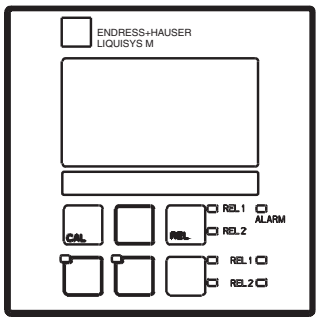
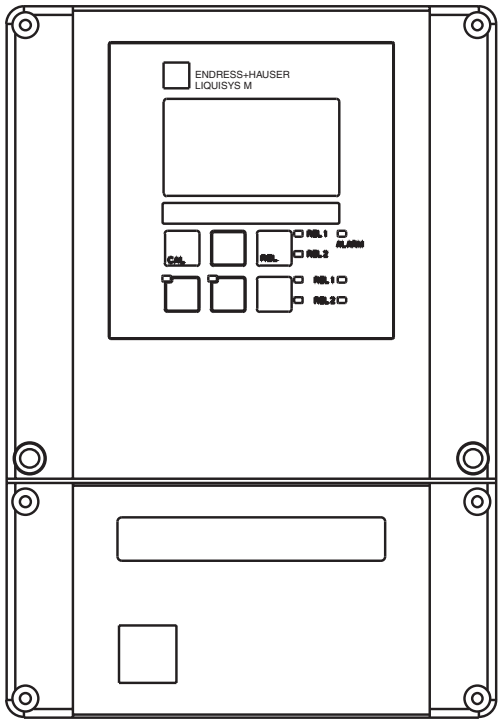
BA 193C/07/en/05.99
No. 51500270
CV 5

valid from software version 2.0 upward

Liquisys M
CLM 223 / 253
Transmitter for Conductivity

Operating Instructions





Endress+Hauser
The Power of Know How

Correction sheet to BA 193C/07/en/05.99

Correction to page 12

Connection diagram

The connection diagram depicted in Fig. 3.10 shows the connections for an inductive or conductive measuring cell (dashed lines).

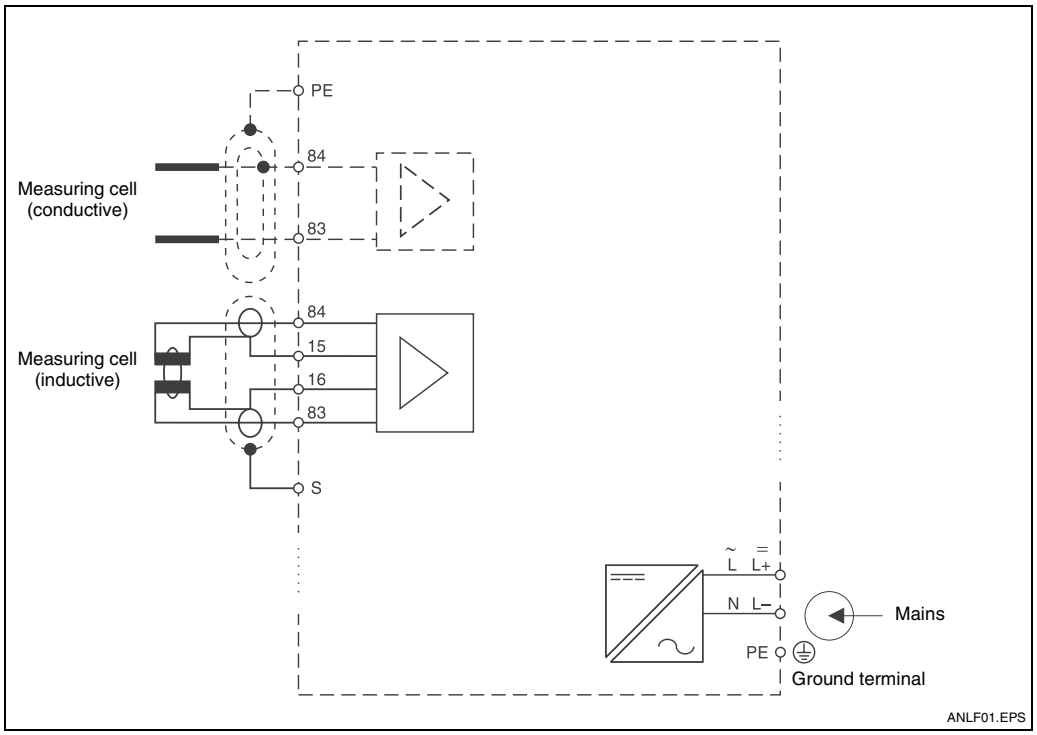


Fig. 3.10 Electrical connection of Liquisys M CLM 223 / 253

Note:

The instrument has protection class II. Grounding of the measuring cable screen requires a ground connection.

Correction to page 13

Connections of field instrument

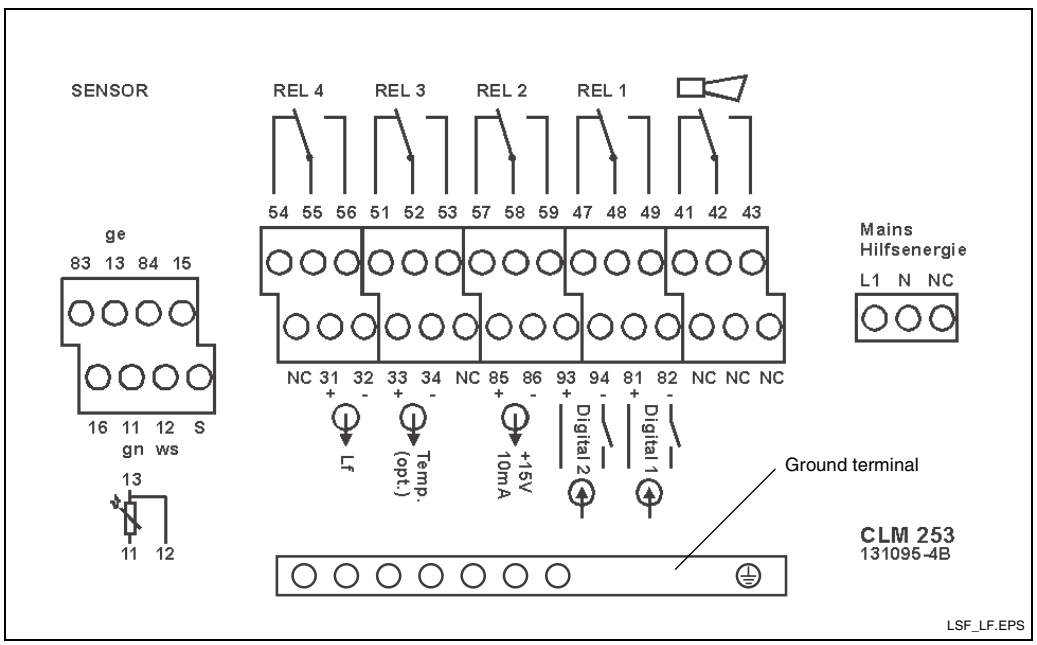


Fig. 3.11 Connection compartment sticker for field instrument CLM 253

Connections of panel mounted instrument

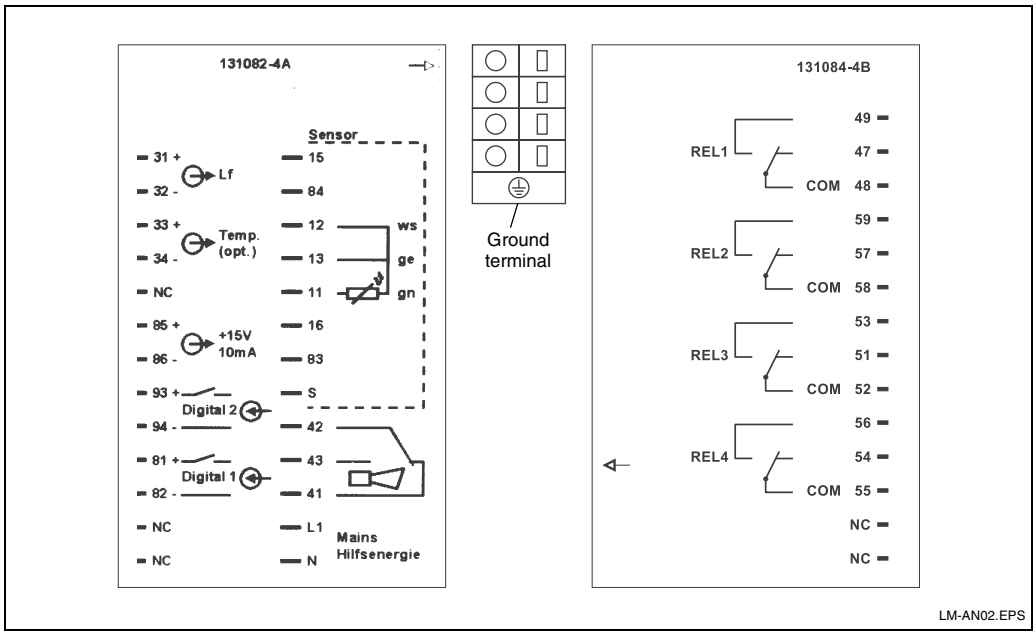


Fig. 3.12 Connection compartment stickers for panel-mounted instrument CLM 223

Correction to page 14

Structure and termination of measuring cable CYK 71

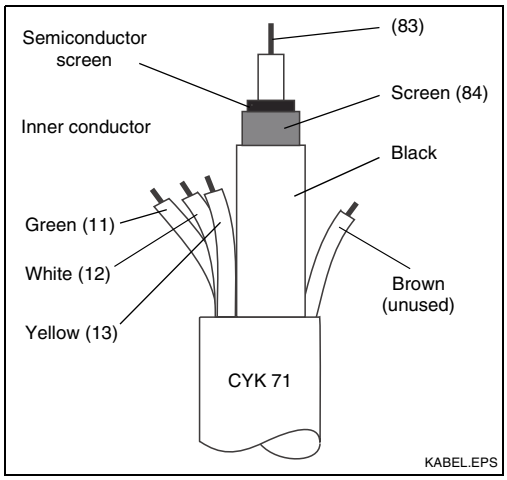


Fig. 3.13 Structure of special measuring cable CYK 71

Correction to page 15

Examples for connection

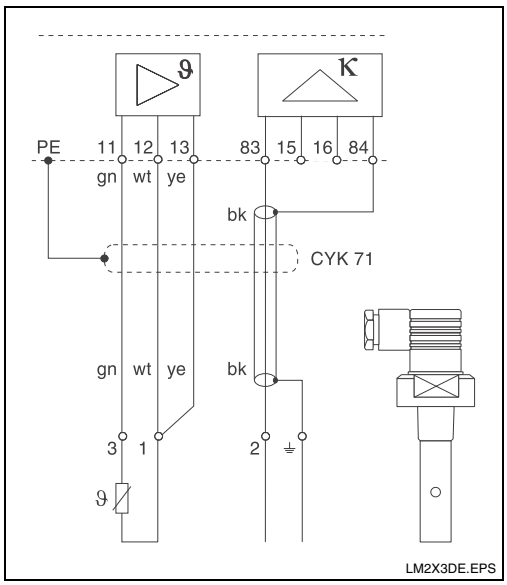


Fig. 3.14 Connection of conductive measuring cells (CLS 15, CLS 19, CLS 20, CLS 21)

Need information on the instrument?
Please read the following chapters:

General information

Safety

You wish to install the instrument.
The required steps are described in these chapters:

Installation

You wish to operate or reconfigure the instrument. The operating concept is explained in these chapters:

Operation

Instrument configuration

Interfaces

Need help with problems or maintenance?

Diagnosis

Maintenance

Accessories

Technical data

Appendix

Index

Table of contents

1 General information

1.1 Symbols used

Warning:

This symbol alerts to hazards which may cause serious injuries as well as damage to equipment if ignored.

Note:

This symbol indicates important items of information.
Ignoring this information may result in malfunction.

1.2 Storage and transport

The packaging material used to store or transport the transmitter must provide shock protection. Optimal protection is provided by the original packaging materials.

Conformance with the ambient conditions (see technical data) must be assured.

1.3 Unpacking

Verify that the packaging and contents are undamaged! Inform the post office or freight carrier of any damage.
Damaged merchandise must be retained until the matter has been settled.

Check that the delivery is complete and agrees with the shipping documents and your order (refer to nameplate for type and version).

The delivery includes:

- Measuring transmitter CLM 223 or CLM 253
- Operating instructions BA 193C/07/en
- Field instrument:
  – 1 plug-in screw terminal
  – 1 cable gland Pg 7
  – 1 cable gland Pg 16, reduced
  – 2 cable glands Pg 13.5
- Panel-mounted instrument:
  – 1 set of plug-in screw terminals
  – 2 fastening clips

Keep the original packaging materials for future storage or shipping of the instrument.

If you have any questions, consult your supplier or the Endress+Hauser sales agency in your area (see back cover of these operating instructions for addresses).

1.4 Packaging and disposal

Package the assembly properly for reuse at a later point in time. Optimal protection is provided by the original packaging materials. Observe local regulations for disposal.

1.5 Product structure

You can identify the instrument version by the order code on the nameplate.

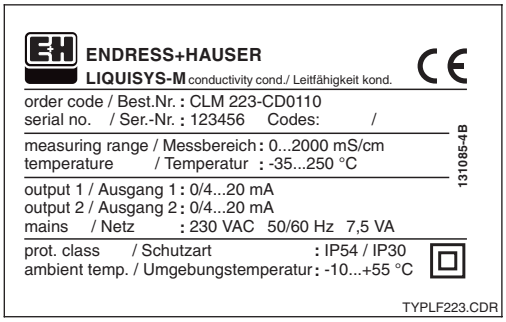


Fig. 1.1 Nameplate of CLM 223 (left)

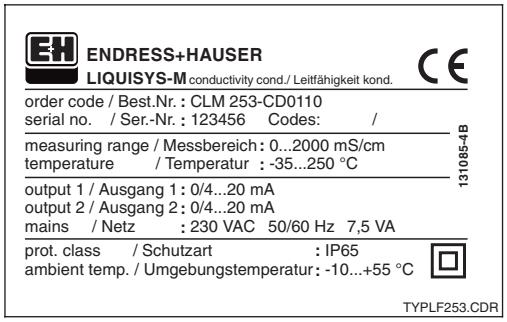


Fig. 1.2 Nameplate of CLM 253 (right)

Liquisys M CLM 223 / 253

Version

CD Conductivity/resistance measurement (two-electrode cell)
CS Conductivity/resistance measurement (two-electrode cell) with additional functions (S version)
ID Conductivity measurement (ind. cell)
IS Conductivity measurement (ind. cell) with additional functions (S version)

Power supply

0 230 V AC
1 115 V AC
5 100 V AC
8 24 V AC/DC

Measurement output

0 Conductivity/resistance
1 Conductivity/resistance and temperature
3 Profibus PA
5 Conductivity/resistance with HART
6 Conductivity/resistance, HART and temperature

Contacts

05 No additional contacts
10 2 contacts (limit / PID / timer)
15 4 contacts (limit / PID / timer / Chemoclean)
16 4 contacts (limit / PID / timer)

CLM223- | | | | |
CLM253- | | | | |

complete order code

2 Safety

2.1 Intended application

The CLM 223/253 transmitter is a field-tested and reliable measuring transmitter used to determine the conductivity and resistance of liquid media.

The CLM 223/253 is particularly suitable for use in the following areas of application:

- Chemical industry
- Pharmaceutical industry
- Foodstuffs industry
- Drinking water processing
- Condensate processing
- Municipal sewage treatment plants
- Water conditioning

2.2 General safety instructions

This device has been manufactured for safe operation according to the state of the art in engineering and conforms to the applicable regulations and European standards (see Technical data). It has been designed according to EN 61010-1 and has left the manufacturer's works in perfect condition.

However, if used improperly or for purposes other than the intended purpose, it may be dangerous, e.g. due to incorrect connection.

Warning:

- Operating this instrument in any way other than as described in these instructions may compromise the safety and function of the measuring system and is therefore impermissible.
- The notes and warnings in these installation and operating instructions must be strictly adhered to!

2.3 Installation, start-up, operation

Warning:

- This device may only be installed, connected electrically, commissioned, operated and serviced by properly trained personnel authorized by the system operator.
- The personnel must be familiar with these operating instructions and must adhere to the instructions described therein.
- Make sure that the power supply ratings match the data specified on the nameplate before you connect the instrument to a power source.
- A clearly identified mains disconnecting device must be installed close to the instrument.
- Live components can be touched through the vent slots in the housing and the openings on the rear of the housing. Do not insert tools, wires, etc., in these slots (CLM 223 only).
- Check that all connections have been properly made before powering up the system!
- Damaged equipment that may be dangerous must not be operated and should be clearly identified as being defective.
- Any troubleshooting of the measuring system is to be performed exclusively by authorized, trained personnel.
- If faults cannot be remedied, the instrument must be removed from service and secured to prevent accidental start-up.
- Repairs not described in these operating instructions may only be performed at the manufacturer's works or by the Endress+Hauser Service Organization.

2.4 Monitoring and safety features

Safety features

The transmitter is protected against external influences and damage by the following design measures:

- Rugged housing
- Degree of protection provided by enclosure: IP 65 (CLM 253)
- UV resistance

Monitoring features

In the event of a system error or power failure, an alarm condition is signalled via a fault-signalling contact.

2.5 Immunity to interference

This instrument has been tested according to the applicable European standards for industrial applications with regard to electromagnetic compatibility. It is protected against electromagnetic interference by the following design measures:

- Cable screen
- Interference suppressor filter
- Interference suppression capacitors

Warning:

The specified immunity to interference only applies for devices connected as outlined in these operating instructions.

2.6 Certificate of conformity

The CLM 223/253 transmitter has been developed and manufactured in accordance with currently valid European standards and directives.

Note:

An EC certificate of conformity is supplied.

3 Installation

The following procedure should be followed for a complete measuring system installation:

- Installation or attachment of transmitter (see chapter 3.3)
- Selection and connection of cable and measuring cell (see chapters 3.4, 3.5 and 9)
- Installation is followed by start-up (see chapter 5).

3.1 Measuring system

The complete measuring system comprises:

- The Liquisys M CLM 223 or CLM 253 transmitter
- A measuring cell with or without an integrated temperature sensor
- A measuring cable CYK 71 (conductive measurement) or measuring cable CLK 5 (cable for inductive measurement permanently attached to sensor)

Optional:

- Extension cable CYK 71 (conductive) or CLK 5 (inductive)
- Junction box VBM

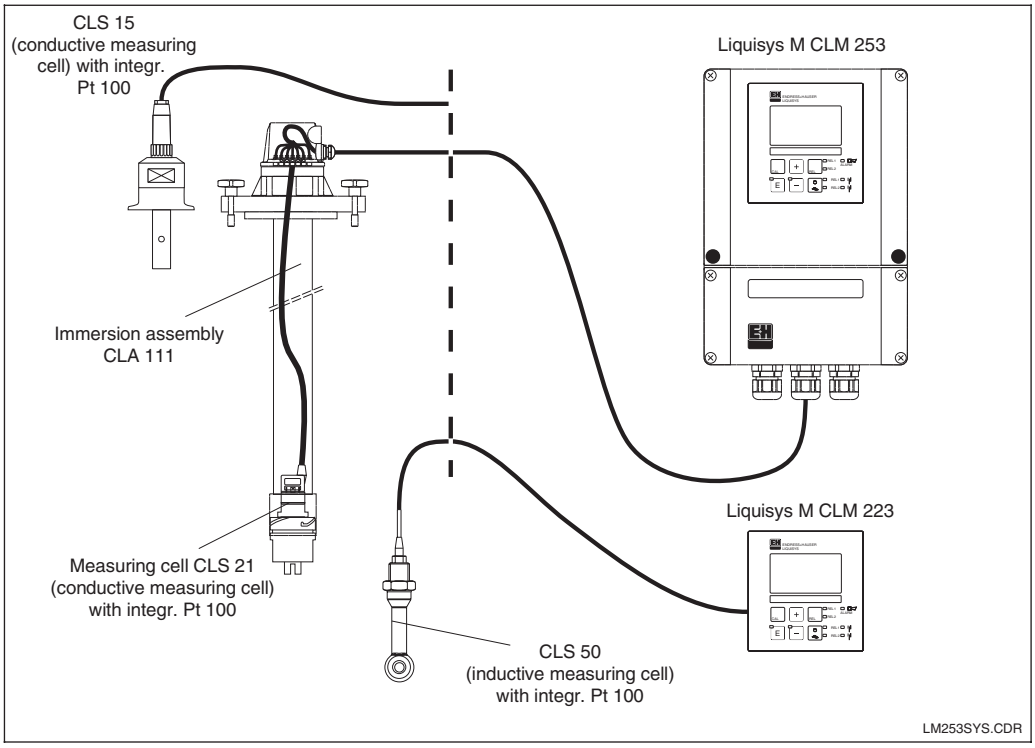
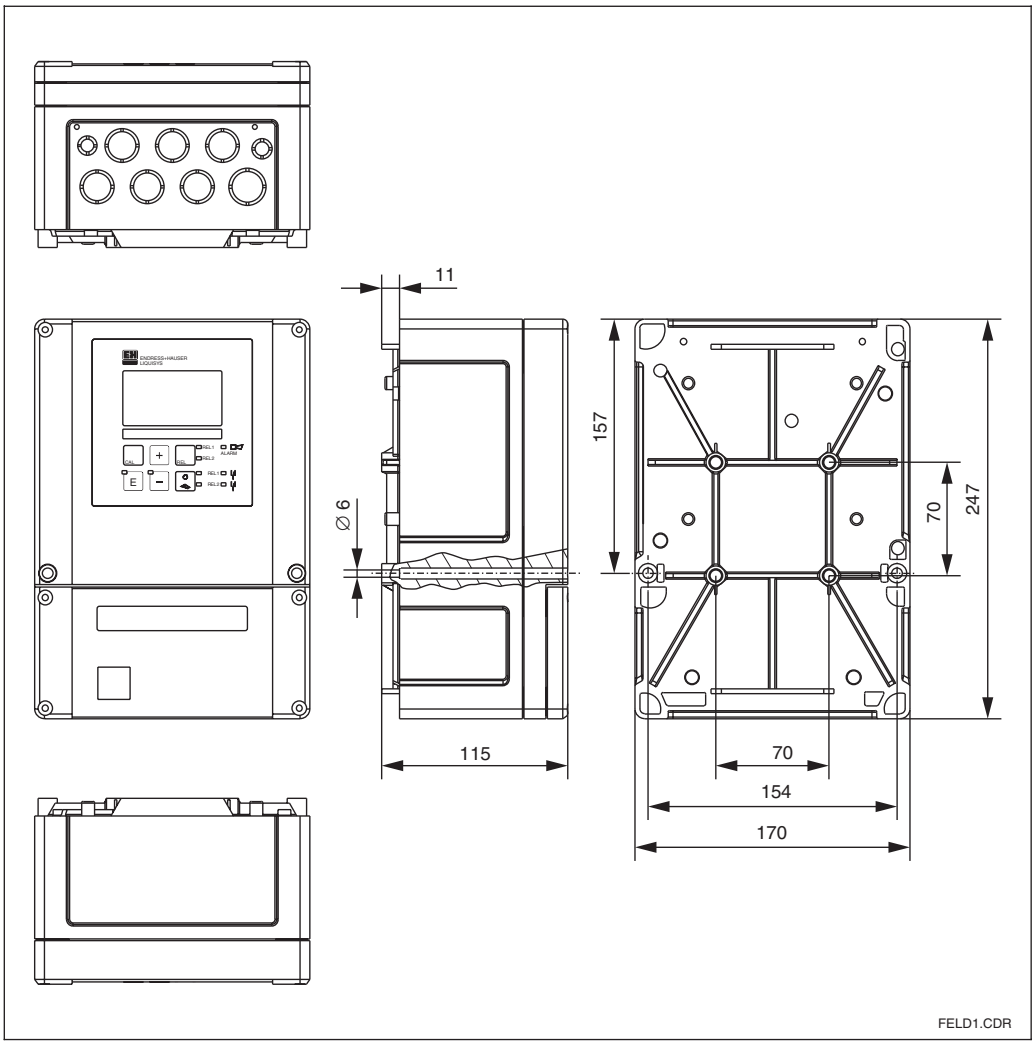


Fig. 3.1 Complete measuring systems consisting of Liquisys M CLM 223 / 253 with measuring cable, assembly and conductivity measuring cell

3.2 Dimensions



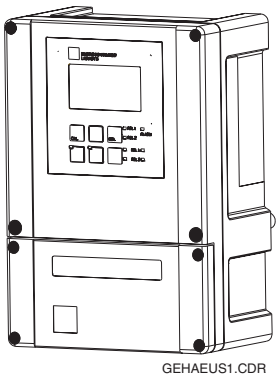


Fig. 3.2 Dimensions of Liquisys M CLM 253

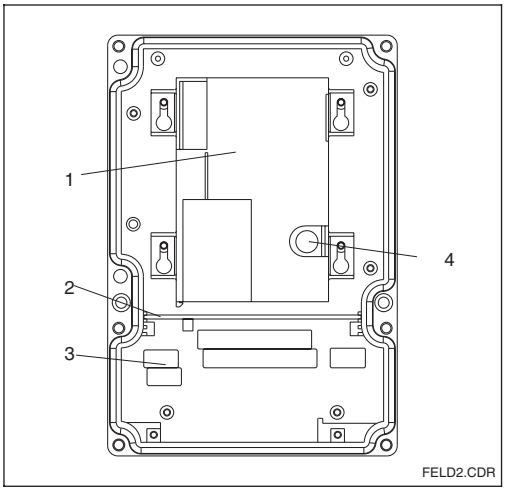
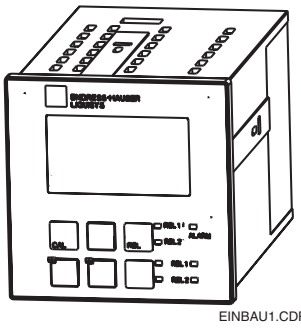


Fig. 3.3 Inside of housing of Liquisys M CLM 253
1 Removable electronics box
2 Partition plate
3 Terminal blocks
4 Fuse



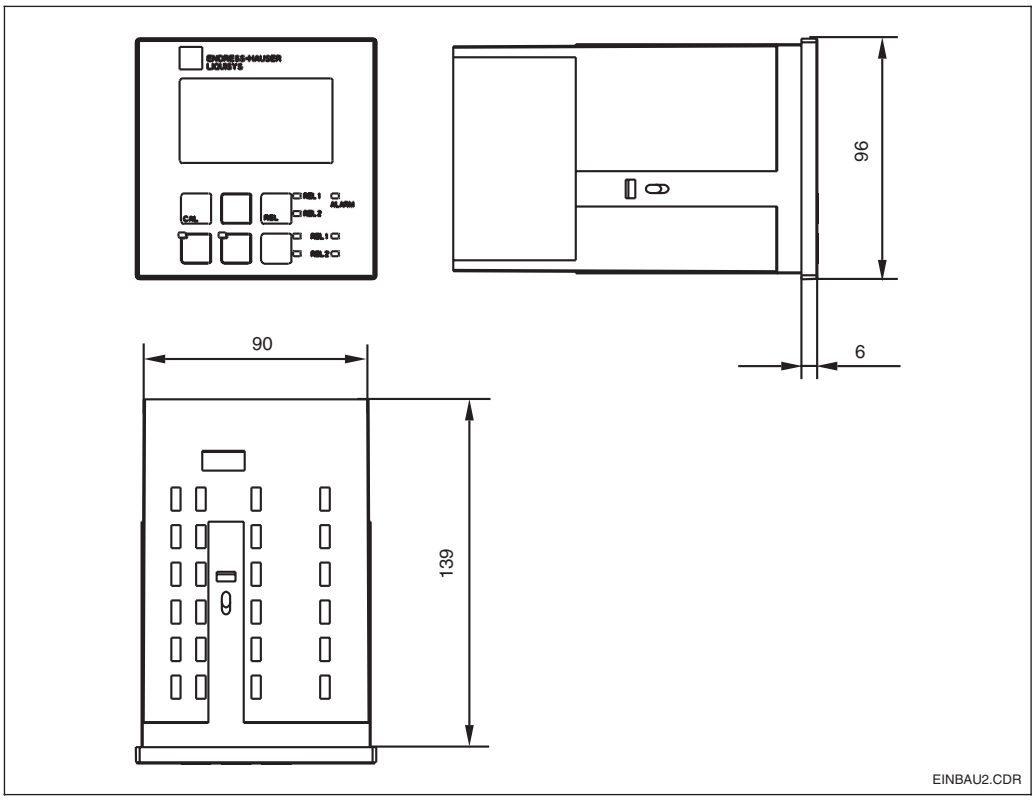


Fig. 3.4 Liquisys M CLM 223, panel-mounted version

3.3 Mounting

3.3.1 Field instrument

Several mounting versions are available for the Liquisys M in the field instrument version:

- Post mounting on cylindrical pipes
- Post mounting on a square post
- Wall mounting with fastening screws

Weather protection cover CYY 101 can be used for outdoor installation in conjunction with all mounting versions.

