



Description and Operating Instructions

2280073 Rev.1

MultiCharger 1500 12V/100A...24V/50A

12V/100A Lithium-ion and Lead-acid Batteries
24V/50A Lead-acid Batteries



Read operating instructions carefully before use!

Imprint

MultiCharger 1500

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1 Use

1.1 Competent person

A person is regarded as competent person if he/she is assigned as instructed to perform particular works on or with the MultiCharger.

1.2 Normal use

The MultiCharger 1500 (referred to below as MC1500) is intended for charging vehicle batteries:

- lead-acid batteries with a nominal voltage of 12 V or 24 V
- lithium-ion batteries with a nominal voltage of 12 V
- external power supply for motor vehicles

1.3 Misuse

- charging of batteries which have a different nominal voltage
- charging of frozen batteries
- connection of non-rechargeable batteries
- connection of dry batteries
- any other use than described above.

2 Fundamental safety instructions

The following fundamental safety instructions are to be understood as supplement to applicable national occupational safety regulations. This means that, next to these fundamental safety instructions, the applicable national occupational safety regulations shall be observed in any case.

The charger unit is not intended to be used by persons (including children) with limited physical, sensory or cognitive abilities or with lack of experience and knowledge unless they are supervised. Children shall not be allowed to play with the charger unit.

2.1 Safety symbols used



Danger!

This symbol indicates the presence of essential health hazards for persons.

In case of possible mortal danger, this will be separately indicated by the phrase „**Danger to life**“.



Danger!

This symbol indicates the presence of electrical health hazards for persons which are caused by electrical voltages.

In case of possible mortal danger, this will be separately indicated by the phrase „**Danger to life**“.



Danger!

This symbol indicates the presence of hazards for the system, the material or environment.

In case of possible mortal danger, this will be separately indicated by the phrase „**Danger to life**“.

2.2 General safety instructions

In order to charge a battery outside of the vehicle, connect the positive (plus) and the negative (minus) cables in accordance with polarity (see section 5).

For a battery installed in the vehicle, first connect the red charging cable of the charger to the positive terminal (+) of the battery (not connected with the chassis) according to the polarity indications and then the black charging cable to the negative terminal (–) of the battery. Do not connect to carburettor or fuel lines. After charging, disconnect the negative cable (chassis-connected cable) first (see section 5).

Danger!
Serious or fatal injuries



Explanation:
Disconnecting the battery during charging can result in temporary sparking

Avoidance measures:
Terminate charging by using control button 2 (start/stop) before disconnecting the battery

Danger!
Serious or fatal injuries



Explanation:
An attempt to charge non-rechargeable batteries causes explosion risk

Avoidance measures:
Connect rechargeable batteries only

Danger!
Serious or fatal injuries



Explanation:
Risk of explosion when battery is overloaded

Avoidance measures:
No overcharging of battery – see instructions for use

Danger!
Serious or fatal injuries



Explanation:
During charging, oxyhydrogen gas is usually generated. There is a risk of explosion!

Avoidance measures:
Read the operating instructions before using the charger and follow the instructions closely.
Operate the charger only in well ventilated areas.
Do not smoke in the vicinity of the battery.
Avoid fire and flying sparks.

Danger!

Serious or fatal injuries and/or damage to the charger unit



Explanation:

During operation in moving vehicles, equipment is not sufficiently safeguarded. It is possible that cables are torn off (spark generation) or that the battery tips over (damaging)

Avoidance measures:

Do not operate charger unit in moving vehicles

Danger!

Occurrence of secondary failures as a result of problems during charging



Explanation:

Problems occurring during charging can result in leakage of acid and, when personal precautions are inadequate or not observed, in secondary failures.

Avoidance measures:

Somebody should be within voice range in order to be able to provide or organize assistance.
Keep plenty of water and soap on hand in case acid comes in contact of with skin or clothes.
Wear protective clothes incl. safety goggles and avoid touching the eyes with your hands.
However, if battery acid comes into contact with skin or clothes, rinse immediately; in case of contact with eyes, intensively rinse at least for 10 min with cold water and then consult an ophthalmologist

Danger!

Serious or fatal injuries



Explanation:

metal items between the battery terminals can result in a risk of short circuit or explosion as well as in severe burns

Avoidance measures:

Cover non-isolated contacts if possible.
Take care when handling metal tools.
Take off rings, necklaces, bracelets, watches

Danger!

Risk of injury due to electric shock



Explanation:

risk of harm to people due to electric shock in case of failure when unearthed sockets and power cables are used

Avoidance measures:

Ensure that the power supply cord is appropriately earthed!

Danger!

Risk of injury due to electric shock



Explanation:

There is a risk of electric shock when touching non-isolated parts of the contacts and non-isolated battery clamps.

Avoidance measures:

Avoid touching any non-isolated parts of the contacts and non-isolated battery clamps.

Danger!

Risk of injury due to electric shock



Explanation:

The use of improper extension cords can result in damages and electric shock.

Avoidance measures:

Use extension cords only if absolutely necessary. Use only suitable cables. Pay attention to:

- a) same number, size and shape of the pins in the plug
 - b) connectors at the charger unit
 - c) proper wiring and sound electric condition of the extension cord
 - d) correct cross-section of the cable
-

Danger!

Risk of injury due to electric shock



Explanation:

There is a risk of electric shock when using defective cables and leads especially in case of power cords.

Avoidance measures:

Defective leads and cables have to be replaced immediately.

Danger!

Risk of injury due to electric shock



Explanation:

There is a risk of electric shock when using equipment which has been exposed to severe mechanical stresses (shocks, dropped equipment, visible external damage).

Avoidance measures:

If the charger unit has experienced severe mechanical impacts, it has to be shipped to a qualified service company for inspection/repair. Abstain from self-repair.

Danger!

Risk of injury due to electric shock



Explanation:

There is a risk of electric shock if actions (cleaning, maintenance, repair) are executed on the charger unit while the power cord is connected.

Avoidance measures:

Disconnect leads before working on the charger unit.

Warning!

Equipment damage or failure possible!



Explanation:

The charger unit might be damaged due to constructional modifications.

Avoidance measures:

Do not modify the construction of the Multicharger! In the case of fixing to accessories, the instructions supplied with said accessories have to be observed.

Warning!

Equipment damage or failure possible!



Explanation:

Outdoor storage and operation of the charger unit in case of rain or snow can lead to equipment damage.

Avoidance measures:

Do not expose the MultiCharger to rain or snow.

Warning!

Equipment damage or failure possible!



Explanation:

Pulling at the cable can result in damage of the corresponding lead.

Avoidance measures:

Always grip the plug of the cables/leads in question (in the case of power cord, first release the strain relief at the charger unit).

END OF SAFETY INSTRUCTIONS

3 Construction of the charger unit

3.1 General mode of operation

The MC1500 is used for charging motor vehicle batteries and can also be used as an external power supply for vehicles. The charger unit is designed for the usage in 12V systems with lithium-ion and lead-acid batteries as well as in 24V systems with lead-acid batteries. The power output is 1500W, which is sufficient to charge all common vehicle batteries.

The MC1500 is fed from the mains supply and transforms the connected alternating current voltage into direct current voltage. The power section is fitted with an isolating transformer to ensure that the output voltage is electrically isolated from the mains supply. For protection, input and output cut-outs are built into the MC1500. Additionally, a current limiter prevents the MC1500 from getting damaged by overload.

The MC1500 is designed as a bench unit, which is cooled by the free flow of air from the base to the top. Therefore, make sure that the MC1500 remains uncovered. All displays and operating controls are located on the front of the MC1500.

3.2 Connections

All connections of the MC1500 are on the front.

Mains voltage is connected to the MC1500 through an inlet connector for non-heating appliances.

