

Intelligent Battery - Charger

c u r a t i o®

P 4

Operating Instructions

bds Bauer Daten-Systeme GmbH

Krokusstraße 8, D-71034 Böblingen, Telefon +49 7031 / 673031, Fax +49 7031 / 674676

eMail mail@batteriecharger.com

Internet <http://www.batteriecharger.com>

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Applies to EPROM Version 3.37 and up

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1 IMPORTANT ! IT IS ESSENTIAL TO READ THIS SECTION...

Please read this document carefully. In case of any damage due to erroneous operation -not in accordance to this manual- of the unit the warranty discontinues. The manufacturer then will not be liable for any damage.

Before attaching the unit to the main supply, please check whether the proper main voltage (115/230V) has been chosen on the main power voltage-switch (optional).

Prior to opening the unit urgently disconnect it from the main supply and detach the batteries.

Be careful !! The transformer and cooling bodies may be hot !!

The unit must be placed in a way, that cooling is not hindered and the air can circulate freely through the ventilation slots of the housing.

Keep the unit out of excessive humidity.

Proper setting of battery type, Number of cells and charging current should be checked prior to connection of a battery. Wrong programming of those values may result in damage of the battery and even result in burning or explosion.

The individual battery cells to be charging within one block must have the identical cell capacities and charging conditions. Else curatio cannot detect end of charging and cells may be damaged when charging or discharging. This should be considered when attaching different cells to curatio in series.

2 TECHNICAL DATA

Curatio will operate with 230V/50Hz main power (optionally 230V/115V)

Up to four batteries can be attached for charging. Connection is done by 4 mm plugs.

The following battery types can be attached: nickel-cadmium batteries, nickel-metal-hydrid batteries with 2 to 12 cells, alkali-mangan-batteries with 2 to 11 cells, lithium-ion batteries with 1 to 4 cells and plumb batteries with 1 to 8 cells.

The minimum cell number outlined above has to be regarded. Single cells cannot be charging.

Serial interface: 9600 bps, 7 databits, even parity, 2 stopbits

Max. charging Voltage: 19.5 V

Max. total current for the four channels: 1.7A or 2.2A for *curatio* with enhanced charging current.

Charging current adjustable individually for each channel from min. 20 mA to max. 1.0A (1.3A for *curatio* with enhanced charging current) in steps of 5 mA.

Main Power Supply: 230V 50Hz 45VA (60VA)

Main Power Switch on the rear of the unit.

Main Power cord length: 1.4m

Dimensions: 280 x 150 x 95 mm

Weight: 2.5kg

Certified according to EN 0081-1, 50082-1

The term *curatio* comes from Latin origin and means maintenance, care.

3 INTRODUCTION

The *curatio* is a microprocessor controlled battery-charger / discharger for connection of up to four rechargeable battery blocks. The battery blocks hooked can be charged or discharged independently of each other. Each of the four channels can be programmed individually to the requirements of the attached battery block type, the charging mode and the current.

Operation of *curatio* is done by use of four buttons: 'CLEAR', '+', '-' and 'ENTER'. The parameter values are shown on a LCD display with 16 x 2 digits.

An individual charging processes is used for each battery type including battery-dependend charging shut-off at a full battery. An overcharging of the batteries, therefore, cannot take place at proper programming of the *curatio*.

For each of the four channels the charging- and discharging current can be programmed individually. The current for each channel can be programmed in steps of 5 mA, starting from 20 mA up to 1A (1.3A). The maximum current for all 4 channels is a total of 1.7 A (2.2A). The values in brackets apply for the *curatio* with enhanced charging current.

Throughout the process of charging or discharging the capacity of the battery is measured and is shown on the display or may be printed via the serial interface.

After complete charging of the battery the *curatio* automatically changes over to stand-by charging.

For batteries suffering loss of capacity -so called 'memory effect'-, the mode 'conditioning' can be programmed. In this mode the batteries will be charged, discharged and charged again several times. The batteries with 'memory effect' improve their capacity by this process

Curatio automatically detects battery connection. The programmed mode will be performed automatically upon connection.

Battery blocks may remain connected while the instrument is switched off. The unit won't take harm. The discharging current drawn in that case is smaller then 1mA.

The examined values of the connected batteries can be read out by *curatio* serial interface.

4 POWERING-ON THE BATTERY CHARGER

Prior to powering on *curatio* it is necessary to check for proper setting of the main power selection. This applies only for those units which have the optional main power selection switch installed.

Curatio will be switched on and off on the rear of the unit.

After power-on, the following message will be shown in the display for approx. 2 seconds:

b		d		s		G	m	b	H				
c	u	r	a	t	i	o			V	.	x	.	x

At positions x.x the version number of the installed EPROMs will be shown.

After that the selftest will be performed.

S	e	I	f	t	e	s	t							
C	P	U		A	1		A	2		A	3		A	4

After powering-on the unit the very first time (or after changing the EPROMs (depending on version), or after a data loss in EEPROM) all channels will reset to basic mode (nickel-cadmium batteries, 200 mA charging current).

After subsequent power-on operations the *curatio* will continue the programmed modes in which it was switched off before.

After powering-on *curatio*, the CPU, the EEPROM and the hardware of the four channels will be checked. Possible mistakes will be displayed. The green LED's (named 'loaded') will pulse one after the other. Throughout this selftesting the fan is running. If no mistakes were found and there were no batteries connected before the power-on, the following message will be shown in the display:

N	o		b	a	t	t	e	r	i	e	s			
C	h	a	n	n	e	l	s		O	K				

If there were batteries connected before the power-on, it will be shown respectively:

B	a	t	t	e	r	v			1		2			
C	h	a	n	n	e	l	s		O	K				

(Batteries 1 and 2 were connected prior to the power-on)

If a battery was connected before the power-on, the programmed mode for the corresponding channel will not be carried out immediately. The mode will be started after approx. 30 minutes. Reason: In case of *curatio* power-off while a charging process was almost ended, and a subsequent power-on, the battery charging condition can not be recognized reliably within the first half hour. The battery could be overcharging.