Weather protection cover CYY 101

Weather protection cover for outdoor installation, to be mounted on field instrument; material: stainless steel 1.4301 (SS 304); order no.: CYY101-A

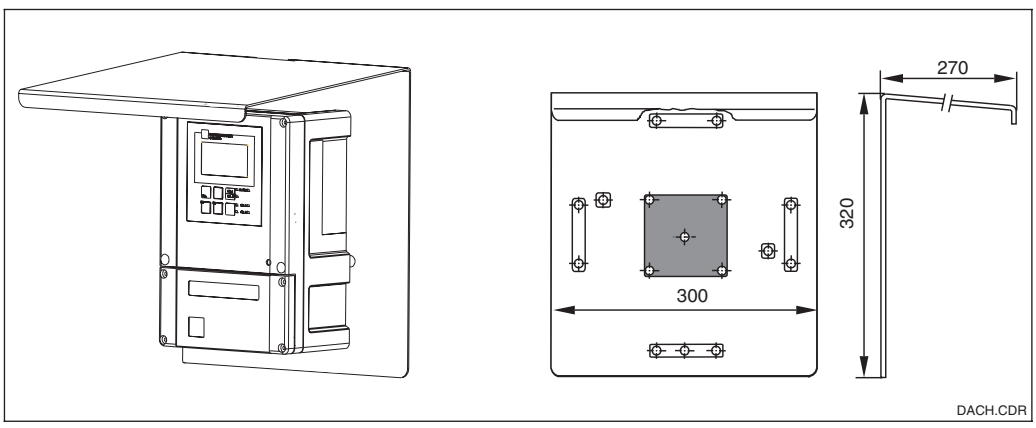


Fig. 3.5 Weather protection cover for field instruments

Post mounting kit

Mounting kit for installation of field housing on horizontal or vertical pipes (max. Ø 60 mm); material: stainless steel VA; order no.: 50086842

Universal mounting post CYY 102

Square tube for mounting of measuring transmitters; material: 1.4301 (SS 304); order no.: CYY102-A

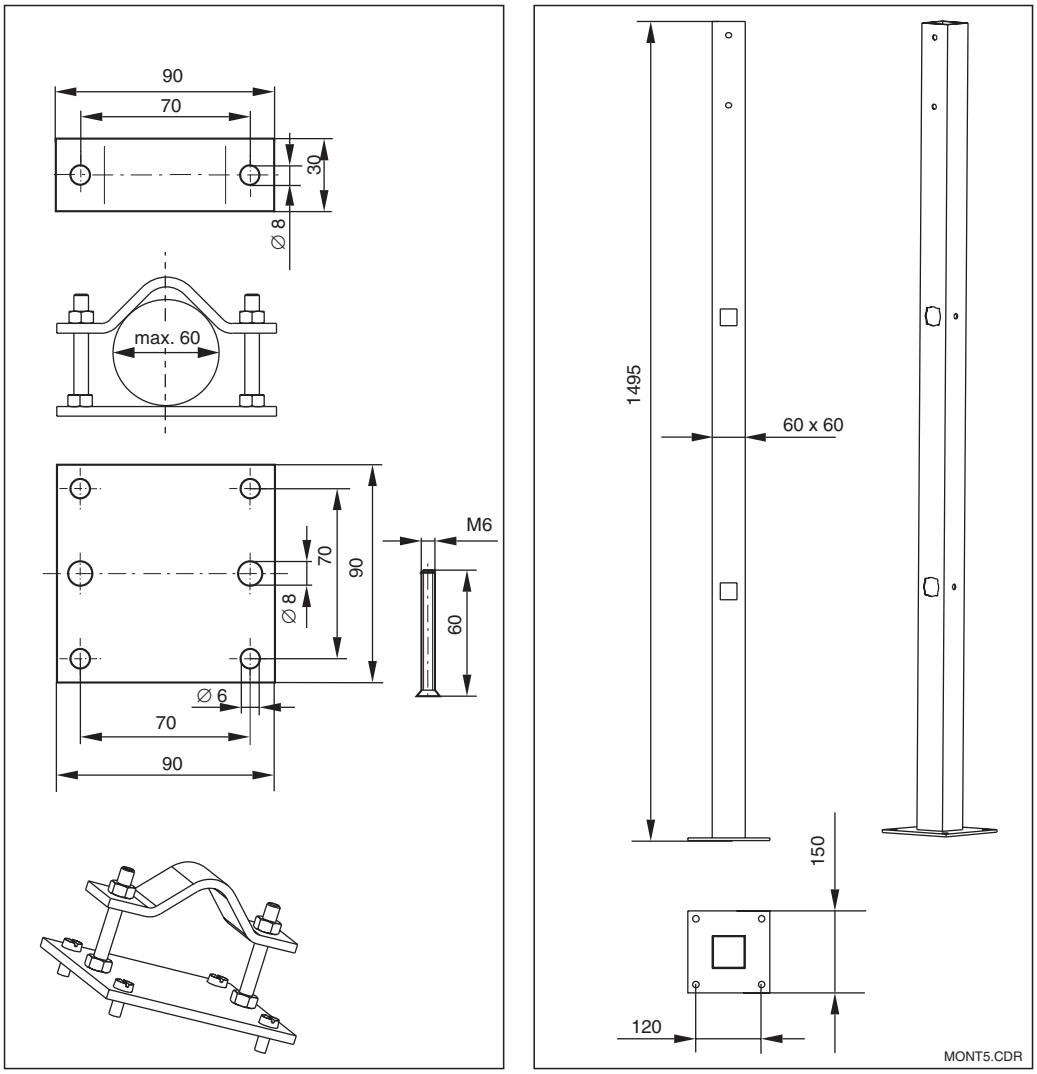


Fig. 3.6 Left: Mounting kit for post mounting on cylindrical pipes
Right: Square mounting post

3.3.2 Mounting examples

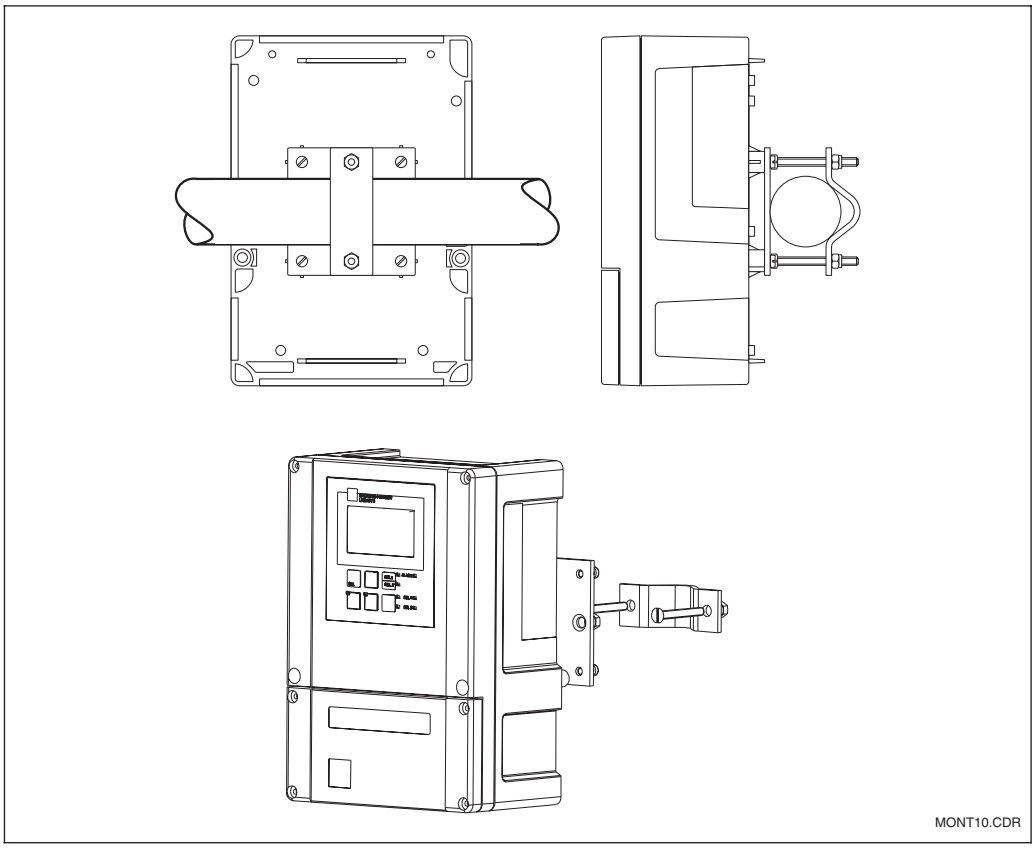


Fig. 3.7 Liquisys M field instrument: Pipe mounting

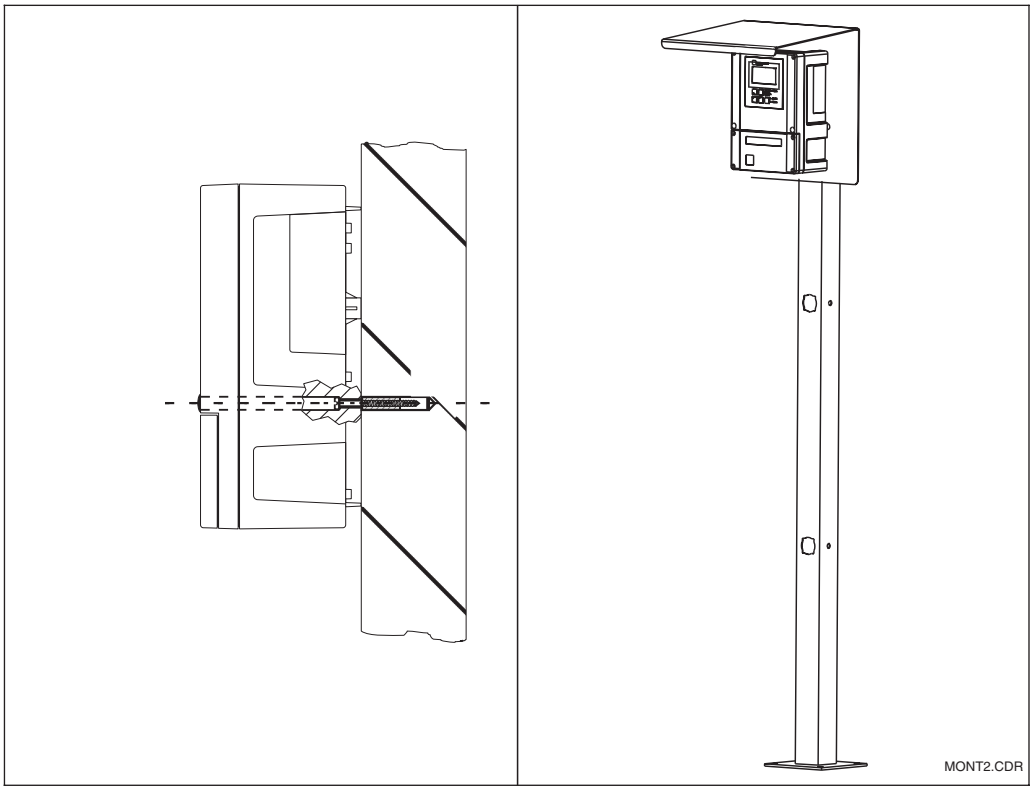


Fig. 3.8 Liquisys M field instrument

Left:
Wall mounting

Right:
Mounting with universal post and weather protection cover

3.3.3 Panel-mounted instrument

The instrument is attached using the supplied tensioning screws (see Fig. 3.9).
The required overall installation depth is approx. 165 mm.

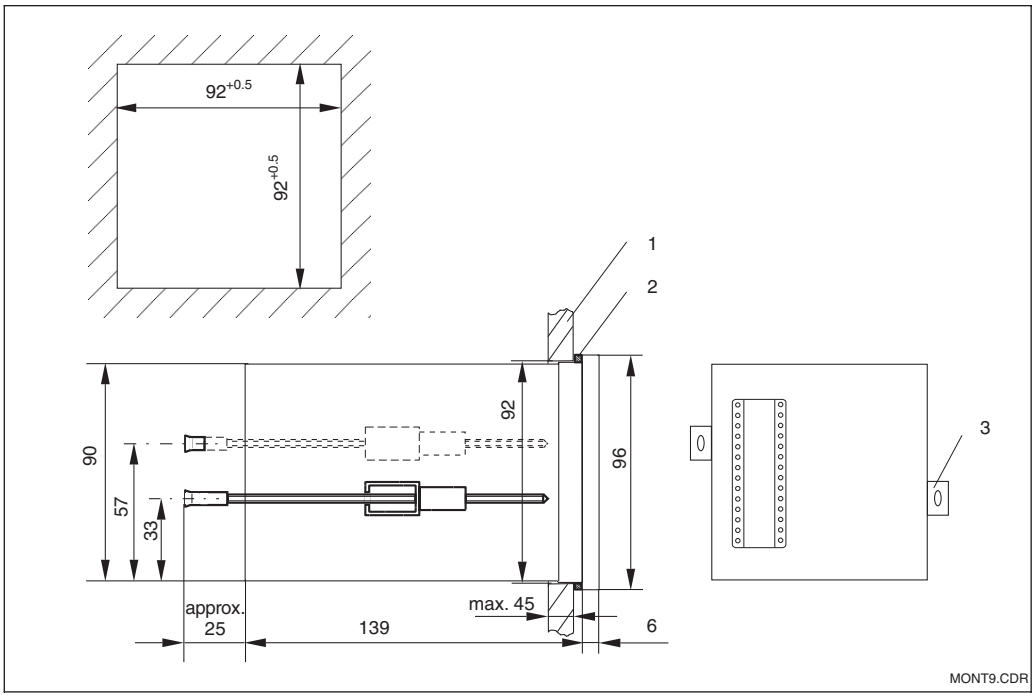


Fig. 3.9 Attachment of panel-mounted instrument
1 Wall of control cabinet
2 Gasket
3 Tensioning screws

3.4 Electrical connection

Connection diagram

The connection diagram depicted in Fig. 3.10 shows the connections for an inductive or conductive measuring cell (dashed lines).

The connection of the various measuring cells is shown in more detail in Figs. 3.13 to 3.15.

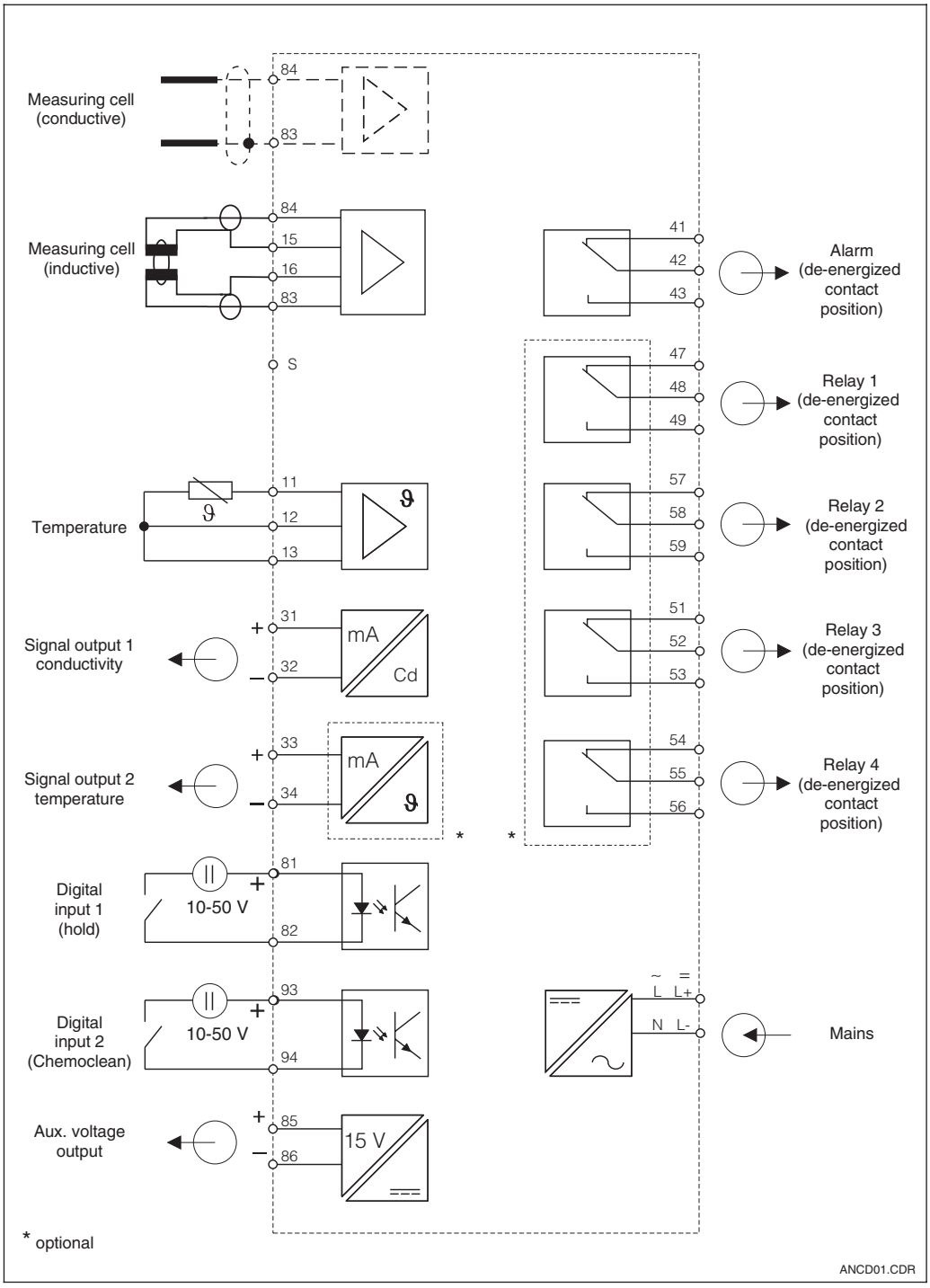


Fig. 3.10 Electrical connection of Liquisys M CLM 223 / 253 (all inputs and outputs connected)

Note:

The instrument has protection class II and is generally operated without protective earth connection.

Connections of field instrument

For connection, the measuring cables are introduced through the cable glands on the field instrument and connected according to the connection diagram in Figs. 3.10, 3.11 and 3.12.

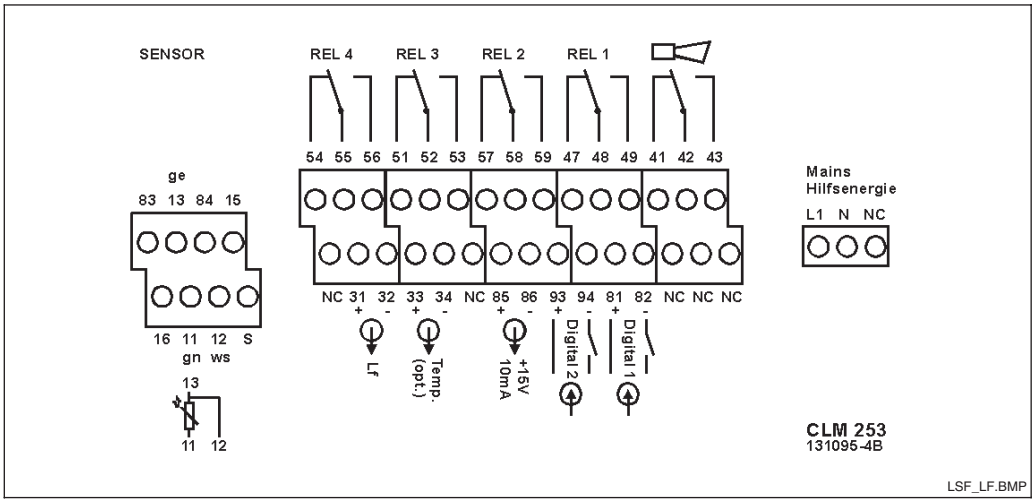


Fig. 3.11 Connection compartment sticker for field instrument CLM 253

Connections of panel-mounted instrument

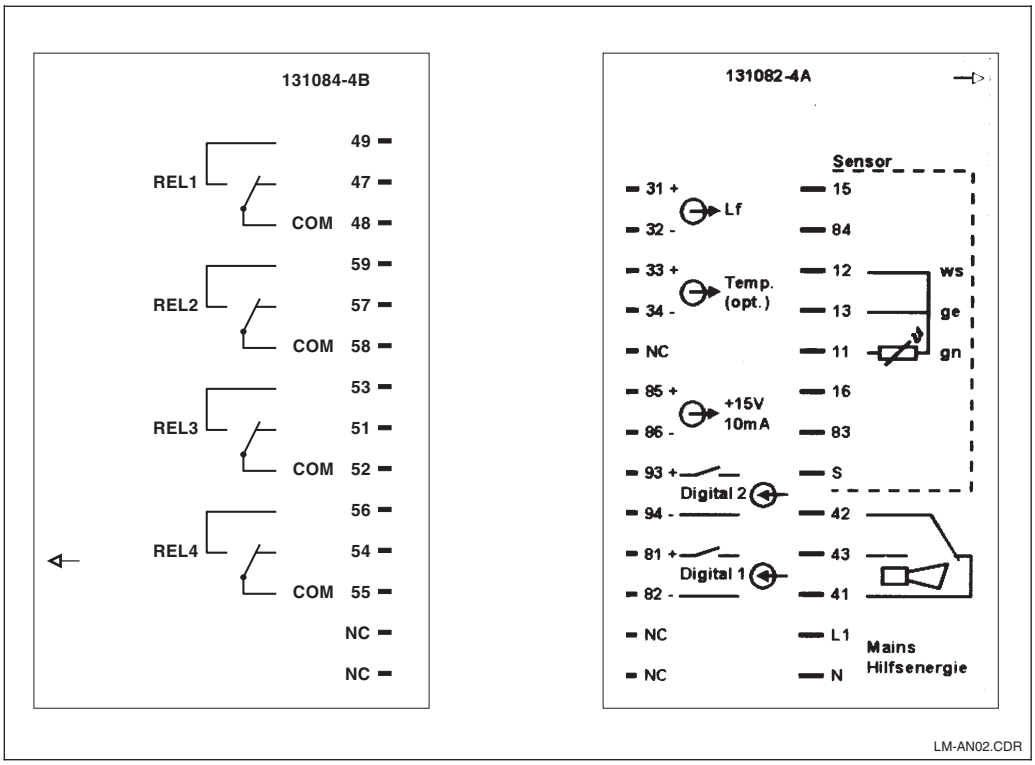


Fig. 3.12 Connection compartment stickers for panel-mounted instrument CLM 223

3.5 Measuring cell installation and cable connection

Measuring cable connection

The conductivity measuring cells are connected using a special, shielded multi-core cable.
Termination instructions are supplied with the measuring cables.
Use junction box VBM (see chapter 9) to extend the measuring cable.

