CDM210 Conductivity Meter

Operating Instructions

D21M006

Introduction

The CDM210 Conductivity Meter forms part of MeterLab™, RADIOMETER ANALYTICAL's complete range of reliable laboratory systems, for convenient pH, ion and conductivity measurements.

Self-explanatory keys, automatic frequency switching and the AUTOREAD function are just some of the features available on the CDM210.

Most importantly, the CDM210 offers high precision measurements: conductivity measurements in the range 0.001 µS/cm to 5.99 S/cm and resistivity measurements in the range 0.2 Ω•cm to 1.0 G Ω•cm.

Conductivity can be corrected to a reference temperature of 20 or 25°C. Sample temperatures can be measured automatically or entered manually.

The CDM210 is equipped with a RS232C port allowing for conductivity measurements to be either printed out on a printer or automated by using a PC equipped with MeterMaster, the MeterLab Automation Program.

For optimal user convenience, connect the SAM7 Sample Stand.

For user convenience, two sets of short-form instructions are included in the centre of this booklet. Please detach it carefully.

Contents

Setting up

The CDM210 Conductivity Meter

Place the CDM210 on a laboratory bench close to an appropriate power outlet and:

(1) Connect the CDM210 to the mains supply via the **POWER IN** (12 V 0.8 A) socket using the AC/DC adapter supplied. For safety reasons, make sure that the power adapter is placed at a distance of more than 1 meter from a water supply.

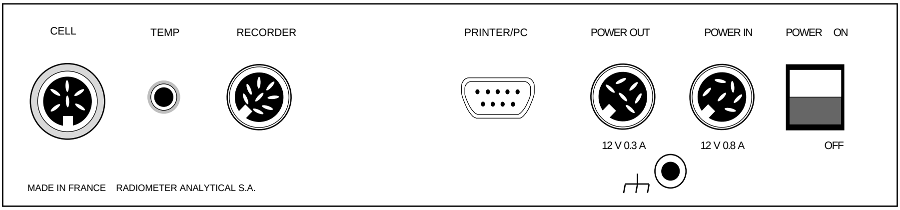


Fig.1: Rear panel of the CDM210

(2) The CDM210 can be switched ON/OFF using the POWER ON/OFF switch situated on the rear panel (see fig.1).

(3) A printer or a PC can be connected to the CDM210 via the RS232C **PRINTER/PC** interface. For printer connection, use the RADIOMETER ANALYTICAL cable, 9-25 pin, part no. A95P201. For PC connection, please refer to page 38.

(4) To connect a recorder use the CDM210 **RECORDER** analogue recorder output and the MAB-8M/3 banana RADIOMETER ANALYTICAL cable, part no. A95R102. For pin connections of the **RECORDER** socket, please see page 36.

(5) If the SAM7 Sample Stand is to be connected, use the CDM210 **POWER OUT** output and the RADIOMETER ANALYTICAL cable part no. A95A110. The SAM7 is powered from the **POWER OUT** socket of the CDM210.

The socket: This non-insulated socket is connected to the electrical zero of the CDM210. When the CDM210 is used with other measurement units, connect the electrical zeros of these instruments together.

Connecting the Conductivity Cell and Temperature Sensor

Secure the conductivity cell firmly into the cell holder of the sample stand.

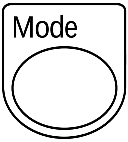
CONDUCTIVITY CELL INPUT

Use the terminal marked **CELL** for connection of the conductivity cell. The CDC641T has a built-in temperature sensor.

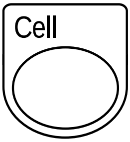
TEMPERATURE SENSOR INPUT

A separate temperature sensor (for example the RADIOMETER ANALYTICAL temperature sensor T201) may be connected to the **TEMP** socket.

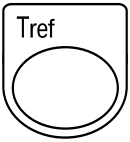
Description of Keys



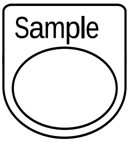
The **MODE** key is used to select between conductivity and resistivity measurements. Measurement ranges and units can also be selected. In the setup state (first 3 secs after switching on) the serial parameters of the printer output can be selected using this key.



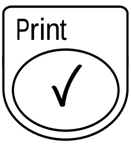
Press the **CELL** key to display the cell constant value. The calibration procedure can also be initiated using this key. In the setup state, press this key to enter the cable resistance.



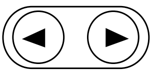
When this key is pressed, the display shows the reference temperature which may be none, 20 or 25°C. The temperature coefficient is also displayed and is fully adjustable between 0.00-9.99 % /°C.



The **SAMPLE** key is pressed to initiate sample measurements. The CDM210 displays guide you through the measurement procedure.



The ✓ key is used to validate a display and thus continue to the next step. Results are accepted and sample measurements are initiated in the AUTOREAD mode. Alternatively, use this key to print out measurements and calibrations when "P" is indicated in the bottom right-hand corner of the display.



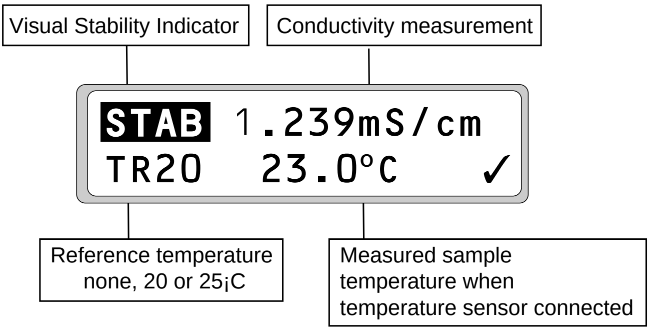
The left and right arrow keys are used to change a number or select an option which appears within the arrows on the display. In order to change parameter data quickly, hold down the left or right cursor key continuously.

Starting up

(1) Switch on the CDM210 with the on/off switch. The first display you see will remain for a few seconds and shows the name of the meter, the software reference and that the CDM210 is performing a self-test.

(2) Select the language you require in the setup state (first 3 seconds after switching on the instrument) using the left and right arrow keys.

(3) If no keys are pressed, the CDM210 switches to the live display (measuring mode) which appears when a sample measurement is performed.



(4) To obtain the most accurate measurements especially in the 400 mS conductance range, the Cable Resistance of the cell must be entered.
During the setup state (first 3 seconds after switching on the instrument), press the **CELL** key and adjust the resistance between 0.00 and 99.99 Ω using the left and right arrow keys (see display overview page 6).

The cable resistance values of some conductivity cells are listed below:

Conductivity cell or cable	CDC641T	CDC741T	CDC749	CDC565	CDC865	CL136	CL336
Resistance (in Ω)	0.260	0.610	0.180	0	0	0.145	0.350

Note: see also chapter 6 "Theory" on page 20.

