USER MANUAL

IS40-PS

ION SOURCE POWER SUPPLY

PREVAC

OPERATING MANUAL

English translation

IS40-PS

ION SOURCE POWER SUPPLY

Document no. 1023549

Rev. 1

Febuary 2021

Firmware version 3.5

Precision and Vacuum Technology

Contents

List of Tables

List of Figures

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 IS40-PS device.

1.1 INFORMATION ABOUT VERSION - RELEASE NOTE

Information about IS40-PS device version can be found at *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 TO USE

The IS40 Power Supply (IS40-PS) is a complete control and power supply device designed for the IS40E1 Ion Source or the IS40C1 Ion Source. When configured for use with the IS40E1 Source, the IS40-PS comprises the following basic units:

- Circuit for regulation and stabilization of electron emission current
- Energy, focus and extractor voltages power supply
- Circuit for Ion beam deflector on X-Y plane
- Control and user interface unit

When configured for use with the IS40C1 Source, the IS40-PS comprises the following basic units:

- Electron emission current control and stabilizing unit.
- Energy Power supply unit
- Control and user interface unit

The IS40C1 configuration is primarily used for sample cleaning in UHV applications.

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.

2. Information on possible damage to the device.

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

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

1.3.3 GENERAL SAFETY INSTRUCTIONS

The IS40-PS 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 to 40 °C.
- Maximum relative humidity: 80% (to 31°C), decreased linearly down to max. 50% at 40°C.
- Fluctuations of supply voltage cannot exceed ±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 IS40-PS . Strictly adhere to the stipulated installation and operation data.

Self-configuration of the device.
Self-configuration of the IS40-PS by the user through the service application results in waiver of the PREVAC's liability for proper functioning of the device.

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

1.3.4 GROUNDING

The IS40-PS 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 mm2 (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.

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

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 IS40-PS , which may be rack-mounted or used as a desktop device.

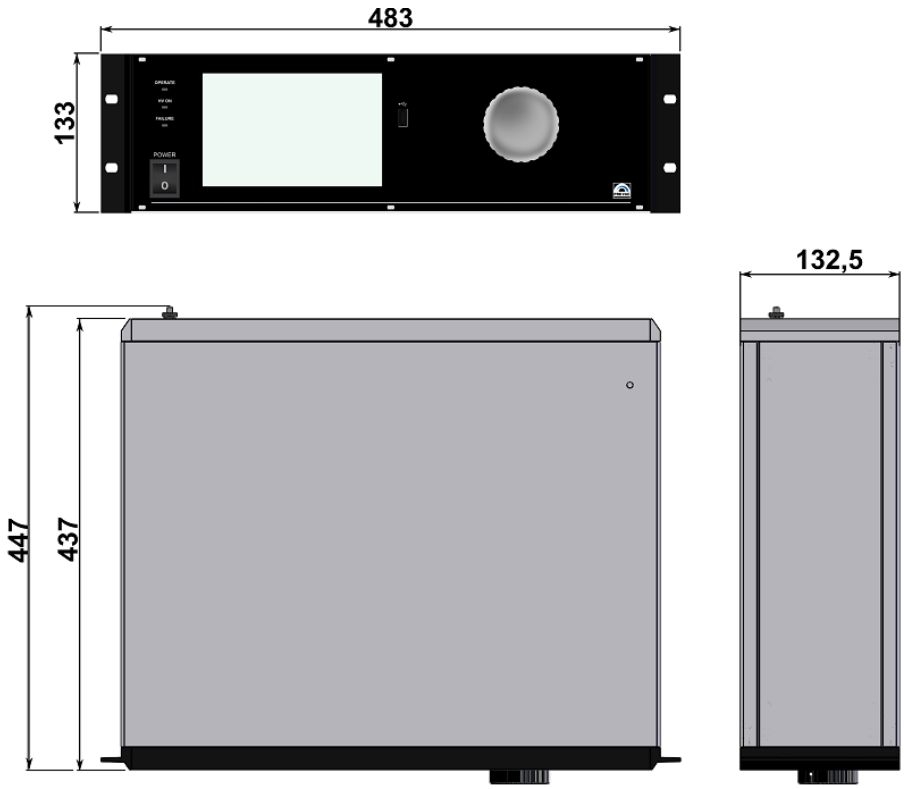


Figure 1.2: Dimensions

1.4.2 SPECIFICATION

PARAMETER	DESCRIPTION
ELECTRICAL PARAMETERS	
Voltage	100-120 VAC/200-240 VAC
Frequency	50 – 60 Hz
Overvoltage category	II
Protection class	1
Connection	European appliance connector IEC 320 C13
Power consumption	Max. 250W
Current consumption	1 A (for 230V) 2 A (for 110V)
Fuse	3,15A
Supply power cord	1.8 m (supplied with the device)
ENVIRONMENT	
Operation temperature	+15 ºC - +45 ºC
Storage temperature	0 - 70°C
Relative humidity	Max. 80% (up to 31°C), decreasing to max. 50% (above 30°C)
Allocation	Use indoors only
MECHANICAL	
Dimensions	Width: 448.8 mm (84HP/19”) Height: 132.5 mm (3HU) Depth: 437 mm
Net weight	9,2kg / 12kg (E)
Installation	Rack mounted or Desktop device
HIGH VOLTAGE OUTPUTS	
Energy Voltage	0 - 5000 V
Emission Current	0.01 - 10 mA
Focus 1 Voltage	0 - 5000 V
Focus 1 Voltage	0 - 5000 V

continued on next page

continued from previous page

PARAMETER	DESCRIPTION
Extractor Voltage	60.0 - 100.0 % related to energy voltage
HV1 Cable length	7.5 m
HV2 Cable length	7.5 m
SCAN PARAMETERS	
Middle point X	-5.00 - 5.00 mm
Middle point Y	-5.00 - 5.00 mm
Scanning area PX	0.00 - 10.00 mm
Scanning area PY	0.00 - 10.00 mm
Time per dot	20 - 30 000 µs
Scan Grid X	0.01 - 2.00 mm
Scan Grid Y	0.01 - 2.00 mm
Sample Angle X	15 - 165°
Sample Angle Y	15 - 165°
Distance Sample S	0.1 - 150. 0 mm
WORKING TIME	
Count UP	Counting in OPERATE mode and displayed value on the screen
Count DOWN	Device operating for a specified period of time from 1 min do 99d23h59
Cathode Working Time	Cathode total operating time,
COMUNICATION	
Comunication Interfaces	RS232, RS485, Ethernet
VACUUM GAUGE INPUT (*)	
Quantity	1
Supported gauges	see table: 1.4.4
ANALOG OUTPUTS (*)	
Quantity	2
Type	0-10V voltage relative to the ground potential
ANALOG INPUTS (*)	
Quantity	2

continued on next page

continued from previous page

PARAMETER	DESCRIPTION
Type	0-10V voltage relative to the ground potential
LOGIC INPUTS	
Quantity	4
Type	Isolated (maximum 50V relative to ground)
RELAY OUTPUTS	
Quantity	6
Type	4 with contact COM i NO - 2A/120VAC or 2A/24VDC 2 with contact COM, NO i NC - 8A/250VAC or 8A/24VDC.
(*) - available as options.	

Table 1.1: Device specification

1.4.3 OPERATION

The device can be controlled in two ways:

- Manually on the display with touch panel.
- Remotely via RS232, RS485 or Ethernet, see chapter 6.

1.4.4 VACUUM GAUGE CHANNEL

Independent vacuum gauge may be connected to the IS40-PS .

PARAMETER	VALUE
PRESSURE CHANNEL:	
Sensor connector	RJ45
Compatible sensors	CTR90/91, TTR90, TTR211/216, PTR225/237, PTR90, ITR90, ITR100, BARATRON, ANALOG-IN, MKS870b, MKS937, MKS937A, PKR251/360/361, PCR280, TPR280/281, PG105, ATMION, IKR360/361
Voltage	Relative to voltage reading: ±0,3%
Absolute	±2 mV
Measuring rate	10 s^{-1}
Display rate	4 s^{-1}
Temperature drift	Temperature drift < 0.1 % per °C
Unit of measurement	mbar, Pa, Torr
Resolution of the A/D converter	24 bit

Table 1.2: Pressure channels specifications

1.4.5 STANDARDS

- The IS40-PS 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.
  - PN-EN 50581:2012 EN 50581:2012 - Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances.
- 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.
  - RoHS 2011/65/UE - Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment Text with EEA relevance.
  - WEEE 2012/19/UE - Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE) Text with EEA relevance.

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 IS40-PS .

   Note: Retain the packaging materials for later use. The IS40-PS must be stored and transported in the original packaging material only.
3. Examine the IS40-PS for completeness.
4. Visually inspect the IS40-PS 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 IS40-PS is designed for installation into a rack according to DIN 41 494 (19", 3 HU) and occupying the whole width of the cassette. Before taking any actions read the safety notes below.

WARNING

Ambient temperature.
Exceeding the maximum permitted ambient temperature may damage the device. Make sure that the maximum permitted ambient temperature is not exceeded and that the air can flow freely through the louvers. Do not expose the device to direct sunlight.

DANGER

Protection class of the rack.
If the product is installed in a rack, it is likely to lower the protection class of the rack (protection from foreign bodies and water) 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 IS40-PS 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 IS40-PS should not be operated at temperatures exceeding 40°C.

2.4 ELECTRICAL INSTALLATION

2.4.1 MAINS CONNECTION

The mains connection is an IEC 320 type connector on the rear side of the unit. A mains cable is supplied with the device. If the plug is not compatible with your wall socket, you should replace it with a suitable mains cable:

- Three-conductor cable with protective ground.
- Conductor cross-section 3x1.5 mm2 or larger.

Figure 2.1: Three-conductor cable with protective ground (example)

DANGER

Mains power.
Improperly grounded devices can be extremely dangerous in the event of a fault. Use three-wire mains or extension cables with protective ground only provided with IS40-PS . Plug the mains cable into wall sockets with protective ground only.

- Connect the European appliance connector of the mains cord with the mains connection 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.

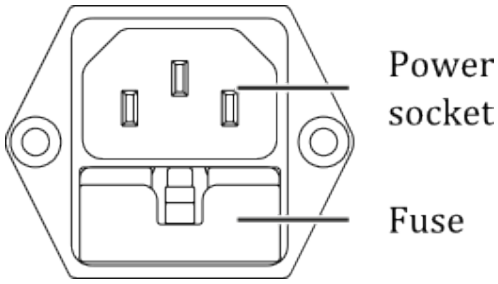


Figure 2.2: Power connector

DANGER

Risk Of Electric Shock - Fuse Replacement
To avoid electrical shock or personal injury, disconnect the power cord before opening the cover on the power entry module.

2.4.2 AC INPUT POWER CONNECTION

The AC (alternating current) power entry module, located in the rear panel of the IS40-PS , provides connection to the power source and a protective ground. It also holds the fuse.

2.4.3 POWER CORD

The IS40-PS comes with a detachable, three-wire power cord for connection to a power source with protective ground. The IS40-PS chassis is connected to the power ground to protect against electrical shock. Always connect to an AC outlet which has a properly connected protective ground. If necessary, or when in doubt, consult a certified electrician.

2.4.4 POWER SWITCH

The power switch is located on the front of the IS40-PS . The switch is a toggle type, marked with **I** and **O**. The **I** (on) position applies the power to the instrument. The **O** (off) position cuts off the power to the instrument. However, turning the power switch off does not fully remove the AC power from inside the instrument.

Always disconnect the power cord from the power entry module to fully remove AC power from inside the instrument.

DANGER

Risk Of Electric Shock
Do NOT use the power switch as a disconnecting device; disconnect the power cord from the power entry module to fully remove hazardous voltage from inside the IS40-PS .

2.5 DEVICE REAR PANEL

This section contains a description of available sockets and connectors on the rear panel.

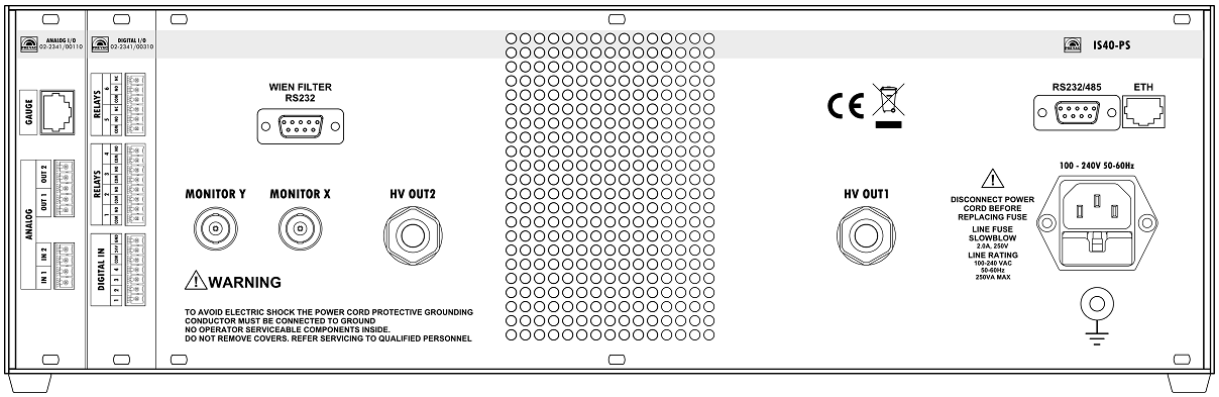


Figure 2.3: Rear view of IS40-PS

2.5.1 HVOUT1 CONNECTOR(C)

The HVOUT1 socket available in basic version of IS40-PS supplies Cathode, Repeller and Anode voltages to Ion source IS 40C1 .

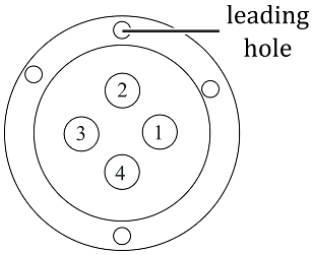


Figure 2.4: HVOUT1 (C) connector - plug view

PIN NUMBER	FUNCTION	DESCRIPTION
1	Cathode	Cathode first pin
2	Repeller	Repeller voltage pin
3	Cathode	Cathode second pin
4	Anode	Anode voltage pin

Table 2.1: HVOUT1 connector pin description

2.5.2 HVOUT1 CONNECTOR (E)

The HVOUT1 socket available in extended version (E) of IS40-PS supplies HV Extractor, Cathode, Repeller and Anode voltages to Ion source IS 40E1 .

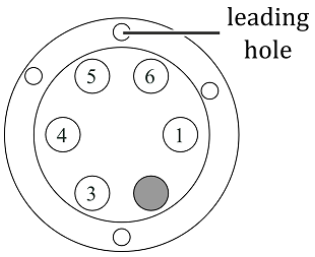


Figure 2.5: HVOUT1 (E) connector - plug view

PIN NUMBER	FUNCTION	DESCRIPTION
1	Extractor	Extractor voltage pin
2	Empty	Pin not used
3	Repeller	Repeller voltage pin
4	Anode	Anode voltage pin
5	Cathode +	Cathode positive pin
6	Cathode -	Cathode negative pin

Table 2.2: HVOUT1 connector pin description

2.5.3 HVOUT2 CONNECTOR (E)

The HVOUT2 socket supplies deflection and focus voltages to ION source. It is only available in extended version (E) of IS40 power supply.

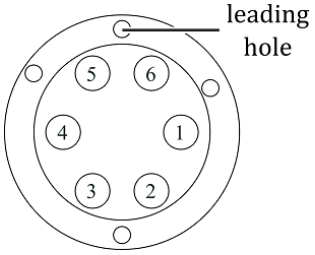


Figure 2.6: HVOUT2 connector - plug view

PIN NUMBER	FUNCTION	DESCRIPTION
1	PosX-	Deflection X negative voltage pin
2	PosX+	Deflection X positive voltage pin
3	PosY+	Deflection Y positive voltage pin
4	Focus 1	Focus 1 pin
5	Focus 2	Focus 2 pin
6	PosY-	Deflection Y negative voltage pin

Table 2.3: HVOUT2 connector pin description

2.5.4 CONNECTOR FOR DEFLECTION CONTROL (E)

The DEFLECTION CONTROL connector is used to control the deflection voltage and to monitor this voltage. If 10V is applied to the *Control X* input, 650V will be applied to the *Position X+* pin of the connector *HV 2* and -650V to the *Position X-* pin. If -10V is applied to the *Control X* input, -650V will be applied to the *Position X+* pin of the connector*HV 2* and 650V to the *Position X-* pin. A similar situation occurs with Y-deflection control. The voltages on *Monitor X/Y* outputs are proportional to the voltages on the *Position X+*/*Position Y+* pins of the *HV 2* connector. The deflection voltage of 650V corresponds to the monitor voltage of 10V. The DEFLECTION CONTROL connector is only available in the extended version (E) of the IS40-PS power supply (only on special request, or until stocks of power supplies without this functionality are exhausted).

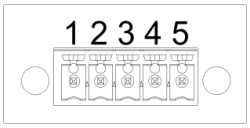


Figure 2.7: Connector for Deflection Control

NUMER PINU	FUNKCJA	OPIS
1	Control X	Control input for deflection voltage X (-10..10V)
2	Control Y	Control input for deflection voltage Y (-10..10V)
3	GND	Ground
4	Monitor X	Reading deflection voltage X (-10..10V)
5	Monitor Y	Reading deflection voltage Y (-10...10V)

Table 2.4: Connector for Deflection Control - description

2.5.5 WIEN FILTER RS232 (E)

The communication interface is designed specifically to connect with the Wien filter power supply (IS40-WPS). It's not possible to connect any other device through this interface. The interface is only available in extended version (E) of IS40-PS power supply.

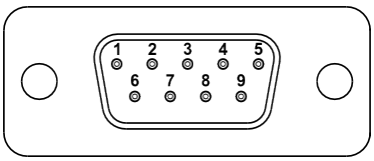


Figure 2.8: Wien Filter interface connector(male)

PIN NUMBER	FUNCTION	DESCRIPTION
2	RX	RS232 - Data signal RX
3	TX	RS232 - Data Signal TX
5	GND	Ground
1,4,6,7,8,9	none	not used

Table 2.5: Wien Filter PS interface connector - pin description

2.5.6 DIGITAL IO CARD

The Digital Input/Output card provides four digital inputs and six relay outputs.

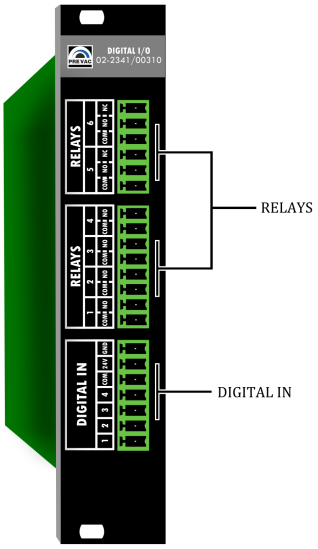


Figure 2.9: DIGITAL IO CARD view

2.5.6.1 DIGITAL IN CONNECTOR

The all digital inputs is active high logic level 24V, to activate single input should be connected as shown in Figure 2.10 below.
Digital IN 1 is reserved for e.g. a vacuum interlock signal from a suitable pressure gauge. The input is active low and should be connected as shown in Figure 2.10 below.
Digital IN 2 is reserved for a remote control signal from a host.

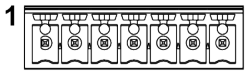


Figure 2.10: Digital In male connector

Interlock protection signal is provided to prevent accidental operation of the device when not under vacuum. If the protection signal is missing (open circuit), the IS40-PS returns to STANDBY mode and displays 'No interlock' message accompanied by a flashing control failure LED.

PIN NUMBER	FUNCTION	DESCRIPTION
1	Master Interlock	The global enable signal to switch the device to *OPERATE* state
2	Digital In 2	Configurable input from the device menu
3	Digital In 3	Configurable input from the device menu
4	Digital In 4	Configurable input from the device menu
5	Digital COM	Reference pin for digital inputs
6	24V	24V power output, the maximum total current can not be greater than 0.5A
7	GND	Ground

Table 2.6: Pin out Digital In description

WARNING

Permission signal

Switching device to *OPERATE* state requires the presence of a signal *MASTER INTERLOCK*. No *MASTER INTERLOCK* signal is indicate by warning message on screen.

Internal diagram of a single digital input shown in Figure 2.11.

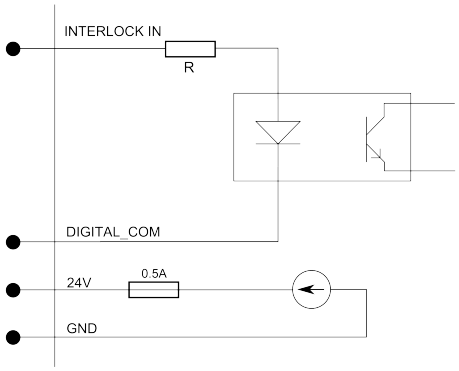


Figure 2.11: Digital in - internal diagram

Examples of control schematics digital inputs.

- Input activated permanently(Fig. 2.12). This connection can be used an initial testing *Digital IN* but is not recommended during normal device operation .
- Activation of the inputs using an external power source (DC supply, PLC, etc.). Allows activate any input by apply 24V relative to *Digital COM* pin .
- Activation input using external relays. Allow control device working state depending on external factors(pressure value, temperature etc.). Shown in figure keys may indicate: vacuum meter relay, bimetallic placed on a vacuum system etc.

WARNING

Digital input maximum voltage
Logic inputs accept signals from a range of 0 to 24 V. Exceeding these values may damage the input and measures should be in place to ensure these limits are not exceeded.

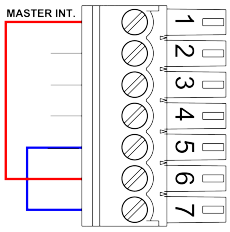


Figure 2.12: Permanently *Interlock*(not recommended)

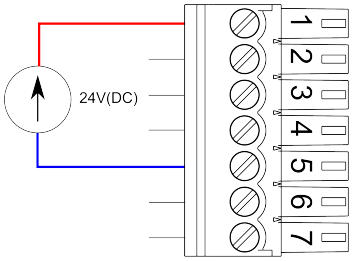


Figure 2.13: Inputs activated by external power supply

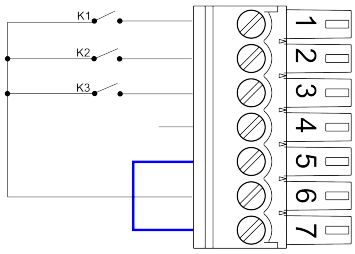


Figure 2.14: *Digital IN* activated by external relays.

2.5.6.2 RELAY OUTPUTS

DIGITAL IO CARD includes six relays outputs:

- four outputs with terminals COM and NO - connector RELAY 1-4,
- two relay outputs with terminals COM, NO and NC - connector RELAY 5 i 6.

The relay outputs pins are physically isolated from the device. The maximum current is limited by the model used relays and is 2 A.

Detailed relay outputs configuration, see 3.4.10.

Figure 2.15: Connector ”RELAYS 1-4”

PIN NUMBER	FUNCTION	DESCRIPTION
1	Relay 1 output	contact COM (common)
2	Relay 1 output	contact NO (normal open), User-defined functions
3	Relay 2 output	contact COM (common)
4	Relay 2 output	contact NO (normal open), User-defined functions
5	Relay 3 output	contact COM (common)
6	Relay 3 output	contact NO (normal open), User-defined functions
7	Relay 4 output	contact COM (common)
8	Relay 4 output	contact NO (normal open),User-defined functions

Table 2.7: Pin out description of connector ”RELAYS 1-4”

WARNING

The maximum current relays.
Output relays are rated for 24 VDC or 120 VAC and 2 A. Proper fusing and adequate wiring isolation and separation should be provided to assure these limits are not exceeded

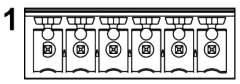


Figure 2.16: Connector ”RELAYS 2”

PIN NUMBER	FUNCTION	DESCRIPTION
1	Relay 5 output	contact COM (common)
2	Relay 5 output	contact NO (normal open), fUser-defined functions
3	Relay 5 output	contact NC (normal close) contact, User-defined functions
4	Relay 6 output	contact COM (common)
5	Relay 6 output	contact NO (normal open), User-defined functions
6	Relay 6 output	contact NC (normal close) contact, User-defined functions

Table 2.8: Pin out description of connector ”RELAYS 5-6”

2.5.7 ANALOG IO CARD (OPTION)

Analog Input/Output card contains analogue inputs, outputs and connection for a suitable vacuum gauge .

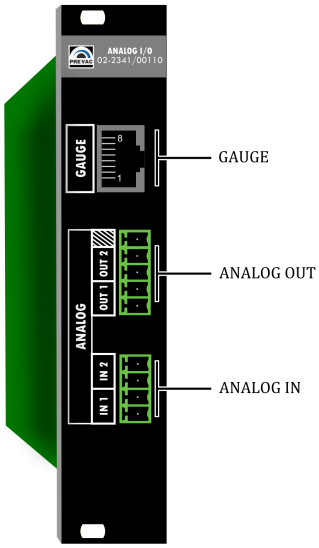


Figure 2.17: Analog I/O overview

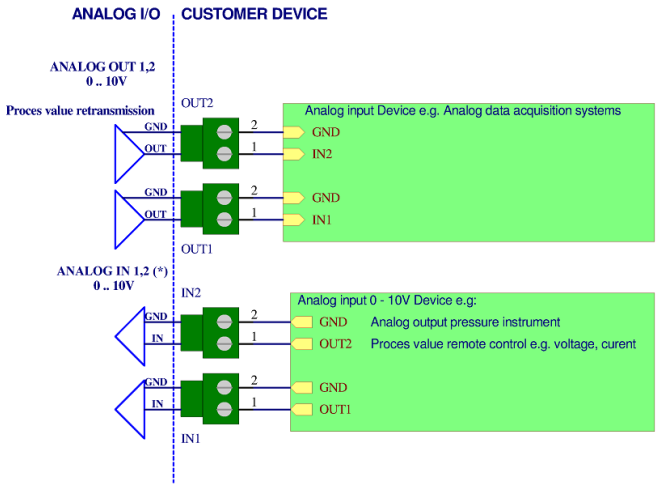


Figure 2.18: Analog Connection

In order to connect a vacuum gauge to the IS40-PS , an appropriate transmitter must be used as described below.

Pin assignment of this connector is shown in Table 2.9:

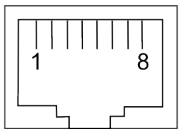


Figure 2.19: RJ45 Gauge connector

PIN NUMBER	FUNCTION	DESCRIPTION
1	24 V DC	Power supply
2	0 V DC	Ground
3	0 - 10 V DC	Analog measurement signal
4	Identification	Gauge type identification signal
5	GND	Signal GND
6	Input signal	CHANNEL STATUS
7	No connect	Not connected
8	24 V	HV ON (emission) steering signal

Table 2.9: Pin assignment of the channel sensors connector

WARNING

Improper transmitter.
Transmitters which are not designed for use with the IS40-PS may damage the device. Operate the IS40-PS with proper transmitters only. See compatible sensors list in Measuring Channel section in Operation chapter.

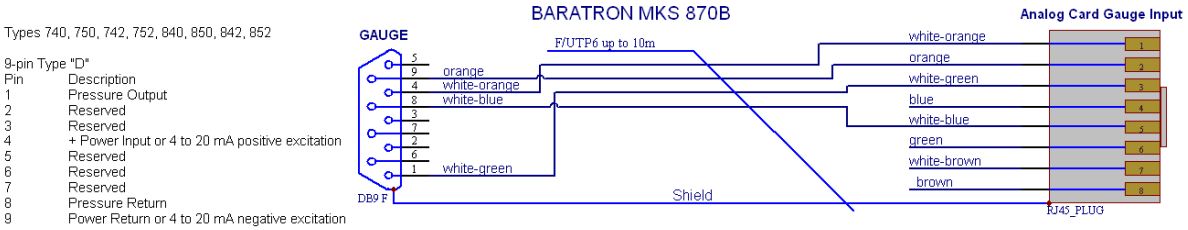


Figure 2.20: Baratron MKS gauge connection

Figure 2.21: Pirani gauge connection

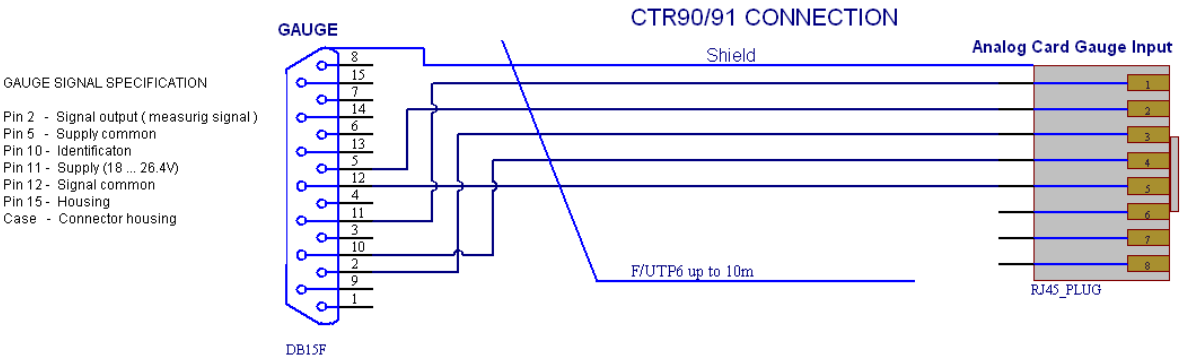


Figure 2.22: CTR90/91 gauge connection

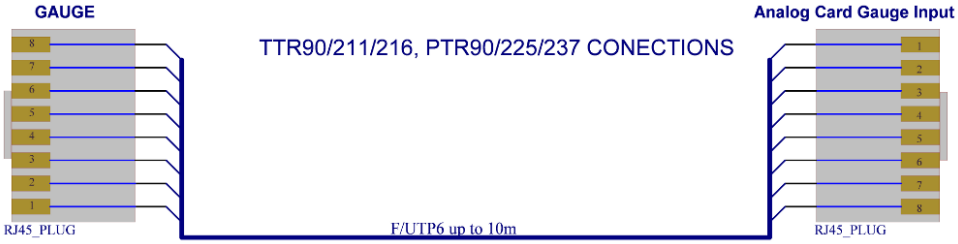


Figure 2.23: TTR/PTR gauge connection

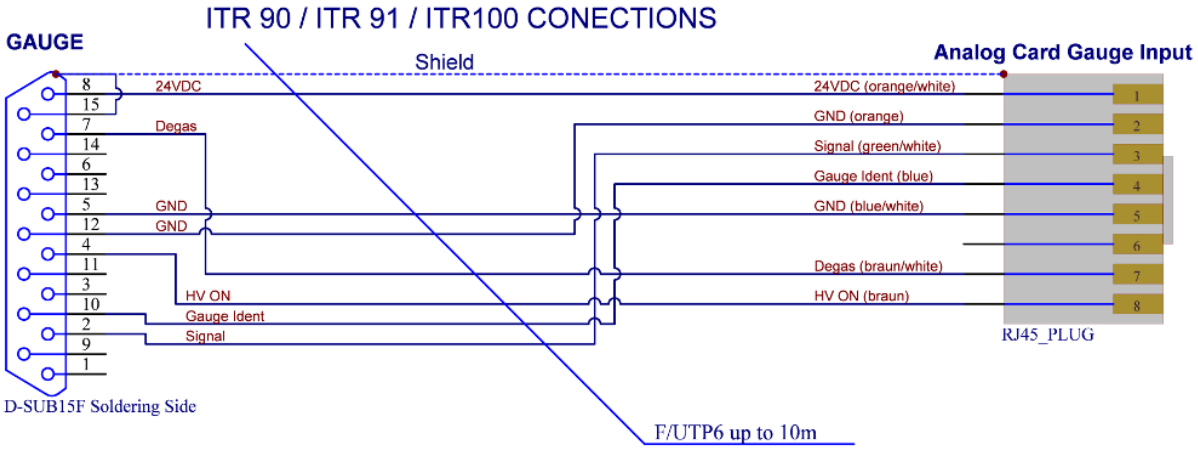


Figure 2.24: ITR gauge connection

2.5.8 REMOTE CONTROL

The device comes supplied with the following communication interfaces:

- Serial interface RS232/RS485 (selected from menu),
- Ethernet interface (IEEE 802 standard),

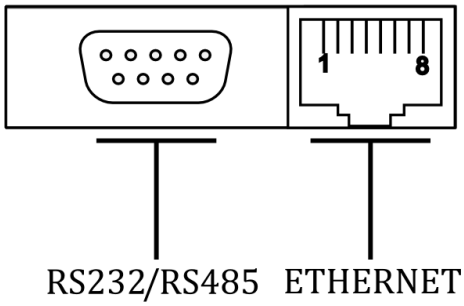


Figure 2.25: Remote control module

The remote interface allows read-back of the device parameters. In order to control and set the device parameters, the device must be switched to the remote control mode.
For a detailed description of the remote interface configuration, please see section 2.5.8

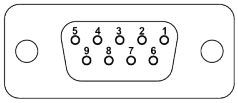


Figure 2.26: Serial interface connector(female 9 pin)

PIN NUMBER	FUNCTION	DESCRIPTION
2	RX	RS232 - Data signal RX
3	TX	RS232 - Data Signal TX
5	GND	Ground
8	D+	RS485 - Data signal positive
9	D-	RS485 - Data signal negative
1,4,6,7	none	not used

Table 2.10: Serial interface connector - pin description

2.6 CONNECTION TO THE ION SOURCE

Connect Ion source to the IS40-PS using the cables supplied with the unit. A sample diagram is shown in the figure 2.27.