Special measuring cable required for connection of conductivity measuring cells		
Measuring cell type	**Cable**	**Extension**
2-electrode measuring cell with or without temperature sensor Pt 100	CYK 71	Junction box VBM + CYK 71
Inductive measuring cell CLS 50	Cable permanently attached to sensor	Junction box VBM + CLK 5
Maximum cable length		
Conductive conductivity measurement	max. 100 m with CYK 71 (corresponds to 10 nF)	
Resistance measurement	max. 15 m with CYK 71 (corresponds to 2 nF)	
Inductive conductivity measurement	max. 55 m (with CLK 5 and sensor cable)	

Structure and termination of measuring cables

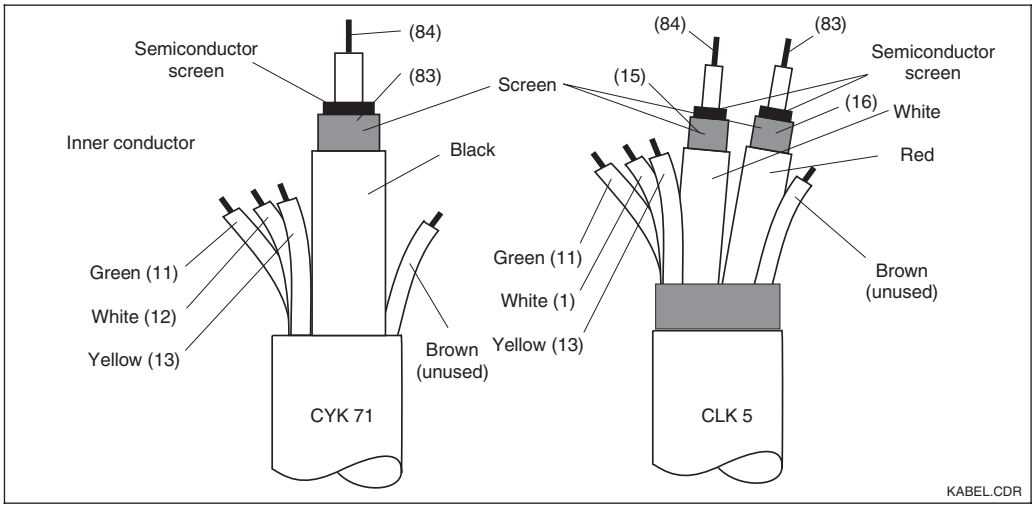


Fig. 3.13 Structure of special measuring cables CYK 71 (left) and CLK 5 (right)

Examples for connection

Note:

The sensor screen must be grounded to ensure faultless operation of the conductive instrument. For that purpose, a PE distribution board is available. This is located on the cover frame of the panel-mounted instrument CLM 223 or in the connection compartment of the field instrument CLM 253, respectively.

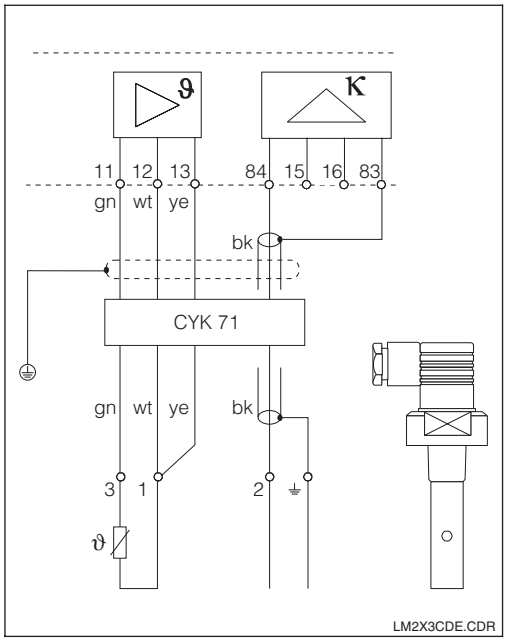


Fig. 3.14 Connection of conductive measuring cells (CLS 15, CLS 19, CLS 20, CLS 21)

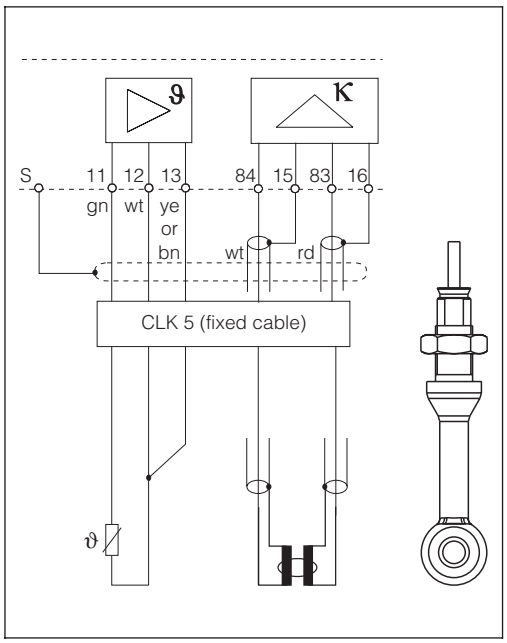


Fig. 3.15 Connection of inductive measuring cells (CLS 50 or CLS 52)

4 Operation

4.1 Operator interface

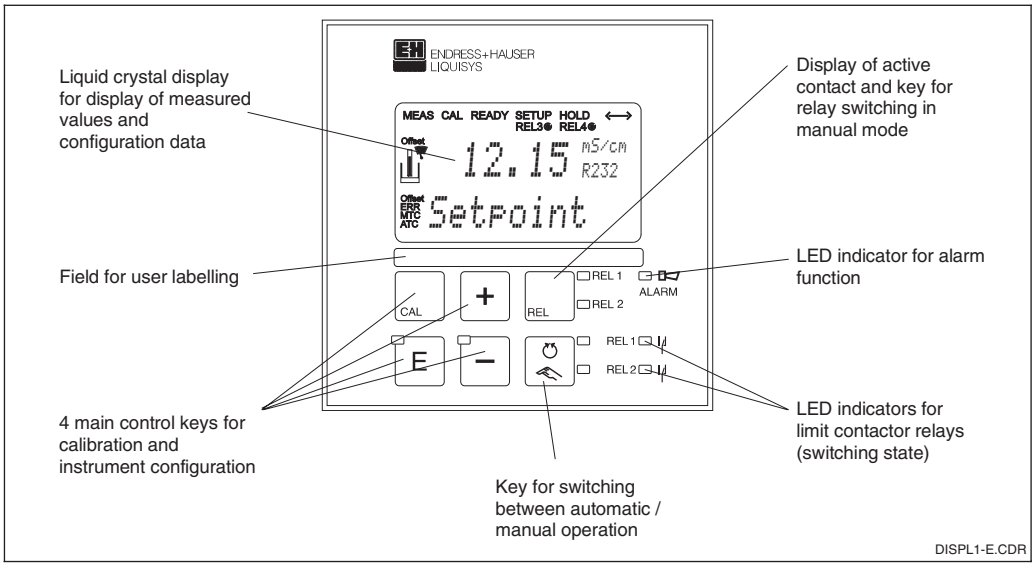


Fig. 4.1 Operating elements of Liquisys M

4.2 Display

LED indicators

Indication of current operating mode: “auto” (green LED) or “manual” (yellow LED)

REL

Indication for relay controlled in “manual” mode (red LED)

REL 1
REL 2

Indicates the state of relays 1 and 2.
LED green: measured value is within permissible limits, relay is inactive.
LED red: measured value is outside permissible limits, relay is active.

ALARM

Alarm indication for continuous limit violation, temperature sensor failure or system errors (see error list in chapter 7)

Liquid crystal display

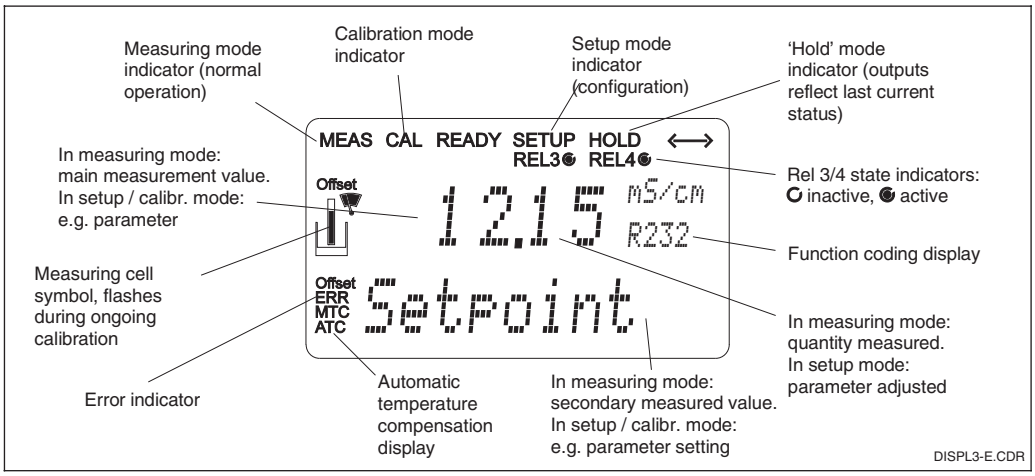


Fig. 4.2 Liquid crystal display

4.3 Key functions

CAL key

When the CAL key is pressed, the instrument prompts for the calibration access code (fixed setting: 22 for calibration or any other number to view the calibration data). Acknowledge with the CAL key to proceed. Use the CAL key to continue through the calibration process.

Note:

The calibration data set in function group C is used for calibration.

ENTER key

The ENTER key has several functions:
- It calls up the setup menu from the measuring mode
- It is used to store (acknowledge) data entered in setup mode
- It is used to start calibration (same function as CAL key).

PLUS key

MINUS key

The PLUS and MINUS keys have the following functions:
- They are used to select function groups;
- to set parameters and numeric values (the setting speed increases when the key is held down); and
- to operate the relays in manual mode (see chapter 4.2).
- In the measuring mode, the PLUS key switches to °F and disables the temperature display (see chapter 4.7), while the MINUS key selects the error display (see chapter 4.7).
- Display of the uncompensated conductivity value (PLUS key).

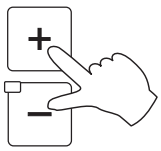
REL key

The REL key is used in manual mode to switch between the relays and the manual start cleaning function.

AUTO key

This key is used to toggle between the automatic and manual modes of operation.

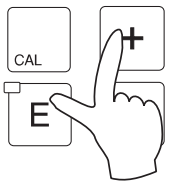
Escape function



Press the PLUS and MINUS keys simultaneously to return to the measuring mode (in calibration mode: at the end of calibration). Press the PLUS and MINUS keys again to return to the main menu.

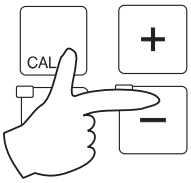
Locking the hardware

Access to field operation can be locked for communication via HART or Profibus.



Press the PLUS key and the ENTER key at the same time to lock the instrument. The code prompt displays the code 9999.

Unlocking the hardware



To unlock, press the CAL and MINUS keys at the same time. The code prompt displays the code 0.

4.4 Auto / manual mode of operation

Auto mode

In this mode of operation, the relays are controlled by the transmitter.

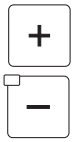
REL key

The REL key is used to select one of the relays present in the instrument.

Switching to manual mode

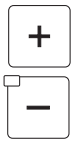
The instrument is switched to the manual mode by pressing the following keys:

Press AUTO key.



Enter code 22.

Select relay or function. Press the REL key to toggle between the relays. The display shows the selected relay in the second line.



Set the relays. Switch on with PLUS, switch off with MINUS. The relay state remains in effect until it is actively reset.

Press AUTO key for returning to the measuring mode.

Note:

- Enable the manual mode by entering access code “22”.
- The operating mode remains in effect even after a power failure.
- The manual mode takes precedence over any other automatic function (hold).
- Hardware locking in the manual mode is not possible.
- The manual settings remain in effect until they are actively reset.
- Error code E102 is signalled in the manual mode.

4.5 Operating concept

Operating modes

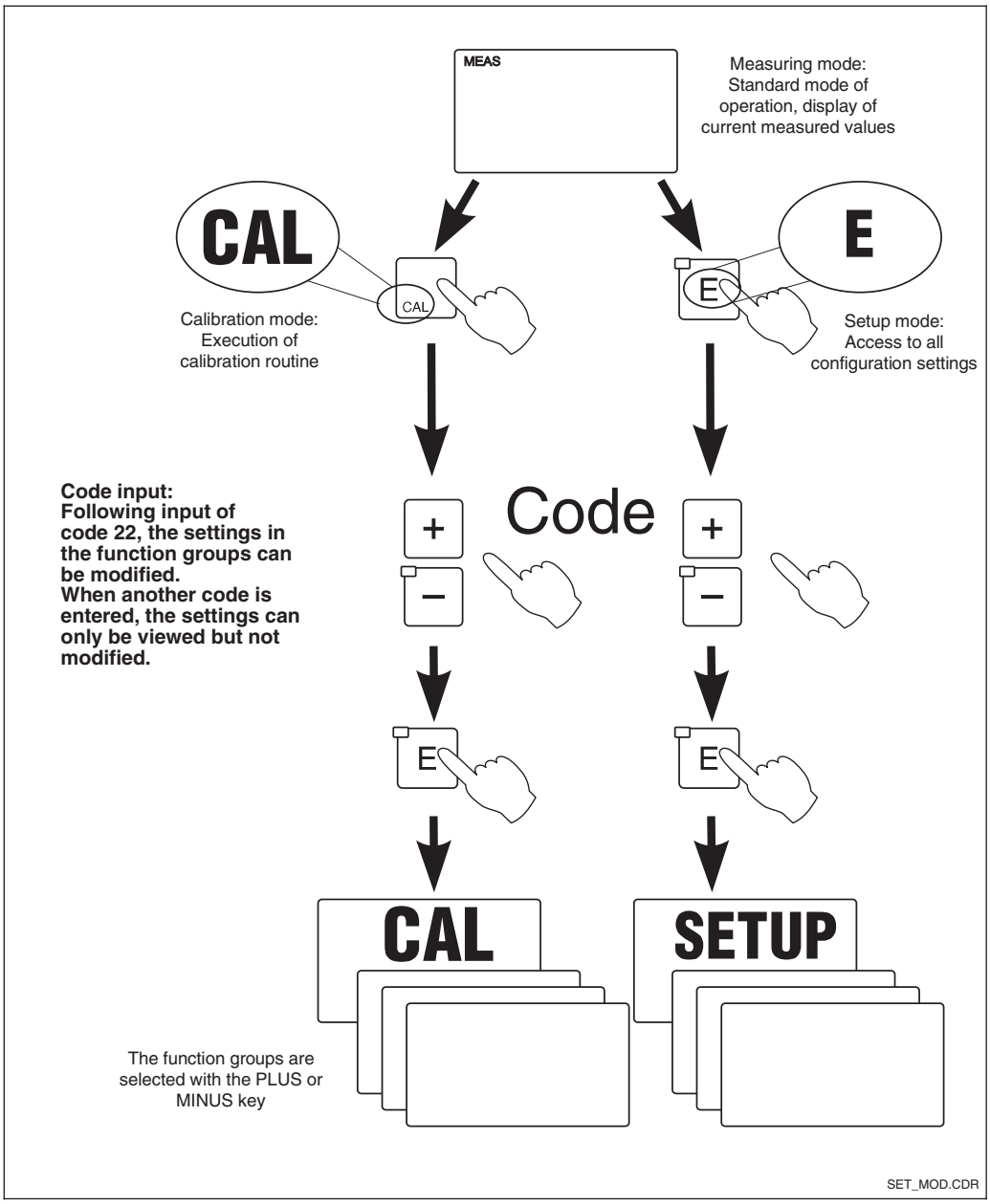


Fig. 4.3 Description of operating modes

Note:

The user can put the functions and contacts on hold during calibration and configuration (see chapter 5.8, page 46; function S2); the duration of the hold period may also be changed.

Menu structure

The configuration and calibration functions are arranged in a menu structure by function groups.

The function groups are selected in the setup mode with the PLUS and MINUS keys. The ENTER key is used to move from one function to the next within a function group. The PLUS and MINUS keys are used for option selection and editing. Selections must be confirmed by pressing the ENTER key. This also moves the cursor to the next function.
Pressing the PLUS and MINUS keys at the same time terminates programming (return to main menu).

Note:

- If a change is made but not confirmed by pressing the ENTER key, the previous setting is retained.
- See the appendix of these operating instructions for an overview of the Liquisys menu structure.

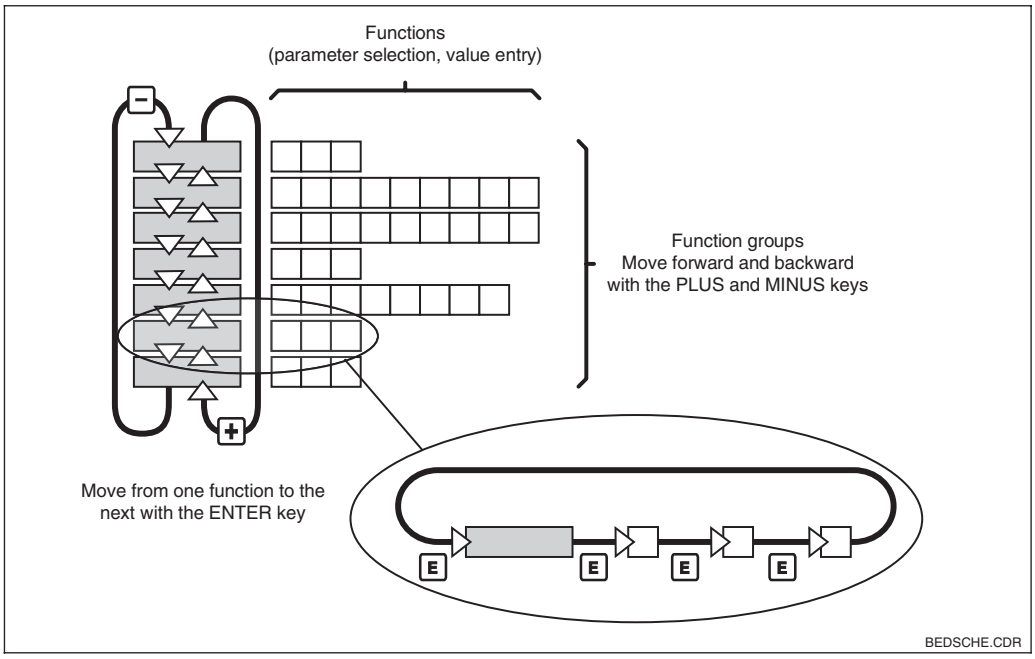


Fig. 4.4 Schematic representation of Liquisys menu structure

Hold function: “freezes” the outputs

The current output is “frozen” in the setup mode and during calibration, i.e. the last current value is constantly output. The display shows the “HOLD” message (see chapter 5.8, page 46 for hold settings).

Note:

- During automatic operation, all contacts will go to their normal positions.
- All hold settings are ignored for Chemoclean, timer and the external hold function, i.e. hold is always activated for these functions.
- Any alarm delay accumulated will be reset to ‘0’.
- This function can also be activated externally via the hold input (see connection diagram in Fig. 3.10; digital input 1).
- The manual hold (field S3) remains active even after a power failure.

4.6 Access codes

All instrument access codes are fixed, i.e. they cannot be modified. Three access codes are distinguished (cf. Fig. 4.3):

- Any code: Read mode access, i.e. all settings can be viewed but not modified (access with ENTER/CAL key, see Fig. 4.3).
- Code 22: Access to calibration and offset menus (access with CAL key, see Fig. 4.3).
- Code 22: Access to configuration menus for instrument configuration and user settings (access with ENTER key, see Fig. 4.3).
- See chapter 4.3, page 17 for hardware locking and unlocking.

4.7 Display during measurement

The measurement display can be individually adapted to user requirements.

Settings accessed with PLUS key:

- Press the PLUS key to display the temperature in °F instead of °C.
- Press the PLUS key a second time to suppress the temperature display.
- Press the PLUS key a third time to display the uncompensated conductivity value.
- Press the PLUS key a fourth time to return to the standard display.

Settings accessed with MINUS key:

- Press the MINUS key to display the first error message.
- Press the MINUS key repeatedly to display the following error messages (up to ten). If no further errors exist, the display returns to the measuring mode.

Note:

Function group F (alarm, see chapter 5.4.1) can be used to define an alarm for each individual error code.

4.8 Calibration

Please refer to chapter 5.11 for the calibration procedure.

5 Instrument configuration

After power-up (connection to power), the instrument performs a self-test and then enters the measuring mode.

Now it can be configured and calibrated for the first time.

The following function groups are available on the Liquisys M (the groups that are only available on the S version are marked accordingly in the function descriptions):

Setup mode

➜ SETUP 1 (A)	see chpt. 5.2.1
➜ SETUP 2 (B)	see chpt. 5.2.2
➜ CURRENT OUTPUT (O)	see chpt. 5.3
➜ ALARM (F)	see chpt. 5.4.1
➜ CHECK (P)	see chpt. 5.4.2
➜ RELAY (R)	see chpt. 5.5
➜ ALPHA TABLE (T)	see chpt. 5.6
➜ CONCENTRATION (K)	see chpt. 5.7
➜ SERVICE (S)	see chpt. 5.8
➜ E+H SERVICE (E)	see chpt. 5.9
➜ INTERFACE (I)	see chpt. 5.10

Calibration mode

➜ CALIBRATION (C)	see chpt. 5.11

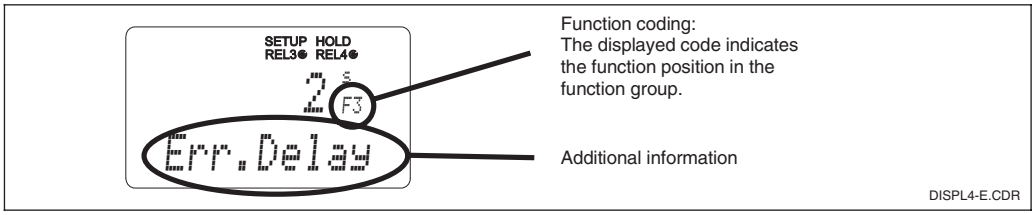


Fig. 5.1 Function display: auxiliary information for user

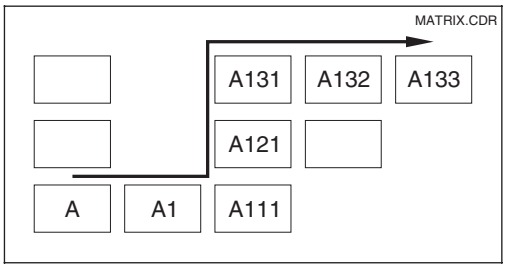


Fig. 5.2 Function coding

Selecting and locating functions is facilitated by a code displayed for each function in a special display field. The structure of this coding is shown in Fig. 5.2.
The first column indicates the function group as a letter (see group designations). The functions in the individual groups are counted from the top to the bottom and from the left to the right.

Factory settings

When the instrument is switched on for the first time, the factory settings are in effect. The following table provides an overview of all major settings.

Please refer to the description of the individual functions in chapter 5 for all other factory settings (the factory settings are printed in **bold** face).

Type of measurement	Conductive or inductive conductivity measurement, temperature measurement in °C oder °F (according to instrument version ordered)
Temperature compensation type	Linear with reference temperature 25 °C
Temperature compensation	Automatic (ATC on)
Limit for controller 1	9999 mS/cm
Limit for controller 2	9999 mS/cm

Hold	Active during configuration and calibration
Measuring range	0 µS/cm ... 2 S/cm (no measuring range adjustment). The measuring ranges float and are determined by the measuring cells connected (see chapter 9).
Current outputs 1 and 2*	4 ... 20 mA
Current output 1: meas. value for 4 mA signal current	0 µS/cm
Current output 1: meas. value for 20 mA signal current	2000 mS/cm
Current output 2: temperature value for 4 mA signal current*	–35.0 °C
Current output 2: temperature value for 20 mA signal current*	250.0 °C

*On versions equipped accordingly

Alarm contacts

The relay state shown on the connection diagrams is the non-operative state.

After switching on, the relay contacts are non-operative, the alarm current circuit is open, the lamp is not on.

In the event of an error, the relay contact closes the alarm current circuit, the lamp lights up.

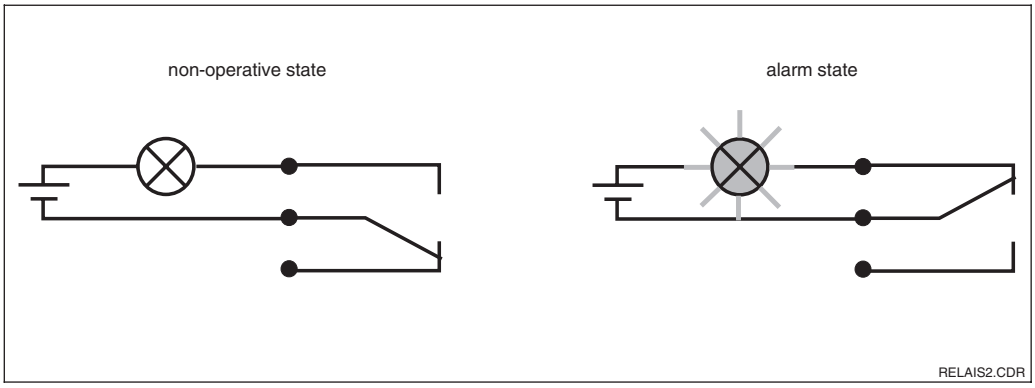


Fig. 5.3 Recommended fail-safe circuit for an alarm contact

5.1 Start-up

After power-up (connection to power supply established), the user must make the following selections in the specified function groups:

- **Function group SERVICE (S)**
  S1: Select language and exit function group.
- **Function group SETUP 1 (A)**
  Adjust all the parameters in this group; see chpt. 5.2.1.
- **Function group SETUP 2 (B)**
  Adjust all the parameters in this group; see chpt. 5.2.2.

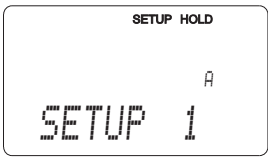
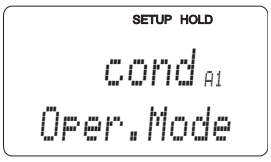
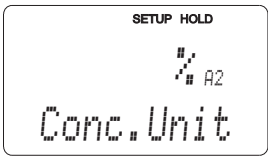
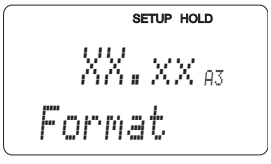
Other configuration options are explained in the chapter to follow for each menu.

5.2 System configuration

The system is configured using the function groups SETUP 1 and SETUP 2. The measurement type and measuring cell are selected here, and the settings for temperature measurement are made.

All the parameters in these two function groups are to be configured to avoid measuring errors or failure to measure at all.