(5) If a printer or a PC is to be connected to the CDM210, the PRINTER OUTPUT format must be selected. Simply press **MODE** in the setup state and then the ✓ key. Using the left or right arrow keys, choose between:

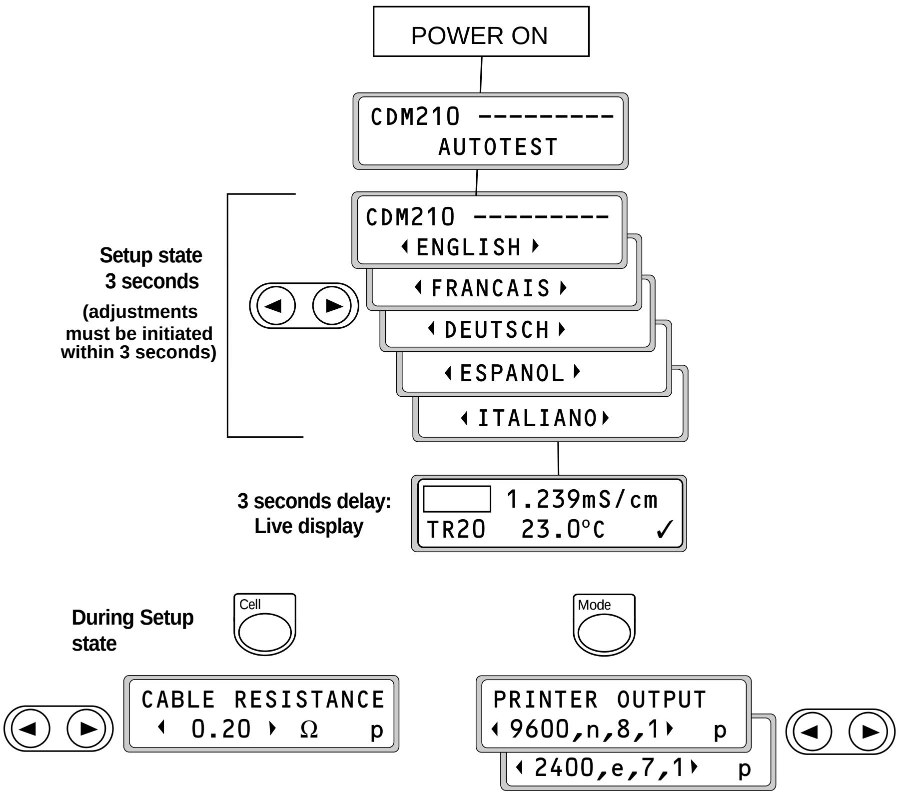
- 9600, n, 8,1: 9600 baud, no parity, 8 data bits, 1 stop bit.
- 2400, e, 7,1: 2400 baud, even parity, 7 data bits, 1 stop bit.

The format should be selected in accordance with the type of printer used.

Note:
However, if you are using the MeterMaster or the TimTalk program or the VIT90 Video Titrator, you must use the 2400 baud setting (refer to the relevant operating instructions).

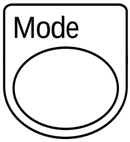
Starting up

Display Overview



Measuring Procedure

Selection of Mode Data



(1) Select conductivity or resistivity measurements after pressing **MODE.** Use the right and left arrow keys for the selection.

(2) **In conductivity:**

By pressing the ✓ key, you can select the conductance measuring range. For most purposes, the conductance ranges can be selected automatically using the AUTORANGE function (use the left and right arrow keys to select AUTORANGE). However, you can select from the 5 available measuring ranges manually using the same arrow keys.

NOTE: The relationship between the conductance and the conductivity of a sample is dependent on the cell constant and the temperature coefficient. For further details, refer to "Theory" page 20.

In resistivity:

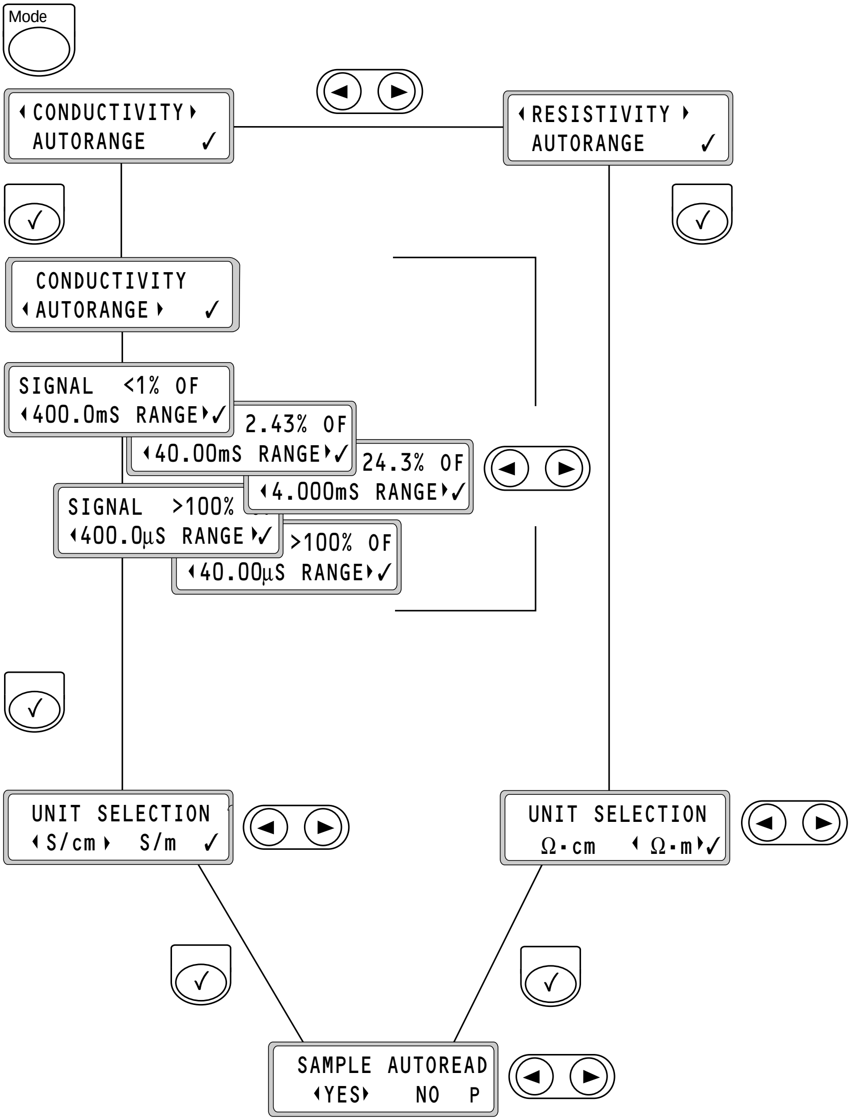
Only the AUTORANGE function is available.

(3) Press the ✓ key and select the measurement units. Conductivity can be measured in either S/m or S/cm and resistivity in Ω•cm or Ω•m.

(4) Press the ✓ key again and select **SAMPLE AUTOREAD YES/NO**. If you select **AUTOREAD = YES**, your result is locked on the display when either the stability criterion or maximum accept time (3 minutes) is reached. The result is then automatically printed out (if a printer is connected). However, if you select **AUTOREAD = NO**, measurements appear on a live display. A printout may be obtained by simply pressing the ✓ key when the "P" character is indicated in the bottom right-hand corner of the display.

Selection of Mode Data

Display Overview



Sample Measurements

(1) Rinse the conductivity cell with deionised water.

(2) Enter the cell constant. Please refer to "Calibration" page 12.

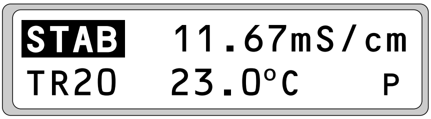
(3) If you require sample measurements at current temperature, press **T_{ref}** and, using the left and right arrow keys, select **NO TEMPERATURE CORRECTION**.

