Conductance Measuring Device LWM-20W

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1 General Remarks

The digital conductance measurement device LWM-20W captures during measurement the complete possible range of indication (for example up to 99,99 mS/cm at K=1/cm), but the unit is measuring 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 unit contains a micro-processor controlled conductance measurement amplifier, a recorder output (0) 4 ... 20 mA, 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 is to be scaled arbitrary within the whole measuring range, so that a conductance range for example of 15 ... 50 mS / cm can be assigned to the current of 4 ... 20 mA.

The device is used in applications for waste water technologies, process water monitoring, desalination plants, etc.

2 Principle of function

2.1 Measurement

The operating mode 'Measurement' is indicated by the continuously lightened green LED beside of the display. The value of the conductance is shown on display, its unit is indicated by one the LEDs above the display. The monitoring of limit values is active.

2.2 Measurement range

The device features 3 measurement ranges (table chapter 6.5). The main measuring range is selected in parameter 2.2. The device always starts at range 0 and switches – if possible – automatically over into the pre-selected main measuring range. In case of measurement range exceeding a back-switching into range 0 occurs automatically.

The switching process may take a few seconds – during the changeover procedure the LED 'BEREICHSWECHSEL' (change of area) flashes.

If DIL 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. In their range, the limit values, the current output and the calibration are always depend on the main measuring range!

2.3 Limit values

The device is equipped with two limit value contacts for conductance and one for 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.

2.4 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 (-> chemical tables) and changes with the reference temperature. Typical values for water, for example, are 2,2%/K as temperature coefficient and 25°C as reference temperature. The reference temperature is to be specified.

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

3.1 Indication of conductance or temperature

The device may indicate the conductance as well as the temperature of the measured medium. The changeover between the display modes takes place on actuating and holding pressed the 'UP' – key [↑] 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 non of the unit-LEDs lights. For service purposes it's also possible to indicate the voltage of the conductance measurement amplifier. If DIL S4 is set 'on', the displayed values changes between LW, ϑ, mV (both unit – LEDs).

3.2 Limit values

Both conductance limit values and the temperature limit value can be brought to indication by 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 'UP' – key [↑] one more time or after elapse of 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 'BETRIEB' (operation) and 'EINGABE' (data input) or 'KALIBRIERUNG' (calibration) is effected. 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 resp. 2 min on calibration), the device returns automatically into operation mode.

4.2 Signification of DIL-Switches

S1	:	parameter input;
S2	:	to replace the lower limit value by an resistor for calibration of the device;
S3	:	measurement always at range 0;
S3 + S4	:	calibration of measuring range 0;
S4	:	calibration of main measuring range, displaying in mV while measuring is possible;

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 Listing

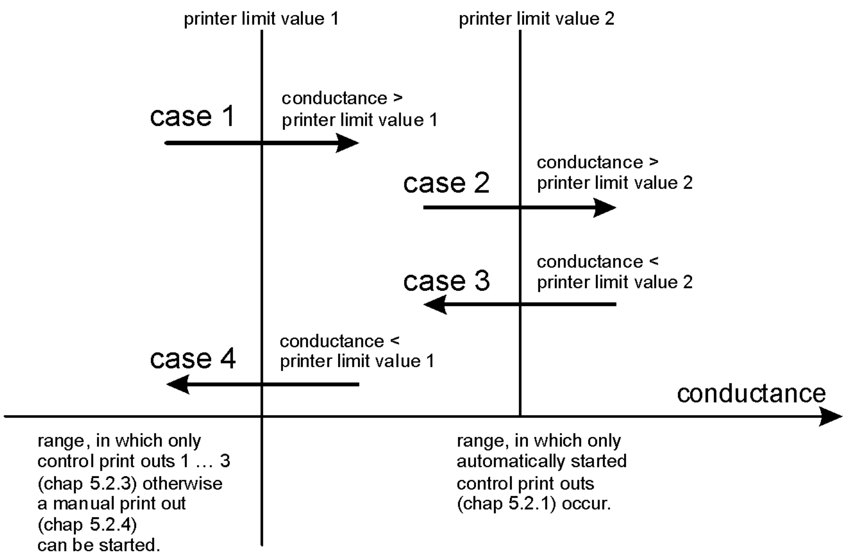
5.1 Current output

The current output is allocated to the currently measured actual conductance and can be parameterised for 0 ... 20mA and for 4...20mA. Output current then never is lower than 0 (4) mA and never 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.

5.2 Printer interface (optionally)

The device is provided with a standard RS-232 printer interface featuring 2400 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 three check printings are parameterised by the parameters 7.6 ... 7.12.

The following diagram shows the cases (4), and which protocol hereby is automatically printed out.