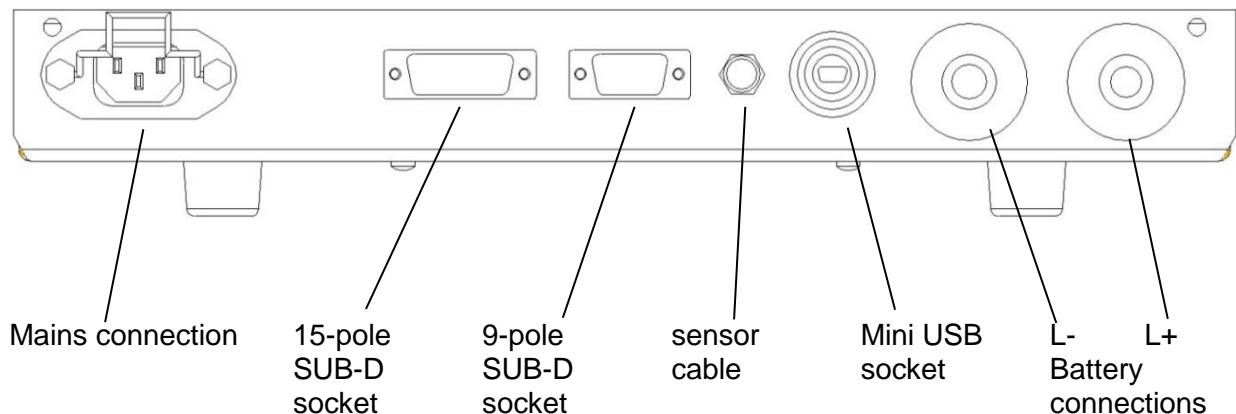
3 potential-free relay contacts which signal various states of the MC1500 as well as a hardware contact "Remote On/Off" can be connected through a **15-pole SUB-D socket**.

To connect a signal light, a **9-pole SUB-D** socket is used.
The signal light (green/yellow/red) signals various states of the MC1500.

A M8 plug-in connector (three-pole socket) can be connected to a sensor cable (only for special applications).





A **Mini-USB** socket is used for configuration via PC and the software WinCharge. Software updates can also be carried out through this interface.

Battery connection is made by means of bayonet connectors. The bayonet connectors are connected with an corresponding charging cable with battery clamps.



3.2.1 9-pole SUB-D socket

A 9-pole SUB-D socket on the front side of the charger unit is used to connect a signal light. The signal light (green/yellow/blue/red) indicates the following states of the MultiCharger:

State	Signal light – LED colours			
	 red	 yellow	 grün	 blau
MultiCharger off, standby, remote OFF, mains OFF	off	off	off	off
MultiCharger on and trickle charging, battery fully charged or second current limit reached	off	off	on	off
MultiCharger on and charging in the Pb or EPS mode	off	on	off	off
MultiCharger not contacted	off	flashing	off	off
MultiCharger on and charging in the lithium-ion mode	off	off	off	on
Device error	on	off	off	off
Operating error (e.g. reversed polarity, short circuit)	flashing	off	off	off
Power-up (charging start with disconnecting switch in open position) power-down (shutdown)	off	off	flashing	off

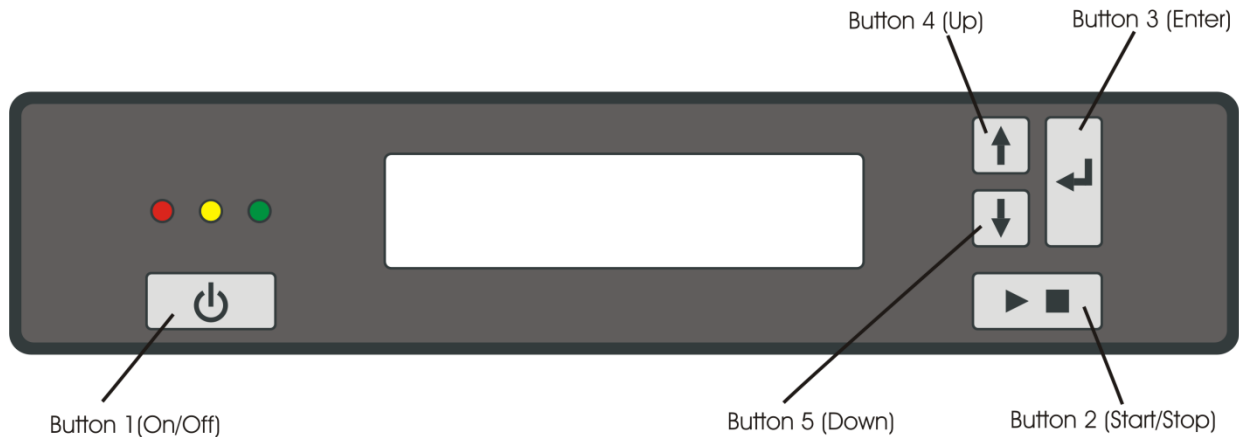
3.2.2 15-pole SUB-D socket

A 15-pole SUB-D socket provides 3 potential-free relay contacts which signal the following states of the MC1500:

State	Relay 3	Relay 2	Relay 1
MultiCharger off, standby, remote OFF, mains OFF	0	0	0
MultiCharger on and trickle charging, battery fully charged or second current limit reached	0	0	1
MultiCharger on and charging in the Pb or EPS mode	0	1	0
MultiCharger not contacted	0	1	1
MultiCharger on and charging in the lithium-ion mode	1	0	0
Device error	1	0	1
Operating error (e.g. reversed polarity, short circuit)	1	1	0
Power-up (charging start with disconnecting switch in open position) power-down (shutdown)	1	1	1

1: relay energized, 0: relay released

3.3 Displays and operating controls



3.3.1 Control button 1 (on/off)

Control button 1 is used to switch the M1500 on and off. If the connected supply voltage is over 90V, pressing button 1 switches the MultiCharger on and makes it ready for use. Furthermore, pressing button 1 is required to deactivate the interlock after a fault-induced shutdown.

3.3.2 Control button 2 (start/stop)

Control button 2 is used to start or stop the charging process or the EPS operation.

3.3.3 Control button 3 (enter)

Control button 3 is used as a button to confirm entries and for system navigation.

3.3.4 Control button 4 (up)

Control button 4 is a navigation button.

3.3.5 Control button 5 (down)

Control button 5 is a navigation button.




3.3.6 USB interface

A Mini USB socket is fitted on the front side of the charger unit which can be used to connect a laptop or PC.

The MC1500 can be configured through this interface and software updates can be carried out. To configure or alter the device software (Firmware Update), the software WinCharge is required. Detailed information about this can be found in the description of the PC software WinCharge.

3.3.7 LED, green, yellow, red

The LEDs (green/yellow/red) on the display signal the following states of the MultiCharger:

State	LED colour		
	 red	 yellow	 green
MultiCharger off, standby	off	off	off
MultiCharger on and trickle charging, battery fully charged or second current limit reached	off	off	on
MultiCharger on and in charging mode	off	an	off
MultiCharger not contacted	off	flashing	off
Device error	on	off	off
Operating error (e.g. reversed polarity, short circuit)	flashing	off	off
Power-up (charging start with disconnecting switch in open position) power-down (shutdown)	off	off	flashing

3.3.8 LC Display

The LC display of the MC1500 has two lines and can display 16 characters per line.

The current values of output voltage and output current are displayed on the top line. The bottom line acts as a status display showing in plain text the operating state and details of any faults that occur (see Appendix A).

The LCD is illuminated and, therefore, can be easily read both in the dark and in direct sunlight.

4 Setting of cable (wire) resistance

The new software version of the MC1500 includes a cable (resistance) compensation to compensate for voltage drop at the connecting cables of the battery.

4.1 Standard battery-connecting cables

In the delivery condition, a cable resistance of 15 mΩ is preset. This applies for a 5 meter/16 mm² battery connecting cable. If a different cable length or a different conductor cross-section is used, the cable resistance has to be adjusted in the service menu (see section 10.7).

Cable-resistance values of the battery's standard connecting cable:

Cable length/conductor cross-section:	cable resistance:
5m/16mm ²	15mΩ
7m/16mm ²	20mΩ

4.2 Calculation of cable resistance

The cable resistance is calculated according to the following equation:

$$\text{cable resistance} = \frac{2 * l}{\kappa * A} + R_{\text{transfer}}$$

Example of a 5m battery connecting cable:

Cable length (*l*): 5m

Electrical conductivity of copper (κ): 56m/(Ω·mm²)

Conductor cross-section (*A*): 16mm²

Transfer (contact) resistance = *R*_{transfer}: 4mΩ (transfer resistance of clamps and screw connections)

$$\begin{aligned} \text{Calculation of cable resistance} &= ((2 \times 5) / (56 \times 16)) + 0.004 \\ &= 0.01516\Omega \\ &= 15\text{m}\Omega \end{aligned}$$

5 Charging process

Carefully read and observe the safety instructions given in section 2 as well as the instructions of the respective battery manufacturer concerning safety and charging current.

