ANALYTICAL INSTRUMENTS

A-96.210.871 / 300824

AMI-II CACE

Operator's Manual

SWISS MADE

AMI-II CACE

Customer Support

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This manual applies to firmware V1.00 and higher.
The information contained in this document is subject to change without notice.

Table of Contents

Operator's Manual

This document describes the main steps for instrument setup, operation and maintenance.

1. Safety Instructions

General

The instructions included in this section explain the potential risks associated with instrument operation and provide important safety practices designed to minimize these risks.
If you carefully follow the information contained in this section, you can protect yourself from hazards and create a safer work environment.
More safety instructions are given throughout this manual, at the respective locations where observation is most important. Strictly follow all safety instructions in this publication.

Target audience

Operator: Qualified person who uses the equipment for its intended purpose.
Instrument operation requires thorough knowledge of applications, instrument functions and software program as well as all applicable safety rules and regulations.

OM location

Keep the Operator's Manual in proximity of the instrument.

Qualification, training

To be qualified for instrument installation and operation, you must:

- read and understand the instructions in this manual as well as the Material Safety Data Sheets.
- know the relevant safety rules and regulations.

1.1. Warning Notices

The symbols used for safety-related notices have the following meaning:

DANGER

Your life or physical wellbeing are in serious danger if such warnings are ignored.

- Follow the prevention instructions carefully.

WARNING

Severe injuries or damage to the equipment can occur if such warnings are ignored.

- Follow the prevention instructions carefully.

CAUTION

Damage to the equipment, minor injury, malfunctions or incorrect process values can be the consequence if such warnings are ignored.

- Follow the prevention instructions carefully.

Mandatory signs

The mandatory signs in this manual have the following meaning:

Safety goggles

Safety gloves

Warning signs The warning signs in this manual have the following meaning:


Electrical shock hazard


Corrosive


Harmful to health


Flammable


General warning


Attention

1.2. General Safety Regulations

Legal requirements

The user is responsible for proper system operation. All precautions must be followed to ensure safe operation of the instrument.

Spare parts and disposables

Use only official Swan spare parts and disposables. If other parts are used during the normal warranty period, the manufacturer's warranty is voided.

Modifications

Modifications and instrument upgrades shall only be carried out by an authorized service technician. Swan will not accept responsibility for any claim resulting from unauthorized modification or alteration.

WARNING

Electrical shock hazard

If proper operation is no longer possible, the instrument must be disconnected from all power lines, and measures must be taken to prevent inadvertent operation.

- To prevent from electrical shock, always make sure that the ground wire is connected.
- Service shall be performed by authorized personnel only.
- Whenever electronic service is required, disconnect instrument power and power of devices connected to.
  - relay 1,
  - relay 2,
  - alarm relay

WARNING

For safe instrument installation and operation you must read and understand the instructions in this manual.

1.3. Restrictions for Use

The AMI-II CACE is designed for determination of:

- specific (total) conductivity
- cation (acid) conductivity after a cation exchanger

in power and industrial plant water.
It calculates the pH value and the concentration of an alkaline substance (NH_3, morpholine, etc.) if present in the water.
It is not suitable for pH determination in high purity water before alkalization agent addition.

Conditions for pH calculation:

- Only one alkalization agent (acid-base pair) in the sample. No mixture.
- The contamination is mostly NaCl.
- Phosphate concentration is <0.5 ppm.
- pH value is >7.5, and <11.5.
- If pH value is <8, the concentration of contaminant must be small compared to the concentration of the alkalization agent.

No sand. No oil. Use of film forming products may reduce lifetime of EDI module. Particle filtration recommended in case of high iron concentration.
The sample must not contain any particles which may block the flow cell. Sufficient sample flow is coercive for the correct function of the instrument.

2. Product Description

2.1. Description of the System

Application range

The AMI-II CACE is a complete monitoring system for the automatic, continuous measurement of the conductivity before (specific conductivity) and after a cation exchanger (cationic or acid conductivity). Based on difference conductivity measurement, the pH of the sample can be calculated.

Available models

The instrument is available in two models:

- Transmitter and fluidic components mounted on one large panel.
- Version on a smaller panel with remote transmitter.

Special features

- Temperature compensation curves for specific conductivity measurement:
  - Strong acids (HCl)
  - Strong bases (NaOH)
  - Ammonia
  - Morpholine
  - Ethanolamines (ETA)
  - Neutral salts
  - UPW
  - Coefficient
- Flow monitoring
- Calculation of pH according to VGBE-S-010-00-2023-08
- Calculates the concentration of an alkaline substance present in the water

Signal outputs

Two signal outputs programmable for measured values (freely scalable, linear, bilinear, log) or as continuous control output (control parameters programmable).

Current loop: 0/4–20 mA

Maximal burden: 510 Ω

Two additional signal outputs with the same specifications available as an option.

Relays

Two potential-free contacts programmable as limit switches for measured values, controllers or timers with automatic hold function. Maximum load: 100 mA/50 V resistive

Alarm relay

Two potential-free contacts (one normally open and one normally closed contact). Summary alarm indication for programmable alarm values and instrument faults.

- Normally open contact:
  Closed during normal operation, open on error and loss of power.
- Normally closed contact:
  Open during normal operation, closed on error and loss of power.

Maximum load: 100 mA/50 V resistive

Input

One input for potential-free contact to freeze the measured value or to interrupt control in automated installations. Programmable as HOLD or OFF function.

Communication interface (optional)

- Two additional signal outputs
- RS485 with fieldbus protocol Modbus RTU or Profibus DP
- HART

Safety features

No data loss after power failure. All data is saved in non-volatile memory. Overvoltage protection of inputs and outputs. Galvanic separation of measuring inputs from signal outputs.

Correction or calibration

Not necessary, auto zero is performed automatically and continuously with each measurement.

Fluidics

The sample flows via sample inlet [M] into the flow cell [D]. The specific conductivity of the sample is measured with the first conductivity sensor [A]. A downstream capillary [G] regulates the sample flow before the sample enters the sample chamber of the EDI module [H]. The cation conductivity is then measured with the second conductivity sensor [B]. Subsequently, the sample flows through the anode chamber, where protons are generated by electrolysis of water.

$$H_2O \rightarrow \frac{1}{2} O_2 + 2 H^+ + 2e^-$$

The water is then led through the cathode chamber where it is reduced according to:

$$2 H^+ + 2 e^- \rightarrow H_2 \text{ resp. } 2 H_2O + 2 e^- \rightarrow H_2 + 2 OH^-$$

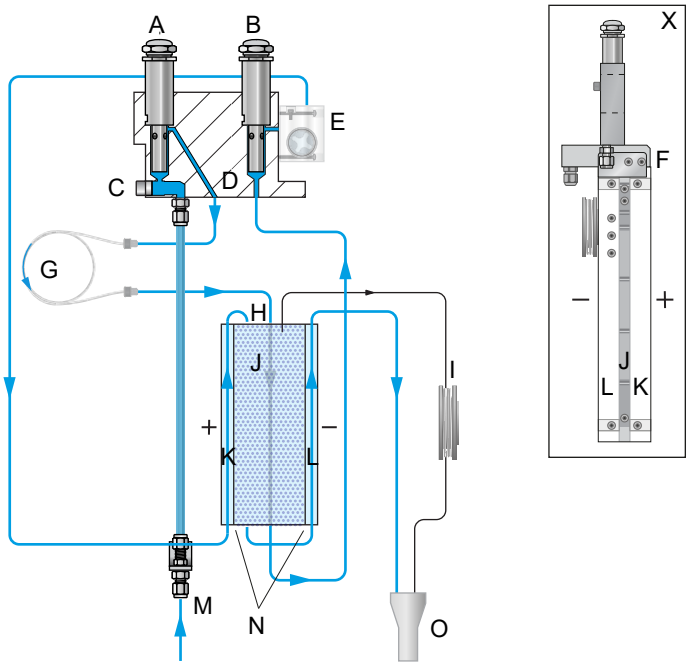
Finally, the sample leaves the EDI module and flows into the drain.

Regeneration of the cation exchange resin

Water is oxidized at the anode of the EDI module, producing protons. These then move towards the cathode under the influence of the electric field. In the process, they pass through the membrane and are taken up by the cation exchange resin in the sample chamber. This releases the cations in the resin. These pass through the second membrane and move to the cathode chamber, where they are taken up by the sample stream and thus flushed out of the EDI module. This process ensures that the resin is continuously regenerated.

Fluidics overview

Note: *To visualize the sample flow more clearly, the EDI module is shown only schematically. Lateral view X shows the correct positions of the chambers and electrodes.*



A *Conductivity sensor (sc)*
B *Conductivity sensor (cc)*
C *Blind plug*
D *Flow cell*
E *Flow meter*
F *Adapter plate*
G *Capillary tube*
H *EDI module*
I *Deaeration tube*
J *Sample chamber*
K *Anode chamber*
L *Cathode chamber*
M *Sample inlet*
N *Membranes*
O *Drain*

Measuring principle

When a voltage is set between two electrodes in an electrolyte solution, the result is an electric field which exerts force on the charged ions: the positively charged cations move towards the negative electrode (cathode) and the negatively charged anions towards the positive electrode (anode). The ions, by way of capture or release of electrons at the electrodes, are discharged and so a current *I* flows through this cycle and Ohm's law $V = I \times R$ applies. From the total resistance *R* of the current loop, only the resistance of the electrolyte solution, respectively its conductivity $^1/_R$, is of interest.
The cell constant of the sensor is determined by the manufacturer and is printed on the sensor label. If the cell constant has been programmed in the transmitter, the instrument measures correctly. No calibration needs to be done, the sensor is factory calibrated. Measuring unit is µS/cm or µS/m.

Specific conductivity

Conductivity from all ions in the sample, mainly the alkalization agent. The contribution of impurities is masked by the alkalization agent.

Cation (acid) conductivity

The alkalization agent is removed in the cation column. All cationic ions are exchanged with H+, all anionic impurities (ions with negative charge) pass through the column unchanged.

Temperature compensation

The mobility of ions in water increase with higher temperature which enlarges the conductivity. Therefore, the temperature is measured simultaneous by an integrated Pt1000 temperature sensor and the conductivity is compensated to 25 °C. Several temperature compensation curves, designed for different water compositions, can be chosen.
After cation exchanger (cation conductivity), the temperature compensation curve strong acids has to be set.
For more information see **Influence of Temperature on Electrical Conductivity, PPChem (2012).**

Standard temperature

The displayed conductivity value is compensated to 25 °C standard temperature.

