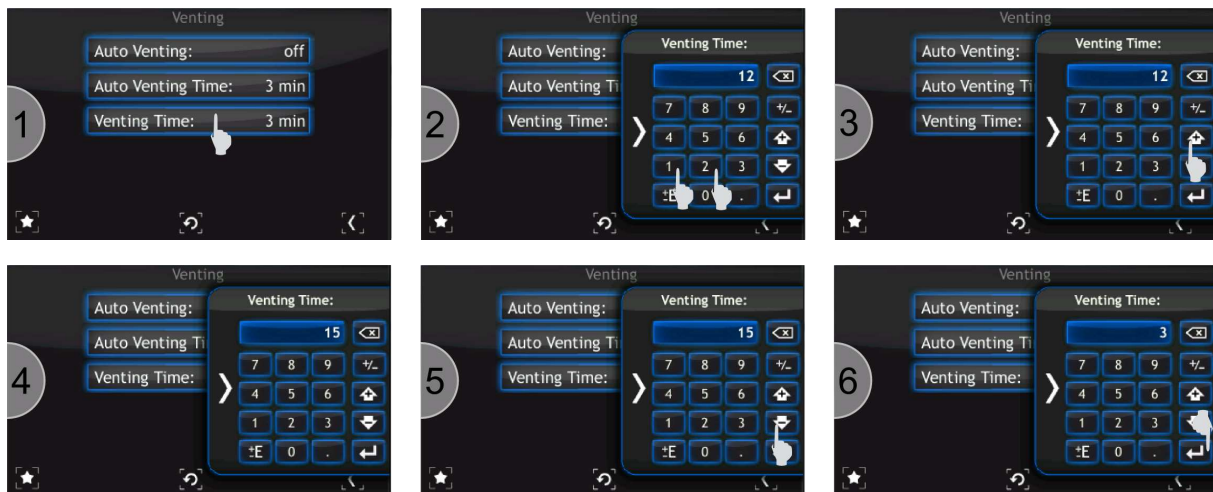


Figure 3.23: Increasing/Decreasing value via numeric keypad

To enter a number in the exponential form:

1. Enter the value of the mantisee with an appropriate character via the numeric keypad (e.g. 12.5).
2. Press the **Exponent** key. The index character can be changes by clicking it twice.
3. Enter the exponent value.
4. After entering the value, it is still possible to modify the sign of mantissa and the sign of exponent by using the **Exponent** key or the **Change sign** key (see 3.22 Figure).
5. Confirm the value with the **Accept value** key.

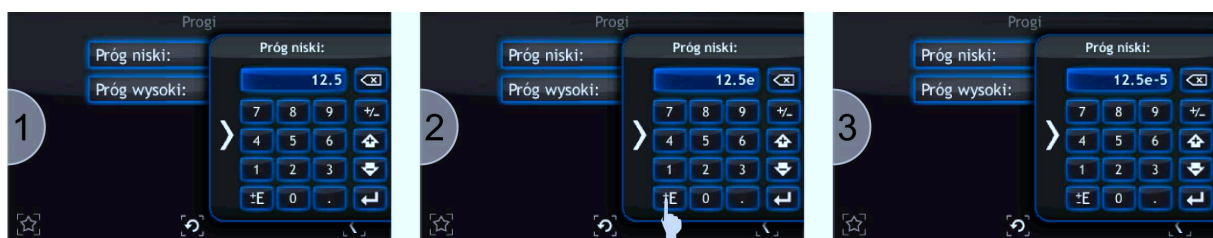


Figure 3.24: Number in exponential form

### 3.4.5 ALPHANUMERIC KEYPAD

The on-screen keyboard is used for entering alphanumeric data and also facilitates text entry. Figure 3.25 shows the alphanumeric keypad with description of the main keys.

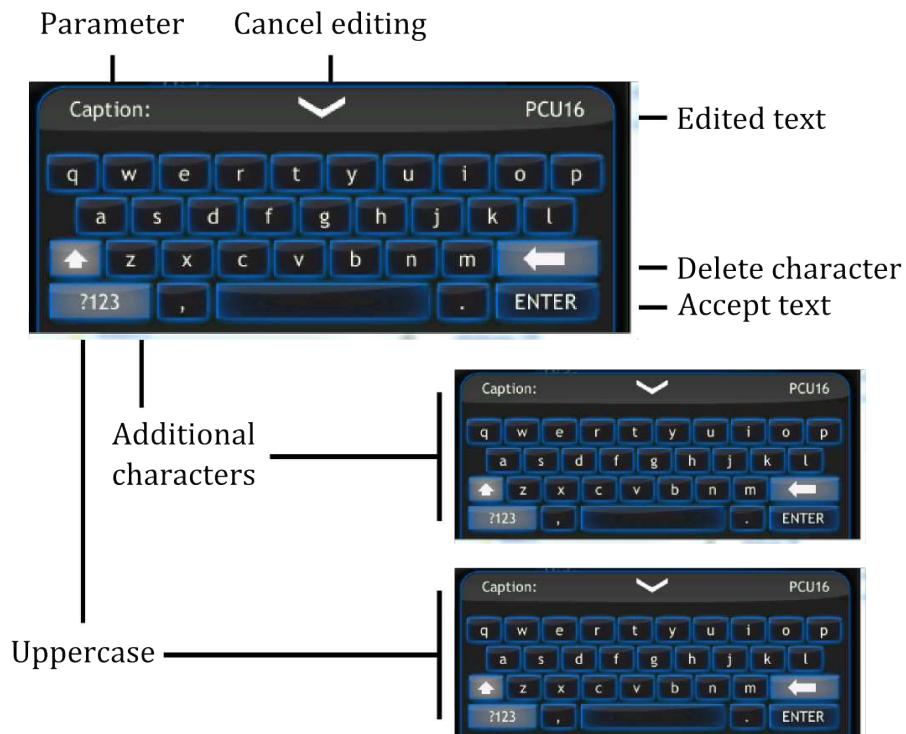


Figure 3.25: Alphanumeric keypad

### 3.4.6 SETUP MENU

Advanced configuration of the device parameters is possible via the setup menu. Press the **Show Menu** icon to expand the menu and then press the **Device setup** button. All the mentioned buttons/icon are described below in fig. 3.26.

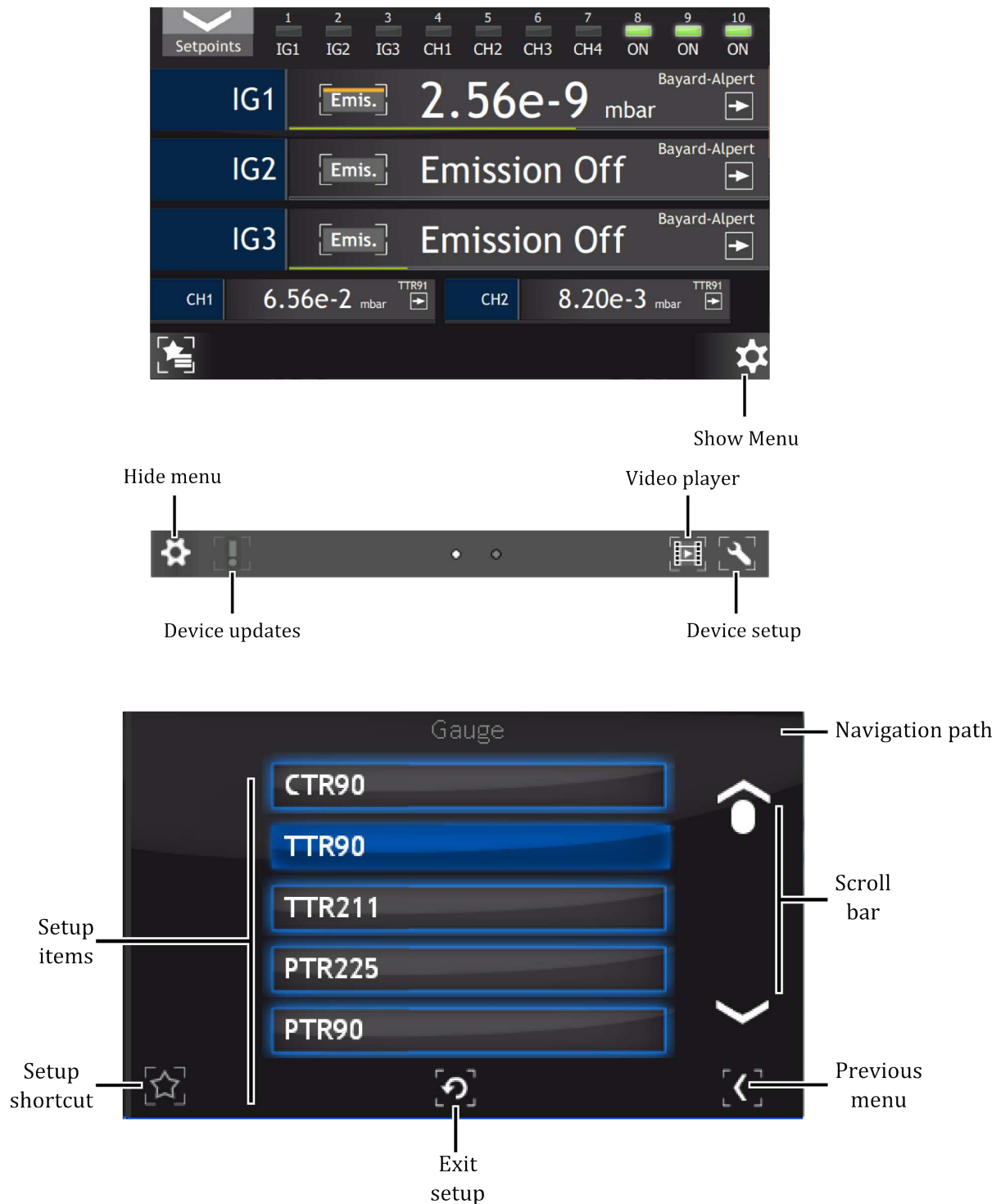


Figure 3.26: Device setup

### 3.4.7 SETUP SHORTCUTS

Frequently used commands/settings can be conveniently accessed by creating shortcuts.

To create a shortcut:

1. Navigate to the setup position where a shortcut should be created.
2. Press on the **Setup shortcut** icon to add the position to shortcuts. To remove position from shortcut list tap again on the **Setup shortcut** icon.

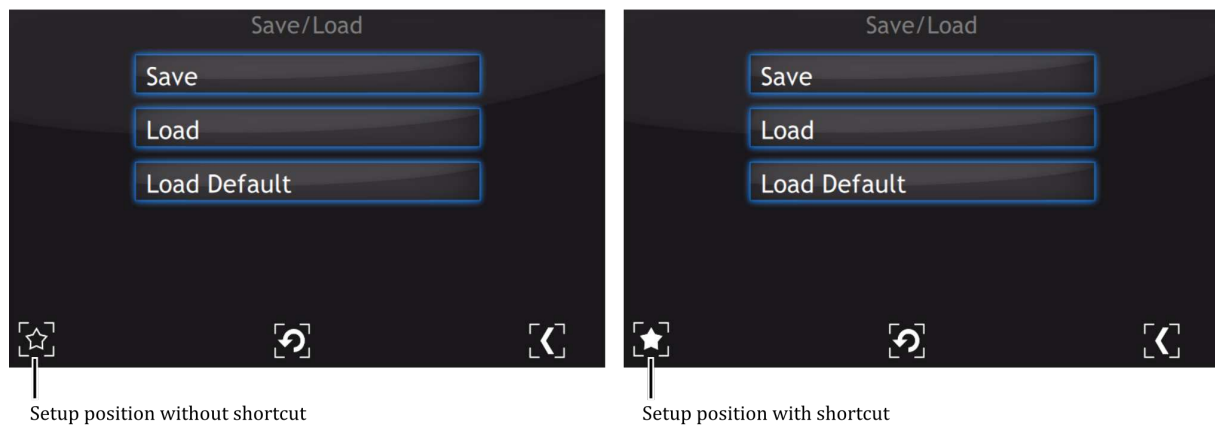


Figure 3.27: Set up shortcut in the setup menu

To use a shortcut:

1. Press on the **Setup shortcut** icon on the main window.
2. Select setup shortcut to enter (e.g. Save/Load).
3. Current setup menu item should be displayed.



Figure 3.28: Example use of shortcut

### 3.4.8 MESSAGES

The MG15 will automatically display both warning and error messages as appropriate.



Figure 3.29: Example warning and error messages.

#### 3.4.8.1 WARNING MESSAGES

Warning messages are displayed on the right of the screen. When present, they can be clicked to display the full warning information (see Figure 3.30). The warning message field consists of its name and description. A warning is information about an event that occurred in the system, but it is not critical for the operation of the device. When the problem causing the error no longer exists, the message is automatically removed whether or not it has been confirmed.

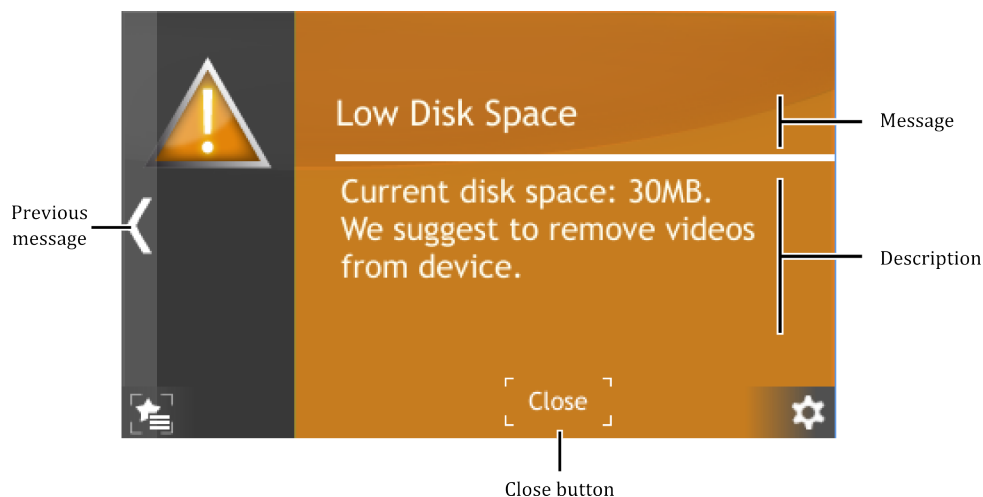


Figure 3.30: Warning message

#### 3.4.8.2 ERROR MESSAGES

Error messages inform about critical events. The message is displayed in full screen (see Figure 3.31). The error message field consists of its name and description. If the cause of error no longer exists, the error message will disappear after the user clicks OK. When the user clicks OK but the error still exists, then information about the event will continue to be displayed on the right hand side of the screen. If the cause of error still exists, please contact the manufacturer.

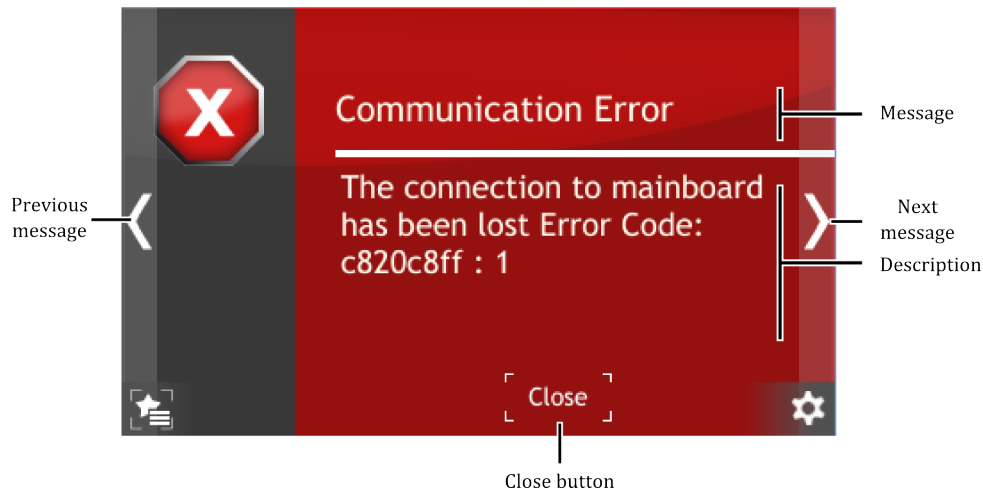


Figure 3.31: Error message

### 3.4.8.3 MULTIPLE MESSAGES

If several errors or warnings occur simultaneously they are indicated with a counter on the right hand corner of a screen. The first digit (red) of the message counter indicates the number of errors, the second digit (yellow) indicates the number of warnings occurred in the device. Clicking on this counter will bring up the message list. The list is displayed in date/time order from most recent to oldest. Error messages appear in the list before Warning messages.

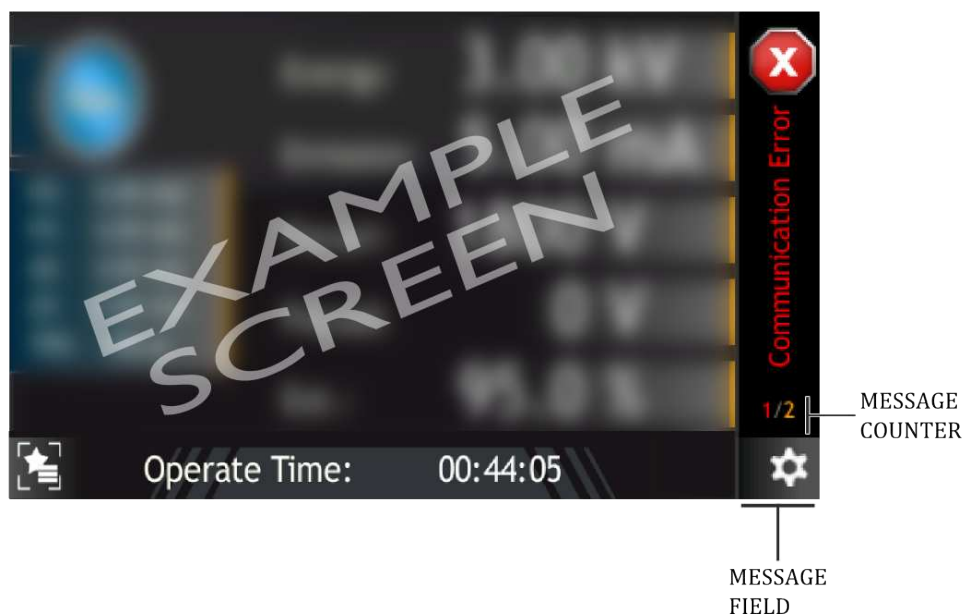


Figure 3.32: Multiple messages

### 3.4.9 VIDEO PLAYER

The MG15 can play video files. Files can be played only from the device. The full instructions on how to copy a video file onto the device is in the subsection *Copy video file to the device*. A short guide on how to play the video is included in subsection *Playing Video*.

### 3.4.9.1 PLAYING VIDEO

In order to play a video go to the main screen and press the **Menu icon** on the bottom right corner of the screen to display the menu bar. Then press the **Video player** icon on the bottom right (see Figure 3.33).

