Operating Instruction

TKZ: 315 015 002 006
Version: 02 / 2013

Battery Tester- / Charger- / Discharger

BT2000CT-E

0 - 31 V / 0 - 40 A / 102 A

TKZ: BT2000-942009-251

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FRONT VIEW


LINEFUSE
ON
CELLTEST
NORTEC
CHARGER / DISCHARGER BT2000CT-E

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1 General Information

1.1 Usage

The equipment is used to charge and analyze the dischargeable capacity of batteries of following technologies and types:

- Sealed NiCd-batteries with rated voltages of 1.2 to 24V (1 to 20 cells) and rated capacities greater or equal to 2.5Ah

- Discharging until the cut off voltage is reached.

For the following described applications the voltage and capacity can be collected within the following limits:

- Charging voltages of 1.2 to 24V in steps of 1.2V.

- Discharging voltages of 1.2 to 24V in steps of 1.2V.

- Charging current of 0.5 to 40A in steps of 0.1A.

- Discharging current of 0.5 to 40A in steps of 0.1A and 102A.

- Discharging cut off voltage of 19 to 31V within 102A and 0.5 to 31V within 40A.

To record the various analysis and charging results the equipment is provided with a printer, which on demand automatically prints the program specific data and results.

1.2 Technical Data

Electrical input and output parameters

- Supply voltage	:	AC 230V ± 10 % (single phase)
- Input frequency	:	45 to 66 Hz
- Mains Input	:	approx. 3000VA / 2000W
- Net fuse	:	16A
- Charging current	:	0.5 A to 40A
- Discharging current	:	0.5 A to 40A until 31V or 102A 19 to 31V
- Charging voltage	:	0.1 V to 40V
- Discharging voltage	:	0.1V to 31V until 40A or 19 to 31V with 102A

Operating temperature

The function of the BT2000 is ensured within a temperature range of -15 °C to +45 °C.

Accuracy of the output parameters

The output parameters show following maximum tolerances:

- charging and discharging currents = 0.5 A	:	< ± 50mA
- charging and discharging currents = 40 A	:	< ± 300mA
- charging and discharging currents = 102 A	:	< ± 3%
- charging voltages	:	< ± 50 mV
- shut down voltages	:	< ± 50 mV
- change over voltages	:	< ± 50 mV
- discharging threshold voltages	:	< ± 50 mV
- cell voltage measurement	:	< ± 10 mV
- charging and discharging periods	:	< ± 0.5 %
- Temperature measurement	:	< ± 2°C

The accuracy of the displayed and printed parameters corresponds to the a.m. values.

- Insulation class	:	VDE 0160, Class I
- Protection class	:	IP20
- Operating temperature	:	-15 - +45°C
- Weight	:	approx. 33 kgs.
- Dimensions	:	W x H x D 504 x 242 x 400mm
- Free of barrier for fan	:	>250 mm

NOTE
Providing the equipment is operated in the temperature range of -15°C to +45 °C.
The accuracy of the output parameters is guaranteed for a period of 2 years from date of delivery.

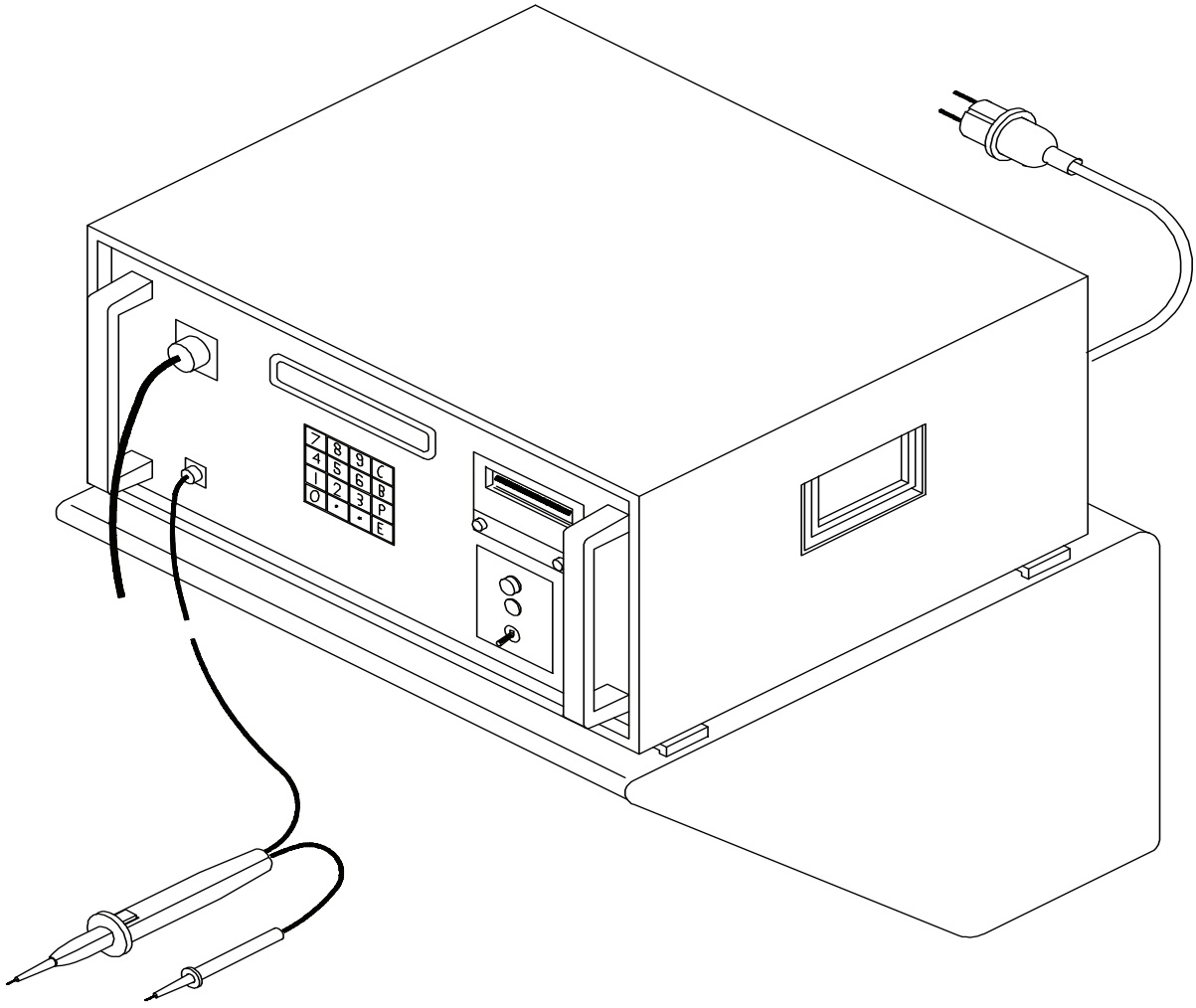


Figure 1: Battery-analyzer and charger BT2000CT-E

2 Operation

2.1 General Information

The BT2000 can only be operated after connecting a rechargeable battery correctly to the output terminals.

2.1.1 Keyboard Functions

Pushbutton	C	=	CLEAR	Clearing the actual Input
Pushbutton	B	=	BREAK	Breaking / terminating the actual program
Pushbutton	P	=	PRINT	selecting automatic / additional protocol printout
Pushbutton	E	=	ENTER	Entering the actual data input
Pushbutton	*	=	special program	Setting date and time
Pushbutton	.	=	Decimal point	Parameter input
Pushbuttons	0-9	=	numbers 0-9	Parameter and Program-No.

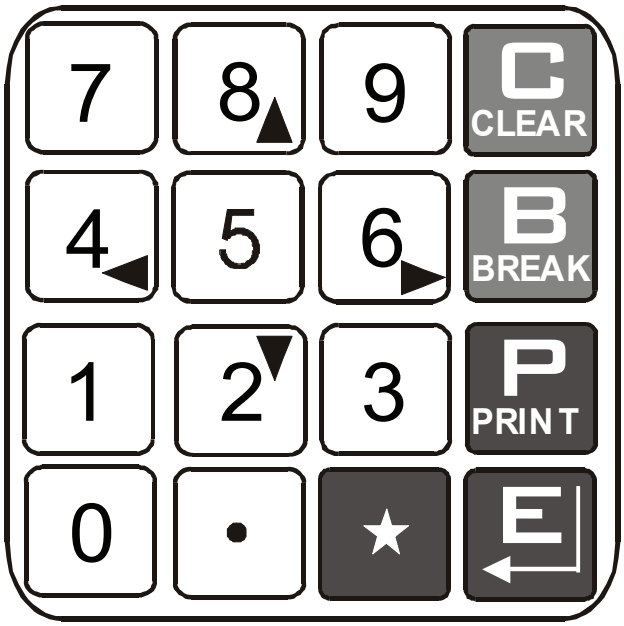


Figure 2: Keyboard

2.2 Description of Function

2.2.1 Start the BT2000CT-E

The standard operating procedure is valid for all programs is described below:

- connect battery
- toggle power switch to position ON

Immediately after switching on the equipment a self test is performed.

2.2.1.1 Power-On Test

After switching on the supply voltage the display shows following information:

- Copyright of the manufacturer
- Type designation
- Date of issue and version number of software
- Indication TEST while self check is active

```
COPYRIGHT 2014 BY NORTEC
BT2000      BT20.013-CTE        06.08.13       TEST
```

After self check is performed with satisfying results:

```
COPYRIGHT 2014 BY NORTEC
BT2000      BT20.013-CTE        06.08.13       TEST OK
```

Additionally the end of the self check is indicated by a short audible alarm, signaling that the equipment is ready for operation.