2.2. Instrument Specification

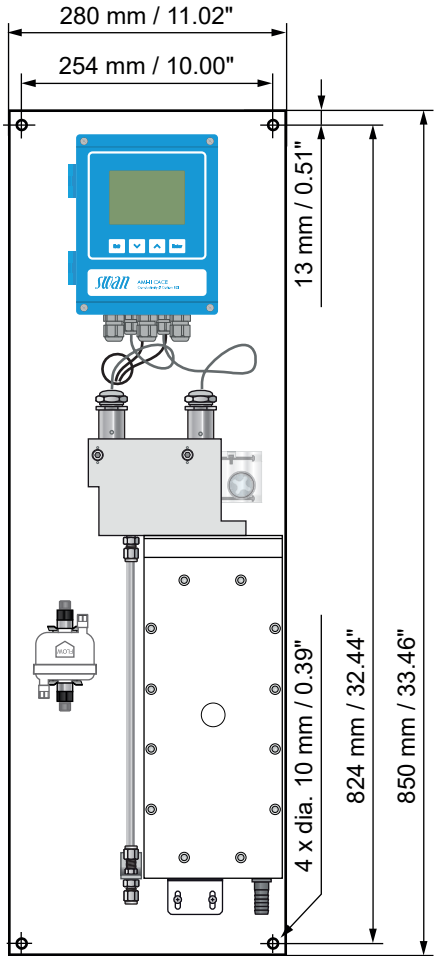
Power supply	AC variant:	100–240 VAC (±10%) 50/60 Hz (±5%)
	DC variant:	10–36 VDC
	Power consumption	max. 35 VA
Sample requirements	Flow rate:	3–4 l/h
	Temperature:	up to 50 °C
	Inlet pressure:	up to 0.5 bar
	Outlet pressure:	pressure free
	Use of a Swan Back Pressure Regulator is highly recommended. Particle filtration recommended in case of high iron concentration.	
	Note: *No oil, no grease, no sand. Use of film forming products may reduce the lifetime of the EDI module.*	
On-site requirements	The analyzer site must permit connections to:	
	Sample inlet:	Swagelok 1/4" adapter for stainless steel tube
	Sample outlet:	G 3/8" adapter for flexible tube diam. 20x15 mm

	Range	Resolution
Measuring range	0.055 to 0.999 µS/cm	0.001 µS/cm
	1.00 to 9.99 µS/cm	0.01 µS/cm
	10.0 to 99.9 µS/cm	0.1 µS/cm
	100 to 999 µS/cm	1 µS/cm

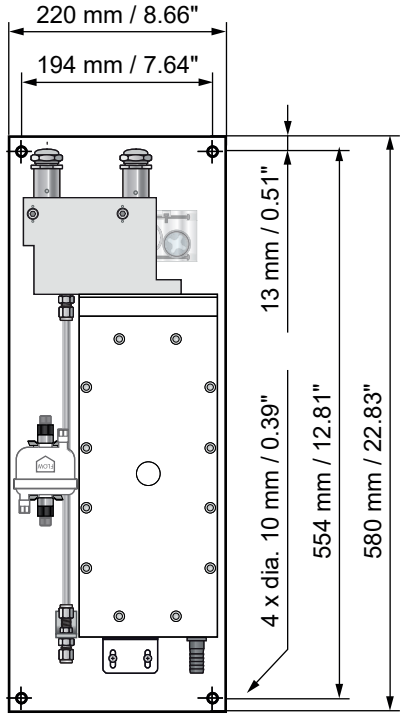
Accuracy	±1% of measured value or ±1 digit (whichever is greater)
EDI capacity	SC_{max} = 40 µS/cm as NH_4OH SC_{max} = 350 µS/cm as NaOH

Transmitter specifications	Housing:	aluminum, with a protection degree of IP 66 / NEMA 4X
	Ambient temperature:	-10 to +50 °C
	Humidity:	10–90% rel., non condensing
	Display:	backlit LCD, 74 x 53 mm

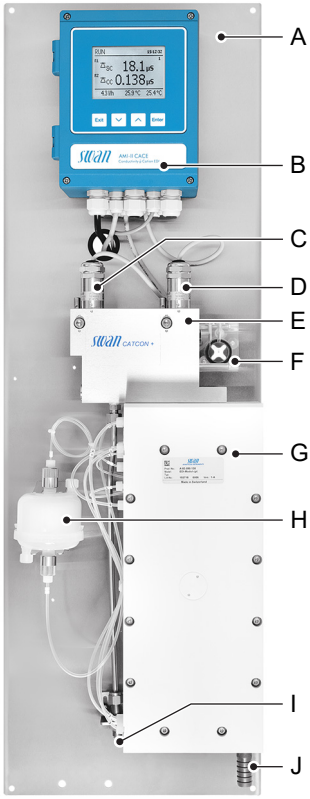
Dimensions	Panel:	stainless steel
	Dimensions:	280x850x200 mm
	Screws:	8 mm
	Weight:	14 kg



Dimensions Swan CACE Module	Panel:	stainless steel
	Dimensions:	220x580x200 mm
	Screws:	8 mm
	Weight:	13 kg



2.3. Instrument Overview



A *Panel*
B *Transmitter*
C *Specific conductivity sensor*
D *Cation conductivity sensor*
E *Flow cell*
F *Flow meter*
G *EDI module*
H *Filter (optional)*
I *Sample inlet*
J *Waste*

3. Installation

3.1. Installation Checklist

On-site requirements	AC variant: 100–240 VAC (±10%), 50/60 Hz (±5%). DC variant: 10–36 VDC Power consumption: 35 VA maximum. Protective earth connection required. Sample line with sufficient sample flow and pressure (3–4 l/h, up to 0.5 bar).
Installation	Mount the instrument in vertical position. Display should be at eye level. Remove the caps from tubes 1B, 2, 3, 5 and 10 and connect them according to the tube numbering scheme (p. 53). Connect sample inlet and outlet.
Electrical wiring	Connect all external devices like limit switches and current loops according to the connection diagram (p. 24). Connect power cord.
Power up	Open sample flow and wait until the instrument is completely filled. Check inlet pressure. Switch on power.
Instrument setup	Program all sensor parameters. If required activate calculations. Program all parameters for external devices (interface, recorders, etc.). Program all parameters for instrument operation (limits, alarms). Program display screens.
Run-in period	Let the instrument run continuously for 1 h.

3.2. Mounting the Instrument Panel

Mounting requirements

Mount the instrument in vertical position. The display should be at eye level to simplify operation and maintenance.
The instrument is only intended for indoor installation.
For dimensions, see p. 16 and p. 17.

3.3. Connecting Sample and Waste

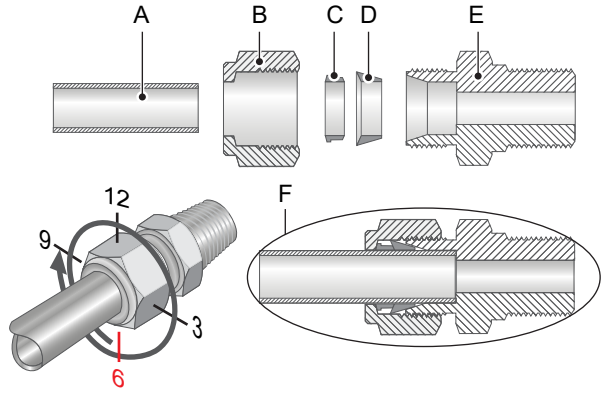
3.3.1 Stainless Steel Swagelok Fitting at Sample Inlet

Preparation

Cut the tube to length and deburr it. The tube must be straight and free from blemishes for approximately 1,5 x tube diameter from the end.
Lubrication with lubricating oil, MoS2, Teflon etc. is recommended for the assembly and reassembly of bigger sized unions (thread, compression cone).

Installation

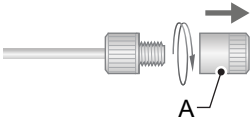
1. Insert the compression ferrule [C] and the compression cone [D] into the union nut [B].
2. Screw on the union nut onto the body, do not tighten it.
3. Push the stainless steel pipe through the union nut as far as it reaches the stop of the body.
4. Mark the union nut at 6 o'clock position.
5. While holding the fitting body steady, tighten the nut union 1¼ rotation using an open ended spanner.



A Stainless *steel tube*
B *Union nut*
C *Compression ferrule*
D *Compression cone*
E *Body*
F *Tightened connection*

3.3.2 Tubes at EDI Module

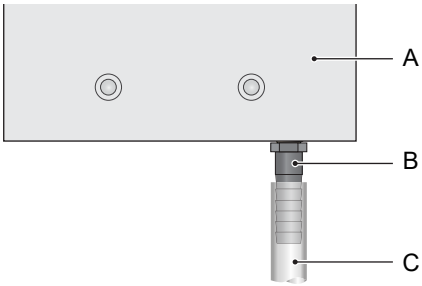
1 Remove the caps [A] from tubes 1B, 2, 3, 5 and 10.
2 Connect the tubes according to Tube Numbering, p. 53.
3 Keep the caps for later use.



A *Cap*

3.3.3 Tube at Sample Outlet

Connect a plastic tube [C] to the hose nozzle [B] and place it into a drain with atmospheric pressure.



A *EDI module*
B *Hose nozzle*
C *Plastic tube 20x15 mm*

3.4. Electrical Connections

WARNING

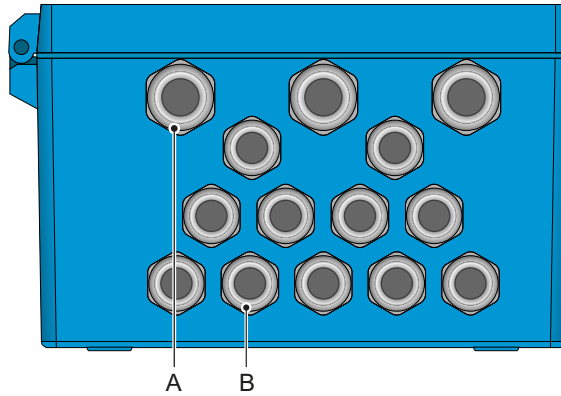
Risk of electrical shock

Failure to follow safety instructions can result in serious injury or death.

- Always turn off power before manipulating electric parts.
- Do not connect the instrument to power unless the ground wire (PE) is connected.
- Make sure the power specification of the instrument corresponds to the power on site.

Cable thicknesses

In order to comply with IP66, use the following cable thicknesses. Protect unused cable glands.

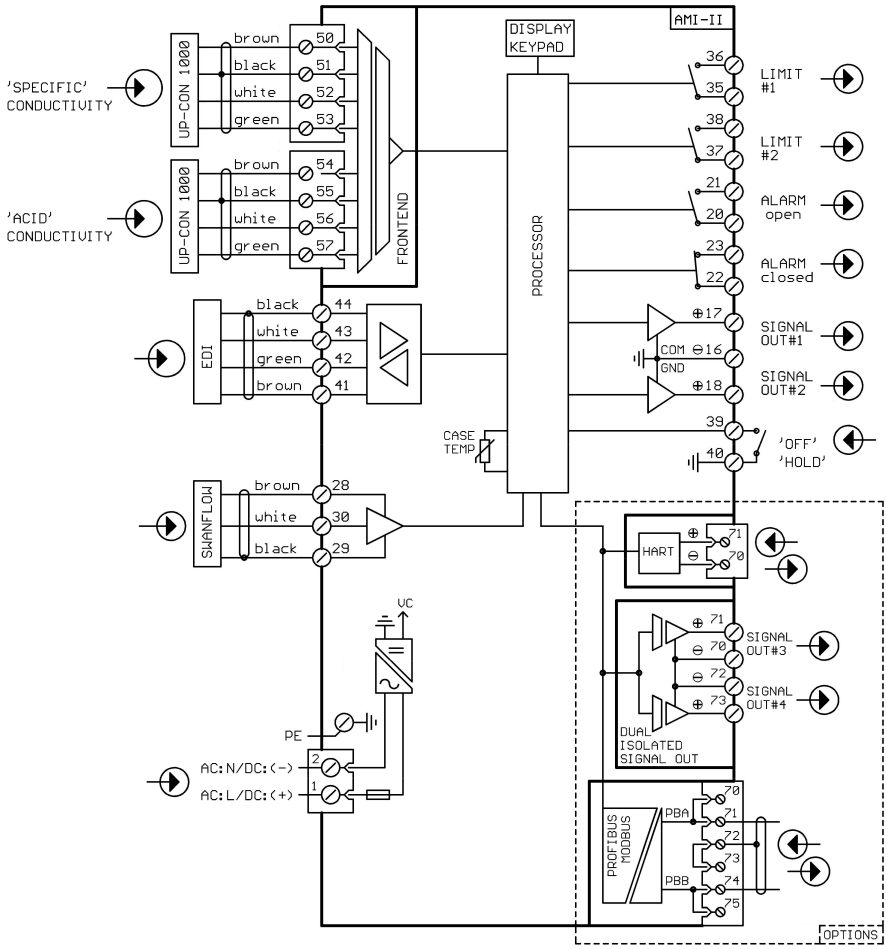


A *M16 cable glands (3x): cable $Ø_{outer}$ 5–10 mm*
B *M12 cable glands (11x): cable $Ø_{outer}$ 3–6 mm*

Wires

For power and relays: Use max. 1.5 mm^2 / AWG 14 stranded wire with end sleeves.
For signal outputs and input: Use 0.25 mm^2 / AWG 23 stranded wire with end sleeves.

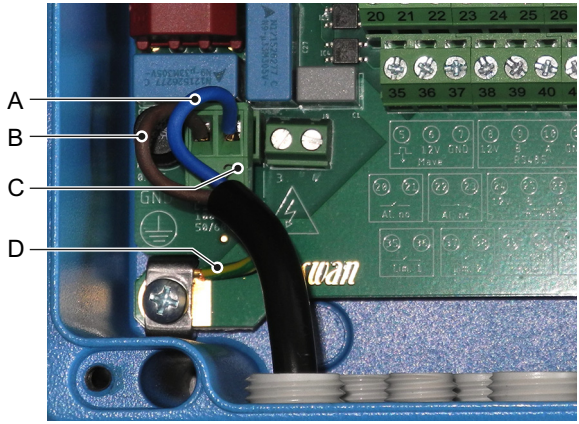
3.4.1 Connection Diagram



CAUTION

Use only the terminals shown in this diagram, and only for the mentioned purpose. Use of any other terminals will cause short circuits with possible corresponding consequences to material and personnel.

