ZEPIA Energy ApS

Programmable Battery Chargers
USERS MANUAL

For chargers with the firmware versions from v2.10

Ver.: 08/2006

ZEPIA301, ZEPIA601 and ZEPIA1001
Battery Charger Families

Microprocessor controlled, continuous duty,
fully programmable, multi-stage battery charger and battery monitor

Batteries have to be properly charged to achieve long term reliability. The ZEPIA301, 601 and 1001 charger families are fully programmable accordingly to the battery manufacturer charging specifications. The parameters may be set in the factory or in the field through a unique PC interface over the charger battery output leads. Through the same interface not only the charging parameters but also a lot of other information is accessible like: charged amp-hours for the last 32 chargings, charging times, error information, voltages at which charging has been started etc.

PRODUCT FEATURES:

- **Fully automatic operation**
  Charger may be left permanently attached to the batteries. It takes care about battery charging and also monitors the charging process.
- **Completely programmable:** Nickel-zinc, Lithium, NiCd, NiMH or lead-acid (flooded, sealed and traction) batteries may be charged accordingly to battery manufacturer specifications. Up to **five charging phases** may be enabled to charge the battery with constant current, constant voltage or floating charge. For each of the charging phases a **lot of parameters** may be set as: max. current and voltage, max. charging time for that phase etc. (see example). Each charging phase (except the first one) may be conditionally executed after a defined number of Ah put into the battery or after a defined number of completed 1st charging phases. The fully automatic **equalization** charging phase is achievable with standard parameter set-up and may be executed after every completed charging or after pre-defined number of chargings or charged Ah's.
  Programmable **automatic top-up cycle** prevents self discharge during non-operational periods - charger starts charging after a pre-defined number of days or when the battery voltage is lower than the parameter value. The charger is fully re-programmable without opening the box. The software for the PC and a Z3610IF adapter is all what you need.
- **Battery monitor and Ah counter**
  This charger is also a battery monitor at no additional cost. It collects data about how the battery has been charged:
  - total number of charging starts and total number of connections to the battery,
  - at what battery voltage the charging has been started – frequent deep discharges can be monitored: 16 voltage windows between 18 and 24V (24V charger) or between 36 and 48 (48V charger),
  - total Ah charged (has the battery pack been used a lot or not) - for each charging phase Ah counting may be separately enabled (for example: Ah are not measured for the floating charge)
  - for each charging phase Ah counting may be separately enabled (for example: Ah are not measured for the floating charge phase),
  - how many Ah have been put into the battery during the last 32 chargings (Ah counters tell you if the battery capacity degrades or if the battery has been properly charged and also how the vehicle has been used), measurement of the charging time for the last charging (each charging phase separately) and for all chargings together.

  This data may be accessed trough the same PC interface as for the charger parameters.
- **High precision**
  Every charger is factory calibrated - no additional user calibration is necessary. No potentiometers or other movable parts are used, therefore no vibration or corrosion problems for chargers built into the vehicles.
- **Temperature compensation**
  The charger adjusts the charging voltage to compensate for the battery temperature, providing an accurate charge in any climate. A low cost external battery temperature sensor may be used to monitor battery temperature. The battery temperature monitoring and voltage compensation can be enabled for each charging phase separately and set separately (two different values) for the main charging process and for the trickle charge
- **Battery status LED indicators**
  Three LED's (Error, Charging and 100%) display the executed charging phase, completed charging, float charge. Charging LED is user programmable.
- **Compact size, low weight, ruggedized construction and maintenance free operation**

1. PC Software Package KOP

1.1. **System requirements**: The software tool runs on the standard PC or notebook under operating systems from Windows ’95 to Windows ’XP. It allows the modification of battery charger parameters and the insight into all the information that the charger saves during operation. The software is always delivered together with the PC interface module. This is an adapter that is put between the battery and the charger and is connected to the PC serial port (COM1 .. COM8). The same PC interface can be used for all versions of the programmable chargers.

The software is delivered on a CD or by e-mail. Updates are distributed by e-mail. The files are delivered as a self-extracting ZIP file. See the installation instructions below.