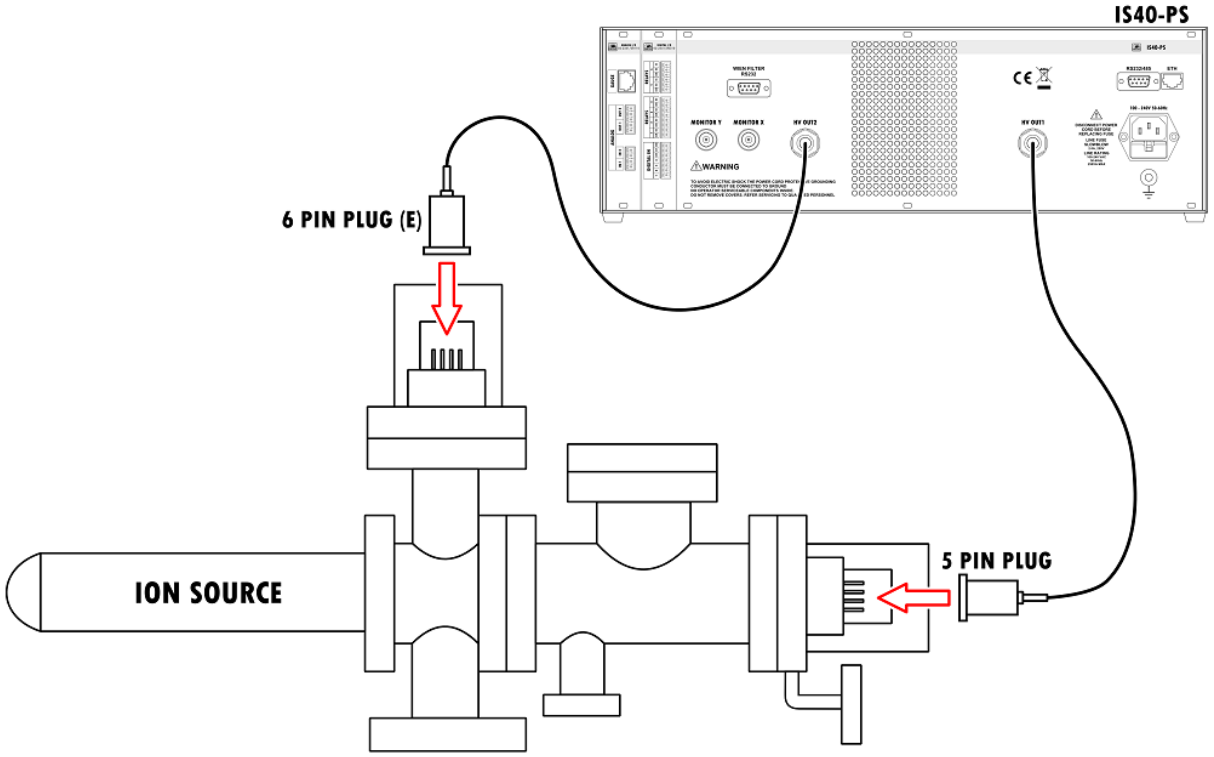


Figure 2.27: Typical Ion source wiring (example)

WARNING

Pressure level in chamber.
The pressure in the vacuum chamber, where the device is installed, must be at the level 5E-6 mbar or lower

3 OPERATING

Interaction with the IS40-PS takes place mainly via the touch panel and encoder. The front panel also contains LED status indicators describing the current state of the power supply.

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 criteria provided in the AC source requirements section. If all the requirements are met, set ***Power Switch*** into ***ON*** position on the front panel.

3.2 FRONT PANEL

There are several principal parts of the IS40-PS user interface:

- LED diode indicators
- Touch panel display
- USB port
- Digital encoder knob for setting parameters
- Power switch
- Back-light logo

The front panel of the IS40-PS is shown in the figure 3.1 below.

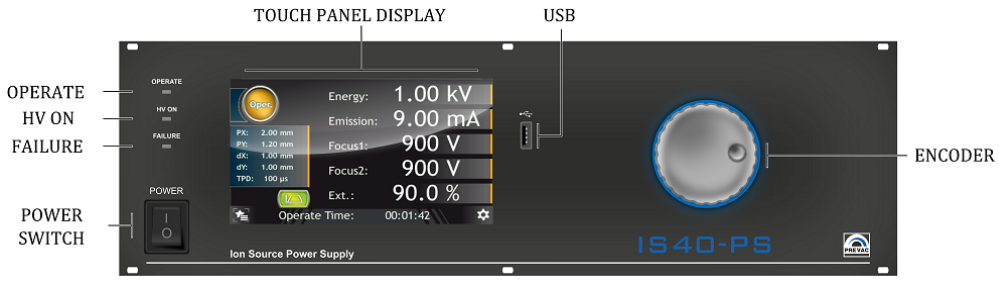


Figure 3.1: Front panel

3.2.1 LED INDICATORS

LED indicators inform about the operating state of the power supply:

- OPERATE – Green diode indicates operate status. Blinking indicates that some of the parameters are still stabilize.
- HV ON – Yellow diode indicates high voltage (> 48V) applied to any output pin,
- FAILURE – Blinking red diode indicates failure of the power supply. Additionally a corresponding failure message is displayed on the touch screen display.

3.2.2 DISPLAY WITH TOUCH PANEL

The device is equipped with a TFT 7inch 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.

3.2.3 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 USER INTERFACE

The IS40-PS is equipped with a color display touch screen. All data and functions are accessible via the menus from this touch screen interface. Every operation must be performed by a tap on screen.

Main view contains 3 elements:

1. Main window
2. Menu – contains device menu from where the user may enter the setup menu, upgrade firmware, show contents of usb stick, etc.
3. Setup shortcut – contains list of favorites setup positions (see section Setup shortcuts)

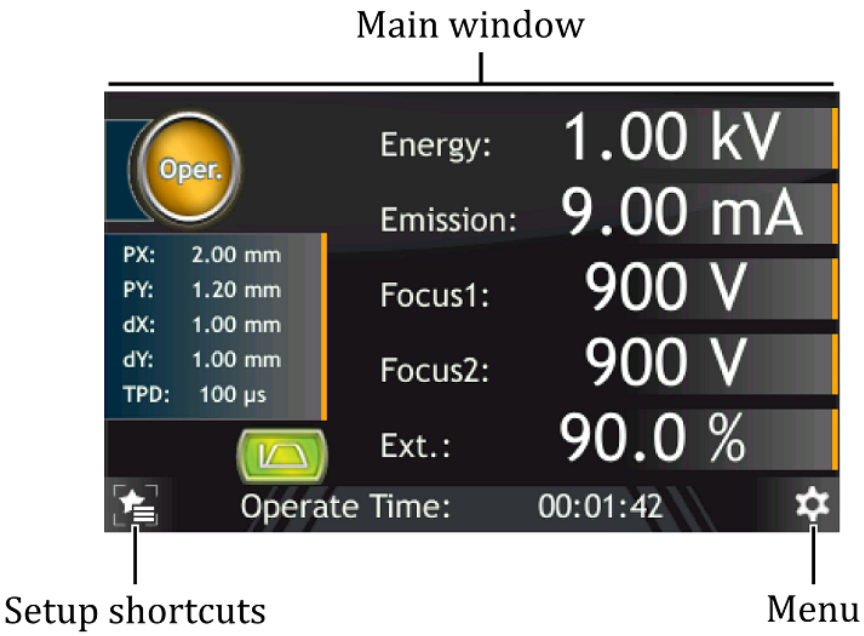


Figure 3.2: Screen main view

3.3.1 MAIN PANEL

The front panel display will vary depending on the device configuration.

3.3.1.1 BASIC VERSION

The device contains one main panel which displays the most important parameters controlled by the device - Energy voltage and emission current. Additionally, the panel shows information on working time or pressure value.

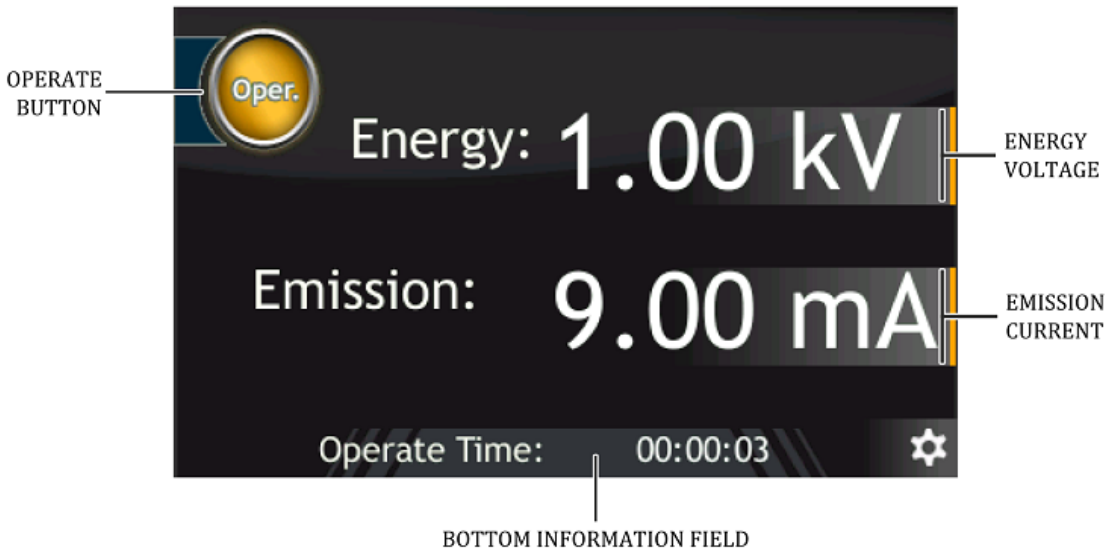


Figure 3.3: Main panel description

- **Operate Button** - Toggles between Operate and Standby Mode

- **Energy voltage value** - Adjustment of energy voltage. Is possible to set energy voltage from 0 kV to 5 kV, by steps of 0,01 kV.
- **Emission Current value** - Adjustment of emission current. Is possible to set emission current from 0,01 mA to 10,00mA by steps of 0,01 mA.

3.3.1.2 EXTENDED VERSION

The device contains one main panel which displays the most important parameters controlled by the device(Energy voltage, emission current, focus voltages, scan postision, TPD etc.). Additionally, the panel shows information on working time, pressure value and Wien filter status.

Because the number of displayed parameters is quite large , the main panel is divided into two group:

- Ion Source supply parameters - Energy voltage, emission current, focus 1,2 voltage and extractor voltage,
- Ion Source scan parameters - PX voltage, PY voltage, dX voltage, dY voltage and TPD.

The parameters for one group are displayed in the main area and can be edited from there. The parameters of the second group are displayed in the preview area. Switching betweenparameter groups is achieved by tapping on the ***Parameters preview*** area see fig. 3.4

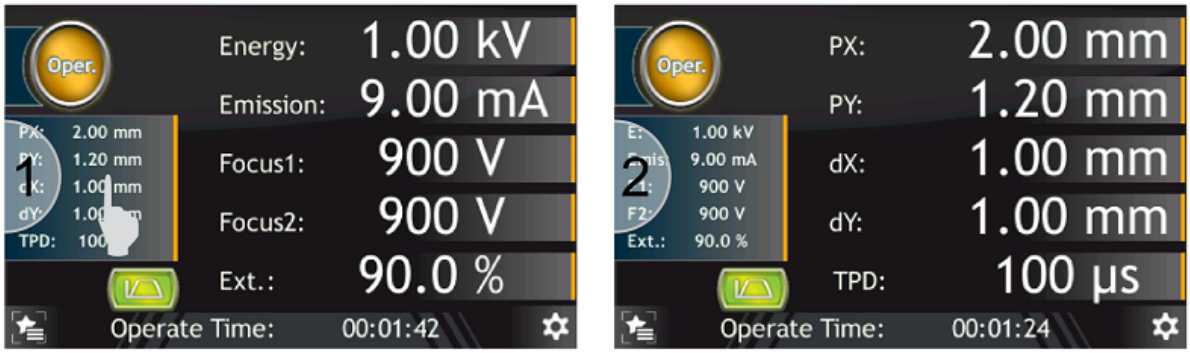


Figure 3.4: Main panel - switching group parameters

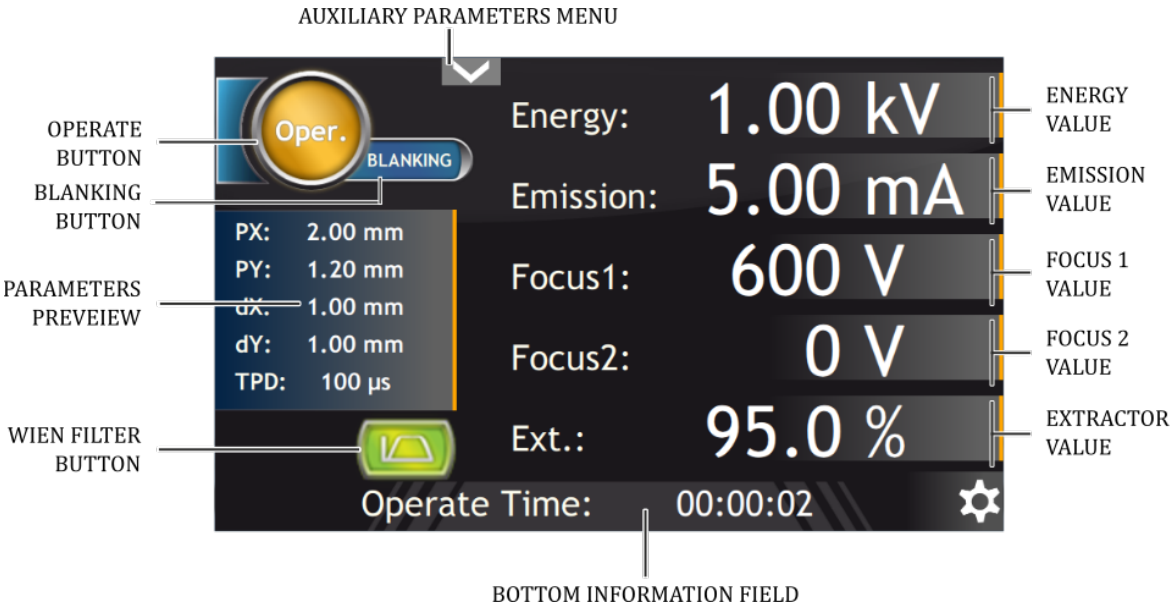


Figure 3.5: Main panel description - Ion Source supply parameters

- **Operate Button** - the button toggles between Operate and Standby Modes.
- **Blanking Button** - The button causes the ion beam to deflect outside the scanning area. This is done by applying the maximum deflection voltage. The blanking beam circulates on the edge of the area resulting from the maximum deflection voltages that can be obtained.
- **Energy voltage value** - Adjustment of energy voltage. Is possible to set energy voltage from 0 kV to 5 kV, by steps of 0,01 kV.
- **Focus 1 voltage** - Adjustment of first focus voltage. Is possible to set first focusing voltage from 0V to current value of energy voltage, in steps of 1V. The value can be displayed in V or kV (default V)
- **Focus 2 voltage** - Adjustment of first focus voltage. Is possible to set second focusing voltage from 0V to current value of energy voltage, in steps of 1V. The value can be displayed in V or kV (default V)
- **Extractor voltage** - allows to set extractor voltage from value 60,0% to 99,9% related to energy voltage, by steps of 0,1%.
- **Horizontal Deflection voltage PX** - set horizontal deflection of middle point of ion beam scanning area. Horizontal deflection values can be set within range -5,00mm to 5,00mm in steps of 0,01mm. If set value of horizontal deflection together with dimensions of ion beam scanning area exceeds physical values of deflection possibilities, warning information message appears: **"SCAN X OVERFLOW"**
- **Vertical Deflection voltage PY** - set vertical deflection of middle point of ion beam scanning area. Vartical deflection values can be set within range -5,00mm to 5,00mm in steps of 0,01mm. If set value of horizontal deflection together with dimensions of ion beam scanning area exceeds physical values of deflection possibilities, warning information message appears: **"SCAN Y OVERFLOW"**
- **Horizontal scanning area dX** - allows to define horizontal dimensions of ion beam scanning area. Dimension of horizontal area can be set within range 0,00mm to 10,00mm. If adjusted

value of horizontal together with PX deflection value exceeds physical values of deflection possibilities, warning information message appears: **"SCAN X OVERFLOW"**.

To remove this message, the user must reduce the dimensions of the scanning area, or move scanning area closer to middle point (PX(0,00mm) and PY(0,00mm)).

- **Vertical scanning area dY** - allows to define vertical dimensions of ion beam scanning area. Dimension of vertical area can be set within range 0,00mm to 10,00mm. If adjusted value of vertical together with PY deflection value exceeds physical values of deflection possibilities, warning information message appears: **"SCAN Y OVERFLOW"**

  To remove this message, the user must reduce the dimensions of the scanning area, or move scanning area closer to middle point (PX(0,00mm) and PY(0,00mm)).

- **TPD(Time per dot) value** - allows to set dwell time on dot from value from 20µs to 30ms. This is the time during which the ion beam stays at one position before moving to the next position. The number of dots per scan line depends on the scanning area and scanning grid parameters. If the total dots is assigned over the whole scanning area then the total scan time is given by the number of dots multiplied by the Time Per Dot.// For example, scanning rectangular area 5x5mm with grid value 0,1mm in both directions, with TPD 3 ms, gives a scan time equal to (2000 dots)·(3ms) = 7.5s.

  The relationship between scan parameters and the sample scan procedure is show on fig. 3.6. For detailed information about Ion Source geometry parameters see section 3.4.5

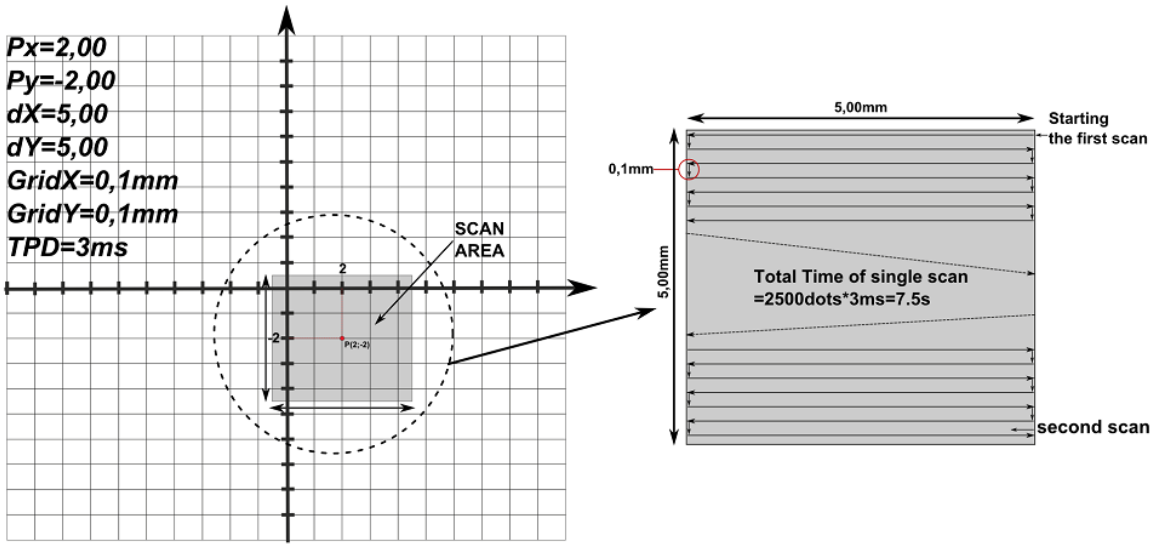


Figure 3.6: Scan parameters - example 1

- **Wien Filter Button** - If Wien filter is disabled the button is hidden. If the Wien filter option is enabled the button informs about the actual status of connected IS40-WPS device.
  -  - wien filter is enabled and connection between IS40 and IS40-PS-WPS is correct.
  -  - wien filter is enabled but there is no communication with the IS40-WPS device.

  Tap the ***Wien filter button*** in order to display Wien filter menu and change settings.

- **Bottom information field** - A field that displays the ***Operate time*** (default) or pressure value

  - **Operate time** - displays time in OPERATE mode, depending on settings in Operate time configuration menu.
  - **Pressure value** - displays the vacuum measurement, depends on settings in Pressure menu. *In order to measure the vacuum this device must be equipped with analog card.* Configuring gauge input see 3.4.7.

- **Auxiliary Parameters Menu** - It is used to display additional parameters that do not fit on the main screen and that the user wants to observe. The parameters are displayed in the form of windows that can be dragged anywhere on the screen so as not to obscure the areas that the user wants to see.

At any time you can switch the screen view by clicking on the preview box parameters.

3.3.1.3 Value controled by Analog Input

If the analog input has been configured to control the power supply, an icon AN IN CTRL will appear under the parameter name. Indicating that the parameter is controlled from the analog input. In this mode it is not possible to change the parameter from the panel level.

Figure 3.7: Value controled by analog input

In Standby mode, the displayed value corresponds to the setpoint via the analog input.
Analogue inputs configuration is based on information included in section 3.4.10.4

3.3.2 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. 3.8.
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).

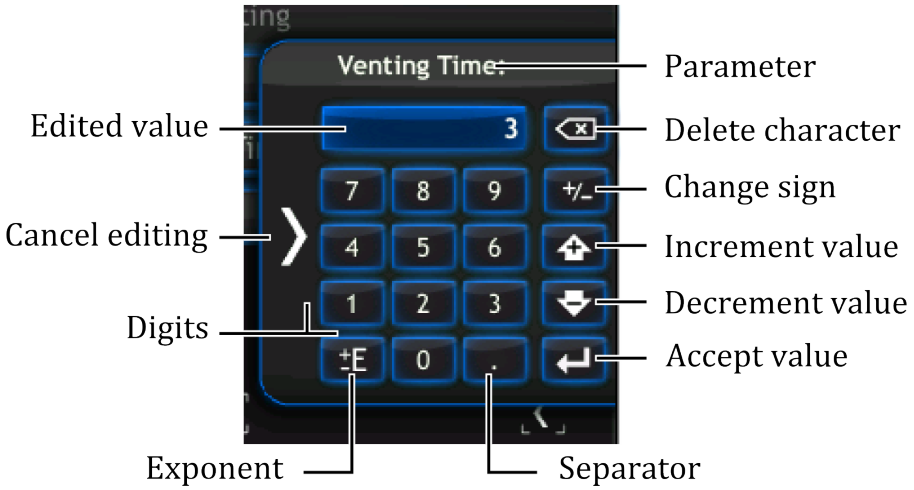


Figure 3.8: Numeric keypad

6. Value is decrement.
7. Confirm the value with the ***Confirm value*** key.

Figure 3.9: 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 3.8 Figure).
5. Confirm the value with the ***Accept value*** key.

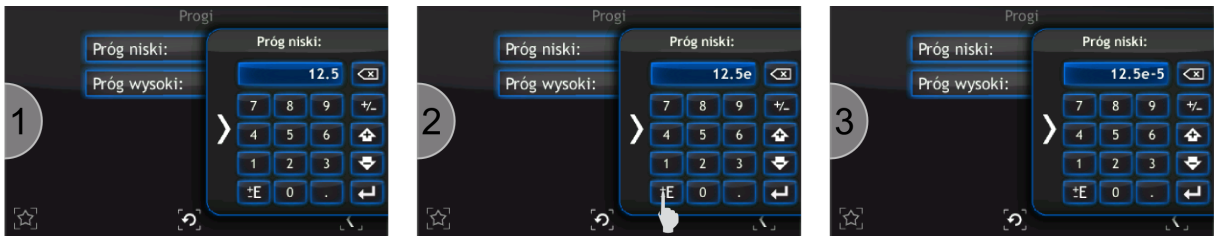


Figure 3.10: Number in exponential form

3.3.3 ALPHANUMERIC KEYPAD

The on-screen keyboard is used for entering alphanumeric data and also facilitates text entry. Figure 3.11 shows the alphanumeric keyboard with description of the main keys.

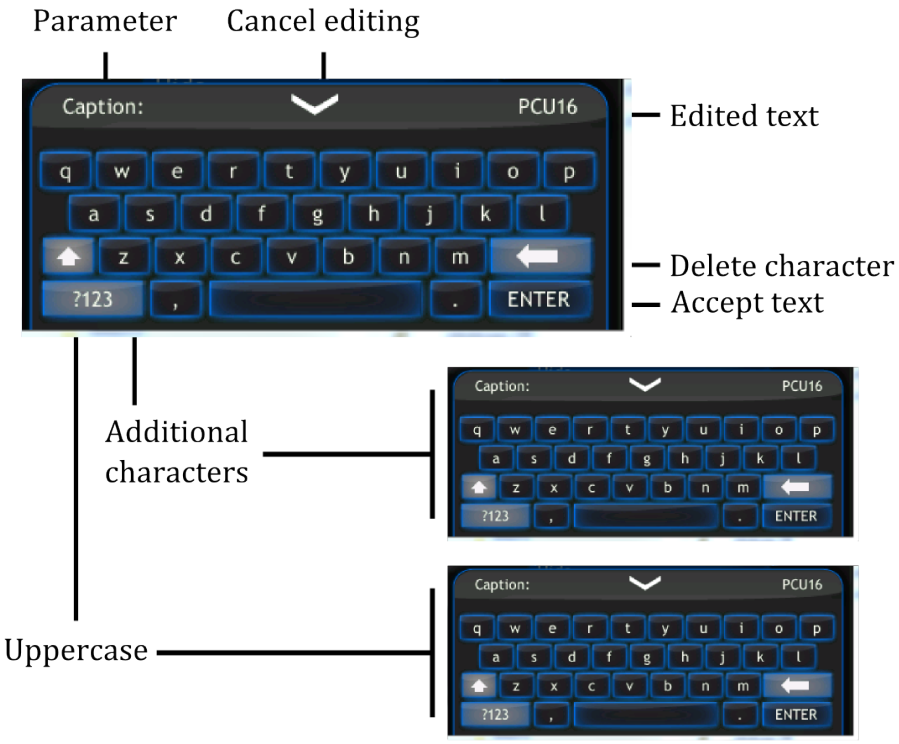


Figure 3.11: Alphanumeric keypad

3.3.4 DEVICE INTERACTION

To change the displayed measurement units:

1. Tap on pressure units to change.
2. Select target units.
3. Value in new units is displayed.

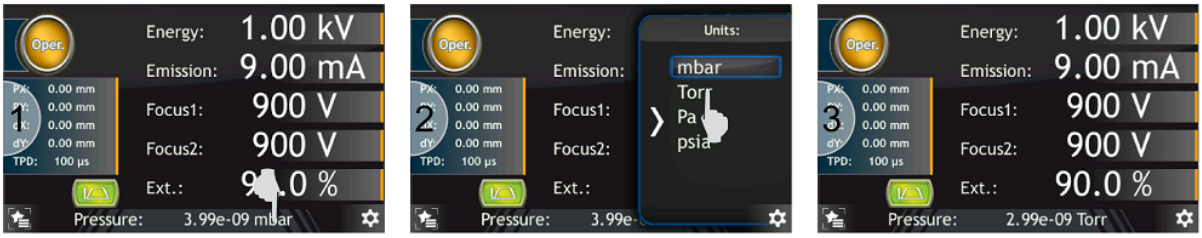


Figure 3.12: Changing displayed measurement units

3.3.5 OPERATING KNOB

Every input value can be modified using the knob located on the front panel. The Knob can be used to change values in both the main windows and setup menu.
Every value in the main window with an orange line can be modified (e.g. U_{source}). Changing the U_{source} value by this method is described by the figure below.

1. Tap $Energy$ value. After tapping, the $Energy$ value will blink
2. Turn knob to change value
3. Tap again on $Energy$ value to disable value editing

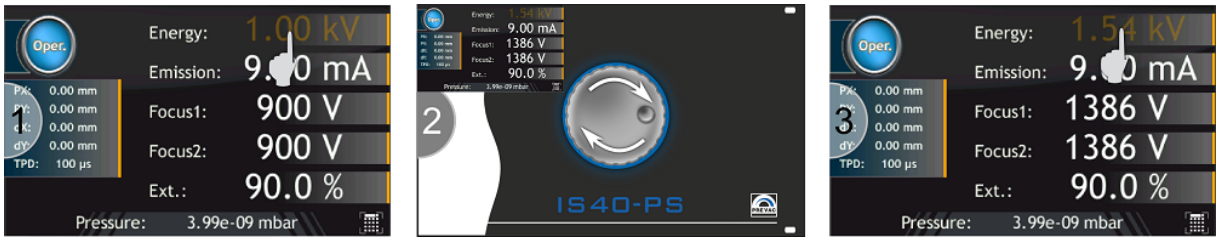


Figure 3.13: Changing $Energy$ value using knob

Each value can also be modified by using the numeric keyboard. In order to display the numeric keyboard:

1. Tap value to edit (e.g. $Energy$),
2. Tap numeric keyboard button (see figure below),
3. For more information about numeric keyboard see *Numeric keyboard* section,

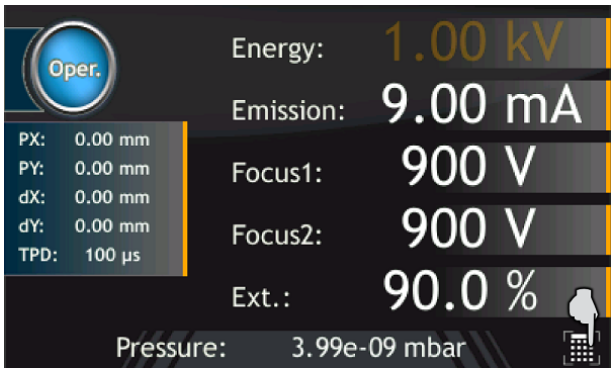


Figure 3.14: Editing value by numeric keyboard

3.3.6 SETUP

Advanced configuration of the device parameters is possible via the setup menu. Tap the menu icon to expand the menu and then tap device setup icon (see Figures 3.15 - 3.16).