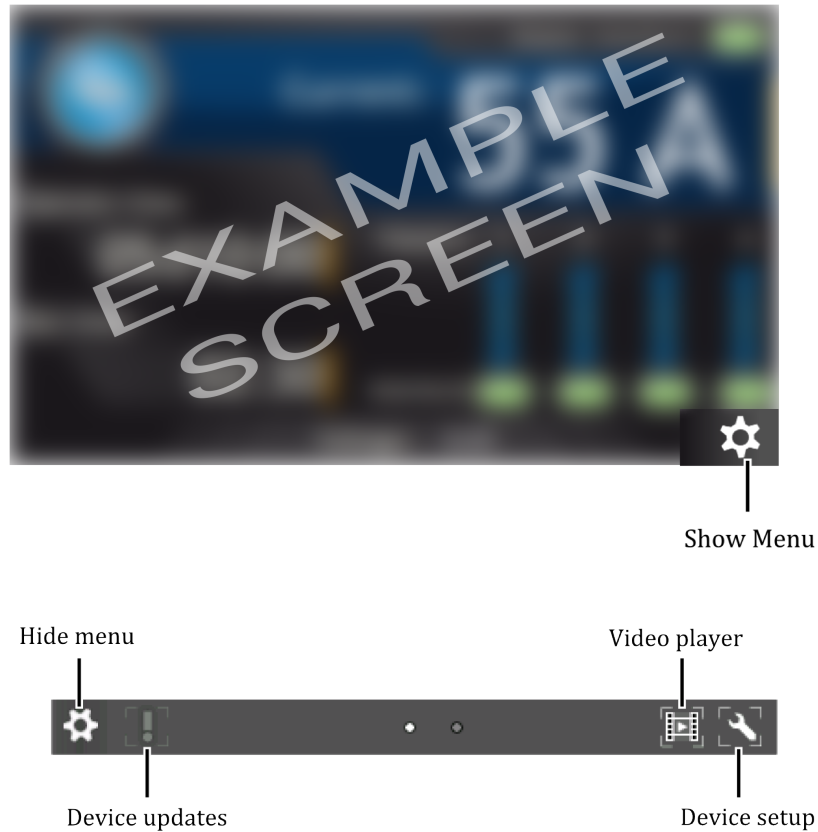


Figure 3.33: Menu bar - video player

1. Tap on the desired file to open video menu.

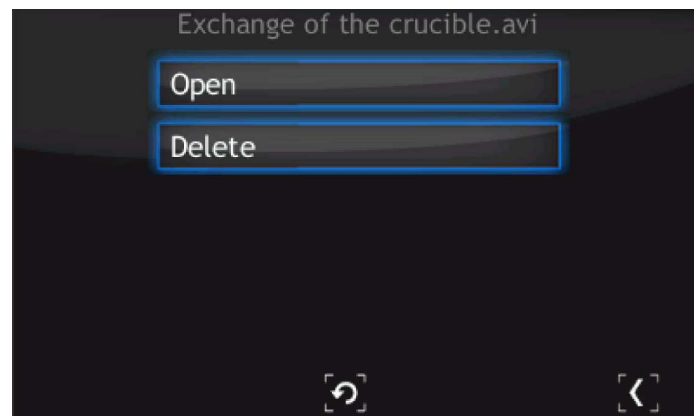


Figure 3.34: Video player - menu

2. From this menu, a video file can be played or deleted. In order to delete the file, press **Delete** and confirm the action by pressing **Yes**.



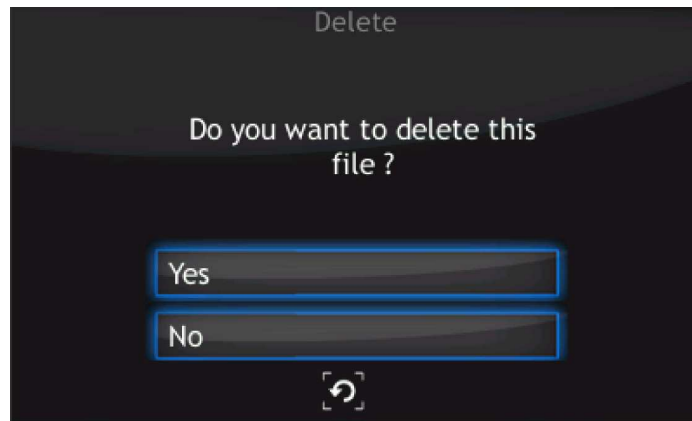


Figure 3.35: Deleting a video file

3. To open a video, press **Open**. The video player is displayed.
4. Tap on the screen to see the video player menu.

All the video player menu items are described in the figure below:

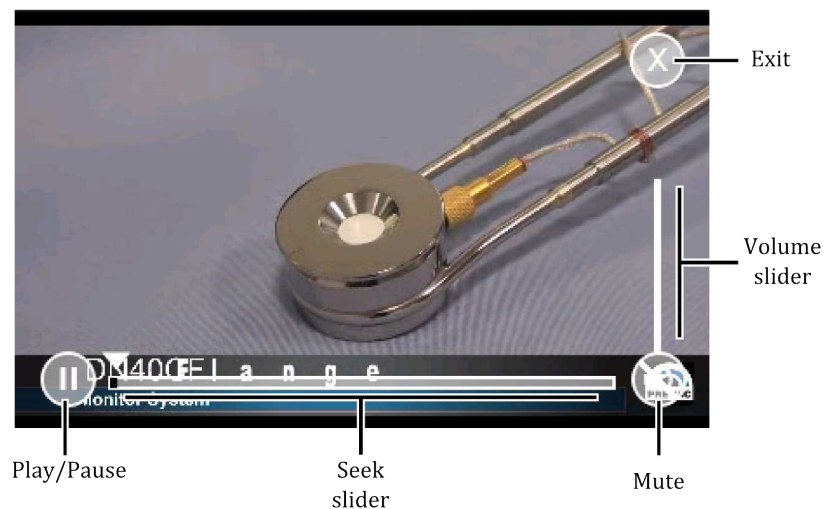


Figure 3.36: Video player

### 3.4.9.2 COPY VIDEO FILE TO THE DEVICE

In order to copy a video file to the device, connect a USB flash drive which contains the files. A new icon and information about detecting a new USB device will appear on the screen: **New USB device detected**. After pressing the icon, the menu will be displayed.

Press on the **List of videos on USB** button to see all the videos stored on the USB drive with \*.avi extension (see Figure 3.38).

1. Choose a file from the list.
2. To copy file, press **Copy file to the device**.
3. Depending on the file size, the copy operation can take from a few seconds to several minutes. At the end of the copy operation, press the **Return** button.



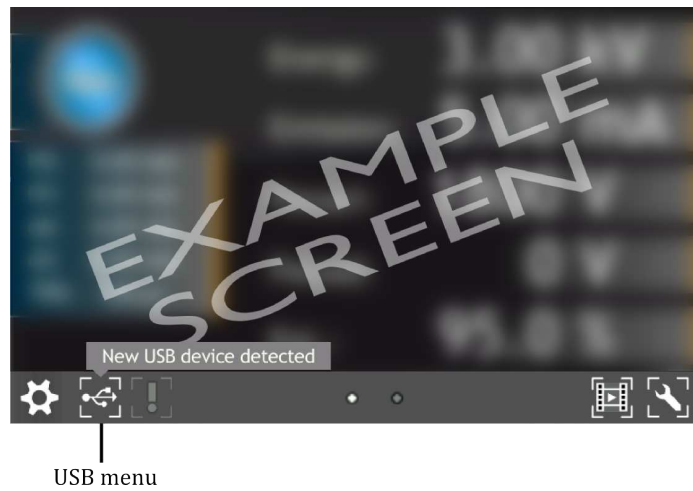


Figure 3.37: Notification about detecting USB

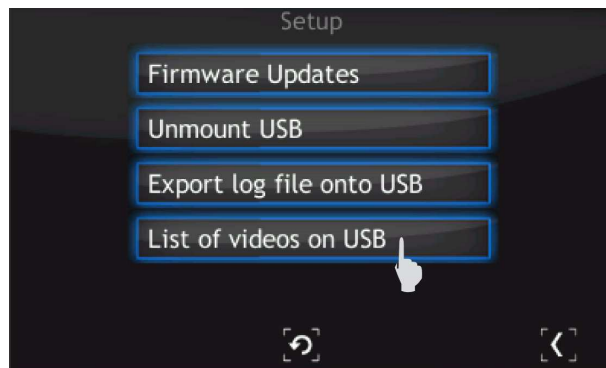


Figure 3.38: USB menu - list of videos on USB



Figure 3.39: Copy \*.avi to device

## 3.5 SETUP MENU

The menu is used to access the device setup options, such as the geometry of chambers, gauges, communication, etc. To save the changes follow the instructions set out in chapter 3.6.15.

## 3.6 MENU TREE

- Sensor
  - IG1, IG2, IG3
  - Gauge
    - IE414
    - IE514
    - UHV-24
    - UHV-24p
    - MKS Series 274
    - NUDE-UHV-8A
    - NR-F-UHV
    - G8130
    - User Defined
  - Gauge Parameters
  - Emission Current
  - Sensitivity
  - Degas Power
  - Calibration Factor
  - Filament
  - Emission Current
  - Sensitivity
  - Degas Power
  - Grid Voltage<sup>1</sup>
  - Filament Voltage<sup>1</sup>
  - Reflector Voltage<sup>1</sup>
  - Filament Max. Current<sup>1</sup>
  - Degas Voltage<sup>1</sup>
  - Name<sup>1</sup>
  - Auto Identification
    - CH1
    - CH2
    - CH3
    - CH4
  - CH1, CH2, CH3, CH4
    - CTR90
      - 0.1 Torr
      - 1 Torr
      - 10 Torr
      - 100 Torr
      - 1000 Torr
    - TTR91
    - TTR211
    - PTR225

<sup>1</sup>Parameters available only for User Defined gauge

- PKR251
- PCR280
- PTR90
- ITR90
- ITR100
- Baratron
  - 10 Torr
  - 50 Torr
  - 100 Torr
  - 500 Torr
  - 1000 Torr
  - 20 psia
  - 30 psia
  - 50 psia
  - 60 psia
  - 100 psia
  - 250 psia
  - 500 psia
  - 725 psia
  - 1000 psia
  - 2000 psia
  - 3000 psia
  - Defined FS
- ANALOG IN
- PG105
- ATMION
- User Defined
  - A factor
  - B factor
  - min. Voltage
  - max. Voltage
  - Name
- Degas
  - IG1, IG2, IG3, CH1, CH2, CH3, CH4
  - Degas Time
  - Degas
- Emission Control
  - IG1, IG2, IG3, CH1, CH2, CH3, CH4
  - Manual
  - Setpoint 1
  - Setpoint 2
  - Setpoint 3
  - Setpoint 4
  - Setpoint 5
  - Setpoint 6
  - Setpoint 7
  - Setpoint 8
  - Setpoint 9
  - Setpoint 10
  - Digital IN 1
  - Digital IN 2

- Digital IN 3
- Digital IN 4
- Gas Type
  - IG1, IG2, IG3, CH1, CH2, CH3, CH4
  - Air
  - He
  - Ne
  - Ar
  - Kr
  - Xe
  - H2
  - CO
  - Define
- Filter
  - IG1, IG2, IG3, CH1, CH2, CH3, CH4
  - Low
  - Medium
  - High
- Display Channels
- Channel Name
  - IG1, IG2, IG3, CH1, CH2, CH3, CH4
- Outputs Settings
  - Relay Outputs
    - Out 1, Out 2, Out 3, Out 4
    - Emission IG1
    - Emission IG2
    - Emission IG3
    - Emission CH1
    - Emission CH2
    - Emission CH3
    - Emission CH4
    - Degas IG1
    - Degas IG2
    - Degas IG3
    - Degas CH1
    - Degas CH2
    - Degas CH3
    - Degas CH4
    - Still OFF
    - Still ON
    - None
  - Analog Outputs
    - Out 1, Out 2, Out 3, Out 4
    - Source
      - Pressure IG1
      - Pressure IG2
      - Pressure IG3
      - Pressure CH1
      - Pressure CH2
      - Pressure CH3
      - Pressure CH4

- None
- Mode
- User Range
- 1 to 1
- EXPO
- Ranges
- Min Pressure
- Max Pressure
- Scale
- Linear
- Logarithmic
- Min Voltage
- Max Voltage
- Trend
  - IG1, IG2, IG3, CH1, CH2, CH3, CH4
  - Time
  - Percent Change
- Device Settings
  - Communication
    - Interface 1
      - Ethernet Parameters
      - IP
      - Mask
      - Gateway
      - DHCP
        - Enable
        - Disable
      - TCP server port
    - Interface 2
      - Interface
        - RS232
        - RS485
        - ProfiNet
      - Interface Parameters
        - Baud Rate
          - 2400 bps
          - 4800 bps
          - 9600 bps
          - 19200 bps
          - 38400 bps
          - 57600 bps
          - 115200 bps
      - Remote Enable
      - Logical Group
      - Address
    - Display
      - Brightness
      - Touch Screen Autolock
      - Customer Name
        - Show
        - Hide

- Caption
- System Date
- Date
- Time
- Language
- Chart Activation
- License key
- Close
- Save/Load
  - Save
    - 1 .. 6
  - Load
    - 1 .. 6
  - Load Default
- Information
  - MG15
  - Version
  - From revision
  - PrevacOS
  - Version
  - From revision
  - Peripheral Version
    - MG15 MainBoard
    - Version
    - From revision
    - Hardware
    - IONgauge Card 1 HW
    - IONgauge Card 2 HW
    - IONgauge Card 3 HW
    - RTC
    - Version
    - From revision
  - Network
    - Ip address
    - Netmask
    - Gateway
    - Ethernet MAC
    - ProfiNet MAC
  - About Software
  - Numer Serii / Produktu
  - Serial / Product number
  - Serial
  - Product
  - Service Maintenance
    - Device Temperature
    - MG15-MB Master Reset
- Logs
- Reboot

### 3.6.1 GAUGE CONFIGURATION - SENSOR MENU

Gauge selection menu. Select a gauge type compatible with the gauge type physically connected with the device. The following types of passive gauges are available: **IE514, UHV-24, UHV-24p, MKS Series 274, NUDE-UHV-8A, NR-F-UHV, G8130, Defined** and active: **CTR90, TTR91, TTR211, PTR225, PKR251, PCR280, PTR90, ITR90, ITR100, Baratron, Analogue input, PG105, ATMION, Defined**. Gauges CTR90/91 and Baratron require additionally to specify the FS parameter (Full Scale) compatible with the connected gauge. The parameter defines the measuring range of the connected gauge. For CTR90/91 gauges the FS parameter is expressed in Torr. For Baratron gauges the FS parameter is expressed in Torr and PSI. The PG105 gauge requires an initial calibration procedure, which is necessary for the correct vacuum display. This is a two-point calibration: at atmospheric pressure and medium vacuum. Connection of the PG105 gauge requires an additional amplifier (PGA13).

#### 3.6.1.1 SETUP OF ACTIVE GAUGES

To obtain correct indications of vacuum choose a gauge compatible with the physically connected one. For that purpose click on **Setup menu → Sensor → IG1 or IG2 or IG3 → Gauge: current gauge**. The user can select one of the standard gauges or a gauge named as **Defined**, which enables specifying all the parameters of a gauge, thus allowing any gauge to be connected 3.6.1.3. Also after selecting a gauge from the list of standard gauges, the user may define its basic parameters 3.6.1.2. The following parameters of passive gauges are permanently monitored during operation:

- anode voltage
- filament voltage (Ubias)
- emission current
- filament current
- reflector voltage

#### 3.6.1.2 PARAMETERS OF PASSIVE GAUGES

##### 1. EMISSION CURRENT

The user may set an emission current between 0.05mA - 10mA:  
Pressure is calculated according to the following formula:

$$P = \frac{I_c}{S_g \cdot I_e}$$

where:

$P$  - pressure

$I_c$  - ion current, see fig. 3.40

$S_g$  - sensitivity factor for a given gas  $g$

$I_e$  - emission current, see fig. 3.40

For most gauges the emission current  $I_e$  must be kept at a low level for high pressures, and for low pressure it should be accordingly increased.



### Excessive emission current

High emission current for relatively high values of pressure may damage the sensor. The emission current may be set at a given value only when the user is sure that the gauge will be operated at appropriately low pressures.

## 2. SENSITIVITY FACTOR

The function describing the dependence between the gas type, gauge geometry and temperature is generally defined as gauge sensitivity factor  $S_g$ .

The factor can be expressed in the following formula:

$$S_g = \frac{I_c}{I_e \cdot P}$$

where:

$S_g$  - sensitivity factor for a given gas  $g$

$I_c$  - ion current, see fig. 3.40

$I_e$  - emission current, see fig. 3.40

$P$  - pressure

Sensitivity factor  $S_g$  is strictly connected with a gauge type. Its value may be set between 0.05 and 100. Sensitivity factor is also called calibration factor in specifications of extractor gauge manufacturers.



### Note

For precise measurements always set an appropriate sensitivity/calibration factor. This parameter is specified by the gauge manufacturer - it can be the same for all gauges of a given type, and in some cases it is strictly connected with the serial number of the gauge.

## 3. DEGAS POWER

The MG15 is used during degassing the electron bombardment method. The power with which the gauge is degassed may be set between 1 and 40 W. This value should be set according to the manufacturer's specifications. The ramp rate of power after activating degassing is set at 1 W/s and cannot be changed. To activate degassing and set its duration enter the Degas menu, see chapter 3.6.2. It is recommended, if possible, to degas with power lower than the nominal one by extending adequately degassing time. It is done to extend the life of the filament.

## 4. CALIBRATION PARAMETER SETTING



### Note

The calibration parameter is defined by some manufacturers of vacuum gauges. The value of this parameter is individual for each gauge and provided by the manufacturer together with the gauge.

This parameter should be set according to the calibration factor of a given gauge. If this factor is missing or lost, contact directly the gauge manufacturer and state its serial number.



## 5. SELECTING FILAMENT

Most of the available B-A gauges have two filaments. In the **Filament** menu the user can choose between them - the MG15 will use the filament selected in this menu. Also the de-gassing procedure applies to this filament.



### Note

EXTRACTOR IE514/515 and B-A IE414/415 gauges have only one filament.

### 3.6.1.3 USER-DEFINED PASSIVE GAUGE

After selecting a gauge enabling setting of all gauge parameters - **Setup menu** → **Sensor** → **IG1 or IG2 or IG3** → **Gauge: current gauge** → **Defined** apart from the standard parameters, set out in 3.6.1.2 it is possible to set the parameters described below. This enables almost any gauge to be connected if their parameters are within the following ranges.

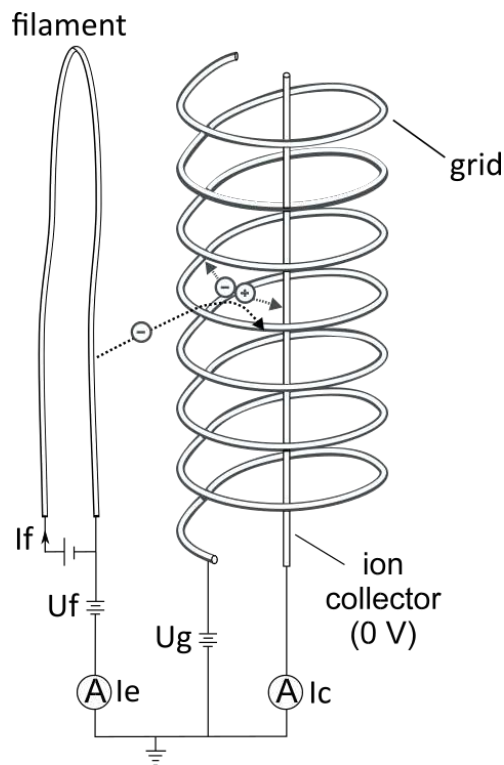


Figure 3.40: Bayard Alpert Gauge

- **Grid voltage** ( $U_g$ ) - also called anode voltage. May be set between 20 and 250V
- **Filament voltage** ( $U_f$ ) - also called  $U_{bias}$  voltage. May be set between 0 and 120V
- **Reflector voltage** - may be set between 0 and 250V. The voltage is not used in Bayard Alpert gauges and should be set at 0V
- **Maximum Filament Current** ( $I_f$ ) - can be set from 1 to 6A. It is important to set this current correctly according to the maximum current specified by the gauge manufacturer. Otherwise, the filament may burn out.

- **Degassing voltage** - May be set between 400 and 600V. The MG15 is used during degassing the electron bombardment method. It is recommended to carry out degassing at the highest voltage admissible by the gauge. At a higher voltage a lower emission current is required to obtain the same degassing power, which affects positively the life of the filament.

### 3.6.1.4 ACTIVE GAUGE SETTING

To obtain correct indications choose a gauge compatible with the physically connected one. For that purpose click on **Setup menu → Sensor → IG1 or CH3 or CH4** and select the required gauge. The user can select one of the standard gauges or a gauge named as **Defined**, which enables any gauge of a logarithmic character with 0 -10 V output to be connected (details in 3.6.1.5). A linear gauge defined by the user can also be added. For that purpose **Baratron** gauges have the **FS Defined** item. This item enables any **Full scale** parameter in Torrs to be introduced.

The MG15 enables also automatic detection of a connected gauge if it has an in-built identification resistor. To activate automatic detection of active gauges enter the **Setup menu → Sensor → Auto identification** and activate this option for the chosen vacuum channel. If the connected gauge has been successfully identified its name will be displayed in the Sensor menu and on the main window by the relevant vacuum channel.

| GAUGE        | IDENTIFYING RESISTANCE |
|--------------|------------------------|
| CTR90/91     | 13,2kΩ                 |
| TTR90/91/221 | 27kΩ                   |
| PTR225       | 100kΩ                  |
| PKR251       | 9,1kΩ                  |
| PCT280       | 3,01kΩ                 |
| PTR90        | 85kΩ                   |
| ITR90        | 42kΩ                   |

Table 3.1: Identifying resistances for supported gauges

For **CTR90/91** gauges, if they are successfully auto-identified, specify also the Full scale factor. It can be done analogically to the manual selection of a gauge type.