In case of detected malfunction the display shows the fault indication:

```
FAILURE: EQUIPMENT
KEYBORD
```

The fault indications and possible reasons are described in chapter 3. All fault messages appear in English language.

NOTE
In case of a fault further functions are disabled until the fault reason is removed.

All inputs, the decision for automatic printout or not, and the decision for continuing or terminating the program in case of a fault have to be acknowledged by actuating the key “E” = ENTER.

2.2.2 Starting the Program

After an error free self check the actual time is displayed

```
SELECT PROGRAM   (0 - 9,P,*) ?       23:44:55
```

After starting the program by pressing the button “E” = ENTER the polarity of the connected battery is tested. For this test the battery voltage must be higher than 0.1V. Fully discharged batteries or batteries with reversed polarity activate following display message:

```
SELECT PROGRAM   (0 - 9,P,*) ?       23:44:55
BATTERY <0.1V    CONTINUE = 1        END = 0
```

Before continuing by entering “1”, check the polarity of the battery first. A reversely connected battery (positive connector to negative battery terminal ....) will be destroyed. A deep discharged battery or a battery with reversed terminal voltages will be properly charged if the battery is not internally defect.
This is the last test to prevent destruction of a battery accidently connected with wrong polarity.

Now the program parameters have to be entered. The appropriate input sequences are described in chapter 2.5.

```
P1: PARAMETER INPUT
NUMBER OF CELLS?      00 CELLS
```

The last point of the parameter input is the decision to run the program with automated protocol printout or not. This is requested with following display message:

```
P1: PARAMETER INPUT
START: 1          WITH PRINT: P       NEW: 0
```

When actuating the **button 0** the display indication returns to the first parameter request

- Actuating the **button 1**: Start of the program without printed protocol
- Actuating the **button P**: System requests further data input for protocol identification:
- Battery-No. (max. 9 digits), e.g.: serial No. of the battery
- Operator No.: (max. 9 digits), e.g. staff No. of the operator

After entering the protocol data the program automatically starts.

During entering the battery, program, and protocol parameter the user is guided via display indications.

For further details on the program specific parameters please refer to chapter 2.5.

Before actually starting the program or preceding the next program step further tests are imparted, e.g.:

```
P1: START OF PROGRAM
START CHECK    -    PLEASE WAIT
```

Depending on the actual equipment status this indication is invisible or can be seen for several seconds.

A fault detected during the test is indicated with one of the fault indications explained in chapter 3.2 and 3.3. The fault reason has to be removed before the program can be continued.

Furthermore before starting the program the battery voltage is checked (>0.1 V). This check is continued during run of program, to detect a fast voltage-drop of possibly sulfated batteries during discharge procedures.

- If the battery voltage is > 0.1 V the program continues.
- If the battery voltage is < 0.1V the display shows following message:

```
P1: START OF PROGRAM
BATTERY VOLTAGE < 0.1V?  CONTINUE = 1    END = 0
```

Having selected the automatic printout each program step is printed with its program specific predefined parameters.
Wrong inputs can be corrected by actuating the key “C” = CLEAR before pressing the ENTER-key.

2.2.3 Finishing a Program

A program can be finished or interrupted as described below:

Automatically after performing all assigned program steps within the relevant safety criteria. In this case the display may show an indication similar to the following:

```
PROGRAM END
12.25V      --.-- A   001.6AH   +00:02H   25.4°C
```

Automatically by program shut down due to an activated safety criteria. In this case the display may show an indication similar to the following:

```
FAILURE:
BATTERY TEMPERATURE TO HIGH
```

Manually by actuating the key “B” = BREAK. This time the display shows:

```
PROGRAM INTERRUPT
CONT = 1    END = 0
```

Actuating the key “1” continues the program at that position where it was interrupted before.

Actuating the key ”0” finally finishes the program. Having selected the automatic printout all actual program and battery data, valid just before finishing the last program step, will be printed followed by:

```
PROGRAM END
12.30V      --.--A    000.1AH   +00:01H   24.4°C
```

2.3 Structure of display indications

The display indication and printout structure is principally identical for all programs and program steps.

2.3.1 Program-No.

The program numbers are indicated in the upper row of the display as P0: P9:

```
P1: S1: DISCHARGE 1
12.30V     25.00A    060.0AH   +01:30H   28.4°C
```

2.3.2 Step-No.

The step number is indicated in the upper row of the display as S1: .....Sn. The amount of program steps varies depending on the used program (please refer to the description of the programs):

```
P1: S1: DISCHARGE 1
12.30V     25.00A    060.0AH   +01:30H   28.4°C
```

2.3.3 Name of the program step

The name of the program step denominates the actual function performed during the program step, for further details please refer to chapter 2.5.

```
P1: S1: DISCHARGE 1
12.30V     25.00A    060.0AH   +01:30H   28.4°C
```

2.3.4 Battery Voltage

The voltage indication (V) shows permanently the actual measured value, at the end of the program the display shows the “off load voltage” of the battery:

```
P1: S1: DISCHARGE 1
12.30V     25.00A    060.0AH   +01:30H   28.4°C
```

2.3.5 Current

During charging steps the charging current (A) and during discharging steps the discharging current (A) is indicated:

```
P1: S1: DISCHARGE 1
12.30V     25.00A    060.0AH   +01:30H   28.4°C
```

2.3.6 Capacity

During charging steps the already charged capacity (Ah) and during discharging steps the already discharged capacity (Ah) is indicated.

Range 0 to 999Ah:

```
P1:S1: DISCHARGE 1
11.40V     25.00A    040.0AH   +01:30H   28.4°C
```

2.3.7 Time

Time indications are displayed in two variations:

Determined periods (time limited functions):

Determined periods (e.g. **TOPPING** charge 90 minutes) count down to zero starting with the determined value. They are identified by a leading "-" sign.

```
P2:S2: TOPPING CHARGE
15.10V      08.00A    000.0AH   -01:30H   28.4°C
```

Non-Determined periods:

All other time indications identified with a leading "+" sign start with zero at a certain start criteria (e.g. start of a discharging period to be stopped at a certain voltage threshold) and display the time passed until the specified stop criteria is achieved:

```
P0:S1: DISCHARGE
12.30V      25.00A    040.0AH   +01:00H   28.4°C
```

2.3.8 Battery Temperature

The battery temperature (°C) is measured only if both temperature sensors are connected. Only the value of the battery terminal with the higher temperature is indicated.

```
P0:S1: DISCHARGE
12.30V      40.00A    040.0AH   +01:00H   30.4°C
```

If the temperature sensors are not connected following display is provided:

```
P0:S1: DISCHARGE
12.30V      40.00A    040.0AH   +01:00H   --.--°C
```

2.4 Programs Overview

The BT2000 is provided with following programs:

Program 0: Discharging with constant current

Program 1: Maintenance of vented NiCd batteries

Program 2: Charging of vented NiCd batteries

Program 3: Residual capacity discharge of F19/27H1CT-EFA-S batteries

Program 4: First charge of F19/27H1CT-EFA-S batteries

Program 5: Cell balancing of F19/27H1CT-EFA-S batteries

Program 6: Second charge of F19/27H1CT-EFA-S batteries

Program 7: High rate discharge test of F19/27H1CT-EFA-S batteries

Program 8: Emergency test of F19/27H1CT-EFA-S batteries

Program 9: Constant current charge of vented NiCd batteries

Program P: Print routines / cell-voltage measurement

Program *: Setting date and time

All parameters can be outputted at the interface RS232 in format 9600,8,1,N.
By using the program BTMON for the BT2000CT-E the data can be read.

ATTENTION!

By using the RS232 interface the battery shall not be grounded, except the computer is galvanic separated, e.g. a used Laptop without plugged mains or by using a galvanic separated RS232 interface.
In case of noncompliance the RS232 interface will be damaged.

2.5 Description of programs

2.5.1 Program 0: Discharging with constant current

The program is used to determine the dischargeable capacity:

```
SELECT PROGRAM (0 - 9,P,*) ? 0 15:44:55
P0: DISCHARGE
```

2.5.1.1 Parameter inputs

Following parameters may be entered:

- Rated voltage (0.01 - 30V in increments of 0.01V)
- Rated capacity (0.1 ..... 999.9 Ah in increments of 0.1Ah)
- Discharging current (0.01-40A in increments of 0.1Ah)
- Turn off voltage (0.01 - 30V in increments of 0.01V)

After choosing program 0 and entering with button “E” the display shows the following:

```
P0: PARAMETER INPUT
NOMINAL VOLTAGE?          00.00 V
```

After parameter entry and confirm by pressing the button “E”:

```
P0: PARAMETER INPUT
NOMINAL CURRENT?          000.0 AH
```

After parameter entry and confirm by pressing the button “E”:

```
P0: PARAMETER INPUT
DISCHARGE?                00.00 A
```

After parameter entry and confirm by pressing the button “E”:

```
P0: PARAMETER INPUT
CUT OFF VOLTAGE?          00.00 V
```

After parameter entry and confirm by pressing the button “E”:

```
P0: PARAMETER INPUT
START=1          WITH PRINT= P       NEW=0
```

After selection of “1” for start or “P” for start with print, the program starts like described in chapter 2.2.2.

2.5.1.2 Program steps

The program consists of step S1.

Step S1: DISCHARGE

Discharging with the determined current until the previously entered discharging threshold is achieved.

```
P0:S1: DISCHARGE
12.30V      40.00A    000.0AH   +00:00H   28.4°C
```

2.5.1.3 Monitoring functions

No additional monitoring functions available.