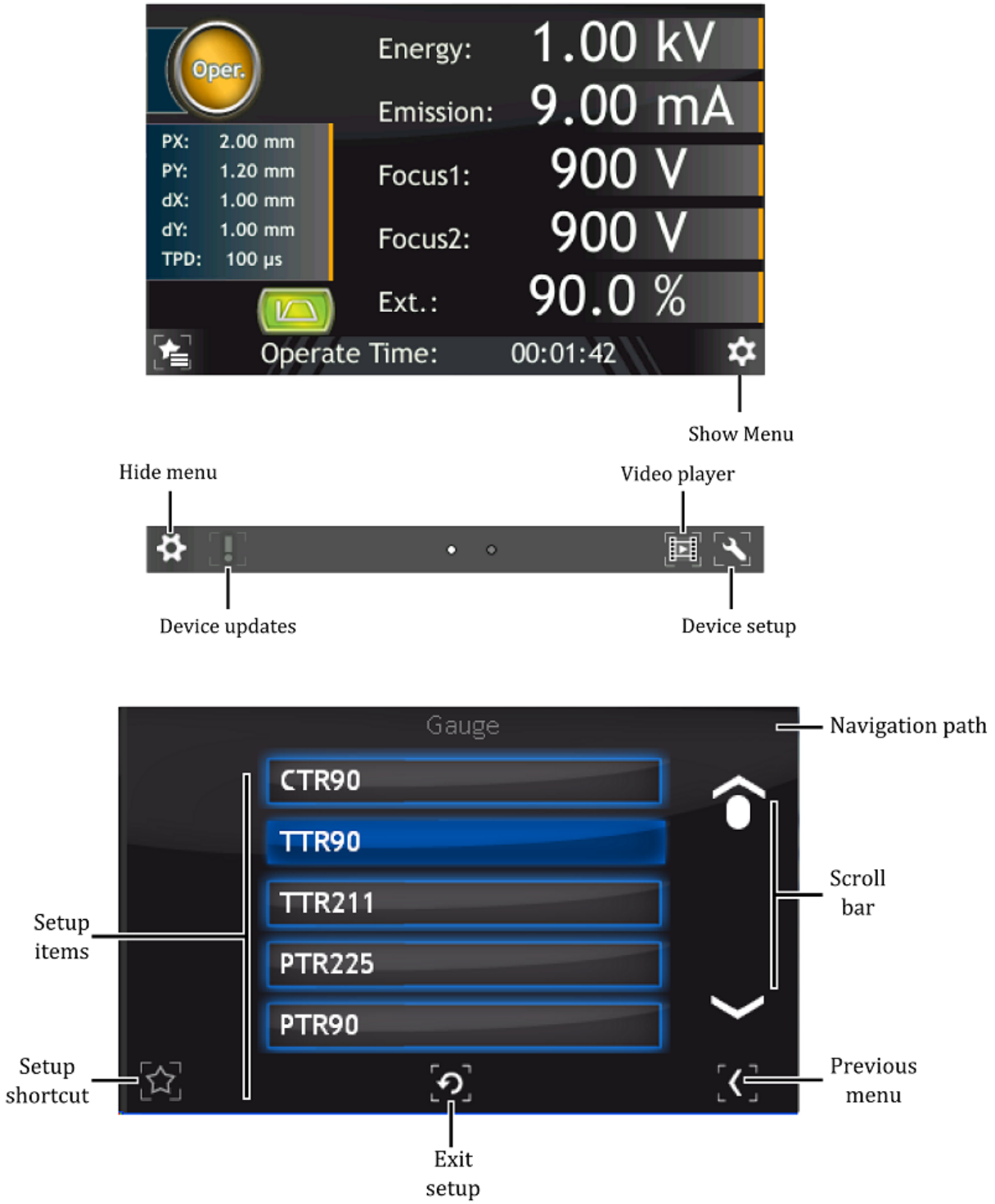


Figure 3.15: Device setup

Figure 3.16: Navigating the setup (example)

3.3.7 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.

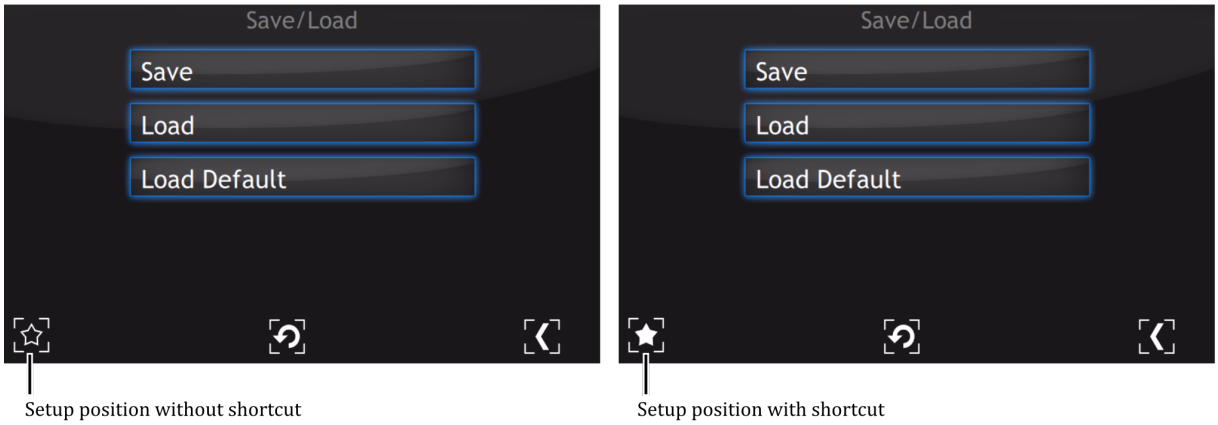


Figure 3.17: Set up shortcut in the setup menu

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 3.18: Example use of shortcut

3.3.8 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 00h:00m:01s to 23h:59m:59s. 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.

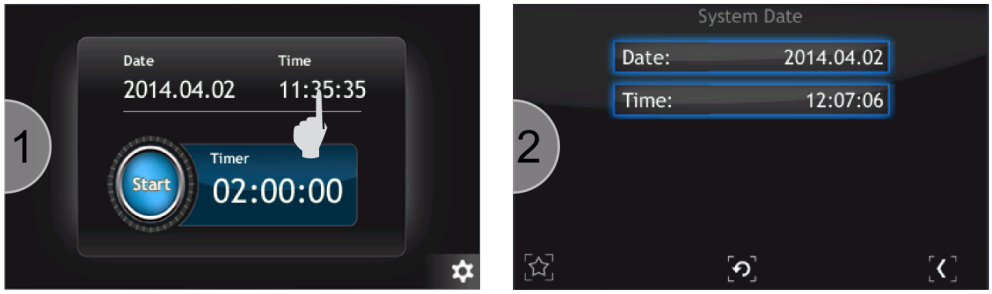


Figure 3.19: Entering system date

3.3.8.1 TIMER SETTING

To set the timer carry out the following operations:

1. Press the ***timer field***.
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

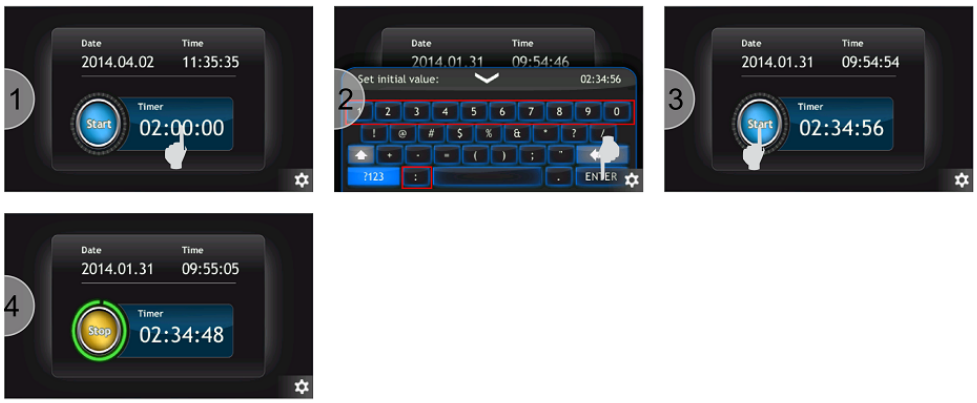


Figure 3.20: Timer setting

3.3.9 MESSAGES

The IS40-PS will automatically display both warning and error messages as appropriate.

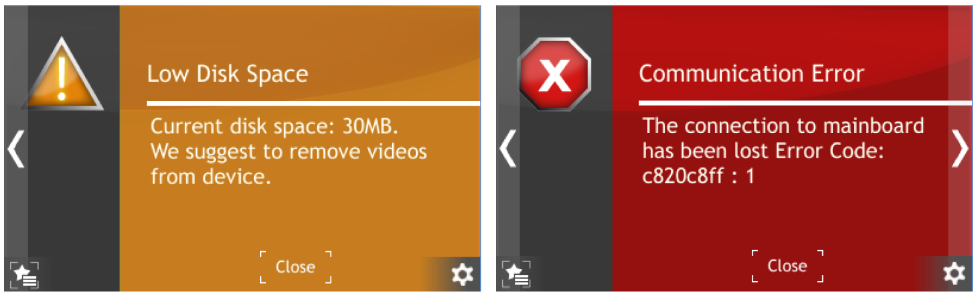


Figure 3.21: Example warning and error messages.

3.3.9.1 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 3.22). 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.

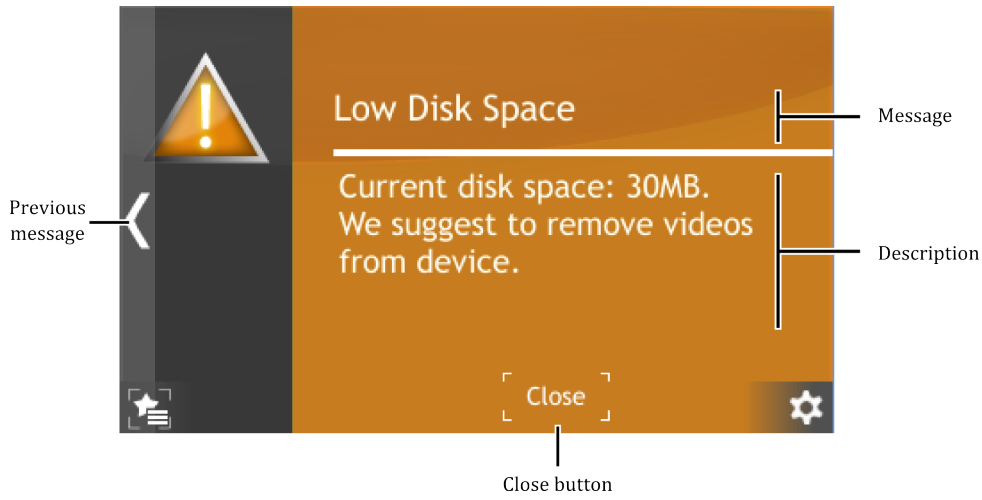


Figure 3.22: Warning message

3.3.9.2 ERROR MESSAGES

Error messages inform about critical events. The message is displayed in full screen (see Figure 3.23). 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.

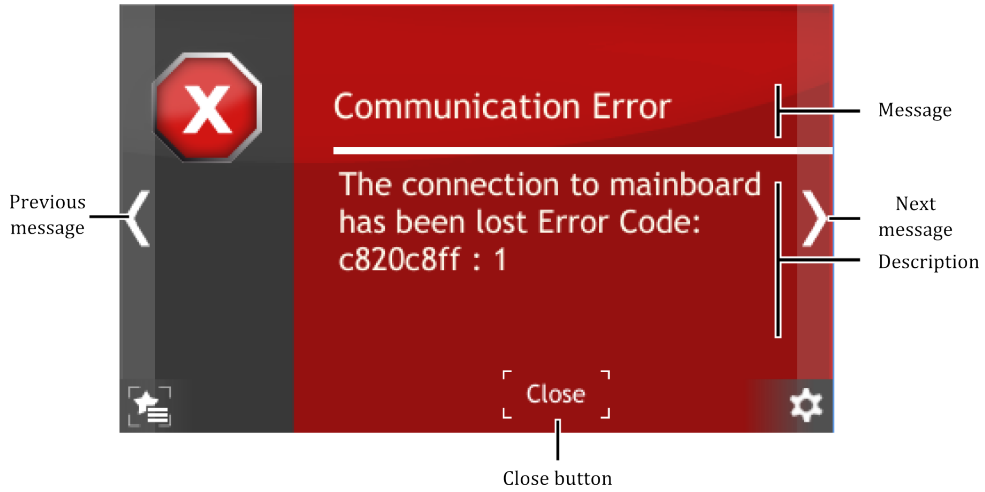


Figure 3.23: Error message

3.3.9.3 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.

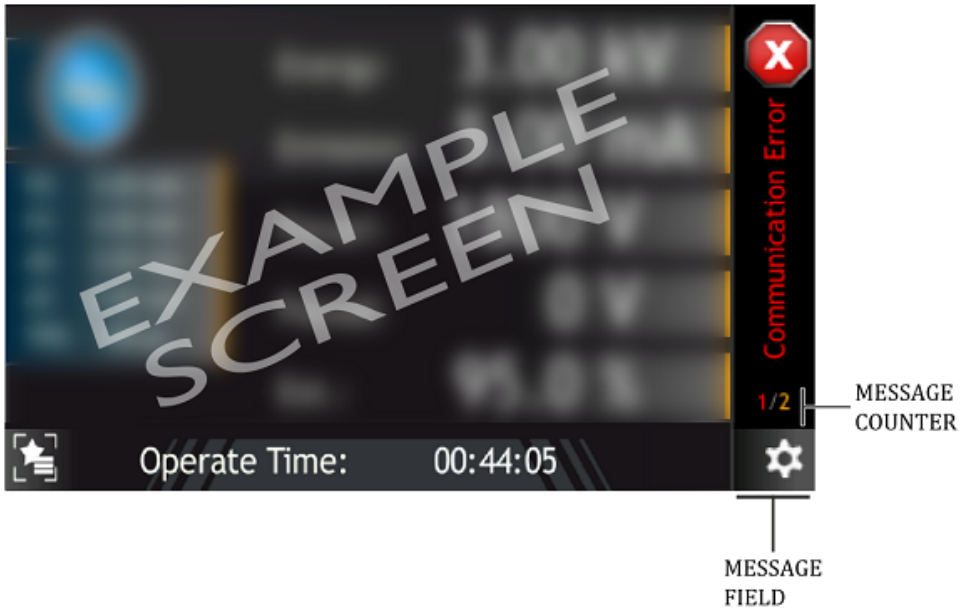


Figure 3.24: Multiple messages

3.3.10 VIDEO PLAYER

The IS40-PS 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***.

3.3.10.1 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 3.25).

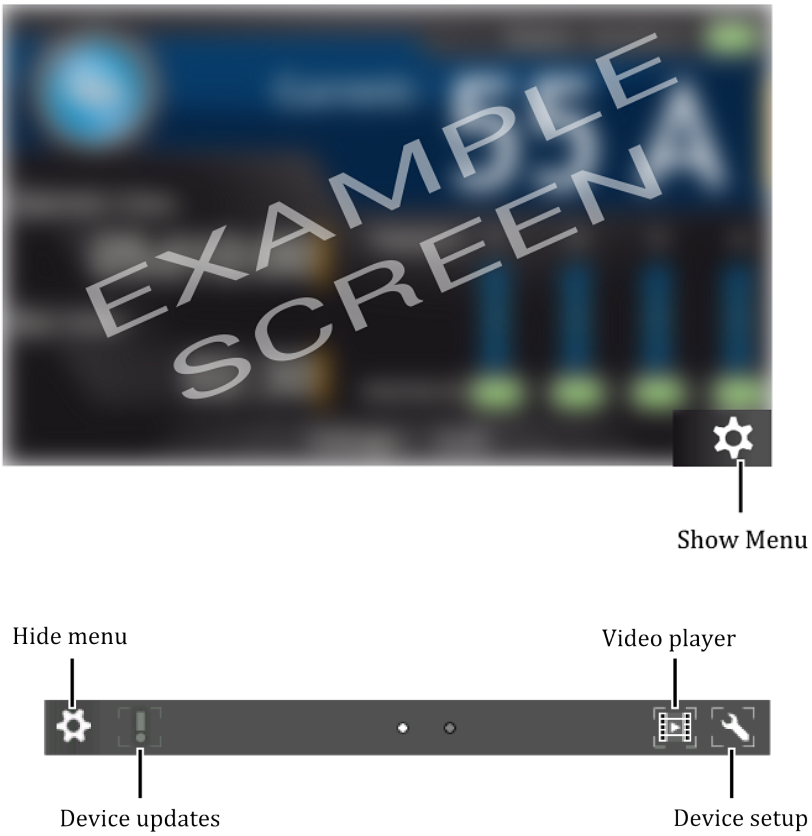


Figure 3.25: Menu bar - video player

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

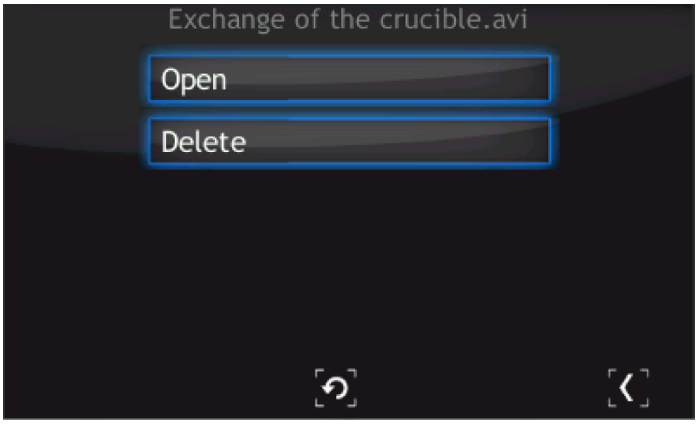


Figure 3.26: Video player - menu

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***.

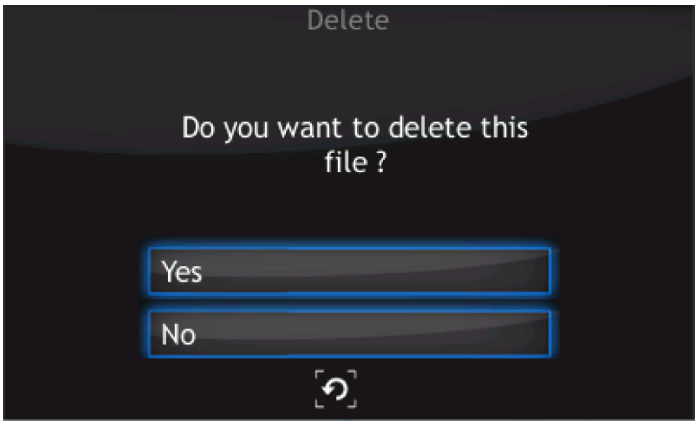


Figure 3.27: Deleting a video file

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:

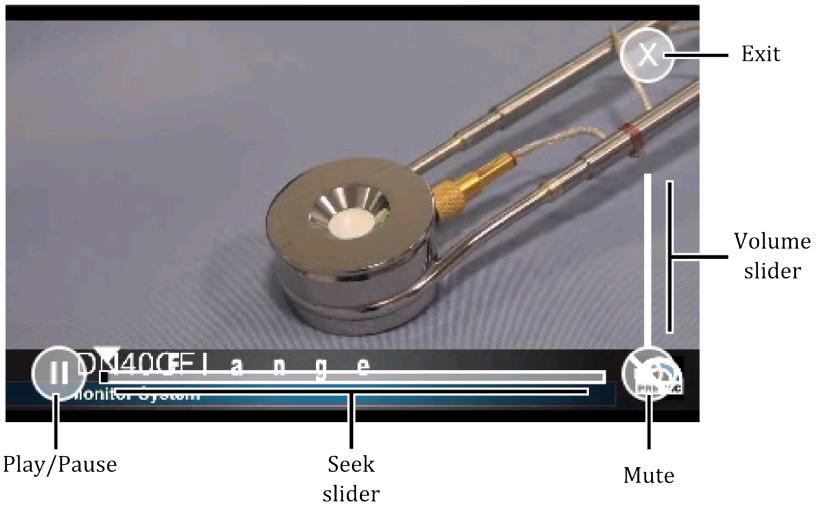


Figure 3.28: Video player

3.3.10.2 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 3.30).

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.

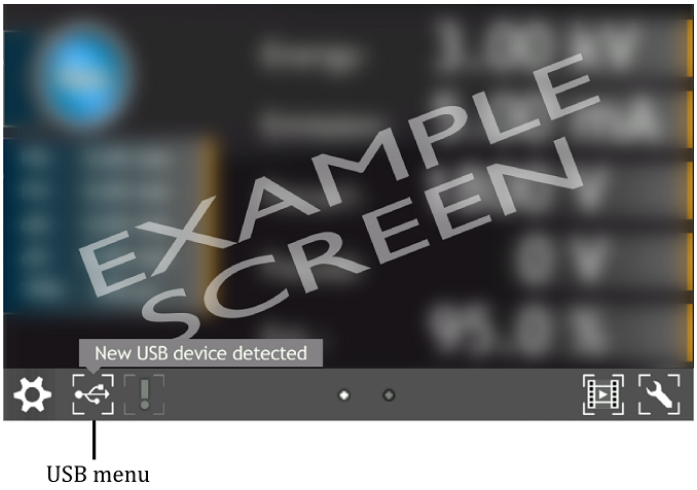


Figure 3.29: Notification about detecting USB

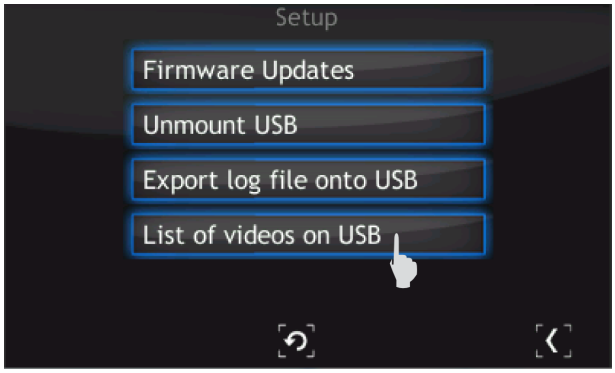


Figure 3.30: USB menu - list of videos on USB

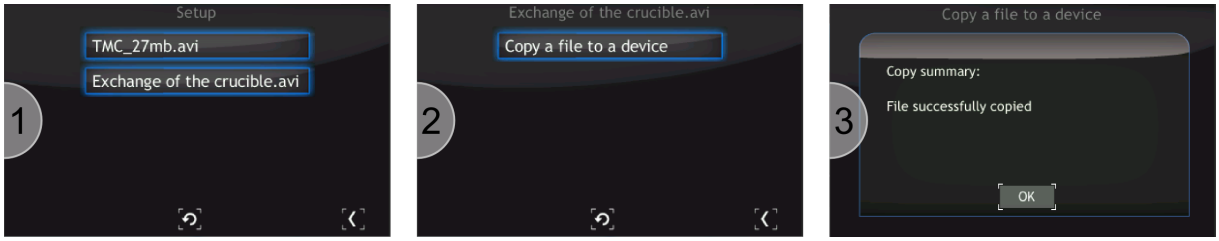


Figure 3.31: Copy *.avi to device

3.4 SETUP MENU

Allows access to the device configuration options such as geometry, communication, etc. To store the changes, save them in accordance with instructions from the section 3.4.13.

3.4.1 SETUP TREE

- Degas
  - Time
  - Degas
- Operate Time
  - Direction
  - COUNT UP

- COUNT DOWN
- Time
- Seconds
- Minutes
- Hours

• Wien Mass Filter
- Wien state
- Enable
- Disable
- Plate Control
- Auto
- Manual
- Gas Type
- He
- Ne
- Ar
- Xe
- Magnet Type
- 0.04T
- 0.24T
- Plate Potential
- Lens In Voltage
- Lens Out Voltage

• Geometry Parameters
- Scan Grid X
- Scan Grid Y
- Sample Angle X
- Sample Angle Y
- Dist. Sample S

• Cathode Work Time
- Work Time
- Reset

• Pressure Channel
- Setpoints
- Setpoint Low
- Setpoint High
- Unit
- mbar
- Torr
- Pa
- psia
- Gauge
- CTR90
- Range...
- TTR91
- TTR211
- PTR225
- PKR251/360/361
- PCR280/TPR28x
- PTR90
- ITR90

- ITR100
- Baratron
  - Range...
- ANALOG IN
- MKS 937A
- PG105
- MG13/14
- ATMION
- IKR360/361

- Gas Type
  - Air
  - He
  - Ne
  - Ar
  - Kr
  - Xe
  - H2
  - CO
  - Define
- Filter
  - Low
  - Medium
  - High
- Degas
  - Time
  - Degas

• Vacuum Interlock

• Inputs Settings

- Digital Inputs
  - Assignment of Inputs
    - Interlock
      - Input 1
    - Operate ON
      - Input 1 .. 4
      - None
    - Operate OFF
      - Input 1 .. 4
      - None
  - Sense Control
    - Input 1, 2
      - High Level
    - Input 3, 4

• Outputs Settings

- Relay Outputs
  - Out 1, 2, 3, 4, 5, 6
    - Pressure Setpoint
    - Operate
    - Failure
    - Still OFF
    - Still ON
    - None

- Analog Outputs
  - Out 1, 2
    - Source
      - Uenergy
      - Iemis
      - Pressure
      - None
    - Mode
      - User Range
      - 1 to 1
      - EXPO
    - Ranges
      - Min Uenergy
      - Max Uenergy
      - Min Iemis
      - Max Iemis
      - Min Pressure
      - Max Pressure
    - Scale
      - Linear
      - Logarithmic
    - Min Voltage
    - Max Voltage
- Advanced Options
  - External Scan Control
  - Flow Controller Configuration
    - Flow Controller
    - Flow Setpoint
    - Full Scale (FS)
    - Voltage for FS
- Device Settings
  - Communication
    - Protocol
      - Modbus
      - Prevac V2.1
    - Interface
      - Ethernet
      - RS232
      - RS485
      - RS232/485/USB
      - Bluetooth
      - Ethernet/IP
    - Parameters
      - Baud Rate
        - 2400 bps
        - 4800 bps
        - 9600 bps
        - 19200 bps
        - 38400 bps
        - 57600 bps
        - 115200 bps

- IP
- Mask
- Gateway
- DHCP
- Enable
- Disable
- TCP server
- TCP server port
- Remote Enable
- Host Address
- Address
- Logical Group
- Display
- Brightness
- Touch screen autolock
- Customer Name
- Show
- Hide
- Caption
- System Date
- Date
- Time
- Language

• Save/Load
- Autosave
- Save
- Load
- Load Default

• Information
• Logs
• Reboot

3.4.2 DEGAS SETTINGS

To change degas settings go to: ***Setup Menu -> Degas***
A degas procedure is available for cleaning the cathode. The IS40 main panel displays information about the degas state. From the setup menu it is possible to:

- configure the duration of degas,
- turn degas on and off.

Time - duration of the degas procedure (1 - 30min).
Degas - enable/disable degassing (”on” / ”off”).

3.4.3 OPERATE TIME

To change operate time settings go to: ***Setup Menu -> Operate Time***
The Operation time counter (which counts how long the IS40-PS stays in OPERATE mode) can work in two modes COUNT UP and COUNT DOWN.

- First mode - timer works as a classic counter , counting in OPERATE mode, and changes to STANDBY mode only as a result of user interaction.
- Second mode - timer work as a countdown timer , from the value set by the user, to zero, after which the device automatically switches to STANDBY mode.

If OPERATE mode is activated when the timer is set to 0:00:00 and the work mode is „DOWN” , then there will be an automatic change to work mode „UP”.
The present state of the IS40-PS operation time counter could be displayed on the bottom information field.

3.4.4 WIEN MASS FILTER SETTINGS (E)

To change wien mass filter settings go to: ***Setup Menu -> Wien Mass Filter***
Wien mass filter is a device used for selection of the ions emitted by the ion gun. The filter is powered from a dedicated external power supply - Wien Filter Power Supply ”IS40-WPS”. Wien Filter Power Supply is controlled by the IS40-PS using the standard RS232 communication interface.

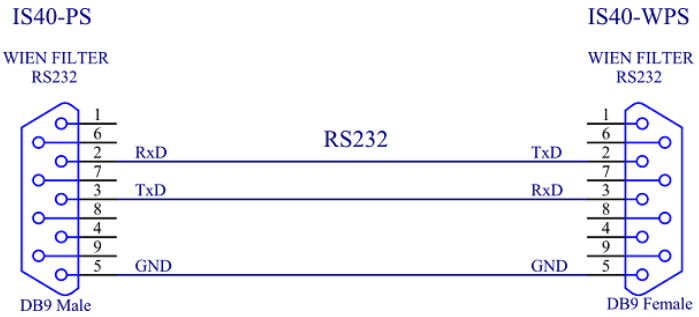


Figure 3.32: Wien Mass Filter communication interface

The use of wien filter is optional and may be disabled if not used:
Wien State - option of using a wien mass filter (”Enable” / ”Disable”).
Wien mass filter can work in automatic or manual mode:
Plate Control - work mode - way to control plate potential (”Auto” / ”Manual”).

When *Plate Control* is selected as *Auto* the *Plate Potential* is calculated using the *Gas Type*, *Magnet Type* and current $Energy$ voltage:

$$U_{plate} = d \cdot \sqrt{\frac{2 \cdot B^2 \cdot E \cdot q}{M_a \cdot 1,66e^{-27}}} \tag{3.1}$$

Where:

U_{plate} : is the plate potential

d : is constant relating to the physical dimensions of the Wien filter - 0,009m

B : is magnetic induction depends of the *Magnet Type*

E : is Energy voltage

q : is elementary charge $1,60e^{-19}C$

M_a : is atomic mass of selected *Gas Type*

$1,66e^{-27}$: is 1/12 of the mass of one atom of carbon-12 [kg]

Gas Type - filtered ions:

- He - helium (4,002602u)
- Ne - neon (20,1797u)
- Ar - argon (39,96238312u)
- Xe - xenon (131,29u)

Magnet Type - used magnetic material:

- 0,4T
- 0,24T

When *Plate Control* is selected as *Manual* the *Plate Potential* is controlled in a direct way.
Plate Potential - voltage supplied to the contacts of wien filter called $plate$ (-1360V - 1360V).
Other parameters required to set for proper work of the wien mass filter:
Lens In Voltage - voltage supplied to the contacts of wien filter called $LensIn$ (-100V - 100V).
Lens Out Voltage - voltage supplied to the contacts of wien filter called $LensOut$ (-100V - 100V).