5.1 Positioning of the MultiCharger

- a) Position the charger unit as far away from the battery as possible, make use of the entire cable length of the connected charging cable and check for (static) stability
- b) Do not place the MultiCharger directly on top of the battery
- c) Avoid dripping of acid onto the charger unit.
- d) Do not place the battery on top of the charger unit

5.2 Battery preparation

- a) For charging, remove the battery from the vehicle if possible. Before charging, switch off all consumers to avoid any arcs. Disconnect the grounded terminal first. Proceed with 5.4; if the battery cannot be removed, proceed with 5.3.
- b) Clean battery terminals and protect eyes against rust particles which might be blown up.
- c) In the case of lead-acid batteries (WET), check the acid level and add distilled water as necessary. This removes excessive gas from cells. Maximum level shall not be exceeded!
In case of a battery without cell caps, carefully follow the manufacturer's charging instructions.

5.3 Charging of a battery installed in the vehicle

- a) Connect to the mains, connect charging cable to the charger unit; arrange mains and charging cables so that they cannot be damaged by the bonnet, door or moving parts.
- b) Switch on the charger unit and set the desired charging mode (see section 6).
- c) Stay clear of fan blades, belts, pulleys, and other moving parts that can cause injuries.
- d) Check polarity of battery terminals. The diameter of the positive battery terminal (POS, P, +) is usually larger than that of the negative terminal (NEG, N, -).
- e) Determine which battery terminal is grounded (connected to the chassis).
If the negative terminal is grounded (as in most vehicles), proceed with (f). If the positive terminal is grounded, proceed with (f). The charging points present in the vehicle should be used.
- f) For negative-grounded vehicle, connect the POSITIVE (RED) clamp to the POSITIVE (POS, P, +) terminal of the battery; connect the NEGATIVE (BLACK) clamp to the chassis, engine block or frame (not to the carburettor, fuel lines, or sheet-metal body parts) as far away from the battery as possible. See section 6 for charging mode.
- g) For positive-grounded vehicle, connect the NEGATIVE (BLACK) clamp to the NEGATIVE (NEG, N, -) battery terminal. Connect the POSITIVE (RED) clamp to the chassis, engine block or frame (not to the carburettor, fuel lines, or sheet-metal body parts) as far away from the battery as possible. See section 6 for charging mode.
- h) Interrupt/terminate the charging process by pressing control button 2 (start/stop).
- i) Disconnection of charger unit – pull mains plug, disconnect clamp from chassis and the other clamp from the battery terminal.

WARNING! Temporary sparking can occur when disconnecting the cable before charging has been terminated without the button 2 (start / stop) to operate.

5.4 Charging of a battery outside the vehicle

- a) Connect to the power supply and connect charging cable to the charger unit.
- b) Check polarity of battery terminals. The diameter of the positive battery terminal (POS, P, +) is usually larger than that of the negative terminal (NEG, N, -).
- c) First, connect the NEGATIVE (BLACK) clamp of the charging cable supplied with the charger to the NEGATIVE (NEG, N, -) terminal.
- d) Connect the POSITIVE (RED) clamp to the POSITIVE (POS, P, +) battery terminal.
- e) See section 6 for charging mode.
- f) Interrupt/terminate the charging process by pressing control button 2 (start/stop).
- g) Disconnect cable connections in reverse order.

6 Operating modes/charging mode (permanent settings)

6.1 Setting of operating modes

Setting operating mode is only possible if the MC1500 is ready for use, i.e. if it has been switched on via button 1 (On/Off). However, there shall no activated charging procedure and no battery connected to the charger's output. After the charger unit has been switched on, the current software version is displayed for ca. 2 seconds before the charger unit switches to the set operating mode.

Pressing control button 3 (Enter) results in a prompt on the LCD to enter a password. The password is made up of four numerical characters and is explained in more detail in section 10. After correctly entering the password, you get to the MC1500's service menu. The navigation in this menu is also done by using buttons 3, 4 and 5 (see section 10).

Setting of operating mode is done under the menu item "Set mode". Here, the following described operating modes „*Charging PB*“, „*Charging LIO*“, „*EPS 12V mode*“, „*EPS 24V mode*“ and „*Auto. start EPS*“ can be selected.

The operating mode for the operation at 24V must be separately enabled under the menu item "*Activate 24V mode*" to make it activatable and to facilitate the recognition of 24V batteries.

The MC1500 in its delivery condition is preset to the battery charging mode 12V Pb ("12V Pb charge").

6.2 Charging mode for lead-acid batteries (Charging Pb)

This operating mode is for charging lead-acid batteries. The MC1500 is ready to use after it has been switched on by pressing control button 1 (on/off). This means that the output voltage of the charger unit remains 0V until a battery has been connected to the charger's output.

When connecting a battery, its voltage is measured first. From this, the nominal voltage of the battery is determined (12V/24V). The charger unit selects the corresponding output voltage and charges the battery.

If the voltage of the connected battery is not within the permissible range (see "*Overview of applicable voltage ranges*" in section 6.7), the MC1500 does not switch on and the output voltage remains at 0V, and the LCD displays an error message "*Faulty battery*".

If the battery is within an applicable voltage range, the MC1500 switches on the corresponding output voltage and charges the battery. The LCD displays the message "*CHRG 12V on*" and, after energization of output relays, the message "*12V Pb charge*".

After recognition of a 24V battery, it is charged with the corresponding IV characteristic (see table in section 6.7), and the LCD displays the message "*Charge 24V on*".

Charging continues until the charging current falls below the limit of 2.5A. Then, the MC1500 remains in a secondary charging (post-charging) mode for an adjustable time (default setting 5min) after which it switches over to trickle charging.

The charger unit will switch on again if, during post-charging time or trickle charging, the current increases and exceeds 2.5A. Hence, the charging cycle starts again.

If, during an adjustable time (default setting 12h), the charging current doesn't fall below 2.5A, the MC1500 is switched over to trickle charging and status message "*Max. CHRG time*" is shown on the display.

6.3 Charging AGM batteries

It is possible that the batteries used in some vehicles may be so-called AGM (**A**bsorbent **G**lass **M**at) batteries, i.e. batteries containing an absorbent glass-fiber mat.

These batteries require special attention. The charging voltage must never exceed 14.8V (or 29.6V for 24V batteries).

When AGM batteries are used, the adjustment of the MC1500's output voltage (see section 10.3) must therefore be made with particular care.

Warning: An AGM battery will be permanently damaged if the charging voltage exceeds 14.8V (or 29.6V for 24V batteries).

The MC1500 is supplied with the output voltage set below the allowable limit for AGM batteries.

6.4 Charging gel batteries

Gel batteries are used in some vehicles.

These batteries require special attention. The charging voltage must be between 14.1V and 14.8V (or 28.2V to 28.8V for 24V batteries).

The trickle-charge voltage should not exceed 13.8V (or 27.6V for 24V batteries).

When gel batteries are used, the adjustment of the MC1500's output voltage (see section 10.3) must therefore be made with particular care.

The charging current should be between 15A and 40A for every 100Ah of battery capacity. For the maximum permitted charging current, refer to the technical specifications of the gel battery in question.

Warning: If the gel battery's charging voltage or trickle-charge voltage exceeds the levels given above, battery life will be shortened. If these levels are regularly exceeded, the battery will be permanently damaged.

6.5 Charging motorcycle batteries

Motorcycle batteries generally have a significantly smaller capacity than car batteries. This can lead to the MC1500's maximum charging current (100A for 12V batteries) being too high for some battery types.

Should this be the case, the MultiCharger's output current limit must be set lower accordingly (see section 10.5).

For the maximum permitted charging current, refer to the technical specifications of the motorcycle battery in question.

6.6 Charging mode for 12V lithium-ion batteries (Charging LIO)

This operating mode is for charging 12V lithium-ion Batteries. The MC1500 is ready to use after it has been switched on by pressing control button 1 (on/off). This means that the output voltage of the charger unit remains 0V until a battery has been connected to the charger's output.

When connecting a battery, its voltage is measured first. If the voltage of the connected battery is not within the permissible range (see table in section 6.7 "Overview of applicable voltage ranges"), the MC1500 does not switch on and the output voltage remains at 0V, and the LCD displays an error message "Faulty battery".

If the battery is within an applicable 12V voltage range, the selects the corresponding output voltage and charges the battery (see table in section 6.7). The LCD displays the message "12V LIO charge".

Charging continues until the charging current falls below the limit of 2.5A. After that the MC1500 switches over to trickle charging without any post-charging time.

During trickle charging, the voltage is increased to charging-voltage level every 3 minutes to avoid battery discharging due to low currents (high voltage stability of lithium-ion battery). The charger unit will switch over to charging again if the current rises back above 2.5A during this test. Hence, the charging cycle starts again.

If, during an adjustable time (default setting 12h), the charging current doesn't fall below 2.5A, the MultiCharger 1500 is switched over to trickle charging and status message "Max. CHRg time" is shown on the display.