If sample measurements are to be corrected to a reference temperature, press **T_{ref}** and select 20 or 25°C using the left and right arrow keys. Press the ✓ key and enter the temperature coefficient. For the determination of the temperature coefficient, refer to page 16.

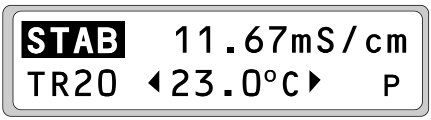
(4) Immerse the cell in the sample beaker and apply proper stirring. The SAM7 Sample Stand, which is a combined electrode holder and magnetic stirrer, is ideal for setups with the CDM210.

(5) Press **SAMPLE** to initiate the first sample measurement.

(6) If a temperature sensor is used, the live display shows the actual conductivity value corrected to the reference temperature (TR) and the measured sample temperature.



If no temperature sensor is connected, the live display shows the actual conductivity value corrected to the reference temperature (TR) and the sample temperature to be adjusted with the left/right arrow keys (resolution: 0.1°C).



If a temperature sensor is used.

A visual stability indicator "STAB" is displayed. If all four segments in "STAB" are displayed, the measured stability is better than 1%/min. The letters " ", "S", "ST" and "STA" appear as stabilisation progresses.

AUTOREAD Measurements (AUTOREAD = YES)

(a) Press ✓ key, as indicated in the bottom right hand corner of the display to start the AUTOREAD function.

(b) As soon as the conductivity measurement has been accepted and corrected to the reference temperature, the following display appears. The result is automatically printed out (when a printer is connected).

```
TR20   11.67mS/cm
RESULT     23.0°C
```

(c) Press the ✓ key to start an AUTOREAD measurement of a new sample. (Press any one of the keys **SAMPLE, MODE**, **CELL** or $\mathbf{T_{ref}}$ to stop the measurement).

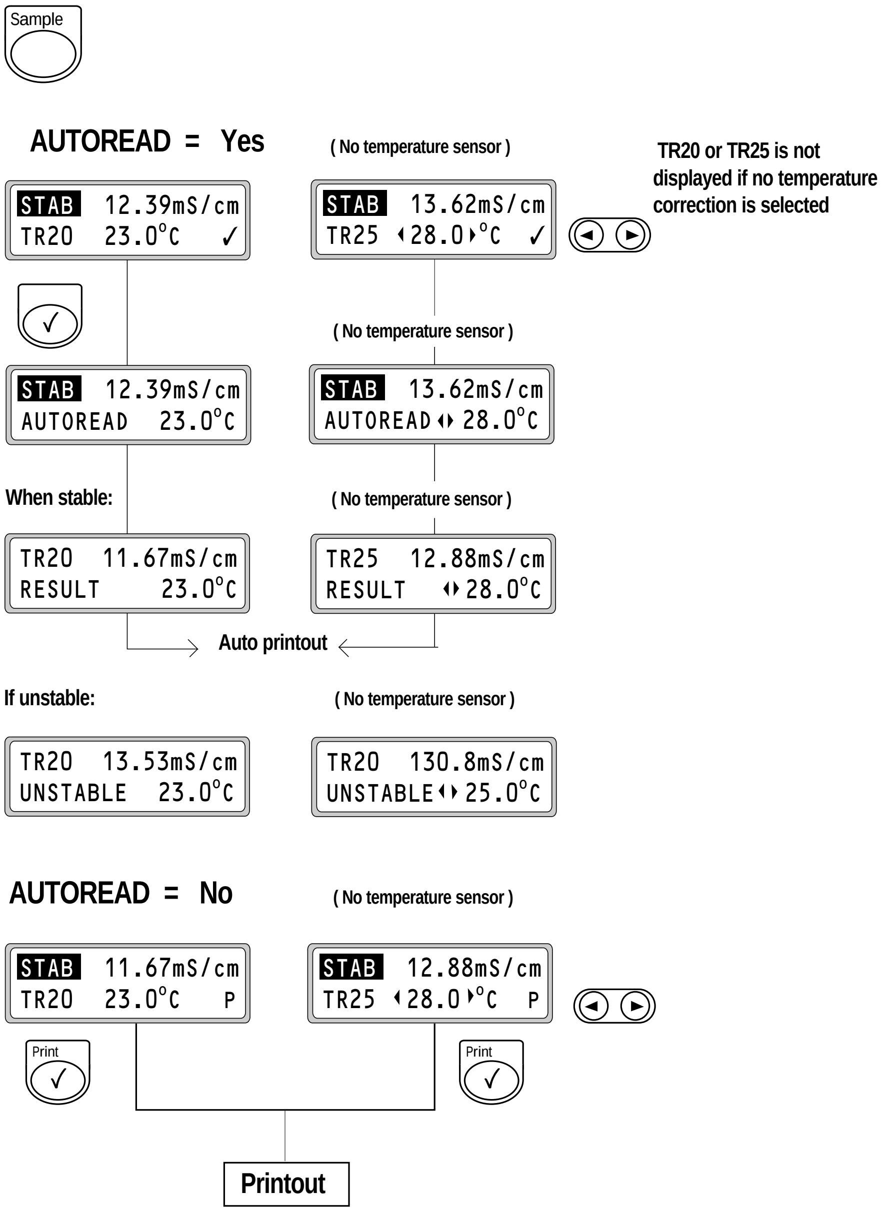
Measurements with live display (AUTOREAD = NO)

(a) Read the conductivity value when the signal becomes stable, i.e. when the visual stability indicator displays "STAB" continuously.

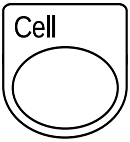
(b) Press the **✓ / Print** key if you require a printout.

Sample Measurements

Display Overview



Calibration



Determine the cell constant value as follows:

(1) Pour your standard solution into a measuring beaker. The tables, page 24 and following give the conductivities/resistivities values against temperature for some standards.

(2) Press **MODE** and select **CONDUCTIVITY** and **AUTORANGE**.

(3) Select the measurement units to be used.

(4) Press **CELL** : the CDM210 displays the cell constant value within arrows.

(5) Press **CELL** again in order to start the calibration procedure.

(6) When indicated on the display, dip the conductivity cell into the standard solution of known conductivity and press the ✓ key.

```
DIP CELL IN
STANDARD       ✓
```

(7) After stabilisation read the conductivity value shown on the display.

(8) If the conductivity value corresponds to the actual value of the standard solution, you may go directly to sample measurements by pressing the **SAMPLE** key.

```
STAB   12.39mS/cm
◂ 0.945▸23.0°C ✓
```

If the value does not correspond, adjust the value of the cell constant using the left or right arrow keys until the measured value matches the actual value of the standard at the actual temperature (temperature measured or entered). The tables, page 24 and following give the conductivity/resistivity values against temperature for some standards.

Note:

No temperature correction is made during a calibration procedure.

(9) Press the ✓ key to confirm the cell constant value which will be stored in the memory. If desired, this reading may be printed out by pressing the ✓ key.

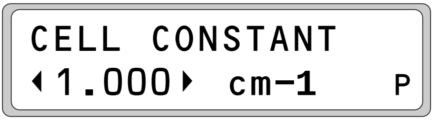
Note:

It is highly recommended to check the cell constant periodically as it may change with time.

