Document no.
99-99-111

MTM

Technical description

CONTENTS

1 INTRODUCTION

1.1 About this description

These instructions are aimed primarily at trained staff and describe how to handle a standard MTM in a standard application.
For special areas of application, such as AGV charging, please see separate documents, which describe the charge curves and functions used in these special cases.

1.2 Installation and commissioning

See the user manuals for the respective chargers. The charger is normally supplied set for the battery type indicated in the order.

1.3 General information on MTM

Charger type MTM is a fully automatic charger designed for charging all types of battery with a system voltage from 12 V up to the charger's rated voltage, and with great variations on ampere-hours.

This charger is able to charge and provide constant trickle charging of both tractionary and stationary batteries. Charging can be optimised for every type of battery and all kinds of operating conditions. With the guidance of a programmed charge curve, the charger's computer constantly calculates the optimum charge power and monitors charging from start to finish.

Voltage, current, charged Ah, charging time, etc. can be viewed in the display using the keyboard.

Faults are indicated by means of one or more flashing LEDs, as well as error messages in the display.

The MTM comes with a real-time clock with battery backup which indicates the precise setting of delayed charging, weekly charging, etc. Important events such as the start of charging and abnormal cutoffs are logged with a time stamp, which facilitates later servicing.

Statistics for the last five charges and information on the battery's operating profile are stored in the memory. With the guidance of this information, it is possible over time to implement actions to minimise the risk of repeated deep discharges, etc. which may damage the battery in the long term.

The MTM is supplied with predefined charge curves for the most common freely ventilated and sealed battery types.

2 CHARGE CURVE

The MTM is able to charge in accordance with a number of charge curves so as to suit any battery. A charge curve is often established by the battery manufacturer and consists of various elements, such as constant current, constant voltage, pause, etc., as well as the parameters, which control the various elements.

Changing the parameters which control current, voltage and charging times can give different charging properties, such as a shorter charging time or very low maintenance requirements. Your requirements should be discussed with the battery manufacturer before making any changes to the charge curve. Inappropriate settings may shorten the service life of your battery.

The MTM has functions for easily setting a number of predefined charge curves for most battery types on the market.

2.1 The various phases of the charge curve

See also the figure in section 2.2 and the description of parameters in section 3.7.2

A Pump phase (all three LEDs flash and the error message "low dc voltage" is displayed)

This charging phase appears in most charge curves. This phase starts if the battery's back voltage is more than 6 V but less than the lower start limit. This occurs in the event of deep discharges due to too high a capacity drain.
Charging takes place with the I3 current up to max U3 voltage over approx 2 min. Then charging pauses for approx. 10 s, during which time the back voltage is measured. If the back voltage exceeds the voltage level Ug, the phase is terminated and the next charging phase starts. If not, another 2 min charging phase begins. This goes on until the approved voltage is attained. This function can be activated/disabled using the control register.

B I0/U0 (first yellow LED comes on)

This charging phase is a precharging phase with constant current and constant voltage used when short charging times are required. I0 is often higher than the battery's 5-hour current. The charging phase continues until U0 has been attained and the current has fallen to I1 (the current for the next charging phase) or if the set max time, "max I0 time", has been attained.
This element can be activated/disabled using the control register.

C I1 (first yellow LED comes on)

This is the first charging phase on a normal charge curve. It consists of a constant current I1 until voltage U1 has been attained or the max time, max I1 time, has been attained. The charging phase can also be terminated if the max number of Ah has been exceeded or if the voltage levels out or even drops (battery fault dU).

D U1 (both yellow LEDs come on)

This phase is a constant voltage phase which continues until the current has fallen to the set limit value, "start I2 phase". The switchover to the next charging phase can be delayed using the parameter "Min I1U1 time".
During this charging phase, voltage drops also take place, with the relevant

measurements in order to ensure that correct recharging takes place. This charging phase is terminated if the max time or max Ah has been exceeded or if the current levels out or even rises (battery fault dI).

E I2 (second yellow LED comes on)

This charging phase is also known as “additional charging”. When it starts, just as many Ah have been recharged as have been discharged from the battery. This Ah value is multiplied by the “charging factor normal” factor and the charging phase continues until this value has been recharged. However, this is limited by the time settings “min I2 time” and “max I2 time”. Current and voltage are limited by the parameters I2 and U2.

F Trickle charging (green LED comes on)

Trickle charging normally continues until the battery is disconnected from the charger. There are two types of trickle charging: constant and pulsed. Which type is used is dependent on the charge curve selected.

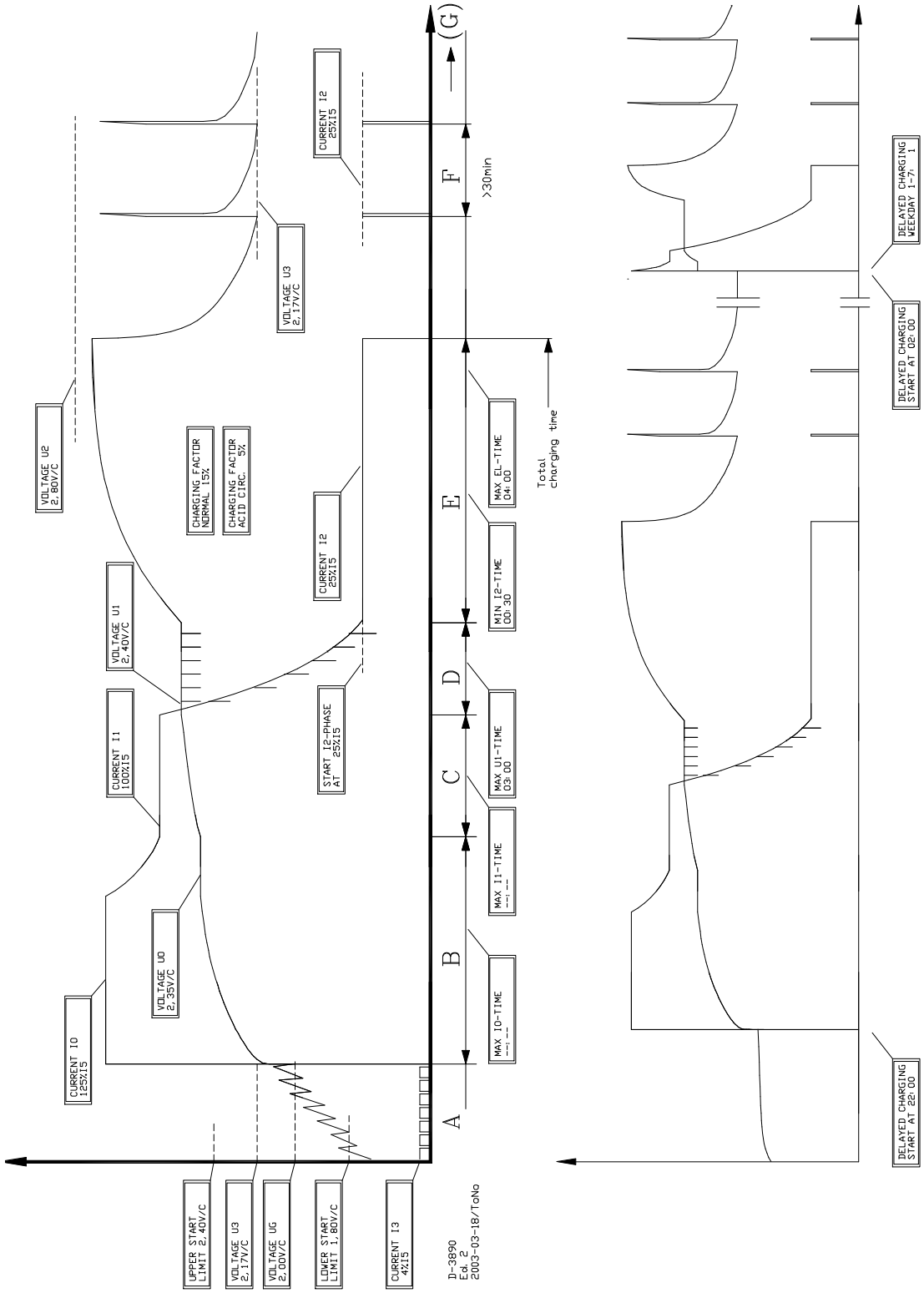
Constant trickle charging indicates – as its name implies – constant voltage U3 (normally 2.26 V/c for this type of trickle charging) with max current I3.