5.2.1 Setup 1

Coding	Field	Selection or range Factory setting	Display	Info
A	Function group SETUP 1			Initial display in function group SETUP 1.
A1	Operating mode selection	**cond** = **conductive** ind = inductive MOhm = resistance *conc* = *concentration*		Display varies according to instrument version: – cond/resistance/conc – ind/conc ⚠ Any change in operating mode causes an automatic reset of user settings.
A2	Selection of concentration unit to be displayed	**%** ppm mg/l TDS none		A2 only active if A1 = conc.
A3	Selection of display format for concentration unit	**XX.xx** X.xxx XXX.x XXXX		A3 only active if A1 = conc.

Factory settings are printed in **bold** face;
base version does not include functions in italics.

Coding		Field	Selection or range Factory setting	Display	Info
	A4	Selection of unit to be displayed	**auto,** µS/cm, mS/cm, S/cm, µS/m, mS/m, S/m, auto Ω, kΩ·cm, MΩ·cm, kΩ·m	SETUP HOLD auto A4 Unit	When “auto” or “auto Ω” is selected, the maximum resolution possible is automatically selected. A4 not active if A1 = conc.
	A5	Enter cell constant for measuring cell connected	cond: **1.000 cm^{-1}** ind: **1.98 cm^{-1}** MOhm: **0.01 cm^{-1}** 0.0025 ... 99.99 cm^{-1}	SETUP HOLD 1.000 1/cm A5 Cellconst.	Refer to the measuring cell quality certificate for the exact cell constant.
	A6	Enter cable resistance	**0 Ω** 0 ... 99.99 Ω	SETUP HOLD 0 Ω A6 Ohm cable	Only if A1 = cond (conductive instrument). See chapter 10.
	A7	Enter measured value damping	**1** 1 ... 60	SETUP HOLD 1 A7 Damping	Measured value damping causes averaging over the specified number of individual measured values. It is used, for example, to stabilise the display with applications that fluctuate a great deal. There is no damping if “1” is entered.

5.2.2 Setup 2

Coding		Field	Selection or range Factory setting	Display	Info
B		Function group SETUP 2		SETUP HOLD B SETUP 2	Initial display in function group SETUP 2.
	B1	Selection of temperature sensor	**Pt100** Pt1k = Pt 1000 NTC30 fixed	SETUP HOLD Pt100 B1 ProcTemp.	“fixed”: No temperature measurement if a fixed temperature value is preset.
	B2	Selection of temperature compensation type	**lin = linear** *Tab = table* NaCl = common salt (IEC 746) Pure = ultrapure water none	SETUP HOLD lin B2 TempComp.	This option is not displayed for concentration measurement. “Pure” is only available on conductive instruments.

Factory settings are printed in **bold** face;
base version does not include functions in italics.

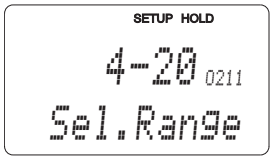
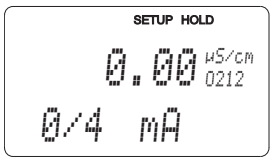
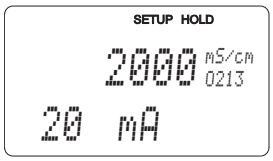
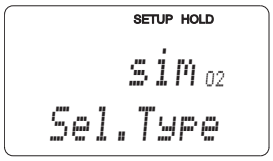
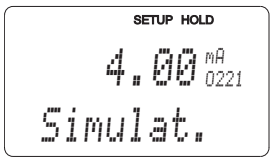
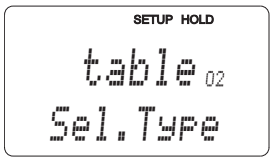
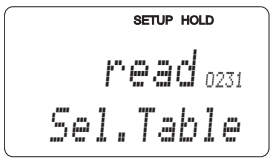
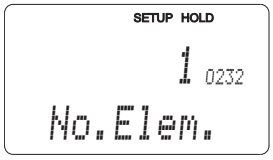
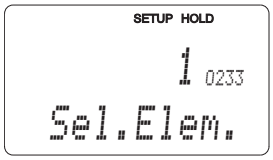
Coding		Field	Selection or range Factory setting	Display	Info
	B3	Enter temperature coefficient α	**2.10 %/K** 0.00 ... 20.00 %/K	SETUP HOLD 2.10 %/K B3 alphaVal	Only if B2 = lin. Any table defined is not active in this case.
	B4	Enter process temperature	**25.0 °C** –35.0 ... 250.0 °C	SETUP HOLD 25.0 °C B4 ProcTemp.	Only if B1 = fixed. Editing is only possible in °C.
	B5	Temperature sensor calibration	**actual value display** –35.0 ... 250.0 °C	SETUP HOLD 0.0 °C B5 RealTemp.	This entry is used to calibrate the temperature sensor to an external measurement. Omitted if B1 = fixed.
	B6	Temperature difference is displayed	**0.0 °C** –5.0 ... 5.0 °C	SETUP HOLD 0.0 °C B6 TempOffs.	The difference between the temperatures measured and entered is displayed. Omitted if B1 = fixed.

5.3 Current outputs

The function group CURRENT OUTPUT is used to configure the individual outputs. Either a linear (O2 (1)) or, in conjunction with the S version, a user-defined current output characteristic (O2 (3)) can be entered. Furthermore, a current output value can be simulated to check the current outputs (O2 (2)).

Coding		Field	Selection or range Factory setting	Display	Info
O		Function group CURRENT OUTPUT		SETUP HOLD 0 OUTPUT	Initial display in function group CURRENT OUTPUT.
O1		Selection of current output	**Out1** *Out2*	SETUP HOLD Out1 O1 Sel.Out	A different characteristic can be selected for each output.
	O2 (1)	Enter linear characteristic	**lin** = **linear** (1) sim = simulation (2) *table (3)*	SETUP HOLD lin O2 Sel.Type	The slope of the characteristic may be positive or negative. See O2 (2), O2 (3) for the simulation and table characteristics.

Factory settings are printed in **bold** face;
base version does not include functions in italics.

Coding	Field	Selection or range Factory setting	Display	Info
O211	Selection of current range	**4–20 mA** 0–20 mA		
O212	0/4 mA value; enter corresponding measured value	cond/ind: **0.00 µS/cm** MOhm: **0.00 kΩ·cm** conc: **0.00 %** temp.: **0.0 °C** entire meas. range		Enter the measured value corresponding to the minimum current value (0/4 mA) at the transmitter output. Display format from A3. (Spreading: see Technical data.)
O213	20 mA value; enter corresponding measured value	cond/ind: **2000 mS/cm** MOhm: **500 kΩ·cm** conc: **9999 %** temp.: **150.0 °C** entire meas. range		Enter the measured value corresponding to the maximum current value (20 mA) at the transmitter output. Display format from A3. (Spreading: see Technical data.)
O2 (2)	Current output simulation	lin = linear (1) **sim** = **simulation** (2) *table (3)*		The simulation is terminated by selecting (1) or (3). See O2 (1), O2 (3) for other characteristics.
O221	Enter simulation value	**current value** 0.00 ... 22.00 mA		The current value entered here is output through the current output.
O2 (3)	Enter current output table (S version only)	lin = linear (1) sim = simulation (2) **table** *(3)*		Values may also be added or changed at a later point in time. See O2 (1), O2 (2) for other characteristics.
O231	Selection of table option	**read** edit		
O232	Enter number of table value pairs	**1** 1 ... 10		This is where the number of pairs of x and y values (measured value and associated current value) is entered.
O233	Selection of table value pair	**1** 1 ... number of table value pairs asign		

Factory settings are printed in **bold** face;
base version does not include functions in italics.

Coding			Field	Selection or range Factory setting	Display	Info
		O234	Enter x value (measured value)	cond/ind: **0.00 µS/cm** MOhm: **0.00 kΩ·cm** conc: **0.00 %** temp.: **0.0 °C** entire meas. range	SETUP HOLD 0.00 µS/cm 0234 Meas.val.	x value = measured value determined by user.
		O235	Enter y value (current value)	**0.00 mA** 0.00 ... 20.00 mA	SETUP HOLD 0.00 mA 0235 mA value	y value = current value determined by user to be associated with measured value entered in O234.
		O236	Enter whether or not the table status is okay	**yes** no	SETUP HOLD yes 0236 Status ok	If “yes”: return to O2. If “no”: return to O233.

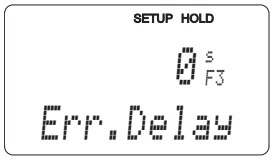
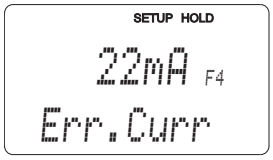
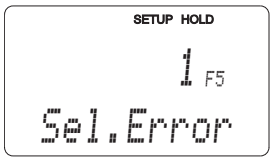
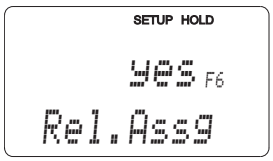
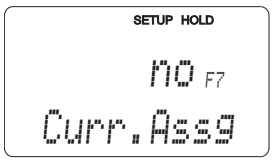
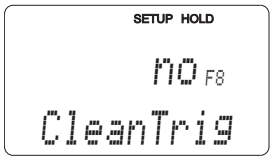
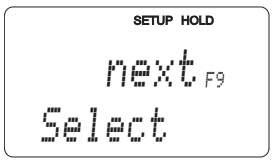
5.4 Monitoring functions

The monitoring functions are used to define various alarms and to set output contacts. Each individual error can defined to be effective or not (at the contact or as an error current). Moreover, measuring cell polarisation (P1) can be detected, or the measuring signal can be checked to ascertain that the measuring cell is working properly (it must supply plausible values). An alarm condition can be defined to activate a cleaning function (F8).

5.4.1 Alarm

Coding		Field	Selection or range Factory setting	Display	Info
F		Function group ALARM		SETUP HOLD F ALARM	Alarm function settings.
	F1	Selection of contact type	**Stead** = **steady contact** Fleet = fleeting contact	SETUP HOLD Stead F1 Cont.Type	The contact type selected here only applies to the alarm contact.
	F2	Selection of time unit	**s** min	SETUP HOLD s F2 Time Unit	

Factory settings are printed in **bold** face;
base version does not include functions in italics.

Coding		Field	Selection or range Factory setting	Display	Info
	F3	Enter alarm delay	**0 s** 0 ... 2000 s (min)		Depending on the unit selected in F2, the alarm delay is entered in s or min.
	F4	Selection of error current	**22 mA** 2.4 mA		This selection must be made even if all errors are suppressed in F5.
	F5	Selection of error	**1** 1 ... 255		This is where the errors are selected that are to trigger an alarm signal. The errors are selected via the error number. Please refer to the table in chapter 7 for the error numbers. The factory settings remain in effect for all errors not edited.
	F6	Set alarm contact to be effective for selected error	**yes** no		If set to “no”, all the other alarm settings (e.g. alarm delay) are also deactivated. The settings themselves are retained. This setting **only** applies to the error selected in F5. Factory setting is **no** starting with E080!
	F7	Set error current to be effective for selected error	**no** yes		The error current selected in F4 becomes effective or is suppressed in case of error. This setting **only** applies to the error selected in F5.
	F8	Automatic start of cleaning function?	**no** yes		This field does not exist for some errors; see chapter 7.1.
	F9	Return to menu or select next error	**next** = **next error** <---R		If next is selected, the display returns to F5. If <---R is selected, the display returns to F.

Factory settings are printed in **bold** face;
base version does not include functions in italics.

5.4.2 Check

Polarisation detection

Polarisation effects in the interface between electrode and measuring solution limit the measuring range of conductive conductivity measuring cells. The Liquisys M transmitter has the ability to detect polarisation effects using an intelligent signal evaluation process.

PCS alarm (Process Check System)

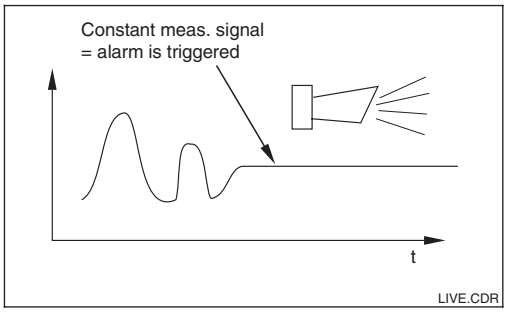


Fig. 5.4 PCS alarm (live-check)

This function is used to examine the measuring signal for deviations. If the measuring signal is constant for a specific period of time (several measured values), an alarm is issued. This type of measuring cell behaviour may be caused by soiling, etc.

Note:

A current PCS alarm is automatically deleted as soon as the sensor signal changes.

Coding		Field	Selection or range Factory setting	Display	Info
P		Function group CHECK (S version only)		SETUP HOLD P CHECK	Settings for measuring cell and process monitoring.
	P1	Switch polarisation detection on or off (conductive only)	**off** on	SETUP HOLD off P1 Pol.Detec	Polarisation only occurs with conductive measuring cells. Polarisation is detected but not compensated. (Error no.: E071.)
	P2	Set PCS alarm (live-check)	**off** 1h 2h 4h	SETUP HOLD off P2 PCS Alarm	This function is used to examine the measuring signal. An alarm is signalled if it does not change for the period selected here. Monitoring limit: 0.3 % of mean value over selected period. (Error no.: E152.)

Factory settings are printed in **bold** face;
base version does not include functions in italics.

5.5 Relay contact configuration

The relay contacts described below can be selected and configured as required (up to four with four contacts depending on options installed).

- Limit contactor for measured conductivity value: R2 (1)
- Limit contactor for temperature: R2 (2)
- P(ID) controller: R2 (3)
- Timer for cleaning function: R2 (4)
- Chemoclean function: R2 (5)
- USP 23: R2 (6) (S version, conductive only)

5.5.1 Limit contactor for measured conductivity value and temperature

The relay contacts in the Liquisys M can be assigned different functions.
Switch-on and switch-off points and pickup and dropout delays can be defined for the limit contactor. Moreover, an alarm threshold can be set to issue an error message and to start a cleaning function.
These functions may be used for conductivity and temperature measurement.

Please refer to Fig. 5.5 for a graphic representation of the contact states of any relay or alarm contact.

When the measured value increases (max function), the relay contact is closed at time t_2 when the switch-on point has been exceeded (t_1) and the pickup delay ($t_2 - t_1$) has expired. When the alarm threshold (t_3) is reached and the alarm delay ($t_4 - t_3$) also has expired, the alarm contact is switched.
When the measured value decreases, the alarm contact is reopened when the measured value drops below the alarm threshold (t_5), and the relay contact also opens (t_7, after the dropout delay $t_7 - t_6$).
When the pickup and dropout delays are set to 0 s, the switch-on and switch-off points are identical to the contact switching points.
Settings analogous to the max function can also be made for a min function.

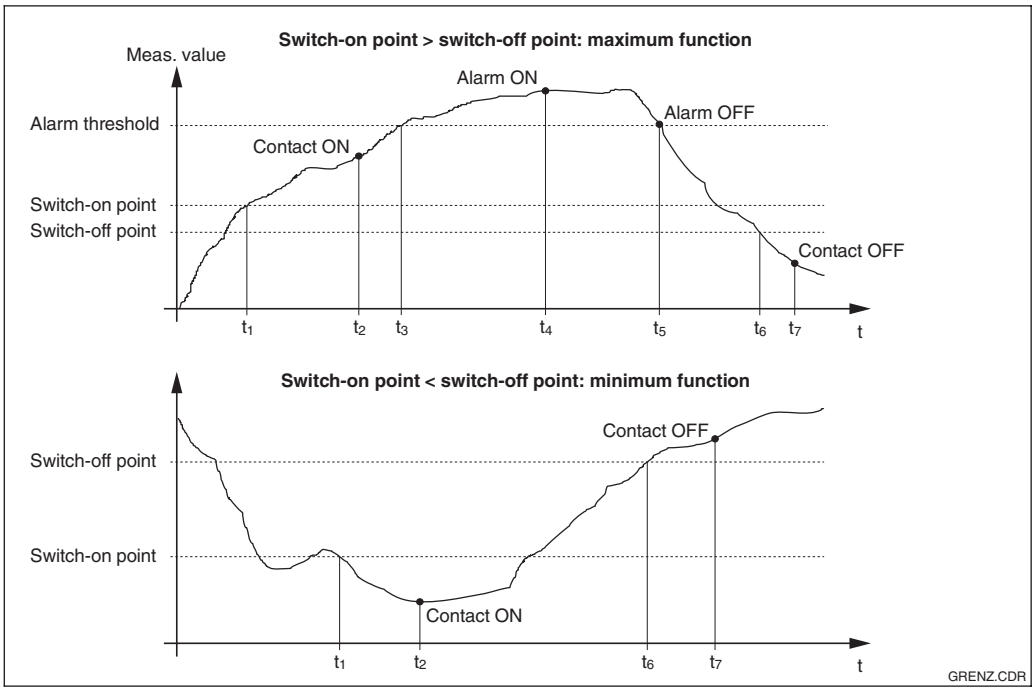


Fig. 5.5 Relationships between switch-on and switch-off points and pickup and dropout delays

5.5.2 P(ID) controller

The Liquisys M supports the definition of various controller functions. On the basis of the PID controller, P, PI, PD and PID controllers can be implemented. The best control response is obtained using the controller best suited to the application in question:

P controller: Used for simple linear control purposes with small system deviations. Where major changes are to be controlled, overshooting may occur. A control offset is to be expected.

PI controller: Used for processes where overshooting is to be avoided and permanent offsets are not allowed.

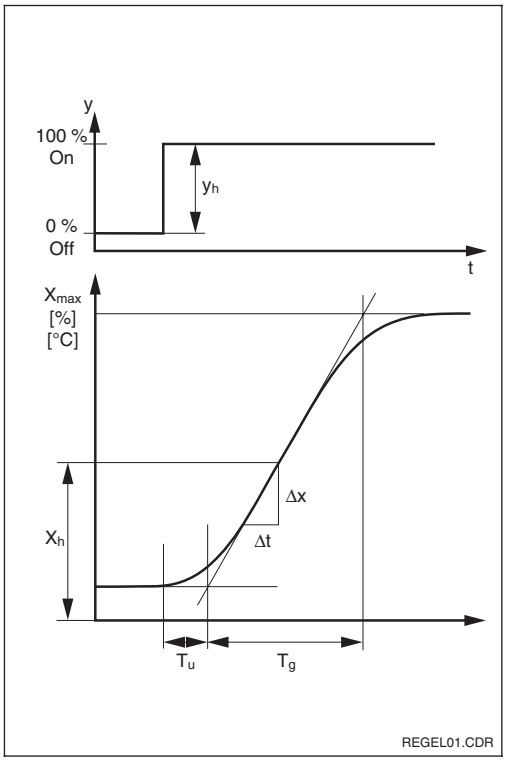


Fig. 5.6 Control characteristic

$$y_\ell = K_p \cdot \left[e^*_\ell + \underbrace{\frac{1}{T_n} \cdot \sum_i e^*_i}_{\text{I comp.}} + \underbrace{T_V \left(e^*_\ell - e^*_{\ell-1} \right)}_{\text{D comp.}} \right],$$

$$e^* = \frac{set\ point - actual\ value}{set\ point}$$

where *set point* = set point from R332.

Recommendable settings for all types

Contr. response	K_p [%]	T_v [s]	T_n [s]
P	K	0	0*
PI	2.6 K	0	6 T_u
PD	0.5 K	T_u	0*
PID	1.7 K	2 T_u	2 T_u

* $T_n = 0$: component is not calculated
$T_n \rightarrow \infty$: calculated component $\rightarrow 0$

PD controller: Used for processes that require quick response and where peaks are to be corrected.

PID controller: Used for processes for which the type of control provided by a P, PI or PD controller is inadequate.

Adjustments of P(ID) controller

Three parameters can be adjusted in the case of a PID controller:

- the control gain K_p (P influence)
- the integral action time T_n (I influence)
- the derivative action time T_v (D influence)

Step response of process

y = set value
y_h = control range
T_u = delay time [s]
T_g = recovery time [s]

$$V_{max} = \frac{X_{max}}{T_g} = \frac{\Delta x}{\Delta t}$$

= maximum slew rate of control variable [K/s]
X_{max} = maximum process value
X_h = controller adjustment range

Controller characteristics

$$K = \frac{V_{max}}{X_h} \cdot T_u \cdot 100\,\%$$

Start-up

If there is no previous experience for the control parameter settings, values should be used which guarantee maximum control loop stability (see table).

For optimisation, the control gain K_p is reduced until the control variable overshoots slightly. Then K_p is increased somewhat, and the T_n setting is reduced (shorter times) to obtain the shortest possible correction time without overshooting.
T_v must also be adjusted in the case of fast correction times.

Checking and fine tuning of parameter settings using a recorder

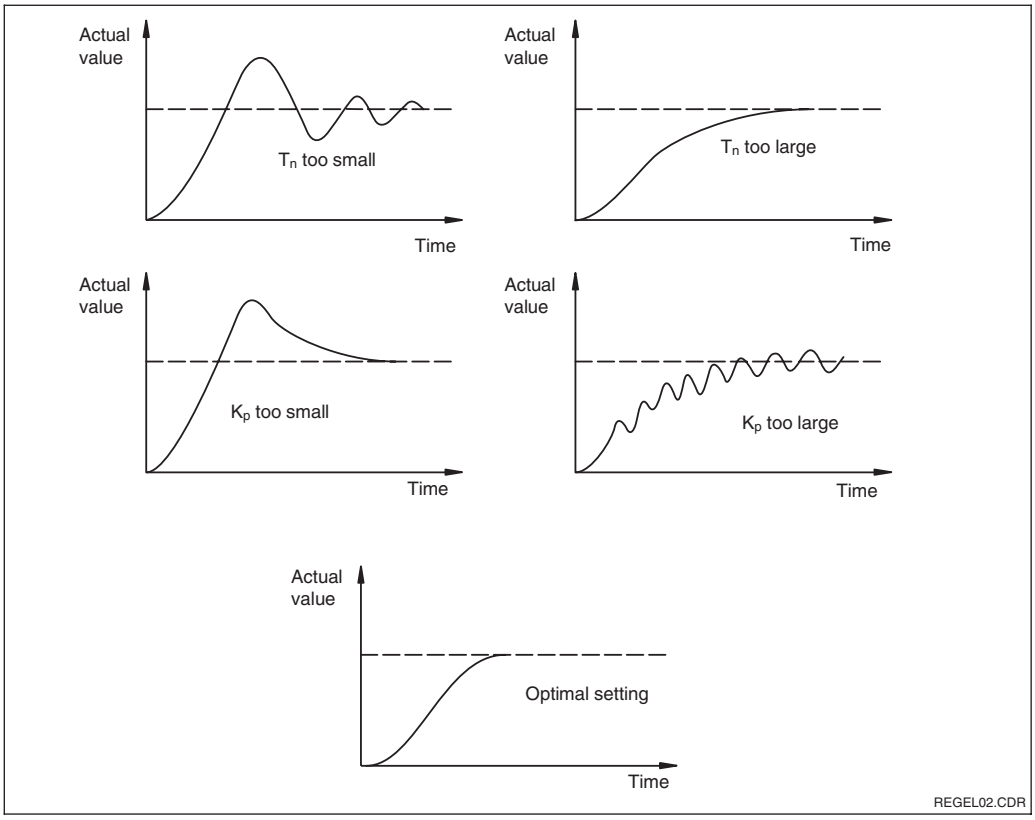


Fig. 5.7 Optimisation of settings for T_n and K_p

Actuating signal outputs (R237 ... R2310)

The control contact in question outputs a switched signal. The intensity of this signal is proportional to the controller's control output. A distinction is made according to the type of signal output:

- *Pulse length modulation*
  The greater the calculated control output, the longer the contact in question remains picked up. The period can be adjusted between 0.5 and 99 s. Pulse length-modulated outputs are used to control solenoid valves.

- *Pulse frequency modulation*
  The greater the calculated control output, the higher the switching frequency of the contact. The maximum switching frequency 1/T can be adjusted between 60 and 180 min^{-1}. The ON period t_{ON} is constant. Pulse frequency-modulated outputs are used to control solenoid-operated metering pumps.

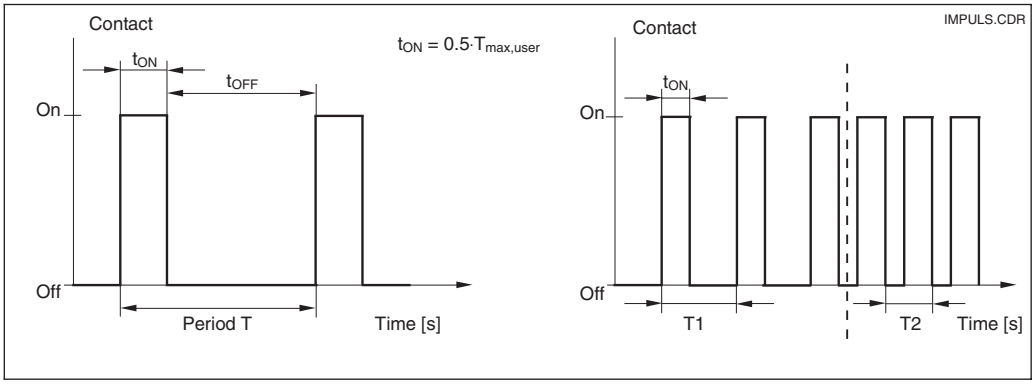


Fig. 5.8 Signal of a pulse length-modulated (left) and a pulse frequency-modulated (right) control contact

Control characteristic for direct and inverted control action

Field R236 offers two control characteristics for selection which have the effects shown in the following diagram.