3.4.2 Power Supply



A *Neutral conductor, terminal 2*
B *Phase conductor, terminal 1*
C *Power supply connector*
D *Protective earth PE*

Installation requirements

The installation must meet the following requirements.

- Mains cable to comply with standards IEC 60227 or IEC 60245; flammable rating FV1
- Mains equipped with an external switch or circuit-breaker
  - near the instrument
  - easily accessible to the operator
  - marked as interrupter for AMI-II CACE

3.5. Relay Contacts

3.5.1 Input

Use only potential-free (dry) contacts.
Terminals: 39/40

3.5.2 Alarm Relay

Two alarm outputs for system errors.

- Normally closed contact (terminals: 22/23):
  Active (opened) when no error is present. Inactive (closed) on error and loss of power.
- Normally open contact (terminals: 20/21):
  Active (closed) when no error is present. Inactive (opened) on error and loss of power.

Max. load 100 mA/50 V resistive

3.5.3 Relay 1 and 2

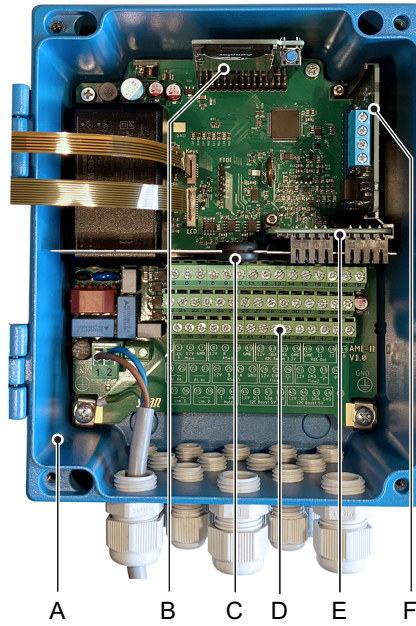
Max. load 100 mA/50 V resistive
Relay 1: terminals 35/36.
Relay 2: terminals 37/38.

3.6. Signal Outputs

3.6.1 Signal Output 1 and 2 (Current Outputs)

Max. burden 510 Ω.
If signals are sent to two different receivers, use signal isolator (loop isolator).
Signal output 1: Terminals 17 (+) and 16 (-)
Signal output 2: Terminals 18 (+) and 16 (-)

3.7. Interface Options



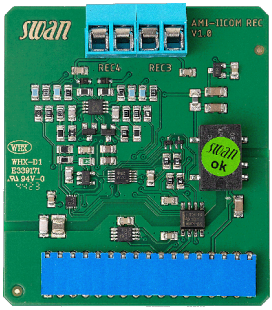
A *AMI-II transmitter*
B *SD card slot*
C *Cable grommet*
D *Screw terminals*
E *Frontend*
F *Communication option*

The slot for interfaces can be used to expand the functionality of the AMI-II transmitter with either:

- Two additional signal outputs
- Profibus or Modbus
- HART

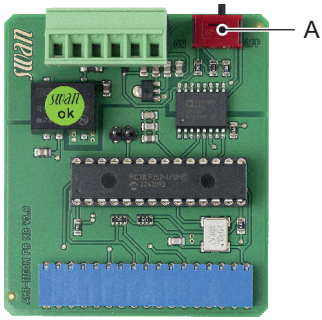
3.7.1 Signal Outputs 3 and 4

Max. burden 510 Ω.
If signals are sent to two different receivers, use signal isolator (loop isolator).
Signal output 3: terminals 71 (+) and 70 (-).
Signal output 4: terminals 73 (+) and 72 (-).



3.7.2 RS485 (Profibus or Modbus Protocol)

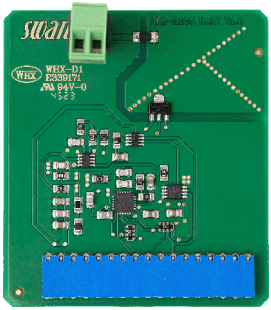
Terminal 74/75 PB, terminal 70/71 PA, terminal 72/73 shield
The switch [A] must be set to “ON” if only one instrument is installed or on the last instrument in the bus.



A *On/off switch*

3.7.3 HART

Terminals 71 (+) and 70 (-).



4. Instrument Setup

4.1. Establish Sample Flow

1 Open the sample tap.
2 Check inlet pressure.
3 Switch on power.
4 Let the instrument run in for 1 h.

4.2. Programming

Sensor parameters

Menu 5.1.2.1, sensor 1
Menu 5.1.2.2, sensor 2
The sensor characteristics are printed on the label of each sensor.

87-344.203	UP-Con1000SL	Sensor type
SW-xx-xx-xx	ZK = 0.0417	Cell constant
SWAN AG	DT = 0.06 °C	Temperature correction

Enter for each sensor separately the:
- Cell constant [cm^{-1}]
- Temperature correction [°C]
- Cable length. If the flow cell is installed on the monitor, set the cable length to 0.0 m.
- Temperature compensation: The default setting for sensor 1 (specific conductivity) is ammonia. For sensor 2 (cation conductivity), the default setting is strong acids.

Calculations

Menu 5.1.1.1
Set Calculations to “Yes” if you want to have pH and concentration of alkalization agent calculated and displayed.

Measuring unit

Menu 5.1.1.2
Set the measuring unit:
- µS/cm
- µS/m

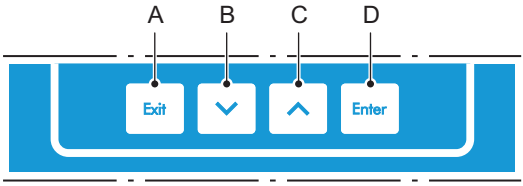
Display

Menu 4.4.1, Screen 1
Menu 4.4.2, Screen 2
Select the values to be displayed on screens 1 and 2.

External devices	Menu 5.2 Signal Outputs Menu 5.4 Interface
Limits and alarms	Menu 5.3 Relay Contacts Program all parameters for instrument operation (limits, alarms).

5. Operation

5.1. Keys



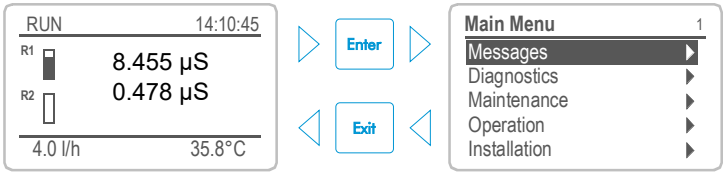
A to exit a menu or command (rejecting any changes)
to move back to the previous menu level

B to move down in a menu list and to decrease digits

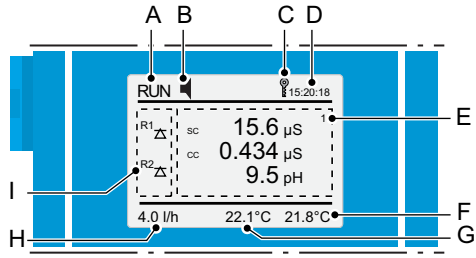
C to move up in a menu list and to increase digits
to switch between display1 and 2

D to open a selected menu item
to accept an entry

Program access, exit



5.2. Display



A RUN — Normal operation

HOLD — Input active or cal delay: Instrument on hold (shows status of signal outputs)

OFF — Input active: Signal outputs go to 4 mA.

B Error — Non-fatal error — Fatal error

C Keys locked, transmitter control via Profibus

D Time

E Process values (SC: Specific conductivity, CC: Cation conductivity)

F Sample temperature 2

G Sample temperature 1

H Sample flow in l/h

I Relay status

Symbols used for relay status:

Upper/lower limit not yet reached

Upper/lower limit reached

Control upw./downw. no action

Control upw./downw. active, dark bar indicates control intensity

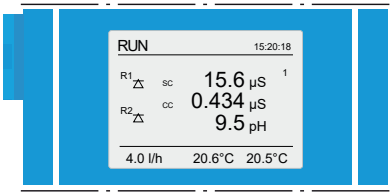
Timer

Timer: timing active (hand rotating)

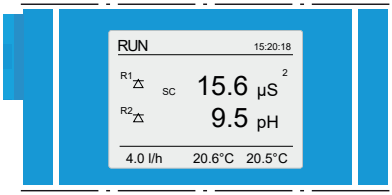
Switching between screens

Toggle between screens 1 and 2 using the ^ key.

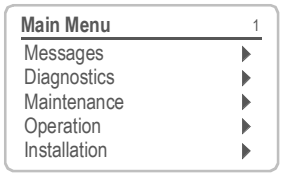
Example of screen 1:

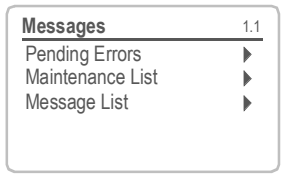


Example of screen 2:



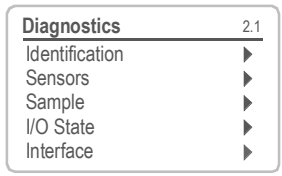
5.3. Software Structure





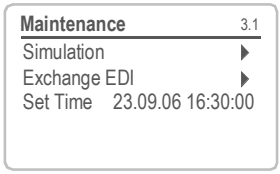
Menu Messages 1

Shows pending errors as well as the event history (time and state of events that have occurred at an earlier point of time).
Contains user-relevant data.



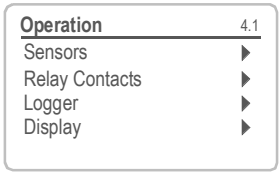
Menu Diagnostics 2

Provides user-relevant instrument and sample data.



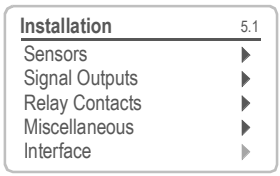
Menu Maintenance 3

For instrument calibration, relay and signal output simulation, and to set the instrument time.
Used by service personnel.



Menu Operation 4

User-relevant parameters that might need to be modified during daily routine. Normally password protected and used by the process operator.
Subset of menu 5 - Installation, but process related.



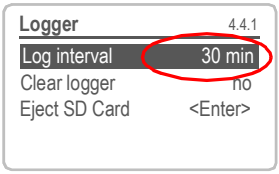
Menu Installation 5

For initial instrument set up by Swan authorized person. Can be protected by means of a password.

5.4. Changing Parameters and Values

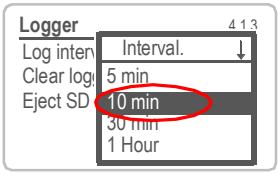
Changing parameters

The following example shows how to change the logger interval:



1 Select the parameter you want to change.

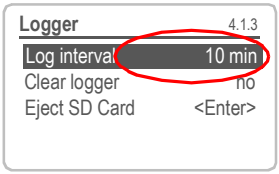
2 Press [Enter].



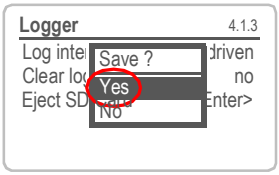
3 Press ^ or v to highlight the required parameter.

4 Press [Enter] to confirm the selection or [Exit] to keep the previous parameter).

⇒ *The selected parameter is highlighted (but not saved yet).*



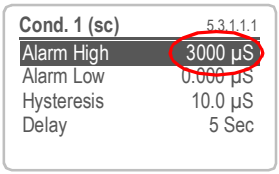
5 Press [Exit].