6.7 Overview of applicable voltage ranges

The following table provides an overview of the applicable voltage ranges battery charging:

Voltage range	MultiCharger ready for use	Error message	MultiCharger at 14.0V/LIO at 14.8V/Pb	MultiCharger at 28.8V
0V to 5V	x			
5V to 7V		x		
7V to 15V			x	
15V to 17V		x		
17V to 30V				x
>30V		x		

6.7.1 Output voltage in battery charging mode

The following table gives an overview of the MC1500's default voltage levels:

Charging 12V Pb	Trickle charging 12V Pb	Charging 12V LIO	Trickle charging 12V LIO	Charging 24V Pb	Trickle charging 24V Pb
14.8V	13.4V	14.0V	13.4V	28.8V	26.8V

The charging process can be stopped by pressing button 2 (Start/Stop). If the battery remains connected, the charging process can be continued by pressing button 2 (Start/Stop) again. If the battery is disconnected, the charging process is over and will be restarted automatically if the battery is connected again.

If the battery is disconnected during the charging process without pressing button 2 (Start/Stop), the process will likewise be stopped. It will be restarted again automatically if the battery is reconnected.

Warning:

Disconnecting the battery without prior termination of the charging process can result in temporary sparking.

The charging process can also be stopped at any time by pressing button 1 (On/Off). When the MultiCharger 1500 is switched back on, the charging process would then begin again from the start.

6.7.2 Output current in battery charging mode

In the battery charging mode, the MC1500 can be briefly (max. 1 minute) subjected to an output current increased by 25%.

The following table provides an overview of the maximum levels of output current for the MC1500:

Inominal for 12V CHRG Pb	I _{max} for 12V CHRG Pb	Inominal for 12V CHRG LIO	I _{max} for 12V CHRG LIO	Inominal for 24V CHRG Pb	I _{max} for 24V CHRG Pb
80.0A	100.0A	80.0A	100.0A	40.0A	50.0A

If the MC1500's nominal current is exceeded during use, the charger unit internally measures how long this situation lasts. After a maximum of 1 min, the current limit is reset to the nominal value.

To avoid overheating of the M1500, the charger unit allows a period of time for the charger to recover which is five times as long as the duration for which the nominal current has been exceeded. For example, if the nominal current is exceeded for 30s, the output current of the MC1500 is limited to nominal current for 2.5min. After that time, the nominal current can again be exceeded.

6.8 EPS mode

This operating mode enables power to be supplied to vehicles that have no battery. Once the MC1500 has been switched on by pressing control button 1 (On/Off), it is ready for use. That means that the MC1500's output voltage will stay at zero volts until button 2 (Start/Stop) is pressed.

The MC1500 then starts to charge at the relevant voltage.

The following table contains an overview of the default setting of voltage levels for the EPS mode:

EPS 12V mode	EPS 24V mode
14.2V	28.0V

The output voltage on the MC1500 remains switched on until button 2 (Start/Stop) is pressed again. When this button is pressed, the MC1500 switches the output voltage to 0V until control button 2 (Start/Stop) is pressed once again. Then, the output voltage is switched back on again.

The output voltage can also be switched off by pressing button 1 (On/Off).

Connecting a battery (with a voltage of >1V) to the MC1500 before the output voltage is switched on is not allowed. If this is done, a '*Return voltage*' error message will appear. The output voltage at the MC1500 cannot be switched on until the battery is removed.

Warning:

It is not permissible to connect a battery to the MC1500 while the charger unit is in EPS mode.

6.9 EPS autostart mode

This mode works in a similar way to the EPS mode. The difference between the two operating modes is that the EPS autostart mode requires a battery to be connected to the MC1500. The MC1500 automatically sets the output voltage according to the battery connected.

7 Operating modes (temporary settings)

7.1 Setting of operating modes

Several operating modes can be temporarily set. This temporary setting is possible without entering any password and applies for one charging cycle only. Installed batteries as well as batteries removed from the vehicle can be charged using the functions described in 7.2 to 7.4. The procedure is subsequently described in tabular form.

7.2 Charging mode for lithium-ion batteries, temporary

The MC1500 is in its permanently set operating mode "charging Pb" and is to be set to "Charging LIO" for one charging cycle.

	Message on display
Press button 1 "On/OFF" to switch on unit	Pb no contact
Press button 4/5 „up or down“ until	Charging LIO
Press button 3 „Enter“	LIO no contact
Connect battery, red L+ / black L-	
Battery will be recognized	CHRG 12V on
Battery charging starts	charging 12V
Battery charging active	12V LIO charge
Yellow LED on if charging current >3A	
Green LED on if charging current <3A	
Press button 2 "Start/Stop"	LIO 12V standby
Disconnect battery	System test
	Pb no contact

7.3 Charging mode for lead-acid batteries, temporary

The MC1500 is in its permanently set operating mode "Charging LIO" and is to be set to "Charging Pb" for one charging cycle.

	Message on display
Press button 1 "On/OFF" to switch on unit	LIO no contact
Press button 4/5 "Up or Down" until	Charging Pb
Press button 3 "Enter"	Pb no contact
Connect battery, red L+ / black L-	
Battery is recognized	CHRG 12V on
Battery charging starts	charging 12V
Battery charging active	12V Pb charge
Yellow LED on if charging current >3A	
Green LED on if charging current <3A	
Press button 2 "Start/Stop"	Pb 12V standby
Disconnect battery	System test
	LIO no contact

7.4 Refresh (if disconnecting switch of the lithium-ion battery is open)

The lithium-ion battery is equipped with a disconnecting switch to protect the battery against e.g. exhaustive discharge. In the case of an error, the disconnecting switch opens and isolates the battery from the load. The function "Refresh" is used to reclose the disconnecting switch.

	Message on display
Press button 1 "On/OFF" to switch on unit	Pb no contact <i>or</i> LIO no contact
Press button 4/5 "Up or Down" until	LIO Batt Refresh
Press button 3 "Enter"	Refresh Start?
Connect battery, red L+ / black L-	
Press button 2 "Start/Stop"	Refresh Stop?
Green LED keeps flashing	12V LIO charge (<i>disconnecting switch open</i>)
Yellow LED on if charging current >3A	12V LIO charge (<i>disconnecting switch closed</i>)
Green LED on if charging current <3A	
Press button 2 "Start/Stop"	LIO 12V standby
Disconnect battery	System test
	Pb/LIO no contact

7.5 Shutdown (only possible in the charging mode for lithium-ion batteries)

Cold temperatures and high battery-charging currents can lead to a situation in which the disconnecting switch of the lithium-ion battery opens. To avoid the vehicle becoming de-energized after battery charging and disconnection of charging cable, the function "Shutdown" can be used. This function checks during charging if the disconnecting switch of the battery is closed. This function is only active in the operating mode "Charging LIO".

	Message on display
Battery charging active	12V LIO charge
Yellow LED on if charging current >3A	12V LIO charge
Green LED on if charging current <3A	
Press button 3 "Enter"	LIO Shutdown
Green LED on	Shutdown ok
Red LED flashes	Shutdown error
Disconnect battery	Clamp contact
	Pb/LIO no contact

8 Internal monitoring

The MC1500 has several internal monitoring functions that ensure safe operation. These functions are individually described in the following sub-sections.

8.1 Mains power monitoring

If the supply voltage drops below 85V, the MultiCharger signals a fault and switches off. The message "*Mains error*" appears on the LCD.

If the supply voltage rises above 90V, the MC1500 can be made ready for use by pressing button 1 (On/Off).

8.2 Monitoring of intermediate-circuit voltage

Intermediate-circuit voltage is monitored for undervoltage and overvoltage. If either limit (350V and 430V, respectively) is passed, the MC1500 signals a fault and switches off to the unlocked position. The message "*PFC error*" appears on the LCD and the red LED comes on. If either of the limits is exceeded again after restarting, the MultiCharger is switched off to the locked position.

8.3 Output overvoltage

For safety reasons, the output voltage is monitored for excessive levels in two independent ways.

The threshold of the controller-independent hardware monitoring for the overvoltage output is fixed at 16V or 32V. This monitors the internal output voltage. If the internal voltage exceeds this threshold, the MC1500 signals a fault and switches off to the locked position. The message "*OVP error*" appears on the LCD and the red LED comes on.

The digital-monitoring threshold for overvoltage output is adjustable. The default setting for this is also 16V or 32V. If the output voltage exceeds this threshold, the MC1500 signals a fault and switches off to the locked position. The message "*Overvoltage*" appears on the LCD and the red LED comes on.

