KORALEWSKI
INDUSTRIE - ELEKTRONIK

Conductance Measuring Device LWM-8E

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1 General Remarks

The digital conductance measurement device LWM-8E is used in applications for waste water technologies, process water monitoring, desalination plants, etc. and features the following measurement ranges:

Probe factor	Measuring range 0 (values in brackets reduced exactitude, errors ≥ 5%)	Measuring range 1	Measuring range 2
K=10 cm-1	0 ... 200,0 mS/cm (200,0 ... 999,9 mS/cm)	0 ... 20,00 mS/cm	0 ... 2000 µS/cm
K=1 cm-1	0 ... 20,00 mS/cm (20,00 ... 99,99 mS/cm)	0 ... 2000 µS/cm	0 ... 200,0 µS/cm
K=0,1 cm-1 (ex works setting)	0 ... 2000 µS/cm (2000 ... 9999 µS/cm)	0 ... 200,0 µS/cm	0 ... 20,00 µS/cm
K=0,01 cm-1	0 ... 200,0 µS/cm (200,0 ... 999,9 µS/cm)	0 ... 20,00 µS/cm	0 ... 2,000 µS/cm

The complete possible range of indication (for example up to 99,99 mS/cm at a probe factor of K=1/cm) is captured during measurement, but the unit measures with decreasing resolution and exactness in case of measurement range exceeding. Cable capacities up to 50 nF may be masked by means of a special measuring procedure.

The device is equipped with a micro-processor controlled conductance measurement amplifier, two recorder outputs (0) 4 ... 20 mA and (0) ... 10 V, as well as two limit value contacts with time delay. A Pt 100 input in three-conductor mounting is provided for the temperature compensation of conductance as well as for the temperature limit contact. The recorder output can be scaled arbitrary within the whole measuring range, so that a conductance range for example of 15 ... 50 mS/cm may be assigned to the current of 4 ... 20 mA and / or to the voltage of 2 ... 10 V.

2 Principle of Function

2.1 Measurement

The operating mode 'Measurement' is indicated by the continuously lightened green LED beside the display. The value of the conductance is shown on display, its scale unit is indicated by one of the LEDs above the display: either mS/cm or µS/cm. The monitoring of limit values is active.

2.2 Release

For the release of the limit value contacts either the internal release (via DIL – Switch S2: set 'on') or an external release (via Input E1: terminals 38 + 43 bridged) is necessary. Thus the limit value analysis can be used or avoided as necessary.

The release of the limit value contacts is indicated by LED 'Freigabe' (release).

2.3 Measurement Range

The device features 3 measurement ranges (table chapter 6.5). The main measuring range is selected in parameter 2.2. At new start he device always measures at range 0 and switches, if possible, automatically over into the pre-selected main measuring range.

If measurement exceeds the measuring range, a back-switching into range 0 takes automatically place. The switching process may take a few seconds.

If DIL – Switch S3 is set 'on' the measurement always takes place in range 0.

Note: It is also possible to select range 0 for the main measuring range. In this case no switching over of measurement ranges will occur. The limit values, the current output and the calibration are always depended on the main measuring range!

2.4 Limit Values

The device is equipped with two independent adjustable limit value contacts for conductance, one signal contact to indicate weather the conductance is within its limits and one to indicate excessive temperature. In case of an exceeded limit value the related LED flashes and indicates in this way, that the time delay is active. After the delay time has expired, the LED lights continuously and the assigned relay picks up.

If the measured conductance lies within the preset limit values (parameters 1.1 and 1.3) and the limit value relay 1 is picked up also, relay K5 picks up too and signals by this way, that the conductance is within its both limit values.

If the measured temperature exceeds the preset limit value the temperature relay will pick up after elapse of the adjusted delay time.

Indication of limit values see chapter 3.3.

2.5 Monitoring of Operation

To ensure undisturbed operation, the device is equipped with a disturbance signalling relay (relay 7). This relay picks up, whenever the LWM-8E is in operation mode and releases if for example the power supply fails.