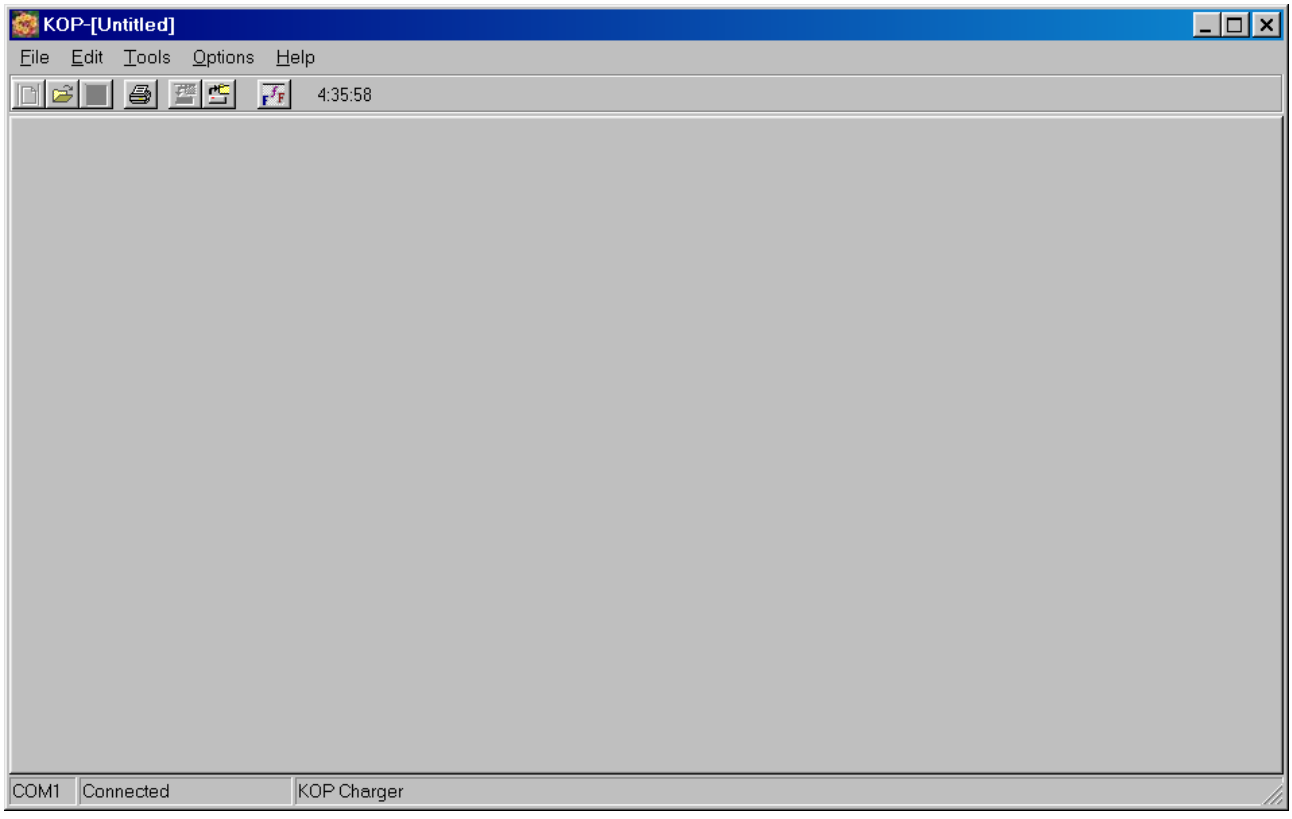
In the DATA folder are always some sample parameter files (files with the extension .K61). When the software is started the first time the “File Open” function will always start inside of this folder. For many battery types ZEPIA or charger distributors already have parameter files, made according to the producer’s references..

1.2 Installation instructions

See the INSTALL.PDF file which is distributed together with the software (on the CD or inside of a ZIP file sent by e-mail).

1.3 First start

The following screen appears after the charger is connected to the PC interface and the PC interface is connected either to the battery or power supply. The energy for the PC interface and for the charger comes



from the battery or power supply. The charger should not be connected to the 230V voltage while it is connected to the PC interface.

If the communication with the charger has failed, the following things must be verified:

1. Is the PC-interface properly connected to the battery (is the polarity OK)?
2. Is the charger properly connected to the PC-interface (look at the label on the box)?

NOTE:

A 24V power supply can be used instead of the battery to power the PC interface for all charger versions (from 12V to 36V). For some 48V chargers a higher voltage may be necessary.

The software can also be used without being connected to the PC interface and the charger (to modify or edit the parameter file, for example).