⇒ *Yes is highlighted.*

6 Press [Enter] to save the new parameter.

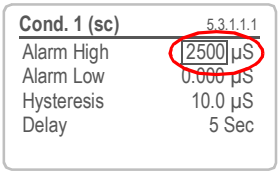
Changing values



1 Select the value you want to change.

2 Press [Enter].

3 Set required value with ^ or v.



4 Press [Enter] to confirm the new value.

5 Press [Exit].
⇒ *Yes is highlighted.*

6 Press [Enter] to save the new value.

6. Maintenance

6.1. Maintenance Schedule

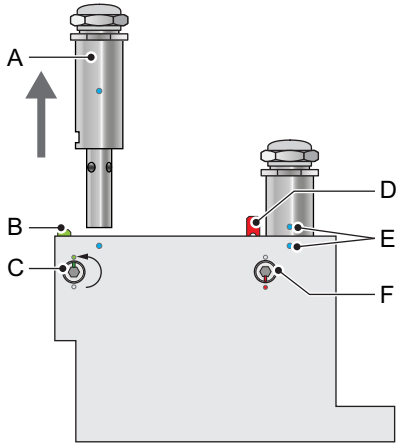
Monthly	◆ Check sample flow. ◆ Check inlet pressure.
As needed	◆ Clean conductivity sensors. ◆ Replace inlet filter (if installed). ◆ Perform a verification measurement.

6.2. Stop of Operation for Maintenance

1 Stop sample flow.

2 Shut off power of the instrument.

6.3. Maintenance of the Sensor



A *Conductivity sensor*
B *Security pin unlocked*
C *Locking screw open*
D *Security pin locked*
E *Alignment marks*
F *Locking screw closed*

6.3.1 Remove the Sensor from the Flow Cell

To remove the sensor form the flow cell proceed as follows:

1. Press the security pin [B] down.
2. Turn the locking screw [C] 180° counterclockwise with a 5 mm allen key.
   ⇒ *The security pin remains down.*
3. Remove the sensor.

Cleaning If the sensor is slightly contaminated, clean it with soapy water and a pipe cleaner. If the sensor is strongly contaminated, dip the tip of the sensor into 5% hydrochloric acid for a short time.

6.3.2 Install the Sensor into the Flow Cell

1. Make sure that the locking mechanism is in unlocked position (locking screw in position [C] and security pin in position [B]).
2. Put the sensor into the flow cell with the alignment marks [E] in line.
3. Turn the locking screw with a 5 mm Allen key clockwise 180°.
   ⇒ *The security pin moves up in lock position.*

6.4. Replacing the Inlet Filter

When to replace the inlet filter

The filter must be replaced if the sample flow through the filter is too low. Error message E010 "Sample flow low" can be used as an indicator.

1 Check the inlet pressure.

2 If the inlet pressure is OK, test the instrument without the filter connected.

3 If the sample flow is now normal, replace the filter.

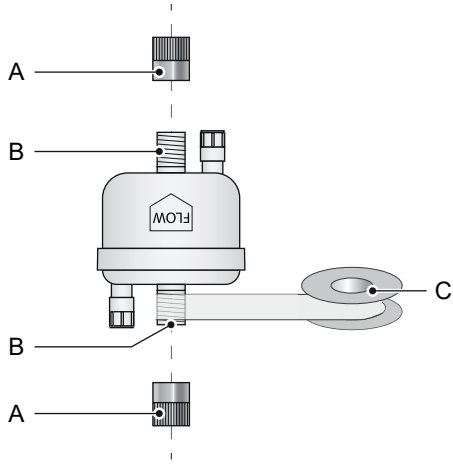
Note:

- *When error message E010 is displayed, the instrument continues to measure normally until error message E044 "No sample flow" appears*
- *Iron particles that accumulate in the filter lead to a dark discoloration of the filter. This is not an indication of a clogged filter and can be ignored.*

Installation of a new inlet filter

1 Apply some Teflon tape to the two threads [B].

2 Remove the adapters [A] from the old filter and screw them onto the new filter.



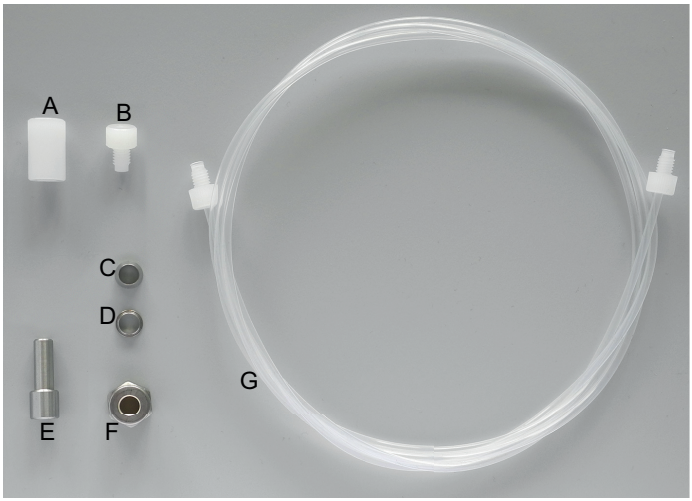
A *Adapter*
B *Thread*
C *Teflon tape*

6.5. Verification

The values measured by AMI-II CACE can be verified with an AMI Inspector Conductivity. Connection is made using an optional adapter kit.

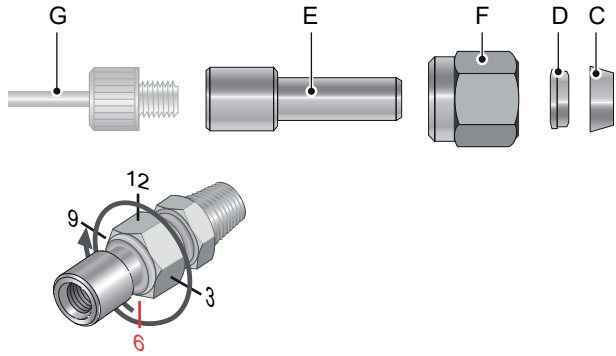
Contents of the adapter kit

The adapter kit contains the following items:



A *M6 to M6 connector*
B *Blind plug*
C *Compression cone*
D *Compression ferrule*
E *¼ inch to M6 adapter*
F *Union nut*
G *170 cm FEP tube*

Sample inlet at AMI Inspector



1 Insert the compression ferrule [D] and the compression cone [C] into the union nut [F].

2 Screw the union nut onto the body, do not tighten it.

3 Push the adapter [E] through the union nut as far as it reaches the stop of the body.

4 Mark the union nut at 6 o'clock position.

5 While holding the fitting body steady, tighten the union nut 1¼ rotation using an open ended spanner.

6 Connect the FEP tube [G] to the adapter [E].

Connecting the instruments

1 Stop sample flow to the AMI-II CACE by closing the corresponding valve (e.g. on the Backpressure Regulator).

2 Connect the two instruments as shown on p. 42 or p. 43.

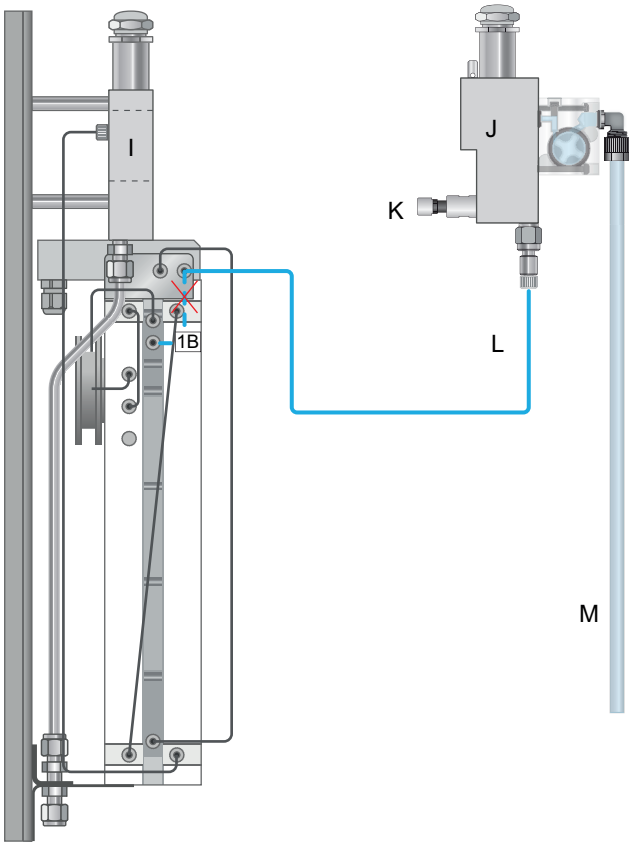
3 Connect the sample outlet of the AMI Inspector to the waste.

4 Switch on the AMI Inspector. Start the sample flow and regulate it to 3–4 l/h using the flow regulating valve [K]. The flow rate is shown on the transmitter of the AMI Inspector.

5 On the AMI Inspector, navigate to **Installation** > **Sensors** > **Temp. compensation** and set it to the same temperature compensation as the sensor to be tested.

6 Wait until the value has stabilized. This takes about 5 minutes.

Tubing for specific conductivity

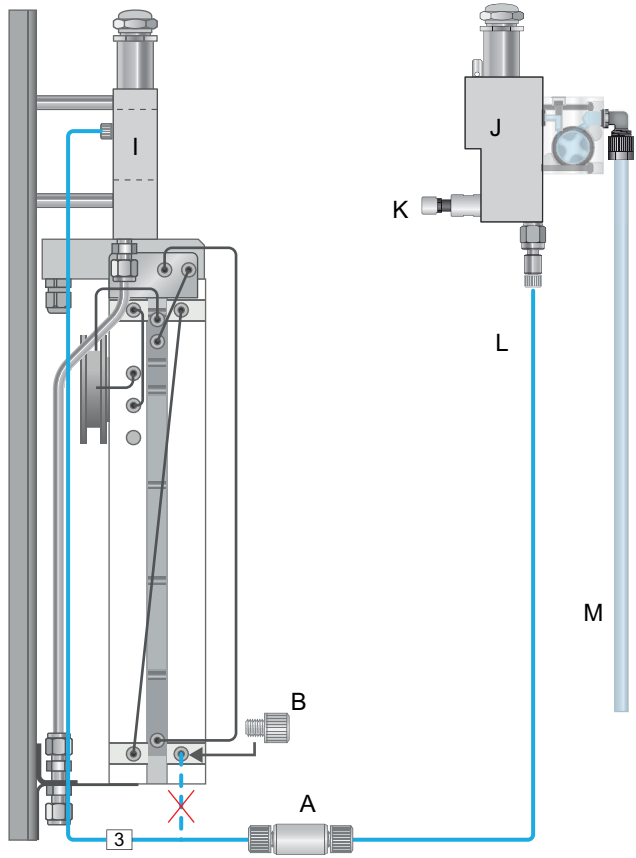


I *Flow cell of AMI-II CACE*
J *Flow cell of AMI Inspector*
F *Flow regulating valve*
K *Flow regulating valve*
L *170 cm FEP tube*
M *Waste*

Note:

- *Since no water flows through the electrode chambers, the instrument should not be operated for more than four hours with this measurement setup.*
- *With this measurement setup, no sample flow will be detected by the AMI-II CACE and a flow error will be issued. This has no influence on the measured value.*

Tubing for cation conductivity



A *M6 to M6 connector*
B *Blind plug*
I *Flow cell of AMI-II CACE*
J *Flow cell of AMI Inspector*
K *Flow regulating valve*
L *170 cm FEP tube*
M *Waste*

Note: *Since no water flows through the electrode chambers, the instrument should not be operated for more than four hours with this measurement setup.*

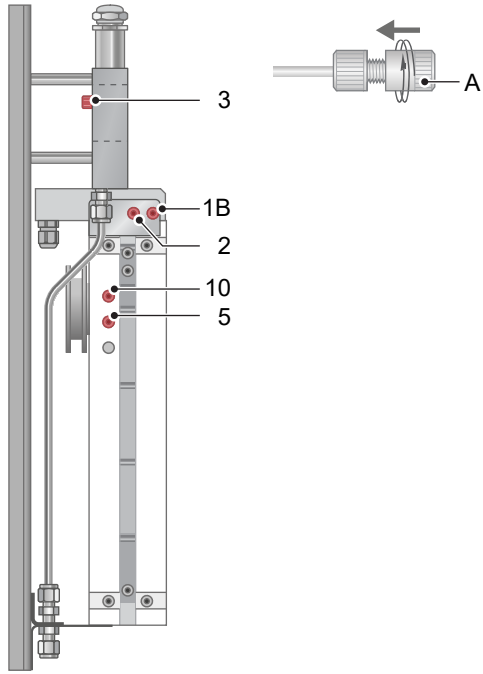
Completion of the measurement

1. Stop the sample flow to the AMI-II CACE by closing the appropriate valve, e.g. back pressure regulator.
2. Close the flow regulating valve of the AMI Inspector.
3. Disconnect the AMI Inspector by removing the tube.
4. Start and regulate sample flow to the AMI-II CACE.
5. Shut off the AMI Inspector.