2.6 Temperature Compensation

The temperature compensation is effected by the following formula:

$$LW(\vartheta_0) = \frac{LW(\vartheta)}{1 + KT \text{ x } (\vartheta - \vartheta_0)}$$

- ϑ_0 = reference temperature
- ϑ = actual – temperature
- KT = temperature coefficient
- LW(ϑ_0) = calculated conductance at reference temperature
- LW(ϑ) = actual - conductance at actual – temperature

By means of the temperature compensation the conductance at actual temperature will be converted to conductance at reference temperature, considering the temperature correction value.

Note. The temperature compensation will only operate accurately, if temperature coefficient and reference temperature are correctly adjusted!

The temperature coefficient is dependent on the medium (see chemical tables) and alters with the reference temperature. The reference temperature is to be specified by the plant operator. Typical values for water are 2,2 %/K as temperature coefficient and 25 °C as reference temperature (ex works setting: 25 °C).

The temperature compensation operates within a range of 0 °C up to +100 °C, the measuring area for temperature ranges from –50 °C up to +150 °C. If the temperature sensor is disconnected manual temperature compensation takes place (parameter 7.5).

3 Display

Additionally to the conductance, the LWM-8E can alternatively indicate the temperature or the voltage measured on the probe, which is displayed in mV.

3.1 Indication of Conductance or Temperature

The changeover between the display modes takes place on actuating and holding pressed the 'Weiter' – key (next) for about 2 seconds. Switching-over is disabled when a limit value indication is active. The temperature indication is quitted automatically after 60 seconds. Thereafter the conductance is shown again. Displaying the temperature value the related LED 'Temperaturanzeige' lights

3.2 Displaying Voltage measured on the Probe

For service purposes it's also possible to indicate the voltage of the conductance measurement amplifier. To indicate the measured voltage, the DIL – Switch S4 must be set 'on'. Than press down the 'Weiter' – key (next) for about 4 seconds. While displaying the measured voltage both unit - LED) are lightened.

3.3 Indication of Limit Values

Both conductance limit values as well as the temperature limit value can be displayed by actuating of key. The first keystroke shows conductance limit value 1, the related LED lights; the second keystroke displays conductance limit value 2, the related LED lights; the third keystroke indicates the temperature limit value, the related LED lights. The LED 'Messung' (Measurement) is off, while one of the limit values is displayed. After actuating the 'Weiter' – key (next) once more, or after elapse of - dependent on pre-setting - 5 seconds the conductance, respectively the temperature is displayed again.

4 Handling

4.1 Switching off Measurement / Input Mode

By simultaneously actuating both keys on front panel the changeover between 'Messung' (measurement) and 'Eingabe' (data input) or 'Kalibrieren' (calibration – dependent on position of service switch) is effected and the respective mode is indicated by the related LED upon the front panel. The limit value relays will be switched off in data input - and calibration mode.

If no key is actuated for a certain time (1 min on data input respectively 2 min on calibration), the device returns automatically into operation mode.

4.2 Signification of DIL-Switches

S1	:	parameter input;
S2	:	internal release in measurement mode 'Messung' (operating status);
S3	:	measurement always at range 0 (without changeover measuring range);
S4	:	calibration of main measuring range, displaying in mV while measuring is possible;
S2 + S4	:	to replace the lower limit value by an resistor for calibration of the device;
S3 + S4	:	calibration of measuring range 0 (instead of range 1 of probe factor);

4.3 Calibration

For detailed description of the calibration procedure see chapter 10.

Note: The devices are, unless otherwise stipulated, calibrated ready for use. A subsequent calibration is usually not necessary. It is recommended not to alter the factory calibration, unless this is required by local terms (for example security barriers, high cable capacitance). If calibration is necessary, it should be accomplished very carefully, for wrong settings may cause faulty measurement results.

5 Logging

5.1 Current- and Voltage Output

The current-output is assigned to the currently measured conductance. This output can be parameterised for 0 ... 20 mA and for 4 ... 20 mA, whereby the output current never is lower than 0 (4) mA or higher than 20 mA. Initial value and final value can be parameterised. If the initial value is larger than the final value, the current output operates inverse, i.e. a rising initial value entails the decrease of the output current. The voltage output behaves analogous to the current output.

5.2 Printer Interface (optionally)

The device is provided with a standard RS-232 printer interface featuring 2.400 baud transmission rate. The data format is: 1 start bit (LOW), 8 data bits (LSB first), 1 stop bit (HIGH). The Printer output is activated by parameter 0.1. For printing a release has to be given by input E1 or DIL-switch DIL 2.

