CONTENTS

1. Photometer *NANOCOLOR*® 400 D

The *NANOCOLOR*® 400 D is not only a high-performance photometer, it also features versatile software capabilities. With its large reserves of light at all wavelengths, the user can perform precise measurements, even at high extinctions.

Storage of all *NANOCOLOR*® analytical methods and multilingual user guidance facilitate measurement. Additional programmes such as measurement of extinction, kinetics, data networks, etc. expand the applicability beyond the *NANOCOLOR*® analytical system as an instrument which can be used in all types of application in the laboratory.

Additional features are: processing of non-linear curves, storage of measurement results, warning for values outside the measuring range, sample identification, possibility of programming the user's own analytical procedures, etc.

1.1 Technical data

Single beam filter photometer for a wavelength range from 340 to 860 nm

Silicon photo-element

Automatic zero adjustment

Display: 2 lines of 16 characters each, 8 mm high

Foil-covered keys with input verification

Cuvettes: rectangular cuvettes 10, 20 and 50 mm
round glass tubes 14 mm ID

Photometric accuracy: ± 1%

Long-term stability: < 0.002 E/h

Power requirements: 9 V, max. 1 A

Power consumption: 10 VA

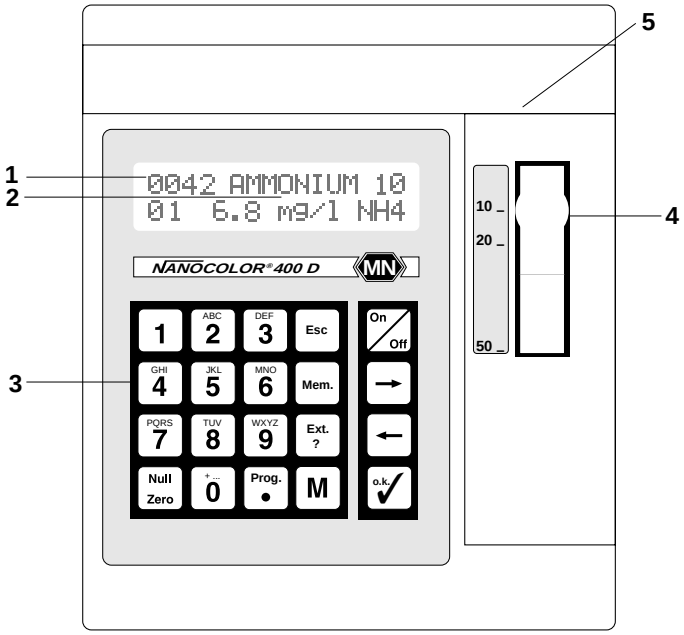
Data interfaces: bidirectional RS 232 C interface
Centronics interface for a printer

Dimensions: 227 x 282 x 105 mm

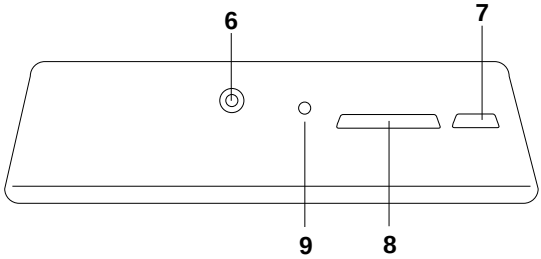
Weight: 2.4 kg

CE This appliance complies with the following EC Directives:
– 73/23/EEC of 02.19.1973 – Low Voltage Directive
– 89/336/EEC of 05.03.1989 (including Amendment Directive 92/31/EEC)
– EMV Directive

1.2 Design of the photometer



Back side of instrument



1 display of method number
2 2-line display
3 20-part keyboard
4 cuvette slot with automatic cuvette identification
5 barcode scanner
6 socket for connection of mains adaptor
7 RS 232 C interface
8 Centronics parallel interface
9 reset key

1.3 Filters

When the photometer *NANOCOLOR®* 400 D is switched on, it automatically performs a filter test. If a deviation is found, the programme asks for a new calibration. Filters which have left the confidence interval, are displayed as <check filter> (filter change is necessary). In order to prevent wrong measurements, further evaluation of tests which require the defective filter is blocked.

Filter position	Wavelength of the light [a] [nm]	HW [b] [nm]	Colour of the light/filter	Colour impression (reaction colour)
1	345 [c]	60	ultraviolet	not visible
2	365	11	deep violet	not visible
3	436	12	violet	yellow
4	470	10	blue	orange
5	520	11	blue-green	magenta
6	540	11	green	red-violet
7	585	10	orange	blue-violet
8	620	10	red	blue
9	690	10	deep red	deep blue
10	800	10	infrared	black

[a] Interference filters: ± 2 nm; [b] HW = band width at half transmission

[c] coloured glass filter

Other interference filters are available on request.

1.4 Power supply and light source

Rechargeable batteries

The built-in rechargeable battery allows stationary and mobile operation of the photometer *NANOCOLOR®* 400 D. Up to 3000 measurements are possible without recharging.

Charger / mains adaptor

If the display asks for charging (battery), the photometer has to be connected to the mains using the charger / mains adaptor which is supplied with the instrument. During charging, the photometer can be operated. Permanent operation with the mains adaptor is possible, overcharging of the battery cannot occur.

Light source

A tungsten lamp supplies the light for the measurement (340 to 860 nm). For every measurement the lamp emits just a short light pulse. This results in a very low energy consumption, i.e. a large number of measurements per battery charge.

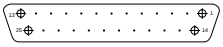
Replacement of lamp

For lamp replacement just open the compartment at the bottom of the instrument. Now the preadjusted lamp unit can be easily replaced.

1.5 Interface description

Centronics parallel interface LPT

25-pin SUB-D socket

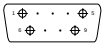


Pin 1	Strobe
Pin 2	Data 0
Pin 3	Data 1
Pin 4	Data 2
Pin 5	Data 3
Pin 6	Data 4
Pin 7	Data 5
Pin 8	Data 6
Pin 9	Data 7
Pin 10	–
Pin 11	Busy
Pins 12 to 17	–
Pins 18 to 25	all GND

RS 232 serial interface COM

(for connecting cable see chapter 3.7)

9-pin SUB-D plug



Pin 1	–
Pin 2	RXD Receive data
Pin 3	TXD Transmit data
Pin 4	–
Pin 5	COM Signal ground
Pin 6	–
Pin 7	RTS Request to send
Pin 8	CTS Clear to send
Pin 9	–

Basic setting: no parity, 8 data bits, 1 stop bit (9600, SDF* (,))
BAUD rates: 9600 / 4800 / 2400 / 1200
* SDF = semicolon delimited format (or optional ASCII format)

1.6 Barcode

The characteristic data of all *NANOCOLOR*® tests are stored in the photometer *NANOCOLOR*® 400 D. Selection of a method via method number is always possible. In addition, with the photometer *NANOCOLOR*® 400 D, a barcode on the test tubes of *NANOCOLOR*® tube tests can perform this feature, further simplifying the measurement and minimising possible errors during operation. The barcode activates the automatic measurement sequence up to the display of results. The barcode scanner is activated by insertion of the test tube.

The automatic measurement sequence can be interrupted and changed at any time by using the arrow keys.

Test tubes with barcode have to be inserted into the photometer *NANOCOLOR*® 400 D with the inscription facing to the front.

Of course, tube tests without barcode can still be used with the *NANOCOLOR*® 400 D, methods are then called up via the method number.

Barcoding also allows to transmit other parameters than the method number to the photometer – if necesssary.

Warning: the barcode scanner is a laser class 1 device. Do not look directly into the scanner during operation.

1.7 Update via INTERNET

For updating the internal programme of the *NANOCOLOR*® 400 D photometer the latest version can be downloaded from the MACHEREY-NAGEL homepage under www.mn-net.com.

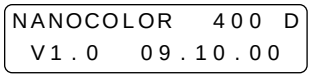
Follow the instructions given there.

2. Preparation for operation

Connect printer and PC, if this equipment is available. Switch on the photometer using key [On/Off]. Once the system has performed its internal check-up, the photometer name and the version number are shown in the display, together with the date of the programme status. When >> cuvette >> is displayed, the instrument is ready to measure. If <recharge battery> is displayed, connect the photometer to the charger/ mains adapter. Start the instrument once again (the built-in battery is charged at the same time).