#### Note

If the active gauge cannot be manually set (empty selection list), it means that the Auto-identification option is active.

### 3.6.1.5 USER-DEFINED ACTIVE GAUGE

The option enables the user to define his own gauge. The condition is that it is a logarithmic active gauge (0 -10 V).

To define a gauge for the selected channel enter **Setup menu → Sensor → IG1 or CH3 or CH4 → Defined** and set accordingly the equation factors characterising the gauge:

$$pressure[mbar] = 10^{A \cdot Voltage - B}$$

where:

**A factor** - factor A in the above equation

**B factor** - factor B in the above equation

**min. Voltage** - lower measuring range of gauge

**max. Voltage** - upper measuring range of gauge max.

**Example:** The **User Defined** gauge as below will behave identically to ITR90 gauge:

**A factor** = 0.725

**B factor** = 10.333

**min. Voltage** = 0.774V

**max. Voltage** = 10.0V

### 3.6.2 DEGASSING

#### *Setup menu → Degassing*

Degassing procedure can be activated for each channel (in case of active channels it available only for ITR100 and ITR90 gauges). In addition, the user can set degassing time.

Due to increased power consumption during degassing, only one active or passive channel can be degassed at a time.



#### **Note**

Set power for passive gauges before degassing. See point **DEGASSING POWER** in chapter 3.6.1.2.

### 3.6.3 EMISSION CONTROL - EMISSION CONTROL MENU

#### *Setup Menu → Emission Control*

One of the advantages is automatic emission control, i.e. passive gauges emission or active gauges emission, may be activated automatically. Emission may be controlled in the following modes:

1. **Manual** - controlled manually by the operator
2. **Setpoint 1 - 10** - - emission is controlled by a selected pressure setpoint. Reaching the setpoint threshold activates emission in a given channel and lack of setpoint deactivates emission.
3. **Digital inputs 1 - 4** - emission is controlled through the selected digital input.

Setting emission current is described in point **EMISSION CURRENT** in chapter 3.6.1.2

### 3.6.4 READINGS CORRECTION OF GAS TYPE - GAS TYPE MENU

#### **Setup menu → Gas type**

As a standard, gauges are calibrated for measurements in nitrogen or air. If pressure measurements are carried out with other gases, readings can be corrected. The Gas Type parameter is used to set correction factor for a given gas type.

For passive gauges correct readings of pressure are achieved by dividing the readings by the correction factor according to the following formula:

$$P = \frac{I_c}{S_g \cdot I_e}$$

$$S_g = S_{N_2} \cdot R_g$$

where:

$P$  - pressure

$I_c$  - ion current, see fig. 3.40

$S_g$  - sensitivity factor for a given gas  $g$

$I_e$  - emission current, see fig. 3.40

$S_{N_2}$  - gauge sensitivity for  $N_2$

$R_g$  - gas correction factor

Correction, due to the gas type, becomes pressure function if pressure exceeds 0.5 mbar. This fact has been taken into account for all gas types available for the MG15 .

The correction factors for Bayard Alpert gauges implemented in the MG15 are listed in table 3.2.

| GAS                  | $R_g$     |
|----------------------|-----------|
| <i>He</i>            | 0.18      |
| <i>Ne</i>            | 0.30      |
| <i>H<sub>2</sub></i> | 0.46      |
| <i>Air</i>           | 1.00      |
| <i>O<sub>2</sub></i> | 1.01      |
| <i>CO</i>            | 1.05      |
| <i>Ar</i>            | 1.29      |
| <i>Kr</i>            | 1.94      |
| <i>Xe</i>            | 2.87      |
| <i>DEFINE</i>        | 0.01-9.99 |

Table 3.2: Correction factors for Bayard Alpert gaugest

| GAS               | $R_g$ |
|-------------------|-------|
| $D_2$             | 0.35  |
| $N_2$             | 1.00  |
| $H_2O$            | 1.12  |
| $NO$              | 1.15  |
| $NH_3$            | 1.23  |
| $CO_2$            | 1.42  |
| $CH_4$ (metan)    | 1.40  |
| $SF_6$            | 2.20  |
| $C_2H_6$ (etan)   | 2.60  |
| $Hg$              | 3.64  |
| $C_3H_8$ (propan) | 4.2   |

Table 3.3: Correction factors for Bayard Alpert gauges not implemented in the device

In the **Gas Type** menu the user can select a relevant correction factor for each channel independently.

In addition, the user may define any other gas correction factor in a range from 0.01 to 9.99, which makes the controller more universal. Table 3.3 present some of factors not implemented in the MG15.

For passive gauges correct readings of pressure are achieved by multiplying the readings by the correction factor according to the following formula:

$$P_{real} = P_{readed} \cdot R_g$$

where:

$P_{real}$  - pressure after correction

$P_{readed}$  - pressure read regardless of gas correction

$R_g$  - gas correction factor



#### Note

Nominal correction factors cannot be treated as ideal (giving high precision of measurements), because they differ even for identically manufactured gauges. Greater discrepancies exist for different gauges types, filament materials or operation voltages. The discrepancies generally do not exceed 10% for popular gauge types and increase to the value slightly exceeding 20% for less popular gas types.

### 3.6.5 FILTER

#### *Setup menu →Filter*

Dependent on whether the user needs stable readings or prompt fast system response, he can choose between three filtering options depending:

- **Low** - no averaging
- **Medium** - averaging out of 9 samples
- **High** - averaging out of 21 samples

### 3.6.6 CHANGING NUMBER OF DISPLAYED CHANNELS - DISPLAYED CHANNELS MENU

#### *Setup menu →Displayed channels*

The menu enables the user to select the number of channels to be displayed on the main window. The menu can display from 3 to 7 channels. The vacuum channels to which no gauge is connected can be hidden.

### 3.6.7 CHANGING CHANNEL NAMES - CHANNEL NAMES MENU

#### *Setup menu →Channels Names*

The menu enables the user to change the names of any channel.

The entered name appears on the main screen and in setpoint settings and all items in the setup menu.

The length of a name is limited to 7 characters.

### 3.6.8 OUTPUTS SETTINGS

#### *Setup menu →Outputs settings*

#### 3.6.8.1 RELAY OUTPUTS CONFIGURATION - RELAY OUTPUTS MENU

##### *Setup menu →Outputs settings →Relay Outputs*

The MG15 has 4 relay outputs, which functioning may be bound with the current values of the parameters measured by the MG15. The outputs are physically separated from the device (potential-free). The outputs are available on the 15-pin I/O connection on the rear panel. The relay outputs may be configured by selecting outputs from **Output 1** to **Output 4** and assigning a required output signal.

The following signal sources are available:

- **Emission** - the state of the output depends on the emission activation state
- **Degas** - the state of the output depends on degassing activation
- **Still OFF** - output inactive
- **Still ON** - output active
- **None**

### 3.6.8.2 ANALOG OUTPUT CONFIGURATION - ANALOGUE OUTPUTS MENU

#### Setup menu

#### *labelrightarrow* Outputs settings → Analogue outputs

Each of the analogue outputs can send a signal in a range between 0-10V. They can be used to control external devices or record data. The behaviour of the analogue outputs and the type of signal that will be converted to an analogue value and available at the output, are freely configured.

The description of analogue output connector pins - see section 2.5.4.

Available configuration options:

1. **SOURCE** - source to be converted to an analogue value:

- IG1
- IG2
- IG3
- CH1
- CH2
- CH3
- CH4

2. **MODE** - selection of conversion method of the measured signal:

- **1 to 1** - the signal is transmitted directly from input to output
- **EXPO** - the mode used when pressure is the input signal. The output voltage is calculated using the exponent without taking mantissa into account. From 1E-14, the output increases by 0.5 V per decade. It is defined by the relation:

$$U_{OUT} = \frac{exponent + 14}{2} [V]$$

- **User Range** - defines the measuring range which will be converted into voltage at the output

3. **RANGES** - defining the conversion range:

- **Min. Range** - input signal value, which will correspond to **Min. Voltage** at the output. *Range* means any input signal - e.g. pressure.
- **Max. Range** - input signal value, which will correspond to **Max. Voltage** at the output. *Range* means any input signal - e.g. pressure.

4. **SCALE** - selection of measured signal conversion type:

- **LINEAR** - linear output. It is sometimes useful to retransmit the vacuum over a narrow range, covering several decades, or other linear signal. In this case, the output voltage is proportional to the input value. An input signal equal to the **Max. Range** corresponds to the upper limit of **Max. Voltage**, and an input signal equal to the **Min. Range** corresponds to the lower limit of the output voltage **Min. Voltage**:

$$U_{OUT} = \frac{(ReadingValue - MinRange) \cdot (MaxVoltage - MinVoltage)}{MaxRange - MinRange} + MinVoltage [V]$$

- **LOGARITHMIC** - logarithmic output It is often useful to retransmit the vacuum or other signal over a wide range, covering a dozen decades. In this case it is most convenient to operate with the input signal logarithm. The range of limits is defined according to the logarithmic relation:

$$U_{OUT} = \frac{\text{Log} \frac{\text{ReadingValue}}{\text{MinRange}} \cdot (\text{MaxVoltage} - \text{MinVoltage})}{\text{Log} \frac{\text{MaxRange}}{\text{MinRange}}} \cdot \text{MinVoltage} [V]$$

where:

*ReadingValue* - current level of the input signal, e.g. pressure

*Min/MaxValue* - output voltage range defined by the user

*Min/MaxRange* - input signal range defined by the user

5. **MIN VOLTAGE** - output voltage corresponding to 0% of the assigned source signal value
6. **MAX. VOLTAGE** - output voltage corresponding to 100% of the assigned source signal value

### 3.6.9 TREND

#### *Setup menu → Trend*

Description of behaviour of vacuum trend arrow on the main window.

- **Time** - defines dynamics with which the trend symbol reacts to the changes of the signal. To observe slow changes of signals, set longer time than for fast changes.
- **Percent Change** - defines the percentage of the input signal changes, which affects the trend visualisation symbol.

### 3.6.10 DEVICE SETTINGS

#### *Setup menu → Device Settings*

In the **Device Settings** submenu, the settings common for different types of devices with a touch screen are available, however, they are not specific for a particular model - in this case for the MG15.

### 3.6.11 COMMUNICATION SETTINGS - COMMUNICATION MENU

#### *Setup menu → Device Settings → Communication*

The communication menu is used to configure the remote control interface. The MG15 is equipped as a standard with two communication interfaces, which may be used independently at a time:

- **Interface 1** - Ethernet
- **Interface 2** - serial interface RS238 or RS485. Optionally, ProfiNet

To change the **Interface 1** parameters enter *Setup menu → Device Settings → Communication → Interface 1*:

- **IP** - adjusted manually if DHCP is disabled. Automatically set in the opposite case, when the device is turned on.
- **Mask** - sub network mask (logically subdivision of an IP network).



- **Gateway** - default gateway on a TCP/IP network,
- **DHCP** - Dynamic "Host" Configuration:
  - **enable** - automatic configuration on connection (IP address, gateway, subnet mask),
  - **disable** -IP protocol parameters must be set manually,
- **TCP server port** - specifies the port number used in network socket created by TCP server, default - 502

To change the **Interface 2** parameters enter **Setup menu →Device Settings →Communication →Interface 2**.

The detailed description of the RS232/485 connection pins is in: 2.5.3

- **Interface** - interface type:
  - RS232
  - RS485
  - ProfiNet (optionally)
- **Baud Rate**:
  - available Baud Rates: 2400 bps, 4800 bps, 9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps,
  - 8 bits of data, 1 stop bit and no parity parameters are fixed and cannot be changed,

In the **Communication menu**, apart from the physical parameters of the communication interfaces, the following parameters can be configured:

- **Remote Control** - the option enables activation of the remote control mode. In the remote control mode changing the parameters through the touch panel is locked. It is only possible to view the parameters on the screen and view the device configuration. The device in the remote control mode displays in the upper part of the main window an information bar with text: "REMOTE: MG15".  
Activating the option does not mean that the device immediately switches to the remote control mode. It happens only after establishing communication with a remote control device. Then the edition of the Remote Control option is locked and local control via the touch panel is not possible. The remote control can be disabled only in two cases:
  - failure of communication for more than 10s,
  - sending a special command resulting in entering into the local control mode.

Entering the *Remote Control* mode is necessary if the device must be controlled through a communication interface. Reading of the parameters, however, is always possible and does not require the mode to be activated.

- **Address** - current communication address of the device. Depending on the type of the device this item can be edited, or can display the address that has been set on the DIP switch located on the rear panel of the device.

### 3.6.12 DISPLAY SETTINGS

To change display settings go to: **Setup Menu →Device Settings →Display**

In *Display* submenu it is possible to change the following parameters:

**Brightness** - display brightness value. Its value can be changed in the range of 10-100%.

**Touch Screen Autolock** - When the value is set to ON, the autolock function is active. If the touch panel is not used for longer than 3 min then the screen is locked. 3 minutes - screen is locked. Unlock the device by pressing "Yes" in the displayed message.

**Customer Name** - The device can be assigned an individual name that appears on the top of main window. This allows to distinguish between several devices of the same type.

**System Date** - The device has a built-in **real time clock** (RTC)(RTC). The menu allows to set the current date and time.

When setting a date separate the individual parts with the sign "-". Example: **21-03-2014**

When setting a time separate the individual parts with the sign ":". Example: **13:20:22**. Alternatively, the following time format is accepted: **3:4:5 -> 03:04:05, 12:8:1 -> 12:08:01**

### 3.6.13 LANGUAGE MENU

This submenu allows to change the device language.

In order to select the language go to **Setup menu →Device Settings →Language**.

To complete changing of the language the device must be restarted.

### 3.6.14 CHART ACTIVATION

**Setup menu →Device Settings →Chart Activation**

The submenu is used to activate the chart module. If the module is active this submenu is not available. For details see chapter 3.4.2.7.

### 3.6.15 SAVING/LOADING SETTINGS

To save/load the configuration settings of the device enter: **Setup Menu →Save/Load**

When the MG15 is powered off, the all unsaved data and configuration parameters are lost. To save the settings, they should be saved in the non-volatile device memory. Up to 6 different configuration settings can be saved, each having an individual name. At any time it is possible to restore the saved configuration or default settings. The current configuration of the device can also be stored in the memory.

To save the configuration of the device:

1. Enter **Setup Menu →Save/Load →Save**.
2. Choose a slot from the list where the settings will be saved (previous parameters will be deleted) and click on it.
3. Enter the required name using the keyboard.
4. Click **Enter** to confirm the name.
5. The current settings will be saved in the selected slot under the chosen name.

Saved device configuration can be restored also in the Setup menu. To load the previously saved settings:

1. Enter **Setup Menu →Save/Load →Save**.

2. Choose one of the slots on the list from which device settings will be loaded and click on it.
3. The selected device settings will be loaded.

Default factory settings may also be loaded as follows:

1. Enter **Setup Menu → Save/Load → Save**.
2. Choose **Load Default** to load the factory settings.

### 3.6.16 INFORMATION MENU

To display the information about the device go to:

**Setup Menu → Information.**

This menu contains information about the device name and version, the current software version, as well as the network parameters such as IP address, netmask and default gateway.

### 3.6.17 LOGS MENU

To display the history log go to: **Setup Menu → Logs.**

This submenu displays the error history log. The displayed list of errors includes the description and date of their occurrence.

### 3.6.18 REBOOT

Restart the application running on the device. To restart the device enter the restart menu: **Setup Menu → Reboot.**

## 4 STEP BY STEP

This chapter describes the configuration procedure and first start-up of the MG15 device.

### 4.1 QUICK START

1. Install the device on the vacuum system and make all the necessary connections - see chapter 2.5.
2. Switch on the device - see chapter 3.1.
3. Configure the measuring channels - select appropriate gauges and set their parameters - see sub-chapter 3.6.1.
4. Set the threshold pressure values (setpoints) for both channels - see chapter 3.4.1.1.
5. In the event of working with gases other than nitrogen or air, enter the appropriate correction factor - see chapter 3.6.4.
6. If necessary, degas the ion gauges - see chapter 3.6.2.
7. Choose the automatic or manual emission control type for each channel - see chapter 3.6.3.
8. Check whether the threshold pressure values (setpoints) have been achieved and if the manual emission control has been selected, press the *Emis.* button, to activate the ion gauge emission. Achieving the set setpoints is signalled by the green Setpoints diodes on the main window, and if emission is active the *Emis.* text appears - see chapter 3.4.1.

### 4.2 COMMUNICATION INTERFACE CONFIGURATION

The following procedure let to configure the RS232 module to work with 19200bps baud rate:

1. Press the Menu button.
2. Click on the Setup menu.
3. In the Setup menu select the Device Settings -> Communication -> Interface 2.
4. From the *Interface* list select the *RS232*.
5. Click on *Baud Rate*.
6. In the displayed list, select the appropriate transmission speed, e.g. 19200bps.

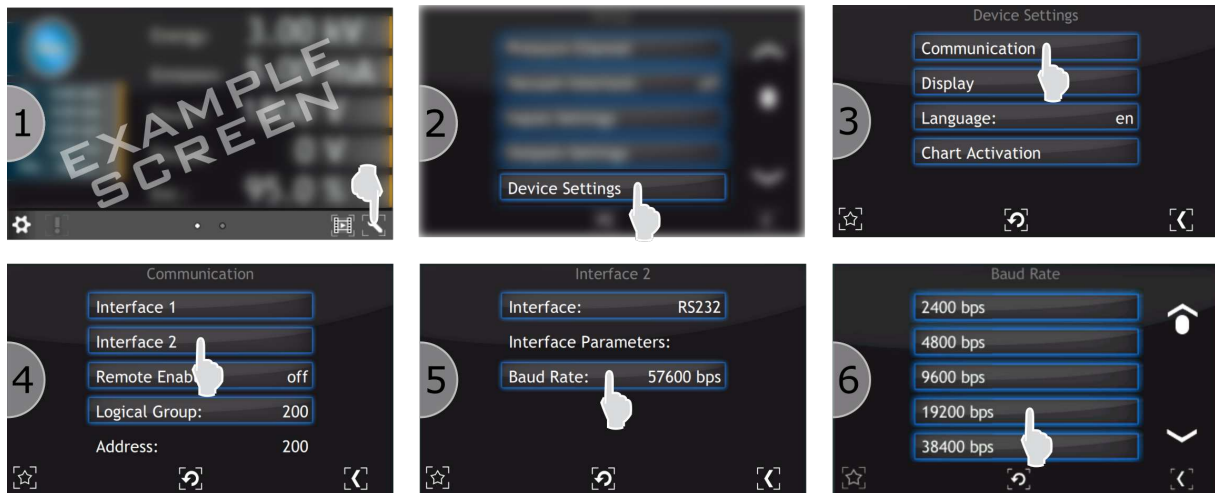


Figure 4.1: Communication interface configuration

### 4.3 LANGUAGE SELECTION

In order to change the language the following steps should be taken:

1. Press the Menu button.
2. Click on the Setup menu.
3. In the Setup menu select the Device Settings -> Language
4. Choose the required language
5. Click YES to restart the device

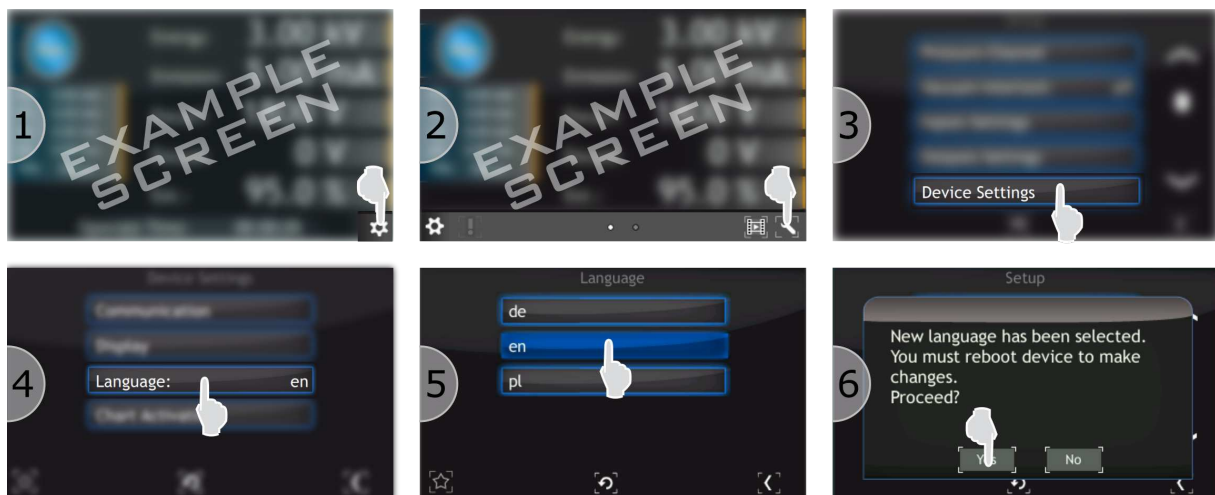


Figure 4.2: Language selection

## 5 TROUBLESHOOTING

This section describes the errors, warnings and notifications appearing in the MG15 . All information displayed on the screens is divided into two groups:

- Errors and warnings , which relate primarily to the device hardware are displayed in the message bar on the right side of the screen. They are identified by the colours red and yellow (more details about them can be found in the chapter on user interface). An error disappears from the bar when it will be physically eliminated.
- All information that is not directly related to operation of the device is displayed as a message. This information presents notifications after user interaction. More information can be found in chapter 5.2 5.2.