5.2.1 Printer limit values

The range of conductance values, within which protocols shall occur is defined by the printer limit values. Hereby are 4 cases distinguished:

1. conductance > limit value 1

The measured conductance exceeds the preset printer limit value 1. Control printout takes place in the form:

> limit value 1
date, time
conductance, temperature
ident-number of device

2. conductance > limit value 2

The measured conductance exceeds the preset printer limit value 2. Control printout takes place in the form:

> limit value 2
date, time
conductance, temperature
ident-number of device

3. conductance < limit value 2

The measured conductance falls below the preset printer limit value 2, while it's still exceeds printer limit value 1. Control printout takes place in the form:

< limit value 2
date, time
conductance, temperature
ident-number of device

4. conductance < limit value 1

The measured conductance falls below the preset printer limit value 1. Control printout takes place in the form:

< limit value 1
date, time
conductance, temperature
ident-number of device

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 when a listing control 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. This timebased control printouts are worthwhile on plants, that constantly work within the limit values, wherefore in normally operation no printouts take place.

5.2.4 Manual control printout

Actuating a key / contact at input E1 (terminal 24 and GND) a manual control printout may be started. The control printout takes place under the following conditions:

- printing has to be released (parameter 0.1).
- no print job, either due exceeded limit values (conductance OK) or timebased, is active. All of the previously received characters have to be printed (previous print jobs have to be finished).
- the release contact at E1 muss has to be closed at least for 1 second.

example for printout:

Man: Druck
LW 200µS 20,0 Grad C
LW 26.01.01 12:00
Leitwert OK

6 Entry of pre-selection values and parameters

6.1 General

By simultaneously actuating the 'UP' – [↑] 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.

Switching back into operation mode takes place by pressing 'UP' – [↑] and 'ENTER' – key simultaneously again, or automatically, if no key is actuated for at least 60 seconds. DIL-S1 may remain switched on constantly. To avoid faulty operation, it's 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;
- actuating the 'UP' – key increases the identification number (trailing edge-> at release of key);
- longer actuating the 'UP' – key increases the parameter level (more than 1 second);

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 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 'UP' the altering of parameter is started:

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

when all 4 digits are taken over:

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

6.4 List of parameters

Level	Ident-No	Parameter	Description	Range	Preset ex works	set
0	1	printer activation	device parameter 0000: do not print 0001: print using RS-232	0000 ... 0001	0000	
	2	ident-number of device	associates control printouts	0000 ... 9999	0000	
1	1	$LW1_{max}$ limit value 1		dependent on meas. range	050.0[µS/cm]	
	2	delay limit value 1		0 ... 9999 sek	0005 sek	
	3	$LW2_{max}$ limit value 2		dependent on meas. range	100.0 [µS/cm]	
	4	delay limit value 2		0 ... 9999 sek	0005 sek	
2	1	probe factor		0,1 / 1 / 10 [1/cm]	00.10 1/cm	
	2	pre-select of measuring range	see chap. 6.5: Table: probe factor ranges	dependent on probe factor	200.0 [µS/cm]	
	3	lower refer. conductance	measuring range 0	dependent on probe factor	200.0 [µS/cm]	
	4	upper refer. conductance	measuring range 0	dependent on probe factor	1000 [µS/cm]	
	5	lower refer. conductance	measuring range 1	dependent on probe factor	020.0 [µS/cm]	
	6	upper refer. conductance	measuring range 1	dependent on probe factor	100.0 [µS/cm]	
	7	lower refer. conductance	measuring range 2	dependent on probe factor	02.00 [µS/cm]	
	8	upper refer. conductance	measuring range 2	dependent on probe factor	10.00 [µS/cm]	
5	1	GIA	dead Zero / live Zero	0...20mA/4...20mA	0...20 mA	
	2	initial value current output	conductance for Zero (0mA resp. 4mA)	dependent on meas. range & probe factor	000.0 [µS/cm]	
	3	final value current output	conductance for 20mA	dependent on meas. range & 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	
7	1	temperature limit value		0 ... 100 °C	035.0 °C	
	2	temperature limit value delay time		0 ... 9999 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		0 ... 9999 µS dependent on meas. range	LW 1	
	7	printer limit value 2		0 ... 9999 µS dependent 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	

In difference to the generally used routine, parameters 2.1, 2.2 and 5.1 are only stepwise altered (using 'UP' – key).