8.4 Output undervoltage

The monitoring threshold for output undervoltage is 7V or 14V.

If the output voltage falls below this threshold, the MC1500 signals a fault and switches off to the locked position. The message "*Voltage too low*" appears on the LCD and the red LED comes on.

8.5 Output overcurrent

If, due to an internal fault in the charger unit, the output current exceeds the prevailing current-limit level by more than 25%, the MC1500 signals a fault and switches off to the locked position. The message "*Overcurrent*" appears on the LCD and the red LED comes on.

8.6 Temperature monitoring

This monitoring function measures the temperature inside the MC1500. If the temperature rises above the maximum limit of 90°C, the MultiCharger signals a fault and is switched off without locking. The message "*Temperature err.*" appears on the LCD and the red LED comes on. The MC1500 remains ready for use.

If the temperature falls back below the limit, the error message is automatically cancelled.

8.7 Relay monitoring

This function monitors the internal relay switches in the MC1500's power circuit. If there is a problem, the MC1500 signals a fault and switches off to the locked position. The message "*Internal error*" appears on the LCD and the red LED comes on.

9 External monitoring

The MC1500 has a number of external monitoring functions that keep a constant check on connected power consumers. These functions are individually described in the following subsections.

9.1 Short circuit

The MC1500 can detect an output short circuit if this occurs in the current limiter and if the output voltage falls below the set lower limit (default setting 7V or 14V). In this case, the MC1500 signals a fault and switches off to the locked position. The message "*Short circuit*" appears on the LCD and the red LED flashes.

9.2 Reverse polarity

If a battery is connected with reverse polarity, the MC1500 signals a fault but remains ready for use. This does not do damage the MC1500. No charging or trickle charging process will be started. The message "*Reverse polarity*" appears on the LCD and the red LED flashes.

9.3 Faulty battery

If the battery connected to the charger has an output voltage outside of the permitted limits (see section 6.7), the MC1500 signals a fault and the charging process does not start. The message "*Faulty battery*" appears on the LCD and the red LED flashes.

9.4 Clamp contact

This monitoring function is active in all operating modes (see section 6).

If the MC1500's output current falls below 10mA during the charging or trickle charging process, the charger unit recognizes that the clamps have been removed from the battery terminals and it briefly signals a fault. The message "*Clamp contact*" appears on the LCD and the red LED flashes but the MC1500 remains ready for use.

9.5 Return voltage

This monitoring function is only active in EPS mode (see section 6.8).

It is not permitted to connect a battery to the MC1500 in this operating mode. If, in spite of that, a battery is connected prior charging, the charger unit signals a fault. The message "*Return voltage*" appears on the LCD and the red LED flashes but the charger unit remains ready for use.

9.6 Return voltage with reversed polarity

This monitoring function is only active in EPS mode (see section 6.8).

It is not permitted to connect a battery to the MC1500 in this operating mode. If, in spite of that, a battery is connected with reverse polarity prior charging, the charger unit signals a fault. This does not do damage the MC1500. The message "*EPS reverse pole*" appears on the LCD and the red LED flashes but the MC1500 remains ready for use.

9.7 Shutdown error

This monitoring function is only active during the manual test of the battery-internal disconnecting switch (see section 10.3.7) in the operating mode "Charging LIO". If the test reveals that the disconnecting switch is open, the MC1500 signals a fault. The message "*Shutdown error*" appears on the LCD and the red LED flashes.

9.8 Refresh error

This monitoring function is only active when manually closing the disconnecting switch (see section 7.4) in the operating mode „LIO Batt Refresh“. If the test reveals that the disconnecting switch does not close, the MC1500 signals a fault. The message "*Refresh error*" appears on the LCD and the red LED flashes.

10 Service menu

The service menu is used to make basic system settings at the MC1500. The structure of this menu is set out below. To avoid mistakes, these settings are protected by a code which should be given access only to properly trained persons.

The code for using the service menu is: **0109**:

Modification of parameters such as charging voltage, current limits, monitoring limits and process times must be made appropriately. Inappropriate changes can influence functionality.

None of the settings can be changed unless the MC1500 is ready for use, i.e. unless it has been switched on with control button 1 (On/Off). However, there should be no active charging procedure and no battery connected to the output.

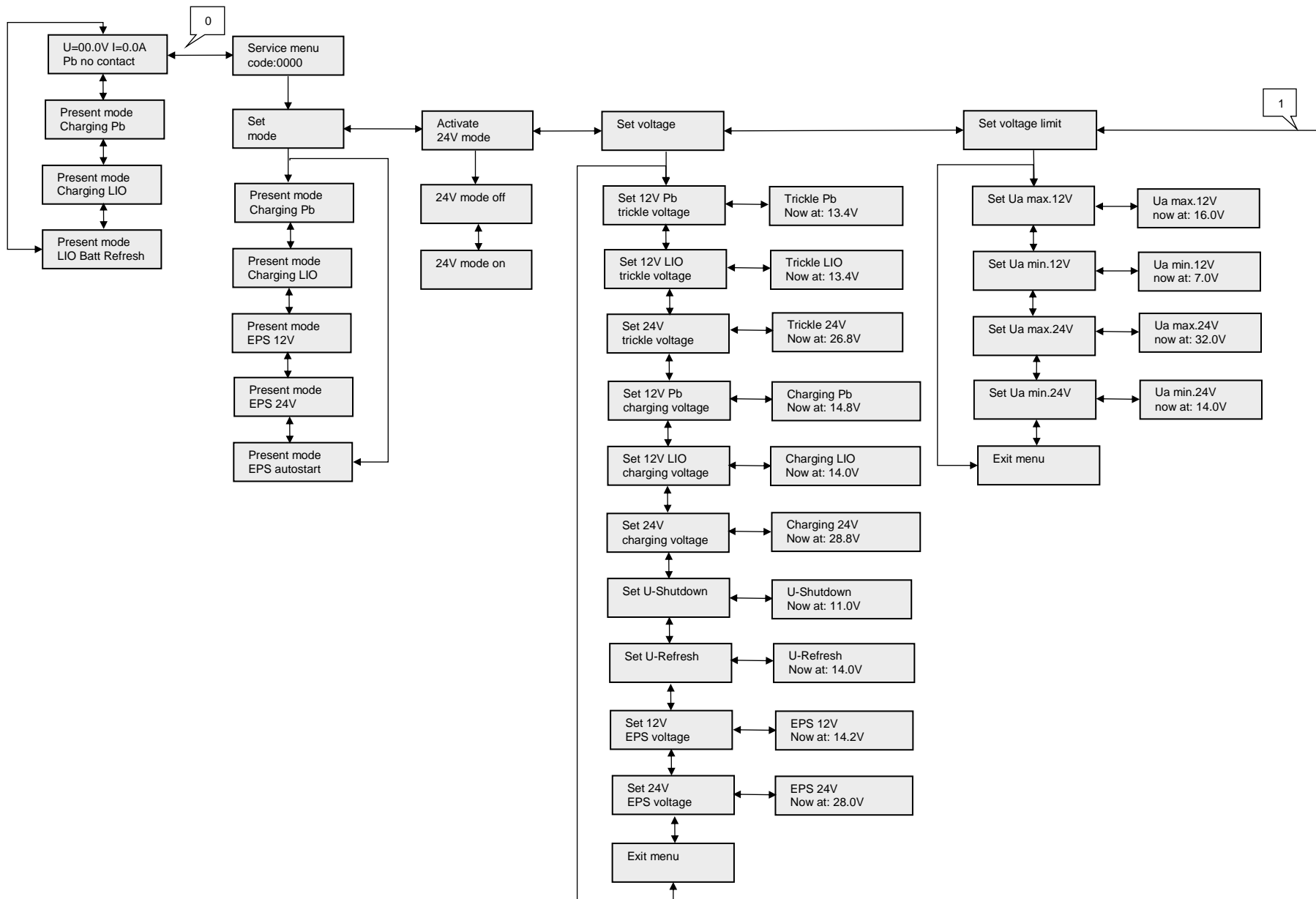
When button 3 (Enter) is pressed, a prompt appears on the LCD to enter a password. This consists of four numeric characters and can be entered by using button 3 (Enter), button 4 (Up) and button 5 (Down). Each of the four characters is selected using button 4 (Up) and button 5 (Down) and then confirmed with button 3 (Enter).

After correctly entering the password, you get to the MC1500's service menu.

