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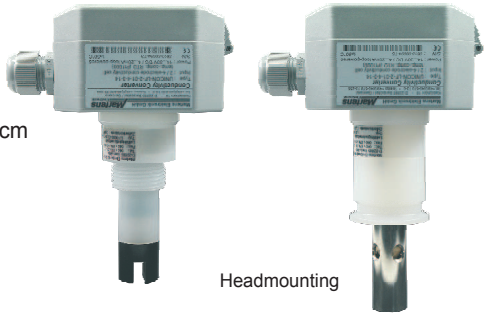
Conductivity-Converter UNICON®-LF

Conductivity measurement with 2-and 4-electrode-cells



Headmounting

Fieldmounting

Features

- Measuring range programmable from 0 ... 5.00 µS/cm up to 0... 500 mS/cm (0 ... 0.500 µS/cm up to 50.0 µS/cm with ultra-pure water cell)
- Output 4 ... 20 mA, 2-wire system
- 2nd measuring range for conductivity, reversible by external signal
- Temperature compensation with RTD (Pt100 or Pt1000) sensor
- Monitoring of ultra-pure water acc. to USP<645>
- Output 4 ... 20 mA for temperature 2-wire system, measuring range programmable
- 2 alarm outputs, transistor, voltage free
- Isolation between input / output
- Simulation mode (manual operation) for conductivity and temperature
- Conductivity cell and connection cable are not included by delivery.

General

The Conductivity converter UNICON-LF is suitable for measuring the conductivity characterising the purity or concentration of a liquid. Covering a wide range of application with only one conductivity cell is another advantage.

Short information

Programming	Parameters are programmed via front side membrane keypad.
Alarm outputs	Switching performance for the alarm outputs is programmable as minimum or maximum function. States are displayed in the LCD Display.
USP monitoring	Devices including option 14 are programmable for monitoring of ultrapure water acc. to USP<645>. Setpoint settings of the alarm outputs are in accordance to the conductivity-temperature table (page 12). The switching performance is programmable for NC or NO contact.
USP calibration	Devices including option 14 have a special routine for USP calibration. Test-equipments in accordance to NIST are e.g. calibration solution EC23.8 and a precision thermometer type N63802.

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Technical data

Supply voltage

Loop voltage	:	14 ... 30 V DC, 2-wire
Operating temperature	:	-15 ... 55 °C (32 ... 122 °F)
Isolation	:	conductivity output/temperature output/alarm output 1/ alarm output 2/measurement range switching
Test voltage	:	500 V DC
CE - conformity	:	EN 50022, IEC61000-4-3/4/5

Conductivity output

Unit	:	µS/cm; mS/cm; kΩ/cm; MΩ/cm programmable
Decimals	:	-"- 0 ... 3 decimals (depending on unit)
Measuring range	:	-"- 500 ... 9999 digit (depending on unit and decimals)
Lowest / highest range	:	0 ... 5.00 µS/cm / 0 ... 500.0mS/cm; 0 ... 0.500µS/cm / 0 ... 50.0µS/cm with ultra-pure water cell
Temperature compensation	:	non linear for ultra-pure water and natural water programmable from 0.000 ... 8.000 %/°C
Cell constant	:	programmable from 0.080 ... 4.000
Standard error	:	± 0.5 % from measured value ± 2Digit
Temperature coefficient	:	<100 ppm/°C
Measuring rate	:	approx. 3/sec

Temperature output

Output signal	:	4 ... 20mA
Burden	:	$RA\ [\Omega] \leq \frac{\text{Supply voltage - 14 V}}{0.02\ A}$
Temperature sensor	:	RTD Pt100 or Pt1000 acc. to DIN IEC 751
Unit	:	°C; °F programmable
Messbereich	:	programmable from -40.0 ... +160.0 °C (-40.0 ... +320.0 °F)
min. / max. span	:	25.0 °C (45.0 °F)/200 °C (360.0 °F)
Standard error	:	± 0.1 % ± 1 Digit
Temperature coefficient	:	<50 ppm/°C
Linearisation error	:	± 0.1 %

Alarm output

Transistor	:	14 ... 30 V DC, max. 60 mA, short circuit protection
Voltage drop	:	< 2V

