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# Manual

## Chemex Chembox CB2

in English

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# 1 Chemex short introduction


Chemex is a data acquisition and experimentation software with windows guidance for operation of the universal interface Chembox. It provides display instruments, an eight channel recorder and a two point controlling system. Evaluation of experiments may be carried out in a text editor module. In addition an information group gives the option to save data required for an experiment. Index cards located on the right side of the screen provide convenient shortcuts to switch between individual functions.

## 1.1 Operating the instruments

All Chemex instruments have the same or similar gadgets. In the following you will find a short introduction.

### 1.1.1 Using the scales

The following functions are available on all Chemex scales:



Display for channel options: Click on unit click-field

Scale the range up by clicking the upper end of the scale  
e.g. 20 in this case

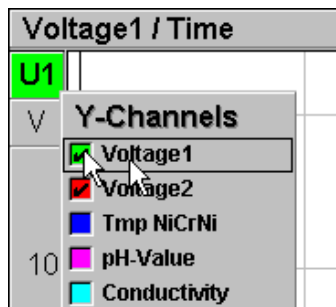
Shift the scale by dragging it

- press the left mouse button
- drag the mouse to the destination
- release mouse button

Scale the range down by clicking the lower end of the scale

All Chemex scales run synchronously. If you change the measurement range, e.g. on the recorder, all displays etc. become adjusted automatically.

### 1.1.2 Selecting the displayed channel





Click on the colored unit click-field at the upper end of the scale, where the measurement unit is displayed. The channel program is displayed. After clicking on the desired superior channel, the window disappears and the scale changes to the channel selected.

The channel window of the recorder's Y-axis (see left), gives enhanced options to select required channels just by clicking on any of the colored click-fields (Check mark = on). Selected channels may also be changed during or after recording. You may use e.g. the Y/t-mode first and switch to X/Y-mode while recording.

## 1.2 Defining channels

Chemex receives its data from Chembox. Before the signal is displayed on the screen, initial calibration as well as a calculation have to be applied. The calculation is used for e.g. calculating multiplying logarithm of the Chembox data received. These functions are on the index card *measure/setup*.

Channel - Linking					
Channel	Calculation	Symbol	Unit	Name	
 =	K1	U1	V	Voltage1	
 =	K2	U2	V	Voltage2	

Chembox								
Input	Sensor1	Sensor2	NiCrNi	pH/mV	Conduct.	Event	Time	Index
Variable	K1	K2	K3	K4	K5	K6	t	Ind
Value	0,000V	0,000V	19,1°C	542mV	0,000S	0,000	6,77s	0

Chembox acquired data has to pass initial calibration, before it can finally be illustrated at the Chembox display. In order to calibrate the input, click on the corresponding channel at the Chembox display. A calibration window appears allowing two point calibration.

The current value is assigned to the variables K1 to K6, t and Ind.. These variables can be linked to any of the calculation fields. In this example, channel one is assigned to the variable K1, being called Voltage1. Due to the linkage to channel1 (green), the value of sensor1.

Complex calculations e.g.  $V1 * \text{Log}(V2 * 3.437)$  may be entered, too.

## 1.3 Measurement, reports

To start any record operation switch the recorder on. Please notice the samplemode (Menu *'Options/Samplemode'*). When record work is finished log off. Now you may zoom, label the curves, set tangents, etc. After labeling the curves click on the print tool of the recorder. Determine your record's insert point on the record screen. Using the table-tool you may create a table the same way. It is also possible to insert graphic files by choosing *'File/Insert Bitmap'*. All Chemex instruments may be copied to clipboard (Menu *'Edit/Copy'*). To scale down graphics in text, click on the picture, and move the black anchor points. Graphics or tables added to text are handled like letters. To move a graphic, first mark, then cut, and finally paste it. Chose *'File/Print'* in the menu to output the info-part or report on your printer. A page preview is available by *'File/Page Preview'*.

## 1.4 Saving experiments

After completing your experiment, lock (*'File/Lock'*) and save it (*'File/Save'*). The lock command write-protects the information data, and asks for a password to save the experiment file. This safeguards your experiment files from unwanted manipulation. By *'File/Add Icon'* you may insert an experiment-icon into the Chemex group of the program manager, which allows direct load-up of the experiment.

# 2 Starting the program

## 2.1 Minimum requirements:

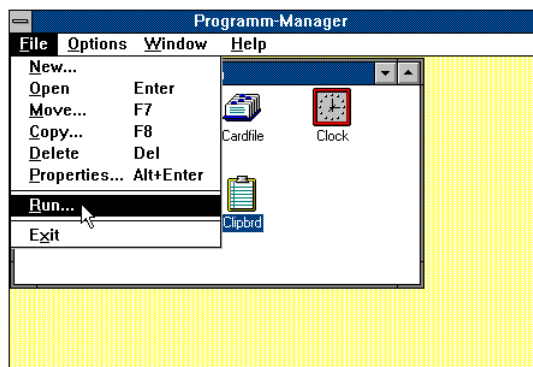
IBM compatible PC meeting the following requirements:

- 386 33 MHz
- 4 Megabyte RAM Memory
- 4 Megabyte free storage space on the harddisk
- MS DOS 5.0 and Windows 3.1 or Windows 3.11
- a free serial port

For fast operation:

- 486DX 33 MHz
- 8 MB RAM Memory

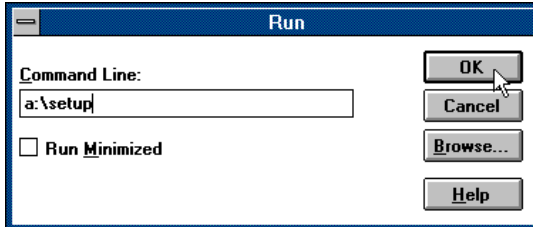
## 2.2 Installation



Installing Chemex is easy:

- Start Windows
- Select 'File/Run' in the program manager
- Insert disc into 3.5" drive
- Enter drive:\setup (e.g. "a:\setup")

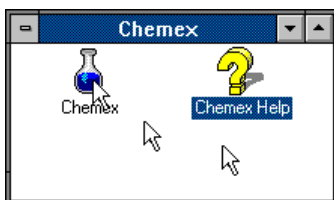
If the program is loaded from a disc you will be asked in which language you want to install Chemex. Choose English and press OK. Now you will be asked in which drive and directory you want to install Chemex. Please enter a path or accept the pre-adjustments and press OK. Chemex is ready to be started. You will find a new group called "Chemex" in the program manager. If you open that group you will see the Chemex symbol as well as Chemex help.



Finally connect Chembox to a socket and switch it on. The bottom relay-light diode will illuminate. Connect Chembox and the PC with a 25pin modem cable. Plug in Chembox first, and then the PC to avoid confusion with the parallel port. Doubleclick the Chemex icon in the program manager to activate Chemex. Chemex and Chembox will start operating now. You may start your measurements.