In case the selftest detects a mistake, the error will be shown by the display.

N	o		b	a	t	t	e	r	i	e	s				
E	r	r	o	r		A		1							

Example above: An error in channel 1 was found.

In case of installation of a new EPROM version the text 'EEPROM reloaded' may be shown (depending on the EPROM version), indicating that the EEPROM parameters were reloaded. In this case the current control, currents and voltages have to be newly adjusted. The message can be deleted using the "CLEAR" key.

CAUTION! No battery block must be attached if the parameters are not set.

P	a	r	a	m	e	t	e	r		A	d	i	u	s	t
E	E	P	R	O	M		r	e	l	o	a	d	e	d	

If the parameters are to be adjusted, the following display is shown:

P	a	r	a	m	e	t	e	r		A	d	i	u	s	t
E	E	P	R	O	M		r	e	l	o	a	d	e	d	

In case of a malfunction throughout program operation, all channels will be switched-off and the message 'WATCHDOG RESET' will be displayed. This message will be shown for approx. 30 sec., and -after that- the operation will be continued in the programmed mode. The message can be deleted using the "CLEAR" key.

During the selftest, no battery must be connected or disconnected.

The push-buttons '+' or '-' select one of the four channels.

The first line displays the channel number (C1) and the mode in coded form (M stands for *mode*).

The first number behind 'M' codes the type of battery, the second number codes the programmed charging mode. Please refer to the table below for the codes.

Example:

A	1		M	2	4					2	0	0	m	A	
N	o		b	a	t	t	e	r	y						

The example code M24 means, a nickel-metal-hydride-battery will be charging, discharged and charging again with 200 mA. No battery is connected.

5 THE CODED MODE-WORD:

Mode word: 1.st digit:	1	nickel-cadmium battery
	2	nickel-metal-hydride-battery
	3	plumb battery
	4	round-cell-battery
	5	alkali-mangan-battery
	6	lithium-ion-battery
	7	set voltage

Mode word: 2.nd digit:	1	charging only
	2	discharging only
	3	discharging - charging
	4	charging - discharging - charging
	5	multiple charging - discharging - charging (conditioning)
	6	charging - discharging - charging every 30 days

Example:

M63: (6) a lithium-ion-battery will be **(3)** discharged and charged

6 EXAMIN THE PROGRAMMED VALUES

The programmed values can be examined in the following way:

Hit 'ENTER' to proceed to the program mode and 'ENTER' again to step through the programmed values. Hit 'CLEAR' at the end of the sequence (at display: 'Store values?'). With this procedure the program mode will be finished without influencing the current running program. If in case the key 'ENTER' was pressed, the display shows 'Values stored into EEPROM'. As no values have been altered, again no influence to the attached battery will occur.

Throughout examination explained above avoid to operate hit '-' or '+'. The key 'CLEAR' ends the program mode at any time. Changes of values are made ineffective by hitting 'CLEAR'.

7 THE SETUP-PROGRAM

The display language can be switched between 'German' and 'English' by the setup-program. The setup-program is called by simultaneously pressing the 'CLEAR' and the '-' key. The display shows the chosen language, which can be altered by use of the '+' or '-' key. Pressing the 'ENTER' key the chosen language will be permanently stored.

8 PROGRAMMING

Each of the 4 channels can be programmed in the desired mode by use of the *curatio* keys. Depending on the charging mode chosen and the type of the battery the following can be programmed: 1) the number of cells, 2) the voltage at the end of discharge and end of charge, 3) the charging/discharging current. Setting of 1) to 3) is dependent on the type of battery and the programmed mode.

For each channel a maximum current of 1.0A (1.3A) can be defined. The minimum charging current is 20 mA. Do the programmed charging currents of all channels used exceed the total of 1.7A (2.2A), the charging current will be reduced automatically. Then the current of the highest channel will be reduced first to the current of 20 mA at the minimum. Does the total charging current still exceed 1.7A (2.2A), the current of the next channel will be reduced as well. Channel 1 has the highest priority. The current of channel 1 always conforms to the programmed current. The discharging current on all channels conforms to the programmed values.

The currents should be programmed in a way that -during charging- the charging current should not be altered. The total of all four programmed currents should not exceed 1.7A (2.2A). In the worst case an early charging-end can be recognized.

Programming starts with selection of the channel. Use the "+" or "-" keys for channel selection. The blinking cursor indicates the selected channel number.

A	1		M	1	1					2	0	0	m	A
N	o		b	a	t	t	e	r	y					

Pressing the key 'ENTER' calls the programming mode for the selected channel.

A	c	c	u		3									
P	r	o	g	r	a	m	m	e	d					

The Status 'Programming' is displayed until the key 'ENTER' will not be operated anymore. Then, the cursor is blinking in the second line of the display.. Now the type of battery has to be programmed. The 2.nd line will display the type of battery entered. The keys '+' and '-' allow to select a type of battery.

The types of batteries are shown one after the other by pressing the 'ENTER' key as follows: nickel-cadmium battery, nickel-metal-hydride-battery, plumb battery, lithium-ion-battery, set voltage selections.

A	c	c	u		3		A	c	c	u	t	v	b	:	
N	i	c	k	e	-	C	a	d	m	i	u	m			

The mode 'set voltage' allows individual programming of the voltage at the end of the charge- and discharge process. Charging in this mode is done with continuous current.

Hit 'ENTER' after selection of the type of battery. Now the desired mode can be selected.

A	c	c	u		3		M	o	d	e	:				
C	h	a	r	.	-	D	c	g	.	-	C	h	a	r	.

The possible modes are shown in sequence by pressing the '+' key as follows: charging, discharging, charge-discharge-charge, conditioning, and - charge-discharge-charge 30days.

