DAKAR SINE WAVE COMBI

12/2500-100, 24/3000-100 & 48/3000-50
12/1500-50 & 24/1800-35

INVERTER/CHARGER COMBINATION
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1 GENERAL INFORMATION

1.1 USE OF THIS MANUAL

This manual serves as a guideline for the safe and effective operation, maintenance and possible correction of minor malfunctions of the COMBI. This manual is valid for ten models:

1. COMBI 12/2500-100 230V AC, art. no 03-00-12500.
2. COMBI 12/2500-100 117V AC, art. no 03-10-12500.
3. COMBI 24/3000-100 230V AC, art. no 03-00-23000.
4. COMBI 24/3000-100 117V AC, art. no 03-10-23000.
5. COMBI 48/3000-50 230V AC, art. no 03-00-43000.
6. COMBI 48/3000-50 117V AC, art. no 03-10-43000.
7. COMBI 12/1500-50 230V AC, art. no 03-00-11500.
8. COMBI 12/1500-50 117V AC, art. no 03-10-11500.
9. COMBI 24/1800-35 230V AC, art. no 03-00-21800.
10. COMBI 24/1800-35 117V AC, art. no 03-10-21800.

It is therefore obligatory that every person who works on or with the COMBI must be completely familiar with the contents of this manual, and that he/she carefully follows the instructions contained herein. Installation of, and work on the COMBI, may be carried out only by qualified, authorized and trained personal, consistent with the locally applicable standards and taking into consideration the safety guidelines and measures (chapter 2 of this manual). The English version contains 32 pages.

1.2 GUARANTEE SPECIFICATIONS

Mastervolt guarantees that this unit has been built according to the legally applicable standards and specifications. Should work take place, which is not in accordance with the guidelines, instructions and specifications contained in this users manual, then damage may occur and/or the unit may not fulfil its specifications. All of these matters may mean that the guarantee may become invalid.

1.3 QUALITY

During their production and prior to their delivery, all of our units are exhaustively tested and inspected. The guarantee period is two years.

1.4 VALIDITY OF THIS MANUAL

All of the specifications, provisions and instructions contained in this manual apply solely to the Mastervolt-delivered standard versions of the Mastervolt COMBI.

1.5 LIABILITY

Mastervolt can accept no liability for:
- damage due to use of the COMBI;
- possible errors in the manual and the results thereof.

Careful!
Never remove the type number plate. Important technical information required for service, maintenance & secondary delivery of parts can be derived from the type number plate.

1.6 CHANGES TO THE COMBI

Changes on the COMBI may be carried out only after the written permission of Mastervolt.
2 SAFETY GUIDELINES AND MEASURES

2.1 WARNINGS AND SYMBOLS

Safety instructions and warnings are marked in this manual by the following pictograms:

⚠️ Careful!
special data, restrictions and rules with regard to preventing damage

⚠️ a WARNING refers to possible injury to the user or significant material damage to the COMBI if the user does not (carefully) follow the procedures.

Never use the COMBI at locations where there is danger of gas or dust explosion!

3 Use other than as mentioned under 2 is not considered to be consistent with the intended purpose. Mastervolt is not liable for any damage resulting from the above.

2.2 USE FOR INTENDED PURPOSE

1 The COMBI is constructed as per the applicable safety-technical guidelines.

2 Use the COMBI only:

- for the charging of 12V, 24V and 48V lead acid batteries and the supply of users attached to these batteries, in permanent systems;

- connected to a dedicated double pole circuit breaker (MCB) or earth leakage;

- with a fuse, protecting the wiring between COMBI output and battery;

- in a technical correct condition;

- in a closed, wel-ventilated room, protected against rain, moist, dust and not condensing circumstances;

- observing the instructions in the users manual.

2.3 ORGANIZATIONAL MEASURES

The user must always:

- have access to the users manual;

- be familiar with the contents of this manual. This applies particular to chapter 2, Safety Guidelines and Measures.

2.4 MAINTENANCE & REPAIR

1 If the COMBI is switched off during maintenance and/or repair activities, it should be secured against unexpected and unintentional switching on:

- remove the fuse(s) from the AC supply or;

- switch off the AC circuit breaker;

- switch off the connection with the batteries or remove the COMBI fuse;

- be sure that third parties cannot reverse the measures taken.

2 If such are required, use only original spare parts.
2.5 WARNING FOR SPECIAL DANGERS

1 Secure the DC wiring with a fuse, according to the guidelines in this user manual.

2 Connection and protection must be done in accordance with local standards.

3 Do not work on the COMBI or the system if it is still connected to a current source. Only allow changes in your electrical system to be carried out by qualified electricians.