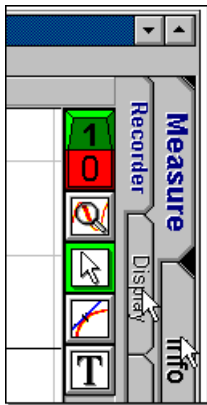
**Caution:** Windows 3 as well as Windows for Workgroups 3.11, are hampered with distributed bugs on serial port drivers. All users of SMC chips (additional serial hardware buffer) are affected. The corrected drivers are on the Chemex setup disc in the WIN\_BUG. directory. To install the new driver exit Windows, go to the WIN\_BUG directory and enter SETUP.



**Note:** Chemex is constantly improved and supported. For that reason the program contains functions which

may not be mentioned in this handbook.

# 3 Operation of Chemex

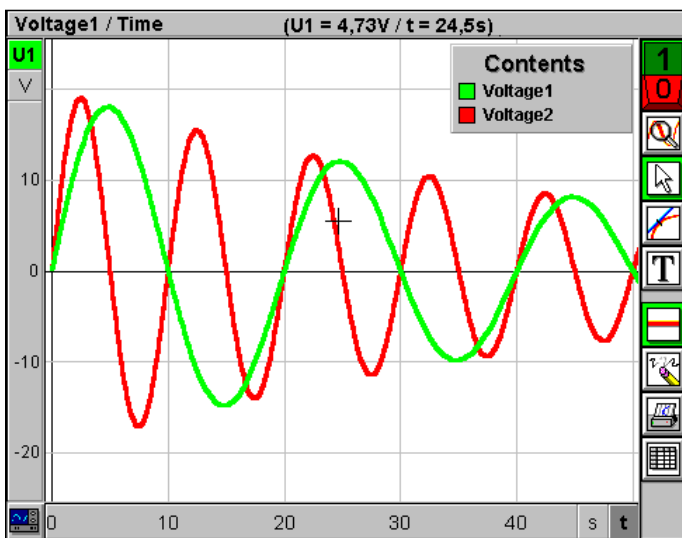


Chose the desired Chemex function on the index cards at the right end of the screen. If you click on *Display*, the display index card will be activated; if you go for *INFO*, the info page is shown.

The following cards are available:

- Measurement
  1. Recorder (Eight channel recorder Y/t, Y/n, X/Y)
  2. Display (4 analog instruments)
  3. Setup (Calibration, Calculation)
  4. Control (2-point-Controllers)
- Info (User information)
- Report (Text editor for planning experiments)

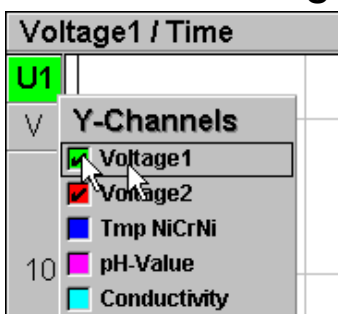
## 3.1 Recorder



The Chemex recorder is an universal 8 channel Y/t and X/Y recorder. The titelbar of the recorder shows the current assignment to the axis as well as the current mouse position. By clicking on the titlebar you may switch the table of contents on or off. On the right side is the ON/OFF switch and tools for revising like zoom, tensions, lines, labeling...

You may assign any variables to the axes (X and Y), allowing vice-versa display of any variables. Time-taking manual copy work of a graph e.g. from the time base of a mechanical recorder to the volume etc. is thus bypassed and not longer necessary.

### 3.1.1 Selecting the displayed channels and bases



By clicking on the colored click-field of the Y-axis, the Y-channel-program is displayed. It lists all color-fields and names for each channel. If you click on any color-field a check-mark appears. It symbolises that the recorder will start displaying the chosen channel on the screen. According to the setting shown on the left, a green and a red curve will be drawn, representing Voltage1 and Voltage2.

Data assigned to the Y-ruler is selected by clicking on the channels name. In this case the bar shows Voltage1, making the Y-axis to show a ruler for Voltage1 (superior channel). The selection of the basis (X-axis) is done accordingly.

## 3.1.2 Recorder tools



### ON/OFF switch:

Activates or deactivates record operation



### Zoom

Key for zoom ON/OFF

Zooming:

- Press zoom symbol
- Move the cursor to the upper left area subject to magnification
- Press left mouse button
- Define the area of interest by dragging a rectangle
- Release mouse button

Switch off zoom function by clicking on the zoom symbol.



### Standard

Deactivate straight line and text tools.

The standard-, the line-, and the text-tool can only be activated one at a time. These three tools take turns.



### Line

To position attendend and a best fitting curve, do the following:

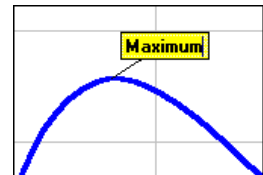
- Click on line-symbol
- Mark any critical point on the curve, to identify the tensions position
- Press left mouse button
- Move to the end of the line
- Release left mouse button



### Text

Labeling curves in the recorder:

- Click on text tool
- Move mouse to any point to be labeled
- Press left mouse button, move to position required, release button
- Enter text.



### Eraser

To erase labels and lines



### Line-Width

To adjust the thickness of a curve's line.

Activation of this function changes the lines thickness to three points. If left in normal position thickness is one point.



### Print

To copy records to a report sheet:

- Click on the symbol
- Set the text-cursor at the wanted insert point on the report sheet
- Press OK



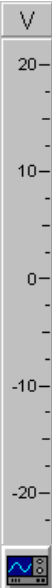
### Table

To insert a data table into your report:

- Click on the symbol
- Enter the number of rows
- Set the text-cursor at the wanted insert point on the report sheet
- Press OK
- A table with measured data of active channels in the recorder appears

**Activated tools show a green frame**

### 3.1.3 Working with the recorder's scales



List of channel options by click on button

Scale range up by clicking on the upper end of the scale e.g. at 20

Shift scale by dragging it

- Press left mouse button
- Shift mouse to destination
- Release button

Scale range down done by mouse-click at the lower scale end e.g. 20 in this case

Auto scale adjusts to optimal scaling by mouse-click

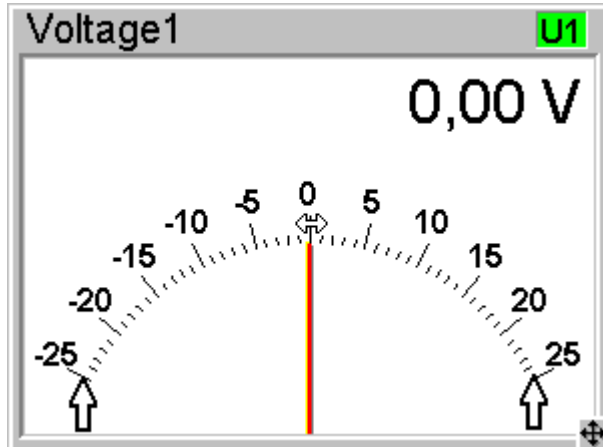
All Chemex scales run synchronously. Once the scaling is changed on the recorder, the change will also affect all analog instruments.