Pulsed trickle charging begins with charging being stopped. When the battery voltage has fallen to voltage U3 (normally 2.17 V/c for this type of trickle charging), a charging pulse, max current I2, max voltage U2, begins which lasts 2 min. Charging is then stopped again. The charging pulses cannot occur more often than once every 30 minutes.

G Equalising charge (green LED comes on)

This charging phase is used mainly in charge curves for sealed lead batteries. It starts after a pause and consists of a low current, I4, with max voltage U4 over a long period. The pause at the start of the charging phase means that it is active only on the rest day which is recommended when sealed lead batteries are used.

2.2 Example of a charge curve and time settings



2.3 Solution to sulphation

If a battery is subject to repeated incomplete charges, the lead sulphate crystals remaining will gradually form larger crystals, which are more difficult to dissolve and do not have time to dissolve during normal charging.

Demands for faster charging, lower energy consumption, reduced water usage and gas production also enhance the risk of sulphation.

A heavily sulphated battery is best charged using a low average current over a longer time. The easiest, most common method is to charge at a current of approx. 0.5-1% of the battery's rated capacity for two days up to several weeks, depending on the degree of sulphation.

Resetting trickle charging on an MTM can allow good results to be attained without you having to invest in new equipment. This is what you have to do:
Select charge curve 10-5. Reset voltage U3 to 2.8 V/c. Set current I3 to 2%. Leave these settings as they are for up to four weeks if you suspect heavy sulphation. Measure the density at regular intervals after full charging. You can continue for as long as the density goes on increasing in any of the cells. Once the cells are equalised or the density is no longer falling, return voltage U3 and current I3 to their normal values.

2.4 Delayed start

To be able to use off-peak electricity, the real-time clock in the MTM can be used to start charging at a time when power is cheap.

If a battery is connected for charging between 13:00 and 23:59, charging will commence only at the time programmed in "Delayed charging". If a battery is connected for charging between 00:00 and 12:59, charging will commence immediately, irrespective of "Delayed charging". This permits lunchtime charging.
The delay is interrupted and charging begins immediately if any of the keys 0-9 is depressed. The * and # keys have no effect on the function for permitting data to be read.

Check that the available charging time is sufficient to charge the battery fully.

If a start time of 0 is programmed, this function is terminated.

2.5 Extra charging

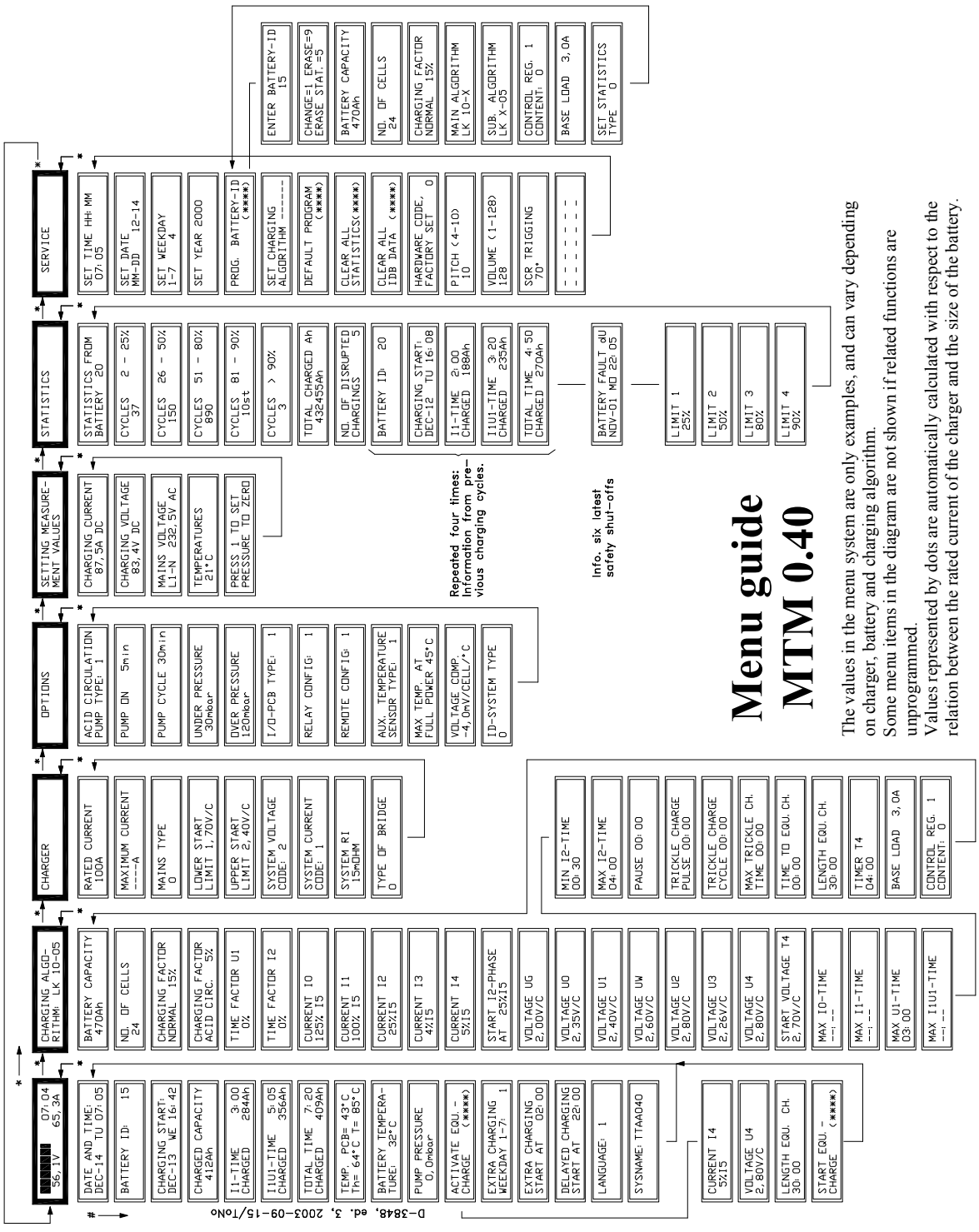
One effective way of rectifying problems with batteries suffering from "that Monday afternoon feeling" is to carry out extra charging, beginning approx. 2 hours before the battery is used.