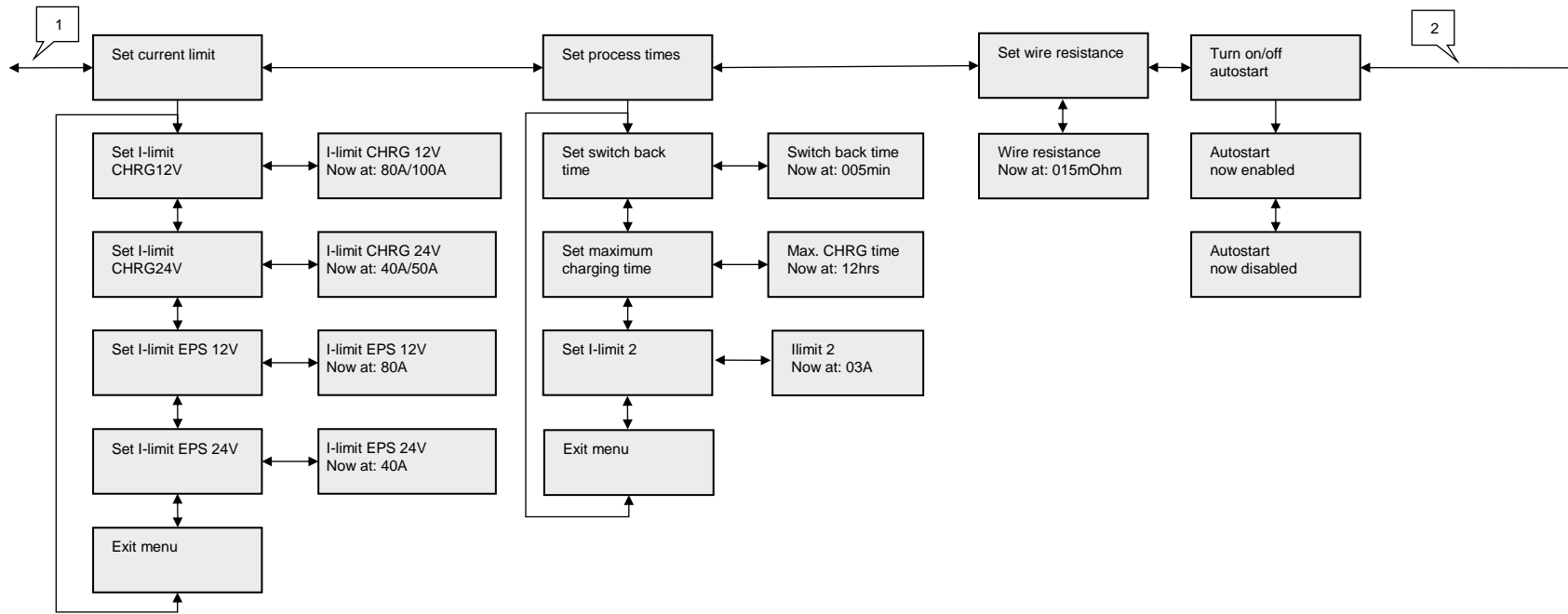
This menu is also navigated by using buttons 3, 4 and 5.

All of the setting options are described below:

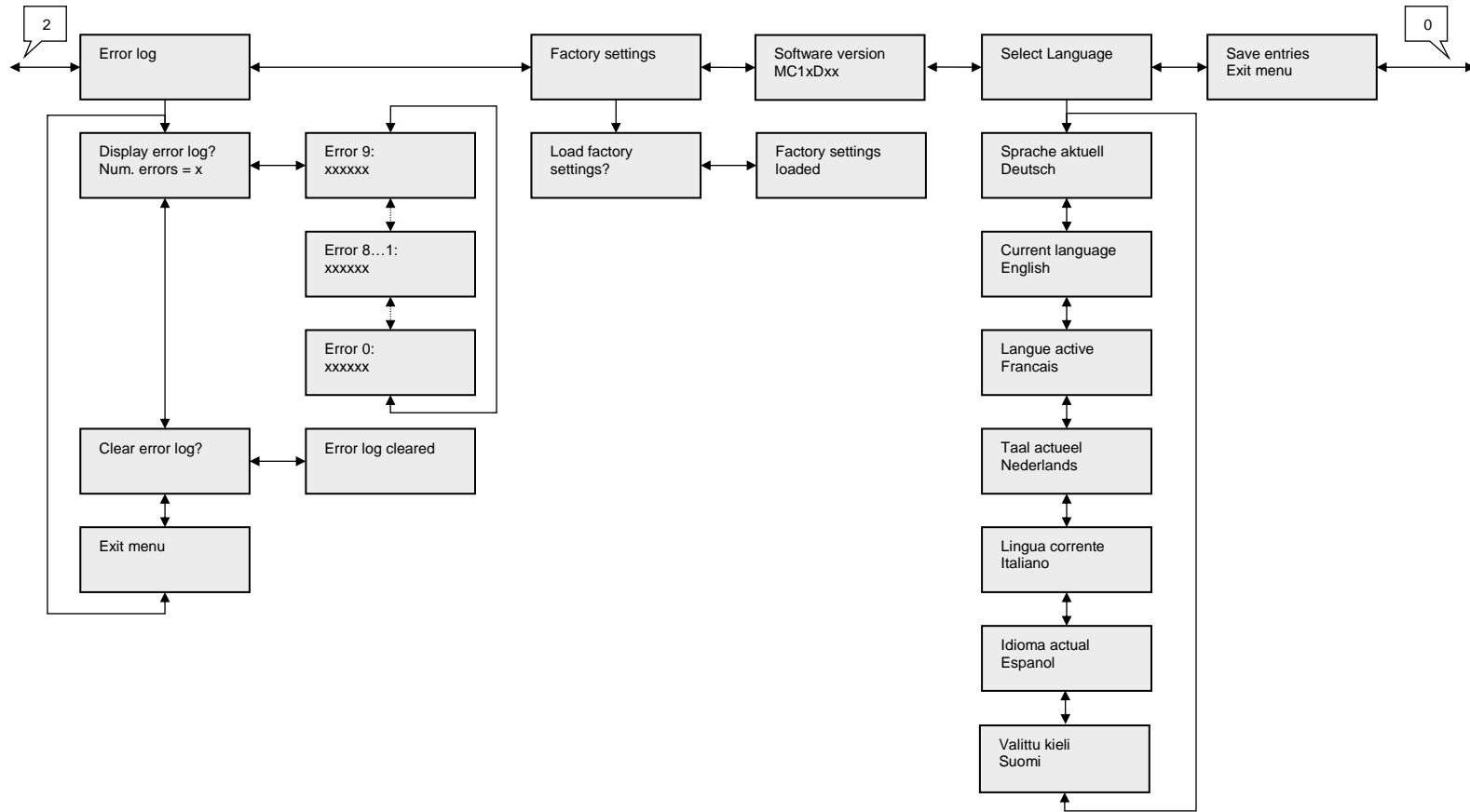
Structure of service menu



Structure of service menu



Structure of service menu



10.1 Setting of operating modes

The '**Set mode**' menu allows the setting and activation of the different operating modes of the MC1500.

These settings should be made very carefully to avoid any potential damage to the vehicle connected to the charger (e.g. connecting a charger in EPS 24V mode to a vehicle with a 12V electrical system will cause damage to the vehicle).

10.1.1 Charging Pb

This is a sub-item of the "**Set mode**" menu. It is used to set the MC1500 to the charging mode for lead-acid batteries. The functioning of this operating mode is described in more detail in section 6.2.

10.1.2 Charging LIO

This is a sub-item of the "**Set mode**" menu. It is used to set the MC1500 to the charging mode for lithium-ion Batteries. The functioning of this operating mode is described in more detail in section 6.6.

10.1.3 EPS 12V mode

This is a sub-item of the "**Set mode**" menu. It is used to set the MC1500 to external power supply mode. The functioning of this mode is described in more detail in section 6.8.

10.1.4 EPS 24V mode

This is a sub-item of the "**Set mode**" menu. It is used to set the MC1500 to external power supply mode. The functioning of this mode is described in more detail in section 6.8. The setting of the "**EPS 24V**" mode is only possible if it is already enabled (see section 10.2).

10.1.5 EPS autostart mode (Auto. start EPS)

This is a sub-item of the "**Set mode**" menu. It is used to set the MC1500 to external power supply mode with automatic battery-voltage recognition. The functioning of this mode is described in more detail in section 6.9.

10.2 Activate 24V mode

The "**Activate 24V mode**" menu allows activation or deactivation of all operating modes with 24V nominal voltage. These settings should be made with particular care to ensure that unauthorized use of the charger with 24 V operating voltage is not possible. Such use could cause damage to any vehicle that might be connected to the charger.