### 3.1.4 Recorder tutorial

- Select samplemode in '*Options/Samplemode*'. The options are: variable clock, every drop, by pressing the space bar.
- Select the channels to be displayed, their basis and the appropriate measurement ranges.
- Switch the big ON/OFF button to 1
- Recording begins according to the clock chosen
- After measuring switch off (ON/OFF to 0)
- You may magnify critical points of the curve. Chose the magnifying glass symbol on the right side of the recorder. Drag a rectangle onto the area of the curve you want to have a closer look at.
- Add best fitting curves or tensions by using the line-tools of the recorder if required.
- Label any curve and points of interest by means of the text tool.
- In order to transfer a recorder-graph into the report, use the print-tool of the recorder. Point the text cursor at the insert place of the recorder picture, press OK.
- To transfer measurements in table form into the report use the table-tool.
- All labels will be erased, if you click on the eraser symbol, exit the recorder or change the axis.

**Hint:** A single mouse-click on a specific curve assigns its unit to the Y-ruler (new superior channel).

## 3.2 Display



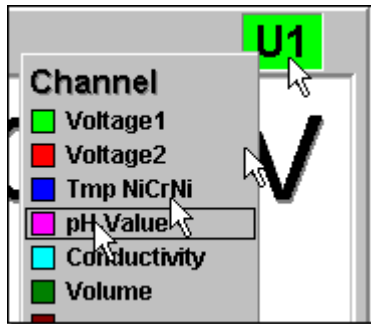
The Chemex display is made up in 4 analog instruments with inserted digital display. The slides position which may be changed with the mouse, determines the exact position and size of the instruments. This slide is shown at the lower right corner of the picture. Its location will always be found at the port of all 4 instruments. As an alternative, you may use the menu 'View/Display' to vary the instruments.

### Hints:

Simply click on the slide for original position, backset.

A click on a digital display switches it on or off.

### 3.2.1 Selecting the displayed channel



To change a channel, click on the colored click-field in the right upper corner of the gauge. The channel program appears. Click on the required channel, and the display changes automatically. The number of channels available depends on the number of parameters setup on the *Setup* index-card.

### 3.2.2 Determining the measurement range

Determining the measurement range can either be accomplished by means of the menu 'Options/Channels' or directly by mouse on the scale. A mouse click on the right end of the scale (25V) increases the measurement range in 1-2-5 steps. A click on the left end (-25V) decreases the measurement range. The zero-position may be changed by dragging the scale.

- Press the left mouse button
- Shift the mouse to the destination
- Release mouse button

If you change the measurement range on the display, settings in the recorder and control function will automatically be adjusted according to the change.

### 3.2.3 Printing

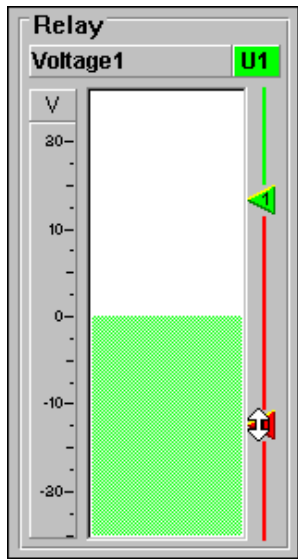
To print the display, insert it into the report

- Select 'Edit/Copy' in the menu
- Shift to the report
- Set the text cursor at the wanted insert for the display.
- Select 'Edit/Paste' in the menu, Chemex inserts the picture into the report.

If you want a smaller graph:

- Click on the picture
- black anchor points appear
- pulling on these points reduces or enlarges the graph

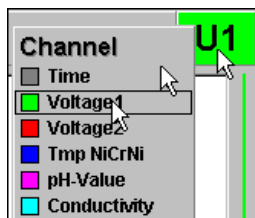
## 3.3 Control



Chemex-control consists of three control fields. One controls the Chemex relay, an other one the main output and the third control field generates alarm messages on the screen.

The left picture shows the relay control field. If the level indicator of the bargraph display runs along the red area of the markers, the relay has gone down. If it is in the green area, the relay goes up. The tabs are on the right side of the bar graph (red or green triangle). The tabs 1 and 0 define the cross over points and may be shifted by mouse. The distance between both ON/OFF tabs defines the hysteresis.

### 3.3.1 Selecting the control channel



To change the control channel of any control field click on the colored click-field in the right upper corner of the control field. A channel program appears. Click on the required channel, the control field changes correspondingly. You may chose of any channels defined in the setup index card.

### 3.3.2 Setting the switch points and the switch direction

The switch points are set by the tabs on the right side of the control field. The ON-tab is green, the OFF-tab is red. The tabs can be shifted by mouse. Press the left mouse button, keep the button down and move the mouse to its new destination. In order to change the switch direction, drag the OFF-tab above the ON-tab. Space between those tabs defines the hysteresis.

### 3.3.3 Determing the measurement range

To determine the measurement range either chose the menu 'Options/Channels', or do it directly by means of the mouse on the scale. A click on the upper end of the scale (here 20V) scales the bar in 1 - 2 - 5 steps up, by clicking at the lower end (-20V) the bar is scaled down. The null point can be delocated by dragging the scale. Move the mouse to any point on the scale, press the left mouse button and drag it with the button kept pressed to a new position. Release the mouse button.

**Hint:** A click on the unit-field at the scale bar (here Volt [V]) opens 'Options/Channels' on the menu directly.

### 3.3.4 Control print out

Select 'Edit/Copy' in the menu to copy the control index card to the clipboard. Now more to the report, position the text cursor at the point, where the graph should be insert and select 'Edit/Paste'. Chemex inserts the graph into the document. If you want a smaller graph, click on the picture and drag the anchor points towards the center.

## 3.4 Defining channels

The Index card 'Setup' is the communication port of Chemex and Chembox. In this function all channels have been defined by Chemex before being displayed. Each channel (color-field) is assigned to a calculation, a symbol, an unit and a name, which represent it. Assignments may be customized, e.g. channel1(light green) = K1, symbol = U1, unit = V, name = Voltage1.