Measuring range change-over

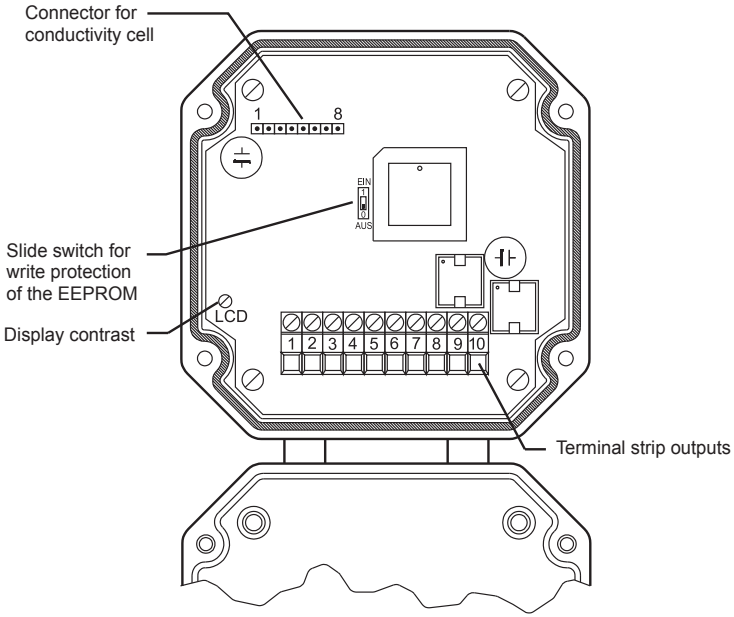
Input resistance	:	>10 KΩ
Range 1 active	:	U = 0 ... 3 V DC
Range 2 active	:	U = 12 ... 30 V DC

Display	:	LCD-dot matrix, 3.8 mm character height 2 lines 16 characters each

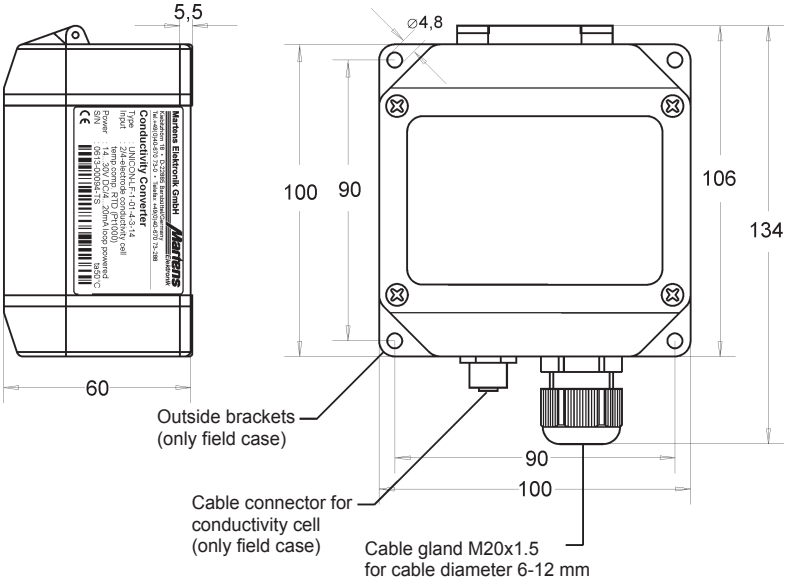
Case

Design	:	Head mounting or field mounting
Protection	:	IP65
Material	:	Polyamide with fibre glass PA6-GF 15/15
Weight	:	0.36 kg
Electrical connection	:	screw terminal with pressure plate, 2.5 mm² fine wire, 4 mm² single wire
Front keyboard	:	polyester

Legend (open lid)