The time and day are programmed in the "Extra charging" menu displays.
If a start time of 0 is programmed, this function is terminated.

3 READING AND EDITING DATA

3.1 Menu system, overview.

This is only an example. The menu system varies depending on the installed program version.



3.2 Menu system structure

The menu is divided into groups of close functions and data as described in the overview in 3.1.

Use the * button to select a group. A new group will be displayed every time you press the * key. The first one will be displayed again after the last one.

The first screen is the one which normally appears in the display. This screen contains information on the charge current, charge voltage and time.
If there is a fault, one or more LEDs flash and an error message appears in the top line of the display. If a number of faults are registered, these are shown one after the other at intervals of a few seconds. An overview of error messages and suggested action can be found in section 4.7.3.

3.3 Reading data

Select the required group by pressing the * key repeatedly. When the required heading is displayed, press the # key to read data in the group. Pressing * will display the heading once again, and new groups can be selected.

If no key is pressed within one minute, the display will return automatically to the first screen.

3.4 Data protection

Data, which affects charger function, is protected against accidental editing. Write protection is switched off temporarily if the security code **2451** is entered when the first screen is displayed. The correct code is indicated by means of a long tone. This procedure is known as “unlocking” in everyday parlance. Write protection is activated automatically if the keyboard is not used for one minute.

If write protection is active, no data can be entered.

To minimise the risk of damage to the battery or charger, a checksum is calculated for charger and battery data. This checksum is compared with stored data every time the charger is started, and if the information in the memory has been edited during any disruption (such as a thunderstorm), this will result in a checksum error (see section 4.7.3, “C/S error EEPROM”). In such cases, charging does not commence.

3.5 Editing data

Unlock the menu system. Press * until the required heading is displayed. Then press # until the required parameter is displayed. Enter a new value and confirm by pressing #. Data is saved at the same time as the next parameter is displayed. When all changes within the group are complete, press * to return to the heading. Your changes will then be confirmed and a new checksum will be calculated and saved.

N.B.: do not switch off the power while changes are in progress unless you have pressed * first. If you do, this will result in a checksum error (see section 3.4 and 4.7.3, “C/S error EEPROM”).

If no key is pressed within one minute, your changes will be saved automatically, the display will return to the start screen and the menu system will be locked.

3.6 Functions

Some menu screens permit the starting of functions such as the equalising charge function, basic programming, deletion of statistics, etc. One thing all these screens have in common is that they have an input field that looks like this (****). This function is

activated immediately if the security code (2451) is entered, as long as write protection has been disabled by entering **2451** in the first screen.

3.7 Description of the menu groups

This description is relevant for standard programs: additional functions may be implemented in other versions.

3.7.1 General functions in the first screen

- Date and time.
  Displays information directly from the real-time clock.
- Charging start.
  Displays the time when the last charge started.
- Charged capacity.
  This function displays the charged capacity while charging is in progress.
- "I1 time", "I1U1 time" and "Total time" inc. charged capacities in these intervals.
  These screens display simple statistics from various parts of the last charge. If charging is in progress and the relevant charging mode has not finished, the time and ampere-hours are set to 0.
  Corresponding information from the previous four charges is stored under the heading "Statistics".
- Component temperatures.
  Displays current temperatures on: circuit board (PCB), thyristor cooler (Th) and transformer or choke (T).
- Pump pressure.
  Displays the current air pressure if the charger is fitted with an acid circulation pump.
- Activate equ charge.
  Some charge curves contain an equalising charge function. Entering the security code activates the equalising charge function for ongoing charging, the user has the opportunity to edit the voltage, current and length parameters. When activated, the equalising charge function begins after regular charging.
- Start equ charge.
  Using this function allows the user to start the equalising charge function directly instead of it starting after regular charging.
- Extra charging, day and time.
  Programming of the time (whole hours) for the starting of extra charging.
- Delayed start in hours.
  Programming of the time (whole hours) for delayed starting. Permits the use of off-peak electricity.

3.7.2 Charging algorithm

In this group, the parameters are programmed which produce a correct charge curve. The MTM charging program contains a number of charge curves which can be selected using the keyboard. The active curve is displayed in the menu header.

- Battery capacity, no. of cells.
  It is important to specify the battery capacity so that all the current values in the charge curve are adjusted to suit the battery. All currents are specified as a percentage of I5 (the battery's 5-hour current, i.e. Ah/5) or I1 (the battery capacity) depending on the programming of control registers (see below).
  The value in "no. of cells" is used to calculate all charge voltages in the charge curve. These charge voltages are specified in V/cell.

The following parameters are set automatically when you select a charge curve under "Service" (see 3.7.7). These parameters are set at delivery and should only be edited in consultation with the supplier of the battery or charger.
N.B.: not all parameters are used in all charge curves.

- Charging factor normal, charging factor acid circ..
  How much energy has been discharged from the battery is calculated during charging. This value is multiplied by the charging factor, and when 100% of the energy discharged has been recharged, additional charging starts which goes on until the calculated number of Ah have been recharged. The user has the option of programming the charging factor for batteries both with and without acid circulation. With the guidance of the pump pressure entered, the program selects a charging factor in accordance with the values programmed into "charging factor normal" or "charging factor acid circ.". This results in correct charging even if there is a fault in acid circulation.
- Current I0, current I1, etc.
  Indicates charge currents as a percentage of I5 or I1 for the various charge curve elements.
- Voltage U0, voltage U1, etc.
  Indicates the charge voltage in V/cell for the various charge curve elements.
- Max I0 time, max I1 time, min I1U1 time, etc.
  Max times exceeded result in safety shutoffs (apart from I0 time). This is designed to protect the battery in the event of a fault. The max times for I0, I1 and I1U1 are calculated automatically, taking into account battery and charger size if the value 0 is programmed. This automatic function is indicated by ··:··.
  Min times mean that the charging program will not continue until this amount of time has passed. E.g. min I1U1 time and min I2 time.
- Baseload
  If the battery is under load during charging, this current should be compensated for. Measure and program the load current. All currents are compensated with this value.
- Control register 1 and 2.
  With different values in the "control register" parameter, it is possible to switch on

and off functions such as the programming of currents as a percentage of I5 or I1, monitoring of the battery current and voltage derivative, I0/U0 phase, etc.

3.7.3 Charger

The charger's rated data, among other things, is programmed in this group (see the rating plate on the charger). See also the table in section 5.1.

- Rated current.
  Program this value in accordance with the rating plate on the charger. Entering an incorrect value may damage the charger or cause a long charging time.
- Maximum current
  Factory set.
- Mains code
  This parameter tells the program what type of mains voltage the charger is connected to. See the table in section 5.1.
  Incorrect value gives incorrect function.
- Lower start limit, upper start limit.
  The charger starts when a battery is connected if the battery voltage is between the limit values of "lower start limit" and "upper start limit". If there is no battery at all, i.e. the voltage is less than 6 V, a "connect battery" message is displayed.
- System voltage code, system current code.
  These parameters tell the program what voltage input is used and which shunt is installed. Incorrect values mean that the charge currents and voltages are too high or too low, which can damage the charger and battery.
  See the table in section 5.1.
  N.B.: if any of these parameters is changed, the corresponding measured value must always be calibrated.
- System RI
  To minimise the charging time, the MTM compensates for voltage drops in secondary cabling and socket. The display shows the compensated value, i.e. the voltage the battery is estimated to have. Specify the measured or estimated resistance in the format 0.1 mΩ. See also the table in section 5.1.
- Bridge type
  Two types of thyristor bridges are used in MTM. Smaller chargers (up to 150A) usually have a 3-pulse bridge. Chargers with a nominal current of 175A and above usually have a 6-pulse bridge. These chargers are fitted with an extra Thyristor Control PCB (see section 4.2). See the table in section 5.1.