3.4.5 GEOMETRY PARAMETERS SETTINGS (E)

To change geometry parameters settings go to: ***Setup Menu -> Geometry Parameters***
A $GeometryParameters$ submenu contains a set of parameters related to the placement of the sample and ion gun dimensions. These parameters affect the size and quality of the scan area.
Scan Grid X (Y) - parameters set from value 0,01mm to 2,00mm. They define movement in millimeters from one beam point to another. Large scan grid settings will give faster overall scan times but can result in incomplete coverage of the sample surface when using a small beam diameter. Smaller scan grid parameter settings result in longer overall scan times but result in a more homogeneous scan. In practical terms, the scanning grid parameters should normally be chosen to be a few times smaller than the ion beam diameter.

Sample Angle X (Y) - alignment of ion source to sample. The current density on the sample can vary with the relative angle between the sample and the beam. In order to reduce this effect, the IS40E-PS controls the scanning process to compensate for the relative angle according to the scheme shown in figure 4.13. Range of changed values X and Y is between 15º and 165º.

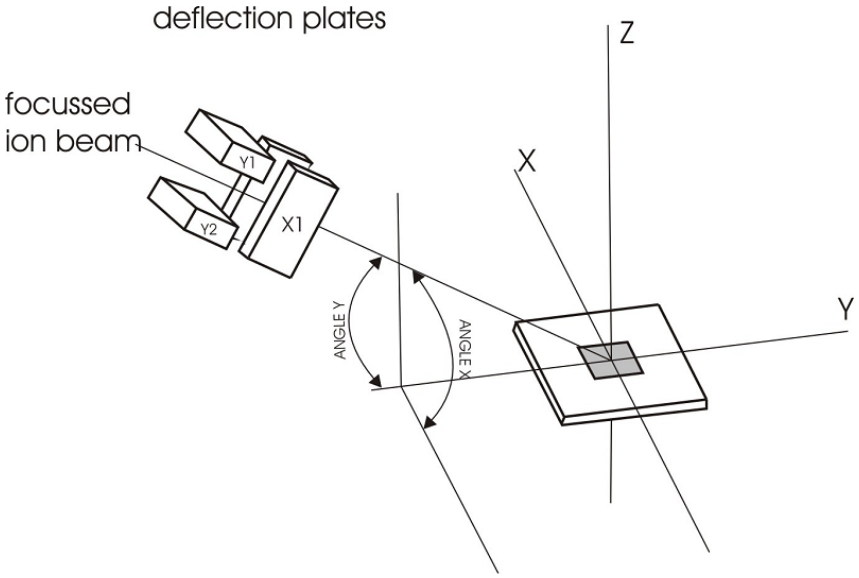


Figure 3.33: Adjusting source angle respect to sample

Dist. Sample S - distance between end of the Ion Source and sample surface - the distance must be known for accurate scanning. The *S* factor is the distance between the undeflected dot (neutral point) and the end of the Ion Source. The user should determine this distance experimentally if not already known.

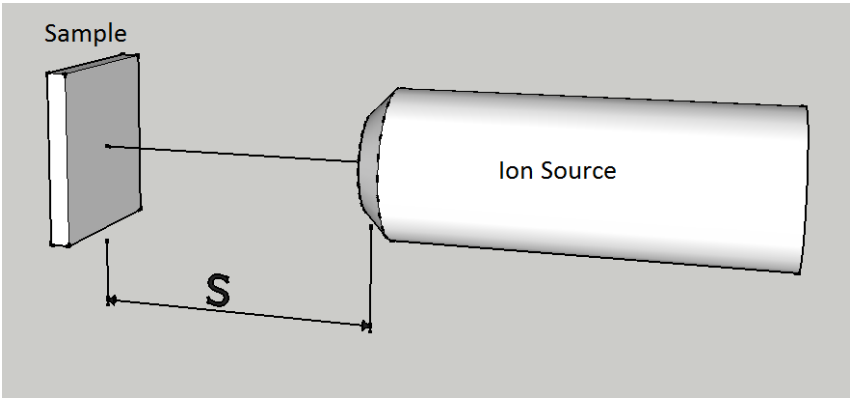


Figure 3.34: Distance S end of the Ion Source to sample

3.4.6 CATHODE WORK TIME

To reset cathode work time go to: ***Setup Menu -> Cathode Work Time***
The total cathode working time since the last reset is stored in nonvolatile memory. It is recommended to reset this time after each cathode replacement. In order to do this, tap the **Reset** button and confirm the rest by pressing the *YES* button.

3.4.7 PRESSURE CHANNEL (OPTIONAL)

To change pressure channel settings go to: ***Setup Menu -> Pressure Channel***
The IS40-PS accommodates one pressure gauge head connections if the *analog card* is installed. The sockets for connecting the gauge heads are located on the rear panel of the device. The device must be properly configured to ensure the correct operation of the connected gauge types. To do this, go to the configuration menu and then select *Pressure Channel*. Configuration options are described below:
Setup Menu -> Pressure Channel -> Setpoints:
Setpoint Low – when one of the outputs has been linked to the pressure channel, then the associated output relay is switched to close when the *Setpoint Low* is reached.
Setpoint High – when one of the outputs has been linked to the pressure channel, then the associated output relay is switched to open when the *Setpoint High* is reached.
Relay output configuration - see subsection 3.4.10.
The *Setpoint* value is limited by the device to the range 1.00E-15 – 1.00E-2 mbar. The software does not allow setpoint values outside of this range. It is also not possible to set the *Setpoint Low* with a value greater than the *Setpoint High* and vice versa.
Settings of the *Pressure Setpoint* are related to *Vacuum Interlock* signal - see subsection 3.4.8.
Setup Menu -> Pressure Channel -> Unit:
Unit - selection of the pressure display unit.

- **mbar** – the pressure is displayed in millibars.
- **Torr** – the pressure is displayed in Torr.
- **Pa** – the pressure is displayed in Pascals.
- **psia** – the pressure is displayed in pound per square inch (psi).

Changing the displayed measurement units is also possible from the main panel, by tapping Unit field.
Setup Menu -> Pressure Channel -> Gauge:
Gauge - type of head selection. Please choose the specific type of head connected to the device. The following types of heads are currently supported - see subsection 1.4.4.
CTR90/91 and *Baratron* models require the additional parameter FS (Full Scale) according to the type of the head attached. This parameter defines the measuring range associated with the specific gauge type. For *CTR90/91* heads, the FS value is expressed in units of *Torr*. For *MKS970B* heads, the FS value is expressed in units of *Torr* and *psi*.
The *PG105* head requires an initial calibration procedure, which is necessary for the correct vacuum display. This is a two-point calibration: at atmospheric pressure and under vacuum. Connection of the *PG105* head requires an additional amplifier (PGA13), shown on the 3.35. The *PG105* is not part of a set IS40-PS and has to be ordered separately.
Setup Menu -> Pressure Channel -> Gas Type:
Gas Type – defines the process gas correction factor. Sensors are normally calibrated for measurement in nitrogen or in air. If pressure measurements are being performed with other gases, it will be necessary to correct the reading accordingly. The Gas Type parameter is used to adjust

Figure 3.35: Pirani PG105 amplifier

the correction factor for the respective gas type. The actual pressure is obtained by multiplying the measured pressure with the correction factor:

$$P = P_{AIR} \cdot R_g \tag{3.2}$$

Where:

P : pressure

P_{AIR} : pressure in air

R_g : gas correction factor

If the gas is not available on the included list it can be defined by the user by selecting *Define* and then manually entering the gas correction value.
Setup Menu -> Pressure Channel -> Filter:
Filter – filtering pressure value. Filtering is done by averaging the measured voltage. Depending on the selected parameter(**Low, Medium, High**) changes as the number of samples taken to averaging.
Setup Menu -> Pressure Channel -> Degas:
A degas procedure is available for ionization gauge heads *(ITR90, ITR100 ...)* . The IS40-PS main panel displays information about the degas state. From the setup menu it is possible to configure the duration of degas and turn degas on/off:
Time - duration of degas (1 - 30min)
Degas - turn degas *on* and *off*

3.4.8 VACUUM INTERLOCK (OPTIONAL)

To turn vacuum interlock on/off go to: ***Setup Menu -> Vacuum Interlock***
Vacuum Interlock signal depends on the setting of *Pressure Setpoint* - see subsection 3.4.7. This protection signal is provided to prevent accidental operation of the device when not under vacuum. When the *Vacuum Interlock* is activated, you can turn on the device in **OPERATE** state only if the *Pressure Setpoint* reached. If the protection signal is missing (deterioration of the vacuum conditions), the IS40-PS rapidly returns to **STANDBY** mode and displays *'Vacuum Interlock Failure'* message accompanied by a flashing control failure LED. Loss of *Vacuum Interlock* signal can also be caused by removing the plug or a damaged cable.

3.4.9 DIGITAL INPUTS CONFIGURATION

To change digital inputs settings go to: ***Setup Menu -> Inputs Settings -> Digital Inputs***
The device has four digital inputs (0-24V). The inputs are available on the Digital Input/Output Card located on the rear panel. Digital inputs are normally active in the *LOW* state.

WARNING

Digital input maximum voltage
Logic inputs accept signals from a range of 0 to 24V. Exceeding these values may damage the input. Observe that these limits are not exceeded.

Assignment of Inputs
The Assignment menu contains the following options:

- **Interlock** - external interlock signal
- **Remote Control** - enables remote control of the device (via RS234/485 or Ethernet interface)
- **Operate ON** - turn Operate on
- **Operate OFF** - turn Operate off

In order to assign a Digital Input:

1. Go to menu ***Setup Menu -> Inputs Settings -> Digital Inputs -> Assignment of Inputs***
2. Tap desired position from the list
3. Tap one of the inputs
4. Selected **Input** will be assigned to chosen action
5. New input configuration will appear in **Assignment of Inputs** menu

Sense Control
After assigning an appropriate action to the specified input, the activation type can be set. There are four activation types available:

- **Low Level** - the input is active by low state (0V or unplugged) (default)
- **High Level** - the input is active by high state (24V)
- **Falling Edge**- input is activated by the falling edge of the signal (change from 24V to 0V)
- **Rising Edge** - input is activated by the rising edge of the signal (change from 0V to 24V)

In order to set the inputs:

1. Go to menu ***Setup Menu -> Inputs Settings -> Digital Inputs -> Sense Control***
2. Tap desired input
3. Tap activation type
4. Activation type will be set
5. New input activation type will appear in **Sense Control** menu

3.4.9.1 INTERLOCK INPUT DEFAULT ASSIGNMENT

Interlock by default is permanently assigned to *Input1* with active high level. To see the connection diagram please refer to the installation chapter 2.5.6, section on digital inputs.

3.4.9.2 REMOTE CONTROL INPUT DEFAULT ASSIGNMENT

Remote Control by default is permanently assigned to *Input2* with active high level.

3.4.10 OUTPUTS SETTINGS

Setup Menu -> Outputs Settings

3.4.10.1 RELAY OUTPUT CONFIGURATION

To change relay outputs settings go to: ***Setup Menu -> Outputs Settings -> Relay Outputs***
The IS40-PS has six relay outputs whose activity can be linked to the desired parameters. These outputs are physically isolated from the device (floating). The outputs are available on the **Digital I/O Card** which is located on the rear panel. Relays can be configured in the *Relay Outputs* menu via the Setup Menu by selecting output from **OUT1** to **OUT6**, and then assigning the desired output signal.
The following signal sources are available:

- **Pressure Setpoint** - the output is controlled by the *Pressure Setpoint* signal 3.4.7
- **Operate** - the output is controlled by the **OPERATE** state
- **Failure** - the output is controlled by the failure status
- **Still OFF** - relay contacts are permanently open
- **Still ON** - relay contacts are permanently closed

In order to assign a signal source to Digital Output:

1. Go to menu ***Setup Menu -> Inputs Settings -> Digital Inputs -> Relay Outputs***
2. Tap one of the available outputs from the list
3. Tap one of the parameters to assign it with selected output
4. Parameter will be assigned to output
5. Parameter will appear in the **Relay Outputs** menu on chosen channel

3.4.10.2 ANALOG OUTPUTS CONFIGURATION

To change analog outputs settings go to: ***Setup Menu -> Outputs Settings -> Analog Outputs***
The rear panel connectors Analog Out 1 and Analog Out 2 each have a 0-10V analog signal available at their respective outputs. They can be used for example to control external devices or for data acquisition tasks. The behavior of the analog outputs, and the type of signal that will be converted to an analog value and available at the output, are easily configured.
To configure the analog outputs use the setup menu and follow **Output Settings/Analog Outputs** path and select the appropriate output to be configured. Available configuration options:
SOURCE – source to be converted to an analog value:

- **Uenergy** – actual value of energy voltage
- **Iemis** – actual value of emission current
- **Pressure** - the measured pressure value from the head attached to Gauge input.

- **None** – set 0V to output

MODE – arithmetic conversion types of the measured signal:

- User Range - defines the measuring range over which the arithmetic conversion will apply.
- 1 to 1 - the signal is retransmitted directly from the input to the output (available for pressure source only)
- EXPO - 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 (available for pressure source only).

$$U_{out} = \frac{Exp + 14}{2}[V] \tag{3.3}$$

Where:

Exp : is pressure exponent value

RANGES – defining the conversion range:

- **Min Value** - the value that will be corresponded to 0 V in the output,
- **Max Value** - the value that will be corresponded to 10 V in the output.

SCALE – measured signal conversion type choice:

- **Linear** -linear output. It is sometimes useful to retransmit the pressure over a narrow range, covering several decades. In this case, the output voltage is directly proportional to the pressure. 10 V corresponds to the upper limit, 0 V corresponds to the lower limit of User Range:

$$U_{out} = 10 \cdot \frac{V_{read} - V_{min}}{V_{max} - V_{min}}[V] \tag{3.4}$$

Where:

V_{read} : is retransmitted value

V_{min} : is minimum retransmitted value, define in Ranges menu

V_{max} : is maximum retransmitted value, define in Ranges menu

- **Logarithmic** - logarithmic output. It is often useful to retransmit the pressure over a wide range, covering over a dozen decades. In this case it is most convenient to operate with a logarithm scale. The logarithmic range is defined according to the relation:

$$U_{out} = Log\left(\frac{V_{read}}{V_{min}}\right) \cdot \frac{10}{Log\left(\frac{V_{max}}{V_{min}}\right)}[V] \tag{3.5}$$

Where:

V_{read} : is read voltage value

V_{min} : is minimum retransmitted value, define in Ranges menu

V_{max} : is maximum retransmitted value, define in Ranges menu

MIN VOLTAGE – voltage output corresponds to 0% of assignment source value
MAX VOLTAGE – voltage output corresponds to 100% of assignment source value

3.4.10.3 SELECTING ANALOG OUTPUT

This section describes how to assign a parameter from some device to the analog output channel. The specific example below is shows how to assign a *Pressure* to Analog Output 1:

1. Go to menu ***Setup Menu -> Outputs Settings -> Analog Outputs***
2. Select channel 1 by tapping **Out 1**
3. Tap on **Source**
4. Select **Pressure**
5. Define ranges by tapping **Ranges**
6. Enter ranges for Pressure

The next example describes how to transfer the *Emission* current value to the analog output on channel 2:

1. Go to menu ***Setup Menu -> Outputs Settings -> Analog Outputs***
2. Select channel 2 by tapping **Out 2**
3. Tap on **Source**
4. Select **Iemis**
5. Define ranges by tapping **Ranges**
6. Enter ranges for Min/Max Iemis

3.4.10.4 ANALOG INPUTS CONFIGURATION

Each of the inputs Analog Input 1 i Analog Input 2on the rear panel can be controlled with an analogue signal 0-10V. Those signals can be used to control the internal parameters of the device. To configure the analog inputs use the position ***Input settings/Analog inputs*** in the configuration menu. The following configuration options are available:

- **CONTROLLED VALUE** – the parameters available in this position (Energy Voltage, Emission Current), can be controlled by:
  - **None** – the parameter is not controlled with analog input
  - **Ain1** – the parameter is controlled by Ain1 input
  - **Ain2** – the parameter is controlled by Ain2 input
- **INPUT RANGE** – defining the range of control voltages:
  - **Min Ain 1** – the value of an input signal, which will correspond to the minimum value of a parameter controlled by Ain1 input
  - **Maks. Ain 1** – the value of an input signal, which will correspond to the maximum value of a parameter controlled by Ain1 input

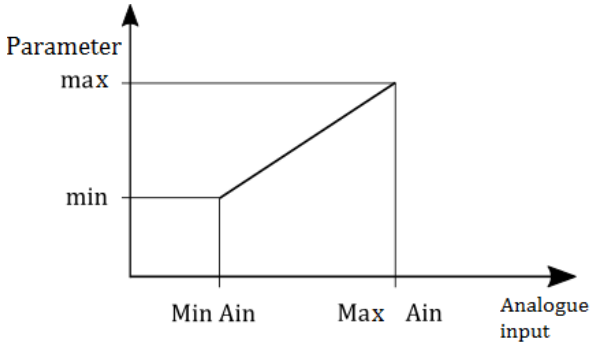


Figure 3.36: Controlling the power supply parameter by an analogue input

- **Min Ain 2** – the value of an input signal, which will correspond to the minimum value of a parameter controlled by Ain2 input
- **Maks. Ain 2** – the value of an input signal, which will correspond to the maximum value of a parameter controlled by Ain2 input

NOTE: When the flow controller is active, analog input 1 is automatically assigned to the flow controller(as a flow value feedback signal). For gas flow controller configuration, see 3.4.11.2.

3.4.11 ADVANCED OPTIONS

Setup Menu -> Advanced Options

3.4.11.1 EXTERNAL SCAN CONTROL

The power supply IS40-PS enables to control and monitor deflection voltages by giving and reading appropriate external voltages. This functionality is available only if the given power supply is equipped with a connector described in chapter 2.5.4. After activating the external scanning control option, the parameters related to the scanning are hidden and the information sign **"EXT. SCAN"** is displayed.

3.4.11.2 FLOW CONTROLLER

The power supply IS40-PS supports the control of an external gas flow controller. The functionality is available only in power supplies equipped with an analogue input/output card 2.5.7. The applied flow controller must have an analogue control interface, which must be connected to the analogue card. Aout1 and Ain1 should be used for connection according to the diagram below 3.37.
To properly configure the power supply to operate an external gas flow controller, the following parameters must be set:

- **Set flow** - the desired flow value to be maintained by the controller.
- **Maximum Flow (MF)** - manufacturer's declared maximum flow value for a given flow controller.
- **Voltage for MF** - a value of control voltage which corresponds to the maximum flow for a given flow controller.

The current flow value can be observed using the

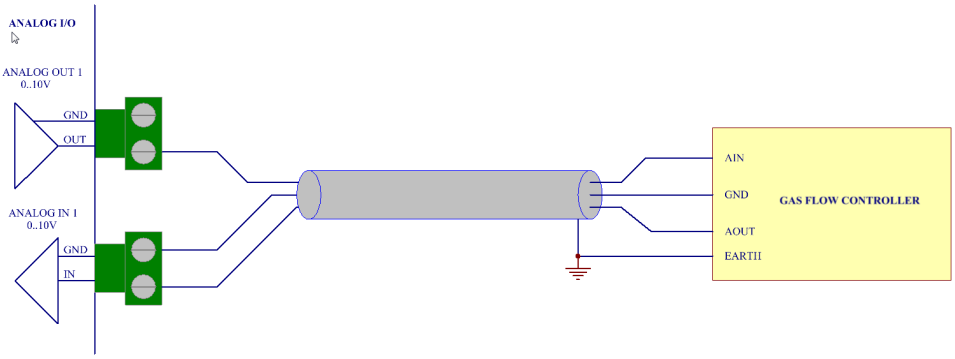


Figure 3.37: Gas flow controller connection to an analogue card

3.4.12 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 IS40.

3.4.12.1 COMMUNICATION SETTINGS - COMMUNICATION MENU

Setup menu →Device Settings →Communication
The communication menu is used to configure the remote control interface and communication protocol. The IS40-PS can communicate in one of two implemented protocols:

- **Modbus** - look 6.4
- **Prevac V2.x** - look 6.5

To change the communication protocol enter ***Setup menu →Device Settings →Communication →Protocol***

To change the communication interface enter ***Setup menu →Device Settings →Communication →Interface***. Available options:

- Ethernet
- RS232
- RS485

To change the **Interface** parameters enter ***Setup menu →Device Settings →Communication →Parameters***
Ethernet interface parameters:

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

Serial RS232/485 interfaces parameters:

- Baud Rate: 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,

The detailed description of the RS232/485 connection pins is in: 6.3
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: IS40-PS ".
  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.

- **Host Address** (Parameter available only for "Prevac V2.x" protocol) - the device ID that have permission to control (set parameters and control functions).

3.4.12.2 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***

3.4.12.3 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.

3.4.13 SAVING/LOADING SETTINGS

All relevant parameters of the device may be saved automatically in a non-volatile memory and restored after turning the power back on. In addition, the current configuration of the device may be saved at any moment for restoration at a later time. Up to 6 different operation configurations of the device can be saved, and each configuration can be assigned an individual name. It is possible to return to the saved configuration or to the default settings at any time.

In order to turn on or turn off the autosave function of parameters, one should:

1. Go to menu ***Setup Menu →Save/Load*** .
2. Click on **Autosave** in order to change its status.

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.

3.4.14 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.

3.4.15 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.

3.4.16 REBOOT

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

4 STEP BY STEP

4.1 ION SOURCE IS 40C1 - QUICK START

Please follow the procedure below when using the IS40-PS for the first time:

1. Check correctness of connections between power supply and Ion source IS 40C1.

2. Turn on power supply, and leave it for 10 minutes (on STAND-BY mode) to warm up and stabilize the cathode.

3. If the ion source has been out of operation for some time, or this is the first use following a chamber vent, DEGAS option has to be turned on for min. 10 minutes.

4. The ion source should only be operated at pressures <5E-6 mbar. The system should be baked following any chamber vent in order to avoid discharges at high energy.

5. Turn on OPERATE mode. Recommended starting parameters are shown below: Energy = 3 kV, Emission = 5 mA

6. Open the gas bottle 'Leak Valve' and set the flow to achieve a pressure in the range 1E-6 - 1E-5 mbar in the chamber.

7. The ion source is now prepared for operation and the user may continue with any optimization steps for ion current and beam profile by adjusting the values of energy, emission current and gas pressure.

4.2 ION SOURCE IS 40E1 - QUICK START

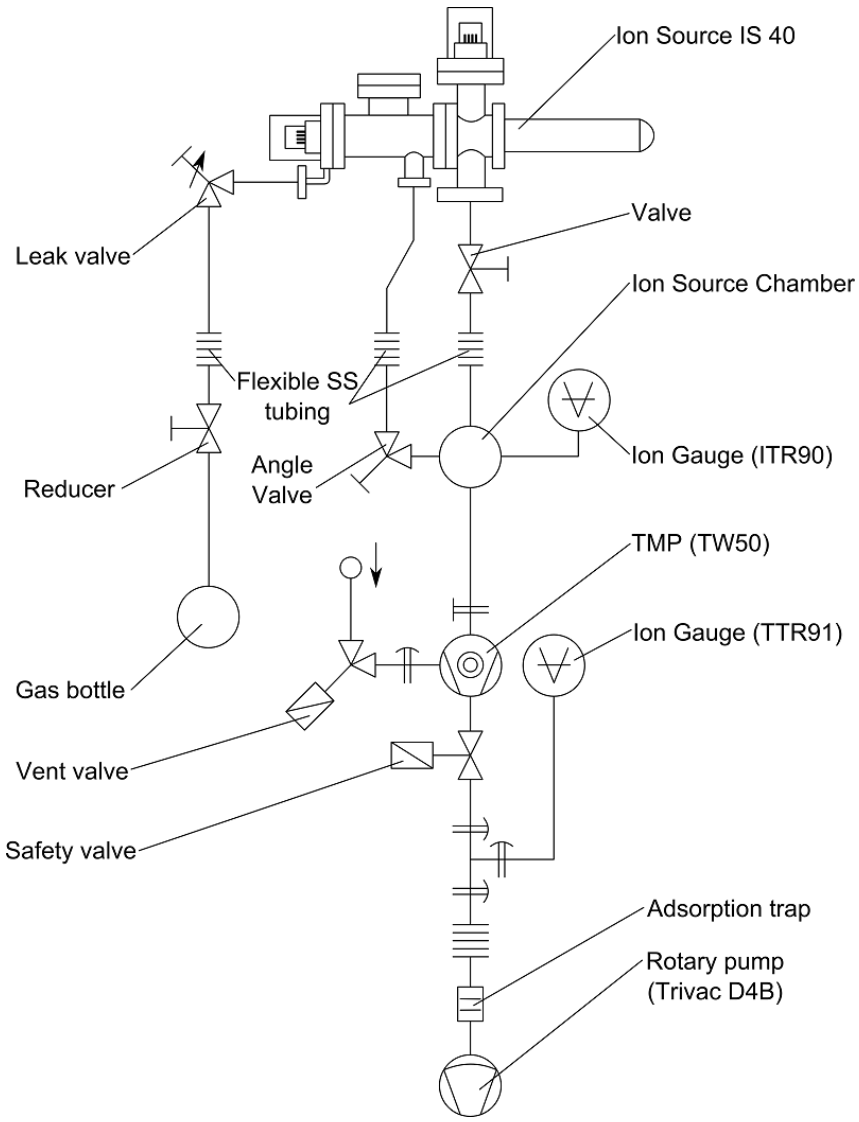
Please follow the procedure below when using the IS40-PS for the first time:

1. Check correctness of connections between power supply and Ion source IS 40E1.

2. Turn on power supply, and leave it for 10 minutes (on STAND-BY mode) to warm up and stabilize the cathode.

3. If the ion source has been out of operation for some time, or this is the first use following a chamber vent, DEGAS option has to be turned on for min. 10 minutes.

4. The following start-up steps refer to the schematic below:



5. The ion source should only be operated at pressures <5E-6 mbar. The system should be baked following any chamber vent in order to avoid discharges at high energy.

6. Turn on OPERATE mode. Recommended starting parameters are shown below: Energy = 3 kV, Emission = 5 mA, Focus1 = 1800 V, Focus2 = 0 V, Ext. = 95%, PX = PY = 0 mm, dX = dY = 0 mm.

7. Although not absolutely necessary, we recommend a phosphorus coated Faraday cup is installed in the chamber for beam measurement during the commissioning stage.

8. Fully open 'Valve' (DN40CF, secondary pumping stage to Ion source) then slightly open 'Angle Valve' (DN16CF, first pumping stage to Ion source) - this valve will be adjusted later to optimize ion current.

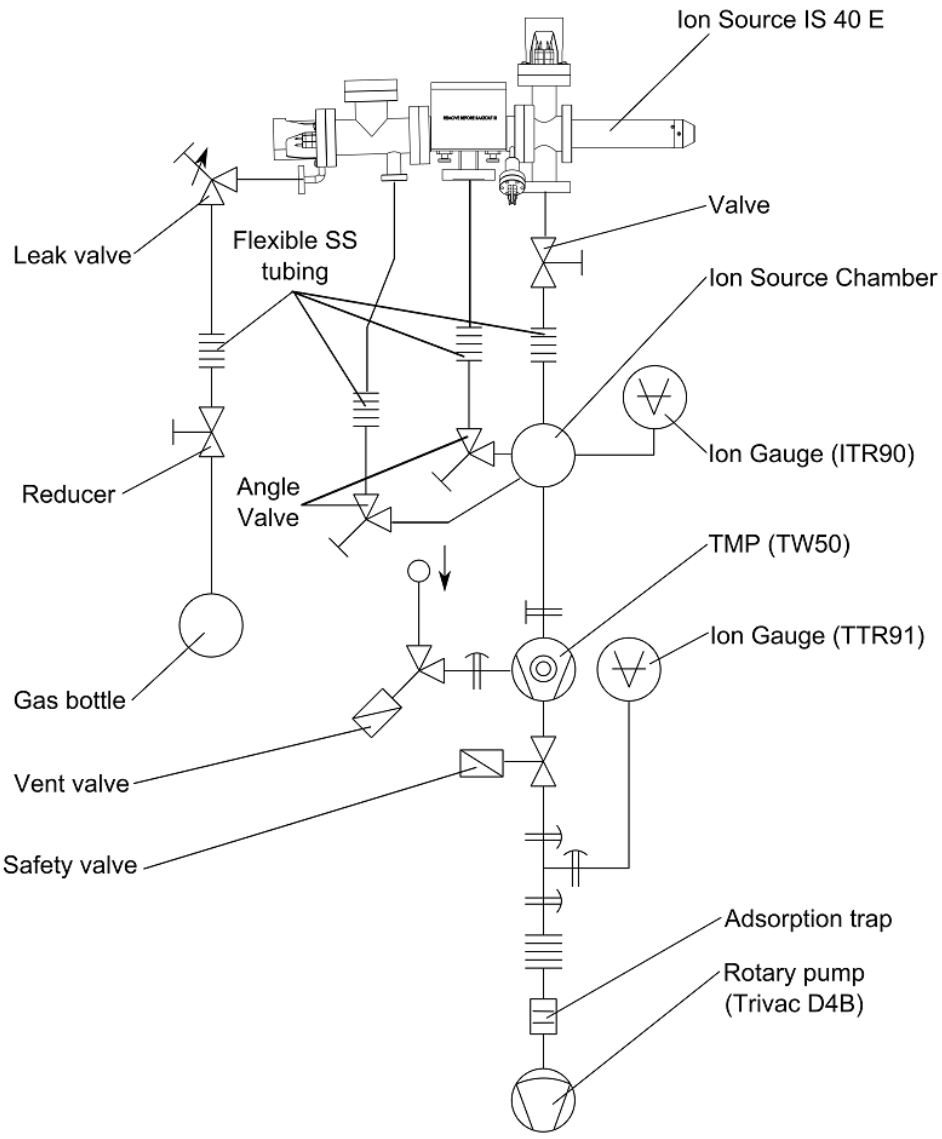
9. Open the gas bottle 'Leak Valve' and set the flow to achieve a pressure of 1E-6 mbar in the ion source chamber as displayed on the ITR90 gauge.

10. The ion source is now prepared for operation and the user may continue with any optimization steps for ion current and beam profile. The initial settings in 6 above are a good starting point but final values will depend on desired beam properties, chamber geometry, pumping system characteristics etc.

4.3 ION SOURCE IS 40E1 WITH WIEN MASS FILTER - QUICK START

Please follow the procedure below when using the IS40-PS with IS40-WPS for the first time:

1. Check correctness of connections between power supply IS40-PS and Ion source IS 40E1.
2. Check correctness of connection between power supply IS40-WPS and Wien Mass Filter (please refer to the IS40-WPS user manual supplied with the IS40-WPS power supply).
3. Check correctness of connection between ion source power supply IS40-PS and Wien filter power supply IS40-WPS (see section 3.4.4).
4. Turn on both power supplies, and left it for 10 minutes (on STAND-BY mode) to warm up and stabilize the cathode.
5. If the ion source has been out of operation for some time, or this is the first use following a chamber vent, DEGAS option has to be turned on for min. 10 minutes.
6. The following start-up steps refer to the schematic below:



7. The ion source with Wien mass filter should only be operated at pressures <5E-6 mbar. The system should be baked following any chamber vent in order to avoid discharges at high energy.