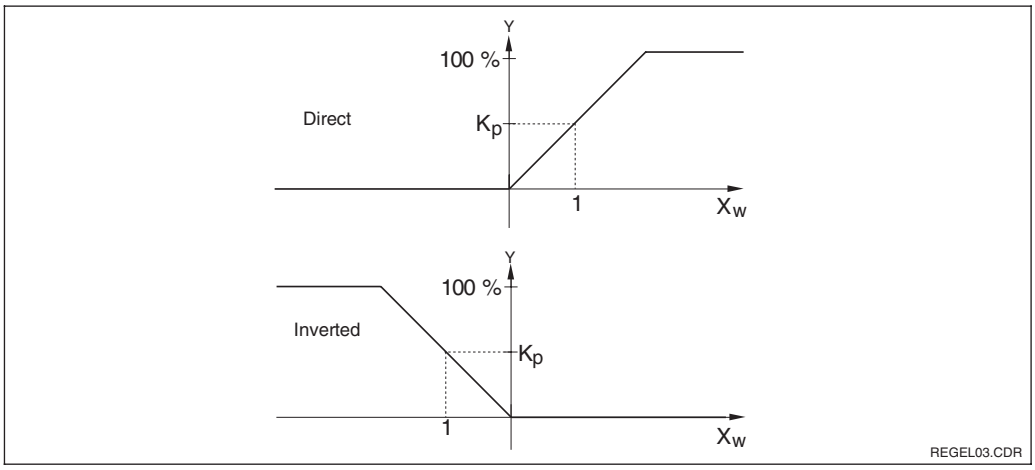


Fig. 5.9 Control characteristic of a proportional controller with direct and inverted control action

5.5.3 USP 23 function (conductive only)

The Liquisys M can measure and monitor the uncompensated conductivity (R2 (6)) according to USP ("United States Pharmacopeia") guidelines.

USP requirements on measurement

The measurement is performed as follows:

- Measurement of uncompensated conductivity
- Temperature measurement at place of conductivity measurement
- Rounding of temperature to the next 5 °C step
- Determination of applicable monitoring value from a table (see below)
- Alarm signalling in the event the monitoring value is exceeded.

The measurement is performed without compensation, and the measured value is compared to a monitoring value (see table) for pure water.
An alarm is issued when the monitoring value is exceeded.
An adjustable pre-alarm can be used to alert to undesirable operating conditions in time.

Temperature [°C]	Conductivity [µS/cm]	Temperature [°C]	Conductivity [µS/cm]
0	0.6	55	2.1
5	0.8	60	2.2
10	0.9	65	2.4
15	1.0	70	2.5
20	1.1	75	2.7
25	1.3	80	2.7
30	1.4	85	2.7
35	1.5	90	2.7
40	1.7	95	2.9
45	1.8	100	3.1
50	1.9		

5.5.4 Timer for cleaning function

This function can be used to implement a simple cleaning routine. The user can specify a time interval after which cleaning is to start; i.e. only constant intervals can be defined.

More extended cleaning functions can be implemented in conjunction with the Chemoclean function (version with four contacts; see chapter 5.5.5).

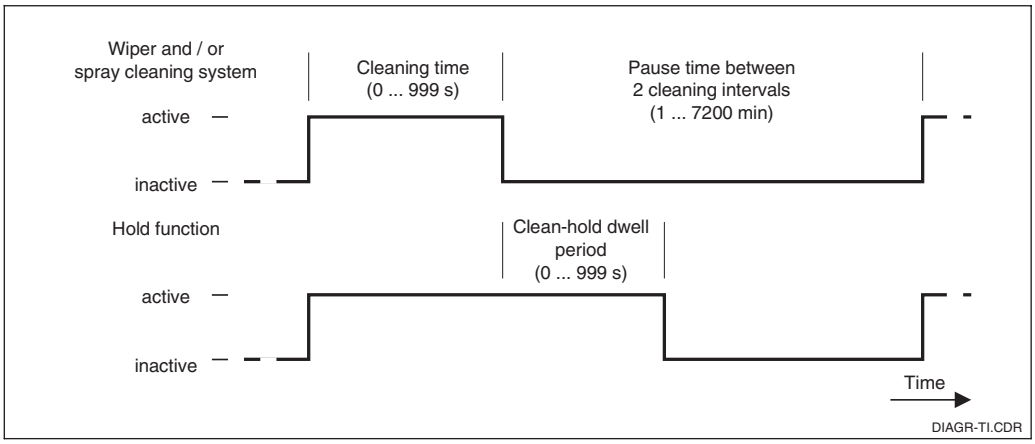


Fig. 5.10 Relationships among cleaning time, pause time and hold dwell period

5.5.5 Chemoclean function

Just like the timer function, Chemoclean can also be used to start a cleaning cycle. However, Chemoclean supports different cleaning and rinse intervals.
Thus, irregular cleaning with different repeat cycles is possible, and cleaning times with post-rinse times can be individually defined.

Note:

- The Chemoclean function is only available with relays 3 and 4.
- Abortion of the cleaning process is always followed by a post-rinse time.
- When “Economy” is selected, cleaning is performed with water only.

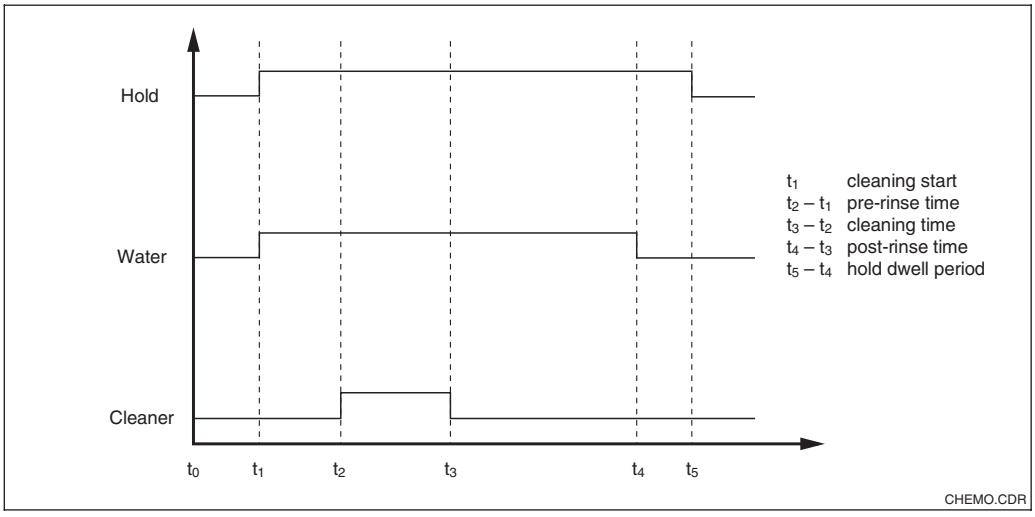


Fig. 5.11 Cleaning cycle sequence

Coding	Field	Selection or range Factory setting	Display	Info
R	Function group RELAY		SETUP HOLD R RELAY	Relay contacts can be selected and adjusted.
R1	Selection of contact to be configured	**Rel1** *Rel2* *Rel3* *Rel4*	SETUP HOLD Rel1 R1 Sel.Relay	Rel3 and Rel4 are only available on instruments equipped accordingly. (Chemoclean is only possible with Rel3/Rel4.)
R2 (1)	Configuration of limit contactor for conductivity, resistance or concentration measurement	**LC PV** = **limit contactor cd** (1) LC °C = limit contactor T (2) PID controller (3) Timer (4) *Clean* = *Chemoclean (5)* *USP23 (6)*	SETUP HOLD LC PV R2 Sel. Type	
R211	Switch function of R2 (1) off or on	**Off** On	SETUP HOLD Off R211 Function	All settings are retained.
R212	Enter contact switch-on point	cond/ind: **9999 mS/cm** MOhm: **200 MΩ·cm** conc: **9999 %** entire meas. range	SETUP HOLD 9999 mS/cm R212 On value	Never set switch-on point and switch-off point to the same value! (Only the operating mode selected in A1 appears.)
R213	Enter contact switch-off point	cond/ind: **9999 mS/cm** MOhm: **200 MΩ·cm** conc: **9999 %** entire meas. range	SETUP HOLD 9999 mS/cm R213 Off value	The switch-off point entry selects a max contact (switch-off point < switch-on point) or a min contact (switch-off point > switch-on point), thereby implementing an always required hysteresis function (see Fig. 5.5).
R214	Enter pickup delay	**0 s** 0 ... 2000 s	SETUP HOLD 0 s R214 On Delay	
R215	Enter dropout delay	**0 s** 0 ... 2000 s	SETUP HOLD 0 s R215 Off Delay	

Factory settings are printed in **bold** face;
base version does not include functions in italics.

Coding	Field	Selection or range Factory setting	Display	Info
R216	Enter alarm threshold (as an absolute value)	cond/ind: **9999 mS/cm** MOhm: **200 MΩ·cm** conc: **9999 %** entire meas. range	SETUP HOLD 9999 mS/cm R216 A.Thresh	When the alarm threshold is violated, the measuring transmitter issues an alarm with an error message and error current (note alarm delay).
R2 (2)	Configure limit contactor for temperature measurement	LC PV = limit contactor cd (1) **LC °C** = **limit contactor T** (2) PID controller (3) Timer (4) *Clean* = *Chemoclean (5)* *USP23 (6)*	SETUP HOLD LC °C R2 Sel. Type	
R221	Switch function of R2 (2) off or on	**Off** On	SETUP HOLD Off R221 Function	
R222	Enter switch-on temperature	**250.0 °C** –35.0 ... 250.0 °C	SETUP HOLD 250.0 °C R222 On Value	Never set switch-on point and switch-off point to the same value!
R223	Enter switch-off temperature	**250.0 °C** –35.0 ... 250.0 °C	SETUP HOLD 250.0 °C R223 Off Value	The switch-off point entry selects a max contact (switch-off point < switch-on point) or a min contact (switch-off point > switch-on point), thereby implementing an always required hysteresis function (see Fig. 5.5).
R224	Enter pickup delay	**0 s** 0 ... 2000 s	SETUP HOLD 0 s R224 On Delay	
R225	Enter dropout delay	**0 s** 0 ... 2000 s	SETUP HOLD 0 s R225 Off Delay	
R226	Enter alarm threshold (as an absolute value)	**250.0 °C** –35.0 ... 250.0 °C	SETUP HOLD 250.0 °C R226 A.Thresh	When the alarm threshold is violated, the measuring transmitter issues an alarm with an error message and error current (note alarm delay).

Factory settings are printed in **bold** face;
base version does not include functions in italics.

Coding	Field	Selection or range Factory setting	Display	Info
R2 (3)	P(ID) controller configuration	LC PV = limit contactor cd (1) LC °C = limit contactor T (2) **PID controller** (3) Timer (4) *Clean =* *Chemoclean (5)* *USP23 (6)*	SETUP HOLD PID R2 Sel. Type	
R231	Switch function of R3 (3) off or on	**Off** On	SETUP HOLD Off R231 Function	
R232	Enter set point	cond/ind: **0.00 µS/cm** MOhm: **0.00 kΩ·cm** conc: **0.00 %** entire meas. range	SETUP HOLD 0.00 µS/cm R232 Setpoint	The set point is the value to be maintained by the control. This value is to be re-established by the control in the event of any deviation (up or down).
R233	Enter control gain K_p	**1.00** 0.01 ... 20.00	SETUP HOLD 1.00 R233 Kp	See chpt. 5.5.2.
R234	Enter integral action time T_n (0.0 = no I comp.)	**0.0 min** 0.0 ... 999.9 min	SETUP HOLD 0.0 min R234 Time Tn	See chpt. 5.5.2. At every hold, the I comp. is set to zero. Hold can be deactivated in S2, but not for Chemoclean and Timer.
R235	Enter derivative action time T_v (0.0 = no D comp.)	**0.0 min** 0.0 ... 999.9 min	SETUP HOLD 0.0 min R235 Time Tv	See chpt. 5.5.2.
R236	Selection of controller characteristic	**dir** = **direct** inv = inverted	SETUP HOLD dir R236 Direction	Setting may or may not be required depending on control deviation (up or down deviation, see chpt. 5.5.2).
R237	Selection of pulse length or pulse frequency	**len** = **pulse length** freq = pulse frequency	SETUP HOLD len R237 Oper.Mode	Pulse length e.g. for solenoid valve, pulse frequency e.g. for solenoid-operated metering pump (see chpt. 5.5.2).
R238	Enter pulse interval	**10.0 s** 0.5 ... 999.9 s	SETUP HOLD 10.0 s R238 PulsePer.	This field only appears if pulse length is selected in R237. When pulse frequency is selected, R238 is skipped and input continues in R239.

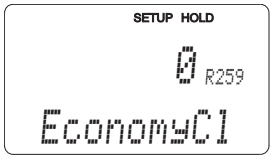
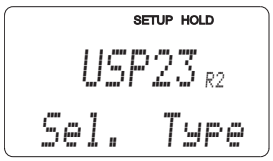
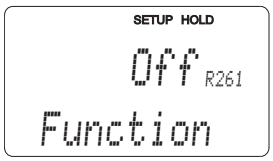
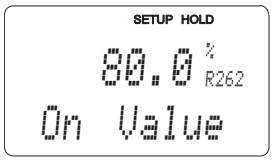
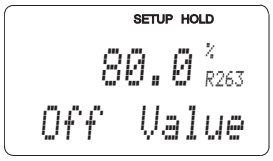
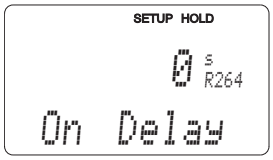
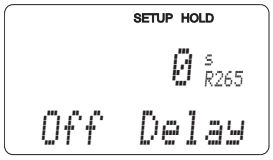
Factory settings are printed in **bold** face;
base version does not include functions in italics.

Coding	Field	Selection or range Factory setting	Display	Info
R239	Enter maximum pulse frequency of actuator	**120 min^{-1}** 60 ... 180 min^{-1}	SETUP HOLD 120 1/min R239 Max.PFreq	This field only appears if pulse frequency is selected in R237. When pulse length is selected, R239 is skipped, and input continues in R2310.
R2310	Enter minimum ON time t_{ON}	**0.3 s** 0.1 ... 5.0 s	SETUP HOLD 0.3 s R2310 Min.PTime	This field only appears if pulse length is selected in R237.
R2 (4)	Configure cleaning function (timer)	LC PV = limit contactor cd (1) LC °C = limit contactor T (2) PID controller (3) **Timer** (4) *Clean =* *Chemoclean (5)* *USP23 (6)*	SETUP HOLD Timer R2 Sel. Type	Cleaning is performed using only one cleaning agent (usually water); see Fig. 5.10.
R241	Switch function of R2 (4) off or on	**Off** On	SETUP HOLD Off R241 Function	
R242	Enter rinse / cleaning time	**30 s** 0 ... 999 s	SETUP HOLD 30 s R242 RinseTime	The hold and relay settings are activated for the period of time specified here.
R243	Enter pause time	**360 min** 1 ... 7200 min	SETUP HOLD 360 min R243 PauseTime	The pause time is the time between two cleaning cycles (see chpt. 5.5.5).
R244	Enter minimum pause time	**120 min** 1 ... 3600 min	SETUP HOLD 120 min R244 Min.Pause	The minimum pause time prevents continuous cleaning when the cleaning trigger is present.
R2 (5)	Configure cleaning with Chemoclean (on version with four contacts and appropriate assignment of contacts 3 and 4)	LC PV = limit contactor cd (1) LC °C = limit contactor T (2) PID controller (3) Timer (4) **Clean** = **Chemoclean** *(5)* *USP23 (6)*	SETUP HOLD Clean R2 Sel. Type	See chpt. 5.5.5.

Factory settings are printed in **bold** face;
base version does not include functions in italics.

Coding			Field	Selection or range Factory setting	Display	Info
		R251	Switch function of R2 (5) off or on	**Off** On	SETUP HOLD Off R251 Function	
		R252	Selection of start pulse	**int** = **internal (timer-contr.)** ext = external (digital input 2) i+ext = intern. + extern. i+stp = internal, suppressed by external	SETUP HOLD int R252 CleanTrig	There is no real-time clock. External suppression is required for irregular time intervals (e.g. weekends).
		R253	Enter pre-rinse time	**20 s** 0 ... 999 s	SETUP HOLD 20 s R253 PreRinse	Water is used for rinsing.
		R254	Enter cleaning time	**10 s** 0 ... 999 s	SETUP HOLD 10 s R254 CleanTime	Cleaning agent and water are used for cleaning.
		R255	Enter post-rinse time	**20 s** 0 ... 999 s	SETUP HOLD 20 s R255 PostRinse	Water is used for rinsing.
		R256	Enter number of repeat cycles	**0** 0 ... 5	SETUP HOLD 0 R256 Rep. Rate	R253 ... R255 is repeated.
		R257	Enter pause time	**360 min** 1 ... 7200 min	SETUP HOLD 360 min R257 PauseTime	The pause time is the time between two cleaning cycles.
		R258	Enter minimum pause time	**120 min** 1 ... R357 min	SETUP HOLD 120 min R258 Min.Pause	The minimum pause time prevents continuous cleaning when the cleaning trigger is present.

Factory settings are printed in **bold** face;
base version does not include functions in italics.

Coding			Field	Selection or range Factory setting	Display	Info
		R259	Enter number of cleaning cycles without cleaning agent (economy function)	**0** 0 ... 9		Cleaning with cleaner can be followed by up to 9 cleaning cycles that use only water until the next cleaning cycle with cleaner is performed.
	R2 (6)		USP contact configuration (S version only)	LC PV = limit contactor cd (1) LC °C = limit contactor T (2) PID controller (3) Timer (4) *Clean =* *Chemoclean (5)* **USP23** *(6)*		The USP contact can be configured as a pre-alarm, i.e. it issues an alarm before the limit is reached. (Error no.: E151.)
		R261	Switch function of R2 (6) off or on	**Off** On		
		R262	Enter alarm threshold (switch-on point)	**80.0 %** 0.0 ... 100.0 %		This is referred to the uncompensated conductivity value at the temperature in question. The pre-alarm causes the contact to respond; when the alarm limit is reached (100.0 %), the alarm relay is additionally switched. Example for 80.0 % setting: A pre-alarm is triggered for 15 °C and 1.0 µS/cm at 0.8 µS/cm (cf. table in chpt. 5.5.3).
		R263	Enter switch-off point	**80.0 %** 0.0 ... 100.0 %		
		R264	Enter pickup delay	**0 s** 0 ... 2000 s		
		R265	Enter dropout delay	**0 s** 0 ... 2000 s		

Factory settings are printed in **bold** face;
base version does not include functions in italics.

5.6 Temperature compensation

The temperature coefficient specifies the change in conductivity per degree of temperature change. It depends on the chemical composition of the medium and the temperature itself.

In order to compensate for this dependence, four different compensation types can be selected in the Liquisys M:

Linear compensation

The change between two temperature points is considered to be constant, i.e. α = const. The α value can be edited for the linear compensation type. The reference temperature is 25 °C.

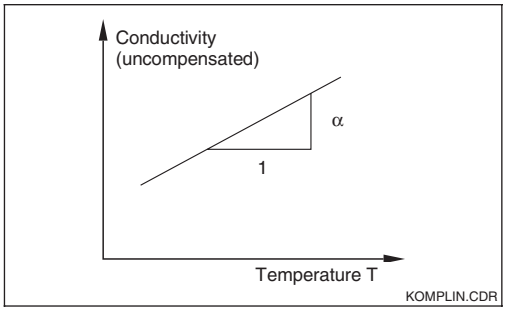


Fig. 5.12 Linear temperature compensation

NaCl compensation

The NaCl compensation (according to IEC 746) is based on a fixed nonlinear curve that defines the relationship between the temperature coefficient and the temperature. This curve is used for lower concentrations.

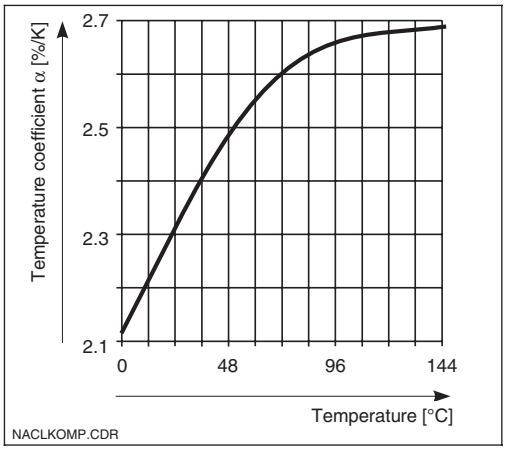


Fig. 5.13 NaCl compensation

Ultrapure water compensation

Just like the NaCl compensation, the ultrapure water compensation is based on a nonlinear curve stored in the instrument.
This curve is split up into NaCl solution and ultrapure water components. These are calculated separately but then used together to determine the overall relationship.

Temperature compensation with table

The user can set up a table containing up to ten value pairs for a special user-defined medium so that the temperature dependence of the temperature coefficient for any fluid can be handled.

If the temperature coefficient for different temperatures is known, the corresponding values can be entered in the table. If the temperature dependence of the medium is not known, it first needs to be determined as follows:

- Select the temperature range in which the measurement is to take place.
- Take a sample of the process medium.
- Measure the uncompensated conductivity at different temperatures. Heat up the sample slowly to do this. Determine the uncompensated conductivity at different temperatures.
- The α value which corresponds to the temperature and the conductivity value is determined using the following formula:

$$\alpha_{(x)} = \frac{(\frac{k_1}{k_2} - 1) \cdot 100}{T_2 - T_1}$$

$$T_{(x)} = \frac{T_1 + T_2}{2}$$

The values thus calculated are entered in the table.

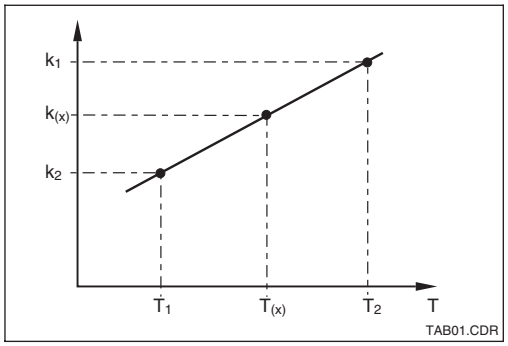


Fig. 5.14 Determination of temperature coefficient $\alpha_{(x)}$

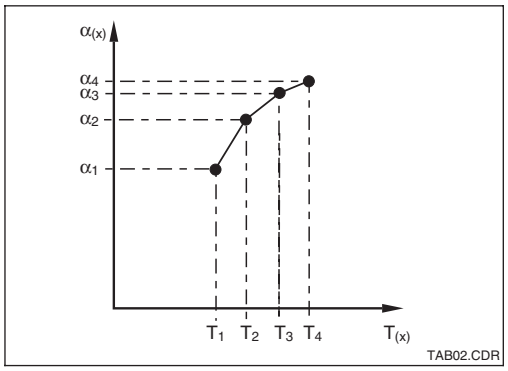


Fig. 5.15 Entry of table values with calculated $\alpha_{(x)}$

Coding		Field	Selection or range Factory setting	Display	Info
T		Function group ALPHA TABLE (S version only)		SETUP HOLD T ALPHA TAB	
	T1	Selection of table option	**read** edit	SETUP HOLD read T1 Sel.Table	
	T2	Enter number of table value pairs	**1** 1 ... 10	SETUP HOLD 1 T2 No.Elem.	Up to 10 value pairs can be entered in the α table. These are numbered from 1 ... 10 and can be edited individually or in sequence.
	T3	Selection of table value pair	**1** 1 ... number of table value pairs asign	SETUP HOLD 1 T3 Sel.Elem.	
	T4	Enter temperature value (x value)	**0.0 °C** –35.0 ... 250.0 °C	SETUP HOLD 0.0 °C T4 Temp.val.	The temperature values must have a minimum distance of 1 K. Defaults for the x values of the table value pairs: 0.0 °C; 10.0 °C; 20.0 °C; 30.0 °C ...
	T5	Enter temperature coefficient α (y value)	**2.10 %/K** 0.00 ... 20.00 %/K	SETUP HOLD 2.10 %/K T5 Alpha val	
	T6	Enter whether or not the table status is okay	**yes** no	SETUP HOLD yes T6 Status ok	If “yes”, return to T. If “no”, return to T3.

Factory settings are printed in **bold** face;
base version does not include functions in italics.

5.7 Concentration measurement

The Liquisys M can convert conductivity values to concentration values.

Since the relationship between concentration and conductivity also depends on the temperature, the conversion is performed based on a user-defined field (three variables: temperature, conductivity, concentration).

The calculation requires a field limited by user-defined upper and lower limits (the 8 values depicted in Fig. 5.16). The expected measured values must be located in the range between the curves defined by the user (hatched area).
The curve defined by the user must rise monotonically (as shown in Fig. 5.16) or fall monotonically.

Note:

The temperature coefficient is determined as described in chpt. 5.6; the corresponding concentration is to be determined separately.

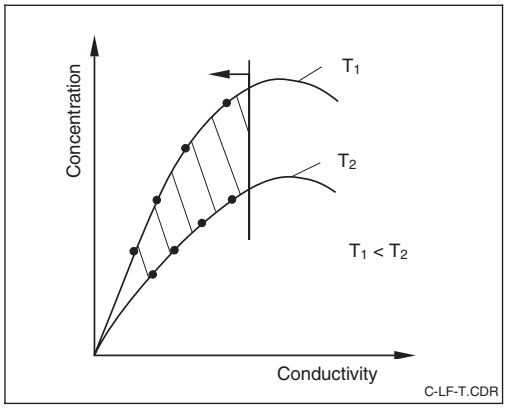


Fig. 5.16 Relationship among concentration, conductivity and temperature (qualitative representation)

Coding		Field	Selection or range Factory setting	Display	Info
K		Function group CONCENTRATION (S version only)		SETUP HOLD K CONCENTRA	Four different concentration fields can be entered in this function group.
	K1	Selection of concentration curve to be used to calculate the display value	**1** 1 ... 4	SETUP HOLD 1 K1 act.Curve	The curves are independent of each other, i.e. four different curves can be defined.
	K2	Selection of table to be edited	**1** 1 ... 4	SETUP HOLD 1 K2 Table	When editing a curve, another curve should be used to calculate the corresponding values (see K1).
	K3	Selection of table option	**read** edit	SETUP HOLD read K3 Table	This selection applies to all concentration curves.
	K4	Enter number of triplets	**1** 1 ... 10	SETUP HOLD 1 K4 No.Elem.	Each triplet consists of three numeric values.

Factory settings are printed in **bold** face;
base version does not include functions in italics.

Coding		Field	Selection or range Factory setting	Display	Info
	K5	Selection of triplet	**1** 1 ... number of triplets in K4	SETUP HOLD 1 K5 Sel.Elem.	Any triplet can be edited.
	K6	Enter uncompensated conductivity value	**0.0 µS/cm** 0.0 ... 9999 mS/cm	SETUP HOLD 0.0 µS/cm K6 conduct.	
	K7	Enter concentration value for K6	**0.00 %** 0.00 ... 99.99 %	SETUP HOLD 0.0 % K7 concentr.	
	K8	Enter temperature value for K6	**0.0 °C** –35.0 ... 250.0 °C	SETUP HOLD 0.0 °C K8 Temp.val.	
	K9	Enter whether or not the table status is okay	**yes** no	SETUP HOLD yes K9 Status ok	Return to K2.