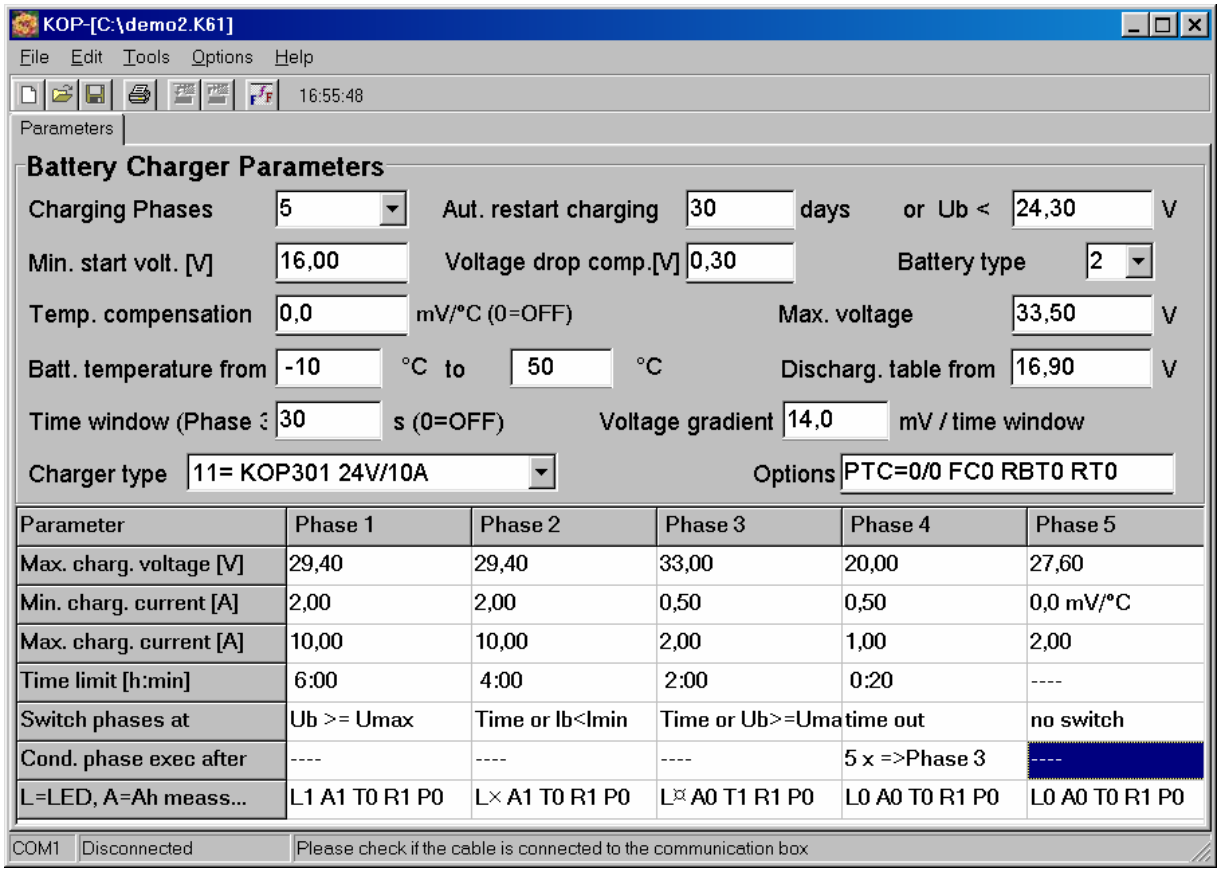
The software should not be started from a write protected medium like CD-ROM or write protected Flash disk. If this will be done, then the charger parameters may be transferred and inspected. However, other data read from the charger (Ah, Status) are not displayed correctly.

ICONS AT THE SCREEN AND THEIR MEANING

Icon	Shortcut	Description of the command
	<Ctrl-N>	A **n**ew parameter file (NEW.K61) with the default parameter values will be opened
	<Ctrl-O>	**O**pen the parameter file
	<Ctrl-S>	**S**ave the modified parameter file (or parameters loaded from the charger) to disk. (may be used to save status / Ah counters to the file also)
	<Ctrl-P>	**P**rint the contents of the currently open window (Parameters, Ah counters or Status)
	<Ctrl-R>	**R**ead the parameters from the charger. This option is available only if the charger is connected to the charger. **Important:** The charger always load complete data from the charger (parameters and all other information which the charger collect). If the file is saved to the disk, then all of this parameters are saved. Thus the complete information file from the charger can be sent to the supplier for the analysis (for example by e-mail).
	<Ctrl-W>	**W**rite parameters to the charger. If many chargers have to receive the same parameter file, then this can be accomplished quickly by loading the parameter file first and then just pressing the <Ctrl-W> key combination (or clicking on this button) after the new charger is connected to the PC interface..
		Selection of the font type and size. This fonts are used in the text windows (Ah counter / Status). At the moment the proportional fonts are not fully supported. We recommend the use of non-proportional fonts like "Courier New".

Description of parameters

ZEPIA chargers are fully programmable. All the parameters can be set either by the producer or by authorized personal. An example of the charger parameters is shown bellow.



This example was chosen to show the most important parameter options. These are not actual parameters for a specific type of battery.

The parameters may be loaded from the charger (start this command with "Tools ⇨ Read the parameters from the charger" or use the appropriate button) or from a file ("File ⇨ Open").

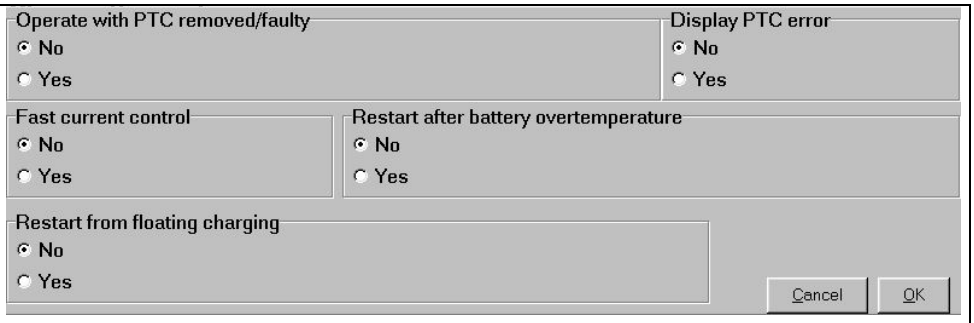
Name	**Description**
Charging phases	Number of charging phases (1…5)
Aut. restart charging __ days or Ub<__	If charger is permanently connected to the battery and supplying mains, this parameter defines, when the charging is automatically restarted.
The following parameters are valid for all charging phases	
Min. start volt.	If the voltage, in the beginning of charging process, is lower than this value, the charger does not start. This function prevents that a charger could not overcharge a battery with a lower nominal voltage (for example 36V charger connected to the 24V battery).
Voltage drop comp.	With this parameter the voltage drops between the charger output and battery terminals are compensated. If the parameter value is equal to zero, the charger voltage is not increased to compensate the voltage drops. If it has a specific value