Channel - Linking				
Channel	Calculation	Symbol	Unit	Name
<span style="color: green;">■</span> =	K1	U1	V	Voltage1
<span style="color: red;">■</span> =	K2	U2	V	Voltage2

To link a Chemex channel with Chembox, enter the corresponding variables in the calculation field. All Chembox variables and their current value are displayed in the chembox-field (see picture below). You may relate variables in mathematical terms if required. Please change calculations only if the experiment is stopped, e.g. the ON/OFF switch on the recorder is turned off. The entered symbol, unit, and name may be defined by the user. Chemex itself adds a prefix to the unit, depending on the measurement range, e.g. k for 10<sup>3</sup>

Chembox								
Input	Sensor1	Sensor2	NiCrNi	pH/mV	Conduct.	Event	Time	Index
Variable	K1	K2	K3	K4	K5	K6	t	Ind
Value	0,000V	0,000V	19,1°C	542mV	0,000S	0,000	6,77s	0

### 3.4.1 Calculation syntax

#### Permitted operations:

Arithmetic operations:	+	Addition
	-	Subtraction
	*	Multiplication
	/	Division
	^	Power
Brackets:	( )	To the depth 16
Variables:	K1-K6, t, Ind	(Big and small letters are equal f.e. k1 instead of K1)
Numbers:	0,003348 or 0.003348 or 3,348E-3	(. equals ,)
Functions:	Ln()	natural logarithm, basis e
	Log()	Logarithm basis 10
	Sqr()	Square root
	Exp()	Exponential function (to basis e)
	Sin()	Sinus
	Cos()	Cosinus
	Tan()	Tangens
	ASin()	Arcus Sinus
	ACos()	Arcus Cosinus
	ATan()	Arcus Tangens
	Abs()	Absolut value

#### Examples:

K1	Voltage Sensor1 [V] is used directly
10*K1 - 2	Voltage Sensor1 [V] is multiplied by ten first, a two gets finally subtracted
10*(k1+2)	To voltage Sensor1 [V] 2 is added, the result being multiplied by ten
sqr(k2*2)	Voltage Sensor2 [V] is multiplied by 2, then the square root is taken
log( k1 * 10,54E-5 ) ^ K3	

## 3.4.2 Using the clipboard

### Copying text

To copy text into the clipboard, mark the passage, and select *'Edit/Copy'*.

### Inserting text

To insert text, e.g. calculations from the clipboard into text, select *'Edit/Paste'* from the menu.

### Copying the index card

To copy the whole index card as a picture in the clipboard do not select a text, and select *'Edit/Copy'* from the menu instead.

## 3.5 Calibration

To calibrate a input port of the Chembox, select *Setup/ index card* and click at the Chembox field on the input to be calibrated e.g. the pH-input, or select *'Options/Calibration/pH-Value'* from the menu. A calibration dialog with calibration instructions according to a chosen Chembox input appears as follows.

The image shows two screenshots from a software interface. The top screenshot is the 'Chembox' main window, which displays various sensor readings in a table-like format. The bottom screenshot is a 'pH-Electrode' calibration dialog box. In this dialog, the 'Value' field is set to '7.00pH' and the unit is 'pH'. The 'Ref1' field is set to '7.000' and the 'Ref2' field is set to '9.000'. The 'Math' field shows the formula  $V4 \cdot 17.764 + 7.194774$ . The 'Calibration' section contains a list of instructions: 1.) Enter unit pH, 2.) Enter reference-value Ref1 [eg. 7 for 7.0 pH-buffer], 3.) Enter reference-value Ref2 [eg. 9 for 9.0 pH-buffer], 4.) Plunge probe in 7.0 pH buffer, 5.) Press button Set Ref1, 6.) Plunge probe in 9.0 pH buffer, 7.) Press button Set Ref2, 8.) Calibration-term is generated automatically, 9.) Press OK to exit dialog. There are 'OK' and 'Cancel' buttons on the right side of the dialog.

Input	Sensor1	Sensor2	NiCrNi	pH/mV	Conduct.	Event	Time	Index
Variable	K1	K2	K3	K4	K5	K6	t	Ind
Value	0,000V	0,000V	19,1°C	542mV	0,000S	0,000	6,77s	0

**pH-Electrode**

Value: 7.00pH pH

Ref1: Set Ref1 7.000

Ref2: Set Ref2 9.000  $\mu=0$

Math:  $V4 \cdot 17.764 + 7.194774$

**Calibration**

- 1.) Enter unit pH
- 2.) Enter reference-value Ref1 [eg. 7 for 7.0 pH-buffer]
- 3.) Enter reference-value Ref2 [eg. 9 for 9.0 pH-buffer]
- 4.) Plunge probe in 7.0 pH buffer
- 5.) Press button Set Ref1
- 6.) Plunge probe in 9.0 pH buffer
- 7.) Press button Set Ref2
- 8.) Calibration-term is generated automatically
- 9.) Press OK to exit dialog

OK Cancel

### Preparation:

First enter the unit (in this case "pH" ), then the reference points at which the probe needs to be calibrated (here 7.0 and 9.0).

### Calibration process:

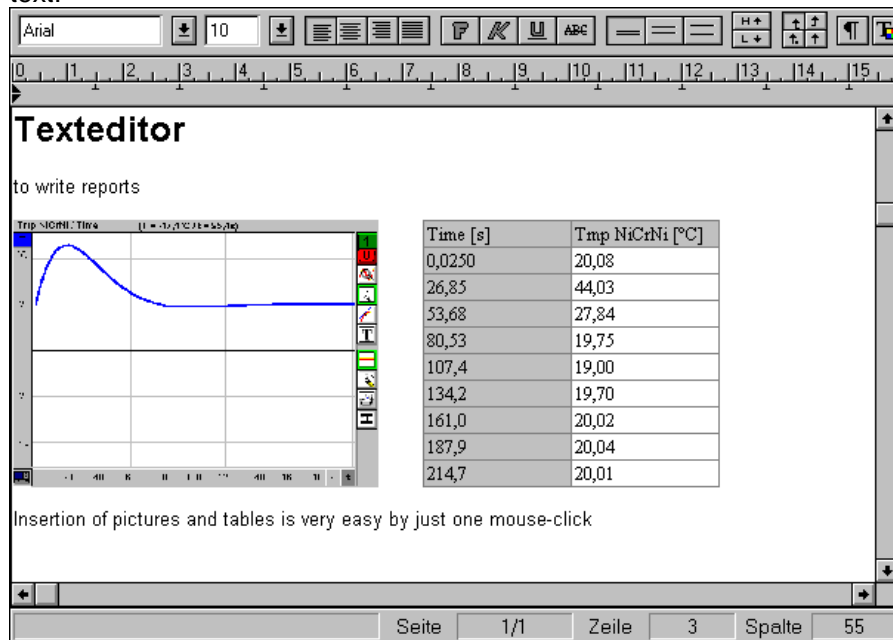
First calibration point: Dip the pH-probe into the pH 7.0 buffer. Wait for the displayed value to be stable, then click Set Ref1. The value shown should be 7.00 pH

2nd calibration point:

Dip the pH-probe into the pH 9.0 buffer, wait for the displayed value to be constant and click on Set Ref2. The calibration process has now been completed. If a calibration point is inoptimal click on Set Ref... again. The button returns to its unpressed position and you may determine a new reference point. If you want to save the calibration on harddisk, select *'File/Save'* from the menu.

## 3.6 Info and report

You will find an Info-, as well as a report index-card with an integrated text editor. The Info-card is intended to assist you in any experimental work. With 'File/Lock' kept activated, Info-text stays write protected. The user can read and print the text, though. On the report page, you may notice some experimental preparations. The required recorder- and display graphs or tables will be insert in the text.