3.7.4 Options

This group includes parameters which define which auxiliary equipment is fitted in the charger. Acid circulation pumps, extra I/O cards and temperature sensors are examples of such equipment.

- Acid circulation pump type, pump on, pump cycle, underpressure, overpressure
  These parameters tell the program what type of pump is fitted, how pumping is to take place (interval and length) and what pressure is to be considered normal. If the pressure is outside of the approved range, the charging factor for a normal battery (without acid circulation) is selected and an error message is displayed.

Pump types: no pump = 0, API pump = 1.
Pump on: Indicates how much of the pump cycle pumping is to cover.
Pump cycle: Indicates how often the pump is actuated in the case of interval pumping.

- I/O PCB type, relay config, remote config
  These parameters tell the program whether additional relay cards are fitted, whether a remote input is used and, if so, how this is to work.
  These functions are used in particular in AGV applications (driverless trucks) and are described in separate documentation.
- Aux temperature sensor type, max temp at full power, voltage compensation.
  If a battery ID unit (IDB) is fitted to the battery, temperature information from this can be used to adjust the charge curve and output so as to achieve optimal charging.
- ID-system type.
  This parameter activates the communication between the charger and the IDB-unit on the battery.

3.7.5 Adjustment of measurement system

The measured values are normally adjusted only when components and PCBs in the unit are replaced.
Use an accurate measuring instrument (digital voltmeter and clip-on ammeter) to measure the unit to be calibrated. Enter this value followed by #. The microprocessor then calculates the trim values, which are stored in the memory. See the instructions in section 4.6.

3.7.6 Statistics

This group shows how the battery has been used in respect of depth of discharge, along with data from the last four charges.

- Cycles nn%- nn%.
  The MTM saves statistics which indicate how much of the battery capacity has been used whenever it has been used, divided over 6 intervals. These intervals are set by means of the parameters “limit 1” – “limit 4”. These intervals are set to 2-50%, 50-70%, 70-80% , 80-90% and over 90% by default. The statistics are based on the calculated depth of discharge, i.e. additional charging is not included.
- No. of disrupted chargings
  Disrupted charging relates to charges which have taken more than one hour but were interrupted by the user before charging was complete. The time limit of one hour means that pause charges are not recorded as disrupted chargings.
- Charging start, I1 time and charged capacity, etc.
  The following screens show data from four of the five last charges (see also 3.7.1).
- Error message statistics
  The last six safety shutoffs, together with when they occurred, are saved here.
- Limit 1, limit 2, etc.
  The MTM saves statistics on discharges in 5 intervals with 4 programmable limits. If the statistics limits are changed, statistics saved previously will become invalid and should therefore be deleted (see 3.7.7).

Interval no.	Area	Range at delivery
1	2% – limit 1	2% – 50%
2	limit 1 – limit 2	50% – 70%
3	limit 2 – limit 3	70% – 80%
4	limit 3 – limit 4	80% – 90%
5	limit 4 and above	90% –

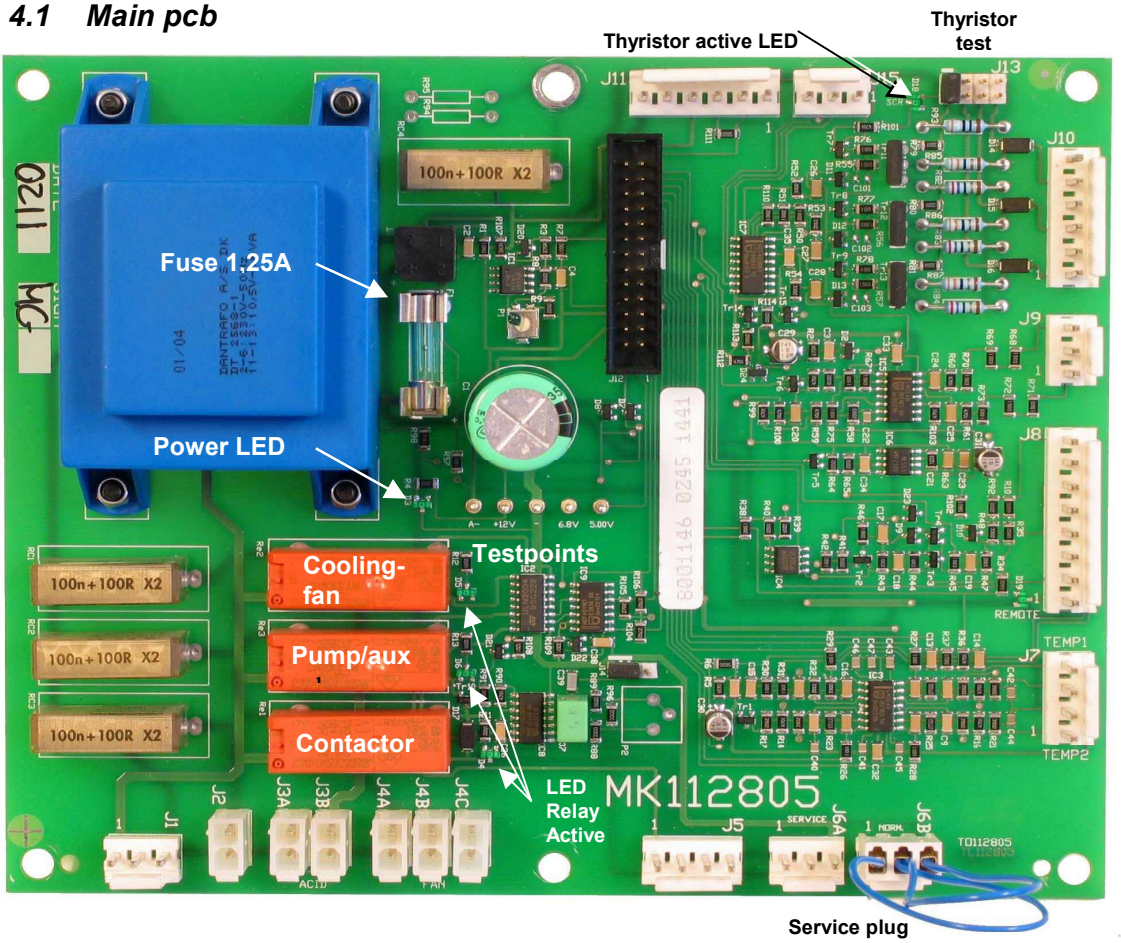
3.7.7 Service

"Service" includes functions for setting the clock, basic programming of the charger, resetting the statistics, etc.