Dimensions



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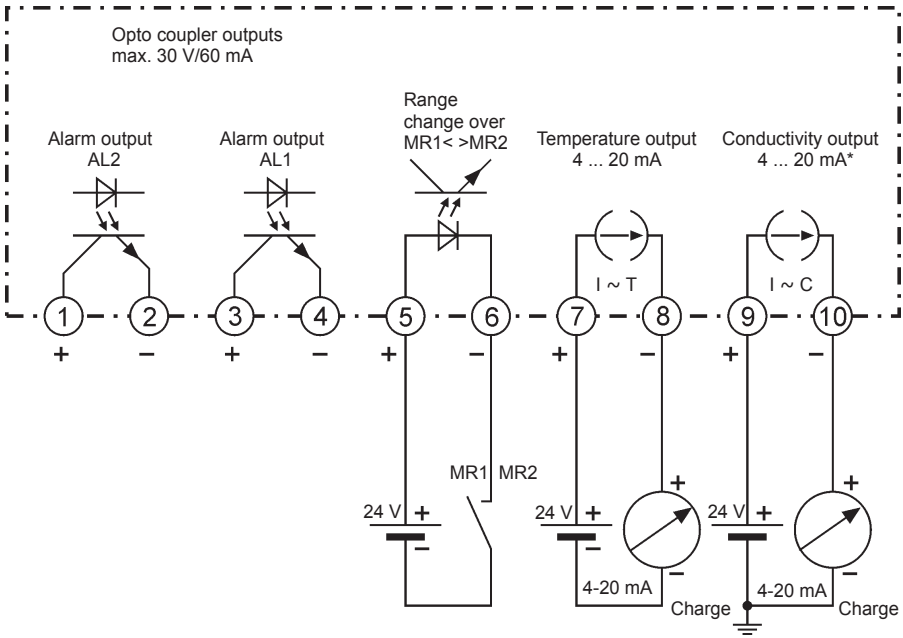
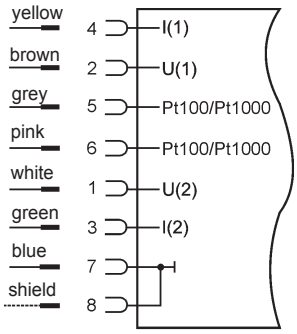
Connection diagram

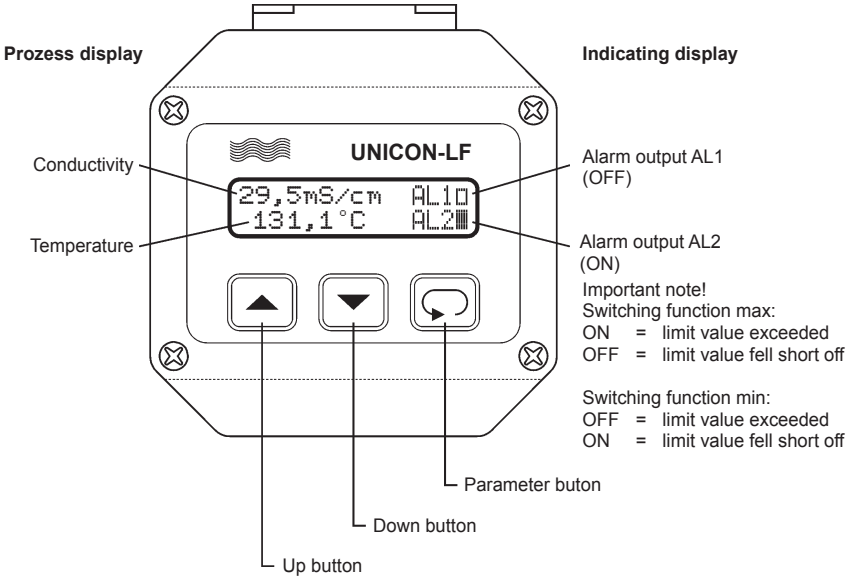


*For supplying the converter use terminals (9) and (10) as shown. If the converter is used for monitoring only, terminals (9) and (10) must be connected direct to supply voltage.

8-pole connector plug for conductivity cell; field mounting
(see separate data sheet or illustrated price list for connection diagram of conductivity cells).



Controls and indicators



Description

After switching on the supply voltage, the converter initializes itself. The display shows the message about device type and software version. After the initialisation, the current measured values and the status of the alarm outputs are displayed.

The device must be configured for the intended use. The configuration level is called up by pressing the button . For selection within the parameters or for entering data, use buttons and . Now all the parameters which defines the function of the converter can be programmed. With the last parameter, the configuration is done and the display shows the process values.

After finishing the configuration or when no button was pushed for more than 2 minutes, the program returns to the working level. Leaving the configuration level is possible at any time by pressing the button for 2 seconds.