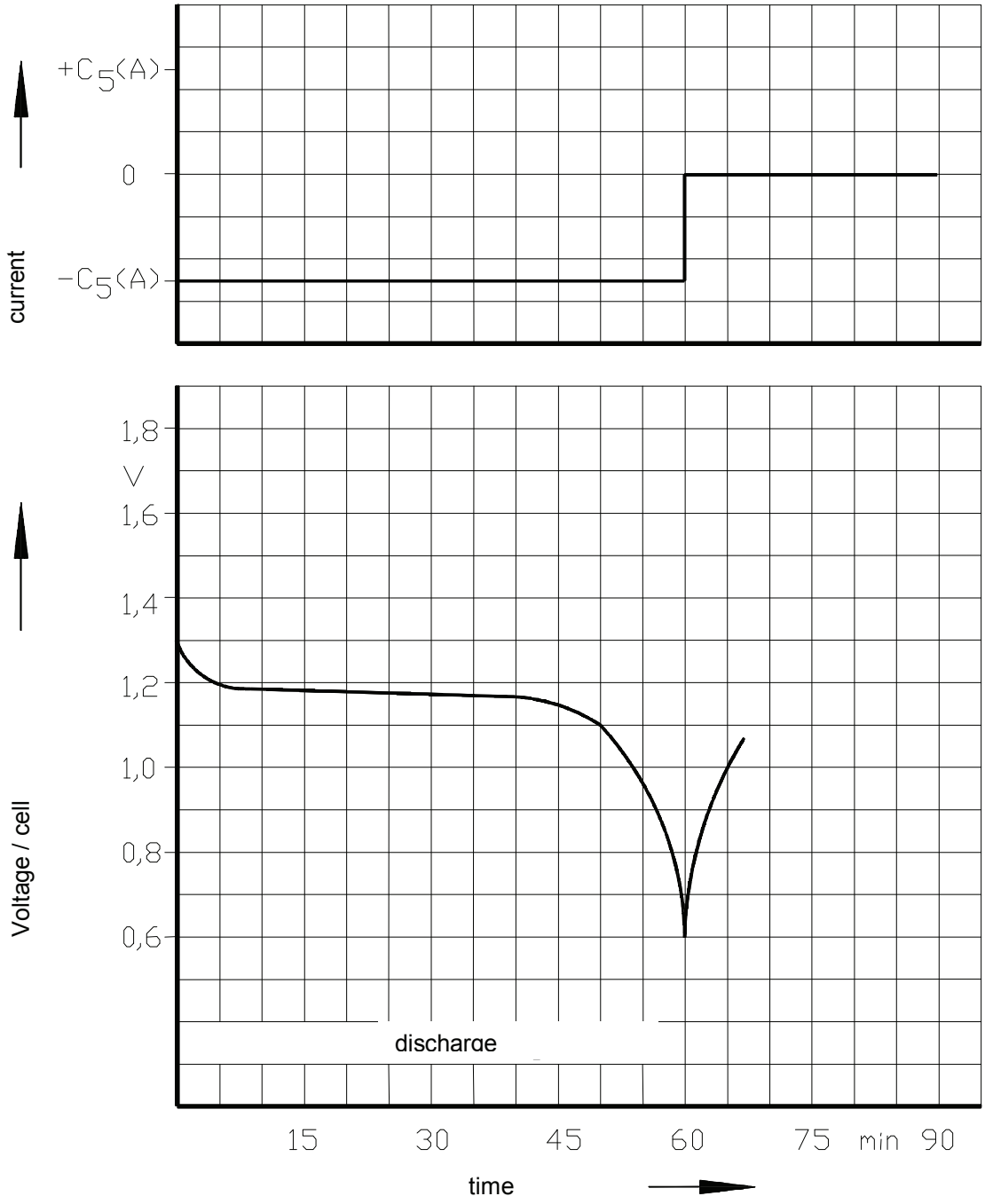


Figure 3: Program 0: Discharging of batteries with constant-current

Example of a discharging graph of a vented NiCad-battery at a load of C_5(A).

2.5.2 Program 1: Maintenance of vented NiCd batteries

Program 1 is used to determine the dischargeable capacity and to rejuvenate the battery in the best way.

```
SELECT PROGRAM        (0 - 9,P,*) ? 1          13:44:55
P1: MAINTENANCE NICD BATTERY VENTED
```

2.5.2.1 Parameter inputs

Following parameters may be entered:

- Amount of cells (1 - 20 cells):
- Rated capacity (2.5 – 999.9 AH in increments of 0.1Ah):

After selection of program 1 and confirm by pressing the button “E”:

```
P1: PARAMETER INPUT
NUMBER OF CELLS?      00 ZELLEN
```

After parameter entry and confirm by pressing the button “E”:

```
P1: PARAMETER INPUT
RATED CAPACITY?       000.0 AH
```

After parameter entry and confirm by pressing the button “E”:

```
P1: PARAMETER INPUT
START=1     WITH PRINT=P   NEW=0
```

The program starts according to Chapter 2.2.2 after entering “1” or “P”. The integrated cell scan adapter can scan up to 20 cells by entering “P” and choice of automatic or manual cell tester.

2.5.2.2 Program steps

The program consists of the steps S1 to S6.

Step 1: S1: DISCHARGE 1

Discharging with constant-current C_5 (A) to discharging threshold-voltage 1.0 V times amount of battery-cells.

```
P1:S1: DISCHARGE 1
11.30V      25.00A    000.0AH   -00:06H   28.4°C
```

Step 2: S2: I-CHARGE 1

Charging with constant-current C_5 (A) to threshold-voltage 1.55 V times amount of battery-cells.

```
P1:S2: I-CHARGE 1
13.45V      25.00A    000.0AH   +000MIN   28.4°C
```

Step 3: S3: TOPPING CHARGE 1

120 minutes IU-charge with constant-current 0,2C_5 (A) and a charging voltage limited to 1.55V times amount of battery-cells

```
P1:S3: TOPPING CHARGE 1
15.10V      05.40A    000.0AH   -120MIN   28.4°C
```

Step 4: S4: DISCHARGE 2

Discharging with constant-current C_5 (A) to discharging threshold-voltage 0.5V times amount of battery-cells.

```
P1:S4: DISCHARGE 2
13.50V      25.00A     040.0AH    +000MIN    28.4°C
```

Step 5: S5: I-CHARGE 2

Charging with constant-current of C_5 (A) to threshold-voltage 1.55V times amount of battery-cells.

```
P1:S5: I-CHARGE 2
13.45V      25.00A     000.0AH    +000MIN    28.4°C
```

Step 6: S6: TOPPING CHARGE 2

90 minutes constant-current charge with $0.2C_5$ (A). 15 minutes before topping charge 2 is finished an audible alarm reminds for cell-voltage measurement and electrolyte equalization.

To interrupt the signal it has to be acknowledged by actuating the key E = ENTER.

The measurement of single-cell-voltages is initiated by actuating the key P = PRINT. The procedure is described in the chapter “Program P”.

Depending on the initial charging state of the battery this program requires a time of 6 to 8 hours.

```
P1:S6: TOPPING CHARGE 2
15.35V      05.40A     040.0AH    -090MIN    28.4°C
```

2.5.2.3 Monitoring functions

During program run, the following parameters of the battery (safety criteria) will be monitored:

Program steps S2, S3, S5 and S6

If the charged capacity exceeds $1.5C_5$ the program is interrupted and a fault message will be displayed.

Program steps S2, S3, S5 and S6

The temperature of the battery is monitored:

If the temperature of the battery reaches 65°C, the program is interrupted and a fault indication will be displayed.

If since start of the charging process the temperature of the battery increases by more than 20°C and in between exceeds 30°C the program stops and a fault message is displayed.

Program steps S4

If the capacity is less than $0.8C_5$ nominal capacity the program is interrupted and a fault indication will be displayed.