	the charging voltage will be increased for this specific value (at charger, not at battery) if the charge current has nominal value. If the charge current is lower, the charge voltage will be increased lower. To set this parameter correctly, the maximal possible charge current must be set and up to the battery voltage, at which battery are measured to the point of end charge voltage. This point is reached when charge current starts to decline. For this parameter set the value of the voltage drop between the charger output and battery terminals. This function is very useful when charge cable is longer. When charge cable changes (length or diameter or connector) change properly this parameter. Many customers use the programmable chargers in similar conditions (for electric vehicles for example). Optimization of parameters is recommended to get the best performance. This optimization procedure is to made only once, and store in the parameter file. This file can be loaded into other chargers working in similar conditions (using PC and PC interface). **Warning:** Use only calibrated instruments, especially for the battery voltage measurement. Consider that most battery types are very sensitive to overcharging.
Battery type	After the charger has been connected to the battery, the red LED flashes as often as this parameter has been set. Many customers use more than one battery type. To make a clear distinction, which charger has been set for which battery type, this parameter can be set differently for different battery types.
Temp. compensation	The value of this parameter indicates how much the charging voltage will be increased or decreased, if the battery temperature changes for 1 ºC. Please consider that battery manufacturers specify the value for one cell only and that, for example, a 12V battery has 6 cells. Here the total value (for all cells together must be entered) If this parameter is equal to zero, the temperature compensation is switched off. In this case the temperature sensor does not need to be connected. The value for trickle (maintenance) charging phase is set separately and this value also has to be zero, if the temp. sensor will not be connected.
Max. voltage	This parameter is used only during the active temperature compensation. It defines to which voltage the charger can increase the voltage due to temperature compensation.

Batt. temperature from ___ ºC to ____ ºC	The battery temperature at which the charger is allowed to operate. If the measured battery temperature is not within this range, the charger stops charging (and increases the error counter). After some time elapses the charger checks if the temperature is within this range and restarts operation (if temperature is within range).
Discharg. table from	The charger stores information about the value of battery voltage when the charging is started. The chargers have 16 counters for 16 voltage windows (See the Appendix 2: second example – "Number of charging starts accordingly to the state of battery voltage"). If the value of the battery voltage is within one of this windows at start of the charging, then the belonging counter is incremented by one. If many counters at lower voltages have larger values then the battery has been not treated properly by the user (deeply discharged too often). It is well known that the battery voltage quickly (within seconds) recovers to a normal value (>12V for lead-acid battery with 12V nominal voltage) after the load is switched off, if the battery has not been deeply discharged. Deeply discharged, already damaged or too old batteries, may never reach normal value after the load is switched off.

NEW Time window and Voltage gradient	The charger can detect if the battery voltage growth has slowed down enough (low positive voltage gradient) or is already falling fast enough (high enough negative voltage gradient). Slow voltage growth (or falling) is for most battery types an indicator that the battery is almost full. The parameter "Time window" defines how many seconds the battery voltage will be measured (middle value). If the difference of values from two consecutive time windows differs more than the value of the parameter "Voltage gradient", then the charger will switch to the following charging phase. This condition can be freely combined with the other – see the description of the parameter *"Switch phases at"*. Remarks: 1. If a value of zero will be entered for the parameter "Time window" then this function will be disabled. 2. If a positive value of the voltage gradient will be set, then the charger will switch to the next charging phase if the voltage increase per window is small enough or negative. If a negative value of the voltage gradient will be set, then the voltage must decline faster as set with the parameter. 3. The voltage gradient detection is limited to the third charging phase. 4. The parameter "Time window" can be set in two second increments (min. 20 s and max. 500 s). 5. Only discrete values can be set for the parameter "Voltage gradient". The entered value will always be "rounded" to the nearest possible value.