Option 14:
For monitoring of ultra-pure water or water for injection acc. to USP<645>, the selected alarm output must be configured as USP-alarm. The device offers a calibration routine for regularly calibration. By appropriate execution all requirements in accordance with USP<645> are fulfilled (see information on page 11).

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Programming

Notes to representation

Parameter is only displayed if configured

Parameter is only displayed if included (see order code)

Note to display message

```
Control MR+AL!
```

Measuring range (MR) and alarm outputs (AL) must be tested

Note: All parameters can be called if they are not blocked by other programmed parameters and if they are available.

Display	Description (Factory settings are shown in the display grafic)
`1,05mS/cm AL1□` `25,7°C AL2■`	Process value for conductivity and temperature. Output indication (only if activated). □= OFF and ■=ON

1
`■ deutsch`
`□ english`
	Language of the operating instructions
	Selection with buttons ▲ and ▼.

2
`■ Configuration`
`□ Calib. USP<645>`
	This Parameter appears only at devices with option 14.
	Parameter for USP<645> calibration, see page 11
	Selection with buttons ▲ and ▼.
	⚠ With selection of calibration USP<645>, the previous values for calibration parameters are deleted.

Configuration

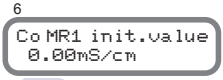
3
`Measuring Unit`
`■ xS/cm □ x Ω*cm`
	Measuring unit for conductivity or resistance.
	Selection with buttons ▲ and ▼.

4
`Co MR1`
`□µS/cm ■mS/cm`
	Conductivity measuring range 1.
	Selection with buttons ▲ and ▼.

5
`Co MR1 dec.point`
`n=1...3 n=2`
	Conductivity measuring range 1, decimal point position.
	Selection with buttons ▲ and ▼ (depending on the unit).

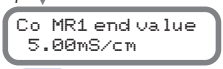
Continue page 7

6



Conductivity measuring range 1, initial value (for 4 mA).
Setting possible in the range of end value - initial value > 400digit
with buttons ▲ and ▼.

7



Conductivity measuring range 1, end value (for 20 mA).
Setting possible in the range of end value - initial value > 400digit
with buttons ▲ and ▼.

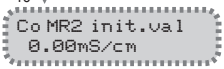
8

Conductivity measuring range 2.
Selection with buttons ▲ and ▼.

9

Conductivity measuring range 2, decimal point position.
Selection with buttons ▲ and ▼ (depending on unit).

10



Conductivity measuring range 2, initial value (for 4 mA).
Setting possible in the range of end value - initial value > 400 Digit
with buttons ▲ and ▼.

11

Conductivity measuring range 2, end value (for 20 mA).
Setting possible in the range of end value - initial value > 400 Digit
with buttons ▲ and ▼.

12

Digital filter.
OFF ⇒ each measured value will be displayed directly
ON ⇒ averaging of the last 16 measured values continuously.
Selection with buttons ▲ and ▼.

13

Cell type .
2-pol. or 4-pol. measuring system
Selection with buttons ▲ and ▼.

14

Cell constant.
Setting possible from 0.080 to 4.000 with buttons ▲ and ▼ (see page 14).
The current conductivity is displayed on the right.

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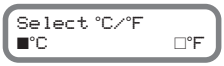
15

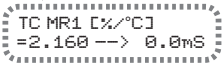


Unit for temperature measurement.
Selection with buttons ▲ and ▼.

16

Temperature compensation measuring range 1.
Selection with buttons ▲ and ▼ between water or linear compensation (see page 14).

17

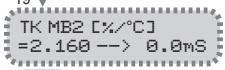


Linear temperature coefficient measuring range 1.
Correction value for conductivity measuring, adapt to the temperature behaviour of the medium.
Setting possible from 0.000 to 8.000 digit with buttons ▲ and ▼ (see page 14). The actual value is shown in the right.

18

Temperature compensation measuring range 2.
Selection with buttons ▲ and ▼ between water or linear compensation (see page 14).

19



Linear temperature coefficient measuring range 2.
Correction value for conductivity measuring, adapt to the temperature behaviour of the medium.
Setting possible from 0.000 to 8.000 digit with buttons ▲ and ▼ (see page 14). The actual value is shown in the right.

20

Temperature measuring range, initial value (for 4mA).
Setting possible from −40.0 ... 135.0 °C (−40.0 ... 275.0 °F) with buttons ▲ and ▼.