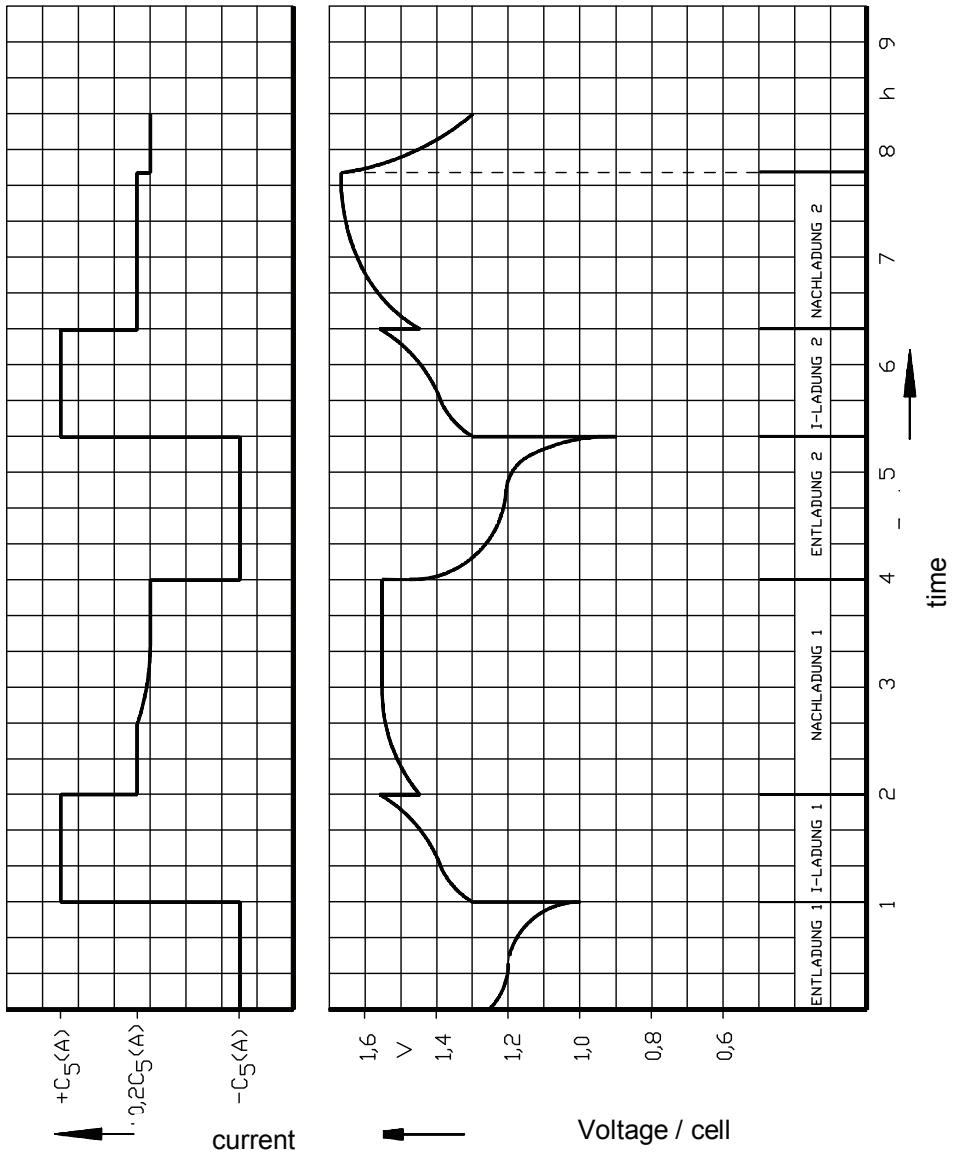


Figure 4: Program 1: Analyses of vented NiCad-batteries

Example of the voltage and current graph of a battery, which was partially charged at the beginning of the maintenance cycle.

2.5.3 Program 2: Charging of vented NiCd batteries

Program 2 is used for NiCd-Cells and -Batteries with sinter-electrodes.
The program is used for shortest time full charging of batteries with any initial charging state.

```
SELECT PROGRAM   (0 - 9,P,*) ? 2     23:44:55
P2: CHARGE NICD BATTERY VENTED
```

2.5.3.1 Parameter inputs

Following parameters may be entered:
- Amount of cells (1 - 20 cells)
- RATED CAPACITY (2.5 – 999.9 AH in increments of 0.1Ah)

After selection of program 2 and confirm by pressing the button “E”:

```
P2: PARAMETER INPUT
NUMBER OF CELLS ?     00 CELLS
```

After parameter entry and confirm by pressing the button “E”:

```
P2: PARAMETER INPUT
RATED CAPACITY ?      000.0 AH
```

After parameter entry and confirm by pressing the button “E”:

```
P2: PARAMETER INPUT
START=1     WITH PRINT= P  NEW=0
```

The program starts according to Chapter 2.2.2 after entering “1” of “P”. The integrated cell scan adapter CT20 scan automatically up to 20 cells by entering “P” and choice of automatic or manual cell tester.

2.5.3.2 Program steps

The program consists of the steps S1 and S2.

Step S1: I-CHARGE
Charging with constant-current C_5 (A) to threshold-voltage 1.55 V times amount of battery-cells.

```
P2:S1: I-CHARGE 1
14.30V      25.00A    000.0AH   +00:00H   28.4°C
```

Step S2: TOPPING CHARGE

90 minutes constant-current charge with 0.2 C_5 (A). 15 minutes before topping charge 2 is finished an audible alarm reminds for cell-voltage measurement and electrolyte equalization.
To interrupt the signal it has to be acknowledged by actuating the key “E” = ENTER.

The measurement of single-cell-voltages is initiated by actuating the key “P” = PRINT. The procedure is described in the chapter “Program P”.

End of program is indicated by a short audible alarm.
Depending on the initial charging state of the battery this program requires a time of 90 to 150 minutes.

```
P2:S2: TOPPING CHARGE
15.50V      05.40A    002.3AH   -01:30H   28.4°C
```

2.5.3.3 Monitoring functions

During program run, the following parameters of the battery (safety criteria) will be monitored:

Steps S1 and S2

The charged capacity must not exceed $1.5C_5$

Steps S1 and S2

If the temperature of the battery reaches 65°C, the program is interrupted and a fault indication will be displayed.

If since start of the charging process the temperature of the battery increases by more than 20°C and in between exceeds 30°C the program stops and a fault message (chapter 3) is displayed.

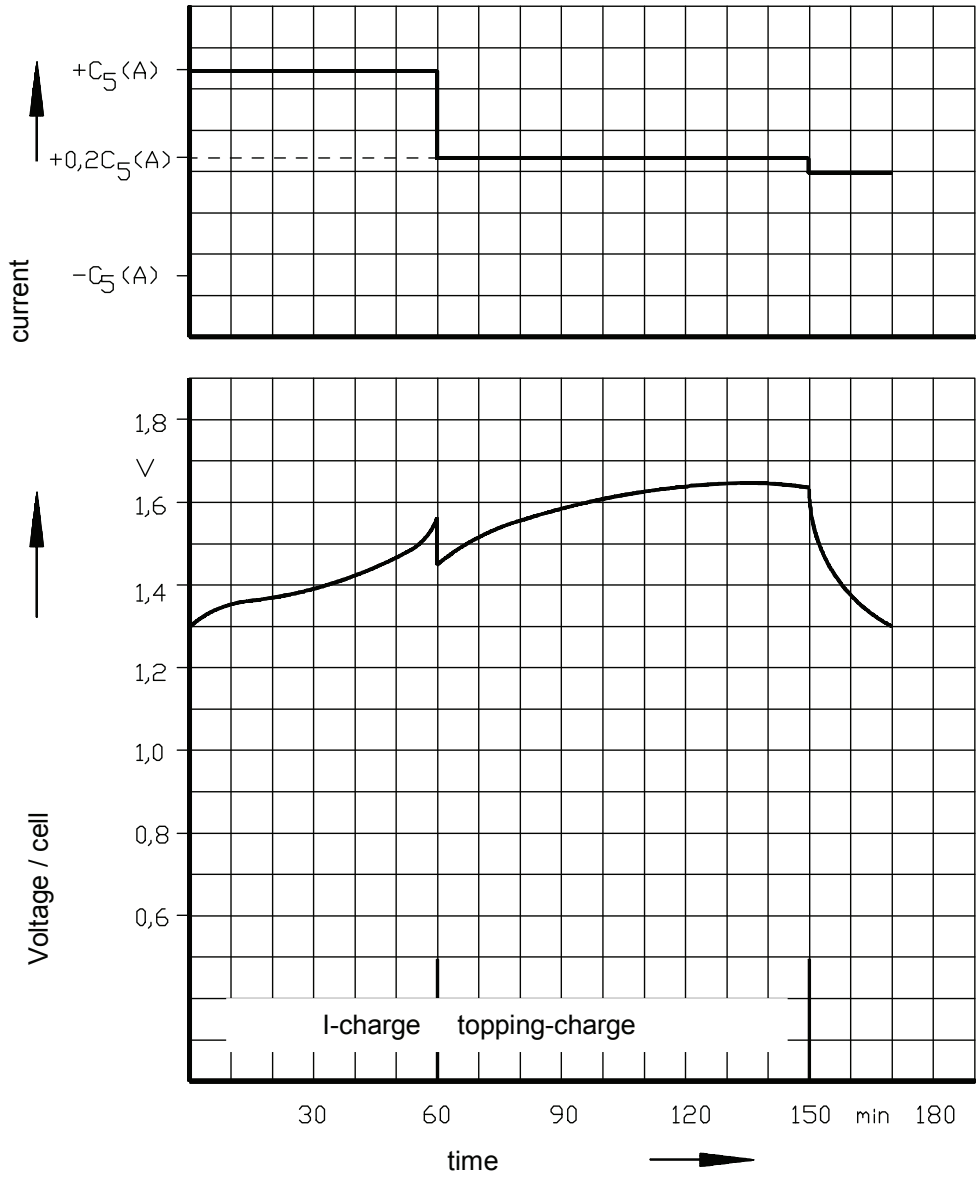


Figure 5: Program 2: Charging of vented NiCd batteries

Example of the voltage and current graph of a vented NiCd-battery.

2.5.4 Program 3: Residual capacity discharge of F19/27H1CT-EFA-S batteries

The program 3 is only working with fixed parameters, 19 cells and 25Ah according to F19/27H1CT-EFA-S batteries. The battery will be discharged with 5.4A to 19V and then the cell voltage will be outputted.

```
SELECT PROGRAM (0 - 9,P,*) ? 3 15:44:55
P3: RESIDUAL CAPACITY DISCHARGE
```

The general program structure is similar to Program 0: Discharging with constant current except the input of the parameters. The battery will be discharged with 5.4A to 19V then the cell voltage will be printed out. For more information please refer to chapter 2.5.1.

2.5.5 Program 4: First charge of F19/27H1CT-EFA-S batteries

Program 4 is for charging F19/27H1CT-EFA-S batteries with 10.8A. This program is working with parameters as well, 19 cells and 25Ah. By using charging with print by entering “P” and choice of automatic or manual cell tester.

```
SELECT PROGRAM (0 - 9,P,*) ? 4 23:44:55
P4: FIRST CHARGE NICD BATTERY
```

2.5.5.1 Program steps

The program consists of the steps S1 and S2.