6.6. Longer Stop of Operation

If the instrument is going to be out of use for an extended period of time (2 months or more), proceed as follows:

1. Stop sample flow.
2. Unscrew the upper end of tube 1B (if the optional inlet filter is installed, unscrew tube 1B from the outlet of the filter).
3. Unscrew the upper end of tube 2 and empty the EDI module through it.
4. Close tubes 1B and 2 with caps [A].
5. Unscrew tubes 3, 5 and 10 at the red marked positions and close them with caps [A].



6. Shut off power of the instrument.

7. Troubleshooting

This chapter provides some hints to make troubleshooting easier.
For information on how to handle/clean parts refer to Maintenance, p. 37.
For information on how to program the instrument refer to Program List and Explanations, p. 61.
If you need help please contact your local distributor. Note serial number of instrument and all diagnostic values before.

Conditions for pH calculation

- Only 1 alkalization agent (acid-base pair) in the sample. No mixture.
- The contamination is mostly NaCl.
- Phosphate concentration is <0.5 ppm.
- If pH value is <8, the concentration of contaminant must be small compared to the concentration of the alkalization agent.
- pH value is >7.5, and <11.5.

What to do if...

Problem	Possible reason / solution
Conductivity value <0.055 µS/cm	◆ Air bubble at sensor tip or sensor in air.
No pH/alkalization agent value available on the display and in the menus for the relays and signal outputs	◆ Switch on calculations in **Installation** > **Sensors** > **Miscellaneous** > **Calculations**. ◆ Afterwards program screen 1 and 2 in **Operation** > **Display** > **Screen 1** and **Operation** > **Display** > **Screen 2**.

7.1. Error List

Two categories of messages are distinguished:

Non-fatal error

Non-fatal instrument error or exceeding of a programmed limit value. Such errors are marked **E0xx** (bold and black) in the following list.

Fatal error (flashing symbol)

Fatal instrument error. Control is interrupted and the displayed measured values may not be correct.
Fatal errors are divided into the following two subcategories:

- Errors which disappear when correct measuring conditions are recovered (i.e. sample flow low).
  Such errors are marked **E0xx** (bold and orange) in the following list.
- Errors which indicate a hardware failure of the instrument.
  Such errors are marked **E0xx** (bold and red) in the following list.

Error	Description	Corrective action
E001	Cond. 1 Alarm high	– Check process. – Check programmed value.
E002	Cond. 1 Alarm low	– Check process. – Check programmed value.
E003	Cond. 2 Alarm high	– Check process. – Check programmed value.
E004	Cond. 2 Alarm low	– Check process. – Check programmed value.
E007	Temp. 1 high	– Check process. – Check programmed value.
E008	Temp. 1 low	– Check process. – Check programmed value.
E009	Sample Flow high	– Check sample inlet pressure.

E010	Sample Flow low	– Check sample inlet pressure.
		– Check if the following components are clogged:
		  – inlet filter (if installed),
		  – tubes,
		  – EDI module.
		– If necessary, replace clogged parts.

E011	Temp. 1 shorted	– Check wiring of temperature sensor. – Check temperature sensor.
E012	Temp. 1 disconnected	– Check wiring of temperature sensor. – Check temperature sensor.
E013	Case Temp. high	– Check case/environment temperature. – Check programmed value.
E014	Case Temp. low	– Check case/environment temperature. – Check programmed value.
E015	pH Calculation undef. (pH out of range, i.e <7.5 or >11.5)	– Check process. – Check if conditions for pH calculation are met.

Error	Description	Corrective action
E017	Control timeout	– Check control device or programming in menus **Installation** > **Relay contacts** > **Relay 1** and **Installation** > **Relay contacts** > **Relay 2**.
E019	Temp. 2 shorted	– Check wiring of temperature sensor. – Check temperature sensor.
E020	Temp. 2 disconnected	– Check wiring of temperature sensor. – Check temperature sensor.
E024	Input active	– Message informing that the relay input has been actuated. – Can be deactivated in menu **Installation** > **Relay contacts** > **Input** > **Fault**.
E026	IC LM75	– Call support.
E030	I2C Frontend	– Call support.
E031	Calibration Recout	– Call support.
E032	Wrong Frontend	– Call support.
E033	pH Alarm high	– Check process. – Check programmed value.
E034	pH Alarm low	– Check process. – Check programmed value.
E035	Alk. Alarm high	– Check process. – Check programmed value.
E036	Alk. Alarm low	– Check process. – Check programmed value.
E037	Temp. 2 high	– Check process. – Check programmed value.
E038	Temp. 2 low	– Check process. – Check programmed value.
E043	EDI out of range	– Check sample inlet pressure and acknowledge this error message. – If the problem persists, stop sample flow and call support.

Error	Description	Corrective action
E044	No sample flow	– Check sample inlet pressure. – Check if the following components are clogged: ◆ inlet filter (if installed), ◆ tubes, ◆ EDI module. – If necessary, replace clogged parts.
E045	EDI DAC disconnected	– Stop sample flow and call support.
E046	EDI ADC disconnected	– Stop sample flow and call support.
E047	EDI module worn out	– Replace EDI module.
E049	Power-on	– None, normal status.
E050	Power-down	– None, normal status.
E065	EDI module exhausted	– Replace EDI module.

7.2. Replacing the EDI Module

When to replace the EDI module

The EDI module should be replaced or serviced when error message E047 is displayed. This error message appears if the voltage of the EDI module exceeds the maximum permissible value of 8 volts for an extended period of time.
When error message E047 appears, approximately 10% of the service life of the EDI module remains. Replacement or service of the EDI module should be carried out within a few weeks.

Storage of EDI modules

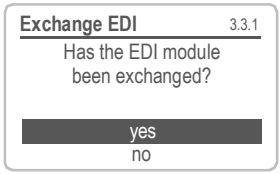
If possible, EDI modules should not be stored, but ordered as needed. The longer the storage period, the longer the rinse-down time during commissioning. If storage is necessary, store the EDI module in a cool and dark place.

Replacing the EDI module

Select **Maintenance** > **Exchange EDI** and follow the instructions on the display.
Status of relays and signal outputs during the procedure:

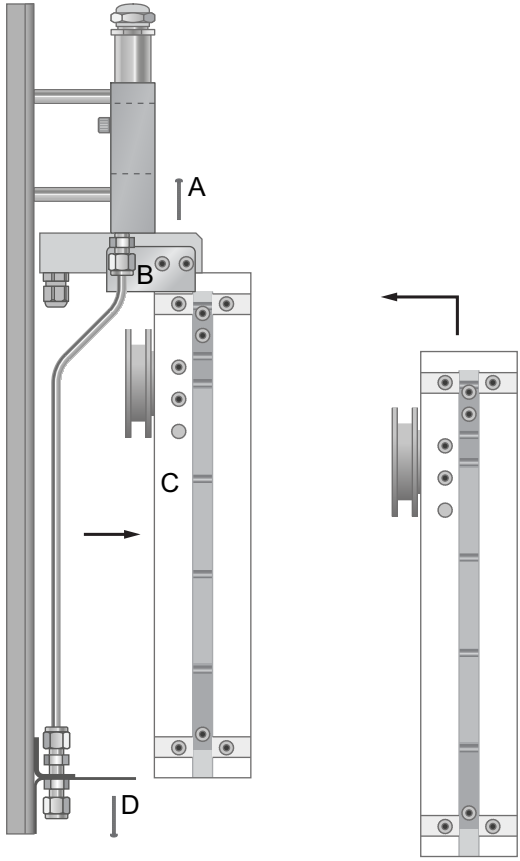
- Signal outputs are on hold
- All limits are switched off

At the end of the procedure, the user is asked if the EDI module has been exchanged. Select “yes” to reset the totalizers in the diagnostics menu and to save the date of exchange.



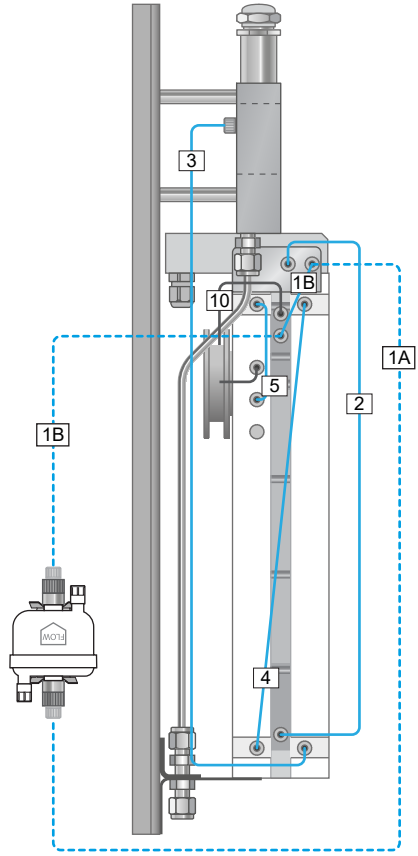
Unmounting the EDI module

To unmount the EDI module, unscrew screws [A] and [D] and the upper ends of tubes [1], [2] and [3].



A *Top screws (2x)*
B *Holder*
C *EDI module*
D *Bottom screw*

7.3. Tube Numbering



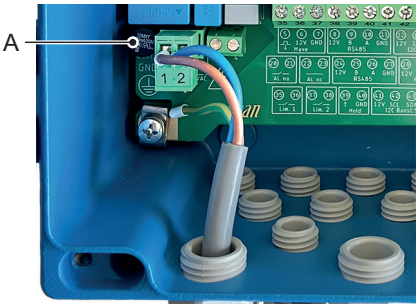
Note: *To replace tube no. 10, the EDI module needs to be unmounted.*

- *Proceed according to Replacing the EDI module, p. 52 and select <no> at the end of the procedure.*

7.4. Replacing Fuses

When a fuse has blown, find out the cause and fix it before replacement. Use tweezers or needle-nosed pliers to remove the defective fuse.
Use original fuses provided by Swan only.

AMI-II transmitter



A *0.8 AT/250V Instrument power supply*

8. Program Overview

Explanations of each parameter in the menus can be found in chapter Program List and Explanations, p. 61.

- Menu 1 **Messages** informs about pending errors and maintenance tasks and shows the error history. Password protection possible. No settings can be modified.
- Menu 2 **Diagnostics** is accessible to anyone at any time. No password protection. No settings can be modified.
- Menu 3 **Maintenance** is intended for service technicians: Calibration, simulation of outputs and set time/date. Please protect with password.
- Menu 4 **Operation** is intended for the user and allows setting of limit values, alarm values, etc. The presetting is made in the Installation menu (for the system engineer only). Please protect with password.
- Menu 5 **Installation**: Defining assignment of all inputs and outputs, measuring parameters, interface, passwords, etc. Menu for the system engineer. Password strongly recommended.