### 3.6.1 Text insertion

The Chemex editor holds 4 elements, called format strip, tabulator-ruler, text input window, and status-strip. The texts outlay and format procedures depend on the settings on the format strip. Elements on the format strip cause the following changes (from the left to the right):

- Select font \*\*
- Select font size \*\*
- Text formatting, right justification, left justification, center justification block
- Font style-bolt, italic, underlined, crossed out \*\*
- Line spacing 1, 1½ or 2 \*\*
- Typeface: Superscript/subscript \*\*
- Tabs left- right- justification, comma-justification, center- justification
- Paragraphs, tabs, spaces (visible/invisible)
- Font colour \*\*

\*\* The corresponding text has to be marked first. Therefore drag the mouse with the left button kept pressed.

## 3.6.2 Graph insertion

There are two methods to insert a graph into text, sourced either from harddisk or clipboard.

### Inserting graph data

Select '*File/Insert Bitmap*' from the menu

Select the format in which the file is saved. The following options are available.

- BMP Windows Bitmap format
- PCX ZSoft Paintbrush format
- TIFF Tag Image File Format of Scanners etc.
- GIF Compuserve Format
- TGA Targa Format
- WMF Windows Meta File

Select the file to be insert from the file list and hit OK. The graph will be insert at the current location of the text cursor.

### Insert graphs from the clipboard

Select '*Edit/Paste*' from the Menu. To insert a graph by using Chemex display instruments, more to the *Measure/Display* - index card and select '*Edit/Copy*'. Return to text input and select '*Edit/Paste*'. Now the graph of the display appears at the current position of the text cursor.

## 3.6.3 Changing the graph size

- Click on the graph. Anchor points appear at the corners of the graph. The size of the graph may be altered through dragging these points by mouse.
- Grab appropriate anchor point and press the left mouse button.
- Dragged to the center of the graph, the graph is reduced after releasing the button. Dragging towards the center of the graph reduces the graphs size, dragging it to the outside enlarges the graph.

If you want to move the graph to a different position in the text, disposition it by using *Cut* and *Paste*.

**Comment:** Graphs are inserted in the same way as letters in text, using the text editor.

**Hint:** Graphs inserted in text require a lot of storage capacity slowing down the editor. It helps to have the text written first before inserting the graph.

## 3.6.4 Other editor features

- Multiple undo-function by menu '*Edit/Undo*' or Alt + BackSpace
- Page preview by menu '*File/Page Preview*'
- Editable table-cells
- Modifyable table columns
  - Select table (click the table)
  - Move the mouse cursor to the right upper corner of a column ( next to other column)
  - The cursor turns into a small triangle
  - Press left mouse button and drag to destination, release mouse button
- Delete tables
  - Position text cursor in front of the table
  - Press the keyboard shift →
  - Press delete-key
- Output prints on all Windows-printers by menu '*File/Print*'

## 3.7 Run experiments

Let us pick the example "Titration of different acids or mixtures" to illustrate principal procedures coming along when doing experimental research with Chemex.

### 3.7.1 Preparing the measurement

#### Install the experiment

You need the following tools to experiment

- Computer + Chembox
- Dropper, pH-probe
- Beaker 250ml, burette
- Stand for burette and dropper, magnet-stirrer
- Sodium hydroxide (NaOH)=0,1mol/l (=4g/l), z.B. phosphoric acid c(H<sub>3</sub>PO<sub>4</sub>)=0,05mol/l

Fasten the burette on the stand and place the dropper underneath. Enforce alkali-drops to fall through the sensor tube without touching it. Fill the beaker with acid for an equivalent point titration of approximately 10 ml, dilute the acid with distilled water. For optical control use an indicator. Fill the burette with alkali.

#### Starting Chemex and Chembox

Plug Chembox on the serial port of the PC, the dropper on the event-input, and the pH-probe on the pH-input of the Chembox. Switch PC and Chembox on, start Chemex (e.g. click the Chemex symbol twice).

#### Open experiment file

Load the experiment file to execute an experiment. Select 'File/Open' from the menu. Select TITRIER.CHX from the file-list (being an experiment file for the titration, and part of the supply of Chemex) loaded on harddisk by the installation program.

### 3.7.2 Measurement

When the setup is complete (the titrand in the beaker, the titrator in the burette, the dropper correctly adjusted) measurement may be started. Switch on the *ON/OFF button* at the upper right corner of the recorder, starting measurement operation. Keep on opening the burette valve until 1 to 2 drops are falling per second. Now the recorder starts working. To stop measuring switch off the *ON/OFF button* on the recorder.

### 3.7.3 Evaluation

- To zoom critical points on the curve, select the magnifying glass on the right side of the recorder, and drag a rectangle onto the area to be enlarged.
- Set best fitting curves or tangents as required by means of the line tool on the recorder index card (Press mouse button, go to the destination, release mouse button)
- Label curves and important points with the text tool on the recorder
- To transfer the recorder's content to the reports, use the print-tool of the recorder
- To add a table to the report click the table-tool

## 3.7.4 Input Calibration

All calibration data is saved in the experiment-file on the harddisk, e.g. measurements with the same burette and sonde can generally be carried out with the same calibration.

### **Dropper**

Pre-adjust dropper and burette, allowing drops to fall through the sensor-tube without touching it. Using a none synchronized regular burette requires calibration, and the same filling level (e.g. 20 - 40 ml) for proper experimental work, as the size of the drops and the height of the filling decreases slightly (hydrostatic pressure). Since usually only liquid solutions are used, viscosity matches the one of water, e.g. the kind of titrator does not/ insignificantly effect the drops size.

Calibrating the dropper:

1. Select *Measure/Setup index tab*, click event-input, the calibration dialogue appears
2. Enter l as an Unit for liter, 0 ml as a start-volume, and the desired calibration volume e.g.: 10ml
3. Check if the dropper records the drops correctly (LED on the dropper has to flash with every drop falling), if necessary clean optics in the tube (pull a net cloth through the sensor tube).
4. Press start value-button on the dialogue [=0ml], get the burette dropping slowly. (1 - 2 drops/s) until calibration is reached. Now close the burette and press the calibration volume key [=10ml].
5. Exit calibration dialogue

### **pH-probe**

Calibration of the pH probe is carried out analogously to the dropper. Two buffer solutions are needed, in which the electrode can be calibrated e.g. 7pH and 9pH.

Enter an unit in the unit box and two calibration points, 7 in one box, 9 in the other. Rinse your pH-electrode, dip it into pH7 buffer and wait on the probe to stabilise (control display). Now press [=7pH]. Rinse the probe again and dip it into the pH9 buffer. When the control display stays stable press [=9pH]. The probe has been calibrated now. A short test-measurment e.g. with pH7 buffer etc. confirms it. Exit the calibration-dialogue. If you want to save calibration data chose '*File/Save*' on the menu.