Step S1: I-CHARGE

Charging with constant current of 10.8A up to 29.45V.

```
P4:S1: I-CHARGE
28.30V      10.80A    005.0AH   +00:00H   28.4°C
```

Step S2: TOPPING CHARGE

120 minutes constant-current charge with 5.4A. 15 minutes before topping charge is finished an audible alarm reminds for cell-voltage measurement and electrolyte equalization.

To interrupt the signal it has to be acknowledged by actuating the key E = ENTER.

The measurement of single-cell-voltages is initiated by actuating the key P = PRINT. The procedure is described in the chapter “Program P”.

End of program is indicated by a short audible alarm.

Depending on the initial charging state of the battery this program requires a time of 180 to 300 minutes.

```
P4:S2: TOPPING CHARGE
29.90V      05.40A    012.3AH   01:30H    28.4°C
```

2.5.5.2 Monitoring functions

During program run, the following parameters of the battery (safety criteria) will be monitored:

Steps S1 and S2

The charged capacity must not exceed $2C_5$

Steps S1 and S2

If the temperature of the battery reaches 65°C, the program is interrupted and a fault indication will be displayed.

If since start of the charging process the temperature of the battery increases by more than 20°C and in between exceeds 30°C the program stops and a fault message is displayed.

2.5.6 Program 5: Cell balancing of F19/27H1CT-EFA-S batteries

The program 5 is used for discharging and following the cell balancing the F19/27H1CT-EFA-S battery. This program is only working with fixed parameters, 19 cells and 25Ah according to F19/27H1CT-EFA-S batteries. It can only be used with the integrated cell scan adapter CT20 and entering “P” for discharging with print.

```
SELECT PROGRAM (0 - 9,P,*) ? 5 23:44:55
P5: CELL BALANCING
```

2.5.6.1 Program steps

The program consists of the steps S1 to S5.

Step S1: DISCHARGE 1

Discharging with constant current of 25A to 9.5V.

```
P5:S1: DISCHARGE 1
18.30V     25.00A    005.0AH   +00:00H   28.4°C
```

At the end the report will be printed.

```
= = = = = = = = = = = = = = = = = = = = = = =
COPYRIGHT (C) NORTEC
2007-2014
- - - - - 20.013CTE- - - - - -06.08.13- - - - - - - -
DATE                : 13.08.13
BATTERY NO          : 123456789
OPERATOR NO         : 987654321
RATED VOLTAGE       : 22.8V
CAPACITY            : 025.0AH
PROGRAM             : 5
- - - - - - - - - - - - - - - - - - - - - - - - - - -
START OF PROGRAM    16:23:24
VOLTAGE             = 12.77V
TEMPERATURE         = 31.1°C
- - - - - - - - - - - - - - - - - - - - - - - - - - -
P5: DISCHARGE1      16:56:33
VOLTAGE             = 9.51V
CURRENT             = 25.00A
CAPACITY            = 09.90AH
                    = 39%
TIME                = 000MIN
TEMPERATURE         = 31.0°C
- - - - - - - - - - - - - - - - - - - - - - - - - - -
* CELL 01           : 0.400V
* CELL 02           : 0.500V
* CELL 03           : 0.600V
* CELL 04           : 0.300V
* CELL 05           : 0.500V
* CELL 06           : 0.500V
* CELL 07           : 0.700V
* CELL 08           : 0.500V
* CELL 09           : 0.500V
* CELL 10           : 0.200V
* CELL 11           : 0.500V
* CELL 12           : 0.500V
* CELL 13           : 0.800V
* CELL 14           : 0.500V
* CELL 15           : 0.500V
* CELL 16           : 0.450V
* CELL 17           : 0.500V
* CELL 18           : 0.550V
* CELL 19           : 0.500V
= = = = = = = = = = = = = = = = = = = = = = =
```

Step S2: BREAK

A short break of about one min.

Step S3: DISCHARGE 2

Discharging with constant current of 5.4A up to 9.5V.

```
P5:S3: DISCHARGE 2
11.30V      05.40A    005.0AH   +00:00H   28.4°C
```

At the end the report will be printed.

Step S4: DEEP DISCHARGE

Discharge with resistors of 1 Ohm up to a voltage of 1V.

Step S5: DEEP DISCHARGE

Discharge with resistors of 1 Ohm for 14h.

```
P5:S5: DEEP DISCHARGE
00.30V      00.00A    005.0AH   +00:00H   28.4°C
```

2.5.6.2 Monitoring functions

During program run, the following parameters of the battery (safety criteria) will be monitored:

If the temperature of the battery reaches 65°C, the program is interrupted and a fault indication will be displayed.

If since start of the charging process the temperature of the battery increases by more than 20°C and in between exceeds 30°C the program stops and a fault message is displayed.

2.5.7 Program 6: Second charge of F19/27H1CT-EFA-S batteries

The program 6 is used for charging the F19/27H1CT-EFA-S battery. The alternative charging mood includes I-charging for a max. of 30 minutes until each cell reached 1.55V. Program 6 is only working with fixed parameters, 19 cells and 25Ah according to F19/27H1CT-EFA-S batteries. By charging with print, it can be selected if the integrated cell scan adapter should be used.

```
SELECT PROGRAM (0 - 9,P,*) ? 6 23:44:55
P6: SECOND CHARGE NICD BATTERY

P6: PARAMETER INPUT
NORMAL CHARGING=1 ALTERNATIVE CHARGING=2
```

2.5.7.1 Program steps

The program consists of the steps S1 and S2.

Step S1: I-CHARGE

Charging with constant current of 25A to 29.45V.

```
P6:S1: I-CHARGE
28.30V      25.00A     005.0AH    +00:00H    28.4°C
```

In the alternative charging mood it will be charge with 25A for a max. of 30 minutes until each cell reached 1.55V

Step S2: TOPPING CHARGE

120 minutes constant-current charge with 5.4A. 15 minutes before topping charge is finished an audible alarm reminds for cell-voltage measurement and electrolyte equalization.

To interrupt the signal it has to be acknowledged by actuating the key “E” = ENTER.

The measurement of single-cell-voltages is initiated by actuating the key “P” = PRINT. The procedure is described in the chapter “Program P”.

End of program is indicated by a short audible alarm.

Depending on the initial charging state of the battery this program requires a time of 120 to 180 minutes.

```
P6:S2: TOPPING CHARGE
29.90V      05.40A     012.3AH    -01:30H    28.4°C
```

2.5.7.2 Monitoring functions

During program run, the following parameters of the battery (safety criteria) will be monitored:

Steps S1 and S2

The charged capacity must not exceed $2C_5$

Steps S1 and S2

If the temperature of the battery reaches 65°C, the program is interrupted and a fault indication will be displayed. If since start of the charging process the temperature of the battery increases by more than 20°C and in between exceeds 30°C the program stops and a fault message is displayed.

2.5.8 Program 7: High rate discharge test of F19/27H1CT-EFA-S batteries

Program 7 is used for high rate discharge of the F19/27H1CT-EFA-S with 102A. This program is only working with fixed parameters, 19 cells and 25Ah according to F19/27H1CT-EFA-S batteries. By charging with print, it can be selected if the integrated cell scan adapter should be used.

```
SELECT PROGRAM (0 - 9,P,*) ? 7 23:44:55
P7: HIGH RATE DISCHARGE TEST
```

2.5.8.1 Program steps

The program consists of the steps S1 to S3.

Step S1: DISCHARGE 1

10min discharging with constant current of 102A. The program will be stopped by reaching the voltage of 19V.

```
P7:S1: DISCHARGE 1
19.30V      102.0A     005.0AH    +00:00H    28.4°C
```

After 5, 7 and 10min (display countdown 5, 3, 0min) of discharge the cells will be measured and a report will be printed.

```
= = = = = = = = = = = = = = = = = = = = = = =
COPYRIGHT (C) 2007-2014  NORTEC
- - - - -20.013CTE- - - - - -06.08.13- - - - - - - -
DATE                 :  13.08.13
BATTERY NO           :  123456789
OPERATOR NO          :  987654321
RATED VOLTAGE        :  22.8V
CAPACITY             :  025.0AH
PROGRAM              :  7
- - - - - - - - - - - - - - - - - - - - - - - - - -
START OF PROGRAM     16:23:24
VOLTAGE              =  22.77V
TEMPERATURE          =  31.1°C
- - - - - - - - - - CHECKPOINT - - - - - - - - - - -
VOLTAGE              =  26.00V
TIME                 =  00:05H
* CELL 01            :  1.400V
* CELL 02            :  1.500V
* CELL 03            :  1.600V
* CELL 04            :  1.300V
* CELL 05            :  1.500V
* CELL 06            :  1.500V
* CELL 07            :  1.700V
* CELL 08            :  1.500V
* CELL 09            :  1.500V
* CELL 10            :  1.200V
* CELL 11            :  1.500V
* CELL 12            :  1.500V
* CELL 13            :  1.800V
* CELL 14            :  1.500V
* CELL 15            :  1.500V
* CELL 16            :  1.450V
* CELL 17            :  1.500V
* CELL 18            :  1.550V
* CELL 19            :  1.500V
= = = = = = = = = = = = = = = = = = = = = = =
```

Step S2: BREAK

A break of about 30 min.

Step S3: DISCHARGE 2

Discharging with constant current of 25A up to a voltage of 19V.

```
P7:S3: DISCHARGE 2
19.30V          25.01A    005.0AH   +00:00H   28.4°C
```

After 14min the actual cell voltage will be printed.