Charging just loads the battery. **Discharging** just discharges the battery. **Charge-discharge-charge** will load the battery first, discharge it and charge it again. **Conditioning** mode will perform the charge-discharge-charge process several times. The **charge-discharge-charge 30days** mode will repeat the charge-discharge-charge process each 30 days. In-between the 30 days the battery is loaded in standby charging mode.

After the selected charging mode has been executed and the battery has been loaded, *curatio* will switch to standby charging. This state will be displayed via the LED's and shown on the display.

If -at this state- 'ENTER' is pressed again, the display will show the following messages depending in the programmed mode:

Mode Conditioning:

A	c	c	u		3					C	o	u	n	t		
C	o	n	d	i	t	i	o	n	.		A	u	t	o		

The keys '+' and '-' allow programming of the number of 2 to 6 charge/discharge cycles at this state. Also 'Auto' can be programmed, in which after each discharging the measured capacity is compared with the capacity of the discharge cycle from before. In case the difference is larger than 10 mA, the 'auto' cycle is repeated. If not, the process is finished after the next charging and the *curatio* switches to standby charging. A minimum of 2 charge/discharge cycles will be executed. There is no limit set for maximum charge/discharge cycles. The 'ENTER' key operation advances to the next programming step.

The user is now requested to enter the number of cells depending on the programmed battery type and the programming mode. In case of selection of a nickel-cadmium battery and is mode 1 (charging only) selected, the number of cells does not have to be programmed. The number of cells is calculated automatically at end of charging. In case the number of cells have to be entered, the display shows the following:

A	c	c	u		3										
C	e	l	l	s			6								

Programming of the cell number is done by operating the '+' or '-' keys. The maximum cell number is limited according to the type of battery. Also, the minimum cell number is 'one' only for some types of batteries. (see below).

Operation of *curatio* with just one cell is possible with plumb batteries and lithium-ion-batteries only. All other types of batteries must have at least two cells for connection to *curatio*. Damage may result else.

After programming of the cell number pressing 'ENTER' again will advance to programming of the charging/discharging current. Both currents are of the same value.

A	c	c	u		3										
C	u	r	r	e	n	t			1	0	0	0	m	A	

The keys '+' and '-' allow selection of the charging/discharging current of max 1000 mA (1300 mA) and min. 20 mA. The current can be chosen in steps of 5 mA.

The charging current should be 1/10C (1/10 of the battery capacity).if not stated else by the battery specifications. For example, the charging current would be 50 mA for a battery with a capacity of 500 mA. Exceeding the 1/10C must conform to the battery specification strictly.

The key 'ENTER' advances to the next programming step. In case the type of battery was programmed 'set voltage' the user is now requested to enter the voltage values. If the mode 'charging' was programmed, the voltage at end of charging has to be entered. If the mode 'discharge' was programmed, the voltage at end of discharging has to be entered. If charging and discharging was programmed, both voltages at the end of charging and discharging have to be entered. The minimal voltage to be programmed is 1.5V, the maximum voltage is 18.0V. The values, which have been entered, are stored by hitting the key 'ENTER' and the unit advances to the next step.

A	c	c	u		3		D	i	s	c	h	a	r	a	e
v	o	l	t	a	g	e					8	.	0	V	

A	c	c	u		3					C	h	a	r	a	e
v	o	l	t	a	g	e				1	6	.	5	V	

If all steps have been programmed, the display shows the following:

A	c	c	u		3		D	a	t	a		s	a	v	e
w	i	t	h		E	N	T	E	R		?				

Hitting 'ENTER' again saves the programmed values in an EEPROM. The values remain in the *curatio* during power-off. They are still available when the unit is switched-on again. In case another key is pressed, the values will not be stored. Then the previously stored values remain in the unit and the display will show the present mode of the selected channel. The unit is in its basic running mode. After hitting 'ENTER' the display will show the following message for a short period of time:

D	a	t	a		i	n		E	E	P	R	O	M		
s	a	v	e	d											

After that the actual mode of the channel is displayed. In case there was a change made to the type of battery, the mode, or the number of cells, *curatio* behaves in the same way, as if a battery was removed and attached again to the unit. The running mode of operation will be interrupted and the newly programmed mode will be started. In case there was made a change to the charging/discharging current only, only the current will be changed to the programmed values and a running mode is not aborted.

Caution! If the charging process is almost finished, end of charging may not be detected and overcharging of the battery may occur. There is a danger of fire or explosion!

Pressing the '+' or '-' key continuously allows cycling through the values.

The 'CLEAR' key allows abortion of programming. The values programmed before remain and the currently running mode will not be influenced.

If in programming mode there is no key pressed for longer than 60 seconds, the mode will be ended automatically. Then the values programmed before remain and the currently running mode will not be influenced.

9 TYPES OF BATTERIES

Nickel-cadmium battery: Detection of 'end of charging' with this battery is done applying the 'Minus-Delta-U-methode (-X/V). At complete charging of this battery the voltage drops and *curatio* detects this. Discharging is done to 0.9V per cell. Measurement of the battery voltage always is done along with battery load. Charging is carried out with pulsing current in the following way: 10 sec. of charging, 2 sec. of pause along with measurement of the battery voltage. Standby charging is done each 6 hours or if the cell voltage drops below 1.3V. One cell has a typical medium voltage of 1.2V. For example, a cell number of 6 has to be programmed for a 7.2V battery.

Nickel-metal-hydride-battery: Same as written above for nickel-cadmium batteries holds true. Due to the very small voltage drop at the end of charging the number of cells has to be programmed with batteries up to 3 cells. Batteries with more than 3 cells also can be loaded under battery type 'nickel-cadmium battery'.

Plumb battery: This batteries are loaded with a continuous current, at first with the programmed current. At the end of charging the current is going to be decreased. The charging is decreased in concurrence to the charging voltage in a way, that -at end of charging- the cell voltage of 2.3V will not be exceeded. Discharging will be done to a minimum of 1.8V. Typical cell voltage is 2.0V. Thus, a cell number of 6 has to be programmed for a 12V battery. Standby charging is done each 6 hours or if the cell voltage drops below 2.2V.