21

Temperature measuring range, end value (for 20mA).
Setting possible from −15.0 ... 160.0 °C (5.0 ... 320.0 °F) with buttons ▲ and ▼.
Minimum span ≥ 25.0 °C (45.0 °F).

22

Sensor correction
Setting possible from −9.9 ... 9.9 °C (-18 ... 18 °F) with buttons ▲ and ▼.

Sense correction

Cable length	Pt100	Pt1000
2 m	-0.7 °C	-0.1 °C
5 m	-1.8 °C	-0.2 °C
10 m	-3.6 °C	-0.4 °C
25 m	- 8.9 °C	-0,9 °C

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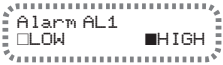
23

Function alarm output AL1
The alarm can be switched OFF or assigned to CoMR1, CoMR2 or temperature.
For devices with option 14, the alarm output can also be assigned to measurement acc. to USP<645>.
Selection with buttons ▲ and ▼.

24



Switching performance AL1
LOW or HIGH (if USP is selected, contact function NO or NC)
Selection with buttons ▲ and ▼.

25

Setpoint AL1
Setting possible in the selected measuring range
with buttons ▲ and ▼.
(If USP is selected in range 50 ... 100 % of the limit value)

26

Hysteresis AL1 (disabled at USP<645>)
Setting possible from 1 ... 9999 Digit
with buttons ▲ and ▼.
(If USP is selected, the hysteresis is fixed to 0.10µS/cm)

27

Function alarm output AL2
The alarm can be switched OFF or assigned to CoMR1, CoMR2 or temperature.
For devices with option 14, the alarm output can also be assigned to measurement acc. to USP<645>.
Selection with buttons ▲ and ▼.

Note: Function, switching performance and hysteresis for alarm output AL1 and AL2 are identical.

⚠Simulation
During the simulation procedure, only the alarm outputs for USP<645> are fixed to their current values. For the analog outputs Co and Temp is valid: start value = process value (hold-function).

28

Simulation of the conductivity (manual operation)
The converter works as simulator. The output current changes in range 4 ... 20 mA in accordance with the conductivity value set.
Setting possible in the preselected measuring range
with buttons ▲ and ▼.

This parameter will **not** be left automatically after 120 seconds.

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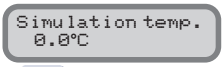
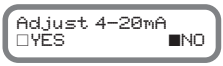
29



Simulation of the temperature (manual operation).
The converter works as simulator. The output current changes in range 4 ... 20 mA in accordance with the temperature.
Setting possible in the measuring range with the buttons ▲ or ▼.

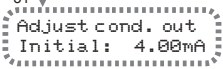
This parameter will **not** be left automatically after 120 seconds

30



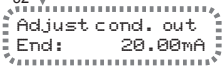
Adjustment of the process outputs (analog outputs).
Selection with buttons ▲ or ▼.

31



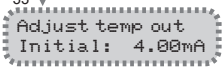
Correction of the initial value analog output for conductivity.
Setting possible from ≈ 3.70 ... 7.50 mA with buttons ▲ or ▼.

32



Correction of the end value analog output for conductivity.
Setting possible from ≈ 16.80 ... 21.00 mA with buttons ▲ or ▼.

33

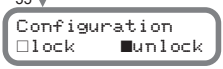


Correction of the initial value analog output for temperature.
Setting possible from ≈ 3.50 ... 7.70 mA
with the buttons ▲ or ▼.

34

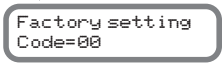
Correction of the end value analog output for temperature.
Setting possible from ≈ 16.40 ... 20.60 mA
with buttons ▲ or ▼.

35



Program lockout
Only setpoints of the alarm outputs AL1 and AL2 are displayed. Selection by pressing buttons ▲ or ▼ for at least 2 sec.

36



Parameter for factory setting

End of configuration

Return to the working level

Calibration in accordance to USP<645>

Following parameters are displayed if USP<645> calibration is selected. Operating with the following parameter assures, that the entire measuring system is calibrated.

⚠ After selection of parameter 2 page 6 for USP<645> calibration, the previous parameter values are deleted. During the calibration procedure the analog outputs for conductivity, temperature and the alarm outputs are fixed to their current values.
More details see page 13.