2.1 Calibration of the *NANOCOLOR*® 400 D

1. When you switch on the photometer, it performs a self-check.



2. After this self-check the method selection mode is activated.

3. If during the self-check the photometer measures a deviation, it asks for a new calibration. Start calibration with key [ok]
You may ignore calibration by pressing key [→]; in this case you can only perform measurements against a blank value.

4. The photometer automatically checks the whole optical system.

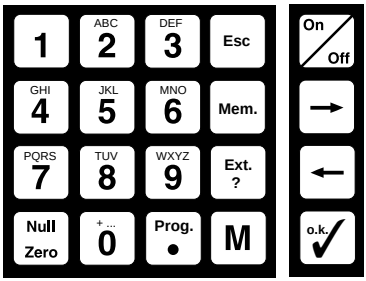
5. After calibration the method selection mode is activated. The cursur blinks.

8. The calibration can be activated at any time from the configuration menu

Filters which have left the confidence interval, are displayed as <check filter> (filter change is necessary). In order to prevent wrong measurements, further evaluation of tests which require the defective filter is blocked. If all filters are displayed as <error>, most probably the lamp is defective. Please see chapter 1.4 or contact MACHEREY-NAGEL.

3. Operation

3.1 Keyboard



The photometer *NANOCOLOR®* 400 D has a 20-part keyboard: 10 numbers and 10 keys with special functions. The whole field is covered with plastic foil and therefore protected against liquid spills and moisture (for example, when a cuvette is spilt). Input verification for all keys increases safety of operation.

Explanation of individual keys:

Key On/Off	On/Off switch of the photometer
Keys + − 0 ... WXYZ 9	For entering digits, letters or special characters
Key Prog. •	For entering the decimal point method selection for special procedures
Key Esc	Method selection key for stored programmes interrupt – return to method selection
Key →	Roll-mode forward key interrupt of the automatic programme sequence / call up next method/submethod / next programme step
Key ←	Roll-mode backward key interrupt of the automatic programme sequence / call up previous method/submethod / previous programme step
Key o.k. ✓	Enter key for confirming any input for confirming the functions selected after measurement call-up of correction measurement
Key Mem.	Key for calling up memory functions for manually storing or suppressing the storage of recorded measurement values
Key Ext. ?	Call-up key for the extinction programme recalling the extinction after measurement display of additional information

Key [Null Zero] Zero adjustment, only if required
The absorption of the inserted cuvette (blank value or base line value) is automatically zeroed in for the following measurements.

Key [M] Measurement
The measurement result is displayed (taking into account dilution and measuring ranges).
Consecutive measurements are numbered continuously.

3.1.1 Special functions of certain keys

[M] When the *NANOCOLOR®* 400 D has turned itself off 20 min after the last value has been measured, or if you have accidentally pressed the [On/Off] key during a method, you can directly select this method again by pressing [M] during method call-up.

[Ext. ?] By pressing key [Ext. ?] during method selection you can directly select the extinction program.

[Mem.] Pressing key [Mem.] during method selection calls up the memory administration (see chapter 3.5.3)

[Prog. •] When you press key [Prog. •] during method selection, you can work with special user-defined methods (see chapter 3.5.4)
Pressing key [Prog. •] prior to a measurement allows adjustment of the sample number.

[→] input of number of the sampling location

[←] input of sample dilution

[o.k. ✓] When the *NANOCOLOR®* 400 D has turned itself off 20 min after the last value has been measured, or if you have pressed the [On/Off] key, you can – after switching the photometer on again – display the last stored value when you press [o.k. ✓] during method selection.
after measurement call-up of determination of a correction value
(see chapter 5.11)

3.2 Measuring procedure

Characteristic test data

The characteristic data for all *NANOCOLOR®* tests are stored in the *NANOCOLOR®* 400 D. When the instrument is switched on, the desired parameters can be activated by inserting the tube test or by input of the method number. The permanent programming of the *NANOCOLOR®* 400 D comprises all characteristic data of the desired test:

analytical parameter; factor; blank or base-line value; dimension; cuvette-dependent measuring range; measuring wavelength; reaction time; linearity of the calibration curve; memory requirements for characteristic data

Method call-up

Many analytical parameters can be measured with different cuvette sizes, measuring ranges, dimensions and measuring wavelengths. The method can be called up in three possible ways:

1. Insert a barcoded tube test and select the characteristic data using the [→] / [←] keys. The required option is confirmed by pressing [o.k. ✓]

2. Call up the method with 3 digits. The characteristic data is also selected with the → / ← keys. The desired option is confirmed with key o.k. ✓ .

3. Select the desired option by calling up the 4-digit method number. Now the option cannot be changed with the → / ← keys.

4. The selected method now becomes the main method (1st priority), i.e. with every new method call-up this method blinks three times, then the test proceeds automatically. During blinking you can interrupt the automatic programme sequence by pressing keys → / ←, or you can select another subroutine by pressing the corresponding fourth digit of the test number. When the automatic test sequence is interrupted, you can either enter the fourth digit of the test number, or you can scroll through the method submenu using keys → / ← and confirm the selected method with key o.k. ✓ .

User guidance

The *NANOCOLOR®* 400 D now determines the further course of the measurement by optical display instructions:

measuring range and dimension, automatically adjusted filter, reaction time, zero adjustment, No. of sampling location, sample number, dilution and readiness to measure any number of samples.

If the measuring range is exceeded, or if any other errors arise, these will be indicated on the display immediately.

Measuring ranges

For each test, the measuring ranges specified in the manual are stored in the *NANOCOLOR®* 400 D. When the measuring result exceeds or falls short of the measuring range, the respective limit is displayed and stored with either the symbol > or < . Dilution is taken into account automatically.

Sampling locations / dilutions

Before measuring the sample, the respective sampling location and/or a preliminary dilution can be entered by actuating the → / ← keys.

Sample number

Pressing key Prog. • after a measurement allows input of a 2-digit sample number. The basic setting starts with „01“.

Change of dimension

The dimension cannot be changed during the measurement sequence. If the dimension has to be changed, one has to start again by calling up the method using the Esc key.

Cuvette change

When a different measuring range requires change of the cuvette size, a one-time zero adjustment for the respective cuvette is necessary. As long as you do not leave the method, you may then change between different cuvette sizes without any further zero adjustment.

3.3 Scheme of operation for *NANOCOLOR*® tests

3.3.1 Scheme of operation when using tube tests with barcode

desired parameter: e.g. COD 160, test 0-26

Display

1. Key [Esc] (if other parameters have been measured before). Cursor flashes. Insert coded test tube into the photometer.

   Method: .
   >> Cuvette >>

2. Display of measuring range
   The interference filter is automatically turned into measuring position

   0261 COD 160
   15-160 mg/l O2

3. The result is displayed.

   0261 COD 160
   01 38 mg/l O2

4. If desired, place other sample test tubes in photometer and measure; samples are numbered in sequence.

3.3.2 Scheme of operation when using tube tests without barcode

desired parameter: e.g. Ammonium 10 test 0-04

1. Key [Esc] (if other parameters have been measured before). Cursor flashes

   Method: .
   >> Cuvette >>

2. Enter test number, keys [0] [0] [4].
3. Press key [→], first measuring range is displayed with dimension

   0041 AMMONIUM 10
   0.2-8.0 mg/l NH4N

4. Press key [→], until required measuring range and dimension appears (can be repeated endlessly in roll mode or back with key [←]).

   0042 AMMONIUM 10
   0.2-10.0 mg/l NH4

   This can also be attained if the fourth digit in the 4-digit test number, e.g. [2], is entered straight away.

5. Confirm the correct measuring range and dimension by pressing key [o.k.] (**does not apply when 4-digit figures are entered)**

   0042 AMMONIUM 10
   0.2-10.0 mg/l NH4

   The interference filter is automatically turned into measuring position

6. Reaction time is displayed and started with key [o.k.]. For skipping the display press [→]. *The test tube with base line value (NULL) is not used.*

   0042 AMMONIUM 10
   react.time 15'00

   0042 AMMONIUM 10
   measure sample>M

7. Place test tube with sample in photometer and press [M], read result,

   0042 AMMONIUM 10
   01 8.3 mg/l NH4

   Underlined sample number (lower left edge of the display) indicates that the measurement value is stored automatically;
   once [Mem.] is pressed, the most recent measurement value is **not** stored

If input of a sampling location or a dilution is required, press either [→] or [←] **after the measurement**.