### 5.1 NOTIFICATIONS IN PRESSURE VALUE/INFORMATION BOX

| NOTIFICATION   | DESCRIPTION  |
|--|--|
| <b>STATUS</b>  |  |
| <b>Wait for emission</b><br>Waiting for starting the gauge emission  | Wait: the device should automatically start the gauge<br><br>Check the type of the selected gauge<br><br>Check the measurement cable/replace the measurement cable |
| <b>Emission off</b><br>Emission is turned off  | To turn on emission press the Emiss button <i>Emiss</i>  |
| <b>Degassing [time]</b><br>Gauge degassing in progress   | Wait until the device finishes degassing   |
| <b>Offset Calib.</b><br>The device is in the internal calibrating mode                                       | Wait until the device finishes calibration   |
| <b>ERRORS</b>  |  |
| <b>ShortFilament</b><br>Current in the filament circuit is too high, and emission current cannot be achieved | Check the filament for short-circuit with ground or other contacts   |
| continued on next page   |  |

| continued from previous page  |  |
|---|--|
| NOTIFICATION  | DESCRIPTION  |
|   | <p>Check the measurement cable for short-circuits</p> <p>Replace the measurement cable Restart emission</p>  |
| <p><b>Overpressure</b></p> <p>Pressure measured exceeds the critical value</p>  | <p>Check for leaks</p> <p>Wait until pressure reaches the minimum value</p> <p>Restart emission</p>  |
| <p><b>HV Failure</b></p> <p>No high voltage at the gauge anode or voltage value differs for over <math>\pm 10</math> V from nominal value</p> | <p>Check the connections of the controller</p> <p>Replace the B-A gauge cable</p> <p>Restart emission</p>  |
| <p><b>Ubias Failure</b></p> <p>Polarity voltage (filament voltage) differs for more than <math>\pm 10\%</math></p>                            | <p>SCheck the measurement cable for short-circuits</p> <p>Check the connections of the controller</p> <p>Replace the measurement cable</p> <p>Restart emission</p> |
| <p><b>Ref. Failure</b></p> <p>Polarity voltage (reflector voltage) differs for more than <math>\pm 10\%</math></p>                            | <p>Check the measurement cable for short-circuits</p> <p>Check the connections of the controller</p> <p>Replace the measurement cable</p> <p>Restart emission</p>  |
| <p><b>Degas Failure</b></p> <p>Degassing procedure failed</p>   | <p>Check the measurement cable for short-circuits</p> <p>Replace the measurement cable</p> <p>Restart the device</p>   |
| <p><b>Low Pressure</b></p> <p>Pressure in the gauge area is out of the measuring range.</p>   | <p>Check the gauge and its type whether it is appropriate for the application/process.</p>   |
| continued on next page  |  |

| continued from previous page  |   |
|---|---|
| NOTIFICATION  | DESCRIPTION   |
| <b>High Pressure</b><br>Pressure in the gauge area is out of the measuring range. | Check the gauge and its type whether it is appropriate for the application/process.   |
| <b>EEPROM Failure</b><br>Internal hardware error                                  | Turn off, wait for 10 s, restart  |
| <b>Filament Failure</b><br>No current in the filament circuit                     | Check whether the gauge filament is burnt out<br>Check the connections of the controller<br>Replace the measurement cable<br>Restart emission |
| <b>Sensor Break</b><br>Gauge damaged or no sensor                                 | Check the connection of the gauge with the device<br>Check and replace the cable if necessary   |

Table 5.1: Notifications in pressure value/information box.

## 5.2 MESSAGE BAR NOTIFICATIONS

### 5.2.1 ERRORS

- **E1: Connection with the mainboard lost Error code: <number>**
  - Connection with the mainboard lost. The error code is displayed to find the source of the problem.
- **E2: We recommend to delete unnecessary video files.**
  - The error caused by lack of free space on the SDHC card. To free space, remove several videos from the card.

### 5.2.2 5.2.2 WARNINGS

- **W1:Low Disk Space: We recommend to remove videos from device.** We recommend to remove videos from device. Warning resulting from insufficient space on the SDHC card. Delete videos in order to free up space.

## 5.3 5.3 NOTIFICATIONS IN MESSAGE BOX

- **M1: Copy summary: Error when copying a log file.**  
Copying Log file failed.



- **M2: Copy summary: Error when copying a translation file.**  
Copying the translation file failed.
- **M3: Copy summary: Error: Copying log file timeout.**  
Copying the log file took too long, the copying process was interrupted.
- **M4: Copy summary: Error: Copying translation file timeout.**  
Copying the translation file took too long, the copying process was interrupted.
- **M5: Copy summary: Error: No space left on USB.**  
Copying Log file failed due to lack of sufficient space on the USB. Free some space and then copy Log file again.
- **M6: Copy Summary: Error: No space left on device.**  
Disk space on the SDHC reached a critical level. Delete videos in order to free up space.
- **M7: Copy summary: File successful copied.**  
Copying process was performed successfully.
- **M8: Copy summary: Log file has been copied.**  
Copying Log file completed successfully.
- **M9: Copy summary: No usb found.**  
Message informing about absence of USB, which could occur for example if the usb drive is removed during copying procedure.
- **M10: Translation file has been copied.**  
Translation file copy process ran correctly.
- **M11: DHCP client couldn't obtain IP address.**  
Attempt to obtain an IP address from the DHCP server failed. Check the device connection to the network and the status of DHCP server.
- **M12: New language has been selected. You must reboot device to make changes. Proceed?**  
After selecting one of the available languages, you must reboot the device to apply the changes.
- **M13: Parameters has been loaded.**  
Process of reading the stored device settings ran correctly.
- **M14: Probably PG 105 is not connected.**  
This message may appear during PG105 calibration, when the calibration fails. It can result from:
  - damaged vacuum gauge
  - disconnected vacuum gauge
  - broken cable
  - the calibration conditions are not fulfilled
  - Analog IO card measurement channel error
- **M15: Unable degasing. Vacuum gauge does not support degasing.**  
Selected gauge does not support degas functionality.
- **M16: Unable degasing. Vacuum gauge failure.**  
Input signal is out of measurement range. Possible solutions to this problem are shown below:

- check gauge configuration and in particular the gauge type
- make sure that vacuum gauge is working
- **M17: Unable degasing. Vacuum is too low.**  
High vacuum is too low. Possible solutions to this problem are shown below:
  - wait until the vacuum level increases
  - check system for leaks
- **M18: Copy summary: <Summary> Click OK to reset the device.**  
After reading summary informations press "OK" button in order to reboot device.
- **M19: Copy summary: Mainboard: Everything is up to date. Click OK.**  
Message informing that following elements (mainboard, bus etc.) are up to date.
- **M20: No external interlock.**  
Switching MG15 to OPERATE mode will not be possible if the protect signal INTERLOCK is missing. There will be a warning displayed. Such a failure can be caused by the following reasons:
  - The interlock signal is not available,
  - Interlock cable is not connected,
  - Damaged digital IO card,

There is no connection to external interlock or interlock is not properly configured. Refer to the Digital input section of the "Installation" chapter
- **M21: Operate switched off: No interlock.**  
During normal operation in OPERATE mode the INTERLOCK signal has ben lost. The MG15 device will rapidly cause the unit to enter into STANDBY mode. Such a failure can be caused by the following reasons:
  - The interlock signal is not available,
  - Interlock cable is not connected,
  - Damage digital IO card,
- **M22: Emission is currently controlled by a digital input.**  
Message appears when you try switch ON/OFF emission but to this operation is assigned digital input.
  - Check **Emission Control** menu and assign to **Manual** option
- **M23: Emission is currently controlled by a Setpoint.**  
Message appears when you try switch ON/OFF emission but to this operation is assigned setpoint state.
  - Check **Emission Control** menu and assign to **Manual** option
- **M24: Unable to turn on emission because of EEPROM hardware failure.**  
Internal hardware error.
  - Try to restart device or contact service department

# 6 COMMUNICATION

## 6.1 INTRODUCTION

This chapter is intended for users who want to use Modbus RTU, Modbus TCP (Ethernet) or optionally ProfiNet communication links. These are communication protocols used to control the functioning of the MG15.

The following chapter includes general information about standards, wiring and electrical connections. It presents the connectors and wiring for serial links RS232, RS485 (Modbus RTU protocols), Ethernet (Modbus TCP) and optionally ProfiNet (Modbus RTU).

In addition, it includes advanced issues, such as access to full resolution of floating point data and user interface permissions.

### 6.1.1 CABLE SELECTION

This section includes general information about types of cables that should be used in the serial communication system.

It is recommended that the digital communication network cable have the following electrical parameters:

- Rated DC resistance should be max.  $100\Omega/\text{km}$ . Generally  $0.14\text{mm}^2$  (24AWG) cables or thicker.
- Rated impedance  $100\Omega$  at  $100\text{kHz}$ .
- With differential communication screened twisted pair should be used.
- Mutual capacitance of a pair should be max.  $60\text{pF}/\text{m}$  (capacitance between two conductors in a pair).
- Stray capacitance max.  $120\text{pF}/\text{m}$  (capacitance between one conductor and all other connected with ground).

Of course, selection of a cable entails compromise between costs and quality of the cable (damping or quality of screening). For applications in an environment with high likelihood of occurrence high levels of electrical interference it is recommended to use a cable with copper screen and ground it. For long-distance communication use a cable with low damping.

### 6.1.1.1 GENERAL WIRING RULES

1. Communication cables should be laid separately and as far as possible from the power supply cables or cables supplying power to external equipment such as contactors, relays or motors.
2. Communication cables may be laid together with signal cables if those cables are not exposed to sources of interference. Signal cables are cables connected with analogue or logic inputs and outputs of any control instruments.
3. **Do not use the remaining conductors in a communication cable for other signals.**
4. Ensure sufficient slack of the laid cable so that its movement do not damage the insulation.
5. Make sure that the cable is connected in series with the devices. This means that the cable runs from one instrument to the next one and so on, until the last device in the chain.

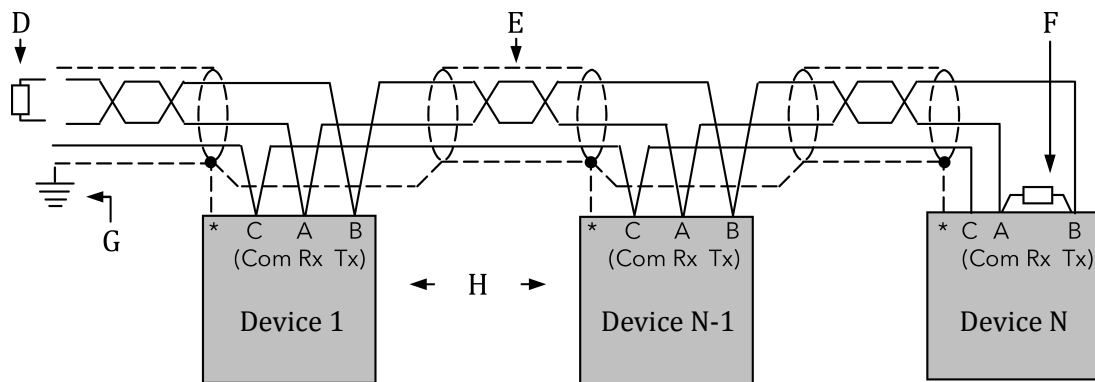


Figure 6.1: Example of 3-conductor (+ screen) EIA485 connection

\* Some devices are equipped with a terminal for connecting screen. If the terminal is not available, ignore this connection.

- **A,B** - Differential communication terminals (A+, B-)
- **C** - Terminal C is usually an insulated device ground (GND)
- **D** - Resistor 220Ω at the first device in the bus
- **E** - Screened conductor - twisted pair
- **F** - Resistor 220Ω at the last device in the bus
- **G** - Single grounding - see chapter 6.1.3
- **H** - Intermediate device connected in series

### 6.1.2 PRECAUTIONS

In some applications with excessive static accumulation it is recommended to add high-resistance resistor (e.g. 1MΩ) between the chassis ground (terminal C) and ground. In the case of connecting devices via RJ45 interfaces, a cable must have plugs with metal shield connected with the cable screen (metal casing clamped on the wire mesh of the cable screen).

### 6.1.3 GROUNDING

The EIA standards suggest that both end of a screen should be connected with protective grounding. When, however, using such a connection, take special care and make sure that the differences of the local ground potentials are not sufficient to enable circulating current to flow. They may cause not only large values of common signals in the data line, which may result in communication breakdown, but also overheating of the cable. In case of any doubts it is recommended to ground the screen of conductors only in one point. The length of a grounding connection should be as short as possible.

## 6.2 REMOTE ENABLE MODE

In the *REMOTE ENABLE* mode changing the parameters through the touch panel is locked. It is only possible to view the parameters on the screen and view the settings in the device setup menu. The device in the remote control mode displays in the upper part of the window an information bar with text: "MG15 - REMOTE".

The remote control mode can be activated in the device only via software.

To enter the REMOTE mode via software use the **REMOTE ENABLE** option in the *COMMUNICATION* sub-menu. If Remote Enable **ON** is selected, then the device switches to the RC mode and stays in this mode until switched again to the local mode by selecting the **OFF** option.

Communication in the software mode is carried out according to the following principles:

- At a given moment the device can be controlled only from one place (device panel or remote computer with *MASTER* rights).
- After taking over the control by the *MASTER* device, return to the local control is locked from the device menu (the **REMOTE ENABLE** position is greyed).
- *MASTER* has the right as long as it maintains communication with the device (pauses between the frames are not longer than 10 s), or do not resigns from the rights to write: (address 1100; data field= 0). See tab 6.13.
- In the event of loss of communication between *MASTER* and the device for more than 10s the **REMOTE ENABLE** position becomes active and it is possible to return to the local control by switching the **REMOTE ENABLE** position to **OFF**.

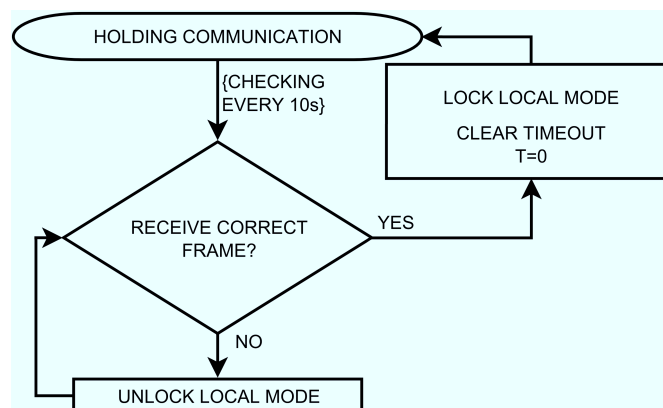


Figure 6.2: Maintaining communication - sequence diagram

## 6.3 COMMUNICATION INTERFACES

Serial communication is possible in different standards. Depending on the protocol chosen, there are different communication connections. Descriptions of the connections for individual protocols are presented below.

### CAUTION



The RS232/RS485, ETH and Profinet ports of the MG15 are not optically isolated. Therefore, it is necessary to ensure the same potentials between the controller(s) and other devices in this bus (common power supply chassis ground). Otherwise problems with communication and even damage to the device may occur.

### 6.3.1 RS232/RS485 CONNECTOR

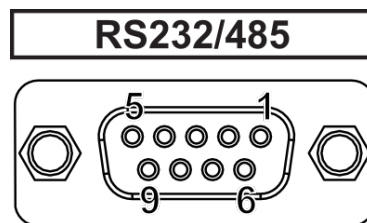


Figure 6.3: Female socket of RS232/RS485 (Modbus RTU) interface

| PIN NUMBER | FUNCTION | DESCRIPTION                                    |
|------------|----------|--|
| 2          | RX       | RS232 - Data reception signal from the device  |
| 3          | TX       | RS232 - Data transmission signal to the device |
| 5          | C (GND)  | Common signal (ground)                         |
| 8          | A+       | RS485 - Data signal (positive)                 |
| 9          | B-       | RS485 - Data signal (negative)                 |
| 1,4,6,7    | N/C      | Not connected                                  |

Table 6.1: Pins description of "RS232/RS485" connector

### 6.3.2 ETHERNET CONNECTOR

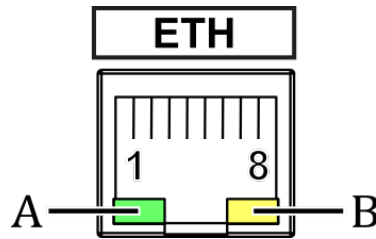


Figure 6.4: Female socket of Ethernet 10baseT (Modbus TCP) interface

| PIN NUMBER    | FUNCTION             | DESCRIPTION   |
|---------------|----------------------|---|
| 1             | TX+                  | Data transmission - differential pair positive conductor  |
| 2             | TX-                  | Data transmission - differential pair negative conductor  |
| 3             | Rx+                  | Data reception - differential pair positive conductor   |
| 6             | Rx-                  | Data reception - differential pair negative conductor   |
| 4,5,7,8       | N/C                  | Not connected   |
| DIODE         | FUNCTION             | DESCRIPTION   |
| A<br>(green)  | Connection<br>status | disabled - no connection, activity<br>always on - connection in the network, no traffic<br>blinking - connection active, traffic in the network |
| B<br>(yellow) | Network<br>status    | disabled - no voltage or IP address not assigned<br>always on - network active  |

Table 6.2: Pins description of "ETH" connector

### 6.3.3 PROFINET CONNECTOR (OPTION)

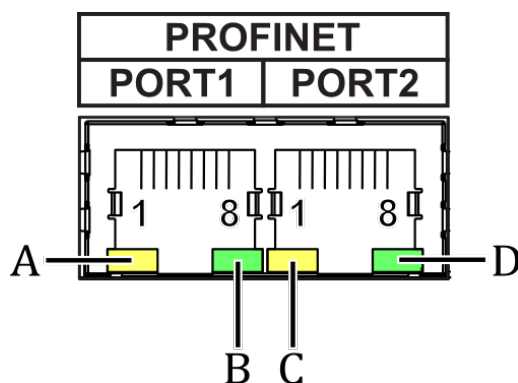


Figure 6.5: Female socket of Profinet (Modbus RTU) interface

| PIN NUMBER    | FUNCTION                     | DESCRIPTION  |
|---------------|------------------------------|--|
| 1             | TX+                          | Data transmission - differential pair positive conductor   |
| 2             | TX-                          | Data transmission - differential pair negative conductor   |
| 3             | Rx+                          | Data reception - differential pair positive conductor  |
| 6             | Rx-                          | Data reception - differential pair negative conductor  |
| 4,5,7,8       | N/C                          | Not connected  |
| DIODE         | FUNCTION                     | DESCRIPTION  |
| A<br>(yellow) | Error status                 | disabled - no connection, activity<br>always on - device error<br>blinking - module test identification  |
| B<br>(green)  | Connection status for Port 1 | disabled - no connection, activity<br>always on - connection in the network, no traffic<br>blinking - connection active, traffic in the network                            |
| C<br>(yellow) | Connection status            | disabled - no voltage or IP address<br>always on - network active, connection<br>blinking 10Hz - device error<br>blinking 2 Hz - waiting for connection/configuration mode |
| D<br>(green)  | Connection status for Port 2 | disabled - no connection, activity<br>always on - connection in the network, no traffic<br>blinking - connection active, traffic in the network                            |

Table 6.3: Pins description of "PROFINET" connector



## 6.4 MODBUS PROTOCOL

### 6.4.1 INTRODUCTION

This implementation is used to provide a popular format of data exchange between the devices in the network. Modbus enables communication between up to 248 devices connected to the same network. Each SLAVE device has its unique address. The MG15 address is set via the switch on the rear panel (details in chapter 2.5.6). It identifies unequivocally the device during communication over the RTU Modbus protocol. During communication with the device through the Ethernet (Modbus TCP) network its IP address is the unique address.