If the voltage of one single cell is below 0.95V, the battery (print out) will be marked as “Capacity Low”.
If the time of discharge 2 is below 14.4min., the battery will be marked as “Capacity Low” as well.

2.5.8.2 Monitoring functions

During program run, the following parameters of the battery (safety criteria) will be monitored:

If the temperature of the battery reaches 65°C, the program is interrupted and a fault indication will be displayed.

If since begin of the charging period the temperature of the battery increases by more than 20°C and in between exceeds 30°C the program is interrupted and a fault message is displayed.

2.5.9 Program 8: Emergency test of F19/27H1CT-EFA-S batteries

Program 8 is used for the F19/27H1CT-EFA-S battery.

```
SELECT PROGRAM (0 - 9,P,*) ? 8 23:44:55
P8: EMERGENCY TEST
```

2.5.9.1 Parameter input

This program is only working with fixed parameters, 19 cells and 25Ah according to F19/27H1CT-EFA-S batteries.

2.5.9.2 Program steps

The program consists of the steps S1 and S2.

Step S1: U-CHARGE

15 min. charging with constant-current 40A up to 28,5V.

Step S2: DISCHARGE

10 min. discharging with constant current of 102A. The program will be stopped by reaching the voltage of 19V.

```
P8:S2: DISCHARGE
19.30V          102.0A    005.0AH   +00:00H   28.4°C
```

After 5, 7 and 10min (display countdown 5, 3 and 0min) of discharge the cells will be measured and a report will be printed.

2.5.10 Program 9: Constant current charge by definition of time of vented NiCd batteries

Program 9 is used for vented NiCd batteries.

```
SELECT PROGRAM (0 - 9,P,*) ? 9 23:44:55
P9: CONSTANT CURRENT (I) CHARGE
```

2.5.10.1 Parameter inputs

Following parameters have to be entered:

- Charge current: 5.4A predefined, but can be changed
- Capacity: 25Ah predefined, but can be changed
- Voltage: 22.8V predefined, but can be changed
- Load time: 7:30h predefined, but can be changed

After selecting program 9 and press “E”:

```
P9: PARAMETER INPUT
CHARGE CURRENT?       00.00 V
```

After parameter entry and confirm by pressing the button “E”:

```
P9: PARAMETER INPUT
CAPACITY?             000.0 AH
```

After parameter entry and confirm by pressing the button “E”:

```
P9: PARAMETER INPUT
I-CHARGE?             00.00 A
```

After parameter entry and confirm by pressing the button “E”:

```
P9: PARAMETER INPUT
LOAD TIME?            000 MIN
```

After parameter entry and confirm by pressing the button “E”:

```
P9: PARAMETER INPUT
START=1     WITH PRINT= P  NEW=0
```

After selection of “1” for start or “P” for start with print, the program starts like described in chapter 2.2.2.

2.5.10.2 Program steps

Program 9 consists of step S1 only.

Step S1: I-CHARGE 1

Constant current for a defined time of charge.

15 minutes before topping charge is finished an audible alarm reminds for cell-voltage measurement and electrolyte equalization.

To interrupt the signal it has to be acknowledged by actuating the key “E” = ENTER.

The measurement of single-cell-voltages is initiated by actuating the key “P” = PRINT. The procedure is described in the chapter “Program P”.

End of program is indicated by a short audible alarm.

```
P9:S1: I-CHARGE
13.30V      05.00A    000.0AH   -123MIN   23.4°C
```

2.5.10.3 Monitoring functions

During program run, the following parameters of the battery (safety criteria) will be monitored:

Program step S1:

The charged capacity must not exceed 1.5C_5. If the capacity will be exceed, the program stop and mark this battery as faulty.

If the battery voltage drops more than 20mV/cell after reaching max. value, the program stop and mark this battery as faulty.

If the temperature of the battery reaches 65°C, the program is interrupted and a fault indication will be displayed.

2.5.11 Program P: Printer Usage and Cell-Voltage Measurement

The program P is a special routine for generation of a protocol printout as a function or independent of other programs. It is especially used for measurement and recording of single cell-voltages.

The program is used in 4 situations:

- Automatic printout during program run
- Manual printout without activated program
- Manual Protocol-Generation within an active program without automatic protocol-generation
- Additional Protocol during Automatic-Protocol-Generation of an active program

Note for all 4 printer usages

Capacity values in % are related to the rated capacity of the battery.

The printout TEMPERATURE is provided only if both temperature sensors are connected. The printed value is the value from the battery terminal with the higher temperature.

NOTE to the "Cell-Voltage-Measurement"

The cell-voltage-measurement is only possible with manual printout selected. The start point is indicated by a short audible alarm. At this point it is possible to measure and print cell voltages with the integrated cell tester CT20. The amount of cell-voltage-measurements is limited to 99 for manual cell measurement and 23 cells by automatic cell measurement.

Bad contact of the measuring probe (invalid measurement) is indicated by a short audible alarm. The measurement has to be repeated. The cell number is incremented with each valid measurement.

A "*" printed prior to a cell voltage value means the voltage is below 1.58 V. Thus a value measured at the correct point during the charging process (acc. manufacturer's information) may point out an increased self discharging rate due to sludge or other battery defects.

If the single cell measurement function was not used the printout of cell numbers and values (Cell 01.....) is suppressed.

If during the print routine input requests are not answered by the user, after 30 seconds the program continues with the next request and finally continues with the normal program.

2.5.11.1 Automatic printout during program run

Having selected the automatic printout by starting the program with the key “P”, after each program step the actual status is printed.

```
P1: PARAMETER INPUT
START: 1          WITH PRINT: P            NEW: 0
```

In addition to the program specific parameters two further information are requested.

The first request is:

```
PP: PARAMETER INPUT
BATTERY-NO:           7654321
```

A previously entered battery No. is indicated and may be overwritten or be accepted by actuating the key “E”. The 9 digit number to be entered may consist of the numbers 0 to 9 and a decimal point.
The next request is:

```
PP: PARAMETER INPUT
OPERATOR-NO:          987654321
```

A previously entered operator No. is indicated and may be overwritten or be accepted by actuating the key “E”. The 9 digit number to be entered may consist of the numbers 0 to 9 and a decimal point.

Now the actual program and battery data are printed:

```
P1:S1: DISCHARGE
12.34V      40.00A    001.2AH   +001MIN   28.4°C
```

At the end of the protocol one of the following information is added:

PROGRAM AUTOMATICLY FINNISHED
BATTERY OK

or:

PROGRAM AUTOMATICLY FINNISHED
BATTERY DEFECT
CAPACITY TO HIGH

(Chapter 3 provides further information about program specific fault indications)

Example 1: Program 0 automatically finished: Battery ok (including single cell voltage measurement).

```
= = = = = = = = = = = = = = = = = = = = = = =
COPYRIGHT (C) 2007-2014   NORTEC
- - - - - 20.013CTE- - - - - -06.08.13- - - - - - -
DATE                :  13.08.13
BATTERY NO          :  123456789
OPERATOR NO         :  987654321
RATED VOLTAGE       :  24.0V
CAPACITY            :  100.0AH
PROGRAM             :  0
- - - - - - - - - - - - - - - - - - - - - - - - - -
START OF PROGRAM    16:23:24
VOLTAGE             =  12.77V
TEMPERATURE         =  31.1°C
- - - - - - - - - - - - - - - - - - - - - - - - - -
P0: DISCHARGE          16:56:33
VOLTAGE             =  9.00V
CURRENT             =  40.00A
CAPACITY            =  20.0AH
                    =  55%
TIME                =  033MIN
TEMPERATURE         =  31.0°C
- - - - - - - - - - - - - - - - - - - - - - - - - -
PROGRAM AUTOMATICLY FINNISHED
BATTERY OK
= = = = = = = = = = = = = = = = = = = = = = =
```

Example 2: Program 2 automatically finished: Battery defect (Capacity to high)

```
= = = = = = = = = = = = = = = = = = = = = = =
COPYRIGHT (C) NORTEC
2007-2014
- - - - - 20.013CTE- - - - - -06.08.13- - - - - - - -
DATE                : 13.08.2013
BATTERY NO          : 123456789
OPERATOR NO         : 987654321
RATED VOLTAGE       : 12.0V
CAPACITY            : 100.0AH
PROGRAM             : 2
- - - - - - - - - - - - - - - - - - - - - - - - - - - -
START OF PROGRAM  08:00:00
VOLTAGE           = 12.80V
TEMPERATURE       = 26.0°C
- - - - - - - - - - - - - - - - - - - - - - - - - - - -
P2:S1: I-CHARGE     12:06:31
VOLTAGE           = 14.00V
CURRENT           = 40.00A
CAPACITY          = 060.0AH
                  = 150%
TEMPERATURE       = 29.9°C
- - - - - - - - - - - - - - - - - - - - - - - - - - - -
P2:S2: TOPPING CHARGE10:42:19
VOLTAGE           =  04.65V
CURRENT           =  02.40A
CAPACITY          = 018.1AH
                  = 150%
TIME              = 022MIN
- - - - - - - - - - - - - - - - - - - - - - - - - - - -
PROGRAM AUTOMATICLY FINNISHED
BATTERY DEFECT
CAPACITY TO HIGH
 = = = = = = = = = = = = = = = = = = = = = = =
```

2.5.11.2 Manual printout without activated program

With this function cell voltages may be measured without starting a charging or test program.