8. Wien mass filter module is equipped with an additional DN 40CF vacuum flange to connect the third differential pumping stage. To maintain UHV conditions in the main chamber during measurements, fully open Valves DN 40CF (second and third pumping stage - to Ion source chamber), then open 'Angle Valve' (DN16CF, first pumping stage to Ion source) - this valve will be adjusted later to optimize ion current.

9. Slowly open 'Leak Valve' and regulate Argon leak to level 1,00 E-4 mbar inside ion source chamber (readout of ITR90 gauge at ion source chamber).

10. Although it is not absolutely necessary, we recommend a phosphorus coated Faraday cup installed in the chamber for beam measurement during the commissioning stage.

11. Put the 0,24 T magnet on the Wien Mass Filter (for proper magnetic field orientation - please refer to the Ion Source with Wien Mass Filter user manual).

12. Turn on OPERATE mode on IS40-PS and set ion source initial operating parameters:
Energy = 3 kV, Emission = 10 mA, Focus1 = 1800 V, Focus2 = 0 V, Ext. = 95%, PX = PY = 0 mm, dX = dY = 0 mm.

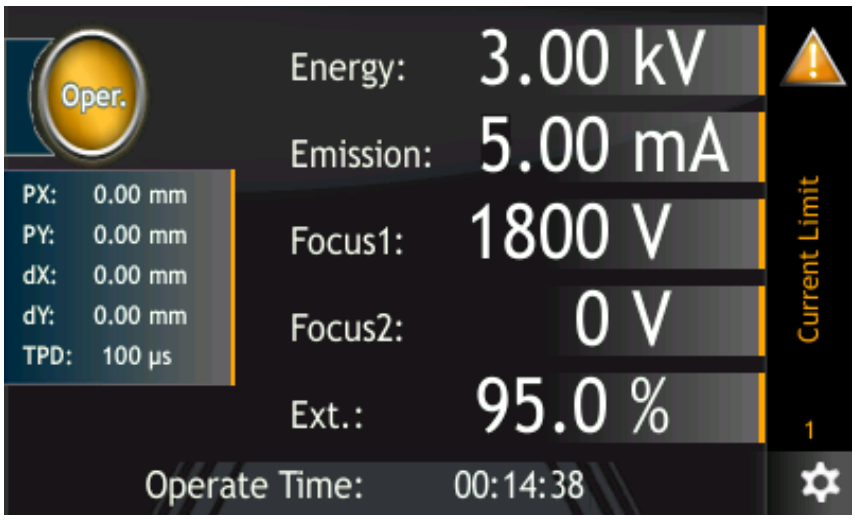
13. Tap Wien Filter Button (see section 3.4.4) in order to display Wien Filter menu and set initial parameters. For Argon and E=3kV set: Plate Potential = 260V, Lens In Voltage = Lens Out Voltage = 0 V.

14. The ion source with Wien filter is now prepared for operation and the user may continue with optimization of ion current by adjusting Argon leak as well as Wien mass filter and ion source parameters. The initial settings recommended above are a good starting point but final values will depend on desired beam properties, chamber geometry, pumping system characteristics etc.

15. Every user who order IS40E with Wien Mass Filter will get Factory Acceptance Test made with his specimen of ion source. Using these parameters, the user can easily find working parameters of his specimen of ion source.

4.4 GENERATION OF ION CURRENT

Ion emission current is obtained by ionization of argon atoms during collision with electrons inside Ionization area. The magnitude of the current depends on pressure of argon and value of emission current. Electron emission is obtained from resistive heating of a tungsten cathode. Electron emission current is measured in emission current regulation circuit, and stabilized by influence on heating current. Electron emission current can be continuously adjusted in range of 0,01mA – 10 mA, by steps of 0,01 mA.
There can be warning message "Current Limit" on the screen, especially during transition from „Standby" state, to normal „Operate" operation mode. This is caused by time needed to stabilize emission current.



4.5 FOCUSING AND STEERING OF ION BEAM

There are two voltages „Focus1" and „Focus2" responsible for focusing the Ion beam, that are given to Ion source focus lenses. These voltages are proportional dependant on energy voltage. Adjustment of „Focus1" and „Focus2" sets proportion factors, relating to energy voltage, simultaneously. This means, that change of energy voltage causes proportional change of „Focus1" i „Focus2" voltages. These voltages can not be higher than current energy voltage.
Both the Extractor voltage "Ext." and the Repeller voltage "Repeller" also have an influence on the ion emission current. Extractor voltage is adjusted in range of 60,0% to 99,9% energy voltage and is responsible for extraction of ions from Ionization area.
Repeller voltage is negative polarized DC voltage (-80V) related to cathode's potential, it's role is to increase Ionization probability, therefore Ion emission current value.

4.6 ION BEAM DEFLECTION

Deflector amplifiers of axis X „PX" and axis Y „PY" are responsible for Ion beam deflection. Deflection voltages in range ± 1300V are present on the Ion source deflector plates.

4.7 VOLTAGE READING IN „OPERATE" MODE

Energy, extractor, focus voltages and emission current can be adjusted in „Standby" state, but are not actively applied in Standby state. The voltages are only applied in "Operate" mode and slowly rise to the defined value (see next section). The display shows the real, measured value at any specific instant.

4.8 SLOW RAMP OF HIGH VOLTAGES FEATURE

The 'high voltage slow ramp' feature was introduced to avoid voltage over-shoot and therefore to prevent damage to the Ion source.
Upon switching to "Operate" mode, the energy, extractor and focus voltages are ramped to their preset values at a rate of 300V every 0.5 sec. The voltage ramp can be observed on the main screen.

4.9 SETPOINTS VACUUM CHANNEL CONFIGURATION

Example of Setpoint High and Setpoint Low values for the first measuring channel:

1. Tap Menu Bar
2. Tap Setup Menu
3. In the configuration menu select the option ”Pressure Channel”.
4. Select the position “Setpoints”.
5. Select “Setpoint Low”.
6. The numeric keypad is displayed by means of which we enter the vacuum value and confirm by pressing button .
7. Selecting “Setpoint High”.
8. The numeric keypad is displayed by means of which we enter the vacuum value and confirm button .

The entered values must be correct: Low Setpoint value cannot be greater than Setpoint High. If an invalid value or a value outside this range is set, the last valid value will be displayed.

Figure 4.1: Setpoint Configuration

4.10 DIGITAL INPUTS CONFIGURATION

Example of how to configure a logic input number 3 [pin 3 on the DIGITAL IN connector] in such a way that a falling signal on its input causes a Operate ON:

1. Tap Menu Bar
2. Tap Setup Menu
3. In the configuration menu select the Inputs Settings.
4. Select Digital Inputs.
5. Select Assignment of Inputs.
6. Select the Operate ON.
7. Select logic input to assign the above operation (Input 3).
8. Go back to the main screen by press of the button “back to main screen”.

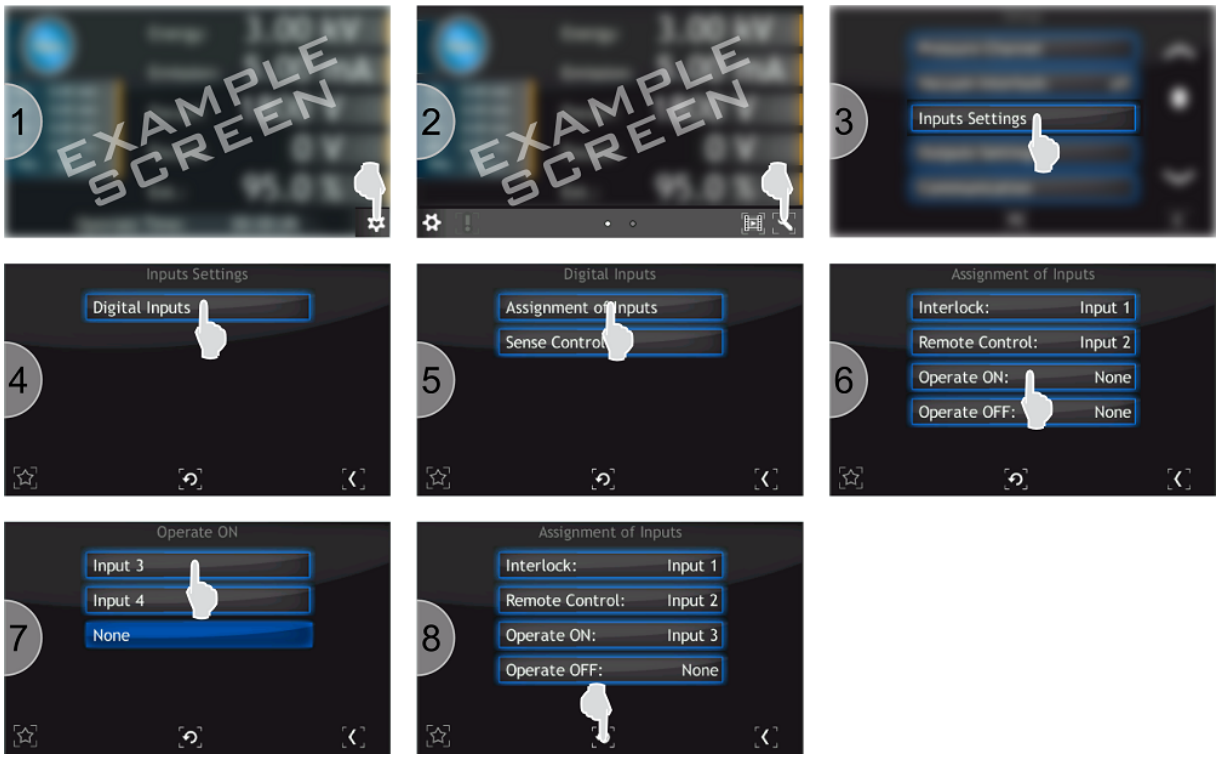


Figure 4.2: Logic input configuration

Then set the trigger type for a corresponding input:

1. Tap Menu Bar
2. Tap Setup Menu
3. In the configuration menu select the Inputs Settings.
4. Select Digital Inputs.
5. Select Sense Control.
6. Select input.
7. Define input sense control.

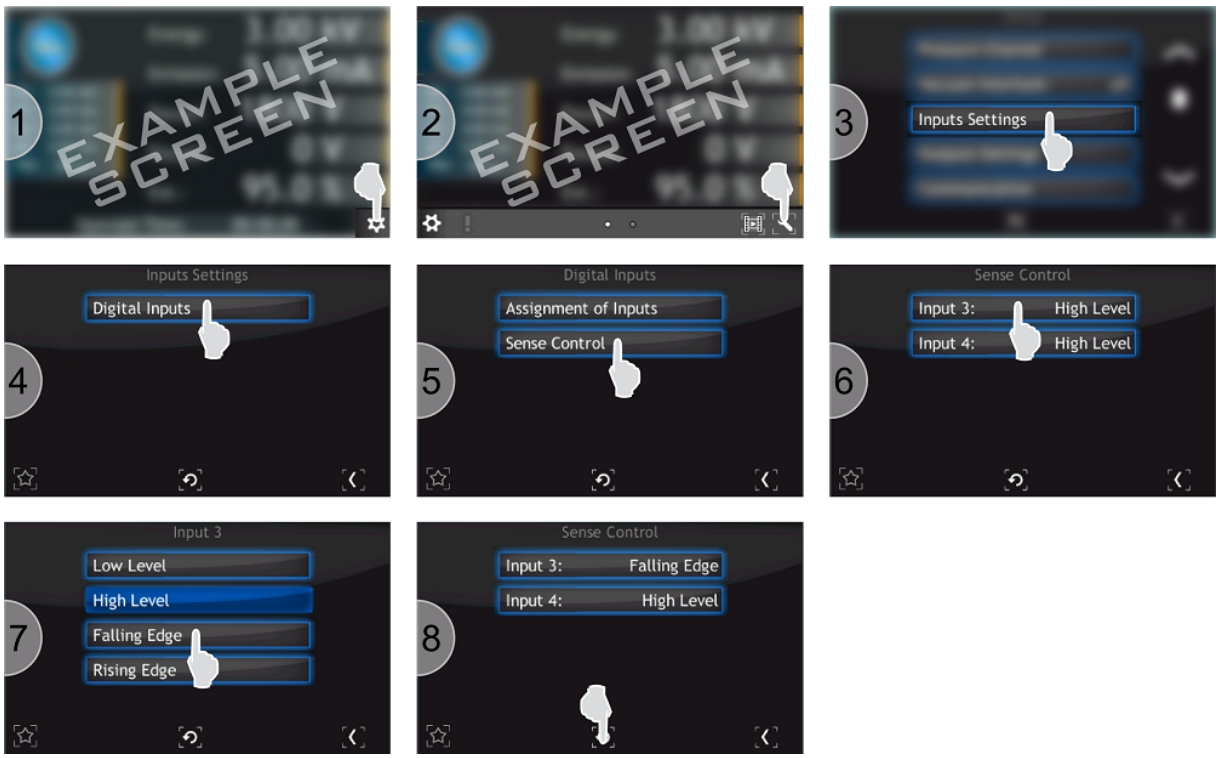


Figure 4.3: Sense Control configuration

4.11 CONFIGURATION COMMUNICATION INTERFACE

The following procedure to configure the module RS232 to work at a rate of 19200bps:

1. Tap Menu Bar
2. Tap Setup Menu
3. In the configuration menu select the Communication -> Module.
4. From the list select the module RS232.
5. Tap Parameters option.
6. The list describes highlighted display parameters that can be configured in the module, other options are grayed.
7. Tap Baud Rate.
8. In the displayed list, select the appropriate baud rate 19200 bps.

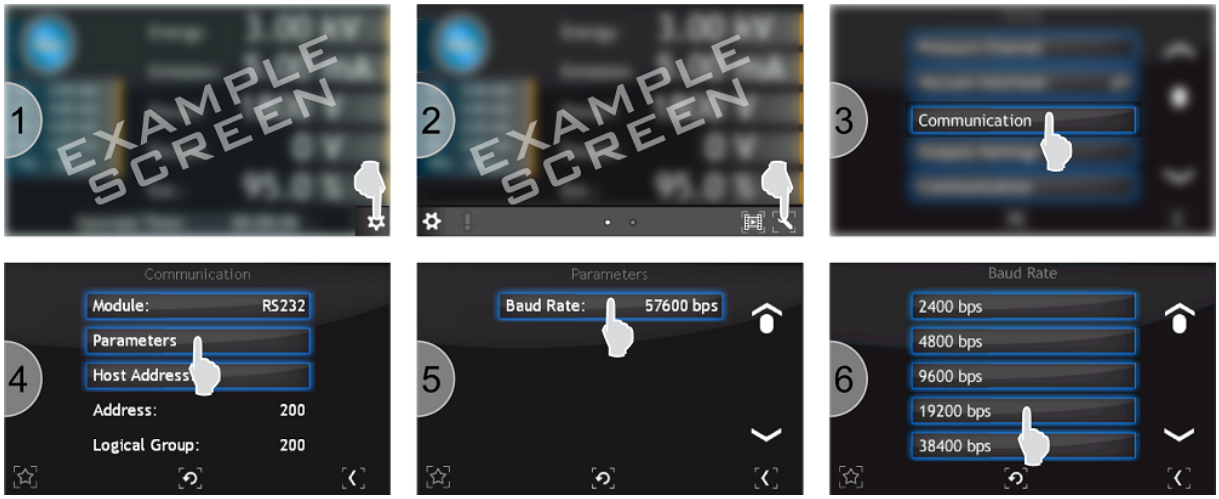


Figure 4.4: Configuration communication interface

4.12 PRESSURE MEASUREMENT FILTERING

If for any reason the pressure measurement is noisy, a filter can be applied on the appropriate channel by following the procedure below.

1. Tap Menu Bar
2. Tap Setup Menu
3. In the configuration menu select the option ”Pressure Channel”.
4. Select the position “Filter”.
5. Into menu “Filter” select “High”.
6. Filter parameter was changed.

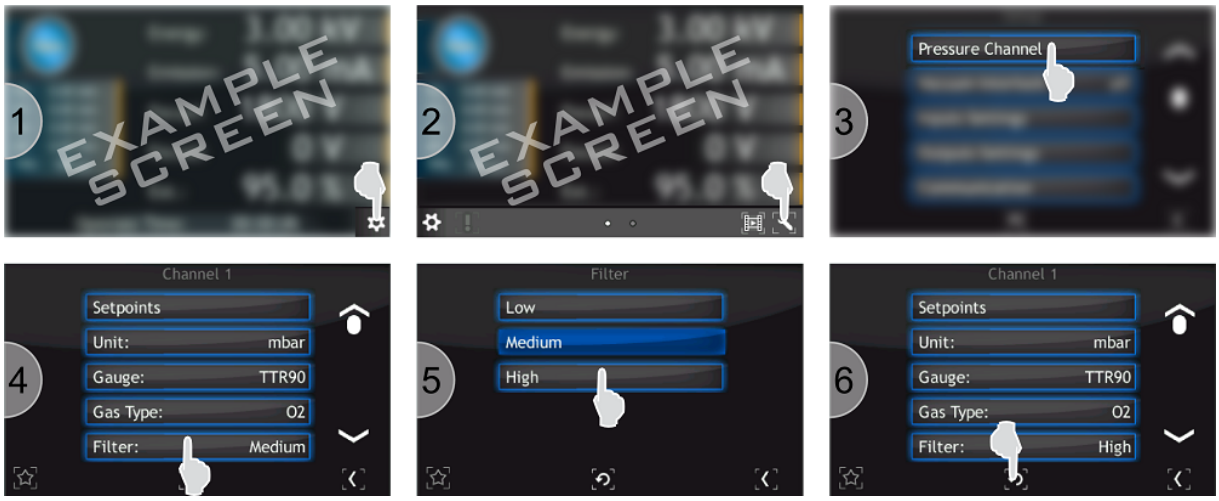


Figure 4.5: Pressure measurement filtering

4.13 LANGUAGE SELECTION

In order to select the language:

1. Tap Menu Bar
2. Tap Setup Menu
3. Tap Language
4. Enter desired language
5. Tap Yes to reboot the device

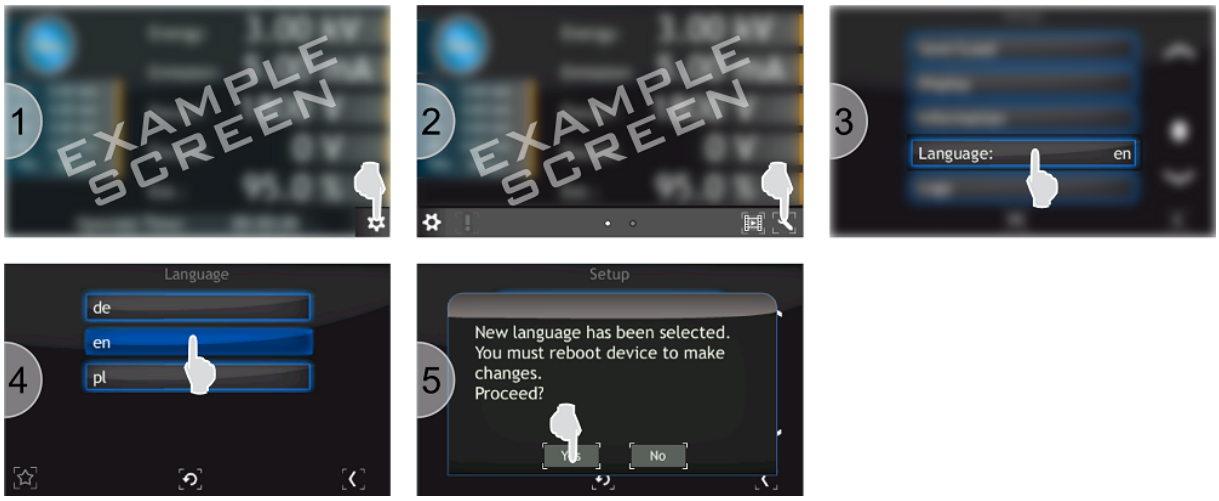


Figure 4.6: Selecting language

4.14 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 gateway.
In order to view this information:

1. Tap Menu Bar
2. Tap Setup Menu
3. Tap Information
4. Information about the device are displayed

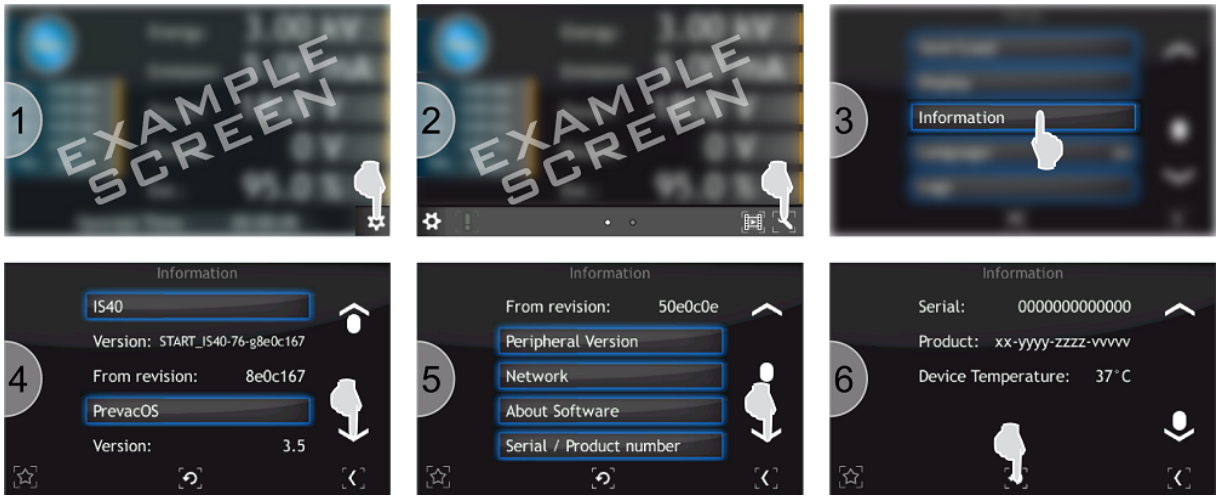


Figure 4.7: Device Information

5 TROUBLESHOOTING

This section describes the errors, warnings and notifications appearing in IS40-PS . All informations displayed on the screen are 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 colors red and yellow (for more information about them can be found in the chapter on user interface). Error disappears from the bar when it will be physically eliminated. This informations are stored in 5.1 section.
- All information that is not directly related to operation of the device is displayed as a message box. This informations presents notifications after user interaction. More informations can be found in 5.2 section.

5.1 MESSAGE BAR NOTIFICATIONS

5.1.1 ERRORS

- **E1: The connection to mainboard has been lost. Error Code: <number>** Connection to the mainboard has been lost. Error code is displayed in order to find the source of the problem.
- **E2: We hightly recomend to remove videos from device.**
  - Error resulting from the insufficient space on the SDHC card. In order to free up some space, delete some videos.
- **E3: External Interlock Failure.**
  - Device not detected external interlock signal. Check cable connection to Digital In connector.
  - There is no connection to external interlock or interlock is not properly configured. Refer to the Digital input section of the “Installation“ chapter.
- **E4: Vacuum Interlock Failure.**
  - Vacuum interlock is ON and the measured vacuum level is out of setpoint ranges. Check setpoint settings and gauge configuration.
  - Gauge is not connected or is broken. Chceck gauge cable, connection.
- **E5: Cathode Failure. Cathode is broken or short circuit.**
  - Not connected power supply device plug to Ion source.
  - Bad connection, thus bad conduction with power supply plug, in electrical transition of Ion source.
  - Burned out cathode (check if there is small resistance between 5 and 6, below 1 Ohm- this means that cathode is OK, otherwise something is wrong).
  - Power supply regulation circuit damage.

- Try to switch power supply off and on subsequently, but if any of those methods will not result in expected effect, it is necessary to repair damaged Ion source or power supply unit.

- **E6: Current Limit. The controller can't achieve given emission current.**
  - Bad connection, thus bad conduction with power supply plug, in electrical transition of Ion source
  - Electrical short of cathode (Check if there is cathode glowing inside chamber – if all is ok, cathode glows)
  - Damage of regulation circuit inside power supply unit

- **E7: Scan X Overflow. Scan range X reached a maximum**
  - adjusted value of horizontal scanning area together with PX deflection values exceeds physical values of deflection possibilities,
  - make scanning area dimensions smaller.
  - move scanning area closer to middle point.

- **E8: Scan Y Overflow. Scan range Y reached a maximum**
  - adjusted value of vertical scanning area together with PY deflection values exceeds physical values of deflection possibilities,
  - make scanning area dimensions smaller.
  - move scanning area closer to middle point.

- **E9: Wien Plate Regulation. Automatic adjustment of the Wien Plate Potential is outside the range of the regulation.**
  - Calculated deflection potential value is out of the range regulation possibilities.
  - Decrease Energy voltage value,

- **E10: Internal Connection Fail. The connection to Energy module has been lost. Error Code: <number>.**
  - Internal connection between the Energy module and the motherboard has been lost. Switch off device, wait 30 seconds, then switch on again. If the problem appears again, it may indicate internal main board damage => contact Prevac

- **E11: Internal Connection Fail. The connection to Focus module has been lost. Error Code: <number>.**
  - Internal connection between the Focus module and the motherboard has been lost. Switch off device, wait few seconds, then switch on again. If the problem appears again, it may indicate internal main board damage => contact Prevac

- **E12: Internal Connection Fail. The connection to Emission module has been lost. Error Code: <number>.**
  - Internal connection between the Emission module and the motherboard has been lost. Switch off device, wait few seconds, then switch on again. If the problem appears again, it may indicate internal main board damage => contact Prevac

- **E13: Internal Connection Fail. The connection to Scan module has been lost. Error Code: <number>.**

  - Internal connection between the Scan module and the motherboard has been lost. Switch off device, wait few seconds, then switch on again. If the problem appears again, it may indicate internal main board damage => contact Prevac

- **E14: Internal Connection Fail. The connection to Bus module has been lost. Error Code: <number>.**

  - Internal connection between the Bus module and the motherboard has been lost. Switch off device, wait few seconds, then switch on again. If the problem appears again, it may indicate internal main board damage => contact Prevac

- **E15: Internal Connection Fail. The connection to Wien Mass Filter module has been lost. Error Code: <number>.**

  - Internal connection between the Energy module and the motherboard has been lost. Switch off device, wait few seconds, then switch on again. If the problem appears again, it may indicate internal main board damage => contact Prevac

- **E16: Hardware error. There is no Digital Card in the device.**

  - Device can not recognize the digital Card. Switch off device, wait few seconds, then switch on again. If the problem appears again, it may indicate internal main board damage or digital card damage. Contact Prevac.

5.1.2 WARNINGS

- **W1: Low Disk Space: We suggest to remove videos from device.** Warning resulting from insufficient space on the SDHC card. In order to free up some space, delete some videos.

- **W2: Interlock Failure: Interlock Failure** Loss of protection signal **INTERLOCK** during normal operation in **OPERATE** mode will rapidly cause the unit to enter into **STANDBY**

  - Protection signal INTERLOCK is usually related to the vacuum level in the chamber. Therefore its loss usually means deterioration of the vacuum conditions and therefore necessity to immediately stop the process (done automatically).
  - Loss of INTERLOCK signal can also be caused by removing the plug or damage the cable.

5.2 MESSAGE BOX NOTIFICATIONS

- **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 IS40-PS 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 IS40-PS 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: No vacuum interlock.**
  Switching IS40-PS to OPERATE mode will not be possible if the vacuum INTERLOCK signal is missing. There will be a warning displayed.
  Such a failure can be caused by the following reasons:

  – Verify that you have selected the correct vacuum head in the menu.
  – The value of the vacuum is outside the min / max value set in the pressure channel. Check the vacuum pressure and the configuration of the min / max values.

- **M23: Device is degassing now**
  Message appears when you try to turn on the device during the **degas procedure**.

  – Wait while degas procedure was finished,
  – Go to Setup Menu(1->1->2) and turn off degas procedure,

- **M24: Device must be in standby mode.**
  Message appears when you try to turn on **degas procedure** during device is in **Operate** mode.

  – Goto Standby mode and then run degas procedure.

- **M25: Cathode is broken or short circuit.**

- **M26: Operate OFF is currently controlled by a digital input.**
  Message appears when you try switch OFF device and to the OPERATE OFF procedure is assigned digital input.

  – Check digital input configuration in setup menu(1->8->4) and assign to OPERATE OFF **none** signal as you need

- **M27: Operate ON is currently controlled by a digital input.**
  Message appears when you try switch ON device and to the OPERATE ON procedure is assigned digital input.

  – Check digital input configuration in setup menu(1->8->3) and assign to OPERATE ON **none** signal as you need

DANGER

Disconnecting Ion source.
Before disconnecting Ion source from power supply please make sure that the HV is OFF and the LED indicator HV ON is off. If not please wait until the HV voltage discharges itself. Then switch off the device with power switch.

6 COMMUNICATION

6.1 INTRODUCTION

This chapter is intended for users who want to use Modbus RTU or Modbus TCP (Ethernet). These are communication protocols used to control the functioning of the IS40-PS .
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) and Ethernet (Modbus TCP).
In addition, it includes advances 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. 100Ω/km. Generally 0.14mm^2 (24AWG) cables or thicker.
- Rated impedance 100Ω at 100kHz.
- With differential communication screened twisted pair should be used.
- Mutual capacitance of a pair should be max. 60pF/m (capacitance between two conductors in a pair).
- Stray capacitance max. 120pF/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.

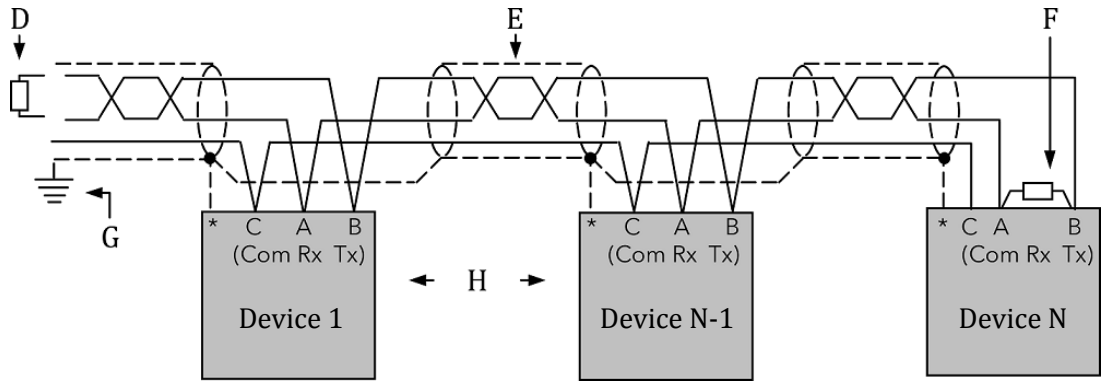


Figure 6.1: Example of 3-conductor (+ screen) EIA485 connection

* 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 shield (metal casing clamped on the braided cable shield).