NEW: Options



The following options can be set:

a) Charging without temperature sensor
If the battery temperature compensation is selected with the parameters, then the charger will display an error if the battery temperature sensor will not be connected or fails. If this option will be selected the charger will charge also if the sensor will not be connected as if battery temperature would be 25°C.

b) Display battery temperature sensor failure
If the battery temperature compensation is programmed, the temperature sensor is not connected (or fails) and the option *"Charging without temperature sensor"* is selected, then it may be selected (with this option) if the charger should display an error or not. The error is displayed with red (ERROR) LED blinking every four seconds. This blinking may be suppressed with this option.

c) Fast current control
If the charger is used as a power supply also, then the charger has to react quickly if a big consumer is switched on. If a relatively small battery is being charged, then the battery voltage would fall if the charger would not delivery current very quickly after the load is switched on.
IMPORTANT: Do not switch this option on for normal charging since the current control may not be so accurate as with the normal current control.

d) Automatic restart after the battery cools down
If for example the vehicle is exposed to direct sunlight during charging, the battery may be very hot and the charger will switch off charging. If this option is selected, then the charger will automatically restart charging after the battery cools down.
If the NiCd or NiMH Batteries are being charged, then overheating signals that the battery is full or that the voltage gradient detection was not able to detect the full condition (for example if one or more cells failed). In such case charging must not be restarted.

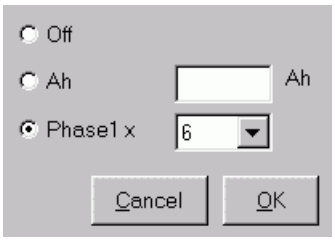
e) Restart from the trickle charging phase
If the charger is permanently connected to the battery and 230V and there is also a larger load which may be switched on during charging, then this option should be selected. The charger will automatically restart the charging then from the first charging phase after the voltage in the last (trickle charging phase) will fall under the value set with *"Aut. restart charging ___ days or Ub < _____ V"*.

The following parameters must be set for each charging phase separately:	
Max. charg. voltage	The maximal output voltage of the charger. When the battery voltage reaches this value, the charging current is reduced as far as necessary. If the temperature compensation is active, the charging voltage is equal to the value of this parameter only at 25ºC. If the battery temperature is higher than 25ºC, the charging voltage is consequently lower, and increased if the temperature is lower. **NEW: PAUSE during charging**: 1. Some of the charging algorithms need a so called resting charging phase where no current flows into the battery for some hours. A charging phase will be a pause if the charging voltage will be set to the minimal value (for example to 20V for a 24V charger). In such charging phase will the charger switch off completely (including the Relay and LED's) for the time defined with the parameter *"Time limit"*. After this charging phase will the charger continue charging in the consecutive charging phase. The pause is used for example for lead acid batteries: between normal charging phases and floating charging. 2. If the charging phase is used as pause, then parameter *"Cond. phase exec after"* has the following meaning. It defines how many times the previous charging phase will be repeated. In other words: how many times the charger will jump from the current charging phase (pause) to the previous charging phase. This function can be used for example for the so called "Autobalance" function – equalization of many batteries/cells connected in series.
Min. charg. current	This parameter is used only if the charging phase should be terminated, when Ib<Imin (see the description bellow) Otherwise, the parameter has no meaning. In the so called trickle charging phase (Switch phases at = No switch) this parameter represents the value of temperature compensation for this charging phase. For all other charging phases, the main parameter for the temperature compensation is active.
Max. charg. current	This is the maximum output current that the charger can provide. This value is reached only, when battery voltage is lower than set with the “Max. charg. voltage” parameter.
Time limit (h:min)	Max. duration of charging time (hours : minutes). This parameter can be used in two different ways. If this parameter is not used as time switch for the next charging phase, the charger switches off and reports an error (Time out). If this parameter is set as time switch for the next charging phase, on “Switch phases at”, then the charger just switches the phases when this time elapses. If the environment temperature is very high or the cooling fan is disabled, the

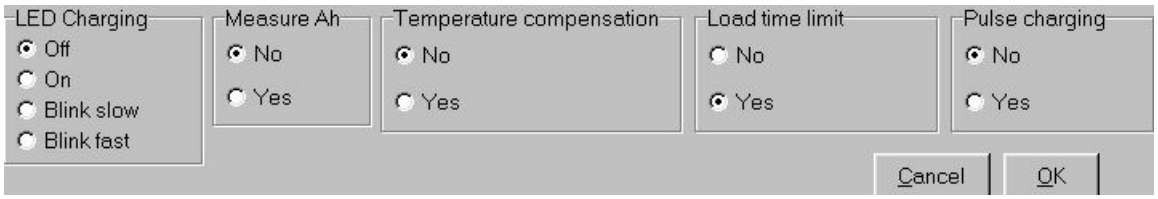
<table>
<tr><td></td><td>charger reduces the current. The maximal time duration is then extended accordingly.

NEW: This Parameter has a different meaning for pulse charging – see the description in the chapter "PULSE CHARGING".</td></tr>
<tr><td>Switch phases at</td><td>The following criteria can be selected for the termination of a charging phase. The charger switches to the following charging phase or switched off after the last charging phase.
<table>
<tr><td>Ub >= Umax</td><td>The battery voltage must reach the voltage set by this parameter.</td></tr>
<tr><td>Ib < Imin</td><td>The battery current must be reduced under the minimal min. charge current, determined by this parameter.</td></tr>
<tr><td>Time out</td><td>The determined time duration must pass over- by the charging phases, where it is necessary</td></tr>
<tr><td>No switch</td><td>No switch of charging phases. This parameter is used for trickle (maintenance) charge.</td></tr>
<tr><td>T+Ub>=Uma x</td><td>It is switched over, after the time T or when the battery voltage reaches the voltage determined by this parameter.</td></tr>
<tr><td>T+Ib<Imin</td><td>It is switched over, when the time T passes over or when the battery current drops under the minimal value, set by this parameter.</td></tr>
</table>
NEW: For the third charging phase an additional "switching" condition may be set. See the description of the parameters "Time window" and "Voltage gradient". This condition may be freely combined with the above shown conditions.