Display

8. To enter the sampling location, call up the sampl. place No. with key [→], enter the new number and confirm with key [o.k.]

```
0042 AMMONIUM 10
sampl.placeNo.
```

9. To enter a preliminary dilution of the sample, call up dilution with key [←] and enter new dilution (e.g. diluted 1:1000: input 1 + **999**) and confirm with key [o.k.]. The dilution is immediately taken into account when result is displayed
   No. of sampling place and dilution are stored with the measurement value, for example

```
0042 AMMONIUM 10
dilution: 1+
```

```
0042 AMMONIUM 10
measure sample>M
```

```
0042 AMMONIUM 10
01 8.3 g/l NH4
```

10. If necessary, place other test samples in photometer and measure acc. to procedure given above; the samples are numbered in sequence. No. of sampling place and dilution are always displayed prior to the measurement and must be confirmed with key [M] or altered with either key [→] or key [←].

3.3.3 Scheme of operation for standard tests

desired parameter with reagent blank value: e. g. Nitrite test 1-67

1. Key [Esc] (if other parameters have been measured before). Cursor flashes

```
Method:
>> Cuvette >>
```

2. Enter test number, keys [1] [MNO 6] [PQRS 7]

```
167_ NITRITE
```

3. Press key [→], the first measuring range is displayed with dimension

```
1671 NITRITE
0.002-.3mg/lNO2N
```

4. Press key [→], until required measuring range and dimension appears (can be repeated endlessly in roll mode or back with key [←]).
   This can also be attained if the fourth digit in the 4-digit test number, e.g. [ABC 2], is entered straight away.

```
1672 NITRITE
0.005-1 mg/l NO2
```

5. Confirm the correct measuring range and dimension by pressing key [o.k.] **(does not apply when 4-digit figures are entered**)
   The interference filter is automatically turned into measuring position

```
1672 NITRITE
0.005-1 mg/l NO2
```

6. Reaction time is displayed and started with key [o.k.]. For skipping the display press [→].

```
1672 NITRITE
react.time 10'00
```

```
1672 NITRITE
measure blank->Z
```

7. Place cuvette with blank value in photometer and press [Null Zero] for zero adjustment (use cuvette of same size as for sample, e.g. 50 mm)

```
1672 NITRITE
00 0.000mg/l NO2
```

```
1672 NITRITE
measure sample>M
```

Display

8. Place rectangular cuvette with sample in photometer and measure by pressing key [M].

```
1672 NITRITE
01 >0.25mg/l NO2
```

If the measuring range is exceeded, the measurement sequence can be repeated in 10 mm rectangular cuvettes. Transfer blank value and sample solution to 10 mm cuvettes.

9. Place 10 mm cuvette with blank value in photometer, press [Null Zero] for zero adjustment
No. of sampling location and dilution remain stored (if they have been entered.)

```
1672 NITRITE
00 0.000mg/l NO2
```

```
1672 NITRITE
measure sample>M
```

10. Place 10 mm rectangular cuvette with sample in photometer and measure by pressing key [M].

```
1672 NITRITE
01 0.31 mg/l NO2
```

In case of dilution, e.g. (1+24)

```
1672 NITRITE
01 7.75 mg/l NO2
```

11. If necessary, place other samples in photometer and measure acc. to procedure described above; the samples are numbered in sequence.

3.4 Basic photometric functions

By calling up method **9xx** you can select basic photometric functions (such as measurement with factor or standard). You can preselect with the roll mode by pressing [→] / [←] and confirm the desired option with [o.k. ✓].

Available options:
Method: 901 FACTOR
Method: 902 STANDARD
Method: 903 EXTINCTION
Method: 904 KINETICS

3.4.1 901 FACTOR

Since the colour reactions normally used for measurements obey the Lambert-Beer Law ($E = \varepsilon \times c \times d$), the photometer can be calibrated by using a factor.

concentration = extinction x factor

The above applies only to the limited range specified for every test. Test results, which exceed this range, should be repeated after dilution of the test sample. Test results, which are below the range can be repeated using a cuvette with longer optical path or must be recorded as: "smaller than the lower range limit" (e.g. < 0.05 mg/l). Should a test method not conform to the Lambert-Beer Law, then the concentration can only be determined by measuring the extinction and then reading off the results from a conversion table.

Determinations with factor

1 Select Method: 901
2 The pre-set wavelength is displayed. Select the wavelength required using the [→] and [←] keys and confirm the selection with [o.k. ✓]. The filter wheel automatically turns the proper filter into measuring position.
3 Set factor via keyboard – 4 digits with decimal point. The accuracy of the display is determined by the number of decimal places of the factor.
4 Perform measurement following the instruction of the display
(The extinction can be displayed during the measurement by pressing [Ext. ?].)
5 Return to method call-up by pressing [Esc]
(The factor is erased.)

3.4.2 902 STANDARD

There are certain determinations, where the colour reaction very strongly depends on different parameters, such as temperature, time, concentration of the reagents (e.g. medications). In such cases it is necessary to analyze a standard with a known concentration, as well as the test sample. The test results are then compared with those of the standard. The Lambert-Beer Law must apply here once again ($E_1 : \beta_1 = E_2 : \beta_2$) as follows:

$$\text{unknown concentration} = \text{concentration of standard} \cdot \frac{\text{extinction (test sample)}}{\text{extinction (standard)}}$$

Determinations with standard

1 Select Method: 902
2 The pre-set wavelength is displayed. Select the wavelength required using the [→] and [←] keys and confirm the selection with [o.k. ✓]. The filter wheel automatically turns the proper filter into measuring position.
3 Set concentration of standard via keyboard – 4 digits with decimal point . The accuracy of the display is determined by the number of decimal places of the standard concentration value.
4 Perform measurement following the instruction of the display
(The extinction can be displayed during the measurement by pressing [Ext. ?])
5 Return to method call-up by pressing [Esc]
(The standard value is erased.)

3.4.3 903 EXTINCTION

The extinction is a basic term in photometry, upon which many definitions are based.

$$\text{extinction} = \text{logarithm} \cdot \frac{\text{light transmitted through blank value}}{\text{light transmitted through test sample}}$$

The *NANOCOLOR®* analytical system gives direct reading of results. In spite of this fact, and especially in cases where the test results are near the limits of the range, extinction should not be ignored, since the four digit display does not offer any information about accuracy and consistency of test results. In photometry the desired absorbance range lies between 0.1 – 1.0 extinction. The extinction of a test sample can be called up any time during other measurement programmes.

Negative extinctions are found for methods where a colour decrease is used for the measurement.

Determination of extinction

1 Select Method: 903 or directly press key [Ext. ?]

2 The pre-set wavelength is displayed. Select the wavelength required using the [→] and [←] keys and confirm the selection with [o.k. ✓]. The filter wheel automatically turns the proper filter into measuring position.

3 Perform measurement following the instruction of the display

4 Return to method call-up by pressing [Esc]

3.4.4 904 KINETICS

For following the colour development (reaction) with time, the kinetics programme offers the possibility of repeating the measurement at defined time intervals, and to store and print results.

Measurement of kinetics

1 Select Method: 904

2 The pre-set wavelength is displayed. Select the wavelength required using the [→] and [←] keys and confirm the selection with [o.k. ✓]. The filter wheel automatically turns the proper filter into measuring position.

3 Set factor via keyboard – 4 digits with decimal point. The accuracy of the display is determined by the number of decimal places of the factor (for measurement of extinction set factor = 1.000)

4 Set time intervall (between 00’10 and 60’00 min can be selected) and confirm by pressing key [o.k. ✓]

5 Perform measurement following the instruction of the display

6 Discontinue the sequence by actuating [Esc] or by removing the cuvette. If required place other cuvettes into the photometer and start again by pressing key [M].