10.2.1 24V mode on/off

These are sub-items of the "**Activate 24V mode**" menu. This is where 24V modes are activated (turned on) or deactivated (turned off). If the MC1500 is in a 24V operating mode and this is deactivated, a 12V mode will be automatically activated as a result.

As soon as the 24V operating modes are deactivated, it is no longer possible to activate these from the "**Set mode**" menu.

If a 24V battery is connected to the MC1500 in this state, the charger unit will display a faulty-battery message.

10.3 Set voltage

The "**Set voltage**" menu enables the level of the MC1500 output voltage to be set.

10.3.1 Set 12V Pb trickle voltage

This is sub-item of the "**Set voltage**" menu. It is used to set the trickle-charge voltage to 12V for the operating mode for charging 12V lead-acid batteries.

Default setting: 13.4V Setting range: 9.0V to 16.0V

10.3.2 Set 12V LIO trickle voltage

This is a sub-item of the "**Set voltage**" menu. It is used to set the trickle-charge voltage to 12 V for the operating mode for charging 12 V lithium-ion batteries.

Default setting: 13.4V Setting range: 9.0V to 16.0V

10.3.3 Set 24V trickle voltage

This is a sub-item of the "**Set voltage**" menu. It is used to set the trickle-charge voltage for the 24V battery-charging mode.

Default setting: 26.8V Setting range: 26.0V to 28.0V

10.3.4 Set 12V Pb charging voltage

This is a sub-item of the "**Set voltage**" menu. It is used to set the charging voltage to 12V for the operating mode for charging 12V lead-acid batteries.

Default setting: 14.8V Setting range: 9.0V to 16.0V

10.3.5 Set 12V LIO charging voltage

This is a sub-item of the "**Set voltage**" menu. It is used to set the charging voltage to 12V for the operating mode for charging 12V lithium-ion batteries.

Default setting: 14.0V Setting range: 9.0V to 16.0V

10.3.6 Set 24V charging voltage

This is a sub-item of the "**Set voltage**" menu. It is used to set the charging voltage for the 24V battery-charging mode.

Default setting: 28.8V Setting range: 27.0V to 30.0V

10.3.7 Set U-Shutdown

This is a sub-item of the "**Set voltage**" menu. It is used to set the output voltage for the shutdown function. This function is only active in the operating mode "Charging LIO".

Default setting: 11.0V Setting range: 9.0V to 16.0V

10.3.8 Set U-Refresh

This is a sub-item of the "**Set voltage**" menu. It is used to set the output voltage for the refresh function.

Default setting: 14.0V Setting range: 9.0V to 16.0V

10.3.9 Set 12V EPS voltage

This is a sub-item of the "**Set voltage**" menu. It is used to set the output charge voltage for the operating mode "12V external power supply".

Default setting: 14.2V Setting range: 9.0V to 16.0V

10.3.10 Set 24V EPS voltage

This is a sub-item of the "**Set voltage**" menu. It is used to set the output charge voltage for the operating mode "24V external power supply".

Default setting: 28.0V Setting range: 27.0V to 30.0V

10.4 Set voltage limits

The "**Set voltage limit**" menu is used to set the monitoring limits for overvoltage and undervoltage.

10.4.1 Set Ua max. 12V

This is a sub-item of the "**Set voltage limit**" menu. It is used to set the monitoring limit for overvoltage where output voltage is 12 V.

Default setting: 16.0V Setting range: 9.0V to 16.0V

10.4.2 Set Ua min. 12V

This is a sub-item of the "**Set voltage limit**" menu. It is used to set the monitoring limit for undervoltage where output voltage is 12V.

Default setting: 7.0V Setting range: 7.0V to 10.0V

10.4.3 Set Ua max. 24V

This is a sub-item of the "**Set voltage limit**" menu. It is used to set the monitoring limit for overvoltage where output voltage is 24V.

Default setting: 32.0V Setting range: 30.0V to 32.0V

10.4.4 Set Ua min. 24V

This is a sub-item of the "**Set voltage limit**" menu. It is used to set the monitoring limit for undervoltage where output voltage is 24V.

Default setting: 14.0V Setting range: 14.0V to 20.0V

10.5 Output-current limits (I-limits)

The "**Set current limit**" menu is used to set the level of the MC1500's maximum nominal current. The MC1500 can constantly deliver whatever current level is entered here. In the battery-charging mode, this level can also be exceeded by 25% for a maximum period of 1min.

10.5.1 Set I-limit CHRG12V

This is a sub-item of the "**Set current limit**" menu. It is used to set the MC1500's maximum nominal current for the 12V battery-charging mode.

Default setting: 80.0A/100A Setting range: 0.0A to 80.0A/100A

10.5.2 Set I-limit CHRG24V

This is a sub-item of the "**Set current limit**" menu. It is used to set the MC1500's maximum nominal current for the 24V battery-charging mode.

Default setting: 40.0A/50A Setting range: 0.0A to 40.0A/50A

10.5.3 Set I-limit EPS 12V

This is a sub-item of the "**Set current limit**" menu. It is used to set the MC1500's maximum nominal current for the 12V external power supply mode.

Default setting: 80.0A Setting range: 0.0A to 80.0A

10.5.4 Set I-limit EPS 24V

This is a sub-item of the "**Set current limit**" menu. It is used to set the MC1500's maximum nominal current for the 24V external power supply mode.

Default setting: 40.0A Setting range: 0.0A to 40.0A

10.6 Set process times

The "**Set process times**" menu is used to set relevant times for the battery-charging mode.

10.6.1 Set switch back time

This is sub-item of the "**Set process times**" menu. It is used to set the duration for secondary battery charging. This time begins as soon as the battery's charging current falls below 2.5A. After this, the MC1500 stays on charge until the expiry of the switch back delay time set here. It then switches to trickle charge.

Default setting: 5min Setting range: 0min to 999min

10.6.2 Set maximum charging time

This is a sub-item of the "**Set process times**" menu. It is used to set maximum time for battery charging. If the battery's charging current does not fall below 2.5A, charging stops at the end of the maximum charging time which has been entered in this submenu.

Default setting: 12h Setting range: 0h to 65h

10.6.3 Set I-limit 2

This is a sub-item of the "**Set process times**" menu. It can be used to set the signaling threshold for the LED at the display or for the signal lamp. If the charging current of the battery falls below the current limit 2, the signal changes from yellow to green. The charging process is not interrupted and the LCD continues to display the charging status.

Default setting: 3.0A Setting range: 0A to 20A

10.7 Set cable (wire) resistance

The menu "Set wire resistance" is used to set the resistance for cable compensation.

Default setting: 15m Ω Setting range: 0m Ω to 255m Ω

10.8 Turn on/off autostart

The "**Turn on/off autostart**" menu is used to enable or disable the automatic starting function for battery charging in the battery-charging mode.

10.8.1 Autostart now enabled and Autostart now disabled

These are the sub-items of the "**Turn on/off autostart**" menu. They are used to enable or disable the autostart function.

Enabling autostart means that the MC1500 (if switched on and in battery charging mode) will begin the charging process as soon as a battery is connected, with no need for any other instructions to be entered.

Disabling autostart means that the MC1500 (switched on and in battery charging mode) will only begin the charging process after a battery has been connected and button 2 (Start/Stop) has been pressed.

Default setting: autostart enabled

10.9 Error log

The last 10 internal and external errors are stored in the "**Error log**" and can be retrieved on demand.

10.9.1 Error 0 - 9

This is a sub-item of the '**Error log**' menu. It allows the retrieval of the last 10 internal or external errors.