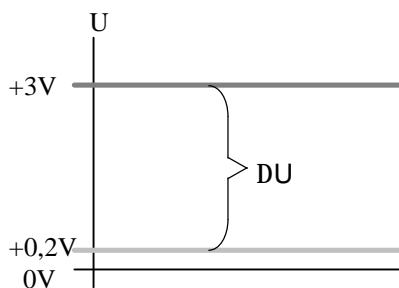
# 4 Chembox CB2

## 4.1 Input and Output specifications

### 4.1.1 Sensor-inputs:

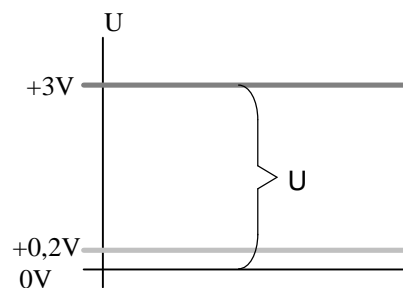
The 2 sensor inputs "Sensor1" and "Sensor2" are two independent inputs with identical functions. They are equipped with two different plugs, connected in parallel, a seven-pole DIN socket and a couple of banana jacks. Direct currents in the range of -32 Volt to 32 Volt can be measured. Therefore the positive pole of the electric field is connected with the red banana jack at the sensor input and the negative pole with the blue banana jack. Measuring voltage is carried out potential-free, e.g. the difference in tension between the two banana jacks is measured without being subject to mass potential.

Potential free measuring:



Result:  $U = +2,8V$

Potential related measuring:



Result:  $U = +3V$

The sensor input shows a common mode rejection, e.g. at synchronised input driving allows correct measurements of the difference in tension. At the 7 . pole DIN-socket tension within the range of -32/32 Volt may be measured, too. It also provides additional supply tension for a sensor connected. Furthermore, this input has the ability to recognize sensors and to communicate with them. (Intelligence input)

**Caution:** If a sensor is connected to the DIN-socket, do not supply the banana jacks with external tension at the same time, due to the output voltage of the sensor being directly situated on those.

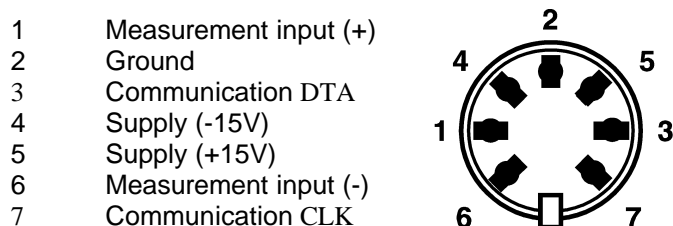
If a sensor is connected to the DIN-input, the possibility is given to measure the output voltage of the sensor on the banana jack couple with a digital voltmeter. Usually, the value of the corresponding sensor is read by Chemex software.

As Chembox inputs are autoranged, measuring mistakes caused by the finite resolution of the A/D transformer are kept at a minimum.

The following sensors from an extensive accessory program of IBK can be connected:

- Glas temperature sensor (also for aggressive liquids)
- NiCrNi-adaptor
- Pressure sensor
- Force sensor
- Hall-sonde
- Luxmeter

The pin positioning of the DIN-socket is shown in the following graph:



Frontview of Chembox. Input resistance of the sensor input is 300k $\Omega$ .

### 4.1.2 NiCrNi Temperature-input:

At this input a NiCrNi temperature element may be connected, either with a thermoelement plug at the yellow socket (right pole security) or directly at the screw-clamps.

**Caution:** At this input no external tension may be connected. The positive pole is connected with the red banana jack. Synchronous connection of two NiCrNi-elements at the thermoelement socket and screw clamps will lead to weird measurement data.

The measurement range allows measurements from a approx. -49°F low to a maximum of 1832°F (45°C ... 1000°C), corresponding to the element connected (see: sensors, technical data). The measurement itself registers currently existing thermotension between the ends of the thermoelement connections. Thermotension will only be generated if differences in temperature between the point of the thermoelement and its connections arise. Therefore it enforces exact acquisition of the plugs temperature by a housed temperature sensor located behind the connections. The software automatically calculates the sensor temperature. The NiCrNi input provides an automatic facility for change of the measurement range.

A NiCrNi thermoelement produces a thermotension of 40,95 $\mu$ V/32°F(°C) at the place of material change (Ni/Cr). Tension measured at the element will always be proportional to the difference in temperature of the warm sensor point and the cold part (transition to the instrument) of the thermoelement.

### 4.1.3 pH input:

At this input the pH sensor is connected to the BNC-socket. The pH sensor creates a tension depending on acidity of the liquid.

**Caution:** If an external tension is connected at this input it must not extend the range from -6V to 6V.

The positive pole (inner conductor of the BNC-socket) is connected to the red banana jack, the mass-shielding with the blue one. Due to a very high input resistance tension measurements at sources with a very high resistance can be carried out without any problems. The input resistance values 10<sup>12</sup>  $\Omega$ ! Thus measurements at sensitive galvanic elements can easily be undertaken without effecting measured data through the elements capacity. Furthermore a redox-sensor may be used for measuring redox-potentials. In addition, the pH input of Chembox provides an automatic facility for change of the measurement range.

The range of the pH value reaches from 0 to 14, (0 to 6 = acidic, 7=neutral, 8 to 14 = alkaline). The pH electrode has a ideal tension of 59,16 mV/pH at 77°F (25°C). The temperature coefficient is 19,84 mV/212°F (100°C) and positive. While measuring, 0V equals 7pH. Aging of the pH sensor occurs very quick requiring calibration. The software of Chemex gives the possibility.

## 4.1.4 Conductivity-input:

In terms of its function, the conductivity input actually provides an exit, as Chembox automatically puts voltage on the connected conductivity-sensor. Very short tension-impulses and switching polarity avoid electrolysis of liquids and polarization of the electrode. Current is measured by its flow through the liquid used determining conductivity. The conductivity probe can either be connected with a BNC socket or with a banana jack. Polarity might be waived in this application.

**Caution:** Avoid to connect an external tension at the conductivity input by any means. Adjustment of the conductivity input is done by an automatic measurement range switch. All 16 measuring ranges reach 5mS to 500mS (unit of conductivity: Siemens)

## 4.1.5 Relays:

The relay on front of the Chembox may be controlled by the Chemex software. It is a single-break-and-make-relay. The intermediate jack is switched to the upper or lower jack. The current switch position of the relay is shown by a red light diode. Light implies a closed contact. The maximum capacity of the relay is 10A or 150W. An active tension limit at 42V avoids arcs when switching inductive currents.

## 4.1.6 Power relay:

On the back-side of Chembox is a controllable power socket. It may be controlled by both, Chemex and the Power relay. Customary 230V (110V) instruments like immersion coils, lamps, etc. with a capacity of 1100 W (110V: 550W) may be connected.

**Caution: !!! High voltage, DANGER !!!** Never connect an appliance on the back-side of this socket not being suited for operation on the power socket-tension. The red light emitting diode on the front panel field "Power Output" shows the current switch position of the power socket relay:

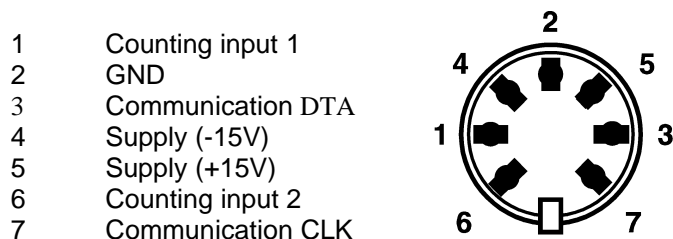
LED on, power voltage on  
LED off, power voltage off.