3.5 Special functions

3.5.1 Display of extinction

Display

After measurement

e. g.

```
0041 AMMONIUM 10
01 0.4 mg/l NH4N
```

the extinction of the measured value can be displayed by pressing key [Ext. ?].

```
0041 AMMONIUM 10
   0.071 E
```

Display of extinction, when the measuring range is exceeded

After measurement

e. g.

```
0041 AMMONIUM 10
01 >8.0 mg/l NH4N
```

the extinction of the measured value can be displayed by pressing key [Ext. ?].

```
0041 AMMONIUM 10
   1.823 E
```

When you release key [Ext. ?], the calculated measuring value is displayed. This orienting value cannot be stored – in this example >8.0 mg/l NH4N is stored.

```
0041 AMMONIUM 10
01 10.4 mg/l NH4N
```

3.5.2 Reaction time

If you wish, the reaction time can be displayed before measurement. Press key [o.k. ✓] to start the clock.

```
0642 NITRATE 50
react.time 10'00
```

```
0642 NITRATE 50
react.time  9'58
```

The reaction time can be skipped or stopped at any time using key [→] or [M] . After completion of the reaction time the sample is measured **automatically,** if there is a cuvette in the cuvette slot. The configuration menu also allows to completely deactivate the reaction timer.

3.5.3 Memory administration

In the standard mode of operation storage is activated (indicated by the underlined sample number)

```
0041 AMMONIUM 10
01 0.4 mg/l NH4N
```

If storage is **deactivated**, every actual measurement value can be stored by pressing key [Mem.], contrary, when storage is **activated**, the last measured value can be deleted from the memory. The storage key [Mem.] can only be used once after each measurement. Measured values are only stored after the cuvette has been removed from the slot.

If the display reads “Memory full“, you have stored 999 data sets. You can either accept this message by pressing key [o.k. ✓] and continue measurements without storage, or you may call up the memory administration by pressing key [Mem.] during method call up, transfer and then delete the contents of the memory. The configuration menu also allows to deactivate storage completely.

Memory administration

For memory administration press key [Mem.] during method call up:

```
Method:    .
 >> Cuvette >>
```

Display

The display will read either

```
MEMORY :        000
```

or, if any measuring values are stored e. g.

```
MEMORY :    180/180
print ? ←
```

The memory administration mode offers several possibilities to handle data. When pressing keys [→] / [←], the following options will appear in sequence:

```
MEMORY :    180/180
display ? ←
```

```
MEMORY :    180/180
delete ? ←
```

```
MEMORY :    180/180
select ? ←
```

Printing and output

When you press key [o.k.] at this point, all stored data or the selected data are transferred to a printer or computer.

```
MEMORY :    180/180
print ? ←
```

Display

When you press key [o.k.] at this point, the data are displayed in the sequence, in which they were stored. If certain data have been selected, only these are displayed.

```
MEMORY :    180/180
display ? ←
```

Example

Method and sampling location remain displayed for 2 seconds

```
0042 AMMONIUM 10
sampl.placeNo.25
```

After 2 s date, time, sample number and measuring value appear.

```
07.09.00   11:43
01  2.7 mg/l NH4N
```

Using key [←], the corresponding method and sampling location can again be displayed, by pressing key [→] the next stored value is displayed. At this point you can delete the displayed set of data by pressing key [Mem.]. Pressing key [o.k.] will print the displayed set of data. At any point you can return to memory administration by pressing key [Ext. ?] or to method call-up by pressing key [Esc].

Deleting data

When you press key [o.k.] at this point, and confirm deletion by pressing [o.k.] once more, the selected values or all values are deleted from the memory.

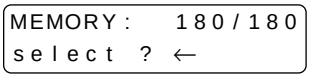
```
MEMORY :    180/180
delete ? ←
```

Selection

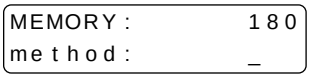
Display

The following options for selection are available:
method number / no. of sampling location / date / time

When you press key [ok] at this point, you reach the selection mode.



Input of the desired method:



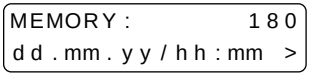
If the method is entered with four digits, all data are selected which belong to this method. When you enter three digits of the method number, all data corresponding to all submethods of this test are selected (e.g. 0041 – 0049). Input of the method can be skipped by pressing key [ok]. In this case all tests are selected.

Note:

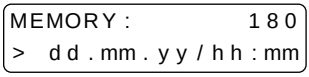
All selection parameters can be either entered completely or skipped by pressing key [ok]. Completely entered parameters are used without confirmation with the [ok] key, partially entered parameters result in correspondingly larger selection ranges. Skipped parameters always mean "all values" from the selection criterium. Pressing key [→] leaves the selection mode. Selection parameters set at this point are maintained.

Input of the number of the desired sampling location: it can be entered or skipped by pressing key [ok]. Skipping means "all sampling locations", input of a number selects all data sets of this specific sampling location.

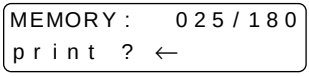
Input of the beginning of the desired time interval with date and, if desired, time:
these parameters can be entered or skipped by pressing key [ok]. Skipping means: select data beginning from the earliest date stored.



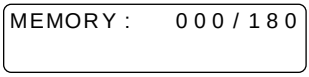
Input of the end of the desired time interval with date and, if desired, time:
again, these parameters can be entered or skipped by pressing key [ok]. Skipping means: select data to the present date and time.



When the selection process is complete, the selected data sets can be used for further manipulation, e.g. they can be printed, transferred to a computer, displayed or deleted.



If there are no values, which meet the selection criteria, all values are again activated for further work (180/180).



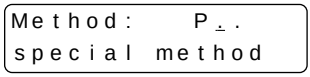
3.5.4 Special (user-defined) methods

The *NANOCOLOR*® 400 D offers the possibility to program up to 100 user-specific methods. These methods can be defined as linear (factor) or as non-linear methods (up to 4th degree functions). For defined methods the same options are available as for the pre-programmed methods (i.e. sampling location, dilution, storage etc.)

Selection of a special method

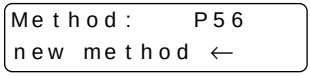
Programming or selection of a special (user-defined) method is started by pressing key [Prog. •]

The display will read



New method

Call up new special method, e. g. P56 by pressing key [Prog. •] and then [JKL 5] [MNO 6]. Confirm with key [o.k. ✓].



Now the method parameters can be entered:

For entering text, selection of filter, cuvette size, factor, measuring direction and range, dimension incl. supplement, and reaction time, every letter or number can be entered directly via the keyboard.

When the display asks <factor linear?>, one can either press key [o.k. ✓] and enter a linear factor ($\beta = E \times F$) where the position of the decimal point of the factor determines the number of decimals of the display, or one can press key [←] and then enter a polynomial up to the 4th order ($\beta = F4 \times E^4 + F3 \times E^3 + F2 \times E^2 + F1 \times E + F0$). Pressing key [←] **before** entering any of the polynomial factors will change the sign of the respective term. **After** all terms of the polynomial have been entered, the number of decimals for the display and the measuring direction (+ = increasing, – = decreasing, ± = both directions) are entered.

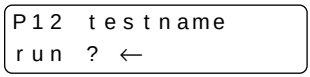
It is possible at any point to return to method editing using key [Ext. ?] or to the method selection mode by pressing key [Esc].

After entering [Prog. •] and two digits for a programmed user-defined method, you can select several options in the roll mode with keys [→] / [←]

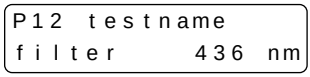
Running a special method

Display

Call up the special method, e. g. P12 by pressing key [o.k. ✓].

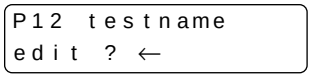


If the method is defined, the normal measuring programme is performed, e. g.



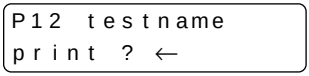
Editing a special method

Confirm by pressing key [o.k. ✓]. Method parameters can be called up and altered, e. g.



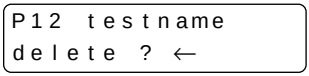
Printing

Confirm by pressing key [o.k.]. Method parameters are printed and/or transferred to a computer.



Deletion

Confirm by pressing key [o.k.]. After a second confirmation with key [o.k.] the special method is erased.



It is possible at any point to return to method editing using key [Ext. ?] or to the method selection mode by pressing key [Esc].

Note:

If you wish to print a list of all user-defined methods, you can do so by pressing keys [Prog. •] and [Mem.] before entering the number of a special method.

3.5.5 Numbering of samples

For an unambiguous identification of samples, every measurement is automatically assigned a sample number (starting with **01**). Further measurement values are numbered in sequence. It is possible to change the sample number after each measurement.