Round cells: Shutting of the charging process is controlled by the end of charging voltage. During charging the Voltage is measured in charging pauses and after the final charging voltage has been reached the charging current is shut off 2 minutes later. Does the battery voltage drop again below 1.4V, charging is continued with the programmed current. If the voltage stays stable within a given time interval 'Loaded' state will be signaled on the display. Does the voltage drop below 1.4V after that time interval, *curatio* switches to standby charging.

Alkali-mangan-batteries: Shutting of the charging process is controlled by the end of charging voltage. Charging will be carried out with a voltage of max. 1.75V per cell. After the cell-voltage of 1.75V has been reached, the charging current will be reduced in a way that the cell voltage does not exceed 1.75V. During charging the voltage is measured in charging pauses and -after the final charging voltage of 1.65V has been reached- the charging current is shut off 2 minutes later. Does the battery voltage drop again below 1.65V, charging is continued with the programmed current. If the voltage stays stable within a given time interval 'Loaded' state will be signaled on the display. Does the voltage drop below 1.65V after that time interval, *curatio* switches to standby charging. Manufacturers of alkali-mangan-batteries recommend to charge the batteries individually only. If the battery should be loaded as block, it should be ensured, that the charging condition of the cells is absolutely identical. Standby charging is done each 6 hours or if the cell voltage drops below 1.55V.

Lithium-ion-batteries: This batteries are loaded with a continuous current, starting off with the programmed current. At the end of charging the current is going to be decreased at end of charging if the cell voltage reaches 4.2V. The charging the current is being decreased in a way, that the cell voltage is not exceeded. Discharging will be done to a minimum of 2.5V. The Typical cell voltage is 3.6V. Thus, a cell number of 2 has to be programmed for a 7.2V battery. Standby charging is done each 6 hours or if the cell voltage drops below 4.0V.

Caution! Lithium-ion-batteries are very sensitiv to overcharging. The charging process should be monitored. Maximum Charging voltage is 4.2V. Danger of fire or explosion!

Set voltage: Charging takes place with a continuous current, starting off with the programmed current. At the end of charging -after reaching the programmed current- the current is going to be decreased. The charging the current is being decreased in a way, that the programmed cell voltage is not exceeded. Discharging will be done to the programmed end of charging voltage. Standby charging is done each 6 hours or if the cell voltage drops below the programmed end of charging voltage by 10%.

The mode 'set voltage' behaves the same way as the 'plumb battery' mode, however, the end of charging voltage may be entered individually.

In General:

End of charging current is set to 20 mA to 50 mA if the end of charging if condition is detected by decreasing the charging current method (i.E. plumb battery). The value is 20% of the programmed charging current. Example: Programmed current: 150 mA results in switching off current of 30 mA.

The lading current for the standby charging id 20% of the programmed current. Smallest value is 20 mA.

As a security feature the charging/discharging process will be finished after 24 hours. The same holds true if the voltage of the battery does not increase within a couple of hours. Standby charging is limited to a max. of 6 hours.

Throughout charging/discharging the values of capacity are monotored and stored in an internal storage. The most current values are displayed. More values may be printed via the serial interface.

10 CONNECTION OF BATTERY BLOCKS

The battery blocks have to be attached in the way that the plus and minus of the batteries are connected to the same channel. External interconnections between the channels must be avoided.

In case the battery was connected with wrong polarization, no message will be displayed. *curatio* is protected against wrong polarization and no harm will occur.

At correct battery connection and a battery voltage of at least 0.4V, the programmed mode will start automatically.

The charging will be terminated, if *curatio* detects the negative slope of battery voltage or the fully charge voltage is reached (depending on the chosen mode). Discharging will be done down to a cell voltage of 0.9V (0.5V with mode 2).

Charging without Monitoring the battery Voltage:

In case there are batteries to be loaded, which have been completely discharged or which were connected to *curatio* by a diode, no monitoring of the battery voltage can be done. In this case *curatio* will start charging by hitting the 'CLEAR' key. This mode only can be executed, when not alkali-mangan-batteries or round cells have been programmed. As with connection via diode no discharging is possible, this mod can only be done, if 'charging' mode has been programmed. After connection of the battery the 'CLEAR' key has to be pressed for about 2 seconds. If *curatio* detects a battery, charging is started. After completion of charging and disconnection of the battery, manual clearing of the display is required by hitting the 'CLEAR' key. Charging in this mode is done by continuous current.

If the battery is attached via a diode, the voltage drop at the diode have to be taken into consideration for the measured values. I.e. the cell number may be displayed wrongly.

Battery blocks with an integrated charging circuitry cannot be attached.

After connecting the batteries the display shows the following:

First row of the display: 1) channelnumber 'C1', 2) programmed mode 'M11' in coded form and 3) the programmed current '200 mA'.

Second row of the display: 1) 'Cg' for charging, 2) 'Dcg' for discharging or 'Stb' for stand-by-charge, 3) the actual batteryvoltage '7.2V' and 4) the real current '200 mA'

For example, if a larger total charging current was programmed than possible for all channels, the 2. row of the display shows the figured charging current after connecting the battery for a short period of time. After switching over, the 2.nd line displays the current as well. In case of stand-by-charging the the stand-by-current will be displayed battery for a short period of time.

Charging:

A	1		M	1	1					2	0	0	m	A
C	g				7	,	2	V		2	0	0	m	A

Discharging:

A	2		M	1	2			4	Z		4	5	0	m	A
D	c	g			4	,	4	V		2	0	0	m	A	

Standby charging:

A	3		M	1	3			6	Z		6	0	0	m	A
S	t	d			8	,	1	V		1	2	0	m	A	

The display can be switched over to show values of charging time and measured capacity by use of the 'CLEAR' key. It then shows in the 1.st row: 1) the channelnumber, 2) the programmed mode and 3) the time in minutes for the actual process. (In stand-by charge the time for the stand-by charge will be displayed).