6.5 Table probe factor ranges

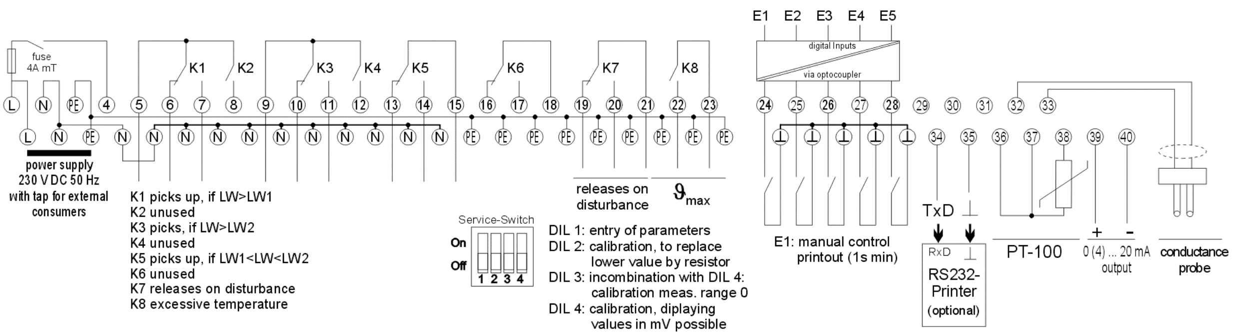
Probe factor	Measuring range 0 (values in brackets reduced exactitude, errors ≥ 5%)	Measuring range 1	Measuring range 2
K=10 cm^{-1}	0 ... 200,0 mS/cm (200,0 ... 999,9 mS/cm)	0 ... 20,00 mS/cm	0 ... 2000 µS/cm
K=1 cm^{-1}	0 ... 20,00 mS/cm (20,00 ... 99,99 mS/cm)	0 ... 2000 µS/cm	0 ... 200,0 µS/cm
K=0,5 cm^{-1}	0 ... 10,00 mS/cm (10,00 ... 50,00 mS/cm)	0 ... 1000 µS/cm	0 ... 100,00 µS/cm
K=0,1 cm^{-1}	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

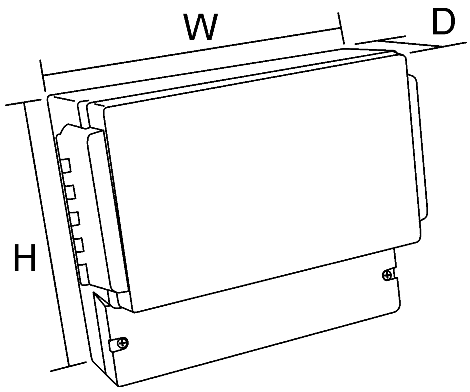
If the actual temperature *) equals the reference temperature, the given values correspond to the value displayed. (see chap. 2.4).
*) without PT-100: manual temperature compensation, parameter 7.5.

7 Pin configuration



8 Technical data

Power supply	230 V AC +5%/-10%, 50 Hz
Power consumption	approx. 15 VA
Fuse protection	4 A mT
Inputs	5 x neutral make contacts towards GND contact voltage approx. 10 VDC, I approx. 9 mA transition resistance max. 1,5 kΩ
Measurement input	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 ... 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 0 ... 2000 µS/cm, 0 ... 20 mS/cm, 0 ... 200 mS/cm bei K=10/cm exactitude: better 1% of final value other 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: 0.5K (rounded internally).
Relay outputs	8 x neutral, max. 230 V AC, 2A
Data output (optional)	for standard-RS-232 – printer interface: 8-Bit UART + start bit(0)+ stop bit(1) , 2400 Baud.
Current output	0(4) ... 20 mA max. load 400 Ω linearity: 0.5% FS
Ambient temperature	-20 ... +55 °C
Housing	DIN plastic housing for wall mounting / IP54 dimensions: W / H / D : 243 x 193 x 116 mm



8.1 Ordering information

Conductance Measuring Device LWM-20W	
Part number	**E1713**

9 Notes for installation

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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' and the respective regional rules, respectively 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 always takes place for the range specified as main measuring range by parameter 2.2. If on entry of the calibration DILS3 is switched 'on' to additionally DIL S4, 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) as well as the limit value LEDs are lighted. The conductance value is continuously displayed using previous calibration factors.
2. Press UP [↑] (START). LED 'GRENZWERT 1' (limit value 1) lights, the conductance value of the calibration liquid expected at first is displayed.
3. Actuate ENTER (ÜBERNAHME – take over). LED 'GRENZWERT 1' (limit value 1) flashes, indication of the measured ADU – value. Immerse the probe into the calibration liquid and wait until the displayed value stops altering. If indication holds on to the displayed values, continue with 4.
4. Actuate ENTER (ÜBERNAHME – take over). LED 'GRENZWERT 2' (limit value 2) lights, the conductance value of the calibration liquid expected at second is displayed.
5. Actuate ENTER (ÜBERNAHME – take over). 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. If indication holds on to the displayed values, continue with 6.
6. Once more pressing ENTER. Both limit value – LEDs lights again. The display shows the conductance value using the newly set calibration factors.

The calibration can be repeated by actuating the 'UP' – key [↑]. It's also possible to repeat only one of both calibration points: therefor actuate the 'UP' - key repeatedly until the conductance value of the chosen calibration point is displayed. Than continue with 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. If DIL-Switch S2 is set 'on' during calibration, the device expects the lower calibration point simulated by an equivalent resistor. 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.