For a change of the sample number simply press key [Prog. •] prior to removal of the cuvette. You can then enter the desired 2-digit sample number. The following measuring values are numbered in sequence, starting from the entered value. The sample number is printed with the report. A subsequent data processing step can assign a sample name for a given sample number. After every method call-up numbering of samples generally starts with **01**.

3.5.6 Identification of sampling locations

For differentiating sampling locations it is possible to assign a 2-digit sample place number (1 to 99) to every sampling location **after** the measurement. For an easy input of the sample place number, press key [→] before removing the cuvette. The message <sampl.placeNo> is displayed, the number can be entered and confirmed with key [ok].

If a number for a sampling location has been stored for a previous measurement (sampl.placeNo ≠ 0), the sample place number is displayed **prior to each measurement**. It can then be confirmed with key [M] or changed after pressing key [→].

The sample place number is printed with the report and can be correlated with a name in the subsequent data processing. Upon starting the instrument, or when the method is changed, the sample place number is always reset to **00**.

3.5.7 Dilution of samples

In analytical practice it is often necessary to dilute a sample, until the concentration to be determined is within the measuring range.

Example: expected measurement value between 80 and 200 mg/l
range for *NANOCOLOR*® 400 D: 0.1 – 10 mg/l

required dilution (200 → 10 mg/l) at least 1 : 20
recommended dilution 1 : 25 or even 1:50, in order to obtain a measuring result in the middle of the measuring range.

Input of the dilution is as “1 part sample plus x parts distilled water”, in order to obtain unambiguous identification of small dilutions, too. It is possible to program dilutions between 1:2 and 1:1000, in the form of 1 + 1 to 1 + 999. Once a dilution has been entered, it is directly taken into account, when measuring range or result are displayed.

For a rapid input of a dilution, press key [←] before removing the cuvette. The message <dilution 1+_> is displayed, the values can be entered and confirmed with key [ok].

If a dilution has been stored for a previous measurement (dilution ≠ 1 + 0), it is displayed **prior to each measurement**. It can then be confirmed with key [M] or changed after pressing key [←]. Upon starting the instrument, or when the method is changed, the dilution is always reset to **1 + 0**.

3.5.8 Automatic determination of a correction value

Turbid or coloured samples require preparation of a correction value. After normal evaluation (with colouration/turbidity) measurement of the correction value is activated by pressing key [ok]. The programme asks for a cuvette with the correction value (see chapter 5.11), which is then measured. The corrected measuring result will be displayed and stored.

3.6 Configuration of the *NANOCOLOR®* 400 D

In the method selection mode you choose CONFIGURATION by pressing [WXYZ 9] [+/- 0] [+/- 0]. All topics of the configuration menu can be selected with keys [→] / [←]. **Key [Esc] allows to leave any point without altering the setting.**

```
KONFIGURATION
```

1. For language selection scroll with keys [→] / [←], then confirm with key [ok].

```
KONFIGURATION
 (D) → ( ) ? ←
```

Wait until your language is displayed and confirm your selection by pressing key [ok] .
You can choose between:
deutsch, **english**, français, italiano, nederlands, español, magyar, and polski

```
KONFIGURATION
language: (GB) ←
```

2. For setting the date and time scroll with keys [→] / [←], then confirm with key [ok].

```
date    11.09.00
time       13:27
```

For changing the date (upper line), press key [→] and enter the new date.

```
date    dd.mm.yy
time       13:27
```

For changing the time (second line), press key [←] and enter the new time.

```
date    11.09.00
time       hh:mm
```

3. For calibration scroll with keys [→] / [←], then start calibration with key [ok] .

```
CONFIGURATION
calibrate ←
```

First the photometer automatically checks all filters.

```
CONFIGURATION
please wait !
```

For the second calibration step the *NANOCOLOR®* 400 D requires the included calibration tube (or a clean *NANOCOLOR®* test tube filled with dist. water).

```
CONFIGURATION
insert cal. tube
```

```
CONFIGURATION
please wait !
```

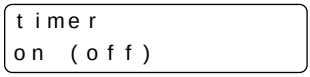
The calibration values are automatically measured, stored and used for all following measurements.

```
please remove
cuvette
```

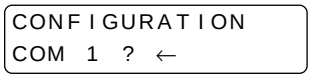
4. For setting the storage mode, scroll with keys [→] / [←], then confirm with key [ok]. Using key [←], you can switch the memory off or on.

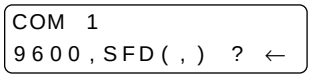
```
memory
on (off)
```

5. For setting the reaction timer, scroll with keys → / ←, then confirm with key ok. Using key ←, you can switch the timer off or on.

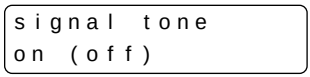


6. For setting the interface, scroll with keys → / ←, then confirm with key ok.
Adjust the interface setting in the roll mode with keys → / ← and confirm with key ok.
The following options are possible:
baud rate 9600, 4800, 2400, 1200
ASCII or SDF (semicolon delimited format)
decimal point (.), decimal comma (,)

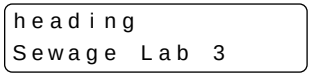




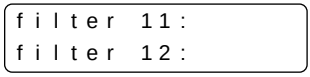
7. For setting the signal tone, scroll with keys → / ←, then confirm with key ok. Using key ←, you can switch the tone off or on.

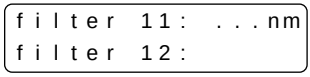


8. If you want to change the heading, scroll with keys → / ←, then confirm with key ok. You can then enter up to 16 characters by selecting the letters in the roll mode with key ← and confirmation with key ok.



9. For wavelength definition of the special filters, positions 11 and 12, scroll with keys → / ←, then confirm with key ok.
For entering filters 11/12 press keys → / ← and enter the wavelength using 3 digits. For erasing wrong data select the corresponding filter and enter the correct wavelength or delete the value by pressing ok.





10. Confirm programme update with key ok. Follow the instructions given on the MACHEREY-NAGEL homepage.

3.7 Data transfer

The *NANOCOLOR*® 400 D can communicate with almost any conventional Windows® terminal software. The RS 232 interface corresponds to the standard.

For data transfer the *NANOCOLOR*® 400 D has to be connected to a free serial port of the PC via a zero modem cable (Cat. No. 919 680). In some cases an adaptor 9 → 25 pin SUB-D socket may be required (Cat. No. 919 681).

NANOCOLOR® software Photometer Data Export (Cat. No. 919 02.1)

This program manages the complete communication between photometer and PC. Transferred data can be either directly written into an EXCEL spreadsheet or processed as ACCESS data base. For more information visit www.mn-net.com

Terminal software

You may also use the terminal software under Windows®.

Adjustment of the data transfer rate between photometer and computer (in general 9600 baud) and the selection of the PC interface have to be set in the configuration of the terminal software corresponding to the settings of the photometer.

Transfer of stored data from the photometer

Switch on the photometer, call up memory administration using key [Mem.]. Select data to be transferred if necessary.
Using keys [→] / [←], scroll until you reach <print ? ←>; with key [OK] transfer of the data to the computer is started.
Output of the data can also be started from the terminal programme by sending "**X**". For this option the photometer has to be in the method selection mode.

Online measurements

Each measurement value is automatically transferred to the interface, and if the software is activated, values are displayed on the computer monitor and stored, if required.