Limit values, printing intervals, printing delay as well as control printouts are pre-adjusted by the parameters 7.6 ... 7.12.

5.2.1 Printer Limit Values

The conductance range, which shall be traced is adjusted by printer limit values. There are the following 3 different setting options:

- **1. limit value 1 < limit value 2:**

  Protocol printouts take place in range 0 µS up to limit value 1 and limit value 2 up to 999 mS. If the conductance value is *between* limit value 1 and 2, an unique printout takes place: 'GRENZWERT OK' (limit value all correct).

- **2. limit value 1 > limit value 2:**

  Protocol printouts are given for the range LW_{ist} (*actual conductance*) < limit value 1 up to LW_{ist} (*actual conductance*) > limit value 2. If the conductance value is *outside* of the limit values, an unique printout 'GRENZWERT OK' (limit value all correct) takes place.

- **3. limit value 1 = limit value 2:**

  A continuously printout takes place.

5.2.2 Print Interval and Print Delay Time

This two parameters predefine the time interval between two printouts and the delay for start of printing after the preset limit values are exceeded.

5.2.3 Control Printouts

Three independent times, at which a protocol printout shall take place, can be set by parameters 7.10 ... 7.12. Each of these times can be set for the full hour of 01.00 ... 23.00. If time hereby is adjusted to 00.00, the automatically printing is deactivated.

6 Preselection Value- and Parameter-Input

6.1 General

By simultaneously actuating the 'Weiter' – (next) and 'Enter' – key and if DIL-S1 is 'on', the device switches into the parameter selection mode. Hereby the operation relays will be switched off, the fault relay remains picked up.

The switching back into operation mode will take place by pressing 'Weiter' – (next) and 'Enter' – key simultaneously again, or automatically, if no key is actuated for at least 60 seconds. The DIL-S1 may remain switched on constantly, but to avoid faulty operation, it is recommended to set it back after finishing the parameterisation.

6.2 Selection of Parameters

In parameter selection mode the two middle digits of the display indicate the identification number of the current parameter. The parameters are collected to groups on several levels:

- The digit of parameter number left-hand of the dot denotes the parameter level;
- a short actuating of the 'Weiter' – key will increase the identification number *right-hand of dot* at release of the key;
- longer actuating the 'Weiter' – key (> 1 second) increases the parameter level *left-hand of dot*;

By pressing 'Enter' the value of the selected parameter is shown. The device is now in entry mode. A further actuating of 'Enter' switches the device back again into the parameter selection mode.

6.3 Entry Mode

When entering the entry mode, the parameter to be altered is displayed. Pressing 'Enter' again the entry mode will be quitted directly – without changing the parameter. Actuating 'Weiter' (next) the altering of parameter is started:

- the first 3 digits darken, the 4th is counted up with the 'Weiter' – key;
- pressing 'Enter' the value will be set and the 3rd digit can be altered;
- the highlighted digit is increased by actuating 'Weiter' (after 9 follows 0);
- pressing 'Enter' will accept the set value and jump to the following digit;

when all 4 digits are accepted:

- all digits are lighted with the same brightness;
- press 'Enter' to turn back to the parameter selection;
- press 'Weiter' to repeat this entry;