- Set time hh:mm
  Specify the time in 24-hour format.
- Set date
  Specify a date in month-day format.
- Set day of week
  Specify a day of the week, 1-7: day 1 is Monday and day 7 is Sunday.
- Set year
  Specify the year using four digits (e.g. 2003).
- Set charging algorithm.
  Adjust the charger to the battery by selecting the correct charge curve. This should be done in consultation with the supplier of the battery or charger.
- Default program
  See the detailed description in section 4.5
- Clear all statistics
  Input the security code to delete all statistics stored in the charger memory.
- Clear all IDB data.
  If you see the error message "CS err. IDB data" and you are not using an IDB system, this function must be used and the charger restarted.
- Hardware code
  Certain changes have been made to the MTM main pcb in order to enhance performance. The program has to take these changes into account. Hardware code 0 is used for version MK1128-03 and earlier, while hardware code 1 must be used for MK1128-04 and later. NOTE: The display always shows 0 and not the programmed value. See also the table in section 5.1.2
- Volume.
  Influences the volume of the acoustic signal. The volume is set to the highest value at the time of delivery.
  The values 0 – 128 vary the volume from entirely silent to max volume.
- SCR trigging.
  This value gives a measure of the output phase angle. Used for fault finding.
- Internal register, X ram, etc..
  These functions are designed only for advanced troubleshooting.

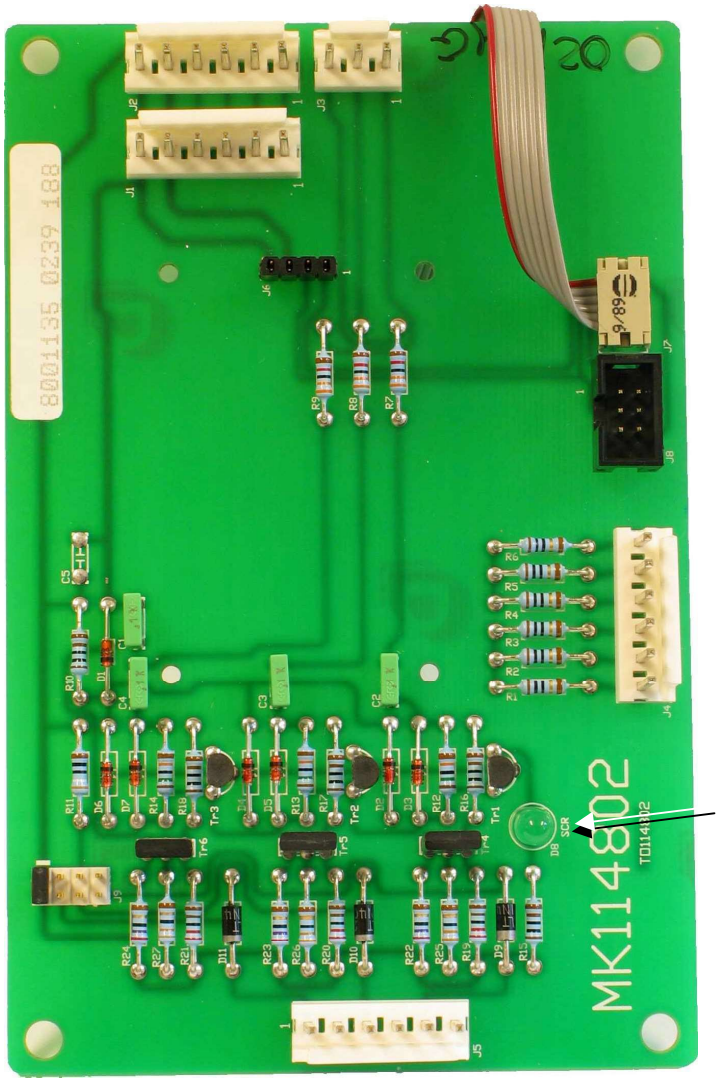
4 SERVICING AND MAINTENANCE

4.1 Main pcb



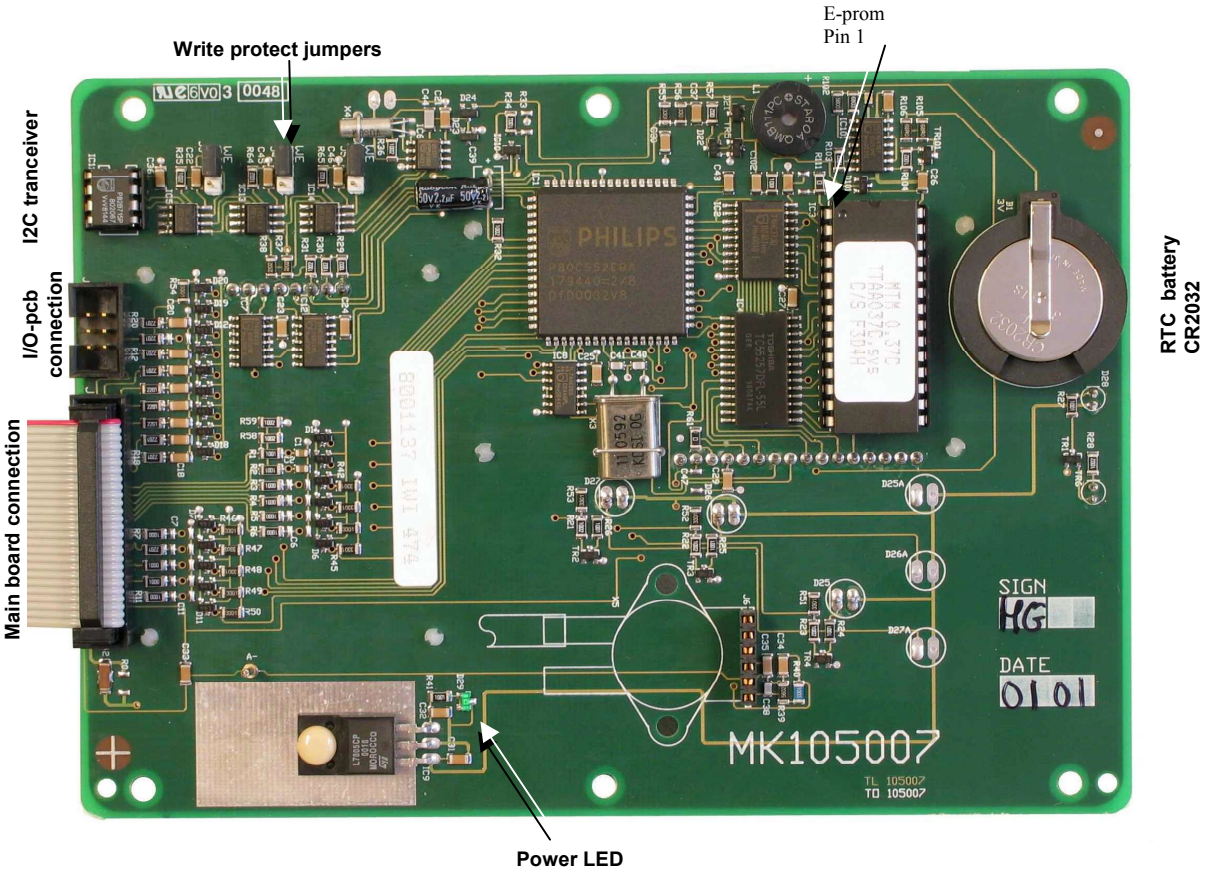
Connection	Function
J1	Power supply 170-260VAC
J2	Contactor control
J3A-B	Acid circulation pump output / Auxiliary relay output
J4A-C	Cooling fan power
J5	Thermostat input (over temperature protection)
J6A-J6B	Service connector
J7	Temperature sensor input (1-2 cooling fin, 3-4 transformer/choke)
J8	Remote start input, shunt signal, analogue 0 and battery voltage.
J9	Input for phase detector
J10	Thyristor gate output
J11	Power supply for optional pcb (I/O-pcb, IDB-transceiver)
J12	Processor c.b. connection (flat ribbon cable)
J13	Thyristor test jumper.
J15	Gate control for extra thyristors (6-pulse)