Data transfer rates (baud rate)

optional 9600, 4800, 2400, 1200 baud

Data transfer formats

ASCII	output of data is in the tab delimited format, which is very well suited for further manipulation in a word processing programme
SDF	(semicolon delimited format); fields of a set of data are separated by semicolons and can thus easily be imported into spread sheets or data bases.
SDF(.)	selection of the decimal point (for spread sheets) transfers the data with a decimal point
SDF(,)	selection of the decimal comma (for spread sheets) transfers the data with a decimal comma

3.8 Troubleshooting

Display (error message)	**Explanation**	**Suggested remedy**
recharge battery	battery voltage is below the minimum	recharge battery with the charger for about 24 h (photometer can be operated during charging)
memory full	the memory of the photometer is full, 999 data sets are stored	accept message by pressing [ok ✓] and continue measurements without storage or in the method selection mode call up storage administration by pressing key [Mem.], transfer memory contents and then delete the data from the memory or turn of storage in the configuration mode
calibrate	deviation(s) found during self-check	start calibration by pressing [ok ✓] calibration can be skipped by pressing key [→], however, then only measurements against a blank value are possible
check filter	serious deviation(s) found during self-check or calibration	restart calibration in the configuration menu; if error remains, filter has to be replaced
lamp defect?	no light at the photo cell	if necessary, replace lamp, recalibrate the system
please remove cuvette	cuvette in the optical beam at a wrong time no cuvette in the beam	remove cuvette cuvette control switch is blocked
check cuvette	method and cuvette size do not fit	select proper method or proper cuvette
error: >->>->>>	too much light at the photo cell	have the instrument adjusted
error: <-<<-<<<	no light at the photo cell	sample solution too dark filter defective lamp defective
photometer does not show any functions when switched on	system hangs	press reset key on the back of the instrument; photometer is initialised again, all measured values and all user-defined methods are erased; date, time, filters 11/12 and filter factors are set to default values and have to be adjusted again

4. Preparation of samples

Water samples are not always suitable for immediate analyses. In the case of heavily polluted water (or waste water) especially, it is often not possible to conduct analyses without pretreating the sample first; otherwise, larger concentrations of organic or inorganic compounds can interfere and lead to falsely negative or positive test results.

Some of the following preparations may be necessary before analyzing the water: (examples in brackets)

1. dissolve undissolved compounds (metal oxides)
2. release complex or adsorptive compounds (hexacyanoferrates)
3. decompose polymer compounds (polyphosphates)
4. change the state of oxidation (Cr(III) $\rightarrow$ Cr(VI))
5. remove interfering substances (nitrite in the case of nitrate determination)
6. separate the substance to be determined by distillation (ammonium, cyanide)
7. eliminate organic substances (waste water)
8. filter turbid and suspended matter (sedimentation); e.g. with membrane filters

We offer a number of methods for sample pretreatment:

The crack set (Cat. No. 918 08) and *NanOx* are used for oxidative treatment of the sample in an acidic medium unter normal pressure at 100 – 120 °C. These methods feature easy handling and solve a large number of decomposition problems.

For samples with difficult matrices, but especially for rapid determination of total nitrogen, total phosphorus and total chromium, we recommend oxidative decomposition with *NanOx* at elevated pressures in a microwave oven.

Very resistant samples (applicable to points 1, 2, 3, and 7 above) can be treated by wet decomposition (oxidation) with nitric and sulphuric acid:

Instructions: add 50 ml of sample, 2 ml nitric acid (65%) and 2 ml sulphuric acid (96%) to a beaker, heat almost to dryness (use fume cupboard with fan on). As soon as a white SO_3 fog appears, stop heating and allow the deposit to cool down to room temperature, then add 20 ml distilled water. Neutralise with sodium hydroxide solution and pour sample into a volumetric flask 50 ml, rinse out the beaker twice with 10 ml distilled water each time and pour into the volumetric flask. Then fill the volumetric flask to the 50 ml mark with distilled water. Almost all metals can be determined directly in this solution.

Depending on the specific problems, this method has to be adjusted or replaced by another sample preparation method. It should always be kept in mind, that on the one hand, when the sample preparation is completed, a defined volume of sample must be present, in order to be able to make an exact statement about the concentrations obtained once the actual analysis is finished. On the other hand, the original chemical milieu of the sample has to be reestablished (pH value, redox potential etc. ...) according to the specific requirements of the analytical method.

As can be deduced from this concise explanation, each analysis has to be individually treated and the sample accordingly prepared in the case of polluted samples. Only then can accurate and realistic test results be achieved. Please contact us should you have any questions.

4.1 Crack Set

Method: Dissolution and decomplexation of heavy metals with sulphuric acid/potassium peroxodisulphate

NANOCOLOR®
reagent set: Crack set (Cat. No. 918 08)

Precautions: *Beware of samples containing high concentrations of cyanides – poisonous vapours will develop!*

Interferences: Some stable heavy metal cyanide complexes cannot be decomposed completely.

Procedure: Requisite accessories: *NANOCOLOR*® heating block, decomposition tube (Cat. No. 916 66), condenser
Switch on heating block, set to 100 °C and 1 h 00 min

Sample
Fill decomposition tube with 10 ml homogenised sample, add 1 ml R1 and 1 level measuring spoon R2, shake slightly, attach condenser and place decomposition tube into the heating block, Press **START** key
After 1 h remove decomposition tube from heating block, cool, add 1 ml R3 and mix. *The pH value should be between a pH of 2 and 5, otherwise add more or less R3.*

A. Tube tests
The decomposed solution can be used directly for the test. Insert test tube and select method number according to the following table:

			Method
Lead 5	test 0-09	0.10 – 5.00 mg/l Pb	**0093**
Cadmium 2	test 0-14	0.10 – 2.00 mg/l Cd	**0143**
Iron 3 *	test 0-37	0.1 – 3.0 mg/l Fe	**0373**
Copper 7	test 0-54	0.1 – 7.0 mg/l Cu	**0543**
Nickel 7	test 0-61	0.1 – 7.0 mg/l Ni	**0613**
Zinc 4	test 0-96	0.1 – 4.0 mg/l Zn	**0963**

Measurement: Call up method
Perform measurement

B. Standard tests
Pour decomposed solution into a volumetric flask 25 ml, rinse decomposition tube with some dist. water and fill flask to about 20 ml with dist. water (corresponds to the 20 ml sample volume mentioned in the test procedures). Measure according to original procedures. Multiply results by 2. Suited for: Iron* test 1-36, Cobalt test 1-51, Copper test 1-53, Manganese test 1-60, Nickel test 1-62, Zinc test 1-95.
* An exact determination of iron requires a reagent blank value, because even analytical grade chemicals may contain traces of Fe.

C. Extraction methods
Pour decomposed solution into a separation funnel 100 ml and rinse decomposition tube with about 40 ml dist. water (corresponds to the 50 ml sample solution mentioned in the procedures). Measure according to original procedures. Multiply results by 5. Suited for: Lead test 1-10, Cadmium test 1-13.

Reference: German standard methods for the examination of water, waste water and sludge (DIN 38 406-E1/2).

4.2 *NanOx* Metal

for oxidative decompositon of metals and total phosphorus

***NanOx* decomposition reagent and *NanOx* neutralisation reagent**

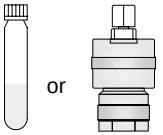
Principle: Oxidative decomposition for determination of complexly bonded metals or metal ions, which are present in an oxidation state, which without decomposition would not be determined by the test (e.g. chromium(III)). Also suitable for the determination of total phosphorus by oxidation of all inorganic and organic phosphorus compounds to form *ortho*-phosphate.

Application:

Decomposition in a heating block: the decomposition with *NanOx* solid reagents in a heating block at 100 °C features a lower oxidation potential than microwave decomposition. We recommend 120 °C for an optimised decomposition in the heating block. For mainly industrial waste waters this method can be used if the matrix is constant over a longer time period. In regular intervals the applicability of the method should be checked against a reference procedure (e.g. microwave decomposition).

Pressurised microwave decomposition: this method features the advantages of easy handling, considerable time-saving and very high recovery for complexes and even for organic compounds, which are difficult to decompose.

Decomposition with *NanOx* Metal



Method: Acid oxidative pressurised microwave or heating block decomposition followed by neutralisation

NANOCOLOR® reagent set: *NanOx* Metal (Cat. No. 918 978)

Precautions: *We recommend to read the instructions for use, which come with the NanOx reagent set, before you start practical work. They contain further important details.*

Procedure: Requisite accessories: microwave testing unit (Cat. No. 919 58) or *NANOCOLOR*® heating block and *NANOCOLOR*® test tubes 14 mm ID (Cat. No. 916 80)

	Sample
Procedure Heating block:	Pipet 5.0 ml test sample into a reaction tube 14 mm ID, add 1 level orange measuring spoon ***NanOx* Metal decomposition reagent**, close and shake thoroughly. Place the reaction tube into the heating block and heat at 100 °C for 1 hour or at 120 °C for 30 min. Remove tube from the heating block, shake gently and leave it to cool. Open the reaction tube and test the decomposition solution for peroxides using *QUANTOFIX*® Peroxide test sticks. If peroxides are present, close tube, and heat again **without** further addition of ***NanOx* Metal decomposition reagent.** Remove from the heating block and let cool for about 10 min. Turn the reaction tube upside down once, open it and again test for peroxides. Then carefully add 1 – 2 level microspoons ***NanOx* neutralisation reagent** (evolution of gas)**,** close and shake thoroughly.