The data register map is unique for the MG15 device and its definition is given in the tables starting from 6.4.8.

The data transmission protocol describes the rules and structure of the messages used by all the devices in the data exchange network. This protocol determines also the sequence of data exchange, error detection and defines that in serial networks only the Master device can initiate transmission, and in Ethernet networks any device may send commands, but this is usually done by the Master device. It enables creating a single- or multi-branch network structure. These two types of network are presented in fig. 6.6.

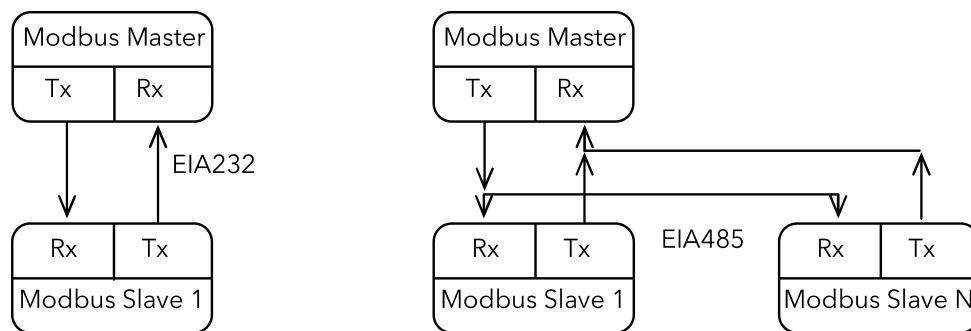


Figure 6.6: Modbus RTU network structures model

- Each Slave device in the network has its unique address (see chapter 2.5.6).
- The MG15 device supports subset of Modbus codes.
- Refer through “parameter address” to the MG15 parameters.
- Sending queries with the device unique address results in response only of the device from this address. Then the Slave device will check errors, execute the required task, and send a response with its own address, data and correct checksum.
- Address “0” of the device is a special case. It used for messages send to all the Slave devices and is used only for writing.
- Sending a query with the device address = “0” activates broadcast communication. This means that the information will be received by all the devices in the network. Each of them will execute the requested action, but not send a response.

The data link layer includes the following properties/behaviours:

- identification of the Slave device address,
- detection of beginning/end of a frame,
- generation of CRC-16 checksum (Modbus RTU),
- transmission/reception of "time-out" messages,
- detection of buffer thrashing,
- detection of frame errors,
- detection of line idleness.

### 6.4.2 INTERFACE CONFIGURATION

There are four communication interfaces - RS232, RS485, Ethernet and ProfiNet (option). For standard MG15 devices with a display, selection of interface, preview and change of its parameters is available in the menu, and their complete configuration is described in subchapter 3.6.11.

In case of a device without a display ( BlackBox) communication over Modbus RTU protocol is executed always with the same parameters (baudrate 57600bps, 8 data bits, 1 stop bit, no parity), and the transmission channel (RS232, RS485, ProfiNet(option)) is selected by means of jumpers on the device rear panel. The description is in point 2 of subchapter 2.5.6.

Communication over Modbus TCP protocol is configured using relevant commands of the Modbus RTU protocol.

Communication in the ProfiNet(option) network is available through the interface described in chapter 6.5. Transmission is executed as encapsulation of the Modbus RTU protocol frame in the ProfiNet frame. This means that the MG15 is visible in the network as a standard device compatible with the ProfiNet standard and an IP address is assigned to it. Communication, however is executed by formulating appropriate queries compatible with the Modbus RTU protocol and sending them in a frame of the ProfiNet protocol to the Slave device. In the sent frame user should to include the address setted up on the jumpers of the device rear panel (according to the Modbus RTU protocol). This is a difference in relation to communication via the Ethernet interface, where the device is unequivocally identified only through an IP address.

#### CAUTION



It is recommended to make all the settings of the communication interface before connecting device to the Ethernet or EIAxxx network.

It is not necessary, however, the MG15 default settings may cause conflicts with the devices already connected to the network.

In the Modbus RTU protocol there is only one parameter - device address. In case of the Ethernet network there are several other parameters: IP address, subnet mask, network, default gate address and DHCP.

### 6.4.3 MODBUS RTU

The serial communication for the Modbus RTU is made through EIA232, EIA485 (formerly RS232 and RS485) or optionally ProfiNet (as encapsulation of the data frame) transmission. The EIA standards have been introduced by the Electronics Industry Association and describe the electrical characteristics of communication networks. Table 6.4 includes the summary of different physical layers described by these two standards.

| EIA Standard                  | EIA232C  | EIA485 3-wire   |
|-------------------------------|--|---|
| Transmission type             | From point to point, nominally $\pm 12$ Volt (min 3V, max 15V) | One or Two Pairs of wires. Differential Mode. Half duplex - communication occurs in both directions but not at the same time. Typically once a unit begins receiving a signal it must wait for the transmitter to stop sending before it can reply. |
| Electrical connections        | 3 wires: Tx, Rx, GND(common)                                   | 3 wires: A, B, C(common)  |
| Number of devices in the line | 1 transmitter, 1 receiver                                      | 31 receivers, 1 transmitter   |
| Maximum data rate             | 115,2Kb/s  | 10Mb/s  |
| Maximum cable length          | 15m  | 1200m   |

Table 6.4: EIA Standard

**Note 1:** The EIA232C standard enables connecting **one** device to a computer, PLC controllers or similar devices with a cable max. **15m** long.

**Note 2:** The EIA485 standard enables connecting **at least one** device to a computer, with a cable max. **1200m** long. In this way up to 31 receivers (SLAVE) and one transmitter (MASTER) can be connected. EIA485 is a balanced two-conductor transmission system, which means that information is carried out by the difference in voltage between two conductors, instead of the voltage in relation to the common conductor or ground, as it is done in EIA232C. One voltage polarity indicates logic "1", reverse polarity indicates logic "0". The difference must be at least  $\pm 200$ mV. The EIA485 differential transmission is less vulnerable to influence of external signals and if the device is in an environment with substantial interference, it should be used instead of the EIA232C. Even though the EIA485 standard is commonly described as a two-conductor connection, a chassis ground/screen two-conductor connection as a "common" signal should be used to ensure additional protection against interference.

**Note 3:** The MG15 works in a half-duplex system, which does not enable transmission and reception of data in the same time. Data are transmitted interchangeably, once query, once response.

**Note 4:** Most PC computers is equipped with an EIA232 port for communication. A limit of 32 devices may be bypassed by dividing most networks into segments, which are electrically isolated. When communication with more than 32 devices on the same bus is required, a PC computer with a special EIA485 attachment is required for buffering EIA485 networks. It can also be used to change a 3-conductor EIA485 to a 5-conductor EIA485.

**Note 5:** For EIA485 connection between the MG15 devices and a MASTER device, in particular at greater distances and transmission speeds ( $>38400$ bps,  $>10$ m) it is recommended to use a 2-conductor twisted pair, preferably, with an additional screen. Remember also to add a terminator ( $120\Omega \dots 470\Omega$  resistor connected between lines A and B) at the beginning and the end of the EIA485 bus.

**Note 6:** The MG15 enables communication with a MASTER device with a write/read speed not exceeding 100 frames/second.

#### 6.4.3.1 CONNECTION PARAMETERS

| PARAMETER    | VALUE           |
|--------------|-----------------|
| Data bits    | 8               |
| Parity       | None            |
| Stop bits    | 1               |
| Flow control | None            |
| Baudrate     | 57600 (default) |

Table 6.5: Connection parameters

#### 6.4.3.2 FRAME FORMAT

Typical data exchange consists in sending a query from the MASTER device and a response to this query from the SLAVE device.

A typical message in both directions should consist of the following information:

| Start   | Device address | Function code | Data     | CRC     | EOT     |
|---------|----------------|---------------|----------|---------|---------|
| 3 bajty | 1 bajt         | 1 bajt        | n bajtów | 2 bajty | 3 bajty |

Table 6.6: Modbus RTU frame format

- **Start** - is an inactivity period, which equals to at least 3.5 times of the transmission time of a single character. E.g. for baudrate 9600bps with 1 start bit, 1 stop bit and 8 bits of data, the Start time is 3.5ms. Very often Start time results from the EOT time of the previous frame.
- **Device address** - unique 1-byte device address set on the jumpers in the rear panel (chapter 2.5.6). Address 0 is a broadcast address.
- **Function code** - 1-byte code unequivocally identifying action to be executed by the Slave device.
- **Data** - length and type of data depends on the function code. Usually, a data segment will contain the parameter address and number of data to read or write.
- **CRC** - 2-byte checksum used to check the correctness of data in a communication frame. Calculation of checksum see chapter 6.4.3.3.
- **EOT** - the segment at the end of a frame showing to the slave devices that a new message will be transmitted next. As a standard, at least 3.5 times of the transmission time of a single character.

### 6.4.3.3 CRC CHECKSUM

The CRC checksum is a test of data correctness, and its length equals to 2 bytes (16 bites). After constructing a message (data field) the transmitting device calculates the CRC checksum and attaches it to the end of the message. The slave device calculates the CRC checksum out of the received message, and after that it check the correctness with the one received in the frame.

If the CRC checksum differs from the one sent in the frame, this means that a communication error occurred.

If the MG15 detects an error in the message, it ignores such frame (leaves without a response).

The CRC checksum is generated in the following steps:

1. Enter value 0xFFFF to 16-bit CRC register.
2. Execute XOR operation of the first byte of the message with the oldest byte (MSB) of the CRC register. Save the result in the CRC register.
3. Shift the CRC register right by one bit.
4. If an overflow bit or flag equals to 1, execute the XOR operation of the CRC register with value 0xA001 and enter the result in the CRC register.
5. If an overflow bit or flag equals to 0, repeat step 3.
6. Repeat steps 3 and 4, until the overall number of shifts is 8.
7. Execute XOR operation of the next byte of the message with the oldest byte (MSB) of the CRC register. Save the result in the CRC register.
8. Repeat steps 3 to 7 until all the message bytes will be XOR with the CRC register and shifted 8 times.
9. In the CRC register there are two bytes of the checksum, which are added to the message where the most significant bit is added first.

Figure 6.7 illustrates this algorithm of checking CRC errors.  
Symbol ' $\oplus$ ' indicates XOR operation. "n" means a number of data bits.

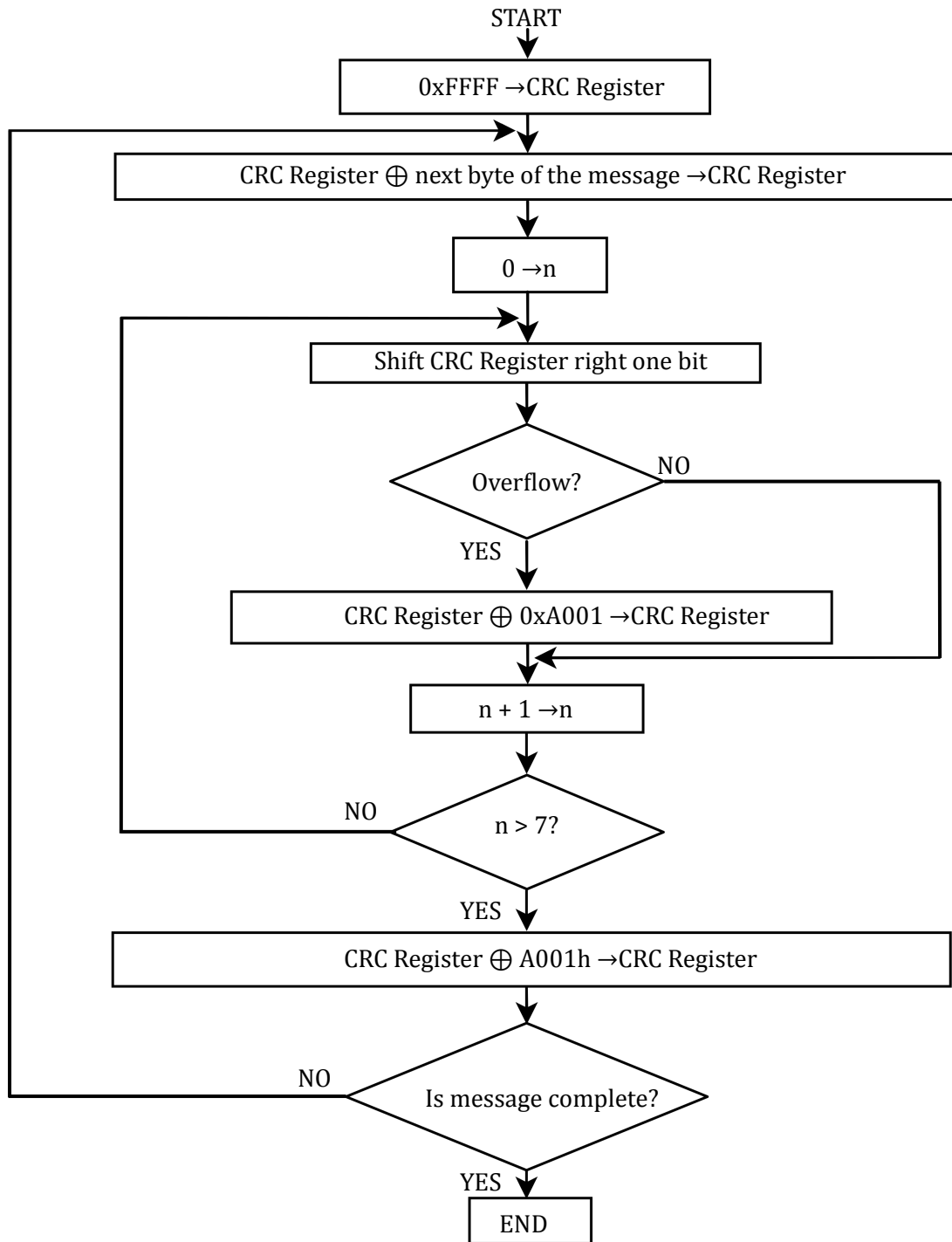


Figure 6.7: Checksum calculation algorithm

## CRC CHECKSUM CALCULATION - EXAMPLE IN C LANGUAGE

The example uses data of "uint16" and "uint8" types. The signs correspond, in turn, 16-bit integer number without sign (usually for most types of compilers "unsigned short int") and 8-bit integer number without sign ("unsigned char"). "z\_p" indicates Modbus data messages, and "z\_message\_length" means their length without CRC checksum.

```

1 | uint16 calculate_crc(char *z_p, uint16 z_message_length)
2 | /* CRC runs cyclic Redundancy Check Algorithm on input z_p */
3 | /* Returns value of 16 bit CRC after completion and */
4 | /* always adds 2 crc bytes to message */
5 | /* returns 0 if incoming message has correct CRC */
6 | {
7 |     uint16 next, carry, n, CRC= 0xffff;
8 |     uint8 crch, crcl;
9 |     while (z_message_length--) {
10 |         next = (uint16)*z_p;
11 |         CRC ^= next;
12 |         for (n = 0; n < 8; n++) {
13 |             carry = CRC & 1;
14 |             CRC >>= 1;
15 |             if (carry) {
16 |                 CRC ^= 0xA001;
17 |             }
18 |         }
19 |         z_p++;
20 |     }
21 |     crch = CRC / 256;
22 |     crcl = CRC % 256;
23 |     z_p[z_message_length++] = crcl;
24 |     z_p[z_message_length] = crch;
25 |     return CRC;
26 | }

```

### 6.4.4 MODBUS TCP

The MG15 supports the Modbus TCP protocol via Ethernet connection. It is a protocol version used for communication in TCP/IP networks. The connection is executed in port 502 by default. The checksum is not placed in the frame, due to the fact that the lower layers of the TCP/IP protocol ensures error control and identification of the device.

#### 6.4.4.1 CONNECTION PARAMETERS

All the interface parameters are saved in the non-volatile memory of the MG15. The DHCP protocol option is enabled by default and the device should be assigned with the last parameters such as an IP address, subnet mask and network default gate address.

The MG15 supports standard "ping" tool to test the connection. Other protocols such as http, ftp or telnet are not supported.

#### 6.4.4.2 PARAMETER SETTINGS

In the event when the device must have a permanent, previously established IP address, this can be done by changing the parameters in the device menu, see subchapter 3.6.11. In case of a device without a display (BlackBox) transmission parameters for the Modbus TCP protocol can be changed through the communication interface RS232/485. For this purpose, send appropriate commands described in table 6.4.8. After every change of the parameters the Ethernet interface will be restarted.

**CAUTION**

It is recommended to make all the settings of the communication interface before connecting to the Ethernet network. It is not necessary, however, the MG15 default settings may cause conflicts with the devices already connected to the network.

In case of the Modbus TCP network there are several other parameters: IP address, subnet mask, network default gate address and DHCP. Changing any of these parameters may assign immediately a new network address to the device. Therefore, it is recommended to make such changes when the device is in the “offline” mode, i.e. disconnected from the communication network.

Each MG15 device has its own unique MAC address, usually as a 12-digit hexadecimal number in the “aa-bb-cc-dd-ee-ff” format. The MAC address can be viewed in the device menu or through the communication interface according to the data in the table of chapter 6.4.8.

### 6.4.4.3 FRAME FORMAT

Typical data exchange consists in sending a query from the MASTER device and a response to this query from the SLAVE device.

A typical message in both directions should consist of the following information:

| Transaction Id | Protocol Id | Data length | Device address | Function code | Data    |
|----------------|-------------|-------------|----------------|---------------|---------|
| 2 byte         | 2 byte      | 2 byte      | 1 byte         | 1 byte        | n bytes |

Table 6.7: Modbus TCP frame format

- **Transaction ID** - used to synchronise messages between the server and client.
- **Protocol ID** - identifier of data exchange protocol, which is always 0 for Modbus TCP.
- **Data length** - number of bytes in a frame excluding transaction Id and protocol Id.
- **Device address** - device address to which a frame is directed or response to an address.
- **Function code** - 1-byte code unequivocally identifying action to be executed by the Slave device.
- **Data** - length and type of data depends on the function code. Usually, a data segment will contain the parameter address and number of data to read or write.

### DEVICE IDENTIFICATION IN MODBUS TCP NETWORK



The Modbus TCP specification enables also addressing the device as a part of the Modbus protocol frame (“Device address” byte). In the Ethernet network is it however oversized (the address is set to 0x01), and the main and fully sufficient device identification is executed through the IP address of the device in the network.



### 6.4.5 FUNCTION CODES

The function codes have 1-byte length. These are instructions for Slave devices describing action to be executed.

The following function codes are supported through the MG15 device.

| FUNCTION CODE | FUNCTION      |
|---------------|---------------|
| 0x03          | Read n-words  |
| 0x06          | Write word    |
| 0x10          | Write n-words |

Table 6.8: Modbus protocol function codes

It is recommended to use the 0x03 function to read data, and the 0x10 function to write. It applies also to logic data. Other function codes are supported to ensure compatibility with the Modbus documentation. Exchange of information between the Master and Slave devices is executed through data words. These data consist of parameters. The definitions of individual words for the MG15 are presented in tables, starting from 6.4.8.

Communication frame formats for individual function codes are described below.

#### 6.4.5.1 0x03 - READ N-WORDS

It enables sequential reading of a number of parameters within one query.

It is necessary to define the address of the first parameter and number of words to be read after this address.

##### Query:

| Device address | Function code 0x03 | First word address | Number of words to read | CRC     |
|----------------|--------------------|--------------------|-------------------------|---------|
| 1 byte         | 1 byte             | MSB LSB            | MSB LSB                 | MSB LSB |

The maximum number of read words is 125. The first two bytes are the data for the first parameter (first MSB in organisation). The subsequent byte pairs are the data for the following parameters.