After actuating the key “P” the display shows following status:

```
SELECT PROGRAM   (0 - 9,P,*) ? P          23:44:55
PRINTER
```

With actuating the key “E” the program is selected and following input is requested:

```
PP: PARAMETER INPUT
RATED VOLTAGE:        00.00 V
```

After entering the rated voltage and pressing the key “E” the next information is requested:

```
PP: PARAMETER INPUT
RATED CAPACITY:       00.00 AH
```

Actuating the key “E” starts the printout of the header and the display requests the next input:

```
PP: PARAMETER INPUT
BATTERY-NO:      123456789
```

A previously entered battery No. is indicated and may be overwritten or be accepted by actuating the key “E”. The 9 digit number to be entered may consist of the numbers 0 to 9 and a decimal point.
After an audible signal the system requests the next information:

```
PP: PARAMETER INPUT
OPERATOR NO:          987654321
```

A previously entered operator No. is indicated and may be overwritten or be accepted by actuating the key “E”. The 9 digit number to be entered may consist of the numbers 0 to 9 and a decimal point. Now after an audible signal following information s displayed:

```
PP: PARAMETER INPUT
* CELL 01:            0.000 V
```

The display shows the cell voltage of cell 1, measured with the cell tester. The measuring value is passed to the system by actuating the pushbutton of the cell tester.

Now the measurement of the subsequent cells is requested in ascending order:

```
PP: PARAMETER INPUT
* CELL 02:            0.000 V
```

For a battery of 10 cells the protocol shows following structure:

```
= = = = = = = = = = = = = = = = = = = = = = = =
COPYRIGHT (C) 2007-2014   NORTEC
- - - - - 20.013CTE- - - - - -06.08.13- - - - - - -
DATE                 :  13.08.13
BATTEY NO            :  123456789
OPERATOR NO          :  987654321
RATED VOLTAGE        :  12.00V
CAPACITY             :  40.00AH
PROGRAM              :  P
- - - - - - - - - - - - - - - - - - - - - - - - - - - -
START OFPROGRAM      15:29:18
VOLTAGE              =   13.05V
TEMPERATURE          =   26.1°C
- - - - - - - - - - - - - - - - - - - - - - - - - - - -
* CELL 01            :  1.581V
* CELL 02            :  1.579V
* CELL 03            :  1.377V
* CELL 04            :  1.376V
* CELL 05            :  1,375V
* CELL 06            :  1,377V
* CELL 07            :  1,374V
* CELL 08            :  1,380V
* CELL 09            :  1,378V
* CELL 10            :  1,376V
= = = = = = = = = = = = = = = = = = = = = = = =
```

By using of the automatic cell measurement adapter CT20 is the print out identical, but the cell voltage do not have to measure for each single cell manually. The count of cells is from + to -.

2.5.11.3 Manual printout without automatic protocol generation selected

With this selection it is possible to insert a printout at any time although the automatic printout was not selected before.

At the desired moment the pushbutton “P” is actuated. First of all the header with the standard battery parameter is printed. Then the program asks for battery and operator number:

```
P2: S1: I-CHARGE
BATTERY NO:      123456789
```

A previously entered battery No. is indicated and may be overwritten or be accepted by actuating the key “E”. The 9 digit number to be entered may consist of the numbers 0 to 9 and a decimal point:

```
P2: S1: I-CHARGE
OPERATOR NO:     987654321
```

A previously entered operator No. is indicated and may be overwritten or be accepted by actuating the key “E”. The 9 digit number to be entered may consist of the numbers 0 to 9 and a decimal point.

Now the actual program and battery data are printed:

```
P2: I-CHARGE
* CELL 01:       0.000 V
```

The display shows the cell voltage of cell 1, measured with the cell tester. The measuring value is passed to the system by actuating the pushbutton of the cell tester.

Now the measurement of the subsequent cells is requested in ascending order:

```
P2: I-CHARGE
* CELL 02:       0.000 V
```

After the last measurement the key “E” is actuated to finish the cell-voltage-measurement. If the key is not actuated after a delay the system switches back to the standard program.

For a battery of 10 cells the protocol shows following structure:

```
= = = = = = = = = = = = = = = = = = = = = = =
COPYRIGHT (C) 2007-2014   NORTEC
- - - - - 20.013CTE- - - - - -06.08.13- - - - - - -
DATE                :  13.08.13
BATTERY NO          :  123456789
OPERATOR NO         :  987654321
RATED VOLTAGE       :  12.00V
CAPACITY            :  40.00AH
PROGRAM             :  2
- - - - - - - - - - - - - - - - - - - - - - - - - - - -
P2:S1: I-CHARGE        10:00:00
VOLTAGE             =  15.40V
CURRENT             =  40.00A
CAPACITY            =  044.0AH
                    =  110%
TIME                =  015MIN
TEMPERATURE         =  26.3C
- - - - - - - - - - - - - - - - - - - - - - - - - - - -
* CELL 01           :  1.581V
* CELL 02           :  1.479V
* CELL 03           :  1.477V
* CELL 04           :  1.586V
* CELL 05           :  1.575V
* CELL 06           :  1.587V
* CELL 07           :  1.584V
* CELL 08           :  1.580V
* CELL 09           :  1.588V
* CELL 10           :  1.586V
= = = = = = = = = = = = = = = = = = = = = = =
```

2.5.11.4 Additional Protocol during Automatic-Protocol-Generation of an active program

With this routine it is possible to insert printouts in addition to the standard selected protocols.

At the desired moment the pushbutton “P” is actuated. Immediately in between of the standard protocols an additional printout of the actual battery parameter is inserted.

```
= = = = = = = = = = = = = = = = = = = = = = =
P2:S1: I-CHARGE      13:25:57
VOLTAGE          =   14.97V
CURRENT          =   40.00A
CAPACITY         =   060.0AH
                 =   060%
TIME             =   090MIN
TEMPERATURE      =   30.3C
- - - - - - - - - - - - - - - - - - - - - - - - - - - - -
* CELL 01        =   1.478V
* CELL 02        =   1.590V
* CELL 03        =   1.477V
* CELL 04        =   1.476V
* CELL 05        =   1.475V
* CELL 06        =   1.377V
* CELL 07        =   1.374V
* CELL 08        =   1.380V
* CELL 09        =   1.378V
* CELL 10        =   1.376V
= = = = = = = = = = = = = = = = = = = = = = =
```

2.5.11.5 Paper and ink ribbon Replacement

To replace paper and ink ribbon, the printer has to be taken out of the BT2000/UL10 by loosening the two knurled-head screws on the front panel of the printer.

The paper holder is accessible from below the printer slide-in unit. The new paper coil (paper width 58 mm/diameter 50 mm max) has to be inserted into the spring-clips with paper end pointing to the front panel feeding from bottom to top.
The right angle cut paper is fed through the cutout on top of the printer slide-in unit. From there it has to be carefully inserted into the feed-in slot on top of the printing mechanism mounted behind the front panel. Tighten the paper by moving the paper coil carefully, taking care that the paper end does not slide out of the feed-in slot. Now insert the printer into the BT2000/UL10 and tighten the knurled-head screws. After switching on the BT2000/UL10 the pushbutton on the front panel of the printer has to be actuated until the paper appears at the sharp edge on the front panel. (If the paper does not feed automatically it can be fed manually by moving the upper coil accessible behind the ink ribbon box)

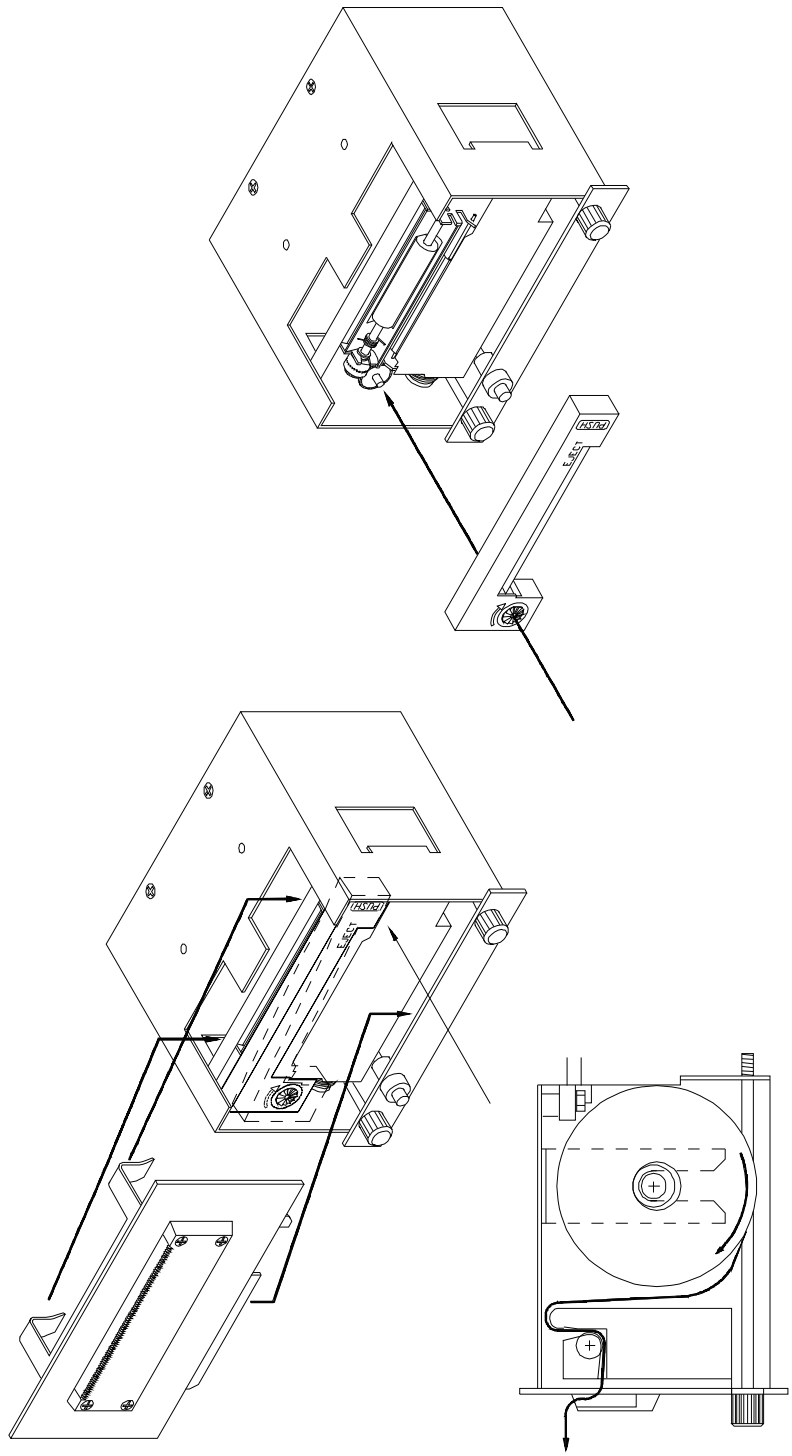
To exchange the ink ribbon the printer has to be removed from the BT2000/UL10 as described above. Then the upper part of the front panel has to be removed from the printer unit by pulling it upwards. Now the ink ribbon box is accessible from the front of the unit. The box now can be disconnected from the drive wheel of the printing mechanism, by slightly pushing on the side inscribed with “PUSH”.