5.8 Service

Coding		Field	Selection or range Factory setting	Display	Info
S		Function group SERVICE		SETUP HOLD S SERVICE	
	S1	Selection of language	**ENG** = **English** GER = German FRA = French ITA = Italian NEL = Dutch ESP = Spanish	SETUP HOLD ENG S1 Language	This field must be configured once during start-up. Then you can exit S1 and continue.
	S2	Hold configuration	**S+C** = **during setup + calibration** CAL = during calibration Setup = during setup none = no hold	SETUP HOLD S+C S2 Auto HOLD	S = setup, C = calibration.

Factory settings are printed in **bold** face;
base version does not include functions in italics.

Coding		Field	Selection or range Factory setting	Display	Info
	S3	Manual hold	**off** on	SETUP HOLD off S3 Man. HOLD	
	S4	Enter hold dwell period	**10 s** 0 ... 999 s	SETUP HOLD 10 s S4 Cont.Time	
	S5	Enter SW upgrade release code (plus package)	**0000** 0000 ... 9999	SETUP HOLD 0000 S5 PlusCode	Entry of an incorrect code returns you to the measurement menu. The number is edited with the PLUS or MINUS key and confirmed with the ENTER key.
	S6	Enter SW upgrade release code for Chemoclean	**0000** 0000 ... 9999	SETUP HOLD 0000 S6 CleanCode	Entry of an incorrect code returns you to the measurement menu. The number is edited with the PLUS or MINUS key and confirmed with the ENTER key.
	S7	Order number is displayed		SETUP HOLD order S7 CD0005	The order code is changed automatically to reflect an upgrade.
	S8	Serial number is displayed		SETUP HOLD SerNo S8 12345678	
	S9	Reset of instrument (restore default values) ⚠	**no** Sens = sensor data Facty = factory settings	SETUP HOLD no S9 S.Default	Facty = All data are erased and reset to the factory settings! Sens = The sensor data are erased. ⚠
	S10	Perform instrument test	**no** Displ = display test	SETUP HOLD no S10 Test	

Factory settings are printed in **bold** face;
base version does not include functions in italics.

5.9 E+H Service

Coding	Field	Selection or range Factory setting	Display	Info
E	Function group E+H SERVICE		SETUP HOLD E E+H SERV	
E1	Selection of module	**Contr** = **controller** (1) Trans = transmitter (2) MainB = mainboard (3) Relay = relay (4)	SETUP HOLD Contr E1 Select	
E111 E121 E131 E141	Software version is displayed		SETUP HOLD xx.xx E111 SW-Vers.	This field cannot be edited.
E112 E122 E132 E142	Hardware version is displayed		SETUP HOLD xx.xx E112 HW-Vers.	This field cannot be edited.
E113 E123 E133 E143	Serial number is displayed		SETUP HOLD SerNo E113 12345678	This field cannot be edited.

5.10 Interfaces

Coding	Field	Selection or range Factory setting	Display	Info
I	Function group INTERFACE		SETUP HOLD I INTERFACE	
I1	Entry of address	Address HART: **0** ... 15 or PROFIBUS: 1 ... **126**	SETUP HOLD 126 I1 Address	For communication only.

Factory settings are printed in **bold** face;
base version does not include functions in italics.

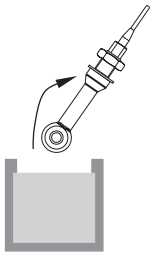
5.11 Calibration

This function group is used to calibrate the transmitter. Two different types of calibration are possible:

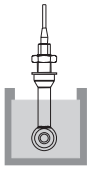
- Calibration by measurement in a calibration solution of a known conductivity.
- Calibration by entry of the exact cell constant of the conductivity measuring cell.

Note:

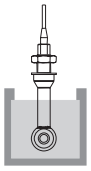
- If the calibration procedure is aborted by pressing the PLUS and MINUS keys at the same time (return to C114, C126 or C136) or if the calibration is faulty, then the previous calibration data are reinstated. A calibration error is indicated by the “ERR” message and flashing of the measuring cell symbol on the display.
  Repeat calibration!
- The instrument is automatically switched to hold during calibration (factory setting).

Coding	Field	Selection or range Factory setting	Display	Info
C	Function group CALIBRATION		CAL C CALIBRAT	
C1 (1)	Calibration of inductive cells with a ring-shaped opening	**Airs** = **Airset** (1) cellc = cell constant (2) *InstF = installation factor (3)*	CAL HOLD AirS C1 Calibrat	For conductive measurement, Airs and InstF are not available. The calibration of the cell is to be performed in air. The cell must be dry.
Remove measuring cell from the medium and dry in air.				
C111	Residual coupling Start calibration (Airset)	**current meas. value**	CAL HOLD 0.0 µS/cm C111 AirSet	Start calibration with CAL.
C112	Residual coupling is displayed (Airset)	–80.0 ... 80.0 µS	CAL HOLD 5.3 µS/cm C112 AirSetVal	Residual coupling of measuring system (measuring cell and transmitter).

Factory settings are printed in **bold** face;
base version does not include functions in italics.

Coding	Field	Selection or range Factory setting	Display	Info
C113	Calibration status is displayed	o.k. E xxx	CAL READY HOLD o.k. C113 Status	If the calibration status is not o.k., then the second display line shows an explanation of the error.
C114	Store calibration results?	**yes** no new	CAL READY HOLD yes C114 Store	If C113 = E xxx, then only no or **new.** If new, return to C. If yes/no, return to “Measurement”.
C1 (2)	Calibration of cell constant	Airs = Airset (1) **cellc** = **cell constant** (2) *InstF* = *installation factor (3)*	CAL HOLD cellc C1 Calibrat	
Immerse measuring cell in calibration solution.				The measuring cell should be immersed at a sufficient distance from the vessel wall (installation factor has no influence).
C121	Enter calibration temperature (MTC)	**25.0 °C** –35.0 ... 250.0 °C	CAL HOLD 25.0 °C C121 MTC temp.	Only exists if B1 = fixed.
C122	α value of calibration solution	**2.10 %/K** 0.00 ... 20.00 %/K	CAL HOLD 2.10 C122 alpha val	This value is given with each calibration solution.
C123	Enter correct conductivity value of calibration solution	**current meas. value** 0.0 ... 9999 mS/cm	CAL HOLD 10.30 mS/cm C123 Real val.	The practical range is depends on the measuring cell, i.e. the calibration solution should be at approx. 40 % of the measuring range determined by the cell (see chpt. 9, Fig. 9.2). The display unit is always mS/cm.
C124	Calculated cell constant is displayed	0.0025 ... 99.99 cm^{-1}	CAL HOLD 1.000 1/cm C124 cellconst	The calculated cell constant is displayed and entered in A5.
C125	Calibration status is displayed	o.k. E xxx	CAL READY HOLD o.k. C125 Status	If the calibration status is not o.k., then the second display line shows an explanation of the error.

Factory settings are printed in **bold** face;
base version does not include functions in italics.

Coding	Field	Selection or range Factory setting	Display	Info
C126	Store calibration results?	**yes** no new	CAL READY HOLD yes C126 Store	If C125 = E xxx, then only no or **new.** If new, return to C. If yes/no, return to “Measurement”.
C1 (3)	Calibration with measuring cell adaptation for inductive measuring cells (S version only)	Airs = Airset (1) cellc = cell constant (2) **InstF** = **installation factor** *(3)*	CAL HOLD InstF C1 Calibrat	Measuring cell calibration with compensation of wall influence.
The measuring cell remains at the place of installation.				
C131	Enter calibration temperature (MTC)	**25.0 °C** –35.0 ... 250.0 °C	CAL HOLD 25.0 °C C131 MTC temp.	Only exists if B1 = fixed.
C132	α value of calibration solution	**2.10 %/K** 0.00 ... 20.00 %/K	CAL HOLD 2.10 C132 alpha val	This value is determined by the calibration solution.
C133	Enter correct conductivity value of calibration solution	**current meas. value** 0.0 ... 9999 mS/cm	CAL HOLD 10.30 mS/cm C133 Real val.	The practical range is depends on the measuring cell, i.e. the calibration solution should be at approx. 40 % of the measuring range determined by the cell (see chpt. 9, Fig. 9.2). The display unit is always mS/cm.
C134	Calculated installation factor is displayed	**1** 0.10 ... 5.00	CAL HOLD 1 C134 InstFact	
C135	Calibration status is displayed	o.k. E xxx	CAL READY HOLD o.k. C135 Status	If the calibration status is not o.k., then the second display line shows an explanation of the error.
C136	Store calibration results?	**yes** no new	CAL READY HOLD yes C136 Store	If C135 = E xxx, then only no or **new.** If new, return to C. If yes/no, return to “Measurement”.

Factory settings are printed in **bold** face;
base version does not include functions in italics.

6 Interfaces

For instruments equipped with a communication interface, please refer to separate operating instructions BA 208C/07/en (HART®) or BA 209C/07/en (PROFIBUS).

7 Maintenance and troubleshooting

7.1 Definition of terms

Maintenance means that all measures which will guarantee the safety of operation and reliability of the entire measuring system are taken in due time.

Maintenance on the CLM 223 / 253 includes:
- Calibration (see chpt. 5.11)
- Cleaning of assembly and sensor
- Checking of cables and connections

Troubleshooting means that the cause of the problem is determined and eliminated. Troubleshooting refers to measures that can be performed without intervention in the instrument (refer to chpt. 8, Corrective maintenance, for defects of the instrument).

Troubleshooting of the CLM 223 / 253 and the measuring system is performed with the aid of the troubleshooting table in chpt. 7.3.

7.2 Safety instructions

Warning:

Please be aware of effects work performed on the instrument might have on the process control system or the process itself.

Warning:

When removing the sensor during maintenance or calibration, please consider potential hazards due to pressure, high temperatures and contamination.

7.3 Troubleshooting common problems

Problem	Possible cause	Remedy	Equipment needed, spare parts
Display deviates from reference measurement	– Calibration faulty	Calibrate instr. acc. to chpt. 4.8	Cal. solution or cell certificate
	– Measuring cell soiled	Clean measuring cell	See chapter 8.8.1
	– Incorrect temperature measurement	Check temperature value on instrument and reference unit	Temp. meas. instr., thermometer
	– Incorrect temp. compensation	Check compensation mode (none / ATC / MTC) and compensation type (linear/subst./user table)	Please note: Liquisys has a separate calibration temperature coefficient setting
	– Reference instrument calibration faulty	Calibrate reference instrument or use calibrated instrument	Calibration solution, operating instructions of reference instrument
	– Incorrect ATC setting on reference instrument	Compensation mode and compensation type must be identical on both instruments	Oper. instr. of reference instrument
	– Polarisation error	Use suitable measuring cell: – use larger cell constant – use graphite in place of stainless steel (resistance requirements)	Measuring range tables, e.g. in SI "Conductivity" or technical data of conductivity measuring cells
Implausible measured values in general: – meas. value overflow – meas. value always 000 – meas. value too low – meas. value too high – meas. value frozen – incorrect current output value	– Short in measuring cell	Check measuring cell	See chapter 8.8.4 / 8.8.5
	– Short in cable or junction box	Check cable and junction box	See chapter 8.8.2 / 8.8.3
	– Interruption in measuring cell	Check measuring cell	See chapter 8.8.4 / 8.8.5
	– Interrupt. in cable or junction box	Check cable and junction box	See chapter 8.8.2 / 8.8.3
	– Incorrect cell constant setting	Check cell constant	Meas. cell nameplate or certificate
	– Incorrect current assignment	Check current assignment	
	– Incorrect output function	Check 0-20 / 4 -20 mA selection	
	– Air cushion in assembly	Check assembly and installation	
	– Short to ground on/in instrument	Measure in insulated container	Plastic container, cal. solutions
	– Transmitter module defective	Simulation directly on instrument	Diagn. and spare parts s. chpt. 8
	– Impermissible instrument operating state (no response to key actuation)	Switch instrument off and back on	EMC problem: check grounding and line routing if problem persists

Problem	Possible cause	Remedy	Equipment needed, spare parts
Incorrect temperature value	– Incorrect sensor connection	Verify connections using connection diagram; three-wire connection mandatory	Connection diagram in chpt. 3.4
	– Measuring cable defective	Check cable for interruption/short/ shunt	Ohmmeter; also see chpt. 8.8.2 / .3
	– Incorrect sensor type	Select sensor type on instrument (field B1)	
Incorrect conductivity meas. value in process	– No / incorrect temperature compensation	ATC: select compensation type; linear: set correct coefficient MTC: set process temperature	
	– Incorrect temperature measurement	Check temperature value	Reference instrument, thermometer
	– Bubbles in medium	Suppress bubble formation: - gas bubble trap - counterpressure (cover) - bypass measurement	
	– Polarisation effects (conductive measuring cells only)	Use suitable measuring cell: - use larger cell constant, - use graphite in place of stainless steel (resistance requirements)	Measuring range tables, e.g. in SI “Conductivity”, or technical data of conductivity measuring cells
	– Flow rate too high (may cause bubbles)	Reduce flow or choose low-turbulence mounting position	
	– Potential in medium (conductive only)	Ground medium close to meas. cell	Problem mainly occurs in plastic lines and tanks
	– Sensor soiled or coated	Clean sensor (s. chpt. 8.8.1)	Heavily soiled media: use spray cleaning
Measured value fluctuates	– Measuring cable interference	Connect cable screen acc. to connection diagram	See chpt. 3.5
	– Signal output line interference	Check line routing, try separate line routing	Separate routing of signal output and meas. input lines
	– Interference potential in medium	Eliminate source of interference or ground medium close to conductivity measuring cell	
Controller or timer cannot be activated	– No relay module installed	Install LSR1-2 or LSR1-4 module	See chapters 8.4 and 8.5
Controller / limit contact does not work	– Controller switched off	Activate controller	See chpt. 5.5 or fields R2xx
	– Controller in “Manual / Off” mode	Choose “Auto” or “Manual / On” mode	Keyboard, REL key
	– Pickup delay setting too long	Disable or shorten pickup delay	See fields R2xx
	– “Hold” function active	“Autom. hold” during calibration, “hold” input activated; “hold” via keyboard active	See fields S2 to S4
Controller / limit contact works continuously	– Controller in “Manual / On” mode	Set controller to “Manual / Off” or “Auto”	Keyboard, REL and AUTO keys
	– Dropout delay setting too long	Shorten dropout delay	See fields R2xx
	– Control loop interruption	Check measured value, current output or relay contacts, actuators, chemical supply	
No conductivity current output signal	– Line open or short-circuited	Disconnect line and measure directly on instrument	mA meter 0–20 mA
	– Output defective	See chpt. 8.3	
Fixed current output signal	– Current simulation active	Switch off simulation	See field O2
	– Processor system out of sync	Switch instrument off and back on	EMC problem: check installation if problem persists
Incorrect current output signal	– Incorrect current assignment	Check current assignment: 0–20 mA or 4–20 mA?	Field O211
	– Total load in current loop excessive (> 500 Ω)	Disconnect output and measure directly on instrument	mA meter for 0–20 mA DC

Problem	Possible cause	Remedy	Equipment needed, spare parts
No temperature output signal	– Instrument does not have 2nd current output – Instrument with Profibus PA	Refer to nameplate for variant; change LSCH-x1 module if nec. PA instr. has no current output!	LSCH-x2 module, s. chapters 8.4.4 and 8.5.4
Chemoclean function not available	– No relay module (LSR1-x) or only LSR1-2 installed or Chemoclean release code not entered (handling like S package, see next line)	Install LSR1-4 module. Chemoclean is enabled via release code supplied by E+H with Chemoclean upgrade ⇒ enter code	LSR1-4 module, see chapters 8.4.4 and 8.5.4
S package functions not available	– S package not enabled (enable with code that depends on serial number and is received from E+H with order of S package)	– S package upgrade: code received from E+H ⇒ enter – Following replacement of defective LSCH/LSCP module: first enter instrument serial number (s. nameplate) manually, then enter code	Detailed description see chpt. 8.5.5
No HART communication	– No central HART module – No or wrong DD (device description) – HART interface missing – Instrument not registered with HART server – Load too low (load > 230 Ω required) – HART receiver (e.g. FXA 191) not connected via load – Incorrect device address (addr. = 0 for single operation, addr. > 0 for multi-drop operation) – Line capacitance too high – Line interference	Verify by looking at nameplate: HART = -xxx5xx and -xxx6xx For further information see chpt. 6, “Interfaces”	Upgrade to LSCH-H1 / -H2
No Profibus PA communication	– No central PA module – Wrong SW version (without PA) – Commuwin (CW) II: CW II version and instrument SW version incompatible – No or wrong DD/DLL – Incorrect baud rate setting for segment coupler in DPV-1 server – Incorrect station (master) address or duplicate address – Incorrect station (slave) address – Bus line not terminated – Line problems (too long, cross section too small; not shielded, screen not grounded, wires not twisted) – Bus voltage too low (bus supply voltage typ. 24 V DC for non-Ex, 13.5 V DC for Ex)	Verify by looking at nameplate: Profibus PA = -xxx3xx For further information see chpt. 6, “Interfaces” Voltage at instrument PA connector must be at least 9 V.	Upgrade to LSCP module

7.4 Problem elimination based on error messages

Error no.	Display	Measures	Contact		Error current		Automatic cleaning trigger	
			Fact.	User	Fact.	User	Fact.	User
E001	EEPROM memory error	Switch instrument off and back on, return instrument to your local Endress+Hauser sales agency for repair or replace instrument. Load software compatible with hardware. Load instrument software specific to parameter measured.	yes		no		—	—*
E002	Instrument not calibrated, calibration data invalid, no user data or user data invalid (EEPROM error) Software does not match hardware (central module)		yes		no		—	—*
E007	Transmitter malfunction Software does not match hardware (transmitter)		yes		no		—	—*
E008	Measuring cell or measuring cell connection faulty	Check measuring cell and measuring cell connection (E+H Service).	yes		no		no	
E010	No temperature sensor connected or temperature sensor short-circuited (temperature sensor faulty)	Check temperature sensor and connections; if necessary, check instrument with temperature simulator.	yes		no		no	
E025	Limit for Airset offset exceeded	Repeat Airset (in air) or replace measuring cell. Dry cell.	yes		no		no	
E036	Calibration range of measuring cell exceeded	Clean measuring cell and recalibrate; if necessary, check measuring cell and connections.	yes		no		no	
E037	Below calibration range of measuring cell		yes		no		no	
E045	Calibration aborted	Recalibrate.	yes		no		—	—*
E046	Current output 1 parameter limits interchanged	Set value for 20 mA > value for 4 mA.	yes		no		—	—*
E047	Current output 2 parameter limits interchanged	Set value for 20 mA > value for 4 mA.	yes		no			—*
E049	Calibration range of installation factor exceeded	Check pipe diameter, clean measuring cell and repeat calibration.	yes		no		—	—*
E050	Below calibration range of installation factor	Check pipe diameter, clean measuring cell and repeat calibration.	yes		no		—	—*
E055	Below measuring range of main parameter	Immerse sensor in conductive medium or perform Airset.	yes		no		no	
E057	Measuring range of main parameter exceeded	Check measurement, control and connections.	yes		no		no	
E059	Below temperature measuring range		yes		no		no	
E061	Temperature measuring range exceeded		yes		no		no	
E063	Below current output range 1	Check configuration.	yes		no		no	
E064	Current output range 1 exceeded	Check measured value and current assignment.	yes		no		no	

Error no.	Display	Measures	Contact		Error current		Automatic cleaning trigger	
			Fact.	User	Fact.	User	Fact.	User
E065	Current output range 2 exceeded	Check measured value and current assignment.	yes		no		no	
E066	Current output range 2 exceeded		yes		no		no	
E067	Set value exceeded: contr. / limit contactor 1		yes		no		no	
E068	Set value exceeded: contr. / limit contactor 2		yes		no		no	
E069	Set value exceeded: contr. / limit contactor 3		yes		no		no	
E070	Set value exceeded: contr. / limit contactor 4		yes		no		no	
E071	Inaccurate measurement / polarisation	Clean measuring cell; check table; choose suitable measuring cell	yes		no		no	
E077	Temperature outside α value table range	Clean measuring cell; check tables.	yes		no		no	
E078	Temperature outside concentration table		yes		no		no	
E079	Conductivity outside concentration table		yes		no		no	
E080	Current output 1 param. range too small	Spread current output.	no		no		—	—*
E081	Current output 2 param. range too small	Spread current output.	no		no		—	—*
E100	Current simulation active		no		no		—	—*
E101	Service function yes	Switch service function off or switch instrument off and back on.	no		no		—	—*
E102	Manual mode active							
E106	Download yes	Wait for download to end.	no		no		—	—*
E116	Download error	Repeat download.	no		no		—	—*
E150	Distance between temp. values in α value table too small or not monotonically increasing	Enter correct values in α value table (minimum distance between temperature values of 1 K required).	no		no		no	
E151	USP error		no		no		no	
E152	PCS alarm	Check measuring cell and connection.	no		no		no	
E153	USP temperature error		no		no		no	

*When this error is present, the cleaning function cannot be started.
(Field F8 does not exist for this error.)

8 Diagnosis and corrective maintenance

8.1 Definition of terms

Diagnosis refers to the identification of instrument malfunctions and defects.

Corrective maintenance means
– replacement of parts diagnosed to be defective;
– testing of instrument and measuring system function;
– restoration of complete functionality.

Diagnosis based on the error table below and depending on difficulty and measuring equipment at hand is to be performed by:
– trained operator personnel
– operator's electricians
– company responsible for system installation/ operation
– E+H Service
Please refer to the tables in chapters 8.4 and 8.5 for identification of spare parts required.

8.2 Safety instructions

Warning:

- Disconnect the instrument from the power source before opening it up.
  Work under tension may only be performed by trained electricians.
- Switched contacts may be supplied from separate circuits. These circuits must also be de-energized before work on the terminals is performed.

Caution: ESD!

- Electronic components are sensitive to electrostatic discharges. Personal protective measures, such as discharge via PE or permanent grounding using a wrist strap, are to be taken.
- For your own safety, use only original spare parts. Original parts will guarantee functionality, accuracy and reliability after repairs.

8.3 Diagnosis

The table below will help you diagnose problems and specifies the spare parts required.

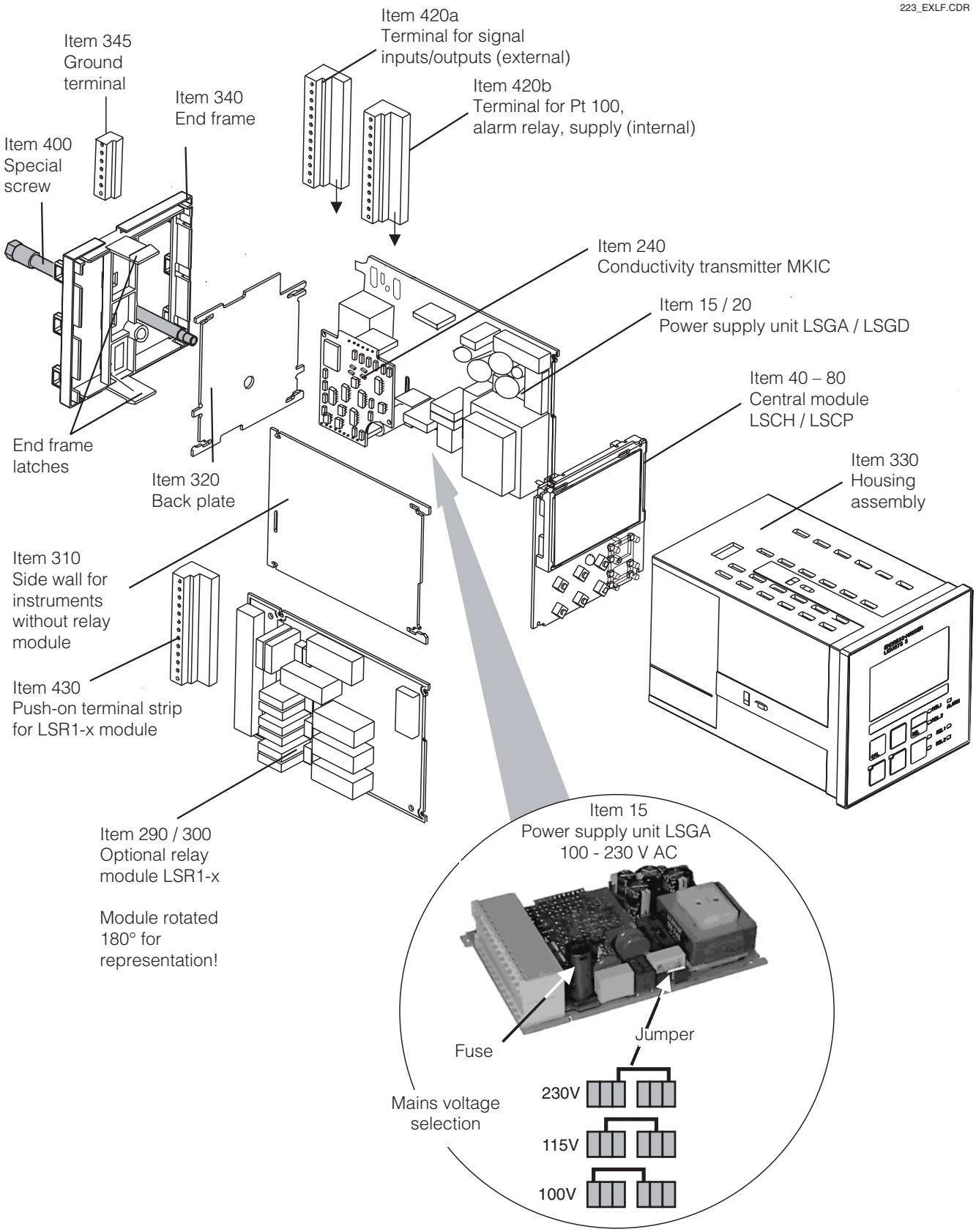
Please refer to chapters 8.4.3 and 8.5.3 for information on the exact designations of the spare parts and their installation.