6.4 Parameter List

Level	Ident-No	Parameter	Description	Range	Preset ex works		set
0	1	system parameter	device parameter	0000 ... 0001	0000		
				0000 0001	do not print print using RS 232		
1	1	$LW1_{max}$ limit value 1		dependent on meas. range	050.0 [µS/cm]		
	2	delay time limit value 1		0 ... 9.999 sec	0005 [sec]		
	3	$LW2_{max}$ limit value 2		dependent on meas. range	100.0 [µS/cm]		
	4	delay time limit value 2		0 ... 9.999 sec	0005 [sec]		
Level	**Ident-No**	**Parameter**		**Preset ex works**			**set**
2	1	probe factor (chapter 6.5)	00,01 [1/cm]	00,10 [1/cm]	0001 [1/cm]	0010 [1/cm]	
	2	pre-selected meas. range	20,00 [µS/cm]	200,0 [µS/cm]	2000 [µS/cm]	20,00 [mS/cm]	
	3	lower calibration reference value for meas. range 0	020,0 [µS/cm]	0200 [µS/cm]	02,00 [mS/cm]	020,0 [mS/cm]	
	4	upper calibration reference value for meas. range 0	100,0 [µS/cm]	1000 [µS/cm]	10,00 [mS/cm]	100,0 [mS/cm]	
	5	lower calibration reference value for meas. range 1	02,00 [µS/cm]	020,0 [µS/cm]	0200 [µS/cm]	02,00 [mS/cm]	
	6	upper calibration reference value for meas. range 1	10,00 [µS/cm]	100,0 [µS/cm]	1000 [mS/cm]	10,00 [mS/cm]	
	7	lower calibration reference value for meas. range 2	0,200 [µS/cm]	02,00 [µS/cm]	020,0 [µS/cm]	0200 [µS/cm]	
	8	upper calibration reference value for meas. range 2	1,000 [µS/cm]	10,00 [µS/cm]	100,0 [µS/cm]	1000 [µS/cm]	

Level	Ident-No	Parameter	Description	Range	Preset ex works	set
5	1	analogue basic settings	dead Zero / live Zero	0...20mA/4...20mA	0...20 mA	
	2	initial value current output	conductance for Zero (0mA resp. 4mA)	dependent on measurement range and probe factor	000.0 [µS/cm]	
	3	final value current output	conductance for 20mA	dependent on measurement range and probe factor	200.0 [µS/cm]	
6	1	time	optional, if RS232 – interface provided		10.07 dot flashes	
	2	date	optional, if RS232 – interface provided		29.01	
	3	year	optional, if RS232 – interface provided		1997	

Level	Ident-No	Parameter	Description	Range	Preset ex works	set
7	1	temperature limit value		0 ... 100 °C	035.0 °C	
	2	temperature limit value delay time		0 ... 9.999 sec	0005 sec	
	3	temperature correction value	for temp. – compensation of the conductance	0 ... 99 %/K	02.00 %/K	
	4	reference temperature	for temp. – compensation of the conductance	0 ... 100 °C	025.0 °C	
	5	manual temperature compensation	if no Pt100	0 ... 100°C	020.0 °C	
	6	printer limit value 1		depend on meas. range	LW 1	
	7	printer limit value 2		depend on meas. range	LW 2	
	8	interval between control printouts		0 ... 9999 sec	0600	
	9	delay time start printing as per measured value < printer limit value 1 or measured value < printer limit value 2		0 ... 9999 sec	0030	
	10	control printout 1	adjustment accuracy: 1 h switched off: 00.00	0 ... 23.00 o'clock	10.00	
	11	control printout 2	adjustment accuracy: 1 h switched off: 00.00	0 ... 23.00 o'clock	00.00	
	12	control printout 3	adjustment accuracy: 1 h switched off: 00.00	0 ... 23.00 o'clock	00.00	

Parameters 2.1, 2.2 and 5.1 will be stepwise altered (actuating the 'Weiter' – key) only.