##### Response:

| Device address | Function code 0x03 | Number of read bytes | Value of first word | ... | Value of last word | CRC     |
|----------------|--------------------|----------------------|---------------------|-----|--------------------|---------|
| 1 byte         | 1 byte             | 1 byte               | MSB LSB             | ... | MSB LSB            | MSB LSB |

**Example:** Read vacuum value and status of IG1 gauge.

##### Query:

TX: 01 03 00 00 00 03 05 CB

##### Response:

RX: 01 03 06 3A 83 12 6F 00 00 54 94

### 6.4.5.2 0x06 - WRITE WORD

#### Query:

| Device address | Function code 0x06 | Address of word to be written | Value to be written | CRC     |
|----------------|--------------------|-------------------------------|---------------------|---------|
| 1 byte         | 1 byte             | MSB LSB                       | MSB LSB             | MSB LSB |

#### Response:

| Device address | Function code 0x06 | Address of word to be written | Value to be written | CRC     |
|----------------|--------------------|-------------------------------|---------------------|---------|
| 1 byte         | 1 byte             | MSB LSB                       | MSB LSB             | MSB LSB |

Slave device is identical with query. Except when transmission error or incorrect data occur. Possible responses in case of error are described in table 6.4.6.

**Example:** For IG1 set gauge type to IE414.

#### Query:

TX: 01 06 00 4A 02 00 A9 7C

#### Response:

RX: 01 06 00 4A 02 00 A9 7C

### 6.4.5.3 0x10 - WRITE N-WORDS

It enables sequential writing of a number of parameters within one transmission.

It is necessary to define the address of the first parameter and number of words to be written after this address.

#### Query:

| Device address | Function code 0x10 | First word address | Number of words to be written | Number of data bytes | Data    | ... | CRC     |
|----------------|--------------------|--------------------|-------------------------------|----------------------|---------|-----|---------|
| 1 byte         | 1 byte             | MSB LSB            | MSB LSB                       | 1bajt                | MSB LSB | ... | MSB LSB |

#### Response:

| Device address | Function code 0x10 | First word address | Number of written words | CRC     |
|----------------|--------------------|--------------------|-------------------------|---------|
| 1 byte         | 1 byte             | MSB LSB            | MSB LSB                 | MSB LSB |

The maximum number of words to be written is 125 which corresponds to 250 bytes. The first two bytes are the data for the first parameter (first MSB in organisation). The subsequent byte pairs are the data for the following parameters. Trying to write using function 0x10 of data blocks containing non-configured (empty) cells, or read only, results in communication error and discarding of the data. All the further values in the block will also be discarded.

**Example:** Set IP address at value 10.10.67.255.

**Query:**

TX: 01 10 06 4F 00 02 06 0A 0A 43 FF D7 B5

**Response:**

RX: 01 10 04 4F 00 02 71 2F

## 6.4.6 RESPONSE IN CASE OF ERROR

The Modbus protocol defines the reaction if errors occurs. The Slave device is able to detect a damaged query or a query which contains incorrect data. It responds then with error code.

However, transmission errors may occur to which Slave devices cannot respond. Then after waiting the Master device will interpret the lack of response as a communication error. The Master should then resend the query.

### 6.4.6.1 ERROR AND WARNING CODES

The Slave device, which detected a damaged query, or a query which contains incorrect data will respond with an error message. An error message consists of the following elements.

| Device address | Function code | Error code | CRC     |
|----------------|---------------|------------|---------|
| 1 byte         | 1 byte        | 1 byte     | MSB LSB |

The function code byte contains a transmitted function code, but with the most significant bit set at 1 (it is the result of adding 128 to the function code - binary 10000000).

In response the error code indicates the type of the error detected.

The MG15 supports the type of the detected error:

| Error code | Error type                | Description   |
|------------|---------------------------|---|
| 0x01       | Incorrect function        | Function code is incorrect for Master (or slave) device.  |
| 0x02       | Incorrect address         | Address out of range or start/end write/read in incorrect place of table.   |
| 0x03       | Incorrect data / argument | Data value of is inadmissible for the word addressed.   |
| 0x04       | Device error              | Error occurred in the Master or Slave device when executing the operation.  |
| 0x05       | Acknowledge               | The Master (or Slave) device accepted the command and the operation is being executed. Its execution takes too long and the response is sent back, to prevent the time limit error in the inquired device. The Slave (or Master) may send a message in the next loop, to determine whether the operation has been completed successfully. |

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|------------------------------|----------------------------------|---|
| Error code                   | Error type                       | Description   |
| 0x06                         | Busy /<br>Message<br>discarded   | The server (Slave) is busy for long time with processing the programme commands. The Client (Master) should try again to send the message later, when the server (Slave) is free. |
| 0x07                         | Not ac-<br>knowledge             | The response of the device inquired when the required action cannot be executed.  |
| 0x0A                         | Network<br>path un-<br>available | Applies to network gates. It indicates that the network gate cannot allocate an internal communication path from the input port to the output port to execute the command.        |
| 0x0B                         | No response                      | Applies to network gates. This means that no response has been received from the target device. It usually means that the device is not present in the network.                   |

Table 6.9: Erros codes

#### 6.4.7 TYPE OF DATA USED IN COMMUNICATION

One of the main limitations of the Modbus protocol is the fact that the device memory is visible as a variable 16-bit integral numbers table. In most cases it is sufficient, because scaling to the appropriate value without losing precision can be used. In fact it has a disadvantage consisting in the fact that the scaling factor must be known for the devices at both ends of the communication link.

The next problem are variables, for which 16-bit representation is not sufficient, e.g. value of vacuum. To solve these problem, different types of variables have been implemented in the MG15, enabling the full resolution of data.

The most precise data type is 32-bit float in the "IEEE-754" standard. This format is written in the memory as two consecutive words (4 bytes) in the order: "MSB first". The rules determining the organisation of data in two consecutive words depends on the type of a given parameter.

Other data types used in the Modbus protocol variables:

- Enumerating parameters are parameters, which have their own text representation in the user interface, e.g.: "Type of gauge:" - "CTR90, TTR91, TTR211,...", etc.
- Parameters of "bool" type are parameters which may be "0" or "1". These parameters are described in the table as "bool".
- Parameters of "integer" type are integral parameters, without decimal points. They include parameters such as "Degassing power" or "Sensitivity". They can be 8- or 16-bit parameters and are marked in the table as "uint8" or "uint16" for integer numbers without sign and "int8" or "int16" for integer numbers with sign.
- Parameters of "float" type are parameters with a decimal point. These are parameters such as "Vacuum value" or "Setpoint" settings. These parameters are marked in the table as "float32" and their writing is compatible with the 4-bytes "IEEE-754" standard.

### 6.4.7.1 ENUMERATED, BOOL AND INTEGER PARAMETERS

These variables are always occupying one word in the memory. For variables smaller than: 2 bytes, the upper byte is filled with 0x00 value.

These variables are read via 0x03 function, and they can be recorded via 0x06 or 0x10 function. Remember to fill with 0x00 the upper byte (MSB) of variables smaller than 2 bytes during writing.

### 6.4.7.2 FLOAT TYPE

The format is compatible with the IEEE-754 standard and is used in almost every programming language of higher level such as C, C++. In addition, most of automatics equipment or built-in systems allows for their automatic decoding.

Variables written in this format are organised as 4-byte data in two consecutive table word in the "MSB first" order. Writing and reading of these variables is possible only via 0x03 and 0x10 commands. An attempt to write or read such variable in half will be discarded and an error message will be generated.

#### CAUTION



Note that in practice, when using C, IEEE floats may usually be decoded by placing the values returned over comms into memory and 'casting' the region as a float, although some compilers may require that the area be byte swapped high to low before casting (e.g. MSB B2 B1 LSB → LSB B1 B2 MSB).

| MODBUS ADDRESS |              | MODBUS ADDRESS + 1 |            |
|----------------|--------------|--------------------|------------|
| MSB            | LSB          | MSB                | LSB        |
| Bits 31 - 24   | Bits 23 - 16 | Bits 15 - 8        | Bits 7 - 0 |

Table 6.10: Float IEEE-754 format in Modbus table

For example, to transfer the value 1.001, the following values are transmitted (hexadecimal):

| MODBUS ADDRESS |      | MODBUS ADDRESS + 1 |      |
|----------------|------|--------------------|------|
| MSB            | LSB  | MSB                | LSB  |
| 0x3F           | 0x80 | 0x20               | 0xC5 |

Table 6.11: Example float IEEE-754 value in Modbus table

**6.4.8 TABLE OF MODBUS VARIABLES - MAP OF REGISTERS**

| NAME OF VARIABLE                               | ADDRESS | TYPE | KIND   | RANGE [UNIT]                |
|--|---------|------|--------|-----------------------------|
| <i>BASIC INFORMATION ABOUT VACUUM CHANNELS</i> |         |      |        |                             |
| Channel 1 – vacuum value                       | 0       | R    | FLOAT  | [mbar]                      |
| Channel 1 – status                             | 2       | R    | UINT8  | see tab. 6.18               |
| Channel 2 – vacuum value                       | 3       | R    | FLOAT  | [mbar]                      |
| Channel 2 – status                             | 5       | R    | UINT8  | see tab. 6.18               |
| Channel 3 – vacuum value                       | 6       | R    | FLOAT  | [mbar]                      |
| Channel 3 – status                             | 8       | R    | UINT8  | see tab. 6.18               |
| Channel 4 – vacuum value                       | 9       | R    | FLOAT  | [mbar]                      |
| Channel 4 – status                             | 11      | R    | UINT8  | see tab. 6.18               |
| Channel 5 – vacuum value                       | 12      | R    | FLOAT  | [mbar]                      |
| Channel 5 – status                             | 14      | R    | UINT8  | see tab. 6.18               |
| Channel 6 – vacuum value                       | 15      | R    | FLOAT  | [mbar]                      |
| Channel 6 – status                             | 17      | R    | UINT8  | see tab. 6.18               |
| Channel 7 – vacuum value                       | 18      | R    | FLOAT  | [mbar]                      |
| Channel 7 – status                             | 20      | R    | UINT8  | see tab. 6.18               |
| <i>BASIC INFORMATION ABOUT SETPOINTS</i>       |         |      |        |                             |
| Setpoints state                                | 21      | R    | UINT16 | 0 .. 1023                   |
| Setpoint 1 LOW – vacuum value                  | 22      | R/W  | FLOAT  | $1e^{-15}$ .. $1e^8$ [mbar] |
| Setpoint 1 HIGH – vacuum value                 | 24      | R/W  | FLOAT  | $1e^{-15}$ .. $1e^8$ [mbar] |
| Setpoint 2 LOW – vacuum value                  | 26      | R/W  | FLOAT  | $1e^{-15}$ .. $1e^8$ [mbar] |
| Setpoint 2 HIGH – vacuum value                 | 28      | R/W  | FLOAT  | $1e^{-15}$ .. $1e^8$ [mbar] |
| Setpoint 3 LOW – vacuum value                  | 30      | R/W  | FLOAT  | $1e^{-15}$ .. $1e^8$ [mbar] |
| Setpoint 3 HIGH – vacuum value                 | 32      | R/W  | FLOAT  | $1e^{-15}$ .. $1e^8$ [mbar] |
| Setpoint 4 LOW – vacuum value                  | 34      | R/W  | FLOAT  | $1e^{-15}$ .. $1e^8$ [mbar] |
| Setpoint 4 HIGH – vacuum value                 | 36      | R/W  | FLOAT  | $1e^{-15}$ .. $1e^8$ [mbar] |
| Setpoint 5 LOW – vacuum value                  | 38      | R/W  | FLOAT  | $1e^{-15}$ .. $1e^8$ [mbar] |
| Setpoint 5 HIGH – vacuum value                 | 40      | R/W  | FLOAT  | $1e^{-15}$ .. $1e^8$ [mbar] |
| Setpoint 6 LOW – vacuum value                  | 42      | R/W  | FLOAT  | $1e^{-15}$ .. $1e^8$ [mbar] |
| continued on next page                         |         |      |        |                             |

| continued from previous page                         |                                   |      |        |                             |        |
|--|-----------------------------------|------|--------|-----------------------------|--------|
| NAME OF VARIABLE                                     | ADDRESS                           | TYPE | KIND   | RANGE [UNIT]                |        |
| Setpoint 6 HIGH – vacuum value                       | 44                                | R/W  | FLOAT  | $1e^{-15}$ .. $1e^8$ [mbar] |        |
| Setpoint 7 LOW – vacuum value                        | 46                                | R/W  | FLOAT  | $1e^{-15}$ .. $1e^8$ [mbar] |        |
| Setpoint 7 HIGH – vacuum value                       | 48                                | R/W  | FLOAT  | $1e^{-15}$ .. $1e^8$ [mbar] |        |
| Setpoint 8 LOW – vacuum value                        | 50                                | R/W  | FLOAT  | $1e^{-15}$ .. $1e^8$ [mbar] |        |
| Setpoint 8 HIGH – vacuum value                       | 52                                | R/W  | FLOAT  | $1e^{-15}$ .. $1e^8$ [mbar] |        |
| Setpoint 9 LOW – vacuum value                        | 54                                | R/W  | FLOAT  | $1e^{-15}$ .. $1e^8$ [mbar] |        |
| Setpoint 9 HIGH – vacuum value                       | 56                                | R/W  | FLOAT  | $1e^{-15}$ .. $1e^8$ [mbar] |        |
| Setpoint 10 LOW – vacuum value                       | 58                                | R/W  | FLOAT  | $1e^{-15}$ .. $1e^8$ [mbar] |        |
| Setpoint 10 HIGH – vacuum value                      | 60                                | R/W  | FLOAT  | $1e^{-15}$ .. $1e^8$ [mbar] |        |
| Setpoint 1 source                                    | 62                                | R/W  | UINT8  | see tab. 6.21               |        |
| Setpoint 2 source                                    | 63                                | R/W  | UINT8  | see tab. 6.21               |        |
| Setpoint 3 source                                    | 64                                | R/W  | UINT8  | see tab. 6.21               |        |
| Setpoint 4 source                                    | 65                                | R/W  | UINT8  | see tab. 6.21               |        |
| Setpoint 5 source                                    | 66                                | R/W  | UINT8  | see tab. 6.21               |        |
| Setpoint 6 source                                    | 67                                | R/W  | UINT8  | see tab. 6.21               |        |
| Setpoint 7 source                                    | 68                                | R/W  | UINT8  | see tab. 6.21               |        |
| Setpoint 8 source                                    | 69                                | R/W  | UINT8  | see tab. 6.21               |        |
| Setpoint 9 source                                    | 70                                | R/W  | UINT8  | see tab. 6.21               |        |
| Setpoint 10 source                                   | 71                                | R/W  | UINT8  | see tab. 6.21               |        |
| <i>VACUUM CHANNEL 1 - PASSIVE GAUGE 1</i>            |                                   |      |        |                             |        |
| Channel 1 - Emission ON/OFF                          | 72                                | R/W  | UINT8  | 0 .. 1                      |        |
| Channel 1 - Degassing ON/OFF                         | 73                                | R/W  | UINT8  | 0 .. 1                      |        |
| Channel 1 - Gauge type                               | 74                                | R/W  | UINT8  | see tab. 6.17               |        |
| Channel 1 - Emission control                         | 75                                | R/W  | UINT8  | see tab. 6.19               |        |
| Channel 1 - filter:                                  | 0 - Low<br>1 - Medium<br>2 - High | 76   | R/W    | UINT8                       | 0 .. 2 |
| Channel 1 - Gas type                                 | 77                                | R/W  | UINT8  | see tab. 6.20               |        |
| Channel 1 - def. correction factor                   | 78                                | R/W  | UINT16 | 0 .. 999                    |        |
| Channel 1 - Degassing time                           | 79                                | R/W  | UINT8  | 0 .. 20 [min]               |        |
| Channel 1 - current time to complete degassing (min) | 80                                | R    | UINT8  | 0 .. 20 [min]               |        |
| continued on next page                               |                                   |      |        |                             |        |

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|--|---------|------|--------|-------------------|
| NAME OF VARIABLE   | ADDRESS | TYPE | KIND   | RANGE [UNIT]      |
| Channel 1 - current time to complete degassing (sec)     | 81      | R    | UINT8  | 0 .. 59 [sek]     |
| Channel 1 - Degassing power                              | 82      | R/W  | UINT8  | 1 .. 40 [W]       |
| Channel 1 - Filament selection                           | 83      | R/W  | UINT8  | 1 .. 2            |
| Channel 1 - Sensitivity                                  | 84      | R/W  | UINT8  | 1 .. 100          |
| Channel 1 - Emission current                             | 85      | R/W  | UINT16 | 10 .. 1000 [10uA] |
| Channel 1 - Calibration factor                           | 86      | R/W  | UINT16 | 1 .. 2000         |
| Channel 1 - Grid voltage of def. gauge                   | 87      | R/W  | UINT8  | 20 .. 250 [V]     |
| Channel 1 - Filament voltage of def. gauge               | 88      | R/W  | UINT8  | 0 .. 120 [V]      |
| Channel 1 - Reflector voltage of def. gauge              | 89      | R/W  | UINT8  | 0 .. 120 [V]      |
| Channel 1 - Degas voltage of def. gauge                  | 90      | R/W  | UINT16 | 400 .. 600 [V]    |
| Channel 1 - Max. filament current of def. gauge          | 91      | R/W  | UINT8  | 10 .. 60 [100mA]  |
| <i>VACUUM CHANNEL 2 - PASSIVE GAUGE 2</i>                |         |      |        |                   |
| Channel 2 - Emission ON/OFF                              | 92      | R/W  | UINT8  | 0 .. 1            |
| Channel 2 - Degassing ON/OFF                             | 93      | R/W  | UINT8  | 0 .. 1            |
| Channel 2 - Gauge type                                   | 94      | R/W  | UINT8  | see tab. 6.17     |
| Channel 2 - Emission control                             | 95      | R/W  | UINT8  | see tab. 6.19     |
| Channel 2 - filter:<br>0 - Low<br>1 - Medium<br>2 - High | 96      | R/W  | UINT8  | 0 .. 2            |
| Channel 2 - Gas type                                     | 97      | R/W  | UINT8  | see tab. 6.20     |
| Channel 2 - def. correction factor                       | 98      | R/W  | UINT16 | 0 .. 999          |
| Channel 2 - Degassing time                               | 99      | R/W  | UINT8  | 0 .. 20 [min]     |
| Channel 2 - current time to complete degassing (min)     | 100     | R    | UINT8  | 0 .. 20 [min]     |
| Channel 2 - current time to complete degassing (sec)     | 101     | R    | UINT8  | 0 .. 59[sec]      |
| Channel 2 - Degassing power                              | 102     | R/W  | UINT8  | 1 .. 40 [W]       |
| Channel 2 - Filament selection                           | 103     | R/W  | UINT8  | 1 .. 2            |
| Channel 2 - Sensitivity                                  | 104     | R/W  | UINT8  | 1 .. 100          |
| continued on next page                                   |         |      |        |                   |