Problem	Possible cause	Tests and / or remedial measures	Equipment, spare parts, personnel
Display dark, no LEDs active	– No mains voltage	Check if mains voltage is available	Electrician / e.g. multimeter
	– Wrong supply voltage / voltage too low	Compare mains voltage and rating on nameplate	Operator (utility company specification or multimeter)
	– Connection fault	Terminal not tightened; insulation clamped in terminal; wrong terminal used	Electrician
	– Fuse blown	Replace fuse, first compare mains voltage and rating on nameplate	Electrician / see drawings in chapters 8.4.1 and 8.5.1 for correct fuses
	– Power supply unit defective	Replace power supply unit using correct variant	On-site diagnosis by E+H Service (test module required)
	– Central module defective	Replace central module using correct variant	On-site diagnosis by E+H Service (test module required)
	– CLM 253: ribbon cable item 310 loose or defective	Check ribbon cable, replace if necessary	S. spare parts for CLM 253
Display dark, LED(s) active	– Central module defective (module: LSCH/LSCP)	Replace central module	On-site diagnosis by E+H Service (test module required)

Problem	Possible cause	Tests and / or remedial measures	Equipment, spare parts, personnel
Display shows measured value but – value does not change and / or – instrument cannot be operated	– Instrument, or module not properly installed in instrument – Impermissible operating system state	CLM 223: Reinstall module CLM 253: Reinstall display module Switch instrument off and back on	Refer to assembly drawings in chapters 8.4.1 and 8.5.1. Possible EMC problem: if problem persists, call E+H Service to have installation checked.
Instrument gets hot	– Incorrect voltage / too high – Power supply unit defective	Compare mains voltage and rating on nameplate Replace power supply unit	 Can only be diagnosed by E+H Service
Incorrect meas. CD / MΩ and / or temperature value	– Transmitter module defective (module: MKIC), please perform tests and take measures acc. to chapter 7.3	Test measuring inputs: – connect resistor in place of conductivity measuring cell, see table in chpt. 8.8.1 – Connect 100 Ω resistor to terminals 11 / 12 + 13 = display 0 °C	If test fails: replace module (using correct variant), refer to exploded views in chapters 8.4.1 and 8.5.1.
Current output, incorrect current	– Not calibrated correctly – Load excessive – Shunt / short-circuit to frame in current loop – Incorrect mode of operation	Test with built-in current simulation, connecting mA meter directly to current output Check whether 0–20 mA or 4–20 mA has been selected	If simulation value is incorrect: recalibration at factory or new LSCxx module required. If simulation value is correct: check current loop for load and shunts.
No current output signal	– Current output stage defective (module: LSCH/LSCP)	Test with built-in current simulation, connecting mA meter directly to current output	If test fails: Replace central module (using correct variant)
Additional relays do not work	– CLM 253: ribbon cable item 320 loose or defective	Make sure ribbon cable is properly connected, replace cable if nec.	S. spare parts for CLM 253
Only 2 additional relays can be used	– Relay module LSR1-2 with 2 relays installed	Convert to LSR1-4 with 4 relays	Operator, E+H Service
Enhanced functions (S package) not available	– No or incorrect release code used – Incorrect serial number of LSCH/LSCP module	If upgraded: verify that correct serial number has been used to order S package Check whether serial number on nameplate matches serial number of LSCH/LSCP (field E113)	Handled by E+H Sales Serial number of LSCH/LSCP module is required to enable S package.
Enhanced functions (S package and / or Chemoclean) are not available after replacement of LSCH/LSCP module	– Serial number entered for replacement module LSCH or LSCP at factory is 0000. S package or Chemoclean has not been enabled with release codes.	For LSCH / LSCP with SNR 0000, an instrument serial number can be entered **once** in fields E114 to E116. Next step is to enter release codes for S package and / or Chemoclean.	A detailed description can be found in chapter 8.5.5
No HART or Profibus PA interface function	– Wrong central module – Wrong software	HART: LSCH-H1 or -H2 Profibus PA: LSCP module, s. field E112 SW version: see fields E1x1	Replace central module; operator or E+H Service

8.4 Corrective maintenance of Liquisys CLM 223

8.4.1 Exploded view



8.4.2 Dismantling of CLM 223

- Consider potential effects on process when removing the instrument from service!
- First pull off the terminal block (item 420 b) on the rear of the instrument to de-energize the instrument.
- Then pull off the terminal blocks (items 420 a and 430 if applicable) on the rear. Now you can dismantle the instrument.
- Push the end frame latches (item 340) inward and pull off the frame towards the rear.
- Loosen the special screw (item 400) by turning it counterclockwise.
- Remove the complete electronics block from the housing. The modules are plugged together mechanically and can be easily separated:
  – Simply pull the processor/display module off towards the front
  – Pull the back plate tabs outward slightly to remove the lateral modules.

8.4.3 Assembly of CLM 223

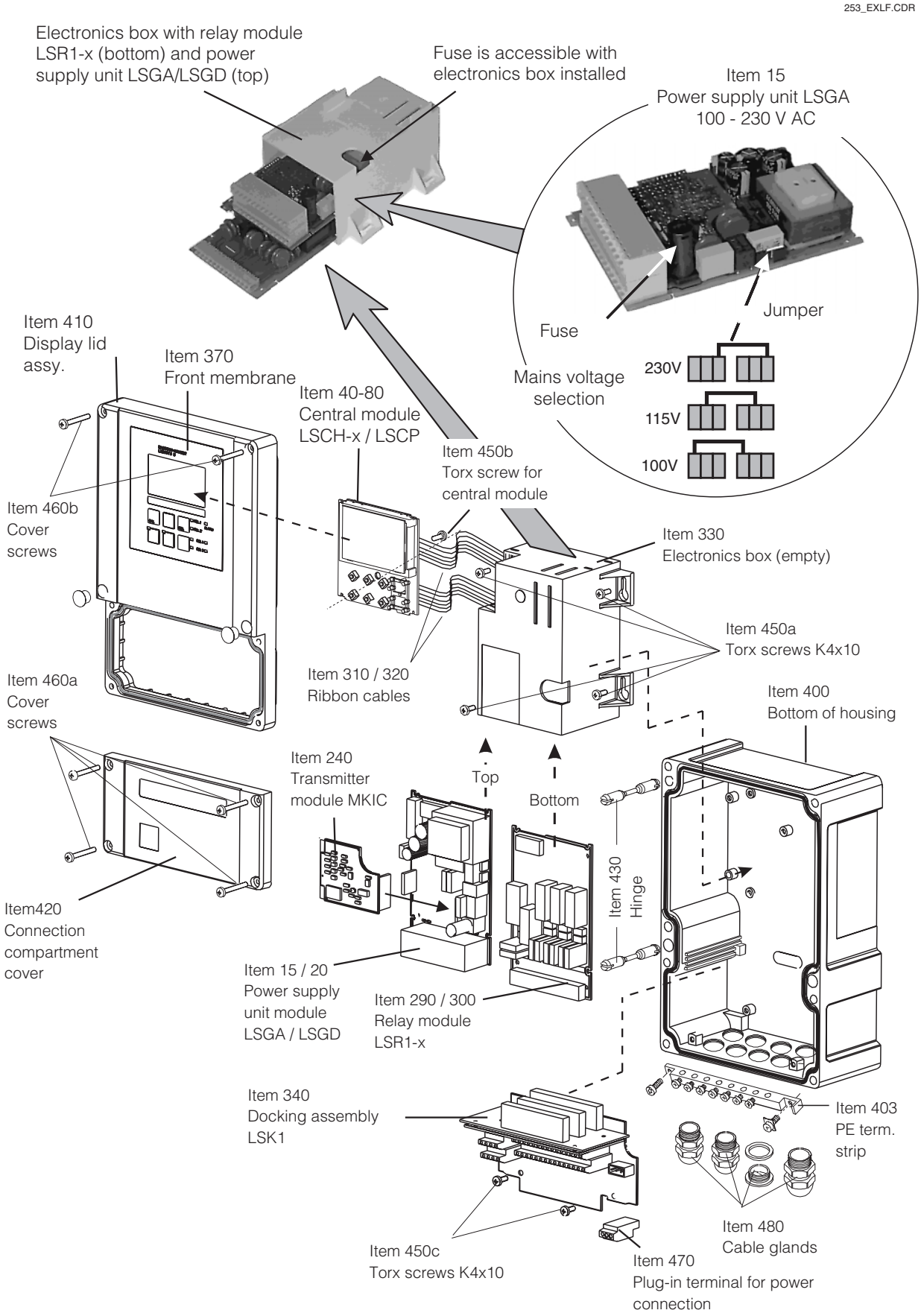
- Reverse the dismantling sequence for assembly.
- Hand-tighten the special screw without using a tool.
- Incorrect assembly is not possible! A module block which has been plugged together incorrectly cannot be inserted in the housing.

8.4.4 Spare parts for CLM 223

Item	Designation	Name	Function	Order number
15	Power supply unit	LSGA	100/115/230 V AC	51500317
20	Power supply unit	LSGD	24 V AC + DC	51500318
290	Relay module	LSR1-2	2 relays	51500320
300	Relay module	LSR1-4	4 relays	51500321
40	Conductive central module	LSCH-S1	1 current output	51501210
50	Conductive central module	LSCH-S2	2 current outputs	51501212
60	Conductive central module	LSCH-H1	1 current output + HART	51501213
70	Conductive central module	LSCH-H2	2 current outputs + HART	51501214
80	Conductive central module	LSCP	Profibus PA / no current outp.!	51501215
40	Inductive central module	LSCH-S1	1 current output	51501216
50	Inductive central module	LSCH-S2	2 current outputs	51501218
60	Inductive central module	LSCH-H1	1 current output + HART	51501219
70	Inductive central module	LSCH-H2	2 current outputs + HART	51501220
80	Inductive central module	LSCP	Profibus PA / no current outp.!	51501221
240	Conductivity transmitter	MKIC	Cond. + temp. input	51501206
330, 340	Housing assembly		With front membrane, key tappets, gasket, special screw, tensioning brackets, all nameplates	51501075
310, 320, 340, 400	Mechanical housing parts		Back plate, side wall, end frame, special screw	51501076
420a, 420b	Terminal strip set		Terminal strips for inputs / outputs and for supply / alarm relay	51501203
430	Terminal strip		Terminal strip for relay module	51501078
345	Ground terminal strip		PE and screen connections	51501086

8.5 Corrective maintenance of Liquisys CLM 253

8.5.1 Exploded view



8.5.2 Dismantling of CLM 253

- Open and remove the connection compartment cover (item 420).
- Pull off the power connection terminal (item 470) to de-energize the instrument.
- Open the display lid (item 410) and remove the ribbon cables (item 310 / 320) on the side of the electronics box (item 330).
- Removal of central module (item 40): Loosen the screw (item 450b) in the display lid.
- Removal of electronics box (item 330): Unscrew screws (item 450a) in bottom of housing 2 revolutions, then slide entire box backward and remove towards the top. Make sure that the module catches do not come unlatched! Bend the module latches outward and remove the module(s).
- Removal of docking assembly (item 340): Remove the screws (item 450c) in the bottom of the housing and remove the entire assembly towards the top.

8.5.3 Assembly of CLM 253

- Insert the module(s) in the electronics box guide rails carefully and latch into the lateral lugs in the box.
- Incorrect assembly is not possible! Modules inserted in the electronics box incorrectly are not operable since the ribbon cables cannot be inserted.
- Make sure that the cover gaskets are intact since they are required to guarantee protection class IP 65.

8.5.4 Spare parts for CLM 253

Item	Designation	Name	Function	Order number
15	Power supply unit	LSGA	100/115/230 V AC	51500317
20	Power supply unit	LSGD	24 V AC + DC	51500318
290	Relay module	LSR1-2	2 relays	51500320
300	Relay module	LSR1-4	4 relays	51500321
40	Conductive central module	LSCH-S1	1 current output	51501210
50	Conductive central module	LSCH-S2	2 current outputs	51501212
60	Conductive central module	LSCH-H1	1 current output + HART	51501213
70	Conductive central module	LSCH-H2	2 current output + HART	51501214
80	Conductive central module	LSCP	Profibus PA / no current outp.!	51501215
40	Inductive central module	LSCH-S1	1 current output	51501216
50	Inductive central module	LSCH-S2	2 current outputs	51501218
60	Inductive central module	LSCH-H1	1 current output + HART	51501219
70	Inductive central module	LSCH-H2	2 current outputs + HART	51501220
80	Inductive central module	LSCP	Profibus PA / no current outp.!	51501221
240	Conductivity transmitter	MKIC	Cond. + temp. input	51501206
370, 410, 420, 430	Housing cover assembly		Display lid, connection compartment cover, front membrane, hinges	51501068
400, 480	Housing bottom (mechanical)		Bottom, cable glands	51501072
330, 340, 450	Internal housing parts		Docking assembly, empty electronics box, small parts	51501073
310, 320	Ribbon cables		2 ribbon cables	51501074
430	Hinges		2 pairs of hinges	51501069
470	Power supply terminal strip		Terminal strip, 2-pin	51501079
403	PE terminal strip		PE and screen connections	51501087

8.5.5 Special case: replacement of central module

Note:

Replacement central module LSCx-x is supplied from the factory with instrument serial no. 0000. Since the serial and release numbers are linked for the S package and Chemoclean, an existing S package or Chemoclean may not be active. All the editable data are reset to the factory settings following central module replacement.

Proceed as described below after central module replacement:

- If possible, record the user settings of the instrument, e.g.:
  – Calibration data
  – Conductivity / resistance and temperature current assignments
  – Relay function selections
  – Limit / controller settings
  – Cleaning settings
  – Monitoring functions
  – Interface parameters
- Dismantle the instrument as described in chpt. 8.4.2 or 8.5.2.
- Refer to the part no. of the central module to determine whether the new module has the same part no. as the old one.
- Assemble the instrument with the new module as described in chapter 8.4.3 or 8.5.3.
- Start up the instrument and test its basic functions (e.g. meas. value and temperature display, operation via keyboard).
- Enter the instrument serial number:
  – Read the instrument serial number (“ser-no.”) on the nameplate.
  – Enter this number in the fields E114 (year), E115 (month), E116 (sequence number).
  – Field E117 displays the complete number for verification; acknowledge with ENTER or abort and re-enter.

  Please note: The serial number can only be entered – and **only once** – in the case of a new module from the factory with serial number 0000! Make sure that your entry is correct before confirming with ENTER! Entry of an incorrect code will prevent the enhanced functions from being enabled. An incorrect serial number can only be corrected at the factory.
- Verify that the S package is enabled (e.g. by accessing function group CHECK / Code P) or the Chemoclean function.
- Restore the user settings of the instrument.

8.6 Spare parts orders

Spare parts are to be ordered from your local E+H Sales Agency. See the back cover of these operating instructions for addresses. Specify the order numbers listed in chapter 8.4.4 or 8.5.4.

To be on the safe side, you should **always** specify the following data with your spare parts orders:

– Instrument order code (order code)
– Serial number (ser-no.)
– Software version where available

Refer to the nameplate for the order code and serial number.
The software version is displayed in field E111 when the instrument processor system is functional.

8.7 Service equipment “optoscope”

The optoscope permits documentation, uploads and downloads of user data and software updates **without** having to remove or open up the Liquisys and **without** establishing a galvanic connection to the instrument.

The optoscope serves as an interface between the Liquisys and PC / laptop. The information exchange takes place via the optical interface on the Liquisys and via a standard RS 232 interface on the PC / laptop.

Handling and operation are described in the optoscope operating instructions.
The user-friendly Windows software required for the PC or laptop is supplied with the optoscope.

The optoscope is also suitable for Mycom CxM 152 and MyPro CxM 431; it is supplied in a sturdy case with all the accessories required.

- **Order number of optoscope: 51500650**

8.8 Corrective maintenance of measuring system

8.8.1 Conductivity measuring cells

Soiling detected on conductivity measuring cells can be removed as follows:

- *Oily and greasy coatings*
  Clean with detergent (fat solvent, e.g. alcohol, acetone, poss. detergent).

Warning:

Hands, eyes and clothes are to be protected when using the cleaning agents described below.

- *Limestone deposits or metal hydroxide coatings*
  Loosen coatings with diluted hydrochloric acid (3 %), then rinse thoroughly.
- *Coatings containing sulphide (from flue gas desulphurizing plants or sewage treatment plants)*
  Use mixture of hydrochloric acid (0.5 %) and thiourea (8 %), then rinse thoroughly.
- *Coatings containing protein (food industry)*
  Use mixture of hydrochloric acid (0.5 %) and pepsin (1 %), then rinse thoroughly.

8.8.2 Simulation of conductive measuring cells for instrument test

A measuring instrument for conductive conductivity is checked by replacing the process and temperature sensor with resistors. The accuracy of the simulation depends on the accuracy of the resistors.

Refer to the table on the right for conductivity (cell constant *k* set to nominal value according to column 2). Otherwise: display of $CD_{[mS/cm]} = k \cdot 1/R_{[k\Omega]}$.

Refer to the table below for temperature (no temperature offset set on Liquisys). Connect temperature equivalent resistance using three-wire arrangement!

- Use the “CD test adapter” service kit to connect decade resistors to the connector of a conductivity measuring cable in place of a conductivity measuring cell.
  Order number: 51500629.

Pt100 equivalent resistances:

Temperature	Resistance
–20 °C	92.13 Ω
–10 °C	96.07 Ω
0 °C	100.00 Ω
10 °C	103.90 Ω
20 °C	107.79 Ω
25 °C	109.73 Ω
50 °C	119.40 Ω
80 °C	130.89 Ω
100 °C	138.50 Ω
200 °C	175.84 Ω

All resistance values are to be multiplied by 10 for a Pt 1000 temperature sensor.

Conductivity equivalent resistances:

Resist. R	Cell const. k	Display for CD	Display for MΩ
10 Ω	1 cm^{-1}	100 mS/cm	
	10 cm^{-1}	1000 mS/cm	
100 Ω	0.1 cm^{-1}	1 mS/cm	1 kΩ · cm
	1 cm^{-1}	10 mS/cm	
	10 cm^{-1}	100 mS/cm	
1000 Ω	0.1 cm^{-1}	0.1 mS/cm	10 kΩ · cm
	1 cm^{-1}	1 mS/cm	
	10 cm^{-1}	10 mS/cm	
10 kΩ	0.01 cm^{-1}	1 µS/cm	1 MΩ · cm
	0.1 cm^{-1}	10 µS/cm	100 kΩ · cm
	1 cm^{-1}	100 µS/cm	
	10 cm^{-1}	1 mS/cm	
100 kΩ	0.01 cm^{-1}	0.1 mS/cm	10 MΩ · cm
	0.1 cm^{-1}	1 µS/cm	1MΩ · cm
	1 cm^{-1}	10 µS/cm	
1 MΩ	0.01 cm^{-1}	0.01 µS/cm	100 MΩ · cm
	0.1 cm^{-1}	0.1 µS/cm	10 MΩ · cm
	1 cm^{-1}	1 µS/cm	
10 MΩ	0.01 cm^{-1}	0.001µS/cm	
	0.1 cm^{-1}	0.01 µS/cm	100 MΩ · cm

Note: The MΩ measurement is normally used for pure and ultrapure water and is therefore only practical with cell constants $k = 0.01$ or possibly $k = 0.1$.

8.8.3 Simulation of inductive measuring cells for instrument test

An inductive measuring cell cannot be simulated by resistors.

However, the overall system comprising the CLM 2x3-ID and inductive measuring cell can be checked using equivalent resistances. Note cell constant k (e.g. $k_{nominal}$ = 2 for CLS 50, $k_{nominal}$ = 5.9 for CLS 52).

For an accurate simulation, the actual cell constant (can be read in field C124) is to be used to calculate the display value: display of $CD_{[mS/cm]} = k \cdot 1/R_{[k\Omega]}$.

Reference values for simulation of CLS 50 at 25 °C:

Simulation resistance R	Cell constant k	Conductivity display
2 Ω	2.00 cm^{-1}	1000 mS/cm
10 Ω	2.00 cm^{-1}	200 mS/cm
100 Ω	2.00 cm^{-1}	20 mS/cm
1kΩ	2.00 cm^{-1}	2 mS/cm

- Performance of simulation:
  Pull a cable through the sensor opening and then connect, e.g. to a decade resistor.

8.8.4 Checking of conductive conductivity measuring cells

- Measuring surface connection:
  The measuring surfaces are connected directly to the connections of the measuring cell connector.
  Check with ohmmeter for < 1 Ω
- Measuring surface shunt:
  A shunt between the measuring surfaces is not allowed.
  Check with ohmmeter for > 20 MΩ
- Temperature sensor shunt:
  A shunt between the measuring surfaces and temperature sensor is not allowed.
  Check with ohmmeter for > 20 MΩ.
- Temperature sensor:
  Refer to the measuring cell nameplate for the temperature sensor type.
  The sensor can be checked at the measuring cell connector with an ohmmeter:
  – Pt 100 at 25 °C = 109.79 Ω
  – Pt 1000 at 25 °C = 1097.9 Ω
  – NTC 10 k at 25 °C = 10 kΩ
- Connection:
  Check terminal wiring (interchanged?) and tightness of clamping screws in the case of measuring cells with screw terminals (CLS 12/13).

8.8.5 Checking of inductive conductivity measuring cells

The following specifications apply to measuring cells CLS 50 and CLS 52:

- Testing of transmitting and receiving coils (white and red coaxial cables, measurement between int. conductor and screen):
  - ohmic resistance approx. 0.5 ... 2 Ω
  - induct. approx. 260 ... 450 mH (at 2 kHz)
- Testing of coil shunt:
  A shunt between the coils (from coax red to coax white) is not allowed.
  Check with ohmmeter for >20 MΩ
- Testing of temperature sensor:
  Use the table in chapter 8.8.3 to check the Pt100.
  The resistance values between the green and white wires and between the green and yellow wires should be identical.
- Testing of temperature sensor shunt:
  Shunts between the temperature sensor (green, white or yellow) and the coils (red or white coaxial cable) are not allowed.
  Check with ohmmeter for >20 MΩ

8.8.6 Checking of line extension and junction box

- Use the methods described in chapter 8.8.2 or 8.8.3 to perform a quick functional check from the sensor connector (conductive measuring cells) or from the sensor (inductive measuring cell) to the measuring instrument.
  Decade resistors are best connected with the “CD test adapter” service kit (order number: 51500629).
- Check junction boxes for:
  – Moisture (influence in low conductivity range or MΩ measurement; dry junction box, replace gaskets, use desiccant bag)
  – Correct line connections
  – Outer screen connections
  – Tightness of clamping screws

9 Accessories

Connection accessories

- Junction box VBM
  Junction box for extension of measuring cable connection between measuring cell and instrument.
  Material: cast aluminium
  Ingress protection: IP 65
  Order no.: 50003987

Note:

The desiccant bag in the junction box must be checked and replaced at regular intervals which depend on ambient conditions in order to prevent inaccurate measurement due to moisture bridges in the measuring line.

- Extension cable CYK 71
  Non-terminated measuring cable for two-electrode conductivity measuring cells with temperature sensor (by the metre)
  Order no.: 50085333

- Extension cable CLK 5
  Non-terminated measuring cable for inductive measuring cells (by the metre)
  Order no.: 50085473

- Software upgrade
  (serial number of instrument to be specified with order)
  – Plus package
    Order no.: 51500385
  – ChemoClean
    Order no.: 51500963
  – Four-relay board for ChemoClean
    Order no.: 51500321

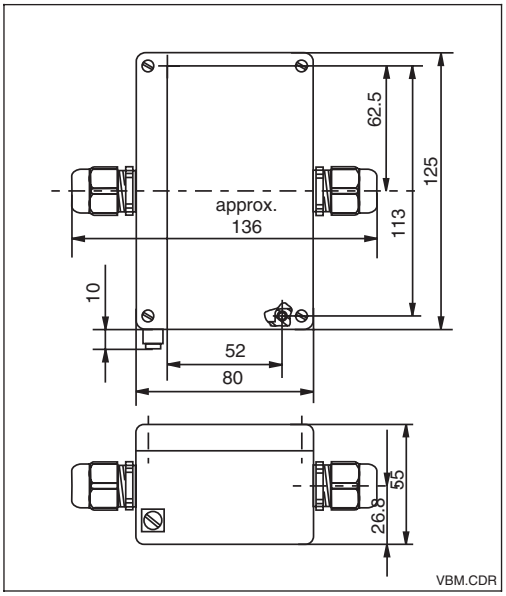


Fig. 9.1 Dimensions of junction box VBM

Conductivity measuring cells

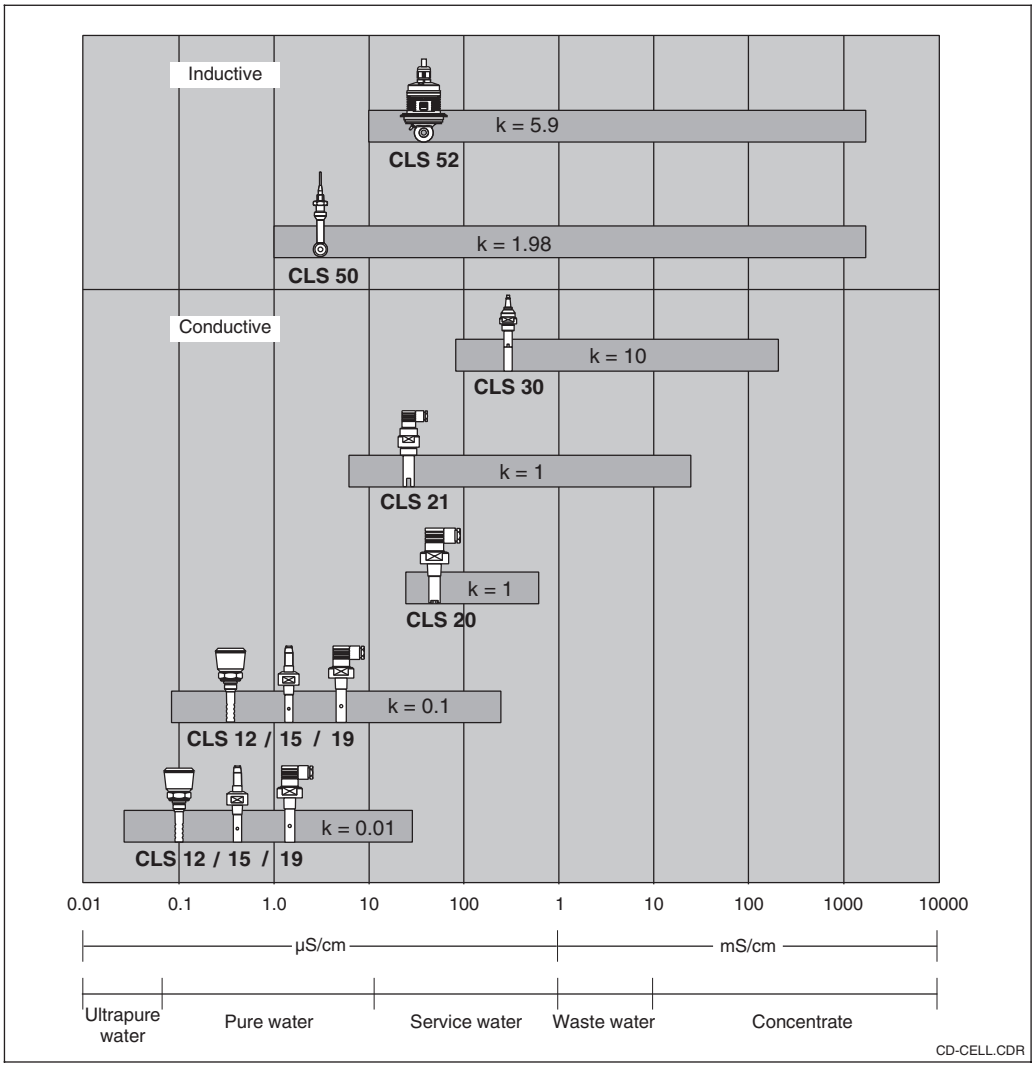


Fig. 9.2 Overview of measuring ranges of E+H conductivity measuring cells

Please refer to the corresponding TIs for detailed technical data.