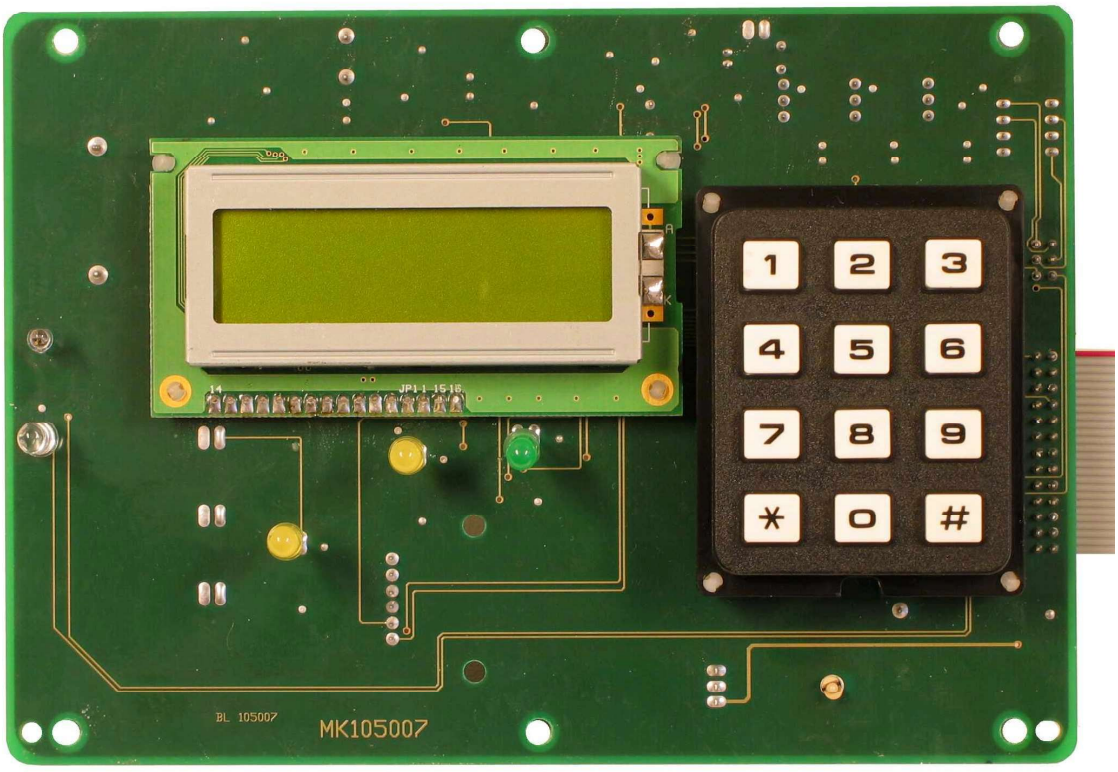
4.2 Thyristor control PCB (6-pulse bridge only)



Connection	Function
J1	Power supply for optional pcb (I/O-pcb, IDB-transceiver)
J2	Power supply from Main PCB
J3	Gate control signal from Main PCB
J4	Shunt Input/Output
J5	Thyristor gate output
J6	Power supply for IDB communication PCB
J7	I2C-bus
J8	I2C-bus
J9	Thyristor test

4.3 Processor c.b.





4.4 Main circuit

Incoming power is connected to terminals L1, L2 and L3. The voltage is fed through the main contactor K1 and chokes L1 – L3 to the primary side of transformers T1 – T3. Contactor K2 activates immediately before K1 and feeds the voltage through resistors R1 – R3 to the transformers which are magnetized. This switching limits the connection impulse.

The secondary side of the transformer is connected to a rectifier with diodes and thyristors. The component type depends on the charger's rated current.

The rectifier bridge is connected to the charger's plus output through a knife or truck fuse and to the minus output through a shunt.

4.5 Basic setting

4.5.1 General

If a new computer card is fitted to the charger, this is normally unprogrammed. The "default program" function can be used to keep to a minimum the number of values which have to be input. Here are some step-by-step instructions on how to do this. Firstly, read through section 3.5 and 3.6.

4.5.2 Procedure

- Remove any protective paper from the real-time clock battery.
- Install the card in the unit.
- Start the charger without connecting the battery.
- When the first screen is displayed, enter the security code 2451 (digits entered will not be displayed). A signal is emitted by way of acknowledgement.
- Press * until you see "service". Press # until you see "default program". Enter 2451.
- The display shows "set charging algorithm". Select a charge curve suitable for the battery (e.g. 10-05) followed by #. A charge curve should be selected in consultation with the supplier of the battery or charger.
- The display shows "set time". Set the time, date, day of week and year, each followed by #.
- Press # until you see "clear all statistics". Press "2451". The menu system returns to "set time".
- Press # until you see "clear all IDB data". Press "2451". The menu system returns to "Service".
- Press # until you see "Hardware code". Programme values in accordance with the table in section 5.1.2.
- Press * until you see "Charging algorithm".
- The display shows information on the active curve. Press # and program the correct value for battery capacity and the number of cells. Other parameters should only be changed in consultation with the supplier of the battery or charger. Finish by pressing # followed by *.

- Press * until the display shows “charger”. Press # and set the correct rated current, mains code, shunt and voltage code, as well as the cable resistance and the type of bridge (see the table in section 5.1.1). Finish by pressing # followed by *.
- Press * until the display shows “options”. Press # and change the parameters required.
- Press * until you see “adjustment of measurement system”. Press # and enter the value 0 for charge current, charge voltage, control voltage and temperature. This procedure roughly adjusts all measured values.
  If the charger is fitted with an acid circulation pump, enter the security code in the “set pressure to zero” function. End by pressing *.
- When the display shows “adjustment of measurement system”, shut down and restart the charger.
- Press # and check the time and date.
- Adjust the measuring system as outlined in section 4.6

4.6 Adjustment of measured values (calibration)

4.6.1 General

All components have a specific tolerance, and this means that values input for current, voltages and temperatures have to be calibrated during the manufacture of the charger. When measured values are adjusted, the processor is allowed to calculate trim values which are stored in the parameter memory.

After delivery, measured values are normally adjusted only when motherboards or computer cards are replaced.
Use an accurate measuring instrument (digital voltmeter and clip-on ammeter) to measure the unit to be calibrated. Then enter this value followed by #.

4.6.2 Procedure

- Connect a voltmeter to the terminals on a discharged battery. Attach a clip-on ammeter around one of the charging cables. Open the door and disconnect the connector for the operating voltage of the contactor.
  Connect the battery to the charger.
- Start the charger and enter the security code 2451 (write protection is disabled).
- Press * until the display shows “adjustment of measurement system”.
- Press # until the display shows “charging voltage”. Read the battery voltage on the external voltmeter and enter this value with a decimal, followed by #.
- Press # until the display shows “mains voltage”. Open the door and measure the voltage between terminals 10 and 11. Key in the value with one decimal, followed by #.
- Turn of the charger. Open the door and install the connector for the operating voltage of the contactor.
- Start the charger and enter the security code (2451).
- Press * until the display shows “adjustment of measurement system”.