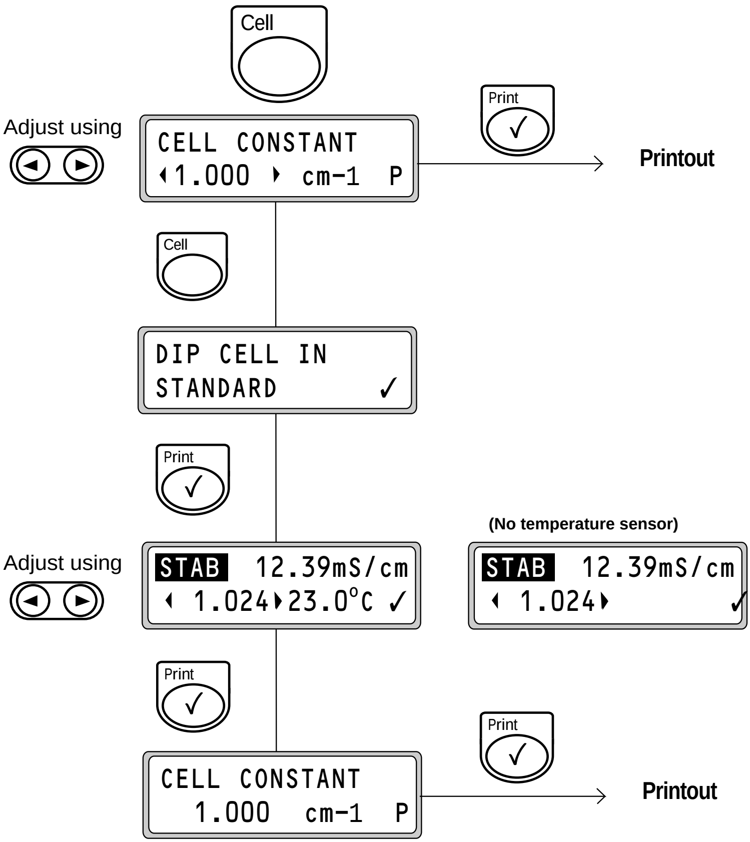
For high precision measurements, it is necessary to determine the cell constant by performing calibration measurements on a standard thermostatted at the desired measuring temperature.

Entry of the cell constant (if the cell constant value is known):

Press **CELL** and enter the cell constant value using the left and right arrow keys.



Entry of the Cell Constant Value
Display Overview

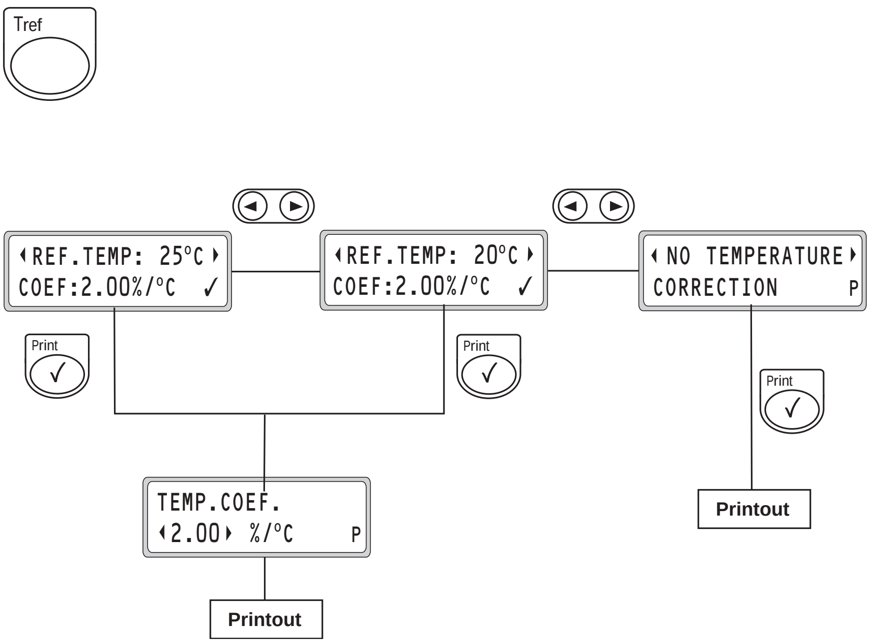


Entry of the Temperature Coefficient and Reference Temperature

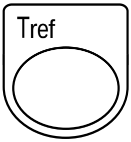
The following display overview shows that sample measurements may be corrected to a reference temperature of either 20 or 25 °C. Alternatively, sample measurements can be reported at sample temperature; simply, select **NO TEMPERATURE CORRECTION**. For further information, refer to page 9.

In order to determine the temperature coefficient, refer to page 16.

Display Overview



Determination of the Temperature Coefficient



The temperature coefficient of a sample may be determined by measuring the conductivity/resistivity of the sample at two different temperatures following the procedure described below.

(1) Press $\mathbf{T_{ref}}$ and, using the left and right arrow keys, set the CDM210 to **NO TEMPERATURE CORRECTION**.

(2) Immerse the conductivity cell in a sample thermostatted to the wanted reference temperature T1(T1 = 20°C or T1 = 25°C).

(3) Press the **SAMPLE** key.

(4) When stable, write down the conductivity value measured at T1.

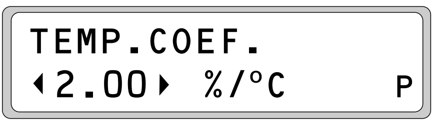
(5) Heat or cool the sample to the desired measuring temperature T2.

(6) Press the **SAMPLE** key and read the conductivity of the sample at the measured temperature.

(7) Enter the conductivity measurements (κ) at T1 and T2 into the following equation and calculate the temperature coefficient (θ) measured at the reference temperature T1.

$$\theta = \frac{(\kappa T1 - \kappa T2) \,.\, 100}{(T2 - T1) \,.\, \kappa T1} \quad \text{(Unit: \%/°C)}$$

(8) Press $\mathbf{T_{ref}}$. Using the left and right arrow keys, select the wanted reference temperature (20°C or 25°C) and press the ✓ key. Then, using the left and right arrow keys, enter the calculated temperature coefficient value.



Troubleshooting

A number of tests are automatically performed when the CDM210 is switched on, during calibration and during measurement. If an error is detected, an error message will appear on the display. The messages are listed below.

The CDM210 will normally return to the operational state during which the error was detected. This makes it possible to correct the error and immediately resume operation.

Error Messages

Message	Error / Action
PRINTER ERROR	If a printer is connected and data transmission cannot be performed properly, this message will appear. Check that the printer has been turned on and that the paper is in place.
TEMP. CORRECTION NOT POSSIBLE	During measurements, if the temperature correction condition (see condition 2 on page 20) is not satisfied, this message is displayed. Press the ✓ key or T_{ref} and correct the fault.
UNSTABLE	During AUTOREAD, if the conductivity signal has not stabilised within 3 minutes. The stability criterion is 1 % of the measured value per minute. Check conductivity cell connections, cell condition, stirring conditions. After correcting the fault, press the ✓ key to continue.

OUT OF RANGE	This message appears if the conductivity/ resistivity measurements are above or below the CDM210 specifications (refer to page 43). Select a higher measuring range if the range is selected manually. Check the condition of the conductivity cell and connection (cell input).
MEMORY ERROR	This message is displayed at power on if the instrument detects an error in the data stored in the non volatile memory. Default values are then restored and used instead of the erroneous data. This error may occur after years of extensive use. Please contact your local RADIOMETER ANALYTICAL representative.