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|--|---------|------|--------|-------------------|
| NAME OF VARIABLE   | ADDRESS | TYPE | KIND   | RANGE [UNIT]      |
| Channel 2 - Emission current                             | 105     | R/W  | UINT16 | 10 .. 1000 [10uA] |
| Channel 2 - Calibration factor                           | 106     | R/W  | UINT16 | 1 .. 2000         |
| Channel 2 - Grid voltage of def. gauge                   | 107     | R/W  | UINT8  | 20 .. 250 [V]     |
| Channel 2 - Filament voltage of def. gauge               | 108     | R/W  | UINT8  | 0 .. 120 [V]      |
| Channel 2 - Reflector voltage of def. gauge              | 109     | R/W  | UINT8  | 0 .. 120 [V]      |
| Channel 2 - Degas voltage of def. gauge                  | 110     | R/W  | UINT16 | 400 .. 600 [V]    |
| Channel 2 - Max. filament current of def. gauge          | 111     | R/W  | UINT8  | 10 .. 60 [100mA]  |
| <i>VACUUM CHANNEL 3 - PASSIVE GAUGE 3</i>                |         |      |        |                   |
| Channel 3 - Emission ON/OFF                              | 112     | R/W  | UINT8  | 0 .. 1            |
| Channel 3 - Degassing ON/OFF                             | 113     | R/W  | UINT8  | 0 .. 1            |
| Channel 3 - Gauge type                                   | 114     | R/W  | UINT8  | see tab. 6.17     |
| Channel 3 - Emission control                             | 115     | R/W  | UINT8  | see tab. 6.19     |
| Channel 3 - filter:<br>0 - Low<br>1 - Medium<br>2 - High | 116     | R/W  | UINT8  | 0 .. 2            |
| Channel 3 - Gas type                                     | 117     | R/W  | UINT8  | see tab. 6.20     |
| Channel 3 - def. correction factor                       | 118     | R/W  | UINT16 | 0 .. 999          |
| Channel 3 - Degassing time                               | 119     | R/W  | UINT8  | 0 .. 20 [min]     |
| Channel 3 - current time to complete degassing (min)     | 120     | R    | UINT8  | 0 .. 20 [min]     |
| Channel 3 - current time to complete degassing (sec)     | 121     | R    | UINT8  | 0 .. 59[sec]      |
| Channel 3 - Degassing power                              | 122     | R/W  | UINT8  | 1 .. 40 [W]       |
| Channel 3 - Filament selection                           | 123     | R/W  | UINT8  | 1 .. 2            |
| Channel 3 - Sensitivity                                  | 124     | R/W  | UINT8  | 1 .. 100          |
| Channel 3 - Emission current                             | 125     | R/W  | UINT16 | 10 .. 1000 [10uA] |
| Channel 3 - Calibration factor                           | 126     | R/W  | UINT16 | 1 .. 2000         |
| Channel 3 - Grid voltage of def. gauge                   | 127     | R/W  | UINT8  | 20 .. 250 [V]     |
| Channel 3 - Filament voltage of def. gauge               | 128     | R/W  | UINT8  | 0 .. 120 [V]      |
| continued on next page                                   |         |      |        |                   |

| continued from previous page                             |         |      |        |                      |
|--|---------|------|--------|----------------------|
| NAME OF VARIABLE   | ADDRESS | TYPE | KIND   | RANGE [UNIT]         |
| Channel 3 - Reflector voltage of def. gauge              | 129     | R/W  | UINT8  | 0 .. 120 [V]         |
| Channel 3 - Degas voltage of def. gauge                  | 130     | R/W  | UINT16 | 400 .. 600 [V]       |
| Channel 3 - Max. filament current of def. gauge          | 131     | R/W  | UINT8  | 10 .. 60 [100mA]     |
| <i>VACUUM CHANNEL 4 - ACTIVE GAUGE 1</i>                 |         |      |        |                      |
| Channel 4 - Emission ON/OFF                              | 152     | R/W  | UINT8  | 0 .. 1               |
| Channel 4 - Degassing ON/OFF                             | 153     | R/W  | UINT8  | 0 .. 1               |
| Channel 4 - Auto identification                          | 154     | R/W  | UINT8  | 0 .. 1               |
| Channel 4 - Gauge type                                   | 155     | R/W  | UINT8  | see tab. 6.17        |
| Channel 4 - Emission control                             | 156     | R/W  | UINT8  | see tab. 6.19        |
| Channel 4 - filter:<br>0 - Low<br>1 - Medium<br>2 - High | 157     | R/W  | UINT8  | 0 .. 2               |
| Channel 4 - Gas type                                     | 158     | R/W  | UINT8  | see tab. 6.20        |
| Channel 4 - def. correction factor                       | 159     | R/W  | UINT16 | 0 .. 999             |
| Channel 4 - Degassing time                               | 160     | R/W  | UINT8  | 0 .. 20 [min]        |
| Channel 4 - current time to complete degassing (min)     | 161     | R    | UINT8  | 0 .. 20 [min]        |
| Channel 4 - current time to complete degassing (sec)     | 162     | R    | UINT8  | 0 .. 59[sec]         |
| Channel 4 - Factor A of def. gauge                       | 163     | R/W  | UINT8  | 1 .. 40 [W]          |
| Channel 4 - Factor B of def. gauge                       | 164     | R/W  | UINT8  | 1 .. 2               |
| Channel 4 - Min. voltage of def. gauge                   | 165     | R/W  | UINT8  | 1 .. 100             |
| Channel 4 - Max. voltage of def. gauge                   | 166     | R/W  | UINT16 | 10 .. 1000 [10uA]    |
| Channel 4 - Full scale parameter of def. gauge           | 167     | R/W  | UINT32 | 1 .. 99999999 [Torr] |
| <i>VACUUM CHANNEL 5 - ACTIVE GAUGE 2</i>                 |         |      |        |                      |
| Channel 5 - Emission ON/OFF                              | 168     | R/W  | UINT8  | 0 .. 1               |
| Channel 5 - Degassing ON/OFF                             | 169     | R/W  | UINT8  | 0 .. 1               |
| Channel 5 - Auto identification                          | 170     | R/W  | UINT8  | 0 .. 1               |
| Channel 5 - Gauge type                                   | 171     | R/W  | UINT8  | see tab. 6.17        |
| Channel 5 - Emission control                             | 172     | R/W  | UINT8  | see tab. 6.19        |
| continued on next page                                   |         |      |        |                      |

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|--|---------|------|--------|----------------------|--|
| NAME OF VARIABLE   | ADDRESS | TYPE | KIND   | RANGE [UNIT]         |  |
| Channel 5 - filter:<br>0 - Low<br>1 - Medium<br>2 - High | 173     | R/W  | UINT8  | 0 .. 2               |  |
| Channel 5 - Gas type                                     | 174     | R/W  | UINT8  | see tab. 6.20        |  |
| Channel 5 - def. correction factor                       | 175     | R/W  | UINT16 | 0 .. 999             |  |
| Channel 5 - Degassing time                               | 176     | R/W  | UINT8  | 0 .. 20 [min]        |  |
| Channel 5 - current time to complete degassing (min)     | 177     | R    | UINT8  | 0 .. 20 [min]        |  |
| Channel 5 - current time to complete degassing (sec)     | 178     | R    | UINT8  | 0 .. 59[sec]         |  |
| Channel 5 - Factor A of def. gauge                       | 179     | R/W  | UINT8  | 1 .. 40 [W]          |  |
| Channel 5 - Factor B of def. gauge                       | 180     | R/W  | UINT8  | 1 .. 2               |  |
| Channel 5 - Min. voltage of def. gauge                   | 181     | R/W  | UINT8  | 1 .. 100             |  |
| Channel 5 - Max. voltage of def. gauge                   | 182     | R/W  | UINT16 | 10 .. 1000 [10uA]    |  |
| Channel 5 - Full scale parameter of def. gauge           | 183     | R/W  | UINT32 | 1 .. 99999999 [Torr] |  |
| <i>VACUUM CHANNEL 6 - ACTIVE GAUGE 3</i>                 |         |      |        |                      |  |
| Channel 6 - Emission ON/OFF                              | 184     | R/W  | UINT8  | 0 .. 1               |  |
| Channel 6 - Degassing ON/OFF                             | 185     | R/W  | UINT8  | 0 .. 1               |  |
| Channel 6 - Auto identification                          | 186     | R/W  | UINT8  | 0 .. 1               |  |
| Channel 6 - Gauge type                                   | 187     | R/W  | UINT8  | see tab. 6.17        |  |
| Channel 6 - Emission control                             | 188     | R/W  | UINT8  | see tab. 6.19        |  |
| Channel 6 - filter:<br>0 - Low<br>1 - Medium<br>2 - High | 189     | R/W  | UINT8  | 0 .. 2               |  |
| Channel 6 - Gas type                                     | 190     | R/W  | UINT8  | see tab. 6.20        |  |
| Channel 6 - def. correction factor                       | 191     | R/W  | UINT16 | 0 .. 999             |  |
| Channel 6 - Degassing time                               | 192     | R/W  | UINT8  | 0 .. 20 [min]        |  |
| Channel 6 - current time to complete degassing (min)     | 193     | R    | UINT8  | 0 .. 20 [min]        |  |
| Channel 6 - current time to complete degassing (sec)     | 194     | R    | UINT8  | 0 .. 59[sec]         |  |
| Channel 6 - Factor A of def. gauge                       | 195     | R/W  | UINT8  | 1 .. 40 [W]          |  |
| Channel 6 - Factor B of def. gauge                       | 196     | R/W  | UINT8  | 1 .. 2               |  |
| continued on next page                                   |         |      |        |                      |  |

| continued from previous page                             |         |      |        |                      |
|--|---------|------|--------|----------------------|
| NAME OF VARIABLE   | ADDRESS | TYPE | KIND   | RANGE [UNIT]         |
| Channel 6 - Min. voltage of def. gauge                   | 197     | R/W  | UINT8  | 1 .. 100             |
| Channel 6 - Max. voltage of def. gauge                   | 198     | R/W  | UINT16 | 10 .. 1000 [10uA]    |
| Channel 6 - Full scale parameter of def. gauge           | 199     | R/W  | UINT32 | 1 .. 99999999 [Torr] |
| <i>VACUUM CHANNEL 7 - ACTIVE GAUGE 4</i>                 |         |      |        |                      |
| Channel 7 - Emission ON/OFF                              | 200     | R/W  | UINT8  | 0 .. 1               |
| Channel 7 - Degassing ON/OFF                             | 201     | R/W  | UINT8  | 0 .. 1               |
| Channel 7 - Auto identification                          | 202     | R/W  | UINT8  | 0 .. 1               |
| Channel 7 - Gauge type                                   | 203     | R/W  | UINT8  | see tab. 6.17        |
| Channel 7 - Emission control                             | 204     | R/W  | UINT8  | see tab. 6.19        |
| Channel 7 - filter:<br>0 - Low<br>1 - Medium<br>2 - High | 205     | R/W  | UINT8  | 0 .. 2               |
| Channel 7 - Gas type                                     | 206     | R/W  | UINT8  | see tab. 6.20        |
| Channel 7 - def. correction factor                       | 207     | R/W  | UINT16 | 0 .. 999             |
| Channel 7 - Degassing time                               | 208     | R/W  | UINT8  | 0 .. 20 [min]        |
| Channel 7 - current time to complete degassing (min)     | 209     | R    | UINT8  | 0 .. 20 [min]        |
| Channel 7 - current time to complete degassing (sec)     | 210     | R    | UINT8  | 0 .. 59[sec]         |
| Channel 7 - Factor A of def. gauge                       | 211     | R/W  | UINT8  | 1 .. 40 [W]          |
| Channel 7 - Factor B of def. gauge                       | 212     | R/W  | UINT8  | 1 .. 2               |
| Channel 7 - Min. voltage of def. gauge                   | 213     | R/W  | UINT8  | 1 .. 100             |
| Channel 7 - Max. voltage of def. gauge                   | 214     | R/W  | UINT16 | 10 .. 1000 [10uA]    |
| Channel 7 - Full scale param. of def. gauge              | 215     | R/W  | UINT32 | 1 .. 99999999 [Torr] |

Table 6.12: Basic registers table

| NAME OF VARIABLE      | ADDRESS | TYPE | KIND    | RANGE [UNIT]      |
|-----------------------|---------|------|---------|-------------------|
| Remote control enable | 1100    | R/W  | UINT8   | 0 .. 1            |
| Logical group         | 1101    | R/W  | UINT8   | 0 .. 255          |
| DHCP                  | 1102    | R/W  | UINT8   | 0 .. 1            |
| IP address            | 1103    | R/W  | 4*UINT8 |                   |
| Subnet mask           | 1105    | R/W  | 4*UINT8 |                   |
| Default gate address  | 1107    | R/W  | 4*UINT8 |                   |
| Port                  | 1109    | R/W  | UINT16  | 502,1025 .. 65535 |

Table 6.13: Communication registers map

| NAME OF VARIABLE                   | ADDRESS | TYPE | KIND  | RANGE [UNIT]  |
|------------------------------------|---------|------|-------|---------------|
| Digital output 1 - assigned signal | 1300    | R/W  | UINT8 | see tab. 6.22 |
| Digital output 1 - status          | 1301    | R    | UINT8 | 0 .. 1        |
| Digital output 2 - assigned signal | 1302    | R/W  | UINT8 | see tab. 6.22 |
| Digital output 2 - status          | 1303    | R    | UINT8 | 0 .. 1        |
| Digital output 3 - assigned signal | 1304    | R/W  | UINT8 | see tab. 6.22 |
| Digital output 3 - status          | 1305    | R    | UINT8 | 0 .. 1        |
| Digital output 4 - assigned signal | 1306    | R/W  | UINT8 | see tab. 6.22 |
| Digital output 4 - status          | 1307    | R    | UINT8 | 0 .. 1        |

Table 6.14: Digital outputs registers map

| NAME OF VARIABLE               | ADDRESS | TYPE | KIND    | RANGE [UNIT] |
|--------------------------------|---------|------|---------|--------------|
| Serial number - 13 characters  | 5000    | R    | 16*CHAR |              |
| Product number - 15 characters | 5010    | R    | 18*CHAR |              |
| MAC address                    | 5020    | R    | 6*UINT8 |              |
| MAC address - ProfiNet         | 5030    | R    | 6*UINT8 |              |

Table 6.16: Additional registers map

| NAME OF VARIABLE               | ADDRESS | TYPE | KIND   | RANGE [UNIT]    |
|--------------------------------|---------|------|--------|-----------------|
| <i>ANALOG OUTPUT 1</i>         |         |      |        |                 |
| Analog output 1 - source       | 1500    | R/W  | UINT8  | see tab. 6.23   |
| Analog output 1 - mode         | 1501    | R/W  | UINT8  | see tab. 6.24   |
| Analog output 1 - scale        | 1502    | R/W  | UINT8  | see tab. 6.25   |
| Analog output 1 - Min. range   | 1503    | R/W  | FLOAT  |                 |
| Analog output 1 - Max. range   | 1505    | R/W  | FLOAT  |                 |
| Analog output 1 - Min. voltage | 1507    | R/W  | UINT16 | 0 .. 10000 [mV] |
| Analog output 1 - Max. voltage | 1508    | R/W  | UINT16 | 0 .. 10000 [mV] |
| <i>ANALOG OUTPUT 2</i>         |         |      |        |                 |
| Analog output 2 - source       | 1509    | R/W  | UINT8  | see tab. 6.23   |
| Analog output 2 - mode         | 1510    | R/W  | UINT8  | see tab. 6.24   |
| Analog output 2 - scale        | 1511    | R/W  | UINT8  | see tab. 6.25   |
| Analog output 2 - Min. range   | 1512    | R/W  | FLOAT  |                 |
| Analog output 2 - Max. range   | 1514    | R/W  | FLOAT  |                 |
| Analog output 2 - Min. voltage | 1516    | R/W  | UINT16 | 0 .. 10000 [mV] |
| Analog output 2 - Max. voltage | 1517    | R/W  | UINT16 | 0 .. 10000 [mV] |
| <i>ANALOG OUTPUT 3</i>         |         |      |        |                 |
| Analog output 3 - source       | 1518    | R/W  | UINT8  | see tab. 6.23   |
| Analog output 3 - mode         | 1519    | R/W  | UINT8  | see tab. 6.24   |
| Analog output 3 - scale        | 1520    | R/W  | UINT8  | see tab. 6.25   |
| Analog output 3 - Min. range   | 1521    | R/W  | FLOAT  |                 |
| Analog output 3 - Max. range   | 1523    | R/W  | FLOAT  |                 |
| Analog output 3 - Min. voltage | 1525    | R/W  | UINT16 | 0 .. 10000 [mV] |
| Analog output 3 - Max. voltage | 1526    | R/W  | UINT16 | 0 .. 10000 [mV] |
| <i>ANALOG OUTPUT 4</i>         |         |      |        |                 |
| Analog output 4 - source       | 1527    | R/W  | UINT8  | see tab. 6.23   |
| Analog output 4 - mode         | 1528    | R/W  | UINT8  | see tab. 6.24   |
| Analog output 4 - scale        | 1529    | R/W  | UINT8  | see tab. 6.25   |
| Analog output 4 - Min. range   | 1530    | R/W  | FLOAT  |                 |
| Analog output 4 - Max. range   | 1532    | R/W  | FLOAT  |                 |
| Analog output 4 - Min. voltage | 1534    | R/W  | UINT16 | 0 .. 10000 [mV] |
| Analog output 4 - Max. voltage | 1535    | R/W  | UINT16 | 0 .. 10000 [mV] |

Table 6.15: Analogue outputs register map

| R/W                   | VACUUM GAUGE TYPES                |
|-----------------------|-----------------------------------|
| Value                 | Description                       |
| <b>ACTIVE GAUGES</b>  |                                   |
| 0                     | CTR90                             |
| 1                     | TTR90                             |
| 2                     | TTR211                            |
| 3                     | PTR225                            |
| 4                     | ITR90                             |
| 5                     | ITR100                            |
| 6                     | MKS870                            |
| 7                     | PTR90                             |
| 8                     | ANALOG_IN                         |
| 9                     | MKS_937A                          |
| 10                    | PG105                             |
| 11                    | MG13_14                           |
| 12                    | PKR251                            |
| 13                    | PCR280                            |
| 14                    | ATMION                            |
| 15                    | User Defined Vacuum Gauge         |
| <b>PASSIVE GAUGES</b> |                                   |
| 0                     | UHV8A                             |
| 1                     | IE514                             |
| 2                     | IE414                             |
| 3                     | UHV24                             |
| 4                     | UHV24p                            |
| 5                     | MKS274                            |
| 6                     | NR_F_UHV                          |
| 7                     | G8130                             |
| 8                     | User Defined Passive Vacuum Gauge |

Table 6.17: Vacuum gauge types

| R     | VACUUM GAUGE POSSIBLE STATUSES                 |
|-------|--|
| Value | Description                                    |
| 0     | Status OK                                      |
| 1     | Wait for emission                              |
| 2     | Emission OFF                                   |
| 3     | Short cathode                                  |
| 4     | Pressure too high (out of vacuum gauge range)  |
| 5     | Anode voltage failure                          |
| 6     | Bias voltage failure                           |
| 7     | Reflector voltage failure                      |
| 8     | Degas failure                                  |
| 9     | Gauge not calibrated                           |
| 10    | No emission                                    |
| 11    | Offset calibration                             |
| 12    | Low vacuum (out of vacuum gauge range)         |
| 13    | High vacuum (out of vacuum gauge range)        |
| 14    | There is no meaningful vacuum value to display |
| 15    | No hardware for passive vacuum gauge           |
| 16    | Passive gauge EEPROM failure                   |
| 17    | Filament failure                               |
| 18    | Degassing                                      |
| 19    | Sensor break for active vacuum gauge           |

Table 6.18: Vacuum gauges possible statuses



| R/W   | EMISSION CONTROL OPTIONS |
|-------|--------------------------|
| Value | Description              |
| 0     | Manual                   |
| 1     | Setpoint 1               |
| 2     | Setpoint 2               |
| 3     | Setpoint 3               |
| 4     | Setpoint 4               |
| 5     | Setpoint 5               |
| 6     | Setpoint 6               |
| 7     | Setpoint 7               |
| 8     | Setpoint 8               |
| 9     | Setpoint 9               |
| 10    | Setpoint 10              |
| 11    | Digital input 1          |
| 12    | Digital input 2          |
| 13    | Digital input 3          |
| 14    | Digital input 4          |

Table 6.19: Emission control options

| R/W   | GAS TYPE OPTIONS |
|-------|------------------|
| Value | Description      |
| 0     | O2               |
| 1     | He               |
| 2     | Ne               |
| 3     | Ar               |
| 4     | Kr               |
| 5     | Xe               |
| 6     | H2               |
| 7     | CO               |
| 8     | define           |

Table 6.20: Gas type options

| R/W   | SETPOINTS SOURCE ASSIGNMENT OPTIONS |
|-------|-------------------------------------|
| Value | Description                         |
| 1     | Vacuum channel 1                    |
| 2     | Vacuum channel 2                    |
| 3     | Vacuum channel 3                    |
| 4     | Vacuum channel 4                    |
| 5     | Vacuum channel 5                    |
| 6     | Vacuum channel 6                    |
| 7     | Vacuum channel 7                    |
| 100   | Always OFF                          |
| 101   | Always ON                           |

Table 6.21: Setpoints source assignment options

| R/W   | DIGITAL OUTPUTS ASSIGNMENT OPTIONS |
|-------|------------------------------------|
| Value | Description                        |
| 0     | Not assigned                       |
| 1     | Emission passive channel 1         |
| 2     | Emission passive channel 2         |
| 3     | Emission passive channel 3         |
| 4     | Emission active channel 1          |
| 5     | Emission active channel 2          |
| 6     | Emission active channel 3          |
| 7     | Emission active channel 4          |
| 8     | Degas passive channel 1            |
| 9     | Degas passive channel 2            |
| 10    | Degas passive channel 3            |
| 11    | Degas active channel 1             |
| 12    | Degas active channel 2             |
| 13    | Degas active channel 3             |
| 14    | Degas active channel 4             |
| 15    | Always OFF                         |
| 16    | Always ON                          |

Table 6.22: Digital outputs assignment options

| R/W   | ANALOGUE OUTPUTS CONTROL SOURCES OPTIONS |
|-------|--|
| Value | Description                              |
| 0     | Not assigned                             |
| 1     | Pressure of passive channel 1            |
| 2     | Pressure of passive channel 2            |
| 3     | Pressure of passive channel 3            |
| 4     | Pressure of active channel 1             |
| 5     | Pressure of active channel 2             |
| 6     | Pressure of active channel 3             |
| 7     | Pressure of active channel 4             |

Table 6.23: Analogue outputs assignment options

| R/W   | ANALOGUE OUTPUTS CONTROL MODES OPTIONS |
|-------|--|
| Value | Description                            |
| 0     | Mode 1 do 1                            |
| 1     | Logarithmic mode                       |
| 2     | User-defined mode                      |

Table 6.24: Analogue outputs modes options

| R/W   | ANALOGUE OUTPUTS SCALES OPTIONS |
|-------|---------------------------------|
| Value | Description                     |
| 0     | Linear scale                    |
| 1     | Logarithmic scale               |

Table 6.25: Analogue outputs scales options

# 7 MAINTANCE AND SERVICE

## 7.1 MAINTANCE

The MG15 does not require any special maintenance work.