Sample
Procedure Microwave: Pipet 10 ml sample solution into the decomposition vessel. Add 2 level orange measuring spoons ***NanOx* Metal decomposition reagent**, close and mix thoroughly. Place pressure vessel on the outer edge of the microwave revolving plate and heat 24 s at 900 VA or 30 s at 750 VA (always use the highest power rating of your microwave oven). Remove vessel from the microwave oven and let cool for about 10 min. Turn the pressure vessel upside down once and open it with caution. Test the decomposition solution for peroxides using *QUANTOFIX®* Peroxide test sticks. If peroxides are present, close vessel, and microwave again **without** further addition of ***NanOx* Metal decomposition reagent.** Remove from the microwave oven and let cool for about 10 min. Turn the pressure vessel upside down once, open it and again test for peroxides. Then carefully add 3 level microspoons ***NanOx* neutralisation reagent** (evolution of gas)**,** close and shake thoroughly.

A. Tube tests

The decomposed solution can be used directly for the determination. Insert test tube and select method according to the following table:

			Method
Cadmium 2	test 0-14	0.10 – 2.00 mg/l Cd	**0142**
Chromate 5	test 0-24	0.03 – 2.00 mg/l Cr	**0244**
Iron 3	test 0-37	0.1 – 3.0 mg/l Fe	**0372**
Copper 7	test 0-54	0.1 – 7.0 mg/l Cu	**0542**
Nickel 7	test 0-61	0.1 – 7.0 mg/l Ni	**0612**
Zinc 4	test 0-96	0.1 – 4.0 mg/l Zn	**0962**
Aluminium 07*	test 0-98	0.02 – 0.70 mg/l Al	**0982**

* only for microwave decomposition

Measurement: Call up method, Perform measurement

B. Standard tests

Pour the decomposed solution into a volumetric flask 25 ml, rinse decomposition vessel or reaction tube with some dist. water and fill flask to about 20 ml with dist. water (corresponds to the 20 ml sample volume mentioned in the test procedures). Measure according to original procedure and multiply results by 2 (microwave procedure) or 4 (heating block), resp.

Suited for: Aluminium test 1-02*, Iron test 1-36, Cobalt test 1-51, Copper test 1-53, Manganese test 1-60, Nickel test 1-62, Zinc test 1-95.

* only for microwave decomposition

C. Extraction methods

Pour decomposed solution into a separation funnel 100 ml and rinse decomposition vessel or reaction tube with about 40 ml dist. water (corresponds to the 50 ml sample solution mentioned in the procedures). Measure according to original procedures.

Multiply results by 5 (microwave procedure) or 10 (heating block), resp.

Suited for: Lead test 1-10, Cadmium test 1-13.

Note: *For determination of total nitrogen with NanOx N please see next page and Test 0-83.*

Analytical quality control: *NANOCONTROL* multistandards Metal 1 (Cat. No. 925 015) / Metal 2 (Cat. No. 925 016)

4.3 *NanOx* N

for oxidative decomposition of total nitrogen

***NanOx* decomposition reagent and *NanOx* compensation reagent**

Principle: Oxidation of all inorganic and organic nitrogen-containing substances to form nitrate. Residues of peroxide which remain after oxidation and oxidised chromium(VI), which interfere with the determination of nitrate, are eliminated by a compensation reagent.

Applications:

Decomposition in a heating block: the decomposition with *NanOx* solid reagents in a heating block at 100 °C features a lower oxidation potential than microwave decomposition. We recommend 120 °C for an optimised decomposition in the heating block. For mainly municipal waste waters this method can be used if the matrix is constant over a longer time period. In regular intervals the applicability of the method should be checked against a reference procedure (e.g. microwave decomposition). For nitrogen compounds, which are difficult to decompose, the recovery from industrial waste waters can be incomplete or not at all possible.

Pressurised microwave decomposition: this method features the advantages of easy handling, considerable time-saving and very high recovery even for organic compounds, which are difficult to decompose.

Refer to Test 0-83 for accessories, reagents and working procedures.

5.11 Procedures for photometric analyses with *NANOCOLOR®* tests when samples are coloured or turbid

These procedures can only be used in connection with the corresponding original instructions in this *NANOCOLOR®* manual.

The photometric analysis of water samples with own colour or turbidity always requires determination of a correction value. Colours and turbidities cause increased light absorption (increased extinction), thus leading to wrong results. Determination of correction values requires individual procedures for every test. For example, it is not possible simply to measure the colour of the sample without reagents and then substract this value from the test result. In many cases, the reagents alter the colour or turbidity of the sample. All changes of the sample during analysis, such as dilution, addition of chemicals which alter pH or redox state have to be taken into account. Only the main reagent, which forms the measured colour complex, is not added.

With the *NANOCOLOR®* photometer, the measurement programme for the correction value is started after the measurement of the (turbid or coloured) sample (value A) by pressing key [0↓✓]. The instrument asks for the cuvette with the correction value (value B) and measures the correction. The corrected measurement result is displayed and stored.

Basic procedure:

Determine measuring result as per original instruction = A

Determine correction value as per special instruction = B

Analytical result = A – B

Exceptions: Methods, where decreasing extinctions are measured against a reagent blank value.
In these cases, analytical result = A + B
The corresponding analytical instructions point out this fact.

It is very important to substract only values with equal dimensions (e. g. mg/l N; mg/l NH_4; mmol/m^3; E).

If, in the same matrix, the correction factor for several samples is so low that it can be neglected, it may be possible to work without correction. However, this conclusion can only be drawn from practical experience and cannot be predicted!

5.11.1 Determination of correction values for *NANOCOLOR*® tube tests 14 mm ID

For measurement of the correction value use as a blank value a clean, empty test tube filled with distilled water (exceptions: Nitrate 50/250 test 0-64/0-66)

Test	Test tube for correction (Value B)
0-03 Ammonium 3	Open ammonium tube test, add 4.0 ml sample, close, mix
0-04 Ammonium 10	Open ammonium tube test, add 1.0 ml sample, close, mix
0-05 Ammonium 50 0-06 Ammonium 200	Open ammonium tube test, add 0.2 ml sample, close, mix
0-07 AOX 3	Almost all colours and turbidities are destroyed under test conditions and do not interfere. Resistant colours and turbidities cause deviating results which cannot be circumvented
0-09 Lead 5	The original test contains a correction; thus no determination of a correction value is necessary
0-14 Cadmium 2	Fill **empty** test tube with 4.0 ml sample, add 0.2 ml R2, close and mix
0-15 Carbonate hardness 15	Open carbonate hardness test tube, add 4.0 ml sample solution, close and mix
0-17 Chlorine/Ozone 2	Fill **empty** test tube with 4.0 ml sample for each test
0-18 Chlorine dioxide 5	Fill **empty** test tube with 4.0 ml sample for each test
0-19 Chloride 200	Open chloride tube test, add 1.0 ml sample solution and 1.0 ml distilled water, close, mix
0-21 Chloride 50	Open chloride tube test, add 4.0 ml sample solution and 1.0 ml distilled water, close, mix
0-24 Chromate 5	Fill **empty** test tube with 4.0 ml sample, add 0.2 ml R2, close, mix
0-243 total Chromium	Proceed as described in the instructions for test 0-243 up to step b incl. After cooling fill 4.0 ml of the preoxidised sample solution into an **empty** test tube.
0-22, 0-23, 0-26 – 0-29, 0-33 COD 40 – 15 000	Almost all colours and turbidities are destroyed under test conditions and do not interfere. COD resistant colours and turbidities cause deviating results which cannot be circumvented
0-31 Cyanide 08	Proceed as described in the instructions for test 0-31, **but add 0,5 ml distilled water instead of 0,5 ml R3!**
0-35 DEHA 1	Open DEHA tube test, add 4.0 ml sample, close and mix
0-37 Iron 3	Fill **empty** test tube with 4.0 ml sample solution, close
0-40 Fluoride 2	no correction possible
0-41 Formaldehyde 8	Open formaldehyde tube test, add 2.0 ml sample solution, close and mix
0-43 Hardness 20	Open hardness tube test, add 0.2 ml sample solution, close and mix
0-45 Potassium 50	Open potassium tube test, add 2.0 ml sample solution, close and mix
0-52 Compl. agents 10 Anal.result = A+B	Fill **empty** test tube with 4.0 ml sample and 1.0 ml dist. water, close and mix
0-54 Copper 7	Fill **empty** test tube with 4.0 ml sample and 0.4 ml distilled water, add 0.2 ml R2, close and mix
0-56 Molybdenum 40	no correction possible
0-58 Manganese 10	Fill **empty** test tube with 4.0 ml sample solution, 0.5 ml distilled water and 0.5 ml R2, close and mix. Add 1 measuring spoon R3, close and shake vigorously.
0-61 Nickel 7	Open nickel test tube, add 5.0 ml sample and 1.0 ml sodium hydroxide solution 15%, close, mix