Immunity interference:

When using the conductivity meter CDM210 in heavy industry: a high level electromagnetic field (>10 V/m) may impair the operation of the conductivity meter. The situation is temporary, operation will return to normal within a few seconds.

Printed messages

Examples:

```
   CONDUCTIVITY MODE
    RANGE              :  AUTORANGE
or  RANGE              :  40.00 mS
    UNIT SELECTION     :  S/cm
    AUTOREAD           :  YES
```

```
   RESISTIVITY MODE
    UNIT SELECTION     :  Ω.cm
    AUTOREAD           :  YES
```

```
   CONDUCTIVITY
    TEMPERATURE        :  25.0°C
    RESULT             :  12.88mS/cm at 25°C
```

```
   RESISTIVITY
    TEMPERATURE        :  25.0°C
    RESULT             :  7.764kΩ/cm at 25°C
```

Theory

The conductance G of a solution is defined as the sum of contributions from the movement of each kind of ion present.

The resistance between the electrodes is proportional to the ratio of the distance (l) between the electrodes and the surface area (s) of the electrodes. This ratio is known as the cell constant:

$$K = \frac{l}{s} \ (cm^{-1})$$

The CDM210 calculates and displays the conductivity of a solution on the basis of the measured conductance G, the cell constant of the conductivity cell used, and a compensation value for the cable resistance. The conductivity is calculated as follows:

$$\kappa = G \bullet K \ (S/cm)$$

κ = conductivity
G = conductance

The influence of the cable resistance on the measured conductance (Gm) is as follows:

$$Gm = \frac{Gs}{1 + (Rc \,.\, Gs)} \ (S)$$

Gs = solution conductance (S)
R = cable resistance (Ω)

Effects of Temperature

The conductivity of a solution will change with temperature. In order to compare measurements taken at different temperatures, the conductivities are corrected using the temperature coefficient:

Temperature correction factor:

Equation (1) : $$\kappa Tref = \frac{100}{100 + \theta \cdot (T - Tref)} \cdot \kappa T$$

Tref = reference temperature in °C

T = sample temperature in °C

κTref = conductivity at Tref

κT = conductivity at T

θ = temperature coefficient of the sample in %/ °C

Since the temperature correction factor should not be allowed to approach zero, the limits for the sample temperature T with respect to the reference temperature Tref (and vice versa) depend upon the θ temperature coefficient and are as follows:

Temperature correction conditions (validity of equation (1)):

Condition 1. $0.00 - \theta - 9.99$ % /°C

Condition 2. $$1/3 \leq \frac{100}{100 + \theta \cdot (T - Tref)} \leq 3$$

If these 2 conditions are not fulfilled, the error message **TEMP CORRECTION NOT POSSIBLE** will be displayed and no result will be obtained.

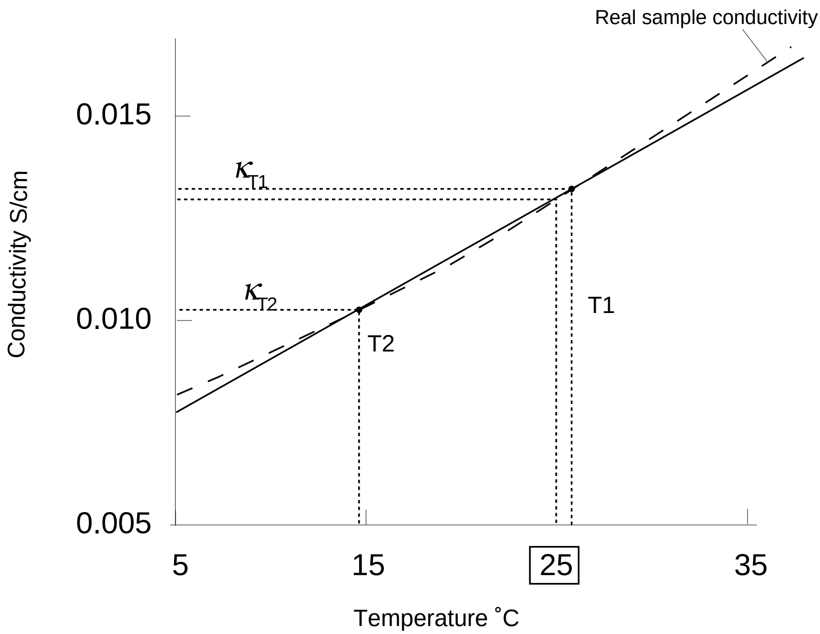
Determination of the temperature coefficient:

By measuring the conductivity of a sample at a temperature T1 close to Tref and another temperature T2, you can calculate the temperature coefficient by using the following equation:

$$\theta = \frac{(\kappa T1 - \kappa T2) \cdot 100}{(T2 - T1) \cdot \kappa T1} \quad \text{(Unit: \%/°C)}$$

T2 should be selected as a typical sample temperature and should be more than 10°C different from T1.

With temperature compensation, the conductivity at the reference temperature is displayed. Note that the compensation is accurate only within a limited temperature range around T1 and T2. On the figure below:
T1 = 26°C, T2 = 14°C and Tref = 25°C.



Maintenance

The CDM210 requires minimum maintenance. However, the outer surface of the meter may need to be cleaned from time to time with a soft cloth and tepid, soapy water. Cleaning must not erase the markings.

Conductivity/Resistivity Tables

Table 1. Conductivity (in mS/cm) of varying concentrations of KCl solutions

Temp (°C)	KCl 1M	KCl 10^{-1}M	KCl 2 x 10^{-2}M	KCl 10^{-2}M
0	65.41	7.15	1.521	0.776
1	67.13	7.36	1.566	0.800
2	68.86	7.57	1.612	0.824
3	70.61	7.79	1.659	0.848
4	72.37	8.00	1.705	0.872
5	74.14	8.22	1.752	0.896
6	75.93	8.44	1.800	0.921
7	77.73	8.66	1.848	0.945
8	79.54	8.88	1.896	0.970
9	81.36	9.11	1.945	0.995
10	83.19	9.33	1.994	1.020
11	85.04	9.56	2.043	1.045
12	86.89	9.79	2.093	1.070
13	88.76	10.02	2.142	1.095
14	90.63	10.25	2.193	1.121
15	92.52	10.48	2.243	1.147
16	94.41	10.72	2.294	1.173
17	96.31	10.95	2.345	1.199

Table 1......Continued

Temp (°C)	KCl 1M	KCl 10^{-1}M	KCl 2×10^{-2}M	KCl 10^{-2}M
18	98.22	11.19	2.397	1.225
19	100.14	11.43	2.449	1.251
20	102.07	11.67	2.501	1.278
21	104.00	11.97	2.553	1.305
22	105.94	12.15	2.606	1.332
23	107.89	12.39	2.659	1.359
24	109.84	12.64	2.712	1.386
25	111.80	12.88	2.765	1.413
26	113.77	13.13	2.819	1.441
27	115.74	13.37	2.873	1.468
28		13.62	2.927	1.496
29		13.87	2.981	1.524
30		14.12	3.036	1.552
31		14.37	3.091	1.581
32		14.62	3.146	1.609
33		14.88	3.201	1.638
34		15.13	3.256	1.667
35		15.39	3.312	
36		15.64	3.368	