The ink ribbon of the new box is tightened by turning the knob on the box (direction indicated by an arrow). Now insert the ink ribbon box (tightening-knob left front side), feeding the paper between casing and ink ribbon. After installing the upper part of the printer front panel, inserts the printer into the BT2000/UL10 and tighten the knurled-head screws.

2.5.11.6 Printer test

The printer test is performed by simultaneously actuating the green pushbutton on the front panel of the printer and switching on the BT2000/UL10. This generates a printout of the complete character set of the printer.

Printer: Replacement of ink ribbon and paper coil



2.5.12 Program *: Setting of speech, date and time

The program * is used for setting speech, date and time via the keyboard.

Select speech via keyboard:

```
SELECT PROGRAM (0 - 9,P,*) ? * 23:44:55
DEUTSCH = 0          ENGLISH = 1
```

Entering date and time: Date and time are entered via the keyboard, e.g. 13.02.13 and 23:44:55

```
SELECT PROGRAM  (0 - 9,P,*) ? *     23:44:55
*: DATE/CLOCK SET
```

The information is stable for a period of approx. 3.5 years (internal battery). Nevertheless they should be verified cyclically and be corrected if required.

Before the end of the life time of the timer battery the equipment should be sent to the manufacturer for repair.

3 Fault-Messages

Based on its structure the BT2000 recognizes various faults and during active programs monitors the connected battery on different technical parameters and safety criteria.

Principally a selected function cannot be continued after a fault occurred.

If the fixed technical parameters or safety criteria are exceeded, active programs are automatically interrupted and the BT2000 generates a continuous audible alarm, which has to be acknowledged by actuating the key “E” = ENTER.

3.1 Hardware failures

Following fault indications may be displayed during self test after switching on the equipment:

FAILURE EQUIPMENT:
LOW VOLTAGE ON BATTERY (E=CONTINUE)

FAILURE EQUIPMENT:
RANDOM ACCESS MEMORY

FAILURE EQUIPMENT:
PRINTER INTERFACE

FAILURE EQUIPMENT:
KEYBOARD INTERFACE

FAILURE EQUIPMENT:
AD-CONVERTER

FAILURE EQUIPMENT:
SYSTEM-TIMER (CTC)

FAILURE EQUIPMENT:
CLOCK NOT FOUND

FAILURE EQUIPMENT:
POWER-CIRCUIT OR ADC

FAILURE EQUIPMENT:
DAC OR REGULATOR UNIT

In case of an indication of one of the a.m. failures the equipment should be sent to the manufacturer with a short note about the failure indication enclosed.

3.2 System failure

The following fault indications may be displayed during selection of programs or during program run.

FAILURE:
CHECK BATTERY CONNECTION

This alarm appears at following situations:

- No battery connected when starting a program
- Battery is connected with wrong polarity
- Battery connection-cables are shortened
- One connection-cable fallen off the terminal

FAILURE:
CHECK CONNECTION CABLE

This alarm is indicated if the voltage-sense-wire in the connection-cables is broken or interrupted, or the cable is not connected correctly.

FAILURE EQUIPMENT:
AMPLIFIER DEFECT

FAILURE EQUIPMENT:
FUSE Si3-1/RELAIS/SNT/REGULATOR

FAILURE EQUIPMENT:
CURRENT TO HIGH

In case of an indication of one of the a.m. failures the equipment should be sent to the manufacturer with short note about the failure indication enclosed.

3.3 Battery faults

The following fault indications are displayed during program run or after finishing a program. They provide information about the life conditions of the battery

FAILURE BATTERY
CURRENT TOO LOW

This message is displayed if within a period of a program step the current does not exceed the determined minimum level (e.g.: Program 3, maintenance cycle for sealed lead-acid-batteries).

FAILURE BATTERY
CURRENT TOO HIGH

This fault-message is indicated when the charging current is to high at the end of a program step (e.g.: Program 4, charging of sealed lead-acid-batteries).

FAILURE BATTERY
CAPACITY TO LOW

This message is indicated if a charging process does not achieve the determined minimum capacity (e.g.: Program 3).

FAILURE BATTERY
CAPACITY TO HIGH

This message is displayed if the charged capacity exceeds a determined maximum (e.g.: Program 1).

FAILURE BATTERY
BATTERY TEMPERATURE TOO HIGH

Fault indication in case of the temperature of one battery terminal reaches 65°C or If since begin of the charging period the temperature of the battery increases by more than 20°C and in between exceeds 30°C.

NOTE
The message BATTERY TEMPERATURE TOO HIGH is generated only, if the battery-connection-cables are provided with temperature-sensors.

4 Installation

The battery-analyzer/-charger BT2000 is designed for inside usage. Under certain ambient conditions, it can be also used outside.

The room in which the equipment is to be installed does not require special construction. The minimum requirement is a 230 V / 50 Hz mains-supply, fused with minimum 20A.

The maximum power consumption is 2000W or 3000VA.

The most important point to be considered is the internal ventilation of the equipment.

Complying with the following directions ensures a safe operation of the BT2000:

- when operating the equipment on a plain surface, leave a clearance of 25 cm between the back of the casing and the wall

- use the mounting-bracket

- use a special casing for mobile operation

Generally, it has to be considered that the equipment requires several m^3 cooling-airs per minute.

5 Definitions

The chapter "Definitions" comprises an overview about abbreviations and terms used in this documentation:

5.1 Battery, sealed

The term “sealed battery” denotes a maintenance-free battery with fixed electrolyte, which has been provided with non-removable locking-caps by the manufacturer.

5.2 Battery, vented

The term “vented battery” denotes a battery, on which conventional maintenance as density measurements and revilement of distilled water can be performed by removing the screw-cap of the cell.

5.3 Rechargeable silver-zinc-battery

Rechargeable silver-zinc-batteries are a combination of sealed and vented batteries.

They are delivered and stored in charged but not filled state. To put them into operation they are filled with potash lye electrolyte, which is delivered separately for each cell in a special barrel.

After that the batteries are closed with locking caps similar to those of vented NiCd-batteries

During the approx. 18 month lifetime of the battery no further maintenance measures have to be taken.

5.4 Charging/Discharging-Threshold-Voltage

The charging/discharging-threshold-voltage is defined by the manufacturer. It is the voltage level to which a battery can be charged or discharged without being damaged.

5.5 Rated voltage

The rated voltage is a characteristic quantity based on the battery technology (e.g.: lead-acid-batteries: 2V/cell; NiCad-batteries: 1.2 v/cell).
In relation to charging/discharging programs, created for different battery-technologies, the term “rated voltage” or “nominal voltage” is also used for change over levels defined by the product of number of cells and voltage.

5.6 Rated Capacity = C_5

The rated capacity (Ah) as magnitude of a battery is based on a fixed discharge to a defined discharge threshold voltage at a defined reference temperature (5 hours discharging current, battery temperature, discharging threshold voltage; values depending on battery-technology).

5.7 Rated Current or 0.2 C_5 (A))

5 hours discharging current (formerly I_5) of a battery, calculated as follows:

$$\frac{C_5\ (Ah)}{5h} = 0.2\ C_5\ (A)$$

5.8 Cell voltage

Within charging or discharging programs designed for different battery-technologies the term “cell voltage” is used in combination with the number of cells of the battery to be maintained, to define a program specific change-over-voltage.

5.9 Analysis cycle / Maintenance cycle

The terms “analysis cycle / maintenance cycle” is a discharging-charging-discharging-charging-cycle, required to determine the actual performance of the battery and prepare the battery for further usage.

5.10 Charge

The term “charge” defines a non damaging full-charge of a battery in minimum time. Immediately after finishing the charge the battery can be used again.

Note

Terms not explained here will be understood by reading the program descriptions.(e.g. IU-CHARGE, IUI-CHARGE or similar abbreviations.)