- Press # until the display shows “charging current”. Read the charge current on the clip-on ammeter and enter this value with a decimal, followed by #.
- Press # until the display shows “temperatures”. Press 0 followed by # and *.
- The charger is now calibrated.

4.7 Troubleshooting

4.7.1 General

Most fault functions result in fault messages on the display. For serious faults on the electronics board there are also LEDs which show the status of supply voltages, inputs and relay outputs. In addition, the motherboard is equipped with measuring points for checking supply voltages and references.

NOTE! Do not work in the charger with the mains voltage or battery connected. If action requires that the mains or battery are connected, observe extreme care.

4.7.2 Checking thyristors and diodes

Thyristor check.

- Turn off the charger and disconnect the battery.
- Disconnect the flatribbon cable from main board J12.
- Change the position for the service plug from ”normal” to ”service” in the service connector.
- Remove the jumper from the leftmost thyristor test connector on the main pcb and from the thyristor control PCB (optional, 6-pulse bridge only).
- Connect a battery and start the charger.
- The contactor will operate and the fan starts. Use a current clamp to measure the currents in all three thyristors. If current is flowing in any thyristor, it is broken and should be replaced.
- Use the jumper to operate the thyristors one at a time by inserting it in the main PCB thyristor test connector position 2-4. If a thyristor does not operate, it is broken and should be replaced.
  Repeat the operation on the thyristor control PCB (optional, see section 4.2).
  Remember to reinstall jumpers in leftmost position on the main PCB and Thyristor Control PCB (optional).
- Replace any faulty thyristor. Maximum mounting torque for a thyristor with a ¼” thread is 5 Nm.

Diode check.

- Disconnect the diode cable.
- Use a digital instrument to measure the forward voltage drop (0,4-0,7V) and that the diode block in the reverse direction.
- Replace any faulty diode. Maximum mounting torque for a diode with a ¼” thread is 5 Nm.

4.7.3 Error messages in alphabetical order and suggested action

!CURR/VOLT-CODE

The programmed value of shunt or voltage code is not valid.

Measures: Check and reprogram the shunt or voltage code.

ACID CIRC. ERROR

Only if acid circulation is activated Requires hardware.
The air pressure was too high or too low during the main charging. The charging factor for standard battery is used.
Possible causes: The air hose is not connected. Leakage. Folded hose. Air pump failure.

Measures: Check airpump, connections and hoses.

Ah-LIM. EXCEEDED

The charged capacity exceeds the programmed value of battery capacity during the I1 or U1-phase. The I1 or U1-phase is terminated and the I2-phase is started.
Possible causes: Incorrect value programmed. Warm battery. Faulty cell. Deep discharged battery.

Measures: Check battery. Check programming.

ALGORITHM ERROR

Programmed value of charging curve is unknown for the charger.

Measures: Program correct value in ”set charging algorithm” under ”service”

BATT.ID UNKNOWN

Only if IDB-function is activated. Requires hardware.
The ID of the battery is unknown to the charger.
Possible causes: The ID of the battery is not programmed.

Measures: Read the battery ID and program the ID and its corresponding data into the memory. See separate instruction for the IDB system

BATTERY FAULT dI

Only if the function is activated in “Control register 1”
The current is not decreasing during the U1-phase. The U1-phase is terminated and the I2-phase is started.
Possible causes: Warm battery. Faulty cell. Other battery problems.

Measures: Check the battery.

BATTERY FAULT dU	*Only if the function is activated in "Control register 1"* The voltage is not increasing during the I1-phase. The I1-phase is terminated and the I2-phase is started. Possible causes: Warm battery. Faulty cell. Other battery problems. Measures: Check the battery.
C/S ERR IDB-DATA	The database storing the IDB-data is invalid or is not initiated. Possible causes: The computer pcb is new and is not base programmed. Programming is terminated in a wrong way (the charger is shut of during programming). Measures: <u>If the IDB-system is in use</u>, check the programmed values. Adjust incorrect values. Finish the programming by pressing # followed by a *. Turn the charger off and on again. <u>If the IDB-system is not in use</u>, use the function "Clear all IDB data" under "Service". Then press * until the normal picture is shown. Turn the charger off and on again.
C/S ERROR EEPROM	Data stored in the EE-prom, or the corresponding checksum is incorrect. Possible causes: The computer pcb is new and is not base programmed. Programming is terminated in a wrong way (the charger is shut of during programming). Measures: Check and adjust programmed values. Reprogram at least one value. Finish the programming by pressing # followed by a *. Turn the charger off and on again.
CHARGER FAULT I^	The output current is momentarily to high. The charging is temporarily terminated and restarts after a moment. Repeated errors causes the charger to shut off permanently. Possible causes: Faulty thyristor. Faulty pcb. Measures: Check thyristors (see "Checking diodes and thyristors"). Replace the main pcb.
CHARGER FAULT I>	The output current exceeds the programmed value. Possible causes: Faulty thyristor. Faulty main pcb. Measures: Check thyristors thyristors (see "Checking thyristors and diodes "). Replace the main pcb.

CHARGER FAULT U^	The output voltage is momentarily to high. The charging is temporarily terminated and restarts after a moment. Repeated errors causes the charger to shut off permanently. Possible causes: Bad connection between the charger and the battery. Bad connection on the battery. Faulty thyristor. Faulty pcb. Measures: Check connections. Check thyristors (see ”Checking thyristors and diodes ”). Check and replace pcb.
CHARGER FAULT U>	The output voltage exceeds the programmed value. Possible causes: Faulty thyristor. Bad connections. Faulty pcb. Measures: Check thyristors (see ”Checking thyristors and diodes ”) and connections. Replace pcb.
CONNECT BATTERY	Battery is not connected or has a back voltage below 6V. Possible causes: Faulty battery. Bad connection. Measures: Check battery and connections.
HARDWARE VER ERR	Programmed value of ”hardware code” is out of range or invalid. Measures: Program a valid value (under ”service ”). N.b. the current program version does not display the programmed value of the hardware code.
HIGH DC VOLTAGE	The back voltage of the battery connected to the charger is higher than the programmed value in ”upper start limit”. Possible causes: The number of cells is to high. Wrong value in ”No. of cell”. Wrong value in ”upper start limit”. A newly charged battery is connected to the charger. Measures: Check the data plates on the battery and the charger. Check the programming.
HIGH MAINS	The mains voltage is too high. Possible causes: The charger is connected to the wrong type of mains connection. Calibration error. Measures: Check the data plate of the charger. Check calibration.