By many chargers two charging phases must be set separately. At the beginning the charging with constant current is executed, until the certain voltage is reached, then this voltage must be kept, until the charging current drops to a certain value.
For the ZEPIA programmable chargers this can be set with a single charging phase. With the parameter "Max. charg. current" the maximal charge current is set and with the parameter "Max. charg. voltage" the charge voltage which must be reached.
The charging phases for constant current and constant voltages must be set separately only, if battery producer defines the max. charging duration for each charging phase separately.</td></tr>
</table>

Cond. phase exec after	In the first charging phase there are no conditional settings. It means that the battery is always charged until ca.80%. In the following charging phases up to 20 repetitions of the available charging phase can be selected or the next phase can be conditionally executed after a defined number of Ah put into the battery.  NEW: 1. If a certain charging phase is programmed as a pause (max. charging voltage set to the minimal value) then this parameter has a different meaning. If it's value is larger than one, then it defines how many times the charger will jump back into the previous charging phase after the pause is finished. 2. This parameter has a different meaning for pulse charging. See the description of the parameter in the chapter "PULSE CHARGING".

The following functions can be switched on or off for every single charging phase:



`L` = LED	**L1** - LED is switched ON **L0** - LED is switched OFF **Lx** - LED flashes slowly **L☼** - LED flashes fast Usually the LED is set as in the following example: • it is ON in the first (or first two) charging phases(s) when the most of energy is charged into the battery • flashes slowly in the charging phase where the battery is quite full, • flashes fast for the equalizing charge and • is OFF for the trickle (maintenance) charge.
`A´ = Ah measurement	It can be switched on or off for every charging phase. **A1** = Ah measurement switched on, **A0** = Ah measurement switched off
`T` = temperature	Compensation of battery voltage accordingly to battery temperature can be switched on or off for every charging phase. **T1** = temperature compensation switched on **T0** = temperature compensation switched off
`R` = reload time limit counter	**R0** – The charging time out counter is not reloaded with the new value – the remaining time from the previous phase is used. For example in the second phase a duration period of 5 hours was programmed and only 3 hours charged. In that case the max. duration time for the next phase is 2 hours. In this way the different charging phases can be fit together or be together limited in their duration. **R1** – the time limit is set separately for this phase.
`P` = pulse charging	**P0**- charging with constant current **P1**- charging with current pulses. See the description of pulse charging in the chapter "PULSE CHARGING".
NOTE: Fan speed always depends on charging current and ambient temperature. The fan speed control can not be switched off as before.	

PIN CODE

For using all of the functions, a pin code is necessary. Without the correct pin code some functions like: changing charger parameters and erasing of various data stored by the charger are disabled. A user without pin code can only inspect the parameters/data, but not change them.

Please open the "Help ⇨ About" and then enter the pin code in the bottom field..

New: **PULSE CHARGING**

Many research has been done on charging batteries with current pulses. It has been shown that battery life in traction and similar applications can be increased if charging is done with pulses - especially in the last charging phase(s). It is now possible to program pulse charging for the every charging phase with the exception of the first one. If pulse charging is programmed then the charger will charge with the programmed current for example for 16 seconds and then make a pause for 12 seconds.

Pulse charging is programmed as following:

1. In the charging phase, in which pulse charging is required, must be selected with the option 'P=1" in the parameter table *"L=LED, A=AH meass..."*.
2. The parameter *"Time limit"* has a new meaning here. The values are displayed as in the following example:

   ⇧ 16 ⇩ 12

   The first number (**⇧16**) defines how many seconds the current should flow and the second number (**⇩12**) defines for how many seconds the current will not flow after this.
3. Maximal number of pulses: This sequence will be repeated for as many times as defined with the parameter *"Cond. phase exec. after"*.

   The maximal time of this charging phase can be calculated as:

   Max. time = number of pulses × (ON time + OFF time)

   This time is used instead of the usual time limit defined with the parameter *"Time limit"*.

   The charger will display an error if this time limit will be reached and time was not selected as one of the conditions to switch into the consecutive charging phase.

   Maximal number of pulses that can be set is 4320. The value 0 is equivalent to 65535 iterations if longer sequences are necessary.

Notes:

a) The last pulse will not be completed if the condition for switching to the consecutive charging phase is fulfilled – for example if the battery voltage reaches the maximal value and the condition has been set to "Ubat > Umax".

b) Pulse charging can not be combined with voltage gradient detection.