6.5 Table - Probe Factor Ranges

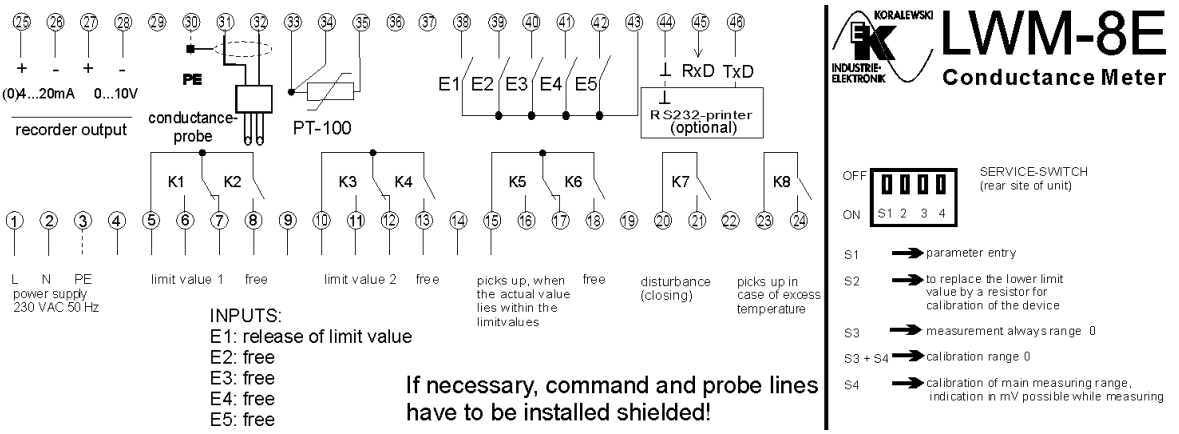
Probe factor	Measuring range 0 (values in brackets reduced exactitude, errors ≥ 5%)	Measuring range 1	Measuring range 2
K=10 cm^{-1}	0 ... 200,0 mS/cm (200,0 ... 999,9 mS/cm)	0 ... 20,00 mS/cm	0 ... 2000 µS/cm
K=1 cm^{-1}	0 ... 20,00 mS/cm (20,00 ... 99,99 mS/cm)	0 ... 2000 µS/cm	0 ... 200,0 µS/cm
K=0,1 cm^{-1} (ex works setting)	0 ... 2000 µS/cm (2000 ... 9999 µS/cm)	0 ... 200,0 µS/cm	0 ... 20,00 µS/cm
K=0,01 cm^{-1}	0 ... 200,0 µS/cm (200,0 ... 999,9 µS/cm)	0 ... 20,00 µS/cm	0 ... 2,000 µS/cm

6.6 Table - Conductance *(LW)* / Resistance *(K)* $(R = K / LW)$

LW / K	1 µS/cm	2 µS/cm	5 µS/cm	10 µS/cm	20 µS/cm	50 µS/cm	100 µS/cm	150 µS/cm	200 µS/cm	500 µS/cm	1000 µS/cm	1500 µS/cm	2000 µS/cm	10000 µS/cm	20000 µS/cm
10 cm^{-1}	10MΩ	5MΩ	2MΩ	1MΩ	500kΩ	200kΩ	100kΩ	66,6k	50kΩ	20kΩ	10kΩ	6,66k	5kΩ	1kΩ	500Ω
1 cm^{-1}	1MΩ	500kΩ	200kΩ	100kΩ	50kΩ	20kΩ	10kΩ	6,66k	5kΩ	2kΩ	1kΩ	666Ω	500Ω	100Ω	50Ω
0,5 cm^{-1}	500kΩ	250kΩ	100kΩ	50kΩ	25kΩ	10kΩ	5kΩ	3,33k	2,5kΩ	1kΩ	500Ω	333Ω	250Ω	50Ω	25Ω
0,1 cm^{-1}	100kΩ	50kΩ	20kΩ	10kΩ	5kΩ	2kΩ	1kΩ	666Ω	500Ω	200Ω	100Ω	66,6Ω	50Ω	10Ω	5Ω
0,05 cm^{-1}	50kΩ	25kΩ	10kΩ	5kΩ	2,5kΩ	1kΩ	500Ω	333Ω	250Ω	100Ω	50Ω	33,3Ω	25Ω	5Ω	2,5Ω
0,01 cm^{-1}	10kΩ	5kΩ	2kΩ	1kΩ	500Ω	200Ω	100Ω	66,6Ω	50,0Ω	20,0Ω	10,0Ω	6,66Ω	5Ω	1Ω	0,5Ω

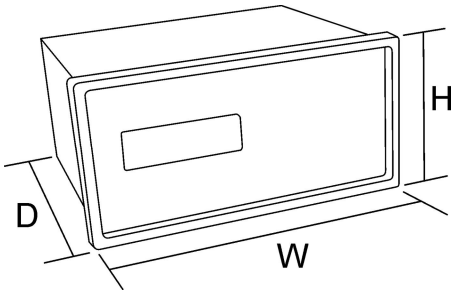
If the actual temperature equals the reference temperature, the given values correspond to the value displayed. (see chap. 2.4).