HIGH TEMPERATURE	When the internal temperature of the charger is to high, the output power is decreased. This message is shown when the output power is 0. Possible causes: Faulty fan. Covered vent openings. A lot of dust inside the charger. Faulty temperature sensors. High ambient temperature. Measures: Check and replace the fan. Free the vent openings. Clean the charger. Check and replace the sensor.
I1-TIME EXCEEDED	The maximum time of the I1-phase is exceeded. The I1-phase is terminated and the I2-phase is started. Possible causes: Warm battery. Faulty cell. Deep discharged battery. Incorrect programming. Measures: Check the battery. Check the programming.
IDB COM. ERROR	*Only if IDB-function is activated. Requires hardware.* The data sent from the IDB-unit on the battery is invalid. Possible causes: Faulty IDB-unit. Faulty IDB-transceiver (inside charger). Long cables. Measures: Try to restart the IDB-unit by disconnecting its power. Replace IDB-unit or tranceiver.
IDB COM. TIMEOUT	*Only if IDB-function is activated. Requires hardware.* The charger is not able to communicate with the IDB-unit on the battery. Possible causes: Faulty IDB-unit. Broken fuse on the IDB-unit. Faulty IDB-transceiver (inside charger). Long cables. Measures: Try to restart the IDB-unit by disconnecting the power. Check the fuse in the plus cable of the IDB-unit. Replace IDB-unit or tranceiver
I/O TYPE 1 ERROR	The I/O-pcb is faulty or not connected. Possible causes: Incorrect programmed value in ”I/O pcb type”. Loosened flat ribbon cable between the I/O-pcb and the computer pcb. The I2C-transceiver (Ic11) on the computer pcb is faulty or missing. Faulty pcb. Measures: Check the programming. Check flat cable and Ic11.

LOW DC VOLTAGE	The back voltage of the battery connected to the charger is lower than the programmed value in ”lower start limit”. Possible causes: The number of cells is to low. Wrong value in ”No. of cell”. Wrong value in ”lower start limit”. The battery is deep discharged. Faulty cell. Bad connection. Measures: Check the data plates on the battery and the charger. Check the programming. Check the battery and it´s connections.
LOW MAINS	The mains voltage is too low. Possible causes: Power ”brown out”. Calibration error. Blown mains fuse. Measures: Check fuses and mains voltage. Check calibration.
MAINS SYNC. ERROR	The charger can not synchronize to the mains frequency. Possible causes: Mains voltage interferences. Faulty pcb. Measures: Check mains. Replace pcb’s.
MAX. OUTPUT	The current is zero or near zero in spite the charger is trying to deliver maximum power. Possible causes: Faulty thyristors. Faulty output fuse. Faulty pcb. Measures: Check thyristors (see ”Checking thyristors and diodes ”), output fuse and pcb’s. Replace broken components.
OFFSET ERROR I	The output signal from the current sensor is outside the specified value when the charger is started. The offset current is measured before the thyristors are opened. Possible causes: Faulty pcb. Leaking or shorted thyristors. Measures: Disconnect the thyristors (see ”Checking thyristors and diodes ”). If the error remains, replace the main pcb and/or the processor p.c.b.
OUTPUT SHORTED	*AGV-application. Only if the function is activated. Requires hardware.* The charger senses a low inpedance on the output terminal. Possible causes: Metal object on the floor contact. Measures: Remove object.

OVER PRESSURE	*Only if acid circulation is activated. Requires hardware.* The air pressure is above the programmed value in ”Over pressure”. Possible causes: Folded air hose. Measures: Check air hoses.
PHASE ERROR	Phase is missing. Possible causes: Blown mains fuse. Bad connection in mains plug or terminal blocks. Faulty contactor. Measures: Check mains fuses. Check connections.
REMOTE MISSING	*AGV-application.* The value in ”Remote config” is programmed for use of the remote start input and parking is not permitted. A battery is connected to the charger and the remote start signal is not activated. Possible causes: Bad connection in the remote start input. The programming of ”remote config” is not according to the desired function. Faulty proximity switch. Measures: Check connections and the proximity switch. Check programming.
TRANSD. ERR T	The signal from the temperature sensor in the transformer or choke is out of range. Possible causes: Faulty sensor. Faulty pcb. Measures: Switch the connectors ”temp 1” and ”temp 2” in connector J7 on the main board. If the error follows the sensor, replace it. If the error follows the input channel, replace the main pcb.
TRANSD. ERR Ty	The signal from the temperature sensor in the thyristor cooling fin is out of range. Possible causes: Faulty sensor. Faulty pcb. Measures: Switch the connectors ”temp 1” and ”temp 2” in connector J7 on the main board. If the error follows the sensor, replace it. If the error follows the input channel, replace the main pcb.
TRANSD. ERR. IDB	*Only if IDB-function is activated. Requires hardware.* The IDB-unit reports a temperature out of range. Possible causes: Faulty battery temperature sensor (short circuit or bad connection). Faulty IDB-unit. Measures: Replace the sensor or the IDB-unit.

TRANSD. ERR. PCB	The signal from the temperature sensor on the main pcb is out of range. Possible causes: Faulty pcb. Measures: Replace the main pcb.
U1-TIME EXCEEDED	The maximum time of the U1-phase is exceeded. The U1-phase is terminated and the I2-phase is started. Possible causes: Warm battery. Faulty cell. Deep discharged battery. Incorrect programming. Measures: Check the battery. Check the programming
UNDER PRESSURE	*Only if acid circulation is activated. Requires hardware.* The air pressure is below the programmed value in ”under pressure”. Possible causes: Leaking air connections. Broken air hoses. Faulty air pumps. Measures: Check air hoses, connections and airpumps.

5 APPENDICES

Wiring diagrams, spares lists, program descriptions, etc. are gathered under this heading.

The program version appears on a label stuck to the program circuit located in sockets on the computer card. Information on the program version installed can also be viewed in the first screen for the menu system.

5.1 Tables

5.1.1 Adaptation to model.

Function	Description		Value
Mains voltage code	3-phase 5-wire (3-phase + neutral + earth) Y-coupled transformers without aux. transformer.		0
	3-phase 4-wire (3-phase + earth) delta-coupled transformers with or without aux. transformer		0
	3-phase 4-wire (3-phase + earth) Y-coupled transformers with aux. transformer		1
System current code	Rated current	< 100A, shunt 75A/50mV	1
		100-150A, shunt 150A/50mV	2
		> 150A, shunt 2x150A/50mV	4
System voltage code	System voltage <	24VDC	0
		24 - 48VDC	1
		72 - 120VDC	2
		240VDC	3
System RI (mΩ)	Rated current	40A	16,5mΩ
		50A	10,0mΩ
		60A	10,0mΩ
		80A	7,0mΩ
		100A	5,0Ω
		125A	4,0mΩ
		150A	4,0mΩ
		175A	3,0mΩ
		200A	2,0mΩ
		225A	2,0mΩ
		250A	1,0mΩ

5.1.2 Hardware code

Description	Hardware code
Main PCB MK112801-MK112803	0
Main PCB MK112804 -	1

5.1.3 Charging algorithms

Description	Charging algorithm
Freely ventilated lead cells, constant-voltage trickle charging	LK 10-05
Freely ventilated lead cells, pulsed trickle charging	LK 10-06
Freely ventilated lead cells with acid circulation. Pumping 5 minutes/half an hour.	LK 10-07
Freely ventilated lead cells with acid circulation. Constant pumping.	LK 10-08
Freely ventilated lead cells with chemical acid circulation and pulsed uh charging.	LK 10-04
Freely ventilated lead cells, W characteristics and pulsed trickle charging	LK 11-01
Sealed lead cells (Dryfit Traction, Hagen PWF)	LK 20-09
Sealed lead cells (Hawker Genesis), basic curve	LK 22-01
Sealed lead cells (Hawker Evolution)	LK 23-02
NiCd battery, basic curve	LK 81-01