## 4.1.7 Event-input:

The seven-pole DIN-socket "Event" provides connection of any counting sensors:

- Dropper
- Photogates
- Geiger-Mueller-tube

Display of counting is shown in the Chemex-software. Up to 65535 events can be counted. If exceeded the counter will automatically be reset. The input level is TTL(5V), CMOS(12V) or 24 V. The PIN positioning is shown in the following figure.



## 4.1.8 Serial port:

The serial port of Chembox is located on the rear of the instrument. With a 25 pole modem cable connection to one serial port of the PC is given. This cable allows data exchange between Chembox and the PC. Chemex automatically determines the com-port connection of Chembox, as well as baud rate and communication protocol.

# 4.2 Technical Data

## Input: Sensor (2x)

Resolution	10 bit
Scanning frequency	0...50Hz with Chemex
Calibration	Zero point and slope - through PC-autocalibration
Differential measurement	potential free
- Common-mode voltage	0 ... ± 40V
- Common-mode rejection	70dB DC
- input resistance	300kΩ
Input-intelligent sensors	7pol. DIN socket (Analog input, 0V-GND; ±15V; clock-signal; digital-input/output bidirectional TTL); 2 banana jacks, parallel to analog input in 7pol. DIN
Analog input	

## Input NiCrNi

Measuring range 1	-58°F..... +212°F (-50°C ... +100°C)	- resolution 0.36°F (0.2°C)
Measuring range 2	-58°F..... +1768°F (-50°C ... +1000°C)	- resolution 3.6°F (2.0°C)
Marked line correction	Type K	
Calibration	Zero point and slope - through PC-autocalibration	
Input connectors	Thermocouple jack typ K und 2 banana jacks (+/-) for wire element connection (parallel)	

## Input: pH/mV

Measuring range 1	0 ... ±600mV -resolution: 1mV / 0 ... 14pH - resolution 0.02pH
Measuring range 2	0 ... ±6V -resolution:10mV
Input resistance	> 1 TΩ
Input-bias-current	< 1 pA
Calibration	Zero point and slope - through PC-autocalibration
Input connectors	1 BNC-jack and 2 banana-jacks (parallel)

## Input: conductivity

Measurement	16 measurement ranges: 5/10/20/50/100/200/500μS 1/2/5/10/20/50/100/200/500mS
Measurement range switch	automatic (autoranging)
Measurement procedure	2 pulse-measurement method (small charge consumption)
Scanning rate	0...50Hz unter Chemex
Calibration	Zero point and slope - through PC-autocalibration
Input sockets	1 BNC-jack and 2 banana-jacks (parallel)

## Input: Event

Input	impulse counting absolute (dropper), Impuls-sampling
Triggering level	TTL and CMOS
Input-intelligent sensors	see input sensor

## Output: Relays

Contacts	1x NC, 1x NO (switch relay)
Capacity	5A / 42V
Level display	2 LED's
Connections	3 Banana-jacks

## Output: power supply relay

Capacity	5A / 230V-1100VA
Condition display	Front panel LED
Output	earthing-contact-type-socket with protective cover, miniature fuse 6,3AT on the rear of the device, software controlled
Level display	ON- display over LED on front panel

## PC-Coupling

Port rate	serial, 19200 Baud
Connection	PC- compatible 25pol. Sub D-connector

## General

Power supply connection	230V ± 10%, 47...63Hz, 35VA, connector for non heating apparatus
Ambieint temperature	32°F... +104°F (0°C ... 40°C)
Size W x D x H	9.646in x 3.346in x 7.087 (245mm x 85mm x 180mm)

# 5 Sensoric

## 5.1 Stactometer

Item: DTZ stactometer

The stactometer gives you the amount of liquid added in titration. The stactometer is connected to the Chembox event-input. An optical electronic device controls a drop falling through the sensor tube and signals it by an installed light emitting diode (LED). Chembox registers the impulse (1 impulse/drop). The experimental software Chemex multiplies the number of impulses with the entered amount/impulse and calculates the volume (see: Chemex calibration). In practice the dropper can easily replace scales or a motoric burette. To make the experimental procedure easier the dropper provides an added holder for up to three sensors with different diameters. A 4.921ft (15 cm) long stand is used to fasten the dropper.

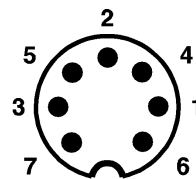
### Technical Data:

Resolution:	depending on burette approx. .0017oz (0.05ml)
Stand dimension:	4.921ft (15cm) long, .394in (10mm) diameter
Holder for 3 sensors:	1 x .315in (8mm) diameter
	2 x .472in (12mm) diameter

### Pin positions:

Pin-Nr. positions

1	+ Output signal
2	GND
3	nc
4	Supply (-15V)
5	Supply (+15V)
6	- Output signal (GND)
7	nc



## 5.2 pH probe

Item: DPH pH probe

The robust pH sensor with an epoxide-shaft and gel-filling is appropriate for universal pH-measurements in liquid media. The one-rod measuring chain include blub protection features a low impedance of less 100M $\Omega$  and a small time constant. Connect the electrode to the BNC input pH/mV of the Chembox.

### Technical Data:

pH range:	0 to 14pH
Temperature range:	32 ... 176°F (0°C ... 85°C)
Resolution:	0,1%
Response Time:	95% within 3sec
Impedance:	<300M $\Omega$
Wetted Materials:	glass, epoxy, teflon, thermoplastic rubber
Dimensions:	.472in (12mm) diameter 6.299in (160mm) length

## 5.3 Conductivity probe

Item: DLS conductivity probe

The conductivity cell is determined for measurements of general liquid media in laboratories. The active part is platinated. Thus the electrode can also be used for measurements of high conductivity. Connect the sensor to the Chembox "Conductivity" input.

### Technical Data:

Cell constant:	95% within 3sec
Temperature Range:	32 ... 212°F (0°C ... +100°C)
Wetted Materials:	glass, platinum
Dimensions:	.472in (12mm) diameter 4.724in (120mm) length

## 5.4 Temperature-probe

Item: DTF Temperature-probe

The temperature sensor is a metal-free electronic thermometer for measuring temperature in aggressive liquids. It is located inside a high temperature alternating resistant Duran glass tube and determines temperature with a high linearity. It is connected to the Chembox at the input Sensor1 and/or Sensor2. The temperature sensor may be used with norm-stoppers.