10 Technical data

General specifications

Manufacturer	Endress+Hauser
Product designation	Liquisys M CLM 223 Liquisys M CLM 253

Input

Measured variables	conductivity, resistance, concentration, temperature

Minimum distance for 0 / 4 ... 20 mA signal

Conductivity measurement	meas. value 0 ... 19.99 µS/cm: 2 µS/cm meas. value 20 ... 199.9 µS/cm: 20 µS/cm meas. value 200 ... 1999 µS/cm: 200 µS/cm meas. value 2 ... 19.99 mS/cm: 2 mS/cm meas. value 20 ... 2000 mS/cm: 20 mS/cm
Resistance measurement	meas. value 0 ... 199.9 kΩ·cm: 20 kΩ·cm meas. value 200 ... 1999 kΩ·cm: 200 kΩ·cm meas. value 2 ... 19.99 MΩ·cm: 2.0 MΩ·cm meas. value 20 ... 200 MΩ·cm: 20 MΩ·cm
Concentration measurement	no minimum distance

Conductive conductivity / resistance measurement

Measuring range	conductivity: 0 ... 2000 mS/cm (uncompensated) resistance: 0 ... 200 MΩ·cm concentration: 0 ... 9999 %
Usable cell constant	k = 0.0025 ... 99.99 cm^{-1}
Maximum cable length to measuring cell	conductivity: 100 m resistance: 15 m
Measuring frequency	conductivity: 299.75 ... 1077.6 Hz resistance: 32.5 ... 425 Hz

Inductive conductivity measurement

Measuring range	0 ... 2000 mS/cm (uncompensated)
Usable cell constant	k = 0.0025 ... 99.99 cm^{-1}
Maximum cable length to measuring cell	55 m (CLK 5)
Measuring frequency	2 kHz

Temperature measurement

Temperature sensor	Pt 100, Pt 1000, NTC
Measuring range	–35 ... +250 °C
Temperature offset range	±5.0 °C

Temperature compensation

Compensation types	linear, NaCl, table, (conductive only:) ultrapure water
Range	–35 ... +250 °C
Reference temperature	25 °C

Digital inputs 1 and 2

Voltage	10 ... 50 V
Current consumption	max. 10 mA

Output

Conductivity / resistance signal output

Current range	0 / 4 ... 20 mA, galvanically isolated; error current 2.4 / 22 mA
Load	max. 500 Ω
Maximum resolution	700 digits/mA
Output range	adjustable
Separation voltage	max. 350 V_{rms} / 500 V DC
Overvoltage (lightning) protection	acc. to EN 61000-4-5:1995

Temperature signal output (optional)

Current range	0 / 4 ... 20 mA, galvanically isolated
Load	max. 500 Ω
Maximum resolution	700 digits/mA
Output range	adjustable, Δ 10 ... Δ 100 % of upper range value
Separation voltage	max. 350 V_{rms} / 500 V DC
Overvoltage (lightning) protection	acc. to EN 61000-4-5:1995

Auxiliary voltage output

Output voltage	15 V ± 0.6 V
Output current	max. 10 mA

Contact outputs (potential-free changeover contacts)

Switching current with ohmic load (cos φ = 1)	max. 2 A
Switching current with inductive load (cos φ = 0.4)	max. 2 A
Switching voltage	max. 250 V AC, 30 V DC
Switching power with ohmic load (cos φ = 1)	max. 1250 VA AC, 150 W DC
Switching power with inductive load (cos φ = 0.4)	max. 500 VA AC, 90 W DC

Limit contactor

Pickup / dropout delay	0 ... 2000 s

Controller

Function (adjustable)	pulse length / pulse frequency controller
Controller response	P, PI, PD, PID
Control gain K_p	0.01 ... 20.00
Integral action time T_n	0.0 ... 999.9 min
Derivative action time T_v	0.0 ... 999.9 min
Period for pulse length controller	0.5 ... 999.9 s
Frequency for pulse frequency controller	60 ... 180 min^{-1}

Alarm

Function (switchable)	steady / fleeting contact; NC / NO contact
Alarm threshold adjustment range	conductivity / resistance / temperature / concentration / USP: entire measuring range
Alarm delay	0 ... 2000 s (min)

Accuracy

Conductivity measurement

Display deviation[1]	max. 0.5 % of meas. value ± 4 digits
Repeatability	max. 0.2 % of meas. value ± 2 digits
Measurement deviation[1], conductivity signal output	0.75 % of current output range

Resistance measurement

Display deviation[1]	max. 0.5 % of meas. value ± 4 digits
Repeatability	max. 0.2 % of meas. value ± 2 digits
Measurement deviation[1], resistance signal output	0.75 % of current output range

Temperature measurement

Measured value resolution	0.1 °C
Display deviation[1]	max. 1.0 % of measuring range
Measurement deviation[1], temperature signal output	max. 1.25 % of current output range

Ambient conditions

Ambient temperature (nom. operating conditions)	–10 ... +55 °C
Ambient temperature (limit operating conditions)	–20 ... +60 °C
Storage and transport temperature	–25 ... +65 °C
Relative humidity (nom. operating conditions)	10 ... 95 %,non-condensing
Protection class of panel-mounted unit	IP 54 (front), IP 30 (housing)
Protection class of field housing	IP 65
Electromagnetic compatibility	interference emission and interference immunity acc. to EN 61326-1:1998

Physical data

Dimensions of panel-mounted unit (H × W × D)	96 × 96 × 145 mm
Installation depth	approx. 165 mm
Dimensions of field housing (H × W × D)	247 × 170 × 115 mm
Weight of panel-mounted unit	max. 0.7 kg
Weight with field housing	max. 2.3 kg
Measured value display	LC display, two lines, five and nine digits, with status indicators

Materials

Housing of panel-mounted unit	polycarbonate
Front membrane	polyester, UV-resistant
Field housing	ABS PC Fr

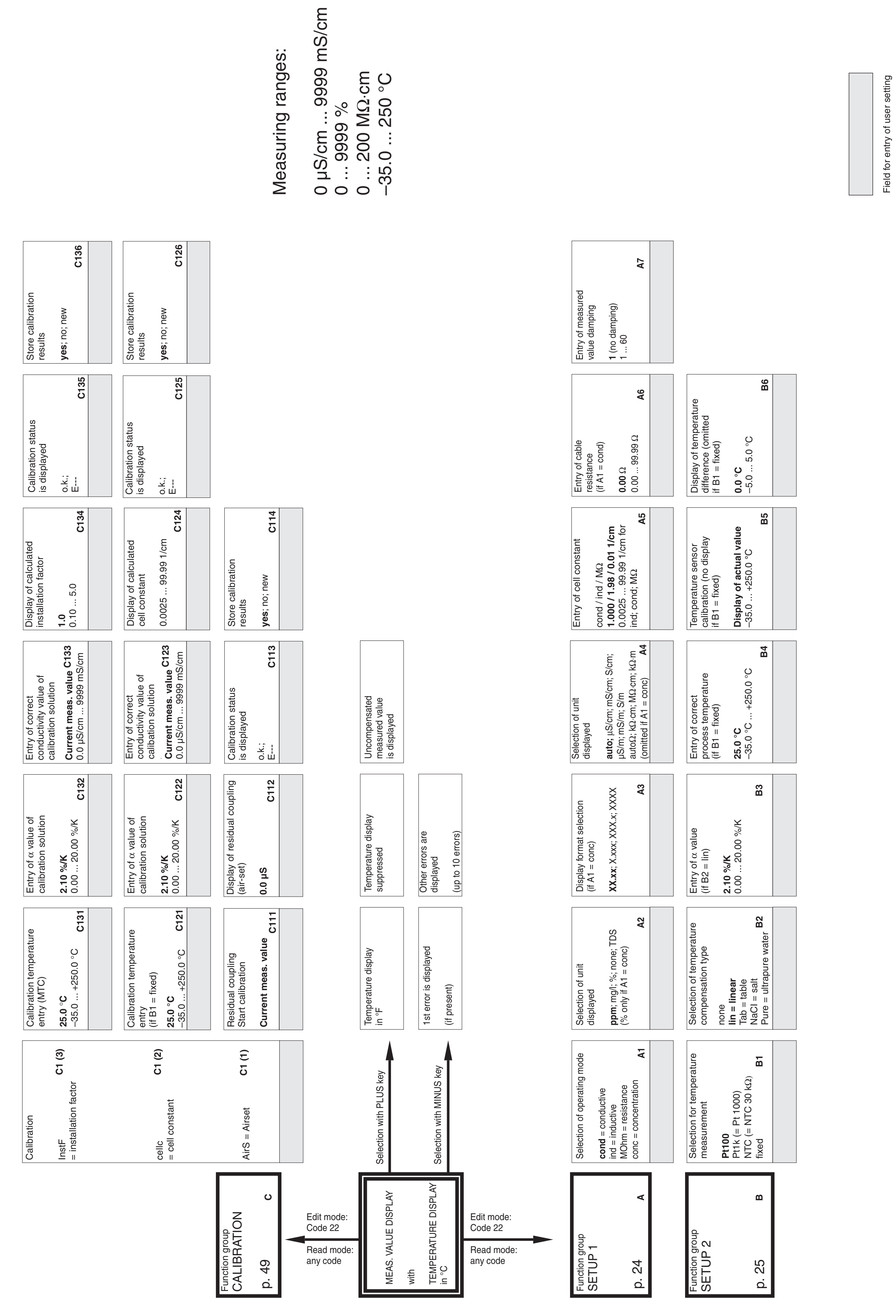
Power supply

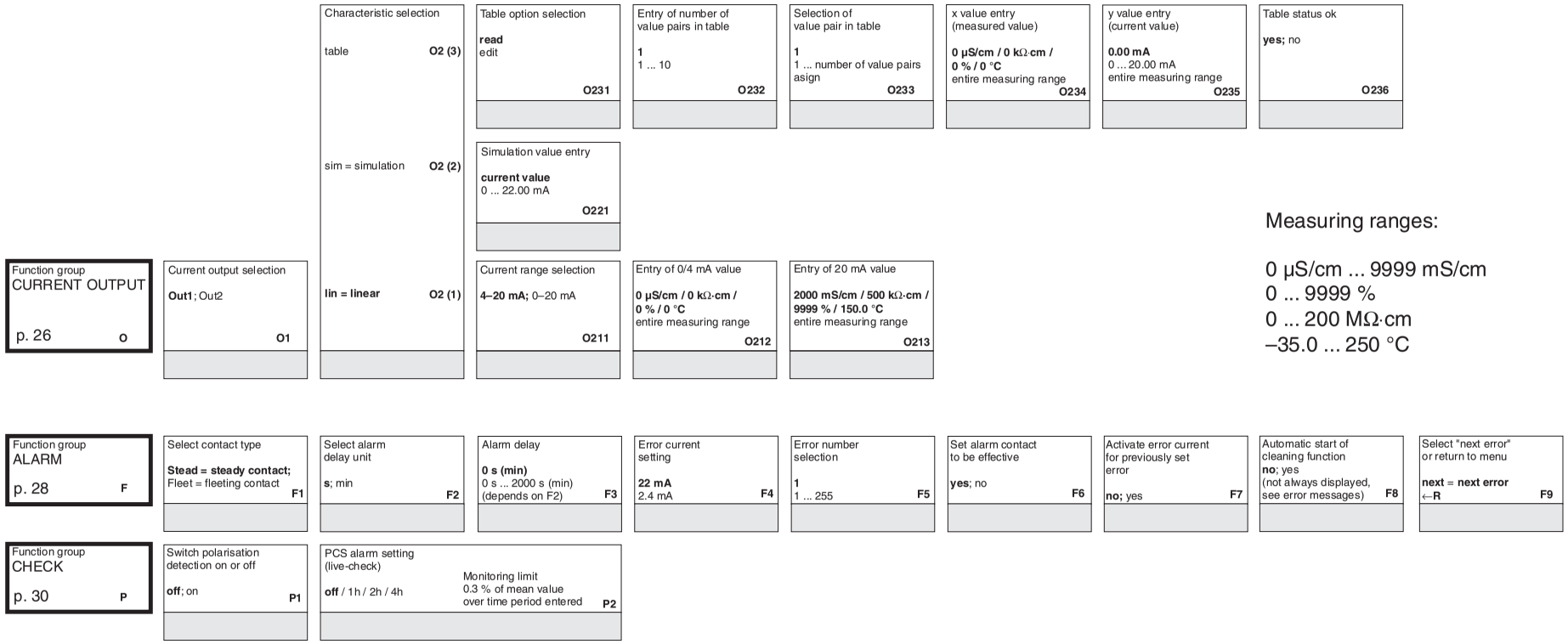
Supply voltage	100 / 115 / 230 V AC +10 / –15 %, 48 ... 62 Hz 24 V AC/DC +20 / –15 %
Power consumption	max. 7.5 VA
Mains fuse	fine-wire fuse, medium time-lag, 250 V / 3.15 A

[1]According to IEC 746-1, for nom. operating conditions

Subject to modifications.

11 Appendix


Measuring ranges:
0 µS/cm ... 9999 mS/cm
0 ... 9999 %
0 ... 200 MΩ·cm
–35.0 ... 250 °C
Field for entry of user setting
Function group CALIBRATION p. 49 C
Calibration
InstF = installation factor C1 (3)
cellc = cell constant C1 (2)
AirS = Airset C1 (1)
Calibration temperature entry (MTC) 25.0 °C –35.0 ... +250.0 °C C131
Entry of α value of calibration solution 2.10 %/K 0.00 ... 20.00 %/K C132
Entry of correct conductivity value of calibration solution Current meas. value C133 0.0 µS/cm ... 9999 mS/cm
Display of calculated installation factor 1.0 0.10 ... 5.0 C134
Calibration status is displayed o.k.; E--- C135
Store calibration results yes; no; new C136
Calibration temperature entry (if B1 = fixed) 25.0 °C –35.0 ... +250.0 °C C121
Entry of α value of calibration solution 2.10 %/K 0.00 ... 20.00 %/K C122
Entry of correct conductivity value of calibation solution Current meas. value C123 0.0 µS/cm ... 9999 mS/cm
Display of calculated cell constant 0.0025 ... 99.99 1/cm C124
Calibration status is displayed o.k.; E--- C125
Store calibration results yes; no; new C126
Residual coupling Start calibration Current meas. value C111
Display of residual coupling (air-set) 0.0 µS C112
Calibration status is displayed o.k.; E--- C113
Store calibration results yes; no; new C114
Edit mode: Code 22
Read mode: any code
MEAS. VALUE DISPLAY with TEMPERATURE DISPLAY in °C
Selection with PLUS key
Temperature display in °F
Temperature display suppressed
Uncompensated measured value is displayed
Selection with MINUS key
1st error is displayed (if present)
Other errors are displayed (up to 10 errors)
Function group SETUP 1 p. 24 A
Selection of operating mode cond = conductive ind = inductive MOhm = resistance conc = concentration A1
Selection of unit displayed ppm; mg/l; %; none; TDS (% only if A1 = conc) A2
Display format selection (if A1 = conc) XX.xx; X.xxx; XXX.x; XXXX A3
Selection of unit displayed auto; µS/cm; mS/cm; S/cm; µS/m; mS/m; S/m autoΩ; kΩ·cm; MΩ·cm; kΩ·m (omitted if A1 = conc) A4
Entry of cell constant cond / ind / MΩ 1.000 / 1.98 / 0.01 1/cm 0.0025 ... 99.99 1/cm for ind; cond; MΩ A5
Entry of cable resistance (if A1 = cond) 0.00 Ω 0.00 ... 99.99 Ω A6
Entry of measured value damping 1 (no damping) 1 ... 60 A7
Function group SETUP 2 p. 25 B
Selection for temperature measurement Pt100 Pt1k (= Pt 1000) NTC (= NTC 30 kΩ) fixed B1
Selection of temperature compensation type none lin = linear Tab = table NaCl = salt Pure = ultrapure water B2
Entry of α value (if B2 = lin) 2.10 %/K 0.00 ... 20.00 %/K B3
Entry of correct process temperature (if B1 = fixed) 25.0 °C –35.0 °C ... +250.0 °C B4
Temperature sensor calibration (no display if B1 = fixed) Display of actual value –35.0 ... +250.0 °C B5
Display of temperature difference (omitted if B1 = fixed) 0.0 °C –5.0 ... 5.0 °C B6


Function group
CURRENT OUTPUT
p. 26 o
Current output selection
Out1; Out2
O1
Characteristic selection
table O2 (3)
sim = simulation O2 (2)
lin = linear O2 (1)
Table option selection
read
edit
O231
Simulation value entry
current value
0 ... 22.00 mA
O221
Current range selection
4–20 mA; 0–20 mA
O211
Entry of number of value pairs in table
1
1 ... 10
O232
Entry of 0/4 mA value
0 µS/cm / 0 kΩ·cm / 0 % / 0 °C
entire measuring range
O212
Selection of value pair in table
1
1 ... number of value pairs asign
O233
Entry of 20 mA value
2000 mS/cm / 500 kΩ·cm / 9999 % / 150.0 °C
entire measuring range
O213
x value entry (measured value)
0 µS/cm / 0 kΩ·cm / 0 % / 0 °C
entire measuring range
O234
y value entry (current value)
0.00 mA
0 ... 20.00 mA
entire measuring range
O235
Table status ok
yes; no
O236
Measuring ranges:
0 µS/cm ... 9999 mS/cm
0 ... 9999 %
0 ... 200 MΩ·cm
–35.0 ... 250 °C
Function group
ALARM
p. 28 F
Select contact type
Stead = steady contact; Fleet = fleeting contact
F1
Select alarm delay unit
s; min
F2
Alarm delay
0 s (min)
0 s ... 2000 s (min) (depends on F2)
F3
Error current setting
22 mA
2.4 mA
F4
Error number selection
1
1 ... 255
F5
Set alarm contact to be effective
yes; no
F6
Activate error current for previously set error
no; yes
F7
Automatic start of cleaning function
no; yes
(not always displayed, see error messages)
F8
Select "next error" or return to menu
next = next error
←R
F9
Function group
CHECK
p. 30 P
Switch polarisation detection on or off
off; on
P1
PCS alarm setting (live-check)
off / 1h / 2h / 4h
Monitoring limit
0.3 % of mean value over time period entered
P2

Measuring ranges:

0 µS/cm ... 9999 mS/cm
0 ... 9999 %
0 ... 200 MΩ·cm
–35.0 ... 250 °C

Limit contactor configuration ^	Function of **R2 (6)** Switch off or on **Off;** On R261	Entry of alarm threshold (switch-on point) **80 %** 0.0 ... 100.0 % R262	Entry of switch-off point **80 %** 0.0 ... 100.0 % R263	Pickup delay entry **0** 0 ... 2000 s R264	Dropout delay entry **0** 0 ... 2000 s R265			
USP R2 (6)	Function of **R2 (5)** Switch off or on **Off;** On R251	Start pulse selection **int = internal** ext = external (digital input 2) i+ext = internal + external i+stp = internal, suppressed by ext R252		Entry of pre-rinse time **20 s** 0 ... 999 s R253	Entry of cleaning time **10 s** 0 ... 999 s R254	Entry of post-rinse time **20 s** 0 ... 999 s R255	Number of repeat cycles **0** 0 ... 5 R256	
Clean R2 (5) = Chemoclean (only with rel. 3 and rel. 4)					Set interval between two cleaning cycles (pause time) **360 min** 1 ... 7200 min R257	Set minimum pause time **120 min** 1 ... R357 min R258	Number of cleaning cycles without cleaning agent **0** 0 ... 9 R259	
Timer R2 (4)	Function of **R2 (4)** Switch off or on **Off;** On R241	Rinse time setting **30 s** 0 ... 999 s R242	Pause time setting **360 min** 1 ... 7200 min R243	Set minimum pause time **120 min** 1...3600 min R244				
PID controller R2 (3)	Function of **R2 (3)** Switch off or on **Off;** On R231	Entry of set point **0 µS/cm / 0 kΩ·cm / 0 %** entire meas. range R232	Entry of control gain Kp **1.00** 0.01 ... 20.00 R233	Entry of integral action time Tn (0.0 = no I component) **0.0 min** 0.0 ... 999.9 min R234	Entry of derivative action time Tv (0.0 = no D component) **0.0 min** 0.0 ... 999.9 min R235	Selection of control characteristic **dir = direct;** inv = inverted R236	Selection **len = pulse length** freq = pulse frequency R237	
					Entry of pulse interval **10.0 s** 0.5 ... 999.9 s R238	Entry of max. pulse frequency **120 1/min** 60 ... 180 1/min R239	Entry of min. ON time t_{ON} **0.3 s** 0.1 ... 5.0 s R2310	
LC °C R2 (2) = T limit contactor	Function of **R2 (2)** Switch off or on **Off;** On R221	Entry of switch-on temperature **250.0 °C** –35.0 ... +250.0 °C R222	Entry of switch-off temperature **250.0 °C** –35.0 ... +250.0 °C R223	Pickup delay setting **0 s** 0 ... 2000 s R224	Dropout delay setting **0 s** 0 ... 2000 s R225	Setting of alarm threshold **250.0 °C** –35.0 ... +250.0 °C R226		
LC PV R2 (1) = cond. limit contactor	Function of **R2 (1)** Switch off or on **Off;** On R211	Select contact switch-on point **9999 mS/cm / 200 MΩ·cm / 9999 %** entire meas. range R212	Select contact switch-off point **9999 mS/cm / 200 MΩ·cm / 9999 %** entire meas. range R213	Pickup delay setting **0 s** 0 ... 2000 s R214	Dropout delay setting **0 s** 0 ... 2000 s R215	Setting of alarm threshold (as an absolute value) **9999 mS/cm / 200 MΩ·cm / 9999 %** entire meas. range R216		

Function group RELAY
p. 36 R

Select contact to be configured
Rel1; Rel2; Rel3; Rel4 R1

Function group ALPHA TABLE — p. 44 — T

Table option selection	Entry of number of table value pairs	Selection of table value	Entry of temperature value (x value)	Entry of temperature coefficient α (y value)	Table status o.k.
read edit **T1**	**1** 1 ... 10 **T2**	**1** 1 ... number of table value pairs asign **T3**	**0.0 °C** –35.0 ... +250.0 °C **T4**	**2.10 %/K** 0.00 ... 20.00 %/K **T5**	**yes;** no **T6**

Function group CONCENTRATION — p. 45 — K

Selection of concentration curve for calculation of display value	Selection of table to be edited	Table option selection	Set number of value pairs	Select value pair	Entry of uncompensated conductivity value	Entry of associated concentration value	Entry of associated temperature value	Table status o.k.
Curve **1** ... 4 **K1**	**1** 1 ... 4 **K2**	**read** edit **K3**	**1** 1 ... 10 **K4**	**1** 1 ... number of value pairs in K4 **K5**	**0.0 µS/cm** 0.0 ... 9999 mS/cm **K6**	**0.00 %** 0 ... 99.99 % **K7**	**0.0 °C** –35.0 ... 250.0 °C **K8**	**yes;** no **K9**

Function group SERVICE — p. 46 — S

Language selection	Hold configuration	Manual hold	Entry of hold dwell period	Entry of SW upgrade release code (plus package)	Entry of SW upgrade release code Chemoclean	Order number is displayed	Serial number is displayed
ENG; GER ITA; FRA ESP; NEL **S1**	- none = no hold - **s+c** = **during setup and calibration** - CAL = during calibration - Setup = during setup **S2**	**off;** on **S3**	**10 s** 0 ... 999 s **S4**	**0000** 0000 ... 9999 **S5**	**0000** 0000 ... 9999 **S6**	**S7**	**S8**

Reset instrument (restore default values)	Perform instrument test
no; Sens = sensor data; Facty = factory settings **S9**	**no;** Displ = display **S10**

Function group E + H SERVICE — p. 48 — E

Module selection	Software version	Hardware version	Serial number is displayed
Relay **E1 (4)**	SW version **E141**	HW version **E142**	**E143**
MainB = mainboard **E1 (3)**	SW version **E131**	HW version **E132**	**E133**
Trans = transmitter **E1 (2)**	SW version **E121**	HW version **E122**	**E123**
Contr = controller **E1 (1)**	SW version **E111**	HW version **E112**	**E113**

Function group INTERFACE — p. 48 — I

Entry of address
HART: **0** ... 15 or Profibus 1 ... **126** **I1**

Measuring ranges:

0 µS/cm ... 9999 mS/cm
0 ... 9999 %
0 ... 200 MΩ·cm
–35.0 ... 250.0 °C

12 Index

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