8.1. Messages (Main Menu 1)

Pending Errors 1.1*	*Pending Errors*	1.1.5*	* Menu numbers
Maintenance List 1.2*	*Maintenance List*	1.2.5*	
Message List 1.3*	*Number*	1.3.1*	
	Date, Time		

8.2. Diagnostics (Main Menu 2)

Identification 2.1*	*Designation*			* Menu numbers
	Version			
	Factory Test 2.1.4*	*Motherboard*	2.1.4.1*	
		Front End		
	Operating Time 2.1.5*	*Years, days, hours, minutes, seconds*		2.1.5.1*
Sensors 2.2*	**Conductivity** 2.2.1*	**Sensor 1** 2.2.1.1*	*Current value*	2.2.1.1.1*
			Raw value	
			Cell constant	
		Sensor 2 2.2.1.2*	*Current value*	2.2.1.2.1*
			Raw value	
			Cell constant	
	Miscellaneous 2.2.2*	*Case Temp.*	2.2.2.1*	
	EDI 2.2.3*	*Actual current*	2.2.3.1*	
		Actual voltage		
		Total current		
		Total flow		
		Last exchange		
Sample 2.3*	*Sample ID*	2.3.1*		
	Sample Flow 2.3.2*	*Sample Flow*	2.3.2.1*	
		Raw value		
	Sample Temp. 2.3.3*	*Temp.1 (Pt1000)*	2.3.3.1*	
		Temp.2 (Pt1000)		
I/O State 2.4*	**Relays** 2.4.1*	*Alarm Relay*	2.4.1.1*	
		Relay 1/2		
		Input		
	Signal Outputs 2.4.2*	*Signal Output 1/2/3/4*	2.4.2.1*	
SD Card 2.5*	*State*	2.5.1*		
Interface 2.6*	*Protocol*	2.6.1*		(only with RS485 interface)
	Baud rate			

8.3. Maintenance (Main Menu 3)

Simulation	**Relays**	*Alarm Relay*	3.1.1.1*	* Menu numbers
3.1*	3.1.1*	*Relay 1*	3.1.1.2*	
		Relay 2	3.1.1.3*	
	Signal Outputs	*Signal Output 1*	3.1.2.1*	
	3.1.2*	*Signal Output 2*	3.1.2.2*	
Exchange EDI				
3.2*				
Set Time	*(Date), (Time)*			
3.3*				

8.4. Operation (Main Menu 4)

Sensors	*Filter Time Const.*	4.1.1*		* Menu numbers
4.10*	*Hold after Cal*	4.1.2*		
Relay Contacts	**Alarm Relay**	**Cond. 1 (sc)**	*Alarm High*	4.2.1.1.1*
4.2*	4.2.1*	4.2.1.1*	*Alarm Low*	4.2.1.1.25*
			Hysteresis	4.2.1.1.35*
			Delay	4.2.1.1.45*
		Cond. 2 (cc)	*Alarm High*	4.2.1.2.1*
		4.2.1.2*	*Alarm Low*	4.2.1.2.25*
			Hysteresis	4.2.1.2.35*
			Delay	4.2.1.2.45*
	Relay 1/2	*Parameter*		
	4.2.2*/4.2.3*	*Setpoint*	4.2.x.200*	
		Hysteresis	4.2.x.300*	
		Delay	4.2.x.40*	
	Input	*Active*	4.2.4.1*	
	4.2.4*	*Signal Outputs*	4.2.4.2*	
		Output / Control	4.2.4.3*	
		Fault	4.2.4.4*	
		Delay	4.2.4.5*	
Logger	*Log Interval*	4.3.1*		
4.3*	*Clear Logger*	4.3.2*		
	Eject SD Card	4.3.3*		
Display	**Screen 1**	*Row 1*	4.4.1.1*	
4.4*	4.4.1*	*Row 2*	4.4.1.2*	
		Row 3	4.4.1.3*	
	Screen 2	*Row 1*	4.4.2.1*	
	4.4.2*	*Row 2*	4.4.2.2*	
		Row 3	4.4.2.3*	

8.5. Installation (Main Menu 5)

Sensors	**Miscellaneous**	*Calculations*	5.1.1.1*	* Menu numbers
5.1*	5.1.1*	*Maes. unit*	5.1.1.2*	
	Sensor parameters	**Sensor 1**	*Cell Constant*	5.1.2.1.1*
	5.1.2*	5.1.2.1*	*Temp. Corr.*	5.1.2.1.2*
			Cable length	5.1.2.1.3*
			Temp. comp.	*Comp.*
			5.1.2.1.5*	5.1.2.1.5.1*
		Sensor 2	*Cell Constant*	5.1.2.2.1*
		5.1.2.2*	*Temp. Corr.*	5.1.2.2.2*
			Cable length	5.1.2.2.3*
			Temp. comp.	*Comp.*
			5.1.2.2.5*	5.1.2.2.5.1*
Signal Outputs	**Signal Output 1/2**	*Parameter*	5.2.1.1/5.2.2.1*	
5.2*	5.2.1/5.2.2*	*Current Loop*	5.2.1.2/5.2.2.2*	
		Function	5.2.1.3/5.2.2.3*	
		Scaling	*Range Low*	5.2.x.40.10/11*
		5.2.x.40	*Range High*	5.2.x.40.20/21*
Relay Contacts	**Alarm Relay**	**Conductivity**	**Cond. 1 (sc)**	*Alarm High*
5.3*	5.3.1*	5.3.1.1*	5.3.1.1.1*	*Alarm Low*
				*Hysteresis *
				Delay
			Cond. 2 (cc)	*Alarm High*
			5.3.1.1.2*	*Alarm Low*
				*Hysteresis *
				Delay
		Sample Temp.	**Temp. 1**	*Alarm High*
		5.3.1.2*	5.3.1.2.1*	*Alarm Low*
			Temp. 2	*Alarm High*
			5.3.1.2.2*	*Alarm Low*
		Case Temp.	*Alarm High*	5.3.1.4.1*
		5.3.1.4*	*Alarm low*	5.3.1.4.2*
	Relay 1/2	*Function*	5.3.2.1/5.3.3.1*	
	5.3.2/5.3.3*	*Parameter*	5.3.2.20/5.3.3.20*	
		Setpoint	5.3.2.300/5.3.3.301*	
		Hysteresis	5.3.2.400/5.3.3.401*	
		Delay	5.3.2.50/5.3.3.50*	

	Input	*Active*	5.3.4.1*	* Menu numbers
	5.3.4*	*Signal Outputs*	5.3.4.2*	
		Output/Control	5.3.4.3*	
		Fault	5.3.4.4*	
		Delay	5.3.4.5*	
Miscellaneous	*Language*	5.4.1*		
5.4*	*Set defaults*	5.4.2*		
	Load Firmware	5.4.3*		
	Password	*Messages*	5.4.4.1*	
	5.4.4*	*Maintenance*	5.4.4.2*	
		Operation	5.4.4.3*	
		Installation	5.4.4.4*	
	Sample ID	5.4.5*		
Interface	*Protocol*	5.5.1*		(only with RS485
5.5*	*Device Address*	5.5.21*		interface)
	Baud Rate	5.5.31*		
	Parity	5.5.41*		

9. Program List and Explanations

1 Messages

1.1 Pending Errors

1.1.5 Provides the list of active errors with their status (active, acknowledged). When all active errors have been acknowledged, the alarm relay is active again. Cleared errors are moved to the message list.

1.2 Maintenance List

1.2.5 Provides the list of necessary maintenance. Cleared maintenance messages are moved to the message list.

1.3 Message List

1.3.1 Shows the error history: Error code, date and time of issue and status (active, acknowledged, cleared). 65 errors are memorized. Then the oldest error is cleared to save the newest one (circular buffer).

2 Diagnostics

2.1 Identification

Desig.: Designation of the instrument.
Version: Version of the instrument firmware.
Bootloader: Version of the bootloader.

2.1.4 **Factory Test:** Test date of the mainboard and frontend.

2.1.5 **Operating Time:** Years, days, hours, minutes, seconds.

2.2 Sensors

2.2.1 **Conductivity:**

2.2.1.1 **Sensor 1:**
Current value in µS
Raw value in µS
Cell Constant

2.2.1.1.4 **Factory Data:** Values of the factory calibration.

2.2.1.2 **Sensor 2:** See sensor 1.

2.2.2 **Miscellaneous:**

2.2.2.1 *Case Temp:* Shows the current temperature in [°C] inside the transmitter.

2.2.3 EDI:

2.2.3.1 *Actual current:* Current in mA applied to the EDI module.
Actual voltage: Resulting voltage in mV.
Total current: Amount of electric charge in Ah since the last exchange of the EDI module.
Total flow: Amount of sample water in L since the last exchange of the EDI module.
Last exchange: Date of the last exchange

2.3 Sample

2.3.1 *Sample ID:* Shows the ID used to identify the location of the sample.

2.3.2 *Sample Flow:* Shows the current sample flow in l/h and the raw value in Hz.

2.3.3 Sample Temp:

2.3.3.1 *Temp 1:* Shows the current sample temperature at sensor 1 in °C.
(Pt 1000): Shows the current temperature at sensor 1 in Ohm.
Temp 2: Shows the current sample temperature at sensor 2 in °C.
(Pt 1000): Shows the current temperature at sensor 2 in Ohm.

2.4 I/O State

2.4.1 Relays:

2.5.1.1

Alarm Relay:	Active or inactive
Relays 1 and 2:	Active or inactive
Input:	Open or closed

2.4.2 Signal Outputs:

2.5.2.1

Signal Outputs 1 and 2:	Current in mA
Signal Outputs 3 and 4:	Current in mA (if option is installed)

2.5 SD Card

2.5.1 *Status:* Shows the status of the SD card.

2.6 Interface

Settings of the installed communication option (if any).

3 Maintenance

3.1 Simulation

To simulate a value or a relay state, select

- alarm relay
- relay 1 and 2
- signal outputs 1 and 2
- signal outputs 3 and 4 (if option is installed)

Change the value or state of the selected item with the arrow keys. Press [Enter].

⇒ *The value is simulated by the relay/signal output.*

At the absence of any key activities, the instrument will switch back to normal mode after 20 min.

3.1.1	**Relays**	
3.1.1.1	Alarm relay:	Active or inactive
3.1.1.2	Relay 1:	Active or inactive
3.1.1.3	Relay 2	Active or inactive
3.1.2	**Signal outputs**	
3.1.2.1	Signal outputs 1 and 2:	Current in mA
3.1.2.2	Signal outputs 3 and 4:	Current in mA

3.2 Exchange EDI

See Replacing the EDI module, p. 51

3.3 Set Time

Adjust date and time.

4 Operation

4.1 Sensors

4.1.1 *Filter Time Constant:* Used to damp noisy signals. The higher the filter time constant, the slower the system reacts to changes of the measured value.
Range: 5–300 Sec

4.1.2 *Hold after Cal.:* Delay permitting the instrument to stabilize again after calibration. During calibration plus hold time, the signal outputs are frozen (held on last valid value), alarm values, limits are not active.
Range: 0–6‘000 Sec

4.2 Relay Contacts

See 5.3 Relay Contacts, p. 72.

4.3 Logger

The instrument is equipped with an internal logger. The logger data can be copied to the SD card.

4.3.1 *Log Interval:* Select a convenient log interval.
Range: 1 s, 5 s, 1 min, 5 min, 10 min, 30 min or 1 h.

4.3.2 *Clear Logger:* If confirmed with yes, the complete logger data is deleted. A new data series is started.

4.3.3 *Eject SD Card:* With this function all logger data are copied to the SD card and the SD card can be removed.

4.4 Display

Process values are displayed on two screens. Toggle screens with the ^ key. Each screen displays a maximum of three process values.

4.4.1 Screen 1:

4.4.1.1 *Row 1*

4.4.1.2 *Row 2*

4.4.1.3 *Row 3*

Possible settings for all rows are:

- None
- Cond 1 (cc)
- Cond 2 (sc)
- Difference

If “Calculations” set to “yes”:

- pH
- Ammonia (depends on the setting in menu **Sensor parameters** > **Sensor 1** > **Temp. comp.**

4.4.2 Screen 2:

See screen 1.

5 Installation

5.1 Sensors

5.1.1 Miscellaneous:

5.1.1.1 *Calculations:* Select “yes” if pH and ammonia concentrations should be calculated. Subsequently, pH and ammonia are available on screen 1 or 2, on the signal outputs and as alarm or limit values.

5.1.1.2 *Meas. unit:* Choose the measuring unit as µS/cm or µS/m.

5.1.2 Sensor parameters:

5.1.2.1 Sensor 1:

5.1.2.1.1 *Cell Constant:* Enter the cell constant printed on the sensor label.

5.1.2.1.2 *Temp. Corr:* Enter the temperature correction printed on the sensor label.

5.1.2.1.3 *Cable length:* Enter the cable length. If the transmitter and the flow cell are mounted together on one panel, set the cable length to 0.0 m.

5.1.2.1.5 Temp. comp:

5.1.2.1.5.1 *Comp.:* Available compensation models:

- Strong acids (never select strong acids for sensor 1!)
- Strong bases
- Ammonia
- Morpholine
- Ethanolamines

5.1.2.2 Sensor 2:

5.1.2.2.1 *Cell Constant:* Enter the cell constant printed on the sensor label.

5.1.2.2.2 *Temp. Corr:* Enter the temperature correction printed on the sensor label.

5.1.2.2.3 *Cable length:* Enter the cable length. If the transmitter and the flow cell are mounted together on one panel, set the cable length to 0.0 m.