7 Pin Configuration



8 Technical Data

Voltage supply	230 VAC +5%/-10%, 50Hz
Power consumption	approx. 7 VA
Measurement input	0 ... 2 µS/cm, 0 ... 20 µS/cm, 0 ... 200 µS/cm bei K=0,01/cm 0 ... 20 µS/cm, 0 ... 200 µS/cm, 0 ... 2 mS/cm bei K=0,1/cm 0 ... 200 µS/cm, 0 ... 2000 µS/cm, 0 ... 20 mS/cm bei K=1/cm 0 ... 2000 µS/cm, 0 ... 20 mS/cm, 0 ... 200 mS/cm bei K=10/cm accuracy: better than 1% of full scale other measuring ranges and cell constants on request
Temperature sensor	Pt100 in three conductor mode temperature compensation within range of 0 ... 100°C, temperature measurement from -50°C ... 150°C resolution: 0.5 K (rounded internally).
Relay outputs	8, max. 230 V AC, 2 A, in 5 neutral groups
Current output	0(4)...20 mA max. load 400 Ω linearity: 0.5% FS
Voltage output	0(2)...10 V min. load 1 kΩ linearity: 0.5% FS
Climatic Conditions:	according to DIN EN 60204-1 (05-2010)
Ambient temperature	
in operation:	-20 °C ... +55 °C
transport and storage:	-25 °C ... +55 °C
Housing	switch panel housing according to DIN 43700 (IP40) with transparent cover IP65 in front of the switchboard dimensions: W / H / D : 144 x 72 x 125 mm (incl. cable connector) mounting depth with clamps & plugs without wiring: min. 126 mm
Cut-out dimensions	B / H 138,5 x 68,5 mm



8.1 Ordering Information

Conductance Measuring Device LWM-8E	
Part number:	**E2021**

9 Notes for Installation

The electrical connection has to be accomplished only by trained personnel in accordance to VDE 0160. For selection of lines and electrical connection of device the specifications of VDE 0100 'Specifications for the installation of power installations with nominal voltages below 1000 V', respectively the respective regional rules, are to be observed!

For maintenance and installation work the device is to separate from the mains.

The external protection of the device's power supply should not exceed the value of 4 A mT. To avoid a welding of the relay output contacts in case of short circuit it has to be ensured, that the load circuit is protected at maximum relay current (2A).

Electrical and magnetic fields in vicinity of the device may affect its function. Inductive consumers, installed in the device's surrounding, must be effected with interference suppressing measures, such as RC – combinations.