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: *"IS40-PS - 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 from the device menu is locked (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: (Modbus protocol: address 1000; data field= 0, see tab 6.12. Prevac protocol: order 0xFFF1; data field= 0).
- 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***.

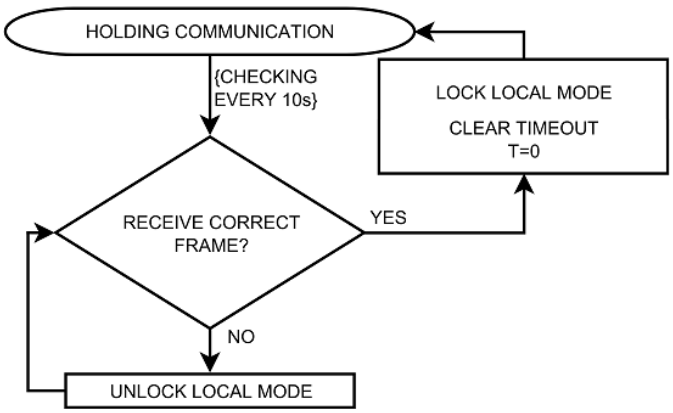


Figure 6.2: Maintaining communication - sequence diagram

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 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

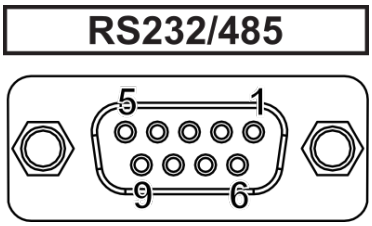


Figure 6.3: Female socket of RS232/RS485 (Modbus RTU) interface

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

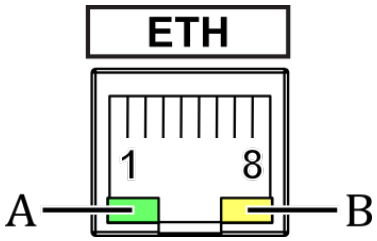


Figure 6.4: Female socket of Ethernet 10baseT (Modbus TCP) interface

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 (green)	Connection status	disabled - no connection, activity always on - connection in the network, no traffic blinking - connection active, traffic in the network
B (yellow)	Network status	disabled - no voltage or IP address not assigned always on - network active

Table 6.2: Pins description of ”ETH” connector

6.4 MODBUS PROTOCOL

6.4.1 INTRODUCTION

This implementation is used to provide a popular format od 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 set from comminication menu (details in chapter 3.4.12.1). 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 IS40-PS 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. 6.5.

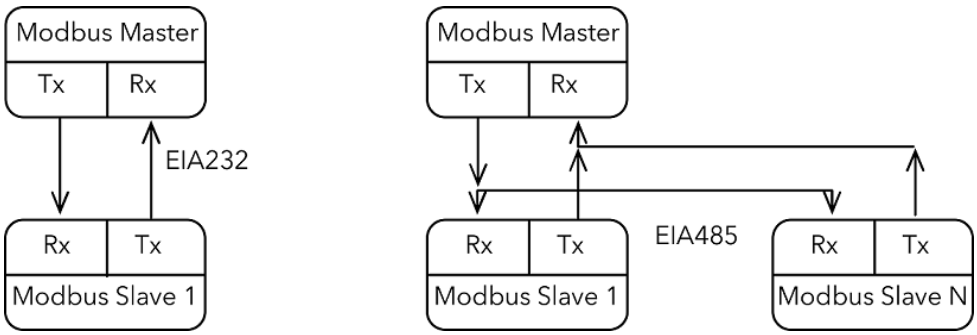


Figure 6.5: Modbus RTU network structures model

- Each Slave device in the network has its unique address.
- The IS40-PS device supports subset of Modbus codes.
- Refer through “parameter address” to the IS40-PS 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 and Ethernet.
For standard IS40-PS 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 3.4.12.1.

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

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 IS40-PS 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 make 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 6.3 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 ±12Volt (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 6.3: 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 ±200mV. 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 IS40-PS 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 require, 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 IS40-PS devices and a MASTER device, in particular at greater distances and transmission speeds (>38400bps, >10m) it is recommended to use a 2-conductor twisted pair, preferably, with an additional screen. Remember also to add a terminator (120Ω...470Ω resistor connected between lines A and B) at the beginning and the end of the EIA485 bus.

Note 6: The IS40-PS 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 6.4: 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 bytes	1 byte	1 byte	n bytes	2 bytes	3 bytes

Table 6.5: 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 in main menu. 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 IS40-PS 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 6.6 illustrates this algorithm of checking CRC errors.
Symbol '⊕' indicates XOR operation. "n" means a number of data bits.

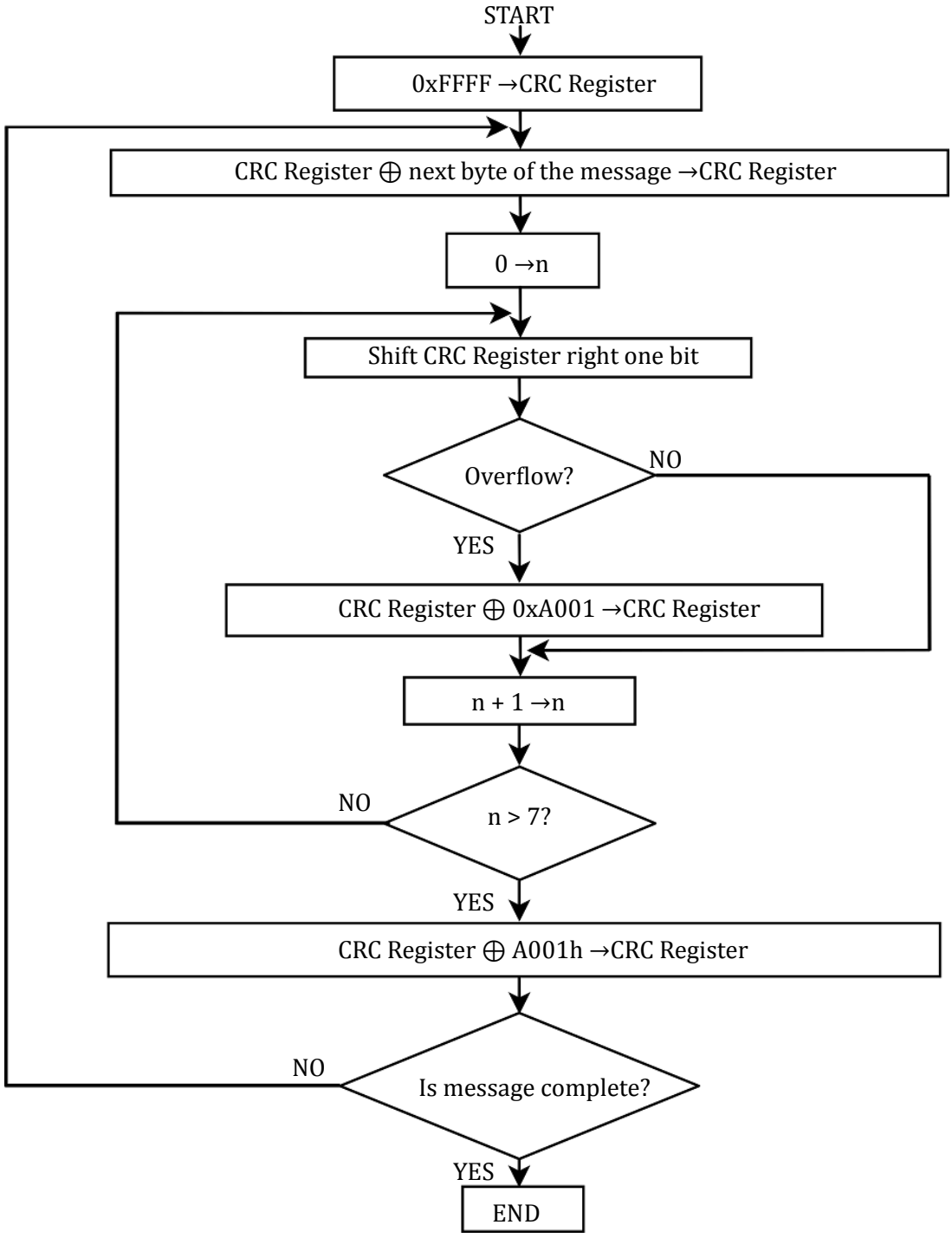


Figure 6.6: Checksum calculation algorithm

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.

```
uint16 calculate_crc(char *z_p, uint16 z_message_length)
/* CRC runs cyclic Redundancy Check Algorithm on input z_p */
/* Returns value of 16 bit CRC after completion and */
/* always adds 2 crc bytes to message */
/* returns 0 if incoming message has correct CRC */
{
  uint16 next, carry, n, CRC= 0xffff;
  uint8 crch, crcl;
  while (z_message_length--) {
    next = (uint16)*z_p;
    CRC ^= next;
    for (n = 0; n < 8; n++) {
      carry = CRC & 1;
      CRC >>= 1;
      if (carry) {
        CRC ^= 0xA001;
      }
    }
    z_p++;
  }
  crch = CRC / 256;
  crcl = CRC % 256
  z_p[z_message_length++] = crcl;
  z_p[z_message_length] = crch;
  return CRC;
}
```

6.4.4 MODBUS TCP

The IS40-PS 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 IS40-PS . 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 IS40-PS 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 3.4.12.1.

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 IS40-PS 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 IS40-PS 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 bytes	2 bytes	2 bytes	1 byte	1 byte	n bytes

Table 6.6: 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 IS40-PS device.

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

Table 6.7: 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 3 words from address 0x0000.
Query:
TX: 01 03 00 00 00 03 05 CB
Response:
RX: 01 03 06 3A 83 12 6F 00 00 54 94
Received data: 3A 83 12 6F 00 00

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: Write word to address 0x004A.
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: Write 2 words from address 0x0005.
Query:
TX: 01 10 00 05 00 02 04 22 33 44 55 3A D8
Response:
RX: 01 10 00 05 00 02 51 C9

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 IS40-PS 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.

continued on next page

continued from previous page

Error code	Error type	Description
0x06	Busy / Message 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 acknowledge	The response of the device inquired when the required action cannot be executed.
0x0A	Network path unavailable	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 6.8: 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 6.9: 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 6.10: Example float IEEE-754 value in Modbus table

6.4.8 TABLE OF MODBUS VARIABLES - MAP OF REGISTERS

FUNCTION	ADDRESS	TYPE	FORMAT	MUL	RANGE [UNIT]
IS40 POWER SUPPLY SETTINGS					
Work state: 0 - STANDBY 1 - OPERATE	0	R	UINT8		
Status 1: bit0: Switch to OPERATE allowed bit1: Degassing not allowed bit2: No master interlock bit3: Degassing bit4: Cathode failure bit5: Cathode current limit bit6: Digital I/O card installed bit7: Analog I/O card installed bit8: Scan X overflow bit9: Scan Y overflow bit10: No vacuum interlock	1	R	INT16		bits field bit11: Beam blanking enable status bit12: Scanning control source: 0 - internal, 1 - external bit13: Status of the flow controller activation
Status 2: bit0: Energy supply short circuit bit1: Energy supply failure bit2: Extrector supply short circuit bit3: Extrector supply failure bit4: First focus supply short circuit bit5: First focus supply failure bit6: Second focus supply short circuit bit5: Second focus supply failure	2	R	INT16		bits field
Energy volage	3	R	INT16		[V]
First focus voltage	4	R	INT16		[V]
Second focus voltage	5	R	INT16		[V]
Emission current	6	R	FLOAT		[mA]
Extractor voltage	8	R	FLOAT		[%]
Time left to complete degassing	10	R	INT16		[s]
Total cathode work time	11	R	INT32		[s]
Device version: 0 - Basic - C 1 - Extended - E	13	R	UINT8		
Go to OPERATE	14	R/W	UINT8		1
Go to STANDBY	15	R/W	UINT8		1
Turn degassing on	16	R/W	UINT8		1
Turn degassing off	17	R/W	UINT8		1
Energy volage set	18	R/W	INT16		0 .. 5000 [V]
First focus voltage set	19	R/W	INT16		0 .. Uenergy
Second focus voltage set	20	R/W	INT16		0 .. Uenergy
Emission current set	21	R/W	FLOAT		0.01 .. 10.00 [mA]
Extractor voltage	23	R/W	FLOAT		60.0 .. 100.0 [%]
Scan position X	25	R/W	FLOAT		-5.00 .. 5.00 [mm]
Scan position Y	27	R/W	FLOAT		-5.00 .. 5.00 [mm]
Scan area X	29	R/W	FLOAT		0.00 .. 10.00 [mm]
Scan areaa Y	31	R/W	FLOAT		0.00 .. 10.00 [mm]
Scan grid X	33	R/W	FLOAT		0.01 .. 2.00 [mm]
Scan grid Y	35	R/W	FLOAT		0.01 .. 2.00 [mm]
Sample angle X	37	R/W	INT16		15 .. 165 [°]
Sample angle Y	38	R/W	INT16		15 .. 165 [°]
Time per dot	39	R/W	INT16		20 .. 30000 [μs]
Sample distance from ion source	40	R/W	FLOAT		0.1 .. 150.0 [mm]

continued on next page

continued from previous page

FUNCTION	ADDRESS	TYPE	FORMAT	MUL	RANGE [UNIT]
Empty - for the future use	42	R	FLOAT		
Degas time	44	R/W	UINT8		1 .. 30 [min]
Vacuum interlock: 0 - Off 1 - On	45	R/W	UINT8		0,1
Wien filter supply: 0 - Not connected 1 - Connected	46	R/W	UINT8		0,1
Wien filter. Plate potential control: 0 - Manual 1 - Auto	47	R/W	UINT8		0,1
Wien filter. Gas type: 1 - Helium 2 - Neon 3 - Argon 5 - Xenon	48	R/W	UINT8		1 .. 3, 5
Wien filter. Magnet type: 0 - 0.4 T 1 - 0.24 T	49	R/W	UINT8		0,1
Wien filter. Plate potential	50	R/W	FLOAT		0.0 .. 1360.0 [V]
Wien filter. Lens in voltage	52	R/W	FLOAT		-100.0 .. 100.0 [V]
Wien filter. Lens out voltage	54	R/W	FLOAT		-100.0 .. 100.0 [V]
Timer counting direction: 0 - Down 1 - Up	56	R/W	UINT8		0, 1
Actual operate time	57	R	INT32		[s]
Operate time setpoint	59	R/W	INT32		[s]
Enable beam blanking	61	R/W	UINT8		1
Disable beam blanking	62	R/W	UINT8		1
Enable external scanning control	63	R/W	UINT8		1
Disable external scanning control	64	R/W	UINT8		1
Enable gas flow controller control	65	R/W	UINT8		1
Disable gas flow controller control	66	R/W	UINT8		1
Flow Setpoint - gas flow value setpoint	67	R/W	FLOAT		0.00 .. FS [sccm]
Maximum flow of the gas flow controller (FS)	69	R/W	FLOAT		0.00 .. 9999.00 [sccm]
Current gas flow readout	71	R	FLOAT		[sccm]
The control voltage of the flow controller, corresponding to the maximum	73	R/W	FLOAT		[V]

Table 6.11: **Map of IS40 Power Supply**

FUNCTION	ADDRESS	TYPE	FORMAT	MUL	RANGE [UNIT]
GLOBAL DEVICE SETTINGS					
Release remote control	1000	R/W	UINT8		
Product number	1001	R	15·CHAR		
Serial number	1009	R	13·CHAR		
Software version - TAG number	1016	R	80·CHAR		
Software version - HASH cocd	1056	R	80·CHAR		
Device name	1096	R	16·CHAR		

continued on next page

continued from previous page

FUNCTION	ADDRESS	TYPE	FORMAT	MUL	RANGE [UNIT]
Customer name	1104	R/W	18·CHAR		
Touch screen autolock	1113	R/W	UINT8		0, 1
System date	1114	R/W	10·CHAR		format: yyyy.MM.dd
System time	1119	R/W	8·CHAR		format: hh:mm:ss
Panel timer time	1123	R/W	8·CHAR		format: hh:mm:ss
Panel timer actual time	1127	R	8·CHAR		format: hh:mm:ss
Error codes - 10 successive codes in a size 2BYTE	1131	R	20·UINT8		look. tab 6.21, 6.24
Warning codes - 10 successive codes in a size 2 BYTE	1141	R	20·UINT8		look. tab 6.22 , 6.25
Status of remote control enable	1151	R	UINT8		0, 1

Table 6.12: Map of global settings registers

FUNCTION	ADDRESS	TYPE	FORMAT	MUL	RANGE [UNIT]
DIGITAL INPUTS SETTINGS					
Channel number to which the digital input would be assigned. For example, if the device supports two vacuum gauges this parameter should be set to 1 or 2 respectively.	1200	R/W	UINT8		1 ..
Logical function code to which the digital input would be assigned: 1 - Interlock 2 - Operate ON. 3 - Operate OFF. 4 - Pressure Emiss ON 5 - Pressure Emiss OFF 6 - Open Shutter 7 - Close Shutter 8 - Zero Thickness 9 - Zero shutter time 10 - Remote Control Availability of functions is device dependent.	1201	R/W	UINT8		
The number of the digital input that is assigned to the selected channel and the logical function	1202	R/W	UINT8		1 .. n
Digital input 1 sense control: 0 - low level 1 - high level 2 - falling edge 3 - rising edge 4 - rising/falling edge 5 - falling/rising edge	1203	R/W	UINT8		1 .. 5
Digital input 2 sense control: *look sense control input 1*	1204	R/W	UINT8		1 .. 5
Digital input 3 sense control: *look sense control input 1*	1205	R/W	UINT8		1 .. 5
Digital input n sense control: *look sense control input 1*	1202 + n	R/W	UINT8		1 .. 5

Table 6.13: Map of digital inputs registers

FUNCTION	ADDRESS	TYPE	FORMAT	MUL	RANGE [UNIT]
RELAYS SETTINGS					
Function code assigned to relay (digital output) number 1: Code corresponds to the position of function in the menu *'Relay Outputs/Out x'*. For example, if the menu looks as below: ∘ *Relay Outputs* ∘ *Out 1* ∘ *Setpoint 1* ∘ *Setpoint 2* ∘ *Still OFF* ∘ *Still ON* ∘ *None* Code of function *Still OFF* is 3	1300	R/W	UINT8		
Operating mode of the relay(digital output) number 1: Description: 0 - Normal Open contact 1 - Normal Close contact	1301	R/W	UINT8		
Function code assigned to relay (digital output) number 2: Description - look output 1	1302	R/W	UINT8		
Operating mode of the relay(digital output) number 2: Description - look operating mode output 1	1303	R/W	UINT8		
Function code assigned to relay (digital output) number n: Description - look output 1	1300 + 2·(n-1)	R/W	UINT8		
Operating mode of the relay(digital output) number n: Description - look operating mode output 1	1301 + 2·(n-1)	R/W	UINT8		

Table 6.14: Map of relays settings registers

FUNCTION	ADDRESS	TYPE	FORMAT	MUL	RANGE [UNIT]
ANALOG INPUTS SETTINGS					
Controlled function code to which the analog input would be assigned: Code corresponds to the position of function in the menu: *Analog Inputs/Controlled Value*. For example, if the menu looks as below: ∘ *Analog Inputs* ∘ *Controlled Value* ∘ *U source* ∘ *I emis* Code of function *I emis* is 2	1400	R/W	UINT8		1 ..
The number of analog input assigned to the controlled function. 0 - no input assigned	1401	R/W	UINT8		0 .. n
Input range minimum value 1	1402	R/W	INT16	1000	0 .. 10 [V]
Input range maximum value 1	1403	R/W	INT16	1000	0 .. 10 [V]
Input range minimum value n	1402 + 2·(n-1)	R/W	INT16	1000	0 .. 10 [V]
Input range maximum valueo n	1403 + 2·(n-1)	R/W	INT16	1000	0 .. 10 [V]

Table 6.15: Map of analog inputs registers

FUNCTION	ADDRESS	TYPE	FORMAT	MUL	RANGE [UNIT]
ANALOG OUTPUTS SETTINGS					
Signal source for analogue output 1: Corresponds to the position of signal source in the menu *Source* of Analog out channel. For example, if the menu looks as below: ◦ *Source* ◦ *Pressure 1* ◦ *Pressure 2* ◦ *Usource* ◦ *Iemis.* ◦ *None* Code of signal source *Iemis* is 4	1500	R/W	UINT8		
Retransmission mode for analog output 1: 0 - 1 to 1 1 - exponent 2 - range	1501	R/W	UINT8		
Retransmission scale for analog output 1: 0 - linear 1 - logarithmic	1502	R/W	UINT8		
Minimum value of retransmitted parametter for analog output 1. It corresponds to the minimum output voltage.	1503	R/W	FLOAT		Unit and min/max is signal source dependent.
Maximum value of retransmitted parametter for analog output 1. It corresponds to the maximum output voltage.	1505	R/W	FLOAT		Unit and min/max is signal source dependent.
Minimum value of the output voltage for analog output 1	1507	R/W	INT16	1000	0 .. 10 [V]
Minimum value of the output voltage for analog output 1	1508	R/W	INT16	1000	0 .. 10 [V]
Signal source for analogue output n: Description - look output 1	1500 + 9·(n-1)	R/W	UINT8		
Retransmission mode for analog output n: Description - look output 1	1501 + 9·(n-1)	R/W	UINT8		
Retransmission scale for analog output n: Description - look output 1	1502 + 9·(n-1)	R/W	UINT8		
Minimum value of retransmitted parametter for analog output n. It corresponds to the minimum output voltage.	1503 + 9·(n-1)	R/W	FLOAT		Unit and min/max is signal source dependent
Maximum value of retransmitted parametter for analog output n. It corresponds to the maximum output voltage.	1505 + 9·(n-1)	R/W	FLOAT		Unit and min/max is signal source dependent
Minimum value of the output voltage for analog output n	1507 + 9·(n-1)	R/W	INT16	1000	0 .. 10 [V]
Minimum value of the output voltage for analog output n	1508 + 9·(n-1)	R/W	INT16	1000	0 .. 10 [V]

Table 6.16: Map of analog outputs registers

FUNCTION	ADDRESS	TYPE	FORMAT	MUL	RANGE [UNIT]
PRESSURE CHANNELS SETTINGS					
Actual pressure value in channel 1	1600	R	FLOAT		[mbar]
Status of pressure channel 1: bit0: sensor break bit1: emission state bit2: degasing state bit3: setpoint state bit4..7: not used	1602	R	UINT8		bit field

continued on next page

continued from previous page

FUNCTION	ADDRESS	TYPE	FORMAT	MUL	RANGE [UNIT]
State of pressure channel 1: 0xFF - Sensor Break 0 - vacuum is displayed 1 - Wait for emission 2 - No Emission 3 - Wait for ignition 4 - Not Calibrated 5 - voltage is displayed 6 - degasing 7 - Exter. Setpoint 8 - Low Pressure 9 - High Pressure 10 - 0.00e+00	1603	R	UINT8		
Pressure unit in channel 1: 0 - mbar 1 - Torr 2 - Pa 3 - psia	1604	R/W	UINT8		
Low setpoint for channel 1	1605	R/W	FLOAT		1.00e-14 .. 1.00e+8 [mbar]
High setpoint for channel 1	1607	R/W	FLOAT		1.00e-14 .. 1.00e+8 [mbar]
Degass possibility for channel 1: 0 - degas possible 1 - sensor break 2 - vacuum gauge doesn't support degas 3 - too low vacuum in chamber, to start the degassing	1609	R	UINT8		
Actual degas time in channel 1	1610	R	INT16		[s]
Vacuum gauge type in channel 1: 0 - CTR90/91 1 - TTR90 2 - TTR211 3 - PTR225 4 - PTR90 5 - ITR90 6 - ITR100 7 - Baratron 8 - ANALOG IN 9 - MKS 937A 10 - PG105 11 - MG13/14 12 - PKR 251/360/361 13 - PCR280/TPR28x 14 - ATMION 15 - reserved 16 - IKR360/361	1611	R/W	UINT8		

continued on next page

continued from previous page

FUNCTION	ADDRESS	TYPE	FORMAT	MUL	RANGE [UNIT]
Full scale parameter for channel 1: *If vacuum gauge type is **CTR90/91**:* 0 - 0.1 Torr 1 - 1 Torr 2 - 10 Torr 3 - 100 Torr 4 - 1000 Torr *If vacuum gauge type is **Baratron**:* 0 - 10 Torr 1 - 50 Torr 2 - 100 Torr 3 - 500 Torr 4 - 1000 Torr 5 - 20 psia 6 - 30 psia 7 - 50 psia 8 - 60 psia 9 - 100 psia 10 - 250 psia 11 - 500 psia 12 - 725 psia 13 - 1000 psia 14 - 2000 psia 15 - 3000 psia	1612	R/W	UINT8		
Type of gas - correction parameter for channel 1: 0 - Air 1 - He 2 - Ne 3 - Ar 4 - Kr 5 - Xe 6 - H2 7 - CO 8 - define	1613	R/W	UINT8		
Defined gas factor for channel 1	1614	R/W	INT16	100	0.01 .. 9.99
Filtration level of vacuum measurement in channel 1: 0 - low 1 - medium 2 - high	1615	R/W	UINT8		
Degas time for channel 1	1616	R/W	UINT8		1 .. 30 [min]
Actual voltage value in channel 1	1617	R	FLOAT		[V]
Low setpoint for sensor type **ANALOG IN** in channel 1	1619	R/W	FLOAT		0 .. 10 [V]
High setpoint for sensor type **ANALOG IN** in channel 1	1621	R/W	FLOAT		0 .. 10 [V]
Start degasing in channel 1	1623	R/W	UINT8		1
Stop degasing in channel 1	1624	R/W	UINT8		1
Emission ON for channel 1	1625	R/W	UINT8		1
Emission OFF for channel 1	1626	R/W	UINT8		1
Actual pressure value in channel n	1600 + 27·(n-1)	R	FLOAT		[mbar]
Status of pressure channel n: Description - look channel 1 (adres: 1602)	1602 + 27·(n-1)	R	UINT8		
State of pressure channel n: Description - look channel 1 (adres: 1603)	1603 + 27·(n-1)	R	UINT8		
Pressure unit in channel n: 0 - mbar 1 - Torr 2 - Pa 3 - psia	1604 + 27·(n-1)	R/W	UINT8		
Low setpoint for channel n	1605 + 27·(n-1)	R/W	FLOAT		1.00e-14 .. 1.00e+8 [mbar]

continued on next page

continued from previous page

FUNCTION	ADDRESS	TYPE	FORMAT	MUL	RANGE [UNIT]
High setpoint for channel n	1607 + 27·(n-1)	R/W	FLOAT		1.00e-14 .. 1.00e+8 [mbar]
Degass possibility for channel n: 0 - degas possible 1 - sensor break 2 - vacuum gauge doesn't support degas 3 - too low vacuum in chamber, to start the degassing	1609 + 27·(n-1)	R	UINT8		
Actual degas time in channel n	1610 + 27·(n-1)	R	INT16		[s]
Vacuum gauge type in channel n: Description - look channel 1 (adres: 1611)	1611 + 27·(n-1)	R/W	UINT8		
Full scale parameter for channel n: Description - look channel 1 (adres: 1612)	1612 + 27·(n-1)	R/W	UINT8		
Type of gas - correction parameter for channel n: Description - look channel 1 (adres: 1613)	1613 + 27·(n-1)	R/W	UINT8		
Defined gas factor for channel n	1614 + 27·(n-1)	R/W	INT16	100	0.01 .. 9.99
Filtration level of vacuum measurement in channel n: 0 - low 1 - medium 2 - high	1615 + 27·(n-1)	R/W	UINT8		
Degas time for channel n	1616 + 27·(n-1)	R/W	UINT8		1 .. 30 [min]
Actual voltage value in channel n	1617 + 27·(n-1)	R	FLOAT		[V]
Low setpoint for sensor type **ANALOG IN** in channel n	1619 + 27·(n-1)	R/W	FLOAT		0 .. 10 [V]
High setpoint for sensor type **ANALOG IN** in channel n	1621 + 27·(n-1)	R/W	FLOAT		0 .. 10 [V]
Start degasing in channel n	1623 + 27·(n-1)	R/W	UINT8		1
Stop degasing in channel n	1624 + 27·(n-1)	R/W	UINT8		1
Emission ON for channel n	1625 + 27·(n-1)	R/W	UINT8		1
Emission OFF for channel n	1626 + 27·(n-1)	R/W	UINT8		1

Table 6.17: Map of pressure channels registers

6.5 PREVAC V2.x PROTOCOL

This chapter describes communication with a IS40-PS using the Prevac V2.x protocol.

6.5.1 CONNECTION PARAMETERS

PARAMETER	VALUE
Data bits	8
Parity	None
Stop bits	1
Flow control	None
Baud rate	57600 (default value)

Table 6.18: Connection parameters

6.5.2 DATA FRAME

DATA FRAME	
Byte	**Description**
1 - HEADER	First byte is responsible for identifying the serial protocol. Header in hexadecimal is 0xBB
2 - DATA LENGTH	Length of the data field. Maximum data file length is 0xFF (256 bytes). Prevac Serial Protocol
3 - DEVICE ADDRESS	Identification of hardware device address. Default value is 0xC8
4 - HOST ADDRESS	Host identification address. Assigned to host during the registration process (using a unique ID).
5 - FUNCTION CODE - MSB	First procedure function code byte 8th (MSB) bit is the read(0)/write(1) select bit
6 - FUNCTION CODE - LSB	Second procedure function code byte
7 .. [7 + DATA LENGTH] - DATA FIELD	Data capture needed to realize defined functions.
[7 + DATA LENGTH] + 1(last frame position) - CRC	CRC is simple module 256 calculated without protocol header byte(see section 6.5.2.4)

Table 6.19: Data frame

6.5.2.1 ORDER TYPES

There are two types of commands:

- write orders,

- read orders.

Type the command defines the most significant bit of command code (see 6.8). If the bit is a logical ”1”, then the function code is interpreted as a command Save/Set. Otherwise, the order read. For example: order 0x7F06(set customer Name) allow read customer Name, and order 0xFF06(MSB set to ”1”) allow set customer Name.

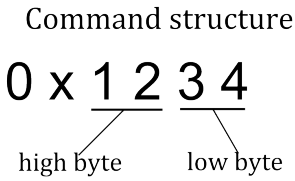


Figure 6.7: Command structure

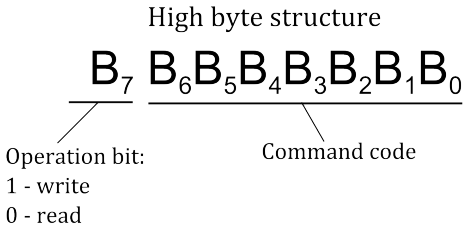


Figure 6.8: High byte command structure

For a read command, the device returns the value in a specific data type assigned to the command (see tables of orders).
For orders write the answers may be as follows:

- write command is correct (proper type, has the appropriate length and value), the device responds 0x00 value in the last byte in the data field.
- write order is incorrect, the device return error code in the last data field byte as shown in Table ref Global communication status codes.

WARNING

Read/Write Parameters.
Reading the parameters of the device is always allowed (even if the device is not in REMOTE CONTROL mode).
Writing parameters to the device requires:

- switching device in REMOTE CONTROL mode,
- registration using a unique ID
- receive permission to control as *Master*.