5.1.2.2.5 Temp. comp:

5.1.2.2.5.1 *Comp.:* Available compensation models:

- Strong acids

5.2 Signal Outputs

Note: *The navigation in the menus Signal Output 1 and Signal Output 2 is equal. For reason of simplicity only the menu numbers of Signal Output 1 are used in the following.*

5.2.1 **Signal Output 1:** Assign process value, the current loop range and a function to each signal output.

5.2.1.1 *Parameter:* Assign one of the process values to the signal output.
Available values:

- Cond 1 (cc)
- Cond 2 (sc)
- Temp. 1
- Temp. 2
- Difference
- Sample flow

If “Calculations” set to “yes”:

- pH
- Ammonia (depends on the setting in menu **Sensor parameters** > **Sensor 1** > **Temp. comp.**

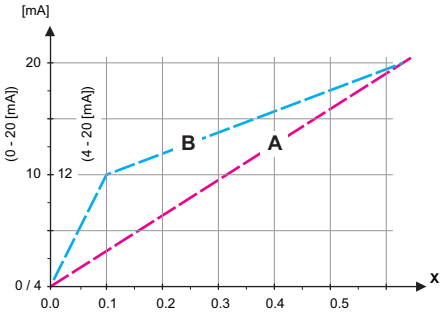
5.2.1.2 *Current Loop:* Select the current range of the signal output.
Make sure the connected device works with the same current range.
Available ranges: 0–20 mA or 4–20 mA

5.2.1.3 *Function:* Define if the signal output is used to transmit a process value or to drive a control unit. Available functions are:

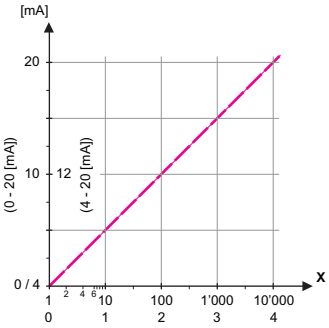
- Linear, bilinear, logarithmic or hyperbolic for process values.
- Control upwards or control downwards for controllers.

As process values

The process value can be represented in four ways: linear, bilinear, logarithmic or hyperbolic*. See graphs below.



A *Linear*
B *Bilinear*
X *Measured value*



X *Measured value (logarithmic)*

* Hyperbolic scaling can be used as an alternative to logarithmic scaling in special cases. Contact Swan for details on this scaling method.

5.2.1.40 **Scaling:** Enter beginning and end point (range low and high) of the linear or logarithmic scale. In addition, the midpoint for the bilinear scale.

Parameters Cond. 1 (sc), Cond. 2 (cc):
5.2.1.40.10 Range low: 0–3000 µS
5.2.1.40.20 Range high: 0–3000 µS

Parameters Temp. 1, 2:
5.2.1.40.13 Range low: -25 to +270 °C
5.2.1.40.23 Range high: -25 to +270 °C

Parameter Difference
5.2.1.40.16 Range low: 0–3000 µS
5.2.1.40.26 Range high: 0–3000 µS

Parameter Sample flow
5.2.1.40.17 Range low: 0–20 l/h
5.2.1.40.27 Range high: 0–20 l/h

Parameter pH
5.2.1.40.18 Range low: 0–14 pH
5.2.1.40.28 Range high: 0–14 pH

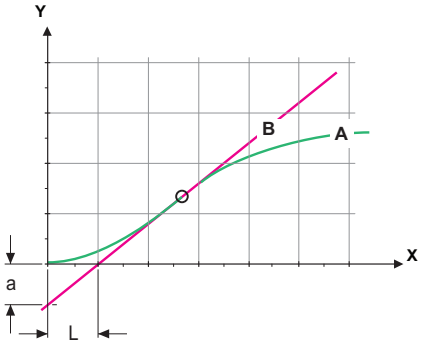
Parameter Ammonia
5.2.1.40.19 Range low: 0–500 ppm
5.2.1.40.29 Range high: 0–500 ppm

As control output

Signal outputs can be used for driving control units. We distinguish different kinds of controls:

- *P-controller:* The controller action is proportional to the deviation from the setpoint. The controller is characterized by the P-Band. In the steady-state, the setpoint will never be reached. The deviation is called steady-state error.
  Parameters: setpoint, P-Band
- *PI-controller:* The combination of a P-controller with an I-controller will minimize the steady-state error. If the reset time is set to zero, the I-controller is switched off.
  Parameters: setpoint, P-Band, reset time.
- *PD-controller:* The combination of a P-controller with a D-controller will minimize the response time to a fast change of the process value. If the derivative time is set to zero, the D-controller is switched off.
  Parameters: setpoint, P-Band, derivative time.
- *PID-controller:* The combination of a P-, an I - and a D-controller allows a proper control of the process.
  Parameters: setpoint, P-Band, reset time, derivative time.

Ziegler-Nichols method for the optimization of a PID controller:
Parameters: Setpoint, P-Band, reset time, derivative time.



A *Response to maximum control output* ***Xp*** *= 1.2/a*
B *Tangent on the inflection point* ***Tn*** *= 2L*
X *Time* ***Tv*** *= L/2*

The point of intersection of the tangent with the respective axis will result in the parameters a and L.
Consult the manual of the control unit for connecting and programming details. Choose control upwards or downwards.

Control upwards or downwards

Setpoint: User-defined process value for the selected parameter.
P-Band: Range below (upwards control) or above (downwards control) the setpoint, within the dosing intensity is reduced from 100% to 0% to reach the setpoint without overshooting.

5.2.1.43 **Control Parameters:**
if Parameter = Cond. 1 (sc), Cond 2 (cc)

5.2.1.43.10 Setpoint
Range: 0–3000 µS

5.2.1.43.20 P-Band:
Range: 0–3000 µS

5.2.1.43 **Control Parameters:**
if Parameter = Temp. 1, Temp. 2

5.2.1.43.13 Setpoint
Range: -25 to +270 °C

5.2.1.43.23 P-Band:
Range: -25 to +270 °C

5.2.1.43 **Control Parameters:**
if Parameter = Difference

5.2.1.43.16 Setpoint
Range: 0–3000 µS

5.2.1.43.26 P-Band:
Range: 0–3000 µS

5.2.1.43 **Control Parameters:**
if Parameter = Sample flow

5.2.1.43.17 Setpoint
Range: 0–20 l/h

5.2.1.43.27 P-Band:
Range: 0–20 l/h

5.2.1.43 **Control Parameters:**
if Parameter = pH

5.2.1.43.18 Setpoint
Range: 0–14 pH

5.2.1.43.28 P-Band:
Range: 0–14 pH

5.2.1.43 **Control Parameters:**
if Parameter = Ammonia

5.2.1.43.19 Setpoint
Range: 0–500 ppm

5.2.1.43.29 P-Band:
Range: 0–500 ppm

5.2.1.43.3 *Reset time:* The reset time is the time till the step response of a single I-controller will reach the same value as it will be suddenly reached by a P-controller.
Range: 0–9'000 sec

5.2.1.43.4 *Derivative time:* The derivative time is the time till the ramp response of a single P-controller will reach the same value as it will be suddenly reached by a D-controller.
Range: 0–9'000 sec

5.2.1.43.5 *Control timeout:* If a controller action (dosing intensity) is constantly over 90% during a defined period of time and the process value does not come closer to the setpoint, the dosing process will be stopped for safety reasons.
Range: 0–720 min

5.3 Relay Contacts

5.3.1 **Alarm Relay:** The alarm relay is used as cumulative error indicator. Under normal operating conditions the contact is active.
The contact is inactive at:

- Power loss
- Detection of system faults like defective sensors or electronic parts
- High case temperature
- Process values out of programmed ranges.

Program alarm levels, hysteresis values and delay times for the following parameters:

- Cond.1 (sc)
- Cond. 2 (cc)
- pH
- Ammonia
- Sample Temp. 1
- Sample Temp. 2
- Case Temperature

5.3.1.1 Conductivity

5.3.1.1.1 Cond. 1 (sc)

5.3.1.1.1.1 *Alarm High:* If the measured value rises above the alarm high value, the alarm relay is activated and E001, is displayed in the message list.
Range: 0 –3000 µS

5.3.1.1.1.25 *Alarm Low:* If the measured value falls below the alarm low value, the alarm relay is activated and E002 is displayed in the message list.
Range: 0 –3000 µS

5.3.1.1.1.35 *Hysteresis:* Within the hyst. range, the relay does not switch. This prevents damage of relays contacts when the measured value fluctuates around the alarm value.
Range. 0 –3000 µS

5.3.1.1.1.45 *Delay:* Duration, the activation of the alarm relay is retarded after the measured value has risen above/fallen below the programmed alarm.
Range: 0–28‘800 Sec

5.3.1.1.2 Cond. 2 (cc)

5.3.1.1.2.1 *Alarm High:* If the measured value rises above the alarm high value, the alarm relay is activated and E003, is displayed in the message list.
Range: 0–3000 µS

5.3.1.1.2.25 *Alarm Low:* If the measured value falls below the alarm low value, the alarm relay is activated and E004 is displayed in the message list.
Range: 0–3000 µS

5.3.1.1.2.35 *Hysteresis:* Within the hyst. range, the relay does not switch. This prevents damage of relays contacts when the measured value fluctuates around the alarm value.
Range. 0–3000 µS

5.3.1.1.2.45 *Delay:* Duration, the activation of the alarm relay is retarded after the measured value has risen above/fallen below the programmed alarm.
Range: 0–28‘800 Sec

5.3.1.1.4 pH (if Calculations = yes)

5.3.1.1.4.1 *Alarm High:* If the measured value rises above the alarm high value, the alarm relay is activated and E033, is displayed in the message list.
Range: 0–14 pH

5.3.1.1.4.25 *Alarm Low:* If the measured value falls below the alarm low value, the alarm relay is activated and E034 is displayed in the message list.
Range: 0–14 pH

5.3.1.1.4.35 *Hysteresis:* Within the hyst. range, the relay does not switch. This prevents damage of relays contacts when the measured value fluctuates around the alarm value.
Range: 0–14 pH

5.3.1.1.4.45 *Delay:* Duration, the activation of the alarm relay is retarded after the measured value has risen above/fallen below the programmed alarm.
Range: 0–28‘800 Sec

5.3.1.1.5 **Ammonia** (if Calculations = yes)

5.3.1.1.5.1 *Alarm High:* If the measured value rises above the alarm high value, the alarm relay is activated and E035, is displayed in the message list.
Range: 0–500 ppm

5.3.1.1.5.25 *Alarm Low:* If the measured value falls below the alarm low value, the alarm relay is activated and E036 is displayed in the message list.
Range: 0–500 ppm

5.3.1.1.5.35 *Hysteresis:* Within the hyst. range, the relay does not switch. This prevents damage of relays contacts when the measured value fluctuates around the alarm value.
Range: 0–500 ppm

5.3.1.1.5.45 *Delay:* Duration, the activation of the alarm relay is retarded after the measured value has risen above/fallen below the programmed alarm.
Range: 0–28‘800 Sec

5.3.1.2 **Sample Temp.**

5.3.1.2.1 **Temp. 1**

5.3.1.2.1.1 *Alarm High:* If the measured value rises above the alarm high value, the alarm relay is activated and E007 is displayed in the message list.
Range: 30–200 °C

5.3.1.2.1.25 *Alarm Low:* If the measured value falls below the alarm low value, the alarm relay is activated and E008 is displayed in the message list.
Range: -10 to + 20 °C

5.3.1.2.2 **Temp. 2**

5.3.1.2.2.1 *Alarm High:* If the measured value rises above the alarm high value, the alarm relay is activated and E037, is displayed in the message list.
Range: 30–200 °C

5.3.1.2.2.25 *Alarm Low:* If the measured value falls below the alarm low value, the alarm relay is activated and E038 is displayed in the message list.
Range: -10 to + 20 °C

5.3.1.3 Case Temp.

5.3.1.4.1 *Alarm high:* Set the alarm high value for temperature of electronics housing. If the value rises above the programmed value E013 is issued.
Range: 30–75 °C

5.3.1.4.2 *Alarm low:* Set the alarm low value for temperature of electronics housing. If the value falls below the programmed value E014 is issued.
Range: -10 to +20 °C

5.3.2 and 5.3.3 **Relay 1 and 2:** The function of relay contacts 1 or 2 is defined by the user.