The 2.row shows: 1) the actually measured discharged 'D' and charged capacity 'C' in mAh. The shown capacity values won't be modified by standby-charging.

A	1		M	1	4			1	6	7		M	i	n	.
D			5	2	0		C		5	7	1		m	A	h

The cursor is blinking on 'D' while discharging, on 'C' while charging or on the channel-number when the mode is finished.

Has the programmed mode come to a complete end, a respective indication is shown on the display

I.e. Mode 11 finished, battery charged:

A	2		M	1	1			4	Z		4	5	0	m	A
C	h	a	r	g	e	d									

I.e. Mode 12 finished, battery discharged:

A	3		M	1	2					8	0	0	m	A	
D	i	s	c	h	a	r	g	e	d						

The condition 'charged' and 'discharged' will be shown on the display and with the green LED's as well.

11 PROGRAMMING - EXAMPLE

A nickel-cadmium battery with a specified capacity of 600 mAh, 6 cells and 7.2V should be verified and a possible memory effect should be eliminated. It will be attached to channel1. *Curatio* still holds the internal adjustments upon delivery.

Power-on *curatio* and , after selftesting, advance to 'C1' with the '+' key. The programmed values will be displayed for channel C1.

A	1		M	1	1					2	0	0	m	A
N	o		b	a	t	t	e	r	i	e	s			

Hit the 'ENTER' key.

A	c	c	u		1									
P	r	o	g	r	a	m	m	e	d					

The programming mode will be called. After releasing the key the display shows the type of battery.

A	c	c	u		1		A	c	c	u	t	v	b	:
N	i	c	k	e	l	-	C	a	d	m	i	u	m	

The desired type of battery already has been programmed. In case another type is desired, press '+' or '-' key for proper selection. The 'ENTER' key selects the type of battery. Next, the mode can be programmed.

A	c	c	u		1		M	o	d	e	:			
C	h	a	r	g	e									

'Charging' is predefined as mode. Using the '+' key, advance until the 2.nd Line shows the following:

A	c	c	u		1									
C	o	n	d	i	t	i	o	n	i	n	g			

The desired mode is being displayed and will be stored by pressing 'ENTER'. Next the number of charging/discharging cycles will be programmed.

A	c	c	u		1					C	o	u	n	t
C	o	n	d	i	t	i	o	n	.	A	u	t	o	

The display shows 'AUTO' for the number, which means, *curatio* will execute charging/discharging cycles as long as the battery has reached the maximum capacity. This mode may take quite a long time. Should be only two cycles executed, it may be advanced to the following by use of the '+' or '-' keys:

A	c	c	u		1					C	o	u	n	t
C	o	n	d	i	t	i	o	n	.	2	x			

The 'ENTER' key stores the values. After that the charging/discharging current may be programmed.

A	c	c	u	1										
C	u	r	r	e	n	t				2	0	0	m	A

60 mA should be programmed for a battery of 600 mAh capacity. Use the '-' key to select the correct value.

A	c	c	u	1										
C	u	r	r	e	n	t				6	0	m	A	

The 'ENTER' key commits the values and you are asked by the display whether the values are to be stored. The 'ENTER' key stores the values and old values are overwritten

A	c	c	u	3		D	a	t	a		s	a	v	e
w	i	t	h		E	N	T	E	R		?			

Hit "ENTER"

D	a	t	a		i	n		E	E	P	R	O	M	
s	a	v	e	d										

A	1		M	1	5						6	0	m	A
N	o		B	a	t	t	e	r	y					

Connect the battery to channel 1. After that the display shows the following:

A	1		M	1	5						6	0	m	A
C	g				5	,	6	V			5	9	m	A

The battery will be charged first. The 2.nd line of the display shows the actual battery voltage of 5.6V. The present current is still at 0 mA for short. The current is then increased to the programmed value. It's value will be measured each second, displayed, and possibly adjusted. After end of charging, the battery will be discharged.

A	1		M	1	5			6	Z			6	0	m	A
D	c	g			8	,	5	V				6	0	m	A

The 1.st line of the display now also shows the calculated cell number of 6. After the 2.nd discharging of the battery follows a charging cycle and, after that, the loaded condition is shown on the display and on the green LED (A1).

A	1		M	1	5			6	Z			6	0	m	A
C	h	a	r	g	e	d									

The key 'CLEAR' allows to switch over to display the measured battery capacity.

A	1		M	1	5			7	8			m	i	n	.
E			5	7	8		L			6	4	9	m	A	h

The last discharging process recorded a capacity of 578 mAh. The battery thus almost has reached it original capacity. The time for the last charging was recorded 78 minutes and 648 mAh where charged.

12 SELF-MONITORING AND ERROR MESSAGES

The *curatio* program is constantly monitored by a 'WATCHDOG'. In case of a program mistake caused by an excessive electrostatic discharge, the current will be cut-off and the program interrupted.

In the display the following message occurs:

S	e	l	f	t	e	s	t								
W	a	t	c	h	d	o	g		R	e	s	e	t		

The message will be displayed for 30 sec. With the 'CLEAR' key the message can be cleared. After that *curatio* program will start-up like after power-on.

The channels are checked constantly for overcurrent. Any error condition will be displayed and the channel will be switched-off.

A	3		M	1	1			6	Z		8	5	0	m	A
E	r	r	o	r		o	v	e	r	c	u	r	r	e	n

The temperature of the internal cooling body will be checked by the microprocessor. In case a predefined temperature is exceeded, the internal ventilator will start to operate. In case the temperature is exceeding a second threshold, charging/discharging will be interrupted. The display shows a message accordingly. **After cooling down, the operation will continue.**

O	v	e	r	t	e	m	p	e	r	a	t	u	r	e	
C	a	r	g	i	n	g		p	a	u	s	e	d		

Does the *curatio* power-on selftest reports a mistake, the erroneous channel can be selected by the '+' or '-' keys and the reason of error will be shown in the display.