Test	Test tube for correction (Value B)
0-64 Nitrate 50	Open nitrate tube test, add 0.5 ml sample and 0.5 ml 2-propanol, close, mix **Blank value for correction:** Open nitrate tube test, add 0.5 ml distilled water and 0.5 ml 2-propanol, close, mix
0-66 Nitrate 250	Open nitrate tube test, add 0.2 ml sample and 0.5 ml 2-propanol, close, mix **Blank value for correction:** Open nitrate tube test, add 0.2 ml distilled water and 0.5 ml 2-propanol, close, mix
0-68 Nitrite 2	Fill **empty** test tube with 4.0 ml sample, add 0.2 ml R2, close, mix
0-72 pH 6.5 – 8.2	The original test contains a correction; thus no determination of a correction value is necessary
0-74 Phenolic index 5	Proceed as described in the instructions for Test 0-74, **but do not add *NANOFIX* R2**, close, mix
0-76/ 0-80/0-81 ortho- and total Phosphate 1–15	Proceed as described in the instructions for test 0-76 / 0-80 / 0-81 but **instead of R4** add 0.2 ml distilled water, close, mix
0-79 ortho- and total-Phosphate 50	Proceed as described in the instructions for test 0-79, but **instead of R3** add 1.0 ml sulphuric acid 20%, close, mix
0-82 Oxygen 12 8-22 / 8-25 BOD_5	The original tests contain a correction; thus no determination of a correction value is necessary
0-83 total Nitrogen 22	Almost all colours and turbidities are destroyed unter test conditions and do not interfere. For samples which are still coloured or turbid after decomposition, correction values are determined as described for the individual tests (0-64, 0-66)
0-84 Residual hardness 1	Open Residual hardness test tube, add 5,0 ml sample solution, close and mix
0-85 Starch 100	no correction possible
0-86 Sulphate 200 0-87 Sulphate 1000	The original test contains a correction; thus no determination of a correction value is necessary
0-89 Sulphite 10	Open sulphite test tube, add 4.0 ml sample and 0.2 ml dist. water, close and mix
0-90 Sulphite 100 Anal.result = A+B	Fill **empty** test tube with 0.2 ml R2, 4.0 ml sample solution and 1.0 ml dist. water, close, mix
0-91 Thiocyanate 50	Fill **empty** test tube with 4.0 ml sample
0-94 TOC 70	The original tests contain a correction; thus no determination of a correction value is necessary
0-96 Zinc 4	Fill **empty** test tube with 4.0 ml sample, add 0.2 ml R2, close and mix
0-97 Tin 3	Proceed as described in the instructions for test 0-97, add 1.0 ml ethanol instead of R4.
0-98 Aluminium 07	Proceed as described in the instructions for test 0-98, add 0,5 ml dist. water instead of R3.
8-38 Ethanol 1000	Open ethanol tube test, add 4.0 ml R1 and 0.5 ml sample solution, mix, add 2 drops R3, close and mix.
8-59 Methanol 15	Open methanol tube test, add 3.0 ml R1 and 1.5 ml sample solution, mix, add 2 drops R3, close and mix.
8-71 Peroxide 2	Fill **empty** test tube with 4.0 ml sample
8-73 Pesticides	no correction possible

5.11.2 Determination of correction values for *NANOCOLOR*® standard tests with reagent blank value

For tests of this category, the instructions require distilled water plus reagents as a reagent blank value. Another volumetric flask 25 ml is necessary for the correction value. Distilled water is used as a blank value for the correction value.

For some tests, a special reagent has to be prepared for correction. If reduced sample volumes are used for a test (dilution due to concentrations which are too high), the sample volume for determination of the correction value must be reduced by the same amount.

Test	Preparation for correction (Value B)
1-02 Aluminium	20 ml sample; 0.2 ml R1, mix; 1 spoon R2, mix; 2 ml R4, mix; fill to 25 ml with distilled water, mix
1-05 Ammonium	20 ml sample; 1 ml R1, mix; fill to 25 ml with distilled water, mix
1-20 Chloride	20 ml sample; 2 ml R1, mix; fill to 25 ml with distilled water, mix
1-44 Hydrazine	20 ml sample; 2 ml R1, mix; fill to 25 ml with distilled water, mix
1-51 Cobalt	20 ml sample; 1 ml R1, mix; 1 ml R3, mix; fill to 25 ml with distilled water, mix
1-63 Nitrate Z	20 ml sample; 1 ml R1, mix; fill to 25 ml with distilled water, mix
1-65 Nitrate	4.0 ml Nitrate R1, 0.5 ml sample, 0.5 ml 2-propanol, mix **Blank value for correction:** 4.0 ml Nitrate R1, 0.5 ml distilled water, 0.5 ml 2-propanol, mix
1-67 Nitrite	20 ml sample; 2 ml R1, mix; fill to 25 ml with distilled water, mix
1-75 Phenol	20 ml sample; 1 ml R3, mix; fill to 25 ml with distilled water, mix
1-77 Phosphate	20 ml sample; 1 ml of a mixture of 80 ml water and 20 ml sulphuric acid 96%, mix; 1 ml R2, mix; fill to 25 ml with distilled water, mix
1-78 Phosphate	20 ml sample, **1.5 ml R1**, mix; fill to 25 ml with distilled water, mix
1-95 Zinc	20 ml sample; 2 ml R2, mix; 1 ml R4, mix; fill to 25 ml with distilled water, mix

5.11.3 Determination of correction values for *NANOCOLOR*® standard tests with sample blank value

For the tests of this category, the correction can already be performed during the measurement. In these cases the following preparations are used as blank values instead of the blank values given in the instructions.

For some tests, a special reagent has to be prepared for correction. If reduced sample volumes are used for a test (dilution due to concentrations which are too high), the sample volume for determination of the correction blank value must be reduced as well.

Test	Preparation for correction blank value
1-16 Chlorine	
free chlorine	20 ml sample; 1 ml R1, mix; fill to 25 ml with distilled water, mix
total chlorine	20 ml sample; 1 ml R1, mix; 1 tablet of R3, mix; fill to 25 ml with distilled water, mix
1-25 Chromate	20 ml sample; 1 ml R1, mix; fill to 25 ml with distilled water, mix
1-30 Cyanide	20 ml sample; 1 spoon R1, dissolve; 2 ml R3, mix; fill to 25 ml with distilled water, mix
1-36 Iron	20 ml sample; 1 ml R1, mix; 1 spoon R2, mix; 1 ml R3, mix; fill to 25 ml with distilled water, mix
1-48/1-48$_3$ Silica	20 ml sample; 1 ml of a mixture of 5 ml sulphuric acid 96% and 100 ml distilled water, mix; 1 ml R2, mix; 1 ml R3, mix; fill to 25 ml with distilled water, mix
1-53 Copper	20 ml sample; 2 ml R1, mix; fill to 25 ml with distilled water, mix
1-60 Manganese	20 ml sample; 1 ml R2, mix; 1 ml R3, mix; 1 spoon R4, mix; fill to 25 ml with distilled water, mix
1-62 Nickel	20 ml sample; 1 ml R1; 1 ml R2, mix; 1 ml R3, mix; fill to 25 ml with distilled water, mix **Note:** The yellow colour produced by the addition of R2 must disappear when R3 is added!
1-88 Sulphide	20 ml sample; 1 ml of a mixture of 60 ml distilled water and 40 ml sulphuric acid 96%, mix; fill to 25 ml with distilled water, mix