Trickle charging: pulse charging can be used for trickle charging also. The number of pulses has no meaning in such charging phase (switch phases condition = 'no switch').

LED charging: The LED will be switched on when the current flows and off when the current does not flow. The LED Charging should be programmed as ON (L=1) during pulse charging phase, otherwise the current pulses will not be displayed properly.

Please, consider the following issues, when parameters setting parameters

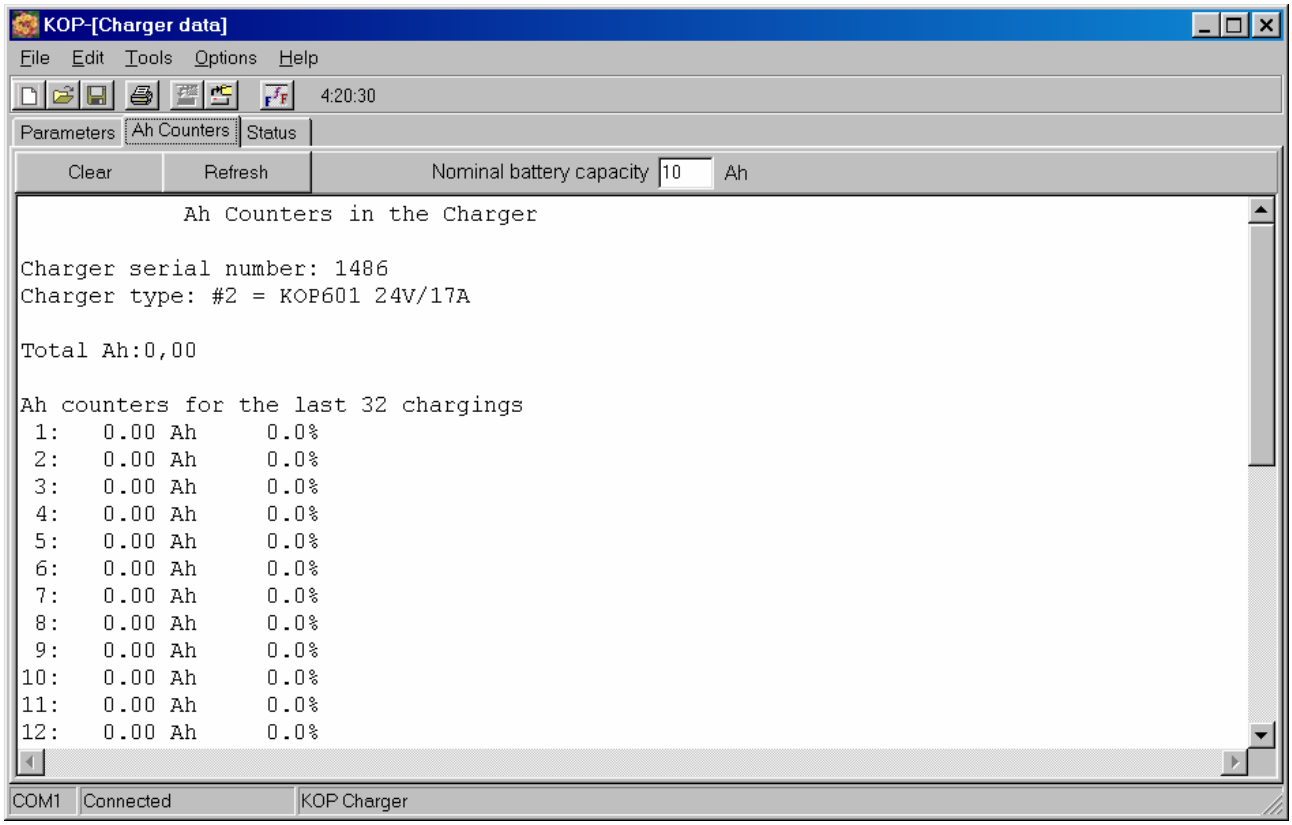
1. The max. output power of the charger is limited. The output power = current x voltage can not go beyond the defined max. power value of the charger. The software informs via error message, if the false parameter are saved on the hard disk or transferred into the charger.
2. Please, consider the battery manufacturer charging recommendations. The life of batteries can be shorted, if the parameters are not set correctly. If batteries are used in a very wide temperature range, the temperature compensation for the most batteries is recommended or even prescribed by the battery manufacturers.
3. The battery temperature sensor should be preferably be mounted to one of the battery terminals. Attachment to the battery housing or even just measurement of ambient temperature does not give very accurate results.
4. The charging voltage is measured at the charger output. Because of the voltage drops on the cables, connectors and battery terminals, the battery voltage is always a little bit lower than it has been set. Particularly at long battery cables and large charging currents the voltage difference should not be neglected. We do not recommend to increase the charging voltages accordingly to the voltage drops, since the battery could be overcharged at the end of the charging phase when the charging current is smaller and the voltage drop also. The better choice is the correct setting of “Voltage drop” parameter. With this parameter the total voltage drop at maximal charger current is set (for example at 17A for 24V/17A charger version). For a specific application this has to be done only once and then the parameters have only to be transferred to other chargers used in the same application.