I.e. Transistor for discharging/charging is out of order.

A	3		M	1	1						2	0	0	m	A
U	n	l	o	a	d		T	r	.		d	e	f	.	

A	2		M	1	1					1	0	0	0	m	A
L	o	a	d		T	r	.		d	e	f	e	c	t	

The reason for the error message 'Load Tr. defect' might be due to wrong adjustment. Check for proper adjustment in this case.

In case of battery connection with wrong polarity or of a short-circuit condition, the following message is displayed:

A	4		M	1	1							5	0	m	A
P	o	l	a	r	i	t	y	/	S	h	o	r	t		C

(The mistake will only be recognized and displayed during the selftest)

In case 'plus' and 'minus' of the battery are not connected to the same channel, *curatio* will recognize the false condition. All channels will be shut-off and the mistake displayed. After approx. 1 minute the error message will be cleared and *curatio* will check again for proper connection.

C	o	n	n	e	c	t	i	o	n		E	r	r	o	r
C	a	r	g	i	n	g		p	a	u	s	e	d		

Pressing the 'CLEAR' key all displayed error message may be erased. *Curatio* then checks, whether the error condition is still present and shows a message accordingly.

Do not connect *curatio* to two 'Minus' outlets. *Curatio* then will suffer damage due to the short circuit current.

13 ADJUSTMENT OF CURRENT CONTROL, CURRENT AND VOLTAGE

Tolerances of *curatio* internal electronic components require -in order to obtain exact measurements- some adjustments. For each of the 4 channels the current-controls, currents and voltages have to be adjusted independently.

The current control parameter determines the behavior for the charging current at switch-on. Wrong adjustment of the current control may cause the message "Overload" or may cause too slowly achievement of the charging current.

At delivery *curatio* will have proper adjustments for current controls, currents and voltages.

New adjustments have to be done after the message 'EEPROM reloaded'.

In case -after charging a battery- a wrong number of cells is shown on the display, most likely there is a defect cell in the battery block. As an exception, the cause might be wrong voltage adjustment. In that case, please check the voltage adjustment.

The adjustment should be done with a battery block of 9 or 10 cells, which is specified for a charging current of at least 1.0A. Adjustment can only be done with a nickel-cadmium battery or a nickel-metal-hydride-battery attached.

Does the *curatio* measured values differs significantly form the real values, the EEPROM should be reloaded to 'Reset condition' bevor adjustment. This is done battery powering on the unit and pressing the keys '+' and '-' simultaneously until the display shows 'EEPROM reloaded'. The 'CLEAR' key resets the display and the adjustment may be started.

13.1 CALLING THE ADJUSTMENT PROGRAM

Upon powering on *curatio* a selftest is carried out. At end of the selftest -after checking of 'C4'- the condition of the keys are polled. At this time the 'CLEAR' key and the 'ENTER' key must be pressed. After releasing these keys, the first row of the display shows the message: "C.Control Adjust" and the 2. row displays channel C1 with the current and the correction value for the comparison in %. The correction value is 100% after each call of the comparison program, even when the adjustment has been carried out. After connecting a battery to the channel of adjustment, the *curatio* automatically optimizes the current control. First the current control for charging current will be determined and, after that, the current control for the discharging current. After successful adjustment the display shows the message 'adjusted'. If it is not possible to determine the current control within a defined time the message 'aborted' occurs. After attachment of the battery the 100% value is increased until it reaches the due value of 20 mA.

The "ENTER" key advances the adjustment modes from adjustment current control to adjustment 'charging-small value-', then to adjustment 'discharging-small value-', then to adjustment 'charging-large value-', then to adjustment 'discharging-large value-', then voltage adjustment and then, again, to adjustment current control.

The "CLEAR" key switches over to the next channel.

Adjustment of current requires attachment of a current-meter in series to the battery. The 'ENTER' key toggle between charging and discharging mode. The adjustment starts with a small current of 90 mA. Continue with a higher current of 500 mA. The current displayed on *curatio* should correspond to the measured current exactly. The '+' and '-' keys allow the adjustment.

For voltage adjustment connect the battery to the chosen channel. Connect a voltage-meter in parallel to the battery. The measured voltage has to correspond with the voltage on the *curatio* display with a precision of +/- 0.1V. The "+" and "-" keys adjust the displayed voltage.

The voltage adjustment must be done very accurate. Mind Tolerances of 0,1V. Wrong voltage adjustment may damage the batteries.

The adjustment program can be finished by pressing the "CLEAR" and "ENTER" keys at the same time. The new values of the adjustment will be saved in EEPROM.

Secure operation requires verification of the adjustments. This is done by monitoring the values on the first battery loaded (on each channel) using an external meter.

Execution of the adjustment program may reset error-bits.

Checking for end of charging can not be done during the adjustment program. The battery used for adjustment has to be disconnected after completion of the adjustment program. The battery used for adjustment must be specified for at least 1.0A current. Protect the battery against overcharging when adjusting.

Disconnect the battery after the measurements and adjustment has been carried out.

14 HINTS FOR SECURE OPERATION OF *CURATIO*

The cables connecting the batteries should be short sufficient for large currents. We recommend cables with a maximum of 50 centimeters of lengths and a cross-section of 2.5mm. Fitting cables may be ordered through us, BDS. Mind well fitting contacts when connecting.

We recommend to use cables with security plugs for connection of batteries in order to prevent short circuits. If other plugs without insulation are used, the cables have to be connected to the *curatio* at first and then to the battery.

The battery blocks must be connected in the way, that the plus and minus of the batteries are always plugged in the "+" and "-" socket of the same channel. No external interconnections between different channels must exist.

During the charging of a battery block the mode and the charging current should not be altered. A modification could cause an early switch-off or an overcharging of the battery.

Batteries which have a large internal load should not be discharged by large currents. Because of the voltage drop on the internal load the voltage of the battery drops rapidly and the *curatio* recognizes the battery as being discharged. The measured capacity for charging and discharging than is smaller than the actual battery capacity.