Table 2. Resistivity (in Ω•cm) of varying concentrations of KCl solutions

Temp (°C)	KCl 1M	KCl 10^{-1}M	KCl 2 x 10^{-2}M	KCl 10^{-2}M
0	15.29	139.86	657.46	1288.66
1	14.90	135.87	638.57	1250.00
2	14.52	132.10	620.35	1213.59
3	14.16	128.37	602.77	1179.25
4	13.82	125.00	586.51	1146.79
5	13.49	121.66	570.78	1116.07
6	13.17	118.48	555.56	1085.78
7	12.87	115.47	541.13	1058.20
8	12.57	112.61	527.43	1030.93
9	12.29	109.77	514.14	1005.03
10	12.02	107.18	501.50	980.39
11	11.76	104.60	489.48	956.94
12	11.51	102.15	477.78	934.58
13	11.27	99.80	466.85	913.24
14	11.03	97.56	456.00	892.06
15	10.81	95.42	445.83	871.84
16	10.59	93.28	435.92	852.51
17	10.38	91.32	426.44	834.03
18	10.18	89.37	417.19	816.33
19	9.99	87.49	408.33	799.36

Table 2......Continued

Temp (°C)	KCl 1M	KCl 10^{-1}M	KCl 2×10^{-2}M	KCl 10^{-2}M
20	9.80	85.69	399.84	782.47
21	9.62	83.96	391.70	766.28
22	9.44	82.31	383.73	750.75
23	9.27	80.71	376.08	735.84
24	9.10	79.11	368.73	721.50
25	8.94	77.64	361.66	707.71
26	8.79	76.16	354.74	693.96
27	8.64	74.79	348.07	681.20
28		73.42	341.65	668.45
29		72.10	335.46	656.17
30		70.82	329.38	644.33
31		69.59	323.52	632.51
32		68.40	317.86	621.50
33		67.20	312.40	610.50
34		66.09	307.13	599.88
35		64.98	301.93	
36		63.94	296.91	

Table 3. Average temperature coefficients of standard electrolyte solutions expressed as %/°C of the conductivity value at 25°C

Temperature Range °C	KCl 1M	KCl 10^{-1}M	KCl 2 x 10^{-2}M	KCl 10^{-2}M	Saturated NaCl
15 - 25	1.735	1.863	1.888	1.882	1.981
15 - 25 - 35	1.730 *(15 - 27)	1.906	1.933	1.937 *(15 - 34)	2.041
25 - 35	1.730 *(25 - 27)	1.978	1.978	1.997 *(25 - 34)	2.101

* Temperature range °C

Table 4. Average temperature coefficients of standard electrolyte solutions expressed as %/°C of the resistivity value at 25°C

Temperature Range °C	KCl 1M	KCl 10^{-1}M	KCl 2 x 10^{-2}M	KCl 10^{-2}M
15 - 25	- 2.09	- 2.30	-2.34	-2.33
15 - 25 - 35	- 2.02 *(15 - 27)	-1.92	-1.95	-1.98 *(15 - 34)
25 - 35		-1.63	-1.65	-1.69 *(25 - 34)

* Temperature range °C

Table 5. Conductivity (in mS/cm) of 1D, 0.1D and 0.01 D KCl Demal solutions

Temp. (°C)	KCl (**) 1 D	KCl (*) 0.1 D	KCl (*) 0.01 D
0	65.14	7.13	0.773
1	66.85	7.34	0.796
2	68.58	7.56	0.820
3	70.32	7.77	0.843
4	72.07	7.98	0.867
5	73.84	8.20	0.891
6	75.62	8.42	0.915
7	77.41	8.64	0.940
8	79.21	8.86	0.965
9	81.03	9.08	0.989
10	82.85	9.31	1.014
11	84.68	9.54	1.039
12	86.54	9.76	1.065
13	88.39	9.99	1.090
14	90.26	10.22	1.116
15	92.13	10.46	1.142
16	94.02	10.69	1.168
17	95.91	10.93	1.194
18	97.81	11.16	1.220
19	99.72	11.40	1.247
20	101.63	11.64	1.273
21	103.56	11.88	1.300
22	105.49	12.12	1.327

Table 5......Continued

Temp. (℃)	KCl (**) 1 D	KCl (*) 0.1 D	KCl (*) 0.01 D
23	107.42	12.36	1.354
24	109.36	12.61	1.381
25	111.31	12.85	1.409
26	113.27	13.10	1.436
27	115.22	13.35	1.464
28		13.59	1.491
29		13.84	1.519
30		14.09	1.547
31		14.34	1.575
32		14.59	1.603
33		14.85	1.632
34		15.10	1.660
35		15.35	1.688
36		15.61	1.717
37		15.86	1.745
38		16.12	1.774
39		16.37	1.803
40		16.63	1.832
41		16.89	1.861
42		17.15	1.890
43		17.40	1.919
44		17.66	1.948
45		17.92	1.977
46		18.18	2.007
47		18.44	2.036
48		18.70	2.065
49		18.96	2.095
50		19.22	2.124

Table 6. Resistivity (in Ω•cm) of 1D, 0.1D and 0.01 D KCl Demal solutions

Temp (°C)	KCl (**) 1 D	KCl (*) 0.1 D	KCl (*) 0.01 D
0	15.35	140.16	1293.51
1	14.96	136.17	1255.81
2	14.58	132.36	1219.94
3	14.22	128.73	1185.76
4	13.87	125.26	1153.18
5	13.54	121.95	1122.09
6	13.22	118.79	1092.39
7	12.98	115.76	1064.01
8	12.62	112.86	1036.86
9	12.34	110.08	1010.87
10	12.07	107.43	985.97
11	11.81	104.87	962.10
12	11.56	102.42	939.21
13	11.31	100.07	917.23
14	11.08	97.81	896.13
15	10.85	95.63	875.84
16	10.64	93.54	856.33
17	10.43	91.53	837.57
18	10.22	89.59	819.50
19	10.03	87.72	802.10
20	9.84	85.92	785.33
21	9.96	84.18	769.16
22	9.48	82.50	753.56
23	9.31	80.88	738.50
24	9.14	79.32	723.97
25	8.98	77.81	709.93
26	8.83	76.35	696.36

Table 6......Continued

Temp (°C)	KCl (**) 1 D	KCl (*) 0.1 D	KCl (*) 0.01 D
27	8.68	74.94	683.24
28		73.57	670.56
29		72.25	658.28
30		70.97	646.40
31		69.73	634.90
32		68.52	623.75
33		67.36	612.95
34		66.23	602.48
35		65.14	592.33
36		64.08	582.49
37		63.04	572.93
38		62.04	563.66
39		61.07	564.65
40		60.13	545.91
41		59.21	537.42
42		58.32	529.16
43		57.46	521.14
44		56.62	513.33
45		55.80	505.75
46		55.00	498.37
47		54.23	491.18
48		53.47	484.19
49		52.74	477.39
50		52.02	470.76

(*) **Reference**: "Organisation Internationale de Métrologie Légale (OIML)", Recommendation n°56 and "The National Institute of Standards and Technology (NIST)", Journal of Solution Chemistry, Vol. 20, no. 4, 1991.

(**) For KCl 1 D solution : Extrapolation of the NIST results from conductivities given at 0°C, 18°C and 25°C by the OIML.