The registration procedure host is described in subsection 6.9

6.5.2.2 APPLIED DATA TYPES

DATA TYPE	DESCRIPTION	EXAMPLE
ASCII	The text value of the length specified in the *DATA LENGTH*	”CUSTOMER”
Long	4 bytes integer value in *Big endian* format(The most significant byte is placed first in data field)	0x000082AC
Byte	1 byte integer value, used for enumerate type and control command(ON/OFF)	0x05
Bool	true/false value (0 = false, 1 = true)	0x01, 0x00
Double	8 bytes value in IEEE 754 double-precision binary floating-point in *Big endian* format(The most significant byte is placed first in data field)	0x4028 A4DD 2F1A 9FBE

Table 6.20: Data types

6.5.2.3 INDEXING

There are 3 types of orders because of the type of indexing:

- indexed - require an index on firs byte of data fields in order to appeal to a particular object (module) on the device. On the following bytes to put the data in a format compatible with the type of order.
- indexed (no matter) - the index does not matter, but it is necessary to provide an index (eg. 1) on first byte data field. On the following bytes to put the data in a format compatible with the type of order
- without an index - only orders from the global group (see global commands table). The value we put from the first byte of the data field.

For example, reading the vacuum level from device that has 2 vacuum channels, needs to be sent command 0x0101 with the index 0x01 to read the value of the first channel:
TX: BB 01 C8 01 01 01 01 CD
Index and 0x02 to read the value of the second channel:
TX: BB 01 C8 01 01 01 02 CE.

WARNING

Index out of range.
If the index value is outside the range defined for a given command, the device returns the error code 0x93 in the last position of the data field.

If the order requires indexing, the table specified item *index* with with the scope of change. If the order does not apply to index this field *Index* is not specified in the table.

6.5.2.4 CRC

CRC is simple modulo 256 calculate without protocol header byte. Below is a sample code for the enumerator checksum value.

```
quint8 mod256_CRC = 0;
for(i= 1; i <= InputFrame->size; i++) mod256_CRC += InputFrame(i);
```

6.5.3 EXAMPLES

6.5.3.1 READ PARAMETERS FROM DEVICES

Read FG pressure value (Function code 0x0101, data field: 0x01 (index): **Request:**
TX: BB 01 C8 01 01 01 01 CD
Answer (CH1=6.25 E-2):
RX: BB 09 C8 01 01 01 01 3F B0 00 00 00 00 00 00 C4

6.5.3.2 SETUP PARAMETERS

Shutter control(Function code 0x8207, data field: 0x01 (index), 0x01 (1-ON / 0-OFF)
Request:
TX: BB 02 C8 01 82 07 01 01 56
Answer:
RX: BB 02 C8 01 82 07 01 00 55
Command executed correctly: last byte in data field equal 0.

Setting the target temperature out of range(Function code 0x8706, data field: 0x01[index], 1500.0 [target temperature])
Request:
TX: BB 09 C8 01 87 06 01 40 97 70 00 00 00 00 00 A7
Answer:
RX: BB 02 C8 01 87 06 01 91 EA
The order not executed: returned error code 0x91 in last byte data field (value too high - see 6.23).

6.5.3.3 TAKING OVER CONTROL AS MASTER

Request:
TX: BB 01 C8 01 FF F1 01 BB
Answer:
RX: BB 01 C8 01 FF F1 00 BA
The data field equal to 0 - to take control goes correctly.

6.5.4 UNIQUE ID

For proper operation of mechanism for the allocation numbers of hosts is necessary to ensure that each computer using the unique ID during the registration process host(command 0x7FF0). A unique string of characters can be extracted from the operating system using the codes explained the program.

6.5.4.1 WINDOWS OPERATING SYSTEM

```
#define _WIN32_DCOM
#include <comdef.h>
#include <comutil.h>
#include <Wbemidl.h>
#pragma comment(lib, "wbemuuid.lib")
```

```
6
7  long get_uuid(char** uuid, int* size)
8  {
9          HRESULT hr = CoInitializeEx(0, COINIT_MULTITHREADED);
10         if (FAILED(hr))
11                 return 1;
12
13         hr = CoInitializeSecurity(
14                 NULL,
15                 -1,                          // COM authentication
16                 NULL,                        // Authentication services
17                 NULL,                        // Reserved
18                 RPC_C_AUTHN_LEVEL_DEFAULT,   // Default authentication
19                 RPC_C_IMP_LEVEL_IMPERSONATE, // Default Impersonation
20                 NULL,                        // Authentication info
21                 EOAC_NONE,                   // Additional capabilities
22                 NULL                         // Reserved
23                 );
24
25         if (FAILED(hr)) {
26                 CoUninitialize();
27                 return 1;
28         }
29
30         IWbemLocator *pLoc = NULL;
31
32         hr = CoCreateInstance(
33                 CLSID_WbemLocator,
34                 0,
35                 CLSCTX_INPROC_SERVER,
36                 IID_IWbemLocator, (LPVOID *)&pLoc);
37
38         if (FAILED(hr)) {
39                 CoUninitialize();
40                 return 1;
41         }
42
43         IWbemServices *pSvc = NULL;
44
45         hr = pLoc->ConnectServer(
46                 _bstr_t(L"ROOT\\CIMV2"), // Object path of WMI namespace
47                 NULL,                    // User name. NULL = current user
48                 NULL,                    // User password. NULL = current
49                 0,                       // Locale. NULL indicates current
50                 NULL,                    // Security flags.
51                 0,                       // Authority (for example, Kerberos)
52                 0,                       // Context object
53                 &pSvc                    // pointer to IWbemServices proxy
54                 );
55
56         if (FAILED(hr)) {
57                 pLoc->Release();
58                 CoUninitialize();
59                 return 1;
60         }
61
62         hr = CoSetProxyBlanket(
63                 pSvc,                        // Indicates the proxy to set
64                 RPC_C_AUTHN_WINNT,           // RPC_C_AUTHN_xxx
65                 RPC_C_AUTHZ_NONE,            // RPC_C_AUTHZ_xxx
66                 NULL,                        // Server principal name
67                 RPC_C_AUTHN_LEVEL_CALL,      // RPC_C_AUTHN_LEVEL_xxx
68                 RPC_C_IMP_LEVEL_IMPERSONATE, // RPC_C_IMP_LEVEL_xxx
```

```
69                  NULL,                           // client identity
70                  EOAC_NONE                       // proxy capabilities
71                  );
72
73          if (FAILED(hr)) {
74                  pSvc->Release();
75                  pLoc->Release();
76                  CoUninitialize();
77                  return 1;
78          }
79
80          IEnumWbemClassObject* pEnumerator = NULL;
81          hr = pSvc->ExecQuery(
82                  bstr_t("WQL"),
83                  bstr_t("SELECT * FROM Win32_ComputerSystemProduct"),
84                  WBEM_FLAG_FORWARD_ONLY | WBEM_FLAG_RETURN_IMMEDIATELY,
85                  NULL,
86                  &pEnumerator);
87
88          if (FAILED(hr)) {
89                  pSvc->Release();
90                  pLoc->Release();
91                  CoUninitialize();
92                  return 1;
93          }
94
95          IWbemClassObject *pclsObj = NULL;
96          ULONG uReturn = 0;
97
98          while (pEnumerator)
99          {
100                 HRESULT hr =pEnumerator->Next(WBEM_INFINITE, 1, &pclsObj, &
                       uReturn);
101
102                 if (uReturn == 0)
103                         break;
104
105                 VARIANT vtProp;
106
107                 hr = pclsObj->Get(L"UUID", 0, &vtProp, 0, 0);
108                 *size = SysStringLen(vtProp.bstrVal);
109                 *uuid = _com_util::ConvertBSTRToString(vtProp.bstrVal);
110                 // ConvertBSTRToString allocates a string you must delete!
111                 VariantClear(&vtProp);
112
113                 pclsObj->Release();
114         }
115
116         pSvc->Release();
117         pLoc->Release();
118         pEnumerator->Release();
119         CoUninitialize();
120
121         return 0;
122 }
123
124 // Usage example:
125 //      char* uuid;
126 //      int size;
127 //      get_uuid(&uuid, &size);
128 //      // do sth with uuid
129 //      delete[] uuid;
```

6.5.4.2 LINUX - OPEARATING SYSTEM

```
#include <stdio.h>
#include <stdlib.h>

// First make a copy of /sys/class/dmi/id/product_uuid to your source directory.
// Type: sudo cp /sys/class/dmi/id/product_uuid ./product_uuid
// Then change file attributes of the file you've copied.
// Type: sudo chmod 777 ./product_uuid

long get_uuid(char** uuid, int* size)
{
 long error = -1;
 FILE *file = popen("cat ./product_uuid | egrep
 '[A-Fa-f0-9]{8}\-[A-Fa-f0-9]{4}\-[A-Fa-f0-9]{4}\
 -[A-Fa-f0-9]{4}\-[A-Fa-f0-9]{12}'", "r");
 if (file != NULL) {
     *size = 36;
     *uuid = (char*)malloc(*size+1);
        // Allocated buffer you must free!
     if (*uuid != NULL) {
         fread(*uuid, 1, *size, file);
         (*uuid)[*size] = 0;
         error = 0;
     }
     pclose(file);
 }
 return error;
}

// Usage example:
//      char* uuid;
//      int size;
//      get_uuid(&uuid, &size);
//      // do sth with uuid
//      free(uuid);
```

6.5.4.3 ORDERS TYPES

There are two types of commands:

- Read/Write orders,
- Read only orders,

For read commands, the device returns the requested value in the specified data format.
For write commands, the depends on the send value:

- When send value is correct(correct type, has the correct length and value), then device sends 0x00 value into data field. The answer is located in last byte of the data field,
- When send value is incorrect, an appropriate error code is sent in the last byte of the data field.

6.5.4.4 REGISTER NEW HOST

If the remote controller connects to the device first time, follow the procedure for obtaining a host address according to the diagram below.

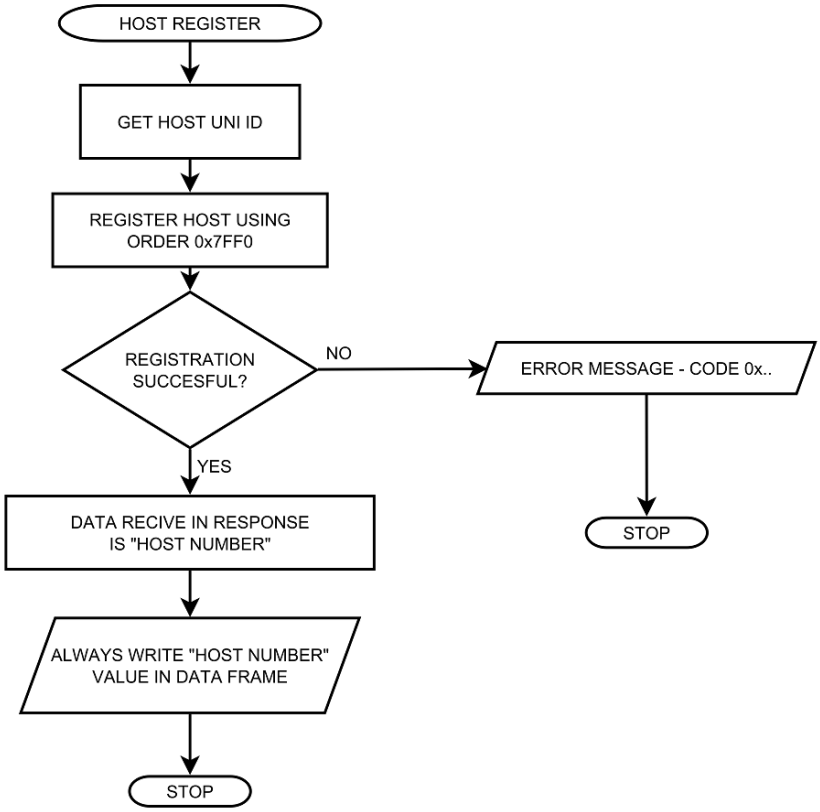


Figure 6.9: Host assign - diagram

Description of the allocation host number order is contained in the table 6.47.

Below is an example procedure for the preparation of a new host address. And then send a command set to Setpoint Low value.

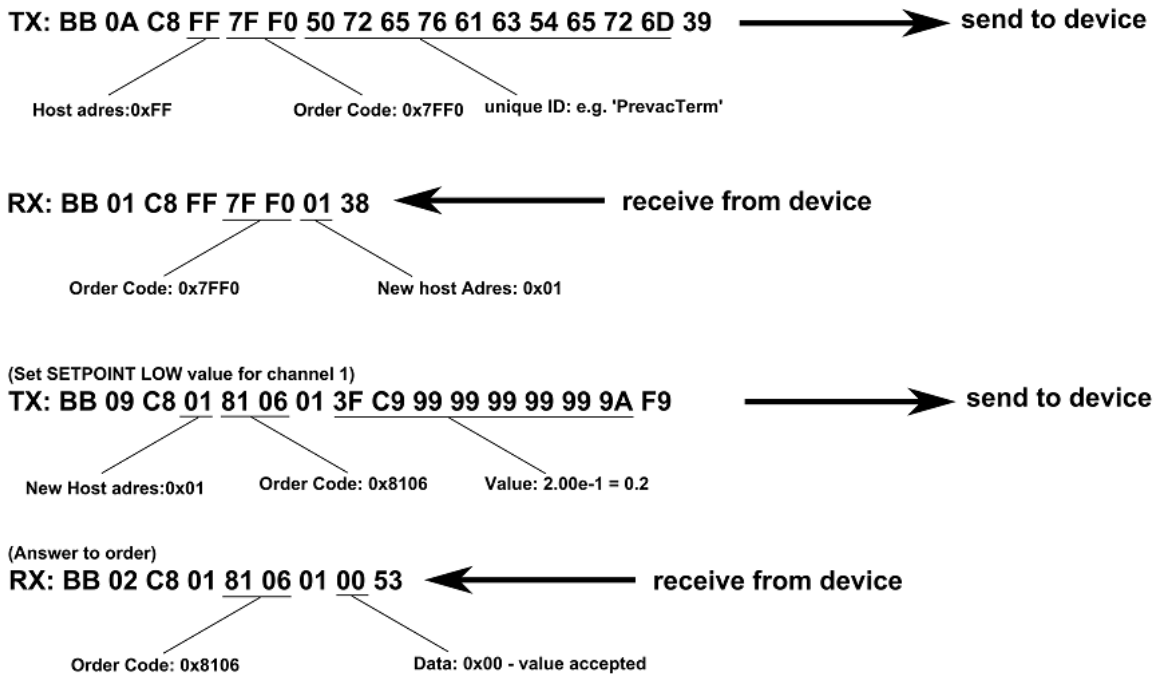


Figure 6.10: Host assign example

6.5.5 GLOBAL DEVICE STATUSES

There are two types of device status: errors and warnings. Status appear in the bar at the right of the main screen of the device. To read the error status, use the command 0x7F51, for warning status use command 0x7F52. In response we receive a code whose meaning is contained in the tables below.

Error code	Description
7F01	Internal communication error
7F02	Communication with Anybus module error
7F03	Communication with Bluetooth Anybus module error
7F04	Critically low disk space

Table 6.21: Global error status

Warning code	Description
7F80	Low disk space.
7F06	Invalid read the internal temperature of the device.
7F07	The internal temperature of the device is above safe level.
7F08	The internal temperature of the unit is too high. Switching to standby mode.

Table 6.22: Global warning status

6.5.6 GLOBAL ERROR CODES

In response to the write command, it is possible to obtain the specifying error status code, which makes impossible execution of the order. The table 6.23 lists the global error codes (apply to all orders). Additionally, the device can return specific error codes, depending on the module in which it is equipped.

Status code	Description
0x00	No errors, order executed correctly
0x91	Value is too large
0x92	Value is too small
0x93	Wrong parameter (probably wrong data format or index out of range)
0x95	Read only parameter, write prohibited
0x96	Host not know and not registered
0x97	Host know but not selected to remote control
0x98	Device configured to work in local mode
0x99	Operation or parameter is not available

Table 6.23: Global status codes

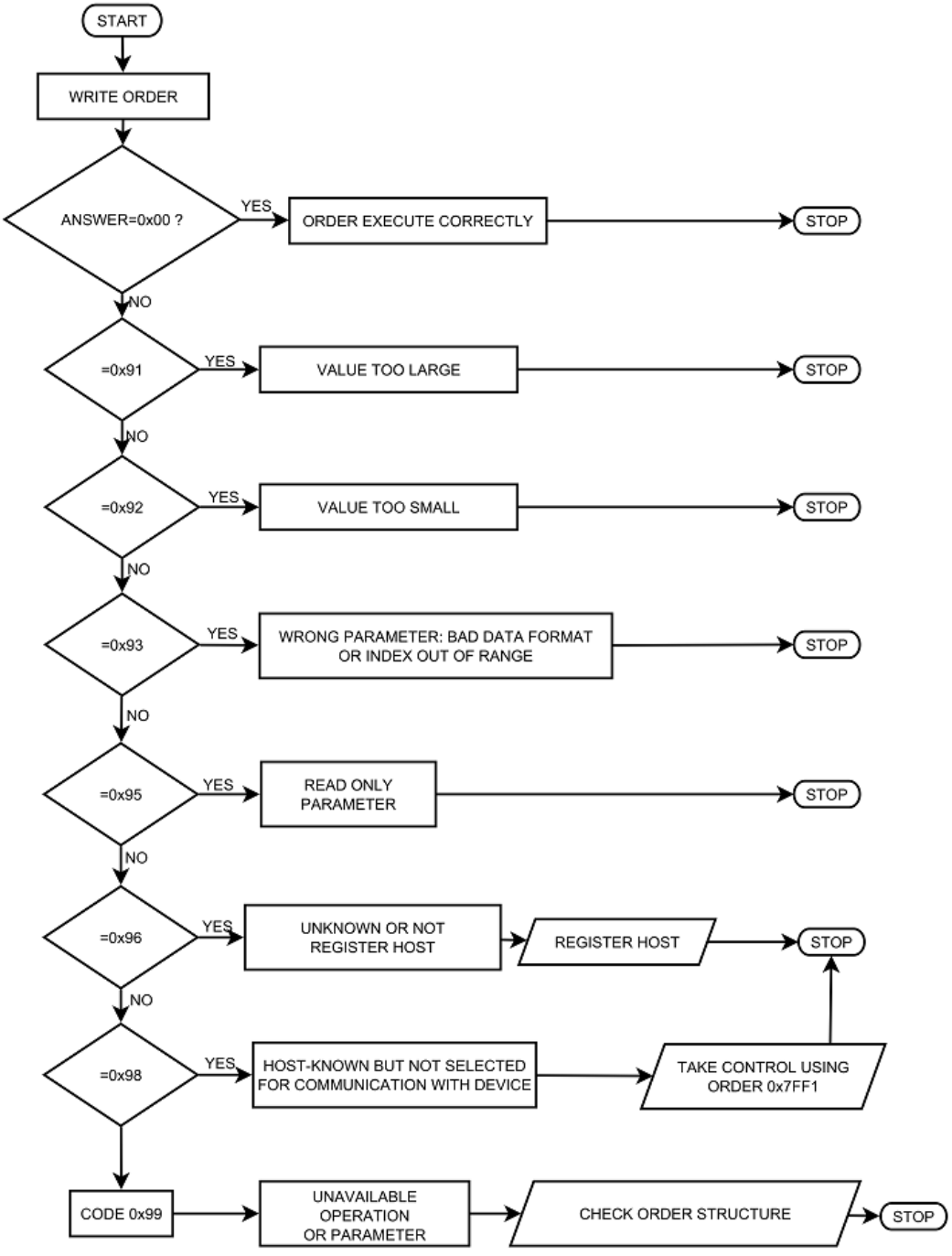


Figure 6.11: Write order example- diagram

6.5.7 IS40-PS STATUS CODE

Tables 6.24 and 6.25 contain specyfic codes for IS40-PS , read codes using function code 0x7F51 (errors) and 0x7F52 (warnings).

Error code	Description
4B01	Communication with ”Energy” module error
4B02	Communication with ”Emission” module error
4B04	Communication with ”Scan” module error
4B05	Communication with ”Mini Bus” error
4B06	Safety relay failure
4B07	Cathode failure
4B08	No ”Digital Card” detected

Table 6.24: IS40-PS error status

Warning code	Description
4B80	Current Limit
4B81	Scan range X reached a maximum
4B82	Scan range Y reached a maximum
4B83	No external interlock
4B84	No vacuum interlock
4B85	Energy supply short circuit
4B86	Focus supply short circuit
4B87	Energy supply Failure
4B88	Focus supply Failure

Table 6.25: IS40-PS warning status

6.5.8 IS40-PS ERROR ORDER CODES

Status code	Description
0x20	Internal communication error
0x21	Energy module communication error
0x22	Focus module communication error
0x23	IGER module communication error
0x24	SDU module communication error
0x25	Mini Magistrala module communication error
0x26	Wien Filter Internal communication error
0x27	Cathode Fail
0x28	No Digital card
0x29	No both interlock(*External Interlock* and *Vacuum Interlock*)
0x2A	No external interlock
0x2B	No vacuume interlock
0x2C	Degasing procedure in progress
0x2D	Operate OFF controlled by Digital IN
0x2E	Degasing unable - OPERATE ON
0x2F	Operate ON controlled by Digital IN

Table 6.26: IS40-PS order error codes

Error code	Description
VACUUM GAUGES COMMUNICATION ERRORS:	
0x80	CTR90 head not selected to set FS.
0x81	MKS870 head not selected to set FS.
0x82	Not selected ”define” gas type.
0x83	Meter damaged.
0x84	Selected head does not support degas function.
0x85	Vacuum is too low to start system degassing.
0x86	Selected head does not support emission function.

Table 6.27: Vacuum gauges communication error codes

6.5.9 ORDERS LIST

6.5.9.1 GLOBAL ORDERS - FUNCTION CODE 0x7F..

ORDER NUMBER 0x7F01 READ PRODUCT NUMBER					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1-15	Product number	ASCII			

Table 6.28: Read product number

ORDER NUMBER 0x7F02 READ SERIAL NUMBER					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1-13	Serial number	ASCII			

Table 6.29: Read serial number

ORDER NUMBER 0x7F03 READ DEVICE VERSION					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1 - [DATA LENGTH]	Device version	ASCII			

Table 6.30: Read device version

ORDER NUMBER 0x7F04 READ HASH CODE VERSION					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1 - [DATA LENGTH]	Hash code	ASCII			

Table 6.31: Read hash code version

ORDER NUMBER 0x7F05 READ DEVICE NAME					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1 - [DATA LENGTH]	Device name	ASCII			

Table 6.32: Read device name

ORDER NUMBER 0x7F06 CUSTOMER NAME					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1 - [DATA LENGTH]	Customer name (max 17 characters)	ASCII			

Table 6.33: Customer name

ORDER NUMBER 0x7F50 DEVICE STATUS					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Number of device errors 0 - no errors			0	255
2	Number of device warnings 0 - no warnings			0	255

Table 6.34: Read device status

ORDER NUMBER 0x7F51 ERROR CODES					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index of device error	BYTE		0	255
2 - 5	Device error code				

Table 6.35: Read error status code

ORDER NUMBER 0x7F52 WARNING CODES					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index of device warning			0	255
2 - 5	Device warning code				

Table 6.36: Read warning status code

ORDER NUMBER 0x7F60 VOLTAGE VALUE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: 1 - U_c 2 - U_e 3 - U_{f1} 4 - U_{f2} 6 - U_{ext} 7 - U_{erg} 8 - U_{wehn} 9 - U_x 10 - U_y	BYTE			
2-9	Value	DOUBLE	V		

Table 6.37: Voltage value

ORDER NUMBER 0x7F61 ACTUAL VOLTAGE VALUE					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: 1 - U_c 2 - U_e 3 - U_{f1} 4 - U_{f2} 6 - U_{ext} 7 - U_{erg} 8 - U_{wehn} 9 - U_x 10 - U_y	BYTE			
2-9	Value	DOUBLE	V		

Table 6.38: Actual voltage value

ORDER NUMBER 0x7F62 CURRENT VALUE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: 1 - I_c 2 - I_e 3 - I_{flux} 4 - I_{fil1} 5 - I_{fil2} 6 - I_{fil3} 7 - I_{fil4}	BYTE			
2-9	Value	DOUBLE	V		

Table 6.39: Current value

ORDER NUMBER 0x7F63 ACTUAL CURRENT VALUE					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: 1 - I_c 2 - I_e 3 - I_{flux} 4 - I_{fil1} 5 - I_{fil2} 6 - I_{fil3} 7 - I_{fil4}	BYTE			
2-9	Value	DOUBLE	V		

Table 6.40: Actual current value

ORDER NUMBER 0x7F70 RTC DATA SETTINGS					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1-10	Data value in format *yyyy.mm.dd*	ASCII			

Table 6.41: RTC data settings

ORDER NUMBER 0x7F71 RTC TIME SETTINGS					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1-8	Time value in format *hh:mm:ss*	ASCII			

Table 6.42: RTC time settings

ORDER NUMBER 0x7F72 PANEL TIMER TIME SETTINGS					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1-8	Set panel timer value in format *hh:mm:ss*	ASCII			

Table 6.43: Panel Timer time settings

ORDER NUMBER 0x7F73 PANEL TIMER ACTUAL TIME					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1-8	Actual panel timer value in format *hh:mm:ss*	ASCII			

Table 6.44: Actual panel timer value

ORDER NUMBER 0x7F74 PANEL TIMER START/STOP					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Panel Timer Start/Stop (Start=1, Stop=0)	BYTE			

Table 6.45: Panel timer start/stop

ORDER NUMBER 0x7F0C TOUCH SCREEN AUTOLOCK					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	0 - Touch screen autolock OFF 1 - Touch screen autolock ON				

Table 6.46: Touch screen autolock

ORDER NUMBER 0x7FF0 HOST NUMBER ASSIGN					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
QUERY:					
1 - [DATA LENGTH]	Unique ID	ASCII			
RESPONSE:					
1	Assigned host address	BYTE		1	255

Table 6.47: Host address assign

ORDER NUMBER 0x7FF1 MASTER MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
FOR WRITE ORDER:					
1	Assignment/release *MASTER* mode control 1 - Assignment control, 0 - Relase control,	Byte		0	1
FOR READ ORDER:					
1	*MASTER* control status (bit field) - status returned on particular bits from B0(LSB) to B7(MSB). **B0:** Working as *MASTER* (0 - no, 1 - yes) **B1:** Take control as *MASTER*(0 - forbidden, 1 - permitted). Bit B1=1 if and only if B2=1, B3=1 i B4=0. **B2:** Device *REMOTE CONTROL* mode(0 - inactive, 1 - activate) **B3:** Host registration status(0 - not registered, 1 - registred) **B4:** Other *MASTER* host device in system (0 - no, 1- yes)	Byte			

Table 6.48: Assignment/release of Master mode

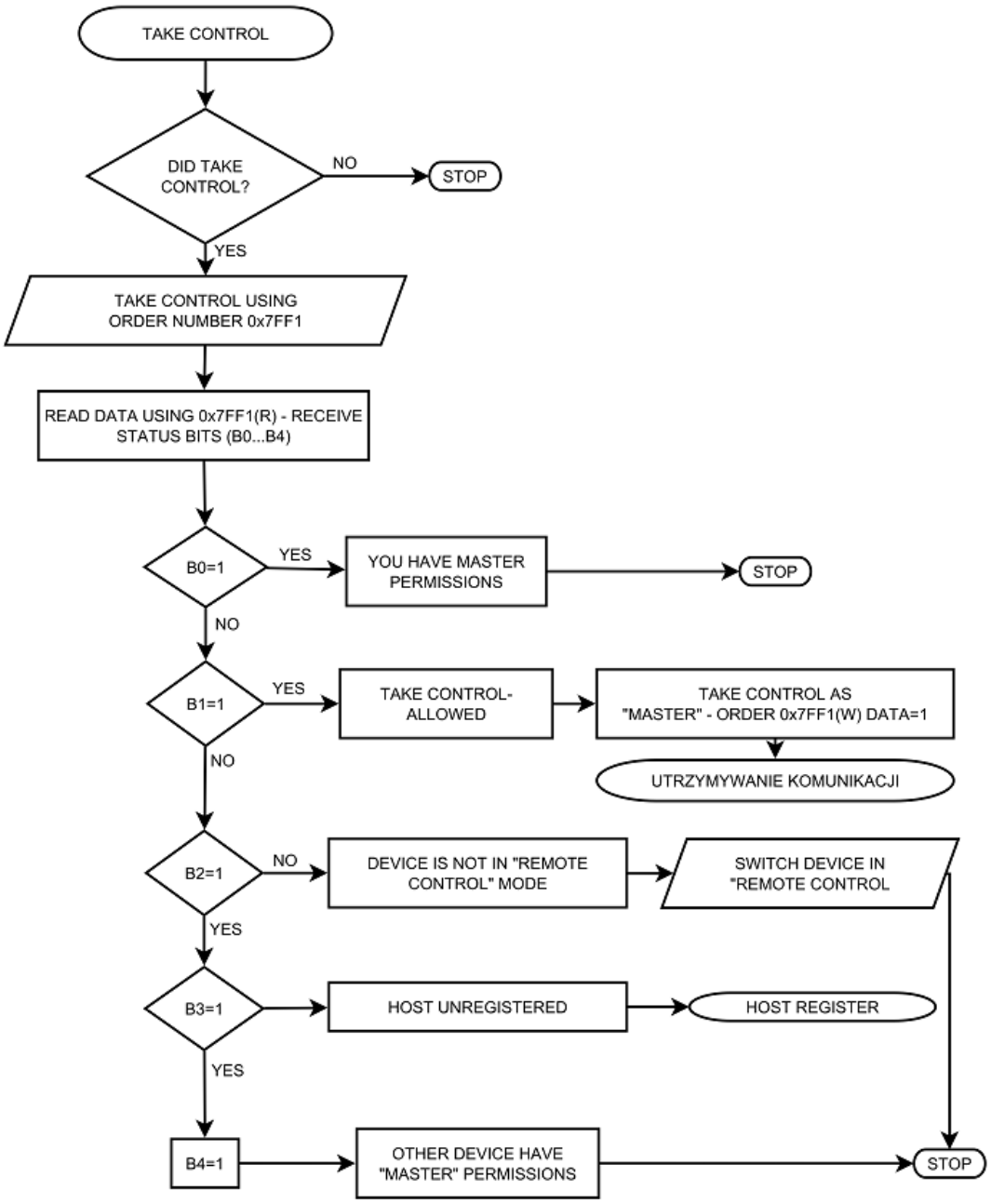


Figure 6.12: Assignment/release of Master mode - sequence diagram

ORDER NUMBER 0x7FAA SEND COMMAND TO DEVICE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1-5	Command (5 characters)	ASCII			
6 - [DATA LENGTH]	Command data (max 32 characters)	ASCII			

Table 6.49: Send command

6.5.9.2 IS40 ORDERS - FUNCTION CODE 0x44..

Index value is without function.