   Some chargers use four wires to compensate for the voltage drops on the cables. We have selected the software compensation, since it is simpler, cheaper for the end customer (less wires, simpler connectors), and also more reliable.

Appendix 1: Ah display

The charger saves also information about the number of Ah put into the battery for the last 32 chargings separately and total counter for all chargings. If the customer has problems with the battery, then it is possible to find out how the battery has functioned during the last month (if for example the battery has been charged once each day). With additional information, how the battery has been charged (information if the single charging phases were completed) or how the battery was discharged (perhaps discharged to much).

The following screen will be displayed after the [Ah Counters] option is selected in the menu.



Appendix 2 – Error and time – display

The following data will be displayed in the [Status] window after this option will be selected in the menu.

```
CHARGER TIME AND ERROR COUNTERS

Charger serial number: 1486
Charger type: #2 = KOP601 24V/17A

Software version: 2.10

Parameters modified by: #255

Total number of charging starts: 0

Phase  Completed chargings  Total time [hours]     Last charging [hours]
  1              0                0:00                  0:00
  2              0                0:00                  0:00
  3              0                0:00                  0:00
  4              0                0:00                  0:00
  5              0                0:00                  0:00


Number of charging starts accordingly to the state of battery voltage
        Ub <= 17,50:   0
17,50 < Ub <= 18,05:   0
18,05 < Ub <= 18,60:   0
18,60 < Ub <= 19,15:   0
19,15 < Ub <= 19,70:   0
19,70 < Ub <= 20,25:   0
20,25 < Ub <= 20,80:   0
20,80 < Ub <= 21,34:   0
21,34 < Ub <= 21,89:   0
21,89 < Ub <= 22,44:   0
22,44 < Ub <= 22,99:   0
22,99 < Ub <= 23,54:   0
23,54 < Ub <= 24,09:   0
24,09 < Ub <= 24,64:   0
24,64 < Ub <= 25,19:   0
        Ub >  25,19:   0

CHARGER ERROR COUNTERS

     0 x #1  "Charger temperature sensor failure"
     0 x #2  "Charging time-out"
     0 x #3  "Battery temperature sensor failure"
     0 x #4  "Charger heat sink temperature too high"
     0 x #5  "Battery voltage too high at start"
     0 x #6  "Battery temperature too low during charging"
     0 x #7  "Battery temperature too high during charging"
     0 x #8  "Charger disconnected from battery during charging"
     0 x #9  "Bad parameter checksum"
     0 x #10 "Bad current measurement offset value"
     0 x #11 "Bad parameter or working variable value"
     0 x #12 "Current does not start to flow"
     0 x #13 "Charging current too high (current limiting problem)"
     0 x #14 "Charging current too high (current control problem)"
```

For each charging phase it is counted, how often the phase was completed. So it can be found out, how the battery is charged by a customer.

The charger saves information about the errors which have occurred during charging. Each time the error occurs the corresponding error counter is incremented by one (up to max. 255). The charger tries to restart charging after a while and if the same error occurs again during restart, the error counter is not incremented once again.

Appendix 3 – Error messages

No LED lights or blinks after connection to the battery and mains.	<u>The following things have to be checked first:</u> 1. Battery connections and cables 2. Mains (230V) connections and cable 3. Is 230V present in the socket 4. Battery voltage (it's value must be higher than the value of parameter "", otherwise the charger is not allowed not start)
Error LED is blinking *2 seconds pause / N x flashes*	N = Number of consecutive LED flashes shows the error number. See the following table for the explanation of errors.

E R R O R M E S S A G E S	
Light signals	**Description**
1	Charger temperature sensor failure *Internal error*
2	Charging time-out *Battery charging has not been completed in the (with the parameter) defined time. This happens for example in case of shorted cell or due to battery aging.*
3	Battery temperature sensor failure *Battery temp. sensor not connected, broken wire to the sensor, problem with the connector,...*
4	Charger heat sink temperature too high *Fan openings covered, ambient temperature very high, charger exposed to direct sunlight, ...*
5	Battery voltage too high at start *Charger has been connected to wrong battery. For example 24V charger to 36V or 48V battery. Please consider that connection of a charger to a battery with over 50% higher voltage may damage the charger.*
6	Battery temperature too low during charging *See below*
7	Battery temperature too high during charging *The battery temperature was not inside the (with parameters) defined window. After the battery cools down (or heats up) to normal temperature charging continues.*
8	Charger disconnected from battery during charging *Always the mains (230V) plug should be pulled out before the charger output plug.*
9	Bad parameter checksum *The parameters should be transferred once again to the charger.*
10	Current measurement offset too high/low *Internal error*
11	Bad parameter or working variable value *If this error does not disappear after the parameters are transferred to the charger, the charger manufacturer has to be contacted (send the parameter file downloaded from the charger).*
12	Current does not start to flow *Internal error*
13	Charging current too high (current limiting problem) *Internal error*
14	Charging current too high (current control problem) *Internal error*