## 7.2 CLEANING

For cleaning of the outside of the device, a slightly moistened cloth will usually do. Do not use any aggressive or abrasive cleaning agents.

### DANGER



#### **Mains voltage.**

Components inside of the MG15 are components at mains voltage. Do not insert any objects through the louvers of the device. Protect the device from liquids. Do not open the device.

## 7.3 FIRMWARE UPGRADE

On the pictures below we will use the names of {device\_name} and {version}:

- {device\_name} in this case means MG15 .
- {version} is in numerical form and contains 3 digits separated by a dots. E.g: 1.0.0 or 3.1.5

### WARNING



#### **Firmware upgrade**

During the upgrade, do not turn off the MG15 or disconnect it from the wall outlet. Failure to do so may cause damage to the MG15 , with the result that the unit is not unfit for use and will require repair.

In order to update the software/firmware via USB the USB memory stick must be formatted as FAT / FAT32. Then simply copy the update file received from us to the memory stick and insert into the USB slot on the front of the MG15 . The “New USB Device Detected” hint will appear on the bottom of the screen.

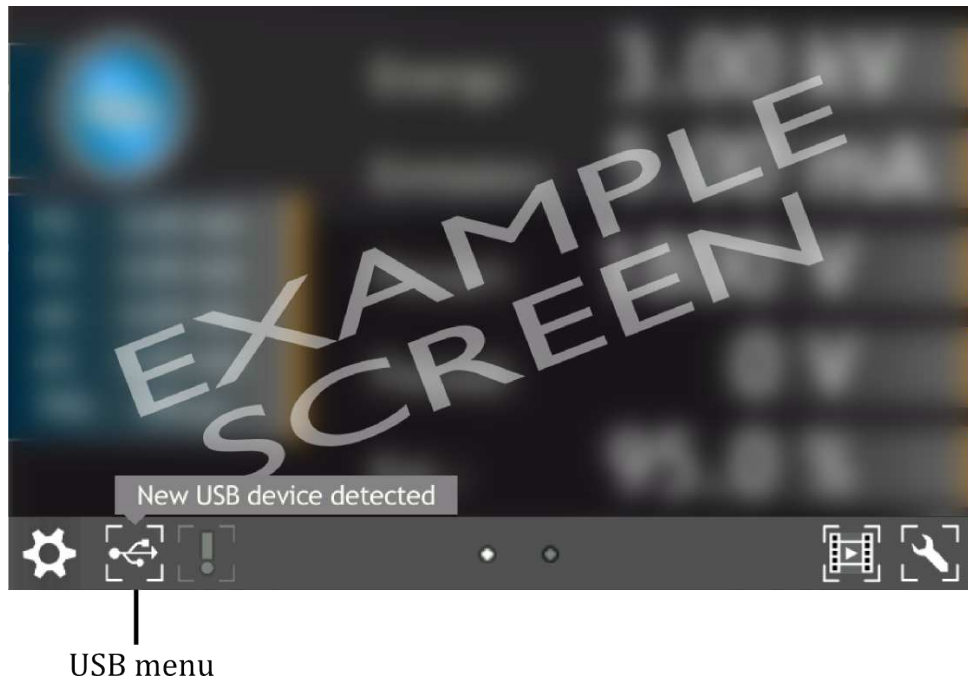


Figure 7.1: USB detected hint

The USB menu is accessed by clicking the USB icon on the bottom of the screen. This displays several options:

- see list of found firmware,
- copy user manual to USB,
- un-mount USB drive,
- export log file onto USB,
- see list of videos on USB,
- copy new language to device,



Figure 7.2: USB menu

To update the current version to a newer version, select the Firmware Updates option. To accelerate the search for updates on the USB drive, delete all files except the updates.



Figure 7.3: Firmware list

In order to choose one of the updates simply click on the name. The “Do you want to update firmware to selected version? After whole procedure device will be rebooted” phrase will appear. Selecting No returns the user to the main menu of Firmware Updates. It is highly recommended to finish all the work on the device and save your data before pressing the “Yes” button.

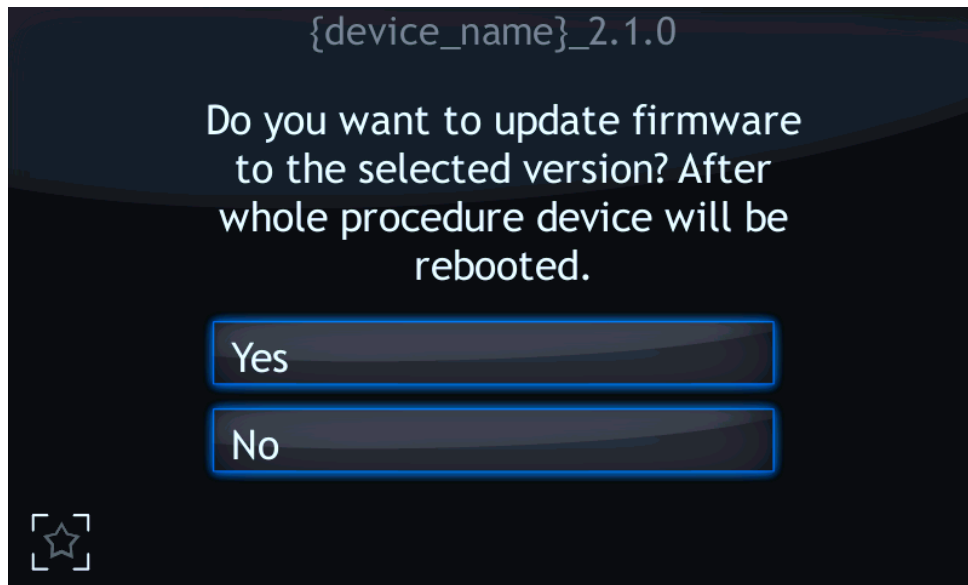


Figure 7.4: Restart message

After selecting to proceed with the update, the device will stop and the updating procedure will be initiated. The update process takes a few minutes during which time the screen below is displayed.

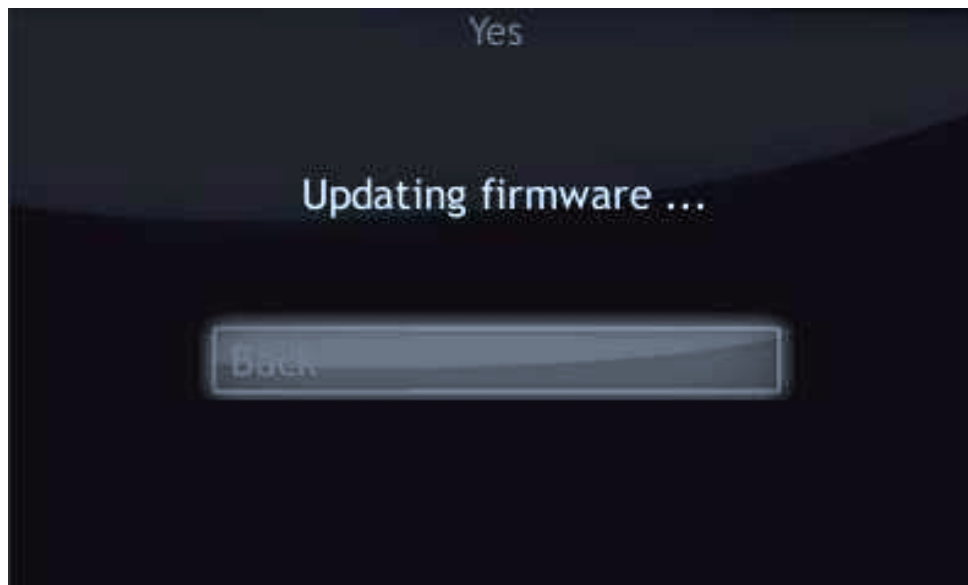


Figure 7.5: Updating firmware

Upon successful installation, the message with "updated" statuses should be displayed.



Figure 7.6: Update summary example

Select "OK" to reboot the device and finish the upgrade.



### 7.3.1 AUTO UPDATE

The auto-update feature compares the current version of main-board and bus firmware with software. In case of any mismatch (for example if the micro SDHC card was swapped) the user will be informed with a blinking exclamation icon.

- To synchronize the firmware, select the exclamation icon.
- The screen below is displayed. If the “Recommended Updates” message is visible, tap the “Auto Update” button in order to synchronize firmware and software. Then follow the procedure from the previous section Upgrading firmware via USB.



Figure 7.7: Auto update 1

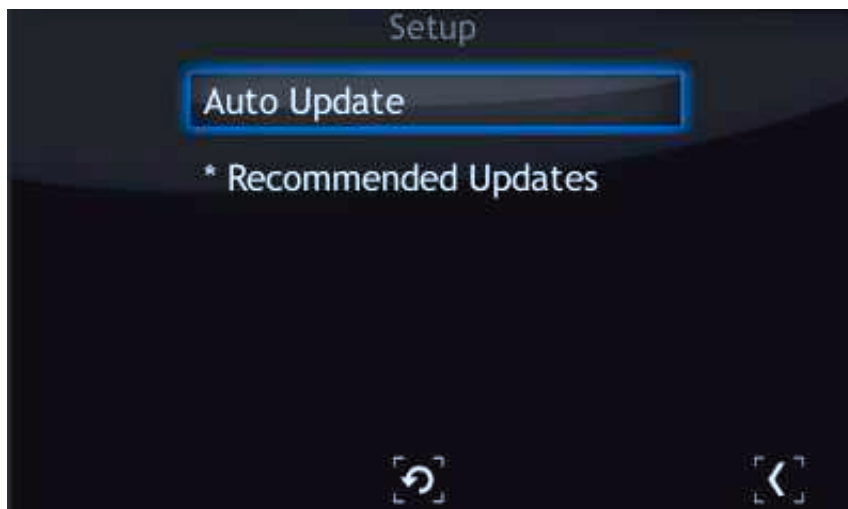


Figure 7.8: Auto update 2

## 7.4 PREBOOT ENVIRONMENT

To run the Preboot application press on the logo at MG15 startup (7.9).



Figure 7.9: Enter into preboot environment

The Preboot Environment is an application to boot the MG15 . Its main task is to launch the device in the version selected by the user. It can also be used to run other tools, such as the gauge calibration application.

The main menu consist three options:

- Reboot – rebooting MG15 .
- Continue booting – close Preboot Environment and continue starting MG15 .
- Continue booting (photo mode) – allow to run device with screenshot function.

### 7.4.1 BOOT MENU

Boot menu allows the user set which version of the MG15 and Preboot Environment will be run after the start of device. In order to switch software version, click on “Software boot version” combo box.



Figure 7.10: Boot menu

Then select one of the available versions, for example default.

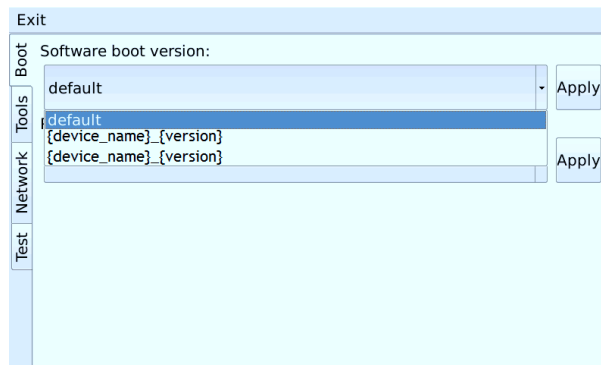


Figure 7.11: Switch software version

To apply changes press Apply button. From now the default version will be automatically run after restarting MG15 .

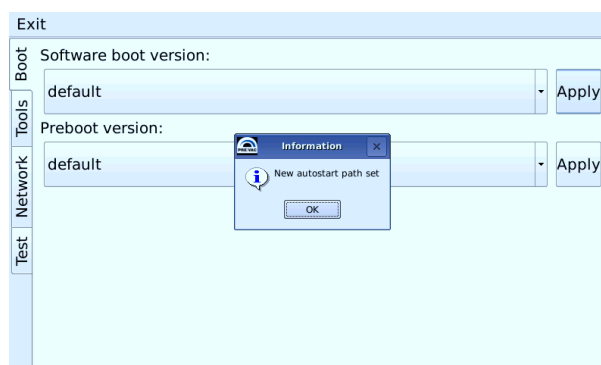


Figure 7.12: Message box confirming the changed settings

### 7.4.2 TOOLS MENU

The Tools menu allows the user to run applications such as touch screen or power supply calibration.



Figure 7.13: Tools menu

In order to select one of the applications, tap the desired application from the tools combo box and tap the Run button.

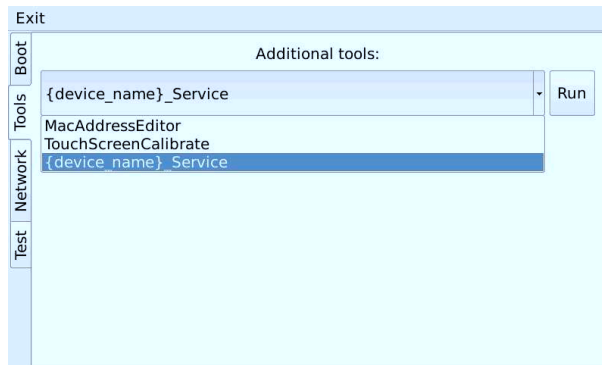


Figure 7.14: Selecting additional tool

### 7.4.3 NETWORK TAB

From this tab the user can configure the IP address, netmask and enable / disable DHCP.

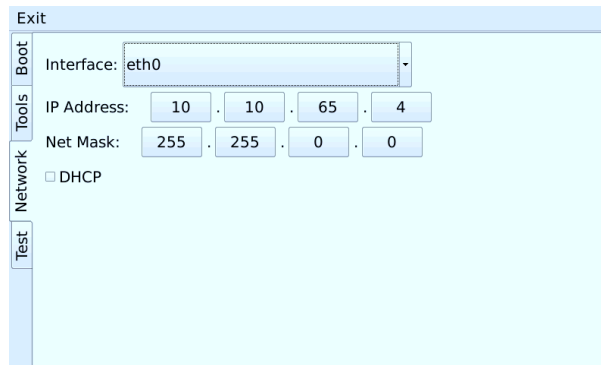


Figure 7.15: Network tab

After tapping on one of the editable fields, the numeric panel for editing values will appear. Input values can be completed by tapping X button in the upper-left corner of the screen.

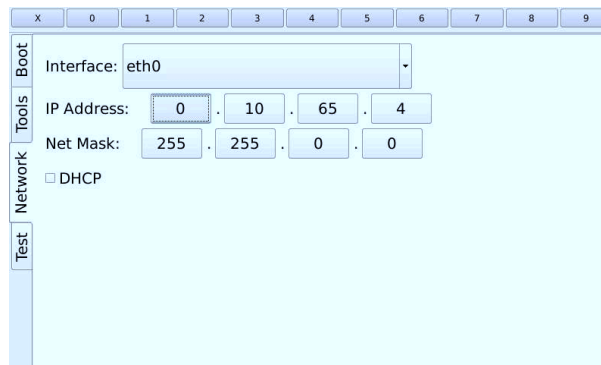


Figure 7.16: Numeric panel

### 7.4.4 TEST TAB

From this tab the user can test the speaker.

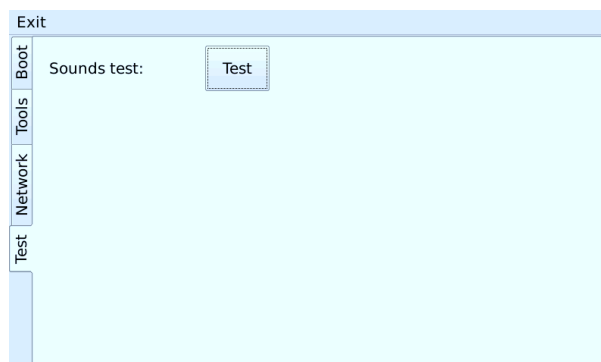


Figure 7.17: Test tab

## 8 STORAGE AND DISPOSAL

### 8.1 PACKING

Please retain the original packaging. The packaging is required for storing the MG15 and for shipping it to an authorized PREVAC service center.

### 8.2 STORAGE

The MG15 should only be stored in a dry room. The following requirements must be met:

| PARAMETER           | VALUE  |
|---------------------|--|
| Ambient temperature | -20...50°C   |
| Humidity            | As low as possible. Preferably in an air-tight plastic bag with a desiccant. |

Table 8.1: Storage parameters

### 8.3 DISPOSAL

The product must be disposed of in accordance with the relevant local regulations for the environmentally safe disposal of systems and electronic components.

# 9 APPENDIX

## 9.1 DIP SWITCH ADDRESSING

| ADDRESS                | DIP SWITCH ON | ADDRESS | DIP SWITCH ON |
|------------------------|---------------|---------|---------------|
| 1                      | 1             | 33      | 1, 6          |
| 2                      | 2             | 34      | 2, 6          |
| 3                      | 1, 2          | 35      | 1, 2, 6       |
| 4                      | 3             | 36      | 3, 6          |
| 5                      | 1, 3          | 37      | 1, 3, 6       |
| 6                      | 2, 3          | 38      | 2, 3, 6       |
| 7                      | 1, 2, 3       | 39      | 1, 2, 3, 6    |
| 8                      | 4             | 40      | 4, 6          |
| 9                      | 1, 4          | 41      | 1, 4, 6       |
| 10                     | 2, 4          | 42      | 2, 4, 6       |
| 11                     | 1, 2, 4       | 43      | 1, 2, 4, 6    |
| 12                     | 3, 4          | 44      | 3, 4, 6       |
| 13                     | 1, 3, 4       | 45      | 1, 3, 4, 6    |
| 14                     | 2, 3, 4       | 46      | 2, 3, 4, 6    |
| 15                     | 1, 2, 3, 4    | 47      | 1, 2, 3, 4, 6 |
| 16                     | 5             | 48      | 5, 6          |
| 17                     | 1, 5          | 49      | 1, 5, 6       |
| 18                     | 2, 5          | 50      | 2, 5, 6       |
| 19                     | 1, 2, 5       | 51      | 1, 2, 5, 6    |
| 20                     | 3, 5          | 52      | 3, 5, 6       |
| 21                     | 1, 3, 5       | 53      | 1, 3, 5, 6    |
| 22                     | 2, 3, 5       | 54      | 2, 3, 5, 6    |
| 23                     | 1, 2, 3, 5    | 55      | 1, 2, 3, 5, 6 |
| 24                     | 4, 5          | 56      | 4, 5, 6       |
| 25                     | 1, 4, 5       | 57      | 1, 4, 5, 6    |
| continued on next page |               |         |               |

| continued from previous page |               |       |                  |
|------------------------------|---------------|-------|------------------|
| ADRES                        | DIP SWITCH ON | ADRES | DIP SWITCH ON    |
| 26                           | 2, 4, 5       | 58    | 2, 4, 5, 6       |
| 27                           | 1, 2, 4, 5    | 59    | 1, 2, 4, 5, 6    |
| 28                           | 3, 4, 5       | 60    | 3, 4, 5, 6       |
| 29                           | 1, 3, 4, 5    | 61    | 1, 3, 4, 5, 6    |
| 30                           | 2, 3, 4, 5    | 62    | 2, 3, 4, 5, 6    |
| 31                           | 1, 2, 3, 4, 5 | 63    | 1, 2, 3, 4, 5, 6 |
| 32                           | 6             |       |                  |

Table 9.1: DIP Switch Addressing