Note: *The navigation in the menus Relay 1 and Relay 2 is equal. For reason of simplicity only the menu numbers of Relay 1 are used in the following.*

1 First select the functions as:
- Limit upper/lower,
- Control upwards/downwards,
- Timer
- Fieldbus

2 Then enter the necessary data depending on the selected function. The same values can also be entered in menu 4.2.

5.3.2.1 Function = Limit upper/lower:

If the relays are used as upper or lower limit switches, program the following:

5.3.2.20 *Parameter:* select a process value

5.3.2.300 *Setpoint:* If the measured value rises above respectively falls below the set-point, the relay is activated.

Parameter	Range
Cond. 1 (sc)	0.000–3000 µS
Cond.2 (cc)	0.000–3000 µS
Temp. 1	-25 to +270 °C
Temp. 2	-25 to +270 °C
Difference	0.000–3000 µS
Sample flow	0–20 l/h
pH	0 –14 pH
Ammonia	0 –500 ppm

5.3.2.400 *Hysteresis:* within the hysteresis range, the relay does not switch. This prevents damage of relay contacts when the measured value fluctuates around the alarm value.

Parameter	Range
Cond. 1 (sc)	0.000–3000 µS
Cond. 2 (cc)	0.000–3000 µS
Temp. 1	0–100 °C
Temp. 2	0–100 °C
Difference	0–3000 µS
Sample flow	0–20 l/h
pH	0 –14 pH
Ammonia	0 –500 ppm

5.3.2.50 *Delay:* Time by which the switching of the alarm relay is delayed after the measured value has risen above or fallen below the programmed alarm.
Range. 0–600 Sec

5.3.2.1 Function = Control upwards/downwards:

The relays can be used to drive control units such as solenoid valves or membrane dosing pumps.

5.3.2.22 *Parameter:* Choose on of the following process values.

- Cond.1 (sc)
- Cond.2 (cc)
- Temp. 1
- Temp. 2
- Difference
- Sample Flow
- pH
- Ammonia

5.3.2.32 **Settings*:*** Choose the respective actuator:

- Time proportional
- Frequency

5.3.2.32.1	Actuator = Time proportional
	Examples of metering devices that are driven time proportional are solenoid valves and peristaltic pumps. Dosing is controlled by the operating time.
5.3.2.32.20	*Cycle time:* duration of one control cycle (on/off change). Range: 0–600 sec.
5.3.2.32.30	*Response time:* Minimal time the metering device needs to react. Range: 0–240 sec.
5.3.2.32.4	**Control Parameters** Range for each parameter same as 5.2.1.43.
5.3.2.32.1	Actuator = Frequency
	Examples of metering devices that are pulse frequency driven are the classic membrane pumps with a potential free triggering input. Dosing is controlled by the repetition speed of dosing shots.
5.3.2.32.21	*Pulse frequency:* Max. pulses per minute the device is able to respond to. Range: 20–300/min.
5.3.2.32.31	**Control Parameters** Range for each parameter same as 5.2.1.43.
5.3.2.1	Function = Timer
	The relay will be activated repetitively depending on the programmed time scheme.
5.3.2.24	*Mode:* Operating mode (interval, daily, weekly).

5.3.2.24 Interval

5.3.2.340 *Interval:* The interval can be programmed within a range of 1–1'440 min.

5.3.2.44 *Run Time:* Enter the time the relay stays active.
Range: 5–32'400 sec.

5.3.2.54 *Delay:* during run time plus the delay time the signal and control outputs are held in the operating mode programmed below.
Range: 0–6'000 Sec.

5.3.2.6 *Signal Outputs:* Select operating mode of the signal output:

Cont.: Signal outputs continue to issue the measured value.

Hold: Signal outputs hold the last valid measured value. Measurement is interrupted. Errors, except fatal errors, are not issued.

Off: Signal outputs are switched off (set to 0 or 4 mA). Errors, except fatal errors, are not issued.

5.3.2.7 *Output/Control:* Select operating mode of the controller output:

Cont.: Controller continues normally.

Hold: Controller continues based on the last valid value.

Off: Controller is switched off.

5.3.2.24 daily

The relay contact can be activated daily, at any time of a day.

5.3.2.341 *Start time:* to set the start time proceed as follows:
tart time: to set the start time proceed as follows:

1 Press [Enter], to set the hours.

2 Set the hour with the ^ or v keys.

3 Press [Enter], to set the minutes.

4 Set the minutes with the ^ or v keys.

5 Press [Enter], to set the seconds.

6 Set the seconds with the ^ or v keys.

Range: 00:00:00–23:59:59

5.3.2.44 *Run Time:* see Interval

5.3.2.54 *Delay:* see Interval

5.3.2.6 *Signal Outputs:* see Interval

5.3.2.7 *Output/Control:* see Interval

5.3.2.24	weekly
	The relay contact can be activated at one or several days of a week. The daily starting time is valid for all days.
5.3.2.342	**Calendar:**
5.3.2.342.1	*Start time:* The programmed start time is valid for each of the programmed days. Range: 00:00:00–23:59:59
5.3.2.342.2	*Monday:* Possible settings, on or off to
5.3.2.342.8	*Sunday:* Possible settings, on or off
5.3.2.44	*Run Time:* see Interval
5.3.2.54	*Delay:* see Interval
5.3.2.6	*Signal Outputs:* see Interval
5.3.2.7	*Output/Control:* see Interval
5.3.2.1	Function = Fieldbus
	The relay is switched via Profibus or Modbus. No further parameters are needed.
5.3.4	**Input:** The functions of the relays and signal outputs can be defined depending on the position of the input contact, i.e. no function, closed or open.
5.3.4.1	*Active:* Define when the input should be active:
	No: Input is never active.
	When closed Input is active when the input relay is closed
	When open: Input is active when the input relay is open
5.3.4.2	*Signal Outputs:* Select the operation mode of the signal outputs when the relay is active:
	Continuous: Signal outputs continue to issue the measured value.
	Hold: Signal outputs hold the last valid measured value. Errors, except fatal errors, are not issued.
	Off: Sets the signal outputs to 0 or 4 mA. Errors, except fatal errors, are not issued.
5.3.4.3	*Output/Control:* (relay or signal output):
	Continuous: Controller continues normally.
	Hold: Controller continues based on the last valid value.
	Off: Controller is switched off.

5.3.4.4 *Fault:*

No:	No message is issued in pending error list and the alarm relay does not switch when input is active. Message E024 is stored in the message list.
Yes:	Message E024 is issued and stored in the message list. The alarm relay switches when input is active.

5.3.4.5 *Delay:* Time which the instrument waits, after the input is deactivated, before returning to normal operation.
Range: 0–6‘000 Sec

5.4 Miscellaneous

5.4.1 *Language:* Set the required language.
The choice of languages depends on the installed language pack:
- LP0 (Europe-1): German, English, French, Spanish
- LP1 (Asia-1): Chinese, English

5.4.2 *Set defaults:* Reset the instrument to factory default values in three different ways:
- **Calibration:** Sets calibration values back to default. All other values are kept in memory.
- **In parts:** Communication parameters are kept in memory. All other values are set back to default values.
- **Completely:** Sets back all values including communication parameters.

5.4.3 *Load Firmware:* Firmware updates should be done by instructed service personnel only.

5.4.4 **Password:** Select a password different from 0000 to prevent unauthorized access to the menus “Messages”, “Maintenance”, “Operation” and “Installation”.
Each menu can be protected by a different password.
If you forgot the passwords, contact the closest Swan representative.

5.4.5 *Sample ID:* Identify the process value with any meaningful text, such as KKS number.

5.5 Interface

Select one of the following communication protocols. Depending on your selection, different parameters must be defined.

5.5.1	*Protocol:* **Profibus**	
5.5.20	Device address:	Range: 0–126
5.5.30	ID no.:	Range: Analyzer; Manufacturer; Multivariable
5.5.40	Local operation:	Range: Enabled, Disabled
5.5.1	*Protocol:* **Modbus RTU**	
5.5.21	Device address:	Range: 0–126
5.5.31	Baud rate:	Range: 1 200–115 200 Baud
5.5.41	Parity:	Range: none, even, odd
5.5.1	*Protocol:* **HART**	
	Device address:	Range: 0–63

10. Default Values

Operation

Sensors:	Filter Time Const.:	20 s
	Hold after Cal.:	0 s
Relay Contacts	Alarm Relay	same as in Installation
	Relay 1/2	same as in Installation
	Input	same as in Installation
Logger	Log Interval	30 min
	Clear Logger	no
Display	Screen 1 and 2; Row 1:	Cond 1(sc)
	Screen 1 and 2; Row 2:	Cond 2(cc)
	Screen 1 and 2; Row 3:	None

Installation

Sensors	Miscellaneous; Calculations:	no
	Miscellaneous; Meas. unit	µS/cm
	Sensor Parameters; Sensor 1, 2; Cell Constant	0.0415 cm^{-1}
	Sensor Parameters; Sensor 1, 2; Temp. corr.	0.00 °C
	Sensor Parameters; Sensor 1, 2; Cable length	0.0 m
	Sensor Parameters; Sensor 1; Temp. comp.; Comp:	Ammonia
	Sensor Parameters; Sensor 2; Temp. comp.; Comp:	Strong Acids
Signal Output 1	Parameter:	Cond 1(sc)
	Current loop:	4 –20 mA
	Function:	linear
	Scaling: Range low:	0.000 µS
	Scaling: Range high:	1000.00 µS
Signal Output 2	Parameter:	Cond 2(cc)
	Current loop:	4 –20 mA
	Function:	linear
	Scaling: Range low:	0.000 µS
	Scaling: Range high:	1000.00 µS
Alarm Relay	Conductivity; Cond. 1 (sc), Cond. 2 (cc):	
	Alarm high:	3000.00 µS
	Alarm low:	0.000 µS
	Hysteresis:	10.0 µS
	Delay:	5 s

Sample Temp: (Temp. 1, Temp. 2)
Alarm High: ..... 160 °C
Alarm Low: ..... 0 °C
Case temp. high: ..... 65 °C
Case temp. low: ..... 0 °C

Relay 1/2
Function: ..... limit upper
Parameter: ..... Cond 1(sc)
Setpoint: ..... 1000 µS
Hysteresis: ..... 10 µS
Delay: ..... 30 s

If Function = Control upw. or dnw:
Parameter: ..... Cond 1(sc)
Settings: Actuator: ..... Frequency
Settings: Pulse Frequency: 120/min
Settings: Control Parameters: Setpoint: ..... 1000 µS
Settings: Control Parameters: P-band: ..... 10 µS
Settings: Control Parameters: Reset time: ..... 0 s
Settings: Control Parameters: Derivative Time: ..... 0 s
Settings: Control Parameters: Control Timeout: ..... 0 min
Settings: Actuator: ..... Time proportional
Cycle time: ..... 60 s
Response time: ..... 10 s

If Function = Timer:
Mode: ..... Interval
Interval: ..... 1 min
Mode: ..... daily
Start time: 00.00.00
Mode: ..... weekly
Calendar; Start time: 00.00.00
Calendar; Monday to Sunday: ..... Off
Run time: ..... 10 s
Delay: ..... 5 s
Signal output: ..... cont
Output/Control: ..... cont

Input	Active	when closed
	Signal Outputs	hold
	Output/Control	off
	Fault	no
	Delay	10 s
Miscellaneous	Language:	English
	Set default:	no
	Load firmware:	no
	Password:	for all modes 0000
	Sample ID:	- - - - - - - -

Appendix: Startup after Maintenance of Power Plant

Purpose

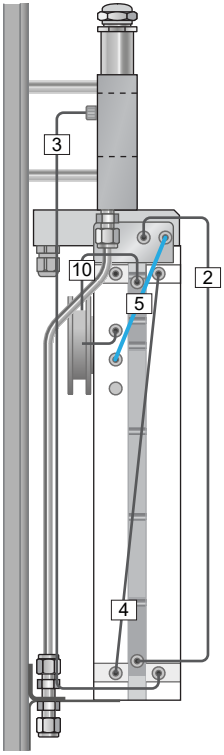
To avoid the accumulation of iron in the sample chamber of the EDI module after a longer standstill of the power plant, the AMI-II CACE can be temporarily operated with a setup that measures only the specific conductivity.

Note: *With this measurement setup, no sample flow will be detected by the AMI-II CACE and a flow error will be issued. This has no influence on the measured value.*

Procedure

1 Unscrew the upper ends of tubes 1 and 5.

2 Connect tube 5 as shown in the picture.



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AMI-II CACE