Display	Descripton
37 Temp.calibration 27.8°C	Calibrate temperature measurement Immerse the ultra-pure water cell into the calibration solution (e.g. EC 23.8). Determine the temperature with a thermometer (e.g. N63802). The cell and the thermometer must be immersed at least 6cm. Wait until the measured temperature doesńt change. The determined temperature can be set with buttons ▲ or ▼. This parameter will **not** be left automatically after 120s.
38 Cond.calibration 23.80µS/cm	Conductivity calibration The conductivity of the calibration solution will be determined in accordance to the measured temperature (see label on the bottle of the calibration solution). The determined conductivity can be set with the buttons ▲ or ▼. This parameter will **not** be left automatically after 120s.
	End of <USP645> calibration
1.05µS/cm AL1□ 25.7°C AL2■	Return to the process display

Error messages

Display	Description
Display flashes	Measuring range overflow
Write protect!!	A changed parameter setting cannot be stored, because write protection is activated by intern slide switch in position 1. Set switch to position 0 and modify settings again
Transm. error RAM <->EEPROM	An error occurred during data transfer between controller and EEPROM
after 2s Transm. error ▲ for Init RAM	Using the button ▲ a re-initialisation of the EEPROM can be stated. The programmed parameters are lost. The converter works with reduced accuracy. Please ship the converter to factory for repair service.
Reset UNICON – LF Version X.X	The converter triggers an internal reset. An attempt is made to read data from the EEPROM.

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Conductivity measurement of ultra-pure water acc. to USP<645>

Special requirements are demanded in the pharmaceutic industry to the used ultra-pure water. The U.S. Pharmacopeia defines the limit values for conductivity in the chapter <645> for monitoring devices. These directives are acknowledged in the EU, too.

This supervising is subdivided in 3 stages. Stage 2 and stage 3 are external tests and stage 1 is an internal test and specified for cost saving and permanent monitoring of the ultra-pure water quality.

USP<645> stage 1
According to stage 1 only the conductivity and the temperature has to be measured without temperature compensation. The limit value of the conductivity is defined in the temperature-conductivity table. For all the 5 °C steps of the temperature is one limit value valid.

Limit table for conductivity of ultrapure water acc. to USP<645> stage 1

Temperature [°C]	Conductivity [µS/cm]
0.0 ... 4.9	0.6
5.0 ... 9.9	0.8
10.0 ... 14.9	0.9
15.0 ... 19.9	1.0
20.0 ... 24.9	1.1
25.0 ... 29.9	1.3
30.0 ... 34.9	1.4
35.0 ... 39.9	1.5
40.0 ... 44.9	1.7
45.0 ... 49.9	1.8
50.0 ... 54.9	1.9

Temperature [°C]	Conductivity [µS/cm]
55.0 ... 59.9	2.1
60.0 ... 64.9	2.2
65.0 ... 69.9	2.4
70.0 ... 74.9	2.5
75.0 ... 79.9	2.7
80.0 ... 84.9	2.7
85.0 ... 89.9	2.7
90.0 ... 94.9	2.7
95.0 ... 99.9	2.9
≥ 100	3.1

Requirements to a conductivity measuring system acc. to USP<645>

A conductivity measuring system must fulfill following requirements:

Calibration

Conductivity-measuring device

Accuracy	±0.1 µS/cm (@ 1.3 µS/cm)
Resolution	±0.1 µS/cm
Temperature measurement	±1 °C
Temperature compensation	without
Dynamic range	10²
Setpoint	1.3 µS/cm @ 25 °C ±0.1 µS/cm
Hysteresis	0.1 µS/cm

Conductivity-cell

Cell-constant	Accuracy ±2 %
Temperature sensor	not intended
Surface roughness of the electrodes	<0.8µm EHEDG-Recommendation (European Hygienic Engineering & Design Group, brussel)

All equipment and conductivity cells for measuring of ultra-pure water fulfills these requirements. For the realization of an pre-alarm the setpoints for Alarm AL1 and AL2 are programmable in the range 50 ... 100 % of the allowed limit value (acc. to table stage 1).

Parameter settings for USP<645> measurement

For the right switching performance of the alarm output, it is only necessary to configure the wanted alarm output.
To display also the announced value in accordance with USP, the following parameter settings are required.