Table 7. Conductivity (in μS/cm) and resistivity (in Ωcm) of a 0.05% NaCl solution

Temp (°C)	Conductivity	Resistivity
0	540.40	1850.47
1	557.73	1792.97
2	575.20	1738.54
3	592.79	1686.93
4	610.53	1637.93
5	628.40	1591.35
6	646.40	1547.02
7	664.55	1504.78
8	682.83	1464.48
9	701.26	1426.01
10	719.82	1389.23
11	738.53	1354.05
12	757.37	1320.36
13	776.36	1288.07
14	795.48	1257.11
15	814.74	1227.38
16	834.14	1198.83
17	853.68	1171.39
18	873.36	1145.00
19	893.18	1119.60
20	913.13	1095.13
21	933.22	1071.56
22	953.44	1048.83
23	973.80	1026.91
24	994.28	1005.75
25	1014.90	985.31
26	1035.65	965.57

Table 7......Continued

Temp (°C)	Conductivity	Resistivity
27	1056.53	946.49
28	1077.54	928.04
29	1098.67	910.19
30	1119.92	892.92
31	1141.30	876.19
32	1162.80	859.99
33	1184.41	844.30
34	1206.15	829.09
35	1228.00	814.34
36	1249.96	800.03
37	1272.03	786.15
38	1294.21	772.67
39	1316.49	759.59
40	1338.89	746.89
41	1361.38	734.55
42	1383.97	722.56
43	1406.66	710.90
44	1429.44	699.57
45	1452.32	688.55
46	1475.29	677.83
47	1498.34	667.40
48	1521.48	657.25
49	1544.71	647.37
50	1568.01	637.75

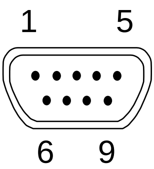
Reference: G.F. Hewitt, Chemical Engineering Division, U.K.A.E.A Research Group Atomic Energy Research Establishment, HARWELL, U.K., Oct 1960.

Connection of Peripherals

The CDM210 Conductivity Meter is equipped with terminals for connection of printer/personal computer/VIT90 Video Titrator, recorder, temperature sensor, conductivity cell and SAM7 Sample Stand. The terminals on the rear panel are illustrated in fig.1 page 1.

Printer/PC

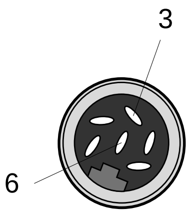
9-pin, Sub D-connector (see page 4 for further specifications).
RADIOMETER ANALYTICAL cable for printer connection: A95P201.



Pin connections:

1. No connection	
2. Receiving Data (input):	RxD
3. Transmitted Data (output):	TxD
4. Data Terminal Ready (output):	DTR
5. Ground:	GND
6. Data Set Ready (input): not connected	DSR
7. Request to Send (output):	RTS
8. Clear to Send (input):	CTS
9. No connection	

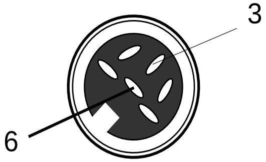
POWER IN input: 6-pin DIN input DC power supply for the CDM210.



Pin connections:

3. 0 V (ground)
6. -12 V, 800 mA max

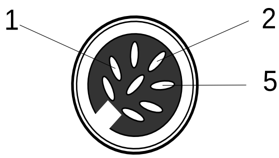
POWER OUT output: 6-pin DIN socket for connection of the SAM7 Sample Stand (RADIOMETER ANALYTICAL cable part no.: A95A110).



Pin connections:

3. Electrical zero
6. -12 V, 300 mA max

RECORDER output: 8-pin DIN socket for connection of a recorder (RADIOMETER ANALYTICAL cable part no. A95R102). The CDM210 offers 2 types of analogue output signals.



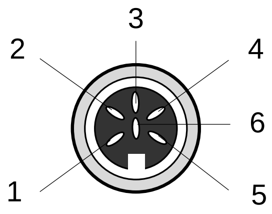
Pin connections:

1. Direct analogue output proportional to the **conductance or resistance measured** by the CDM210 (2000 mV full-scale).
2. Calibrated analogue output proportional to **the conductivity displayed** on the CDM210. 2 digits (i.e. the difference between the displays "0000" and "0002") corresponds to 0.25 mV. Maximum potential output: 1 V.
   To use the calibrated analogue output, **you must select a fixed conductance range** (you cannot use the AUTORANGE mode).
   For **resistivity measurements**, this pin outputs 0 V irrespective of the resistivity displayed.
5. 0 V

Calibrated analogue output: examples of potential output (E) between pins 2 and 5 when working on the 4 mS conductance range:

Displayed conductivity = 2.000 mS/cm : E = 250 mV.
Displayed conductivity = 1.000 mS/cm : E = 187.5 mV.
Displayed conductivity = 4.000 mS/cm : E = 500 mV.
Displayed conductivity = 6.000 mS/cm : E = 750 mV.
Displayed conductivity = 7.998 mS/cm : E = 999.75 mV.
Displayed conductivity = 8.000 mS/cm : E = 1 V.
Displayed conductivity = 9.447 mS/cm : E = 1 V.
Displayed conductivity = 12.78 mS/cm : E = 1 V.

CELL input: 6-pin DIN socket for connection of the conductivity cell with 2 or 4 poles and a temperature sensor.



Pin connections:

1. Pole no. 1
2. Pole no. 2
3. Pole no. 3
4. Pole no. 4, also connected to pin no. 5
5. 0 V (ground)
6. Temperature sensor

A potential of ±200 mV is imposed between poles 2 and 3 for all conductance ranges except for the 2 S range (±40 mV).

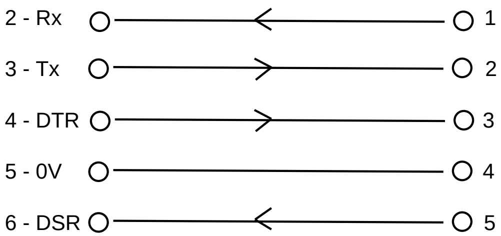
The current passing through poles 1 and 4 is measured. The potential between poles 1 and 4 cannot exceed 1 V in absolute value.

Temperature sensor input: 1 CINCH socket

Connecting the VIT90 Video Titrator to the CDM210 Conductivity Meter

Connect the cable between the CDM210 **PRINTER/PC** terminal and the BURETTE I/O terminal no. 3 on the VIT90 (see pin layout of connecting cable part no. A95A220 below).

9-pin female connector (CDM210) 5-pin male connector (VIT90)



NOTE: The CDM210 must be set to 2400 baud (see page 5) and the AUTORANGE mode must be selected for conductivity measurements.

Remote Control using a PC

Connect the CDM210 printer output to the COM1 serial port on the PC using the RADIOMETER ANALYTICAL cable, part no. A95X501 or A95X502 (A95X501 for PC with a 9-pin serial port and A95X502 for PC with a 25-pin serial port).

Data transmission: 8 data bits, 1 stop bit, no parity. Baud rate: 9600 or 2400 baud if the TimTalk software is used (set in setup state, refer to page 5).

Note: All the commands given in the table below must be followed by a Carriage Return.

Keyboard emulation:

Switch on the CDM210 and send the >CE command first (answer: <CE): the remote control is now active.

Command	Answer	Comments
>M	<M	Mode key
>T	<T	T_{ref} key
>C	<C	Cell key
>S	<S	Sample key
>O	<O	✓ / Print key
>R	<R	Right arrow key
>L	<L	Right arrow key

The >KD command (answer: <KD) disables the instrument keyboard. After this command is received, the keyboard is inactive. Sending the >KE (answer: <KE) will enable again the CDM210 keyboard.