Curatio is made for discharging and charging of battery **blocks**. In case single battery cells are connected to *curatio* it has to be made sure that each cell is having the **same status of charging and the same cell capacity**. That means, the cells have to be selected. If the battery cells of a battery block are having different status of charging, the cells of the battery could be damaged. In the upper case *curatio* might be not able to recognize end of charging characteristics. **Danger of Fire or explosion!**

15 DESCRIPTION OF THE SERIAL INTERFACE

Standard RS232 Connector 9-Pin

Baudrate 9600 bps, 7 databits, even parity, 2 stopbits

Pin 2	receive data	to <i>curatio</i>
Pin 3	send date	from <i>curatio</i>
Pin 4	dtr	from <i>curatio</i>
Pin 8	cts	to <i>curatio</i>
Pin 5	gnd	

Pin 4 and 8 have to be connected together, if the actual measured values should be sent.

When sending the measured values to a printer, pin 8 is used as 'busy' signal.

If this line rise to positive (+V) data will be transmitted. With negative signal (-V) no data are transmitted. Then, *curatio* signals on the display for a short while, that the printer is 'not ready'.

15.1 SERIAL CABLE LAYOUT: *CURATIO* <--> PC

Connector: 9 pins 25 pins.

Pin	2	2
Pin	3	3
Pin	5	7

Connector 9 pins 9 pins

Pin	2	3
Pin	3	2
Pin	5	5

At the 9 pin connector connected pin 4 with pin 8.

15.2 DATA-PROTOCOL-FORMAT FOR MEASUREMENTS

1M11crlf	Transmitted on battery attachment
	Channel-No. 1; Programmed Mode 11
1L1200V125crlf	Channel-No. 1 charged with 1200mA/12,5V
3L0300V056crlf	Channel-No. 3 charged with 300mA/5,6V
2E0850V180crlf	Channel-No. 2 charged with 850mA/18,0V
1LK1500T0130Z08crlf	Channel-No. 1 charged with 1500mAh in 130 min., 8 Cells;
2EK1240T1100Z12crlf	Channel-No. 2 discharged with 1240mAh in 1100 min., 12 Cells;
2Bcrlf	Channel-No. 2, Mode finished
1Acrlf	Channel-No. 1 Battery was disconnected
Wcrlf	Watchdog-Supervision recognized
Tcrlf	Overtemperature detected
Ucrlf	Low supply voltage at 12V main supply usage

The measurements will be send every 12sec. for each channel at which the battery is connected. The measurement will be send only, when using a 9 pin connector and pin 4 is connected with pin 8.

A **PC program** is available which attaches a PC to *curatio*. *Curatio* measurements will be recorded and stored on disc. Graphically the charging and discharging curves may be displayed on screen and printed.

15.3 PRINTING OF BATTERY DATA (FORMATTED AS CHART OR STICKER-LABEL)

The measurements, determined during the charging and discharging, can be printed out. A format of 1) chart of values or 2) self-adhesive labels -which might be stucked onto the battery- can be chosen. The following values -obtains while discharging and charging- will be saved by *curatio*: battery voltage at the beginning of the process, programmed current, measured capacity, numbers of cells and the time for each process.

Printing of these measurements can be done on any printer having a centronics-parallel interface. For the connection between the *curatio* and the printer a special interface cable is required. Printing will be initiated manually by a push-button on *curatio*. The values measured are saved in the *curatio* as long as a new battery will be connected or the instrument will be switched-off.

The printing program will be called by pushing the "CLEAR" key and the "+" key simultaneously. The following message is displayed:

M	e	a	s	u	r	e	m	e	n	t	s				
s	e	n	d		t	o		p	r	i	n	t	e	r	

After releasing these keys the format of printing is asked for:

C	h	a	r	t					P	r	e	s	s		+
L	a	b	e	l					P	r	e	s	s		-

By pressing the "+" key the data will be printed in chart format.

By pressing the "-" key the data will be printed in label format.

By pressing the "CLEAR" and the "ENTER" keys the program will be stopped.

If the printer is not operational, the following message will occur in the display:

P	r	i	n	t	e	r		n	o	t					
r	e	a	d	y											

Will the printer not be operational within the next 5 sec., the printing program will be terminated.

While printing the following message displays:

M	e	a	s	u	r	e	m	e	n	t	s				
s	e	n	t		t	o		p	r	i	n	t	e	r	

15.4 PRINTING STICKER-LABELS

After battery disconnection *curatio* checks, whether pin 4 and pin 8 of the serial interface connector are joint together. If there is no connection and the pin 8 (CTS) positive (connected printer not busy), the battery data will be printed in the label format.

Automatic printing only issues one label for the appropriate channel. Only the most resent values for discharging and charging will be printed.

Chart-format printout

***** b d s GmbH curatio V. 3.0 *****

Channel No.1 Mode 12 Batt.No. _____ Date _____

Charge 5,0V 5,6V 350mA 571 mAh 4 Cells 167 Min
Mode ended

Channel No.2 No battery connected

Channel No.3 Mode 13 Batt.No. _____ Date _____

Discharge 5,3V 3,6V 250mA 446 mAh 4 Cells 114 min
Charge 3,6V 5,8V 250mA 671 mAh 4 Cells 194 min
Mode ended

Channel No.4 Mode 25 Batt.No. _____ Date _____

Charge 11,5V 13,2V 1000mA 1023 mAh 9 Cells 74 min
Discharge 13,2V 7,9V 1000mA 1484 mAh 9 Cells 89 min
Charge 7,9V 13,1V 1000mA 1695 mAh 9 Cells 122 min
Discharge 13,1V 8,1V 1000mA 1492 mAh 9 Cells 90 min
Charge 8,1V 13,2V 1000mA 1698 mAh 9 Cells 123 min
Mode ended

Sticker-Label Format Printout.