10 Calibration of Conductance Measurement Amplifier

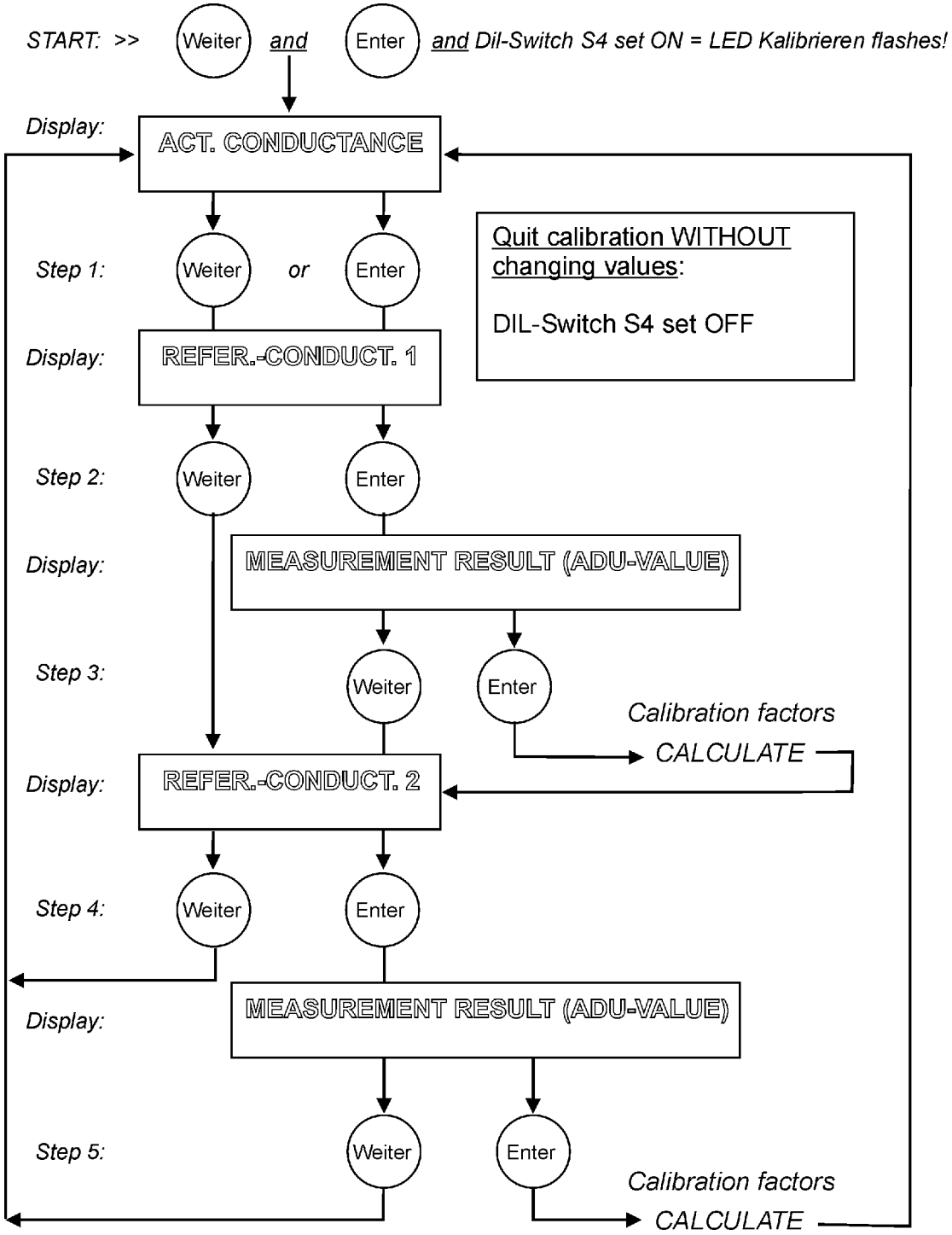
Calibration principally takes place for the range which is specified as main measuring range by parameter 2.2. If for the calibration - additional to DIL S4 - DILS3 is switched 'on', the measurement range 0 will be calibrated!

The calibration should preferably be carried out using 2 liquids with well known conductance values (for example sodium chloride solutions with stepped concentrations). Thereby the cable resistance and cable capacitance as well as the cable polarisation will be taken in account for the calibration factors and measurement configuration operates with maximum exactitude. Using the double spot calibration, even security barriers do not cause to falsifications of the measurement results.

1. DIL-Switch S4 set 'on'. By simultaneously pressing both keys on front, the device changes over into calibration mode. Now the LED 'Kalibrieren' (calibration) lights, the LED 'Eingabe' (input) flashes in secondly intervals. The conductance value is continuously displayed using previous calibration factors.
2. Press 'Weiter' (Start). LED 'Grenzwert 1' (limit value 1) lights, the conductance value of the calibration liquid expected at first is displayed.
3. Actuate 'Enter' (Übernahme : acceptance). LED 'Grenzwert 1' (limit value 1) flashes, indication of the measured ADU – value (analogue digital transducer value). Immerse the probe into the calibration liquid and wait until the displayed value stops altering. When the displayed value is stable: continue with 4.
4. Actuate 'Enter' (Übernahme : acceptance). LED 'Grenzwert 2' (limit value 2) lights, the conductance value of the calibration liquid expected at second is displayed.
5. Actuate 'Enter' – key. LED 'Grenzwert 2' (limit value 2) flashes, indication of the measured ADU – value. Immerse the probe into the calibration liquid and wait until the displayed value stops altering. When the displayed value is stable: continue with 6.
6. Once more pressing ENTER. Both limit value - LED light again. The display shows the conductance value using the newly set calibration factors.