Parameter 3	Measuring Unit	: ■ XS/cm
Parameter 4	Co MR1	: ■ uS/cm
Parameter 5	Co MR1 dec. point	: n=2
Parameter 6	Co MR1 init.value	: 0.00uS/cm
Parameter 7	Co MR1 end value	: 30.00uS/cm
Parameter 16	Temp.-comp.Co MR1	: ■ Linear
Parameter 17	TC Co MR1 [%/C]	: 0.000

Calibration of conductive measuring systems acc to USP<645>

Conductivity systems for ultra-pure water monitoring must be calibrated in regular time intervals. In accordance to USP<645> a calibration has to be traceable acc. to NIST (National Institute of Standards and Technology U.S.) -Measuring device- or acc. to ASTM (American Society for Testing and Materials) -conductivity cell- .
All delivered measuring equipments for ultra-pure water measurement of Martens Elektronik are factory calibrated with precision resistence (feedback to NIST). The cell constant is found out with a calibration solution (feedback to ASTM) and printed on the label. This way of calibration is in accordance with the recommendation of USP<645>.

Field calibration

For the calibration in the field the method how it is carried out before the delivery is not practicable. The calibration of the complete system is simpler and safer. We recommends the calibrating solution EC23.8 and the precision thermometer N63802 for the calibration.
If other calibrating solutions should be used, it is to consider that at pure-water measuring cells can come to a polarization effect at the electrodes if the calibrating solution has a conductivity of more than 50 µS/cm. This leads to an additional measuring error and the demand precision can not be adhered to by 2 % for certain. So such solutions should net to be used.
Devices including option 14 have a special routine for USP calibration for the whole measuring-system. During the calibration procedure the analog outputs for conductivity, temperature and the alarm outputs are fixed to their current values. To be able to extend the measuring cell for the calibration, a lockable bypass must be installed

Important information about the calibration solution EC23.8.

The calibration solution has a conductivity of 23.8 µS/cm @ 25C and is traceable to the standard of the ASTM D-1125 Method A. Each bottle has a label with the temperature-conductivity table and the expiry date. Ideal storage conditions for a storage time of 12 month are a dark room and ambient temperature. For the calibration use clean and sufficiently big vessels. The minimum immersing depth must be at least 60 mm. Used solutions have to be wasted after the calibration (danger of soiling).

Temperature-conductivity-table Calibration solution EC23.8

Temperature [°C]	Conductivity [µS/cm]
15	19.17
16	19.64
17	20.10
18	20.56
19	21.03
20	21.49

Temperature [°C]	Conductivity [µS/cm]
21	21.94
22	22.41
23	22.87
24	23.34
25	23.80
30	26.12

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Adjusting the cell constant

The exact cell constant C is labelled on all our conductivity cells. This cell constant must be taken into account when setting the parameter 14 (see page 7).
Due to aging processes the cell constant may be changed. In order to determine the correct cell constant the cell has to be dipped into a reference solution while carefully stirring. Various reference solutions are available. The chosen reference solution should correspond to the measurement range the of the measuring system operating in.

To determine the cell constant use the following procedure:

① Use the button to select parameter 16 or 18 "Temp.comp."
② Use the buttons or to select "■ linear"
③ Use the button to select parameter 17 or 19 "TC"
④ Use the button to change to "0.000"
Press the button for 2s, to leave the configuration level
⑤ Dip the conductivity cell into the reference solution
⑥ Determine the temperature of the solution by stirring it constantly (notice temperature shown in the display of the converter)
⑦ Watch the temperature / conductivity table (as indicated on the bottle of the reference solution) to determine the correct conductivity.
⑧ Use the button , to select parameter 14 "Cell constant"
⑨ Use the buttons or to change the parameter until the same conductivity as the reference solution will be displayed.
⑩ Finish adjustment and configure the parameters from item ① to ④ with the settings for the intended use.

Temperature compensation
For accurate conductivity measurement a well matched temperature compensation is needed. The converter UNICON-LF offers two modes of temperature compensation:

Water Use this setting for "natural water" like ground water, spring water, above ground water and ultra-pure water. The temperature compensation will be calculated by considering the measured temperature and conductivity. The method of calculation is based on the "non-linear characteristic of natural water" according EN27888 and the electrical conductivity of ultrapure water according ASTM D11245-95 (ASTM=American Society of Testing and Materials). In the temperature range from 0 °C to 100 °C good results are effected.