For printing self-adhesive computer labels in the format 88,9 x 35,7 mm are required.

```
**** b d s GmbH curatio ****
Channel No.1 Mode 12
Batt.No. _____ Date _____
Charge 5,0V 5,6V
350mA 571 mAh 4 Cells 167 min
Mode ended
```

```
**** b d s GmbH curatio ****
Channel No.3 Mode 13
Batt.No. _____ Date _____
Discharge 5,3V 3,6V
250mA 446 mAh 4 Cells 114 min
Charge 3,6V 5,8V
250mA 671 mAh 4 Cells 194 min
Mode ended
```

```
**** b d s GmbH curatio ****
Channel No.4 Mode 25
Batt.No. _____ Date _____
Charge 11,5V 13,2V
1000mA 1023 mAh 9 Cells 74 min
Discharge 13,2V 7,9V
1000mA 1484 mAh 9 Cells 89 min
```

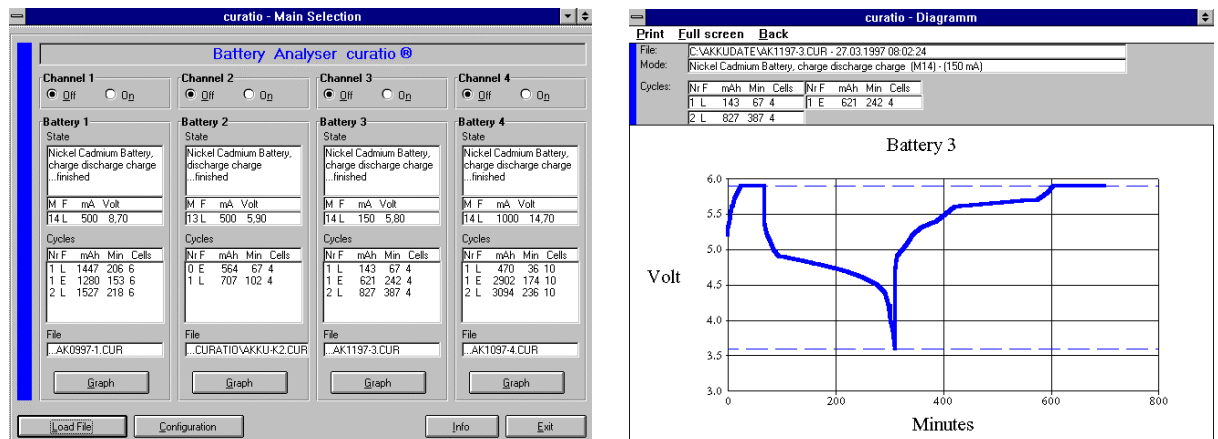
```
**** b d s GmbH curatio ****
Sticker-Label No. 2
Batt.No. _____ Date _____
Charge 7,9V 13,1V
1000mA 1695 mAh 9 Cells 122 min
Discharge 13,1V 8,1V
1000mA 1492 mAh 9 Cells 90 min
```

```
**** b d s GmbH curatio ****
Sticker-Label No. 3
Batt.No. _____ Date _____
Charge 8,1V 13,2V
1000mA 1698 mAh 9 Cells 123 min
Mode ended
```

16 PC PROGRAM FOR CURATIO® BATTERY ANALYSER

curatioWIN

The *curatio*WIN is a program allowing the data of a battery charging/discharging process to record on a PC. The data will be displayed on the PC screen (charts or graphic) and may be printed as well.



System Requirements:

PC processor 486 or higher
Windows 3.1, Windows95 or NT
Storage Memory at least 8Mb
Free space on hard disc at least 1 Mb

Installation of curatioWIN

Insert floppy disk 1 and execute the program „SETUP.EXE“. The program, then, will be installed in a directory named „curatio“. The directory name can be altered during installation. The file AKKU_K2.CUR holds a sample of a Discharging/Charging curve of a battery.

Operating curatioWIN

After starting curatioWIN an Information window is shown. Hitting the OK button will lead to the main window allowing function selection. COM2 is the default preset (done within CURATIO.INI file) for the serial communication port. In case COM2 is used else, a user dialog requests to change the COM port to a different selection within COM1 to COM4. The COM selection can be done within the main selection window as well by operating the button „Configuration“. The selected settings are stored in the CURATIO.INI file.

After start of curatioWIN the four channels are switched off. Recording of curatio data starts by operating the „ON“ button in window „Channel“. The program then will show a default file name. In case the file is already present, the file may be overwritten or a new file name may be chosen. The default file name may be altered in CURATIO.INI.

Important!! Recording of complete data requires the following sequence of operation: „Switch on the channel at first, and , after that, connect the battery to the curatio“.
In case the battery is connected first, the information of the programmed mode is missing. However, the battery data are recorded as well.

curatio continuously is sending measurement values to the PC. Those data are not stored in the battery charger. In order to record complete data, the program must be running permanently.

Operating the button „Load File“ loads battery data which have been stored in a file before. The measurement values are displayed in the channel of their recording. Charging files requires the corresponding channel to be switched to „OFF“.

After switching on a channel or after charging a file, the battery data are displayed in the window „Battery“. The window „State“ displays the programmed mode and type of battery. Completion of charging is shown by the message „...finished“ in the state field. The „Cycle“-window shows the No. of the cycle, the function („E“ for discharging and „L“ for charging), the measured capacity, the time for charging and discharging and the number of cells.

Operating the button „Graph“ displays a graphical chart of the battery data. All cycles of charging and discharging are displayed. The menu item „Print“ allows printing of the diagrams. The curves within the diagrams are actualized throughout measurement in a time interval of 60 seconds. Menu item „Back“ changes back to the main selection window.

Recording of data is terminated by exiting the main selection window. Ending is also achieved by operating the button „Off“ in the window „Channel“.

Files which have been recorded by the DOS version of the PC software are also loadable by *curatioWIN*. In case the files were recorded by a software version below 3.0, the status information is wrongly displayed. Other data are valid.

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