Description of commands and messages:

Command	Answer	Comments
>CE	<CE	Sets the instrument to remote control mode. **After switching on the CDM210, the >CE command must be sent first before any other commands.**
>CD	<CD	Disables remote control mode.

Command	Answer	Comments
>MW n,v	<MW	MEMORY WRITE n,v values: See the data table on page 40.
?MR n	=MR v	MEMORY READ n,v values: See the data table on page 40.
>MU	<MU	MEMORY UPDATE Send this command to the CDM210 before switching the instrument off to avoid loosing the last data entered.
>PE	<PE	Enables the transmission of printer texts.
>PD	<PD	Disables the transmission of printer texts.
?RD D	=RD (L1) (L2)	READ DISPLAY = Display contents of the CDM210. (L1), (L2): 16 characters for each line.
>SD	<SD	AUTOSEND STATUS DISABLE The function described below (>SE) is disabled.
>SE	<SE	AUTOSEND STATUS ENABLE At each display change, the CDM210 will send a status message (!ST dd where dd is a code identifying the display).
?TY	=CDM210 Yyyww	INSTRUMENT TYPE CDM210 software reference. yy: year, ww: week of the version.
?ST	=STdd	Each status number (01 - 44) corresponds to a certain display.
?		List of commands

Data Table

Data Name	Value (v)	Default value (v)	Remote Control number (n)
Language	1: English 2: French 3: Spanish 4: German 5: Italian	■	1
Mode	1: Conductivity 2: Resistivity	■	3
Range	0: Autorange 1: 400.0 mS 2: 40,0 ms 3: 4,0 ms 4: 400,0 µs 5: 40.00 µS	■	4
Result unit	0: Ω.cm 1: Ω.m	■	5
Sample AUTOREAD	0: No 1: Yes	■	6
Reference temperature	0: No temp 1: 20°C 2: 25°C	 ■	7
Temperature coef.	0.00 .. 9.99 %/°C	2.20	8
Cell constant	0.05 ..15.00 cm^{-1}	1	9
Cable resistance	0.00 .. 99.99 Ω	0	10
Temperature	-9.9 .. 99.9 °C	25	11
Printer Output	0: 2400,e,7,1 1: 9600,n,8,1	 ■	12

Accessories

Accessories Supplied

The CDM210 comes in different versions depending on the mains voltage and the adapter to be used.

CDM210 Conductivity Meter, 115 V, US-version (R21M012) including:

Adapter 115 V 60 Hz / Unregulated 12 V, 1 A	A66B002

CDM210 Conductivity Meter, 230 V, EURO-version (R21M011) including:

Adapter 230 V 50 Hz / Unregulated 12 V, 1 A	A66B001

Accessories Available

The following accessories are available to make a complete MeterLab setup:

SAM7	Sample Stand	391-543
	Power supply cable from CDM210 to SAM7	A95A110
CDC641T	Conductivity Cell with built-in temperature sensor ; platinised	B15B001
CDC741T	Conductivity Cell, 2 poles ; platinised, built-in temperature sensor, 3 m cable MAB6 plug	E61M012
CDC745-9	Conductivity Cell, 2 poles ; platinised ; epoxy body ; screw cap	E61M013
CDC565	Conductivity Cell, 4 poles	E61M003
CDC865	Conductivity Cell, 4 poles ; platinised	E61M004
T201	Temperature Sensor	E51M001
CL136	Electrode cable FX / coax 1m / MAB6	A94L136
CL336	Electrode cable FX / coax 3m / MAB6	A94L336

	Plug Adapter UHF-F/MAB6-M	A94P001
	Printer cable, 9-25 pin	A95P201
	PC cable, 9-25 pin	A95X502
	PC cable, 9-9 pin	A95X501
	Recorder cable	A95R102
	Cable for VIT90 to CDM210	A95A220
	Conductivity standard, 500 ml, 1 Demal KCl	S51M001
	Conductivity standard, 500 ml, 0.1 Demal KCl	S51M002
	Conductivity standard, 500 ml, 0.01 Demal KCl	S51M003
	Conductivity standard, 500 ml, 0.05% NaCl	S51M004
KS910	0.1 M KCl solution, 500 ml	C20C250
KS920	0.1 M KCl solution, 500 ml	C20C270
KS930	0.1 M KCl solution, 500 ml	C20C280

Specifications

Measuring range, conductivity

0.01 µS/cm to 400 mS/cm with a cell constant of 1.0 cm^{-1}.

0.001 µS/cm to 5.99 S/cm with a cell constant between 0.05 cm^{-1} and 15 cm^{-1}.

Automatic or manual range selection.

Measuring range, resistivity

2.5 Ω• cm to 49 MΩ• cm with a cell constant of 1.0 cm^{-1}

0.2 Ω• cm to 1.0 GΩ• cm with a cell constant between 0.05 cm^{-1} and 15 cm^{-1}.

Automatic range selection.

Temperature measuring range

-9.9 °C to 99.9°C

Resolution, conductance

1/4000 full-scale

Resolution, temperature

0.1°C

Accuracy, conductivity

± 0.2 % of reading ± 3 of least significant digit.

Accuracy, resistivity

Typically ±1 % of reading ± 3 of least significant digit.

Accuracy, temperature

± 0.5°C

Measuring frequencies

94 Hz in 40.00 µS range

375 Hz in 400.0 µS range

2.93 kHz in 4.000 mS range

23.4 kHz in 40.00 mS range

46.9 kHz in 400.0 mS range

Result units

Conductivity: S/cm or S/m

Resistivity: $\Omega \cdot$ cm or $\Omega \cdot$ m

Stability criterion, AUTOREAD function

1 % of measured value per minute

Max. accept time, AUTOREAD function

3 minutes

Cell constant

0.050 to 15.000 cm^{-1}

The cell constant can be entered manually or determined using any conductivity standard.

Reference temperature

None, 20°C or 25°C

Sample temperature

-9.9 to 99.9°C

Temperature coefficient

0.00 to 9.99 %/°C

Cable resistance

0.00 to 99.99 Ω

Finish

Splashproof cabinet with 2 × 16-character, alphanumeric LCD display.

Languages

English, French, German, Italian or Spanish can be selected.

Outputs/inputs

Inputs for conductivity cell and temperature sensor.

RS232C I/O for connection of printer/ PC and VIT90 Video Titrator. 9-pin, D-connector. 2400 or 9600 baud.

Direct analogue recorder output, 2000 mV full-scale.

Calibrated analogue recorder output for conductivity measurements only, 0.25 mV correspond to 2 digits of the CDM210 display. Maximum potential output: 1 V.

Power supply for SAM7 Sample Stand.

Ambient Temperature

5 to 40°C

Relative humidity

20 to 80 %

Power requirements

12 V mains adapter.

Weight

1.0 kg

Dimensions (H x W x D)

9.5 x 28 x 21.5 cm

EMC Standards

The CDM210 complies with the following regulations:

Emission:	Generic standard	EN50081-1 (1992)
	Basic standard	EN55022 (1987) Class B
Immunity:	Generic standard	prEN50082-2 (1992)
	Basic standard	IEC 801-2 (1991) level 3
		IEC 801-3 (1984) level 3
		IEC 801-4 (1988) level 3

Key Word Index

D21M006

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