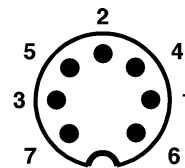
### Technical Data:

Range:	-40°F ... 230°F (-40°C ... +110°C)
Output:	1V/180°F +32°F ±3.6 °F (1V / 100°C ±2°C)
Resolution:	0.18°F (0.1°C)
Glass tube diameter:	.315in (8mm)

### Pin positions:

Pin-Nr. Positions

1	+ Output signal
2	GND
3	nc
4	Supply (-15V)
5	Supply (+15V)
6	- Output signal (GND)
7	nc



## 5.5 NiCrNi-wire-wound

Item: DTD wire-wound thermoelement

The wire thermoelement with impregnated glass fibre isolation is used for general temperature measurements. The probe is welded in argon-atmosphere to avoid oxidation of the thermojunction. The thermotension adjusts in seconds because of a low heat capacity of the element. It is connected to the Chembox input NiCrNi by screw clamps. Watch polarity (colours of the cables) when connecting the thermoelement.

### Technical Data:

Measuring Range: -58°F ... +572°F (-50°C to +300°C)  
Type: K (typical 40,95µV/°C)

## 5.6 NiCrNi-bar element

Item: DTG bar element

The bar thermoelement equipped with a handle and a 11.811in (300mm) lance is used for measurement of flame temperatures. Good linearity enables exact measurements in lower temperature ranges, too. A NiCrNi input gives connection to the Chembox by a thermocouple connector type K.

### Technical Data:

Range: 32 ... 1832°F (0°C to +1000°C)  
Type: K (typical 40,95µV/°C)  
Lance diameter: .158in (4mm)

## 5.7 NiCrNi-converter

Item: DTA thermocouple converter

The NiCrNi thermocouple converter gives connection of any NiCrNi thermoelement to the Chembox. Elements with thermocouple connector, banana plugs or blank wire-connections (differential-cable) may be connected to the banana jacks by a clamp device. Compensation and adaption are done in the converter. Connection to Chembox is provided at the Sensor1 input and/or Sensor2 input.

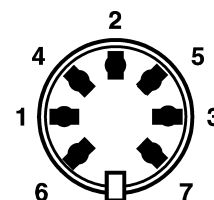
### Technical Data:

Output tension: 1V/ 180°F (1V / 100°C) - as chemical-thermometer  
Inputs: Type K

### Pin positions:

Pin-Nr. positions

1	+ Output signal
2	GND
3	DTA Sensor-communication
4	-15V
5	+15V
6	- Output signal
7	CLK Sensor-communication



Front view of DIN-socket

# 6 Trouble shooting

## LED of Chembox does not illuminate after activation.

- Check if the switch in the rear is set ON
- Check if the power cable is correctly plugged in
- Check if a fuse of Chembox is burnt through.

## Unsuccessful attempts to connect the serial cable.

- The cable has been connected to the parallel port instead of the serial port. Simply plug it into the other socket (firstly connect cable with Chembox, then with the PC)
- Only a 9 pole serial socket is available instead of a 25 pole socket. Use a serial adaptor 9/25.
- No serial port is available on the PC because the only existing one is used for the mouse. A second serial port is necessary.

## The setup-program can not be started

- Try the following: Programmanager-menu 'File/Run' - scan - drive: a: or b: - filename: SETUP.EXE - OK - OK.
- Close all Windows programs except the program manager.

## Chemex software can not be started

- Try to setup software for another time.
- Exit Windows, restart Windows and Chemex
- The program is loaded, the main window remains grey, though, or Chemex displays "Out of memory" etc. The problem is a shortage in your systems resources. The resources in Windows 3.1 are restricted to 64000 byte, a big issue for operation of graphic intensive software like Chemex. It may help to close all programs which are not needed. Close all open applications (except the program manager) and restart Chemex. It may also help to delete autostart programs of the autostart group.
- A further issue may be that although enough memory is available, yet it is not used by active programs. e.g.
  - Network drivers
  - Smartdrive (Harddisccacheprogram)
  - EMM386.sys (Expanded Memory manager driver)
  - ramsys (Drive, running in the memory)
  - diverse DOS driversswitch off RAMDRIVE.SYS (insert REM), smartdrive and EMM386 as follows

### Config.sys

```
DEVICE=C:\DOS\HIMEM.SYS
DEVICE=C:\DOS\EMM386.EXE NOEMS
REM DEVICE=C:\DOS\RAMDRIVE.SYS 1024
DOS=HIGH,UMB
Buffers=20,0
FILES=50
LASTDRIVE=Z
FCBS=16,0
STACKS=9,256
SHELL=C:\DOS\COMMAND.COM /E:256 /P
```

## Autoexec.bat

```
@echo off
C:\WINDOWS\SMARTDRV.EXE
PROMPT $p$g
PATH C:\WINDOWS;C:\DOS;
SET TEMP=C:\
SET TMP=C:\
KEYB GR,,C:\DOS\KEYBOARD.SYS
DOSKEY /INSERT
C:
```

Now restart your computer, Windows, and Chemex.

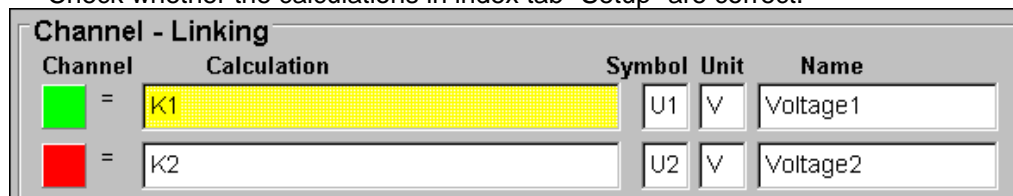
## Chemex starts, but displays "Chembox not active"

The reason for this is that Chemex can not communicate with Chembox. Chemex is checking all available serial ports of the computer to find Chembox.


- Is the serial cable plugged in properly?
- Is it an appropriate cable? You need a 25pole modem-cable, e.g. PIN 1 of the plug is connected with PIN 1 of the socket on the other side. PIN 2 with PIN 2 etc. A crossover cable must not be used.
- Check if the serial port of the computer works. Exit Windows, connect your mouse at this port and restart Windows. If the mouse pointer can be moved as usually, the port is OK.

## Chemex starts but does not show any measured data

- Read chapter "Operation of Chemex"
- Check whether the calculations in index tab "Setup" are correct.



Channel	Calculation	Symbol	Unit	Name
1	K1	U1	V	Voltage1
2	K2	U2	V	Voltage2

- Check whether the recorder switch is set ON "1".
- Check if in "Options/Samplemode" the sampling-clock has been set by pushbutton or by the dropper.
- Check if you have chosen the measurement ranges correctly. Press the "autorange" key on the recorder. 
- Check if all sensors are connected correctly. It is possible to mess up polarity when connecting to the banana jacks. Connection to the 7pole DIN socket may be problematic because sensors of another production may have layout. You may compare this layout with the one described in this manual. You should by no means plug in a sensor deviating from this, as destruction of the sensor may occur.

*If you can not cope with the problem arising with the operation of Chemex, please call our hotline.*

**Remark:** The speed of the program basically depends on the memory capacity (4 MB = relatively slow, 8MB = good, 16MB ideal) and the processor type (386DX good, 486 optimal).  
For experts: Setup virtual memory control on "permanent swap file with 32bit-access", with 8MB RAM 1MB Harddisk-Cache setup.