Linear Use this setting for saline solution, dilute acid, caustic solution and cleansing solution. This solution will be compensated by using a "linear characteristic". By factory setting the temperature coefficient is set to compensate a NaCl solution. Other solutions needs a special TC. Use the data sheet of the suppliers to define the TC. If there is no information about the TC available, use following procedure:

① Dip the conductivity cell into the solution
② Stir the solution constantly and heat it to a temperature of 25 °C (watch temperature on the display)
③ Notice the measured conductivity at 25 °C
④ Heat the solution to the working temperature (minimum difference 10 °C)
⑤ Use button to select "TC" parameter.
⑥ Use the buttons or to change the parameter until the displayed conductivity is the same as shown at 25 °C

If there is no way to use this procedure, following values can be used approximately:

NaCl-solution	(20% weight of electrolyte)	2.160%/°C (factory setting)
NaOH-solution	(20% weight of electrolyte)	2.990%/°C
KOH-solution	(20% weight of electrolyte)	1.980%/°C
H_3PO_4-solution	(20% weight of electrolyte)	1.140%/°C
H_2SO_4-solution	(20% weight of electrolyte)	1.450%/°C
NH_4NO_3-solution	(20% weight of electrolyte)	1.790%/°C

Installation notes

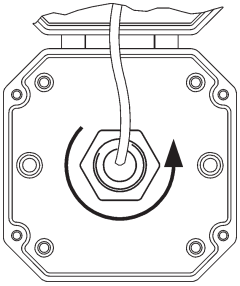
When installing conductivity cells, please make sure, that there is no air at the active area of the conductivity cell.

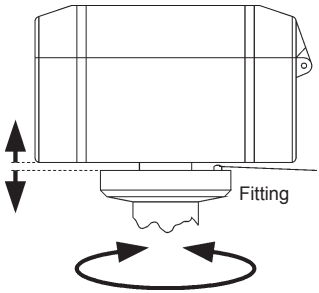
When installing a system with UNICON-LF head mounting, it may be necessary to turn converter and conductivity cell against each other for easy operation and better reading of the display. These assembly variations are possible in steps of 30°.

In order to turn the case against the cell, please proceed as follows:

① Open the UNICON-LF by releasing the 4 cover screws

② Release the nut of the connected UNICON-LF and conductivity cell appr. 2 revolutions.





③ Separate UNICON-LF and conductivity cell and place in the desired angle with the turning lock into the case.

These assembly variations are possible in steps of 30°.

④ Tighten the Lock nut and Armature of the UNICON-LF.

Notes to the Mounting positions. (valid for Mounting mode 01 and 02)
Mounting types for Position 1 are 2 are allowed.
Position 3 is not necessary, because water drops can go across the pressure compensation membrane.
By cleaning the device with high pressure cleaner, humidity can go inside the case, also.

Position 1

Position 2

Position 3

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Ordering code:

	1.		2.		3.		4.		5.
UNICON-LF -	☐	-	☐	-	☐	-	☐	-	☐

1. Model

1	Output 4 ... 20 mA for conductivity, loop powered, 2 voltage free transistor alarm outputs, supply voltage 14 ... 30 V DC
2	as 1, but additional 2. measuring range for conductivity and output 4 ... 20 mA for temperature, loop powered

2. Mounting

01	Head mounting Mounting directly on the UNICON-LF with flat cable connector of the cell
02	Field mounting, connection with seperate connection cable,
03	as 02, but plugs stainless steel 1.4571 **Note:** Conductivity cell and connection cable must be ordered seperately (see data sheet about accessories and illustrated pricelist)

3. Measuring principle

4	4-electrode measurement (2-electrode cell connectable)

4. Temperature measurement (RTD)

1	Pt100 sensor
3	Pt1000 Sensor

5. Options

00	without option
14	Measurement and monitoring accc. to USP<645>(USP23)

For more informationen about pH- and ORP-measuring systems

- 2- and 4-electrode cells
- Ultra pure water cells
- Inline fittings
- Accessories for conductivity measuring systems

please on request.