The calibration can be repeated by actuating the 'Weiter' – key (next). It's also possible to repeat only one of both calibration points: therefor actuate 'Weiter' repeatedly until the conductance value of the chosen calibration point is displayed. Than continue, as described at point 3 respective 5. Pressing both keys simultaneously the calibration can be quitted at any time. It will be quitted automatically, when no key is actuated for longer than 2 minutes. The calibration can be quitted at any time by holding pressed down the 'Enter' – key and actuating 'Weiter' – key. The generated calibration values will be stored in EEPROM. If DIL-Switch S2 is set 'on' during calibration, the device expects the lower calibration point simulated by an resistor equivalent to solution. Hereby the circuitously handling with two solutions is avoided, but falsifications caused by the polarisation capacity as well as deviations of the probe factor are not compensated completely.

10.1 Calibration Procedure

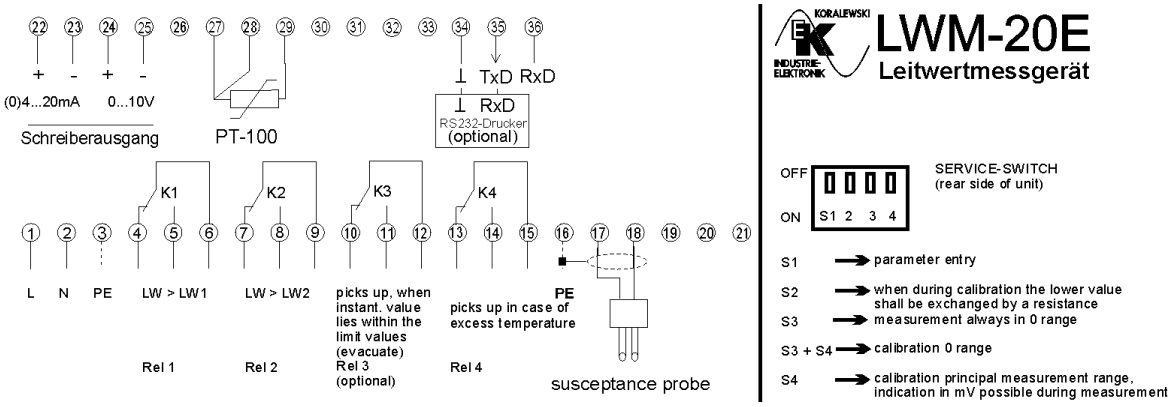


Taking over of calibration values (at any time) by simultaneously actuating of both keys while DIL - Switch S4 is set ON! **Thereafter switch S4 to OFF!**

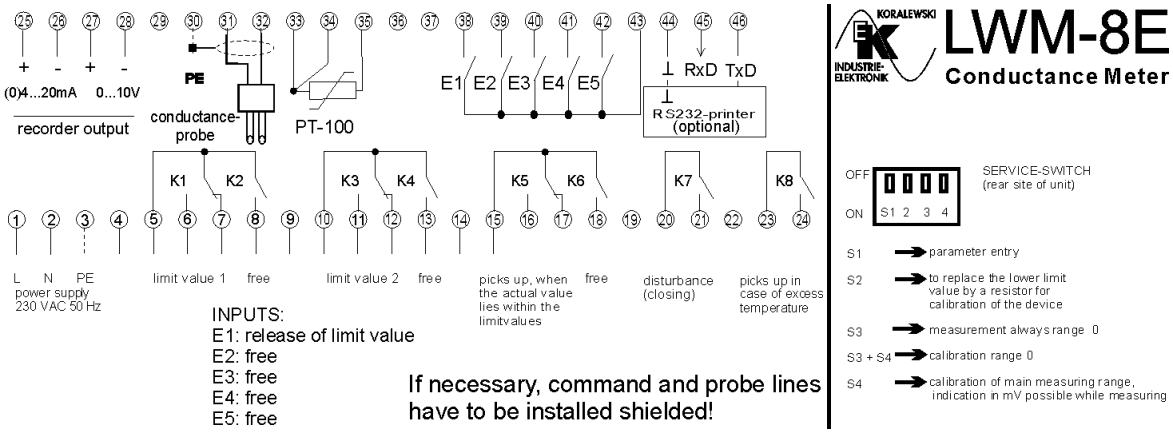
11 Change of Pin Configuration

The previously model LWM-20E is no longer produced by our company. We now manufacture the LWM-8E. Please observe the changes in pin configuration.

- ***Pin configuration LWM-20E:***



- ***Pin configuration LWM-8E:***



12 Connection Example