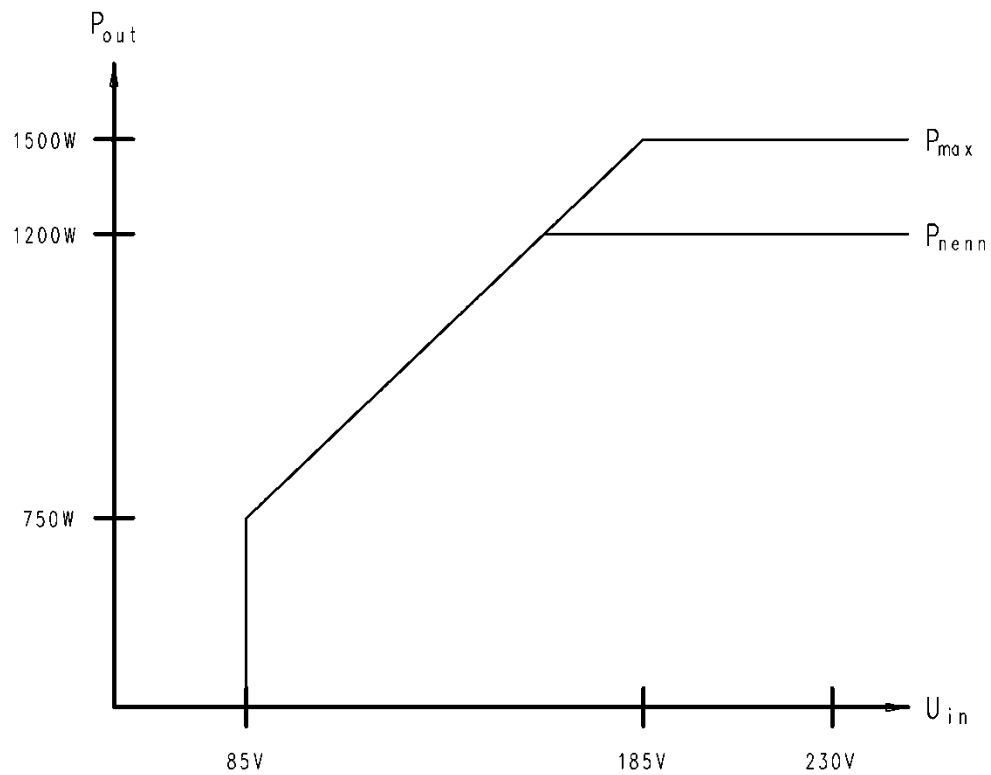
Error 9 is the most recent error, while error 0 is the oldest one in the memory. If over the course of time more than 10 errors occur, the oldest one is always deleted from the memory.

This menu item also provides the option to clear all of the errors out of the log.

11 Derating

The output power is regulated according to the mains input voltage (see diagram). This prevents the mains input current from exceeding the maximum value.

Output power curve:



P_{nenn} = nominal power

12 Factory (default) settings

Selecting the "**Factory settings**" menu and pressing the "**Enter**" key restores the following parameters to their default settings.

12V Pb charging voltage	: 14.8V
12V LIO charging voltage	: 14.0V
24V charging voltage	: 28.8V
12V Pb trickle charge voltage	: 13.4V
12V LIO trickle charge voltage	: 13.4V
24V trickle charge voltage	: 26.8V
Shutdown voltage	: 11.0V
Refresh voltage	: 14.0V
12V EPS voltage	: 14.2V
24V EPS voltage	: 28.0V
12V charging current limit	: 80.0A/100.0A
24V charging current limit	: 40.0A/50.0A
12V EPS current limit	: 80.0A
24V EPS current limit	: 40.0A
12V Ua max.	: 16.0V
24V Ua max.	: 32.0V
12V Ua min.	: 7.0V
24V Ua min.	: 14.0V
Switch back delay	: 005min
Maximum charging time	: 12h
Current limit 2	: 3.0A
Operating mode	: battery charging mode 12V Pb
Autostart	: enabled
24V operating modes	: off

The MC1500 provides the option to make permanent changes to the default settings through external software. In this case, the charger's settings may vary from those shown above. If the default settings are changed, this should be marked in the accompanying documentation.

13 Select language

The "**Select language**" menu can be used to select one of the following languages:

- German
- English
- French
- Dutch
- Italian
- Spanish
- Finnish

Each language is shown on the selection menu in that particular language.

14 Technical data

Type:	12V/100A...24V/50A battery charger
Nominal output:	1200W
Maximum output:	1500W
DC output:	
Nominal voltage:	12V/24V
Max. output current:	80A at 12V (100A for max. 1 min in battery-charging mode) 40A at 24V (50A for max. 1 min in battery-charging mode)
Control:	static tolerance of output voltage: 1% control response for sudden changes of load: 10% for $t_a < 10\text{ms}$, $\Delta U_a < 0.6\text{V}$ (t_a response time, max. U_a deviation)
Short-circuit protection:	current limiting, permanently short-circuit proof
Short-circuit response:	IV characteristic according to DIN41772/73
Mains input:	
Operating voltage:	single phase
Operating-voltage range:	90V to 264V
Nominal frequency:	50Hz
Frequency range:	47Hz to 63Hz
Displacement factor ($\cos\phi$):	1
Power factor (λ):	0.99
Input current in "worst case":	10A
Efficiency factor under nominal conditions:	0.88
Signaling:	LCD (2 × 16 characters) 5 control buttons (display and operation)

Electromagnetic compatibility:	Emission according to	EN 61000-6-3 EN 61000-3-2 EN 61000-3-3
	Immunity according to	EN 61000-6-2
Degree of protection:	IP 52	
Class of protection:	class I according to EN 60335	
Operating temperature:	–20°C to 60°C, with current reduction starting from 40°C ambient temperature	
Type of cooling:	Natural convection (without fan)	
MTBF:	>250 000 hours	
Climatic requirements:	max. 95% relative humidity, non-condensing	
Safety specifications:	EN 60335	
CE marking according to:	EMVG (EMC law)	
Weight:	6.5g	
Dimensions (H × W × L):	110 × 320 × 370 mm (incl. handles)	
Connection types:		
Mains:	inlet connector for non-heating appliances	
Direct current:	bayonet connector	
Interface:	15-pole D-Sub connector 9-pole D-Sub connector Mini-USB socket	
Sensor:	3-pole M8 plug-in connector (only for special applications)	

15 Appendix A Status and error descriptions

Error messages and operating-status details are shown as plain text on the LCD. These messages are described below:

Status displays:

System test	Internal test routines in progress
CHRG 12V on	Mode prior to start of charging process (section 6.2, section 6.6)
24V CHRG on	Mode prior to start of charging process (section 6.2)
Pb no contact	No battery connected (section 6.2)
LIO no contact	No battery connected (section 6.6)
Start CHRG mode?	Prompt to start charging mode if auto start is disabled (section 10.8)
12V Pb charge	12V charging of lead-acid battery in progress (section 6.2)
12V LIO charge	12V charging of lithium-ion battery in progress (section 6.6)
Charge 24V on	24V battery charging in progress (section 6.2)
Pb 12V standby	12V battery charging on standby (section 6.2)
LIO 12V standby	12 V battery charging on standby (section 6.6)
CHRG 24V standby	24V battery charging on standby (section 6.2)
12V Shutdown	Test if the battery contactor (disconnecting switch) is closed, only for lithium-ion batteries (section 7.5)
Shutdown ok	Evaluation if the battery contactor (disconnecting switch) is closed, only for lithium-ion batteries (section 7.5)
Refresh Start?	Prompt to start refresh (section 7.4)
Refresh Stop?	Prompt to stop refresh (section 7.4)
Battery full	Battery fully charged before end of maximum charging time (section 6.2, section 6.6)
Max. CHRG time	Maximum charging time over, battery not fully charged (section 6.2, section 6.6)
Start EPS-12V?	Prompt to start 12V EPS mode (section 6.8)
Start EPS 24V?	Prompt to start 24V EPS mode (section 6.8)
Stop EPS-12V?	Prompt to stop 12V EPS mode (section 6.8)
Stop EPS 24V?	Prompt to stop 24V EPS mode (section 6.8)
Auto. start EPS	EPS autostart mode (section 6.9)
No EPS contact	No battery connected in EPS autostart mode (section 6.9)

Error messages:

Mains error	No mains voltage lower than 85V (section 8.1)
PFC error	Intermediate-circuit voltage is incorrect (section 8.2)
Overvoltage	Output voltage too high (section 8.3)
OVP error	Output voltage too high (section 8.3)
Voltage too low	Output voltage too low (section 8.4)
Overcurrent	Output current too high (section 8.5)
Temperature err.	Internal temperature too high (section 8.6)
Internal error	Internal defect in the charger (section 8.7)
Short circuit	Short circuit at the output (section 9.1)
Reverse polarity	Battery reversely connected (section 9.2)
Faulty battery	Voltage of connected battery not allowed (section 9.3)
Clamp contact	No connection between battery and MultiCharger 1500 (section 9.4)
Return voltage	Battery connected in EPS mode (section 9.5)
EPS reverse pole	Battery reversely connected in EPS mode (section 9.6)
Shutdown error	Evaluation that the battery's disconnecting switch is not closed, only for lithium-ion batteries (section 9.7)
Refresh error	Evaluation that the battery's disconnecting switch is not closed, only for lithium-ion batteries (section 9.8)