ORDER NUMBER 0x4401 OPERATE STATE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2	Operate On/Off 0 - Operate Off 1 - Operate On	INT			

Table 6.50: Operate State On/Off

ORDER NUMBER 0x4402 ENERGY VOLTAGE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-9	Energy voltage value	Double	V	0	5000

Table 6.51: Energy Voltage Set/Read

ORDER NUMBER 0x4403 ACTUAL ENERGY VOLTAGE					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2	Actual energy voltage value	Double	V	0	5000

Table 6.52: Actual energy voltage value

ORDER NUMBER 0x4404 FOCUS 1 VOLTAGE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-9	Focus 1 voltage value	Double	V	0	Energy

Table 6.53: Focus 1 Voltage Set/Read

ORDER NUMBER 0x4405 ACTUAL FOCUS 1 VOLTAGE					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2	Actual Focus 1 voltage value	Double	V	0	Energy

Table 6.54: Actual Focus 1 voltage value

ORDER NUMBER 0x4406 FOCUS 2 VOLTAGE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-9	Focus 2 voltage value	Double	V	0	Energy

Table 6.55: Focus 2 voltage Set/Read

ORDER NUMBER 0x4407 ACTUAL FOCUS 2 VOLTAGE					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2	Actual Focus 2 voltage value	Double	V	0	Energy

Table 6.56: Actual Focus 2 voltage value

ORDER NUMBER 0x4408 EMISSION CURRENT					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-9	Emission current value	Double	A	0.0	0.010

Table 6.57: Emission current Set/Read

ORDER NUMBER 0x4409 ACTUAL EMISSION CURRENT					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-9	Actual emission current value	Double	A	0.0	0.010

Table 6.58: Actual Emission current value

ORDER NUMBER 0x440A EXTRACTOR VALUE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-9	Percentage value of Energy Voltage $Uext = Uenergy * x[\%]$	Double	%	60	100

Table 6.59: Extractor value Set/Read

ORDER NUMBER 0x440B ACTUAL EXTRACTOR VALUE					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-9	Percentage value of Energy Voltage $Uext = Uenergy * x[\%]$	Double	%	60	100

Table 6.60: Actual Extractor value

ORDER NUMBER 0x440C SCAN POSITION X					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-9	Scan position X	Double	mm	-5.00	5.00

Table 6.61: Scan position X

ORDER NUMBER 0x440D SCAN POSITION Y					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-9	Scan position Y	Double	mm	-5.00	5.00

Table 6.62: Scan position Y

ORDER NUMBER 0x440E SCAN AREA X					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-9	Scan area X	Double	mm	0.0	10.00

Table 6.63: Scan area X

ORDER NUMBER 0x440F SCAN AREA Y					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-9	Scan area Y	Double	mm	0.0	10.00

Table 6.64: Scan area Y

ORDER NUMBER 0x4410 SCAN GRID X					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-9	Scan grid X	Double	mm	0.01	2.00

Table 6.65: Scan grid X

ORDER NUMBER 0x4411 SCAN GRID Y					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-9	Scan grid Y	Double	mm	0.01	2.00

Table 6.66: Scan grid Y

ORDER NUMBER 0x4412 SAMPLE ANGLE X					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-9	Sample Angle X	Double	°	15	165

Table 6.67: Sample Angle X

ORDER NUMBER 0x4413 SAMPLE ANGLE Y					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-9	Sample Angle Y	Double	°	15	165

Table 6.68: Sample Angle Y

ORDER NUMBER 0x4414 TIME PER DOT					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-9	Time per dot	Double	us	20	30000

Table 6.69: Sample Angle Y

ORDER NUMBER 0x4415 SAMPLE DIST. FROM ION SOURCE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-9	Sample distance from ION Source	Double	mm	0.1	150.0

Table 6.70: Sample distance from ION Source

ORDER NUMBER 0x4417 DEGAS					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2	Degas On/Off 0 - Degas Off 1 - Degas On	INT		0	1

Table 6.71: Planes distance from analyser

ORDER NUMBER 0x4418 DEGAS TIME					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-5	Degas time set/read	Long	s	60	1800

Table 6.72: Degas time set/read

ORDER NUMBER 0x4419 ACTUAL DEGAS TIME					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-5	Actual Degas time read	Long	s	60	1800

Table 6.73: Actual Degas time read

ORDER NUMBER 0x441A CATHODE WORKING TIME					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-5	Cathode working time read	Long	s		

Table 6.74: Cathode working time read

ORDER NUMBER 0x441B CLEAR CATHODE WORKING TIME					W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2	Clear cathode working time	INT			

Table 6.75: Clear cathode working time

ORDER NUMBER 0x441C VACUUM INTERLOCK					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2	Vacuum Interlock 0 - OFF 1 - ON	INT		0	1

Table 6.76: Vacuum Interlock On/Off

ORDER NUMBER 0x4420 PRESENCE OF WIEN FILTER					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2	Wien Filter power supply 0 - NOT connected 1 - Connected	INT		0	1

Table 6.77: Wien Filter power supply presence

ORDER NUMBER 0x4421 WIEN: PLATE POTENTIAL CONTROL					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2	Wien Filter Plate potential control 0 - Manual 1 - Auto	INT		0	1

Table 6.78: Wien Filter Plate potential control

ORDER NUMBER 0x4422 WIEN: GAS TYPE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2	Gas type 1 - Helium 2 - Neon 3 - Argon 5 - Xenon	INT		1	5

Table 6.79: Wien gas type

ORDER NUMBER 0x4423 WIEN: MAGNET TYPE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2	Magnet type 0 - 0.4T 1 - 0.24T	INT		0	1

Table 6.80: Wien magnet type

ORDER NUMBER 0x4424 WIEN: PLATE POTENTIAL					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-9	Plate potential value	Double	V	0.0	1360.0

Table 6.81: Plate potential value

ORDER NUMBER 0x4425 WIEN: LENS IN VOLTAGE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-9	Lens in voltage value	Double	V	-100.0	100.0

Table 6.82: Lens in voltage value

ORDER NUMBER 0x4426 WIEN: LENS OUT VOLTAGE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	INT			
2-9	Lens out voltage value	Double	V	-100.0	100.0

Table 6.83: Lens out voltage value

6.5.9.3 VACUUM GAUGE ORDERS - FUNCTION CODE 0x01..

ORDER NUMBER 0x0101 ACTUAL VACUUM GAUGE VALUE					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2-9	Value	DOUBLE	mbar		

Table 6.84: Read actual vacuum gauge value

ORDER NUMBER 0x0102 ACTUAL VACUUM GAUGE ANALOG VALUE					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2-9	Value	DOUBLE	V		

Table 6.85: Read actual vacuum gauge analog value

ORDER NUMBER 0x0103 VACUUM GAUGE UNIT					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	Unit: 0 - mbar 1 - Torr 2 - Pa 3 - psia				

Table 6.86: Vacuum gauge unit

ORDER NUMBER 0x0104 NO SENSOR IN THE VACUUM GAUGE					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	State: 0 - False, 1 - True	Bool		0	1

Table 6.87: Read no sensor state

ORDER NUMBER 0x0105 VACUUM GAUGE STATUS					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	Status: -1 - ”Sensor Break!” 0 - Vacuum 1 - ”Wait for emission” 2 - ”No Emission” 3 - ”Wait for ignition” 4 - ”Not Calibrated” 5 - Voltage 6 - ”Degasing ” + time 7 - ”Exter. Setpoint” 8 - ”Low Pressure” 9 - ”High Pressure” 10 - ”0.00e+00”	BYTE			

Table 6.88: Read vacuum gauge status

ORDER NUMBER 0x0106 LOW SETPOINT IN MBAR					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2-9	Setpoint value	DOUBLE	mbar		

Table 6.89: Set/Read LOW Setpoint in mbar

ORDER NUMBER 0x0107 HIGH SETPOINT IN MBAR					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2-9	Setpoint value	DOUBLE	mbar		

Table 6.90: Set/Read HIGH Setpoint in mbar

ORDER NUMBER 0x0108 LOW SETPOINT IN VOLTS					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2-9	Setpoint value	DOUBLE	V		

Table 6.91: Set/Read LOW Setpoint in volts

ORDER NUMBER 0x0109 HIGH SETPOINT IN VOLTS					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2-9	Setpoint value	DOUBLE	V		

Table 6.92: Set/Read HIGH Setpoint in volts

ORDER NUMBER 0x010A TRIGGER STATE					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	State: 0 - Off, 1 -	Bool		0	1

Table 6.93: Read trigger state

ORDER NUMBER 0x010B GAUGE TYPE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	Type: 0 - CTR90 1 - TTR90 2 - TTR211 3 - PTR225 4 - PTR90 5 - ITR90 6 - ITR100 7 - Baratron 8 - ANALOG IN 9 - MKS 937A 10 - PG105 11 - MG13/14 12 - PKR 251 13 - PCR 280/TPR 28x 14 - ATMION 15 - reserved 16 - IKR360/361	BYTE			

Table 6.94: Set/Read gauge type

ORDER NUMBER 0x010C CTR90/91 FULL SCALE PARAMETER					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	FS: 0 - 0.1 Torr 1 - 1 Torr 2 - 10 Torr 3 - 100 Torr 4 - 1000 Torr	BYTE			

Table 6.95: Set/Read full scale parameter for CTR90/91 gauge unit

ORDER NUMBER 0x010D Baratron FULL SCALE PARAMETER					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	FS: 0 - 10 Torr 1 - 50 Torr 2 - 100 Torr 3 - 500 Torr 4 - 1000 Torr 5 - 20 psia 6 - 30 psia 7 - 50 psia 8 - 60 psia 9 - 100 psia 10 - 250 psia 11 - 500 psia 12 - 725 psia 13 - 1000 psia 14 - 2000 psia 15 - 3000 psia	BYTE			

Table 6.96: Set/Read full scale parameter for Baratron gauge unit

ORDER NUMBER 0x010E TYPE OF GAS					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	Typ of gas: 0 - Air 1 - He 2 - Ne 3 - Ar 4 - Kr 5 - Xe 6 - H2 7 - CO 8 - define	BYTE			

Table 6.97: Set/Read type of gas

ORDER NUMBER 0x010F DEFINED GAS FACTOR					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2-9	Gas factor value	DOUBLE			

Table 6.98: Set/Read defined gas factor

ORDER NUMBER 0x0110 DEGASS POSSIBILITY					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	Possibility: 0 - degas possible 1 - vacuum gauge damaged 2 - meter does not support degas 3 - too low vacuum in chamber, to start the degassing	BYTE		0	3

Table 6.99: Read degas possibility

ORDER NUMBER 0x0111 DEGAS STATE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	0 - OFF, 1 - ON	BYTE		0	3

Table 6.100: Set/Read degas state

ORDER NUMBER 0x0112 DEGAS TIME					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2-5	Time	LONG	Seconds		

Table 6.101: Set/Read degas time

ORDER NUMBER 0x0113 READ REMAINING DEGAS TIME					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2-5	Time	LONG	Seconds		

Table 6.102: Read remaining degas time

ORDER NUMBER 0x0114 EMISSION STATE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	Emission: 0 - OFF, 1 - ON	BYTE			

Table 6.103: Set/Read emission state

ORDER NUMBER 0x0115 READ EMISSION STATE FROM VACUUM GAUGE					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	Emission: 0 - OFF, 1 - ON	BYTE			

Table 6.104: Read emission state from vacuum gauge

ORDER NUMBER 0x0116 FILTRATION LEVEL OF VACUUM MEASUREMENT					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE		1	2
2	Filtration level: 0 - low 1 - medium 2 - high	BYTE			

Table 6.105: Set/Read filtration level of vacuum measurement

6.5.9.4 DIGITAL OUTPUTS ORDERS - FUNCTION CODE 0x03..

ORDER NUMBER 0x0301 ASSIGNMENT OF RELAYS FUNCTION					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: Relay (Out) number. From 1 to number of all relays	BYTE			
2	Assigned function code: Code corresponds to the position of function in the menu ”Relay Outputs/Out x”. For example, if the menu looks as below: *Relay Outputs* *Out 1* *Setpoint 1* *Setpoint 2* *Still OFF* *Still ON* *None* Code of function *Still OFF* is 3	BYTE			

Table 6.106: Assigning of relays function

6.5.9.5 DIGITAL INPUTS ORDERS - FUNCTION CODE 0x04..

ORDER NUMBER 0x0401 ASSIGNMENT OF FUNCTION TO THE INPUT					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index 1: Channel number	BYTE	1		
2	Index 2: Function code. 1 - Interlock 2 - Operate On 3 - Operate Off 4 - Pressure Emiss ON 5 - Pressure Emiss OFF 6 - Open Shutter 7 - Close Shutter 8 - Zero Thickness 9 - Zero Time 10 - Remote Control Availability of functions is device dependent.	BYTE			
3	Digital Input number. From 1 to number of all inputs	BYTE		1	

Table 6.107: Assignment of functions to the input

ORDER NUMBER 0x0402 DIGITAL INPUTS SENSE CONTROL					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: Digital Input number. From 1 to number of all inputs	BYTE		1	
2	Sense: 1 - Low level 2 - High level 3 - Falling edge 4 - Rising edge			1	4

Table 6.108: Digital inputs sense control

6.5.9.6 ANALOG OUTPUTS ORDERS - FUNCTION CODE 0x05..

ORDER NUMBER 0x0501 SIGNAL SOURCE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: Out number. From 1 to number of all analog outs	BYTE		1	
2	Assigned signal source: Corresponds to the position of signal source in the menu ”Source” of Analog out channel. For example, if the menu looks as below: *Source* *Pressure 1* *Pressure 2* *Usource* *Iemis* *None* Code of signal source *Iemi* is 4	BYTE		1	

Table 6.109: Set/Read signal source

ORDER NUMBER 0x0502 RETRANSMISSION MODE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: Out number. From 1 to number of all analog outs	BYTE		1	
2	Retransmission mode: 1 - range 2 - 1 to 1 3 - exponent	BYTE		1	3

Table 6.110: Set/Read work mode

ORDER NUMBER 0x0503 RETRANSMISSION SCALE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: Out number. From 1 to number of all analog outs	BYTE		1	
2	Retransmission scale: 1 - linear 2 - logarithmic	BYTE		1	2

Table 6.111: Set/Read retransmission scale

ORDER NUMBER 0x0504 MINIMUM VALUE OF RETRANSMITTED PARAMETER					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: Out number. From 1 to number of all analog outs	BYTE		1	
2-9	Minimum value Unit and min/max is signal source dependent	DOUBLE			

Table 6.112: Set/Read minimum value of the retransmitted parameter.

ORDER NUMBER 0x0505 MAXIMUM VALUE OF RETRANSMITTED PARAMETER					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: Out number. From 1 to number of all analog outs	BYTE		1	
2-9	Maximum value Unit and min/max is signal source dependent	DOUBLE			

Table 6.113: Set/Read maximum value of the retransmitted parameter.

ORDER NUMBER 0x0506 MINIMUM VALUE OF THE OUTPUT VOLTAGE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: Out number. From 1 to number of all analog outs	BYTE		1	
2-9	Output voltage	DOUBLE	V	0	10

Table 6.114: Set/Read minimum value of the output voltage.

ORDER NUMBER 0x0507 MAXIMUM VALUE OF THE OUTPUT VOLTAGE					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index: Out number. From 1 to number of all analog outs	BYTE		1	
2-9	Output voltage	DOUBLE	V	0	10

Table 6.115: Set/Read maximum value of the output voltage.

6.5.9.7 OPERATE TIMER ORDERS - FUNCTION CODE 0x11..

ORDER NUMBER 0x1101 TIMER COUNTING DIRECTION					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2	Counting direction 0 - down 1 - up	BYTE		0	1

Table 6.116: Timer counting direction

ORDER NUMBER 0x1102 OPERATE TIME					R
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2-5	Operate time	LONG	sec		

Table 6.117: Operate time

ORDER NUMBER 0x1103 OPERATE TIME SETPOINT					R/W
Byte	**Description**	**Type**	**Unit**	**Min value**	**Max value**
1	Index	BYTE	1		
2-5	Operate time setpoint	LONG	sec		

Table 6.118: Operate time setpoint

7 MAINTENANCE AND SERVICE

7.1 MAINTENANCE

The IS40-PS 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 IS40-PS 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 IS40-PS .
- {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 IS40-PS or disconnect it from the wall outlet. Failure to do so may cause damage to the IS40-PS , 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 IS40-PS . The “New USB Device Detected” hint will appear on the bottom of the screen.

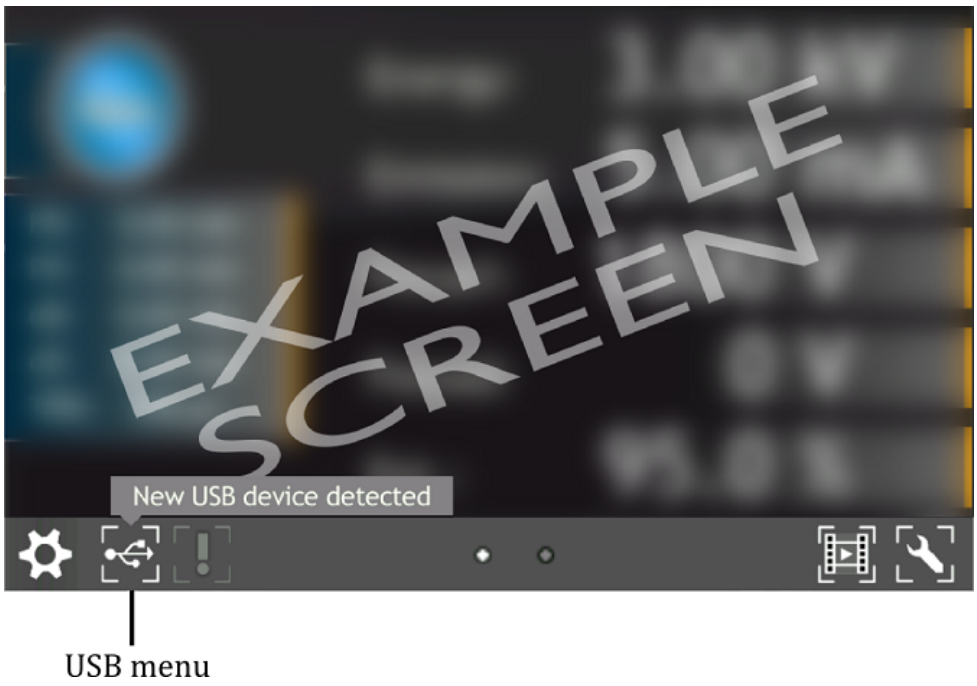


Figure 7.1: USB detected hint

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.

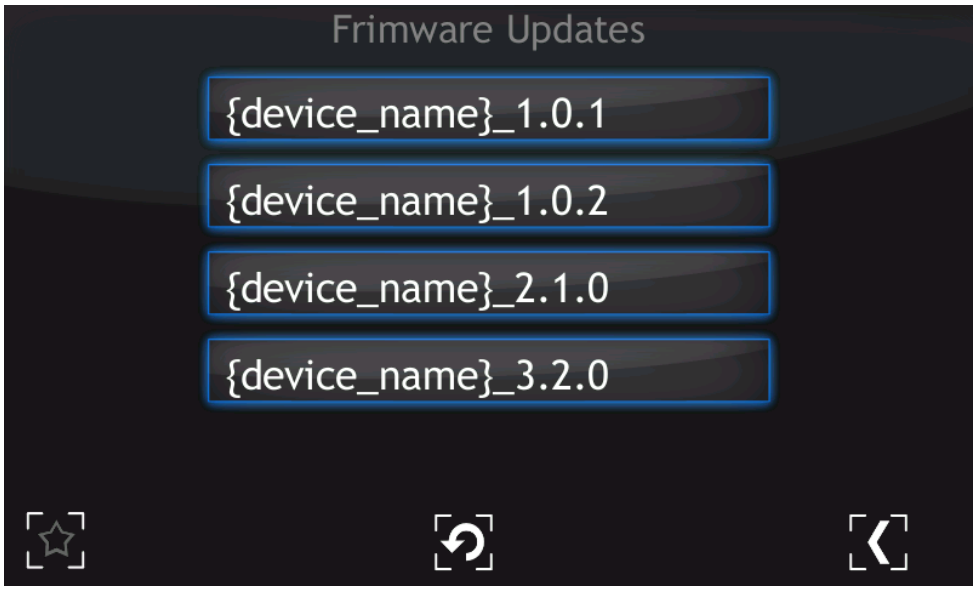


Figure 7.3: Firmware list

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.

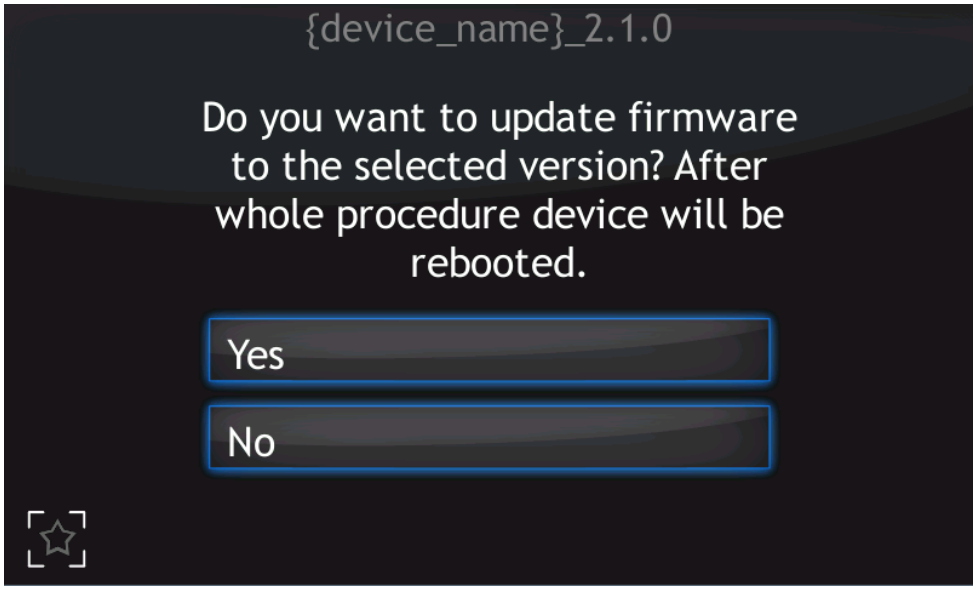


Figure 7.4: Restart message

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.

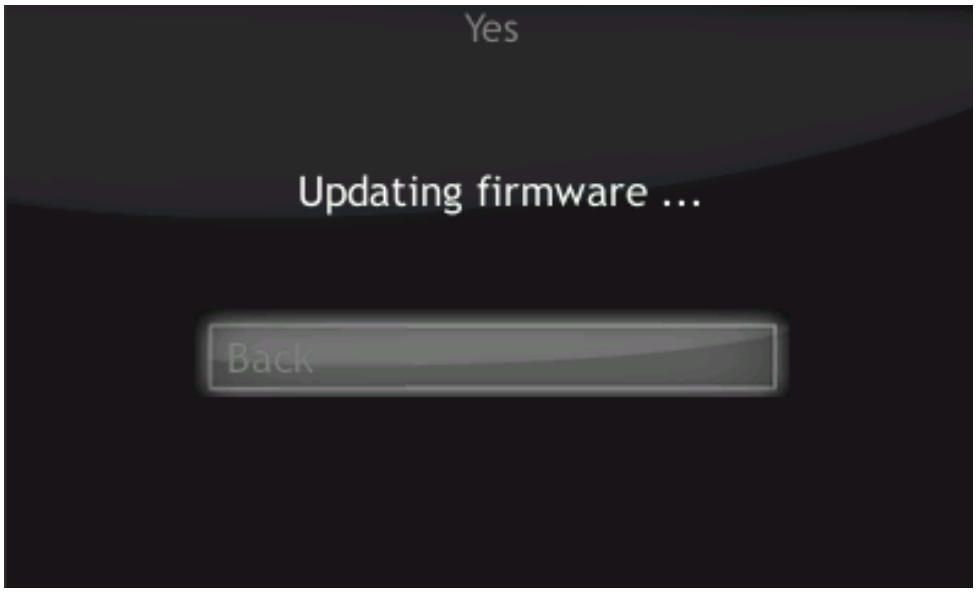


Figure 7.5: Updating firmware

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

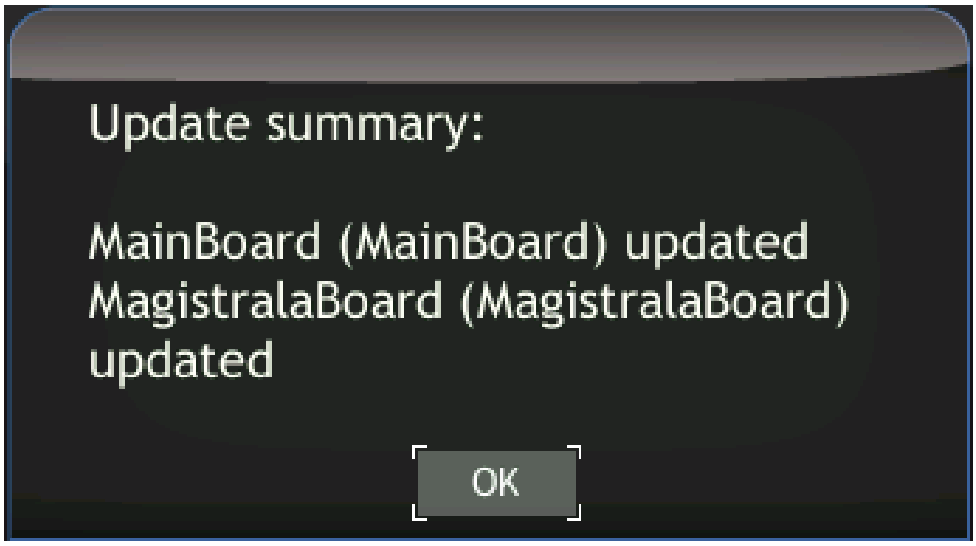


Figure 7.6: Update summary example

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 IS40-PS startup (7.9).

Figure 7.9: Enter into preboot environment

The Preboot Environment is an application to boot the IS40-PS . 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 IS40-PS .
- Continue booting – close Preboot Environment and continue starting IS40-PS .
- 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 IS40-PS 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.

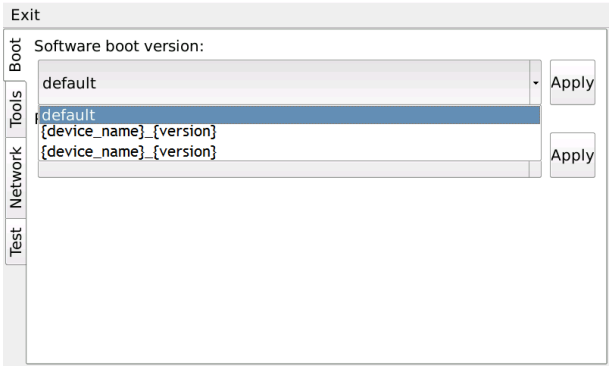


Figure 7.11: Switch software version

To apply changes press Apply button. From now the default version will be automatically run after restarting IS40-PS .

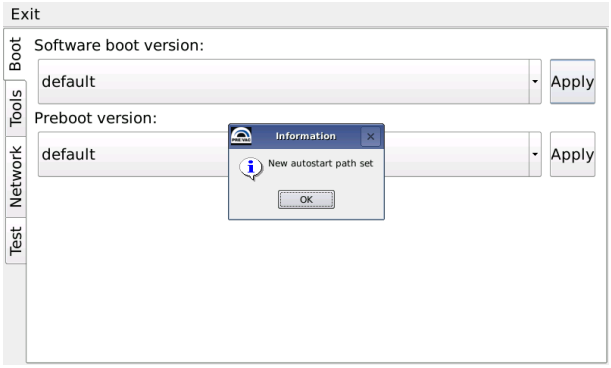


Figure 7.12: Message box confirming the changed settings

7.4.2 TOOLS MENU

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

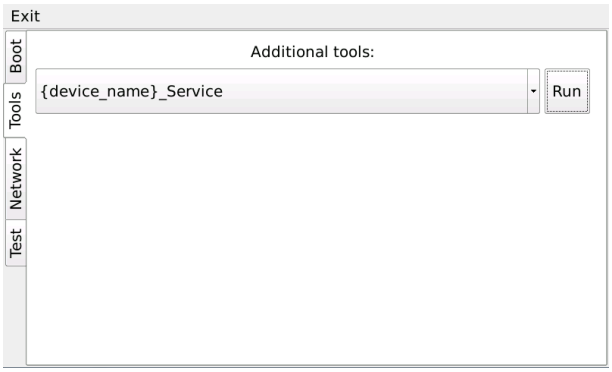


Figure 7.13: Tools menu

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

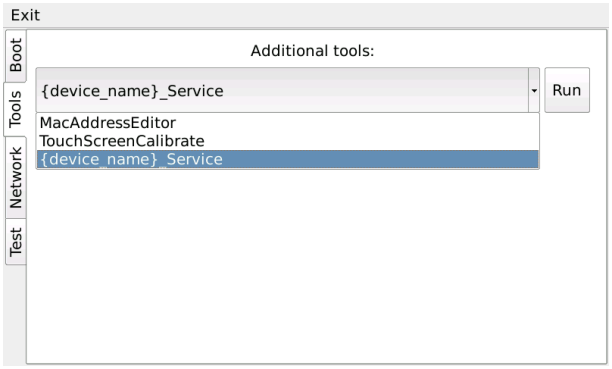


Figure 7.14: Selecting additional tool

7.4.3 NETWORK TAB

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

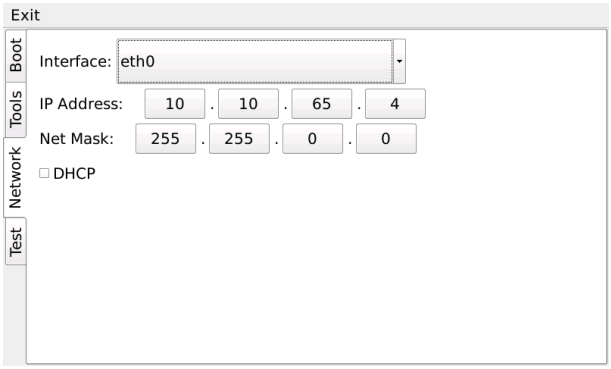


Figure 7.15: Network tab

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.

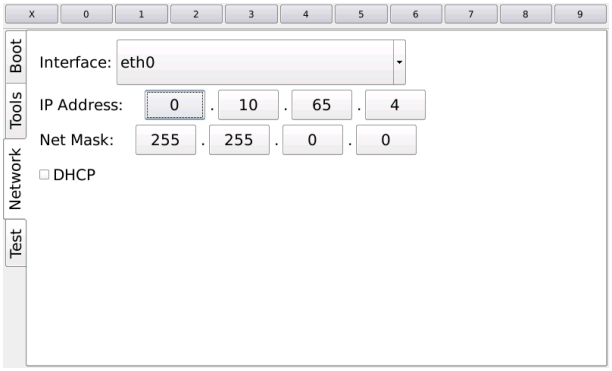


Figure 7.16: Numeric panel

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 IS40-PS and for shipping it to an authorized PREVAC service center.

8.2 STORAGE

The IS40-PS 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 purchased by you was manufactured from recyclable materials. The product is marked in accordance with European regulations pertaining to waste of electrical and electronic equipment – WEEE2.
Waste of electrical and electronic equipment must not be thrown away together with regular domestic waste. According to the European Union WEEE Directive, waste of electrical and electronic equipment is subject to separate utilization procedures.