4 Check the wiring at least once a year. Defects such as loose connections, burned cables etc. must be corrected immediately.

2.6 WARNING REGARDING LIFE SUPPORT APPLICATIONS

Mastervolt products are not sold for applications in any medical equipment intended for use as a component of any life support system unless a specific written agreement pertaining to such intended use is executed between the manufacturer and Mastervolt. Such agreement will require the equipment manufacturer either to contract for additional reliability testing of the Mastervolt parts and/or to commit to undertake such testing as a part of the manufacturing process. In addition such manufacturer must agree to indemnify and hold Mastervolt harmless from any claims arising out of the use of the Mastervolt parts in the life support equipment.
3 TECHNOLOGY

3.1 INTRODUCTION

This users manual describes the DAKAR COMBI series from Mastervolt. This unit performs four distinct functions:

1. DC to AC power inverting;
2. Automatic transfer switching between inverter power and incoming AC power;
3. Three-stage automatic battery charging;
4. AC to DC power converter.

3.2 DESCRIPTION OF THE SEVERAL FUNCTIONS

3.2.1 The inverter

The inverter provides voltage and frequency regulated AC power from a deep-cycle battery bank. For protection reasons low and high battery cutout circuits and overload protection have been implemented. Considerable momentary surge power is available for starting electric motors. High efficiency insures long battery life between recharges. An built in idle circuit reduces battery power consumption when the inverter is unloaded.

3.2.2 The transfer switch

The transfer switch allows the COMBI to be connected to an external AC source. Some of the external AC power is used to operate the battery charger, the rest is switched through the unit to the output. The power sharing feature constantly senses the AC amperage being used by the battery charger and the appliances connected to the output, and automatically reduces battery charger power consumption if usage exceeds the input circuit breaker rating. The load connected to the COMBI will- in case of no AC- power be fed within its capacity by the inverter.

3.2.3 The battery charger

The built-in battery charger is electronically controlled. It is designed to rapidly and optimally recharge either wet or gel cell deep-cycle batteries. Battery charging is accomplished in 3 automatic stages: BULK, ABSORPTION and FLOAT. With an external AC source connected, the COMBI charger also serves the functions of an AC to DC converter to supply DC loads which are connected to the battery. Simple, automatic operation is made possible by the microprocessor that is the brain of the inverter/charger combination. In most cases, the unit is left on and no attention or maintenance is required.

3.2.4 The remote control panel

The optional COMBI System Control Panel (CSCP) provides a power switch, system status LED’s, DC volts and DC amps on LCD display. See chapter 12 for order information. This panel is only available for the 12 and 24V models.

3.3 THINGS YOU SHOULD KNOW

This is a class A product. In a domestic environment, this product may cause radio interference in which case the user may be required to take adequate measures. A transfer between inverter and charge modes of operation may temporarily take place when the product is subjected to electrostatic discharge.
3.3.1 Intended use

The Mastervolt COMBI is intended:

- as a DC to AC inverter/battery charger;
- for use in recreational vehicles;
- for use in professional vehicles;
- for use in recreational and professional marine vessels*;
- for use in residential solar applications;
- to be permanently installed, not portable;
- to be used with a DC fuse as described in chapter 4 / Installation.

* Mastervolt recommends to use stand alone chargers and inverters for use in industrial and other professional environments, see the MASS and COLORADO series in our catalogue (POWERBOOK).

3.4 OPERATION

The only control on the COMBI itself is the power switch. This switch controls ON/OFF and remote. Expect a three second delay when the power switch is turned ON before the unit is activated. The internal transfer switch will continue to be engaged with the switch off and AC power will be available at the output of the unit. If AC power is removed, the unit will come on as an inverter. Inverter overload protection, built idle mode circuitry, transfer switching, power sharing and battery charger regulation will all function automatically.

3.4.1 Control & LED function during charging

The control and indicator status are indicated by means of seven bi-colour LED’s. When charging the frontpanel must be red as follows (see fig 2). depending on the state of the charging process one of the three LED’s will be lit. At first the LED bulk

3.4.2 Control & LED function in inverter mode

When the COMBI inverter is operating the front panel must be red as follows (see fig 3). When normal operation conditions are met, none of the three red alarm LED’s will be lit. The temperature LED will be lit indicating that there is an abnormal temperature rise in the inverter circuits. This can be caused by inadequate ventilation or the connected load exceeds the capabilities of the inverter. Low battery will go on, when the battery voltage drops below the low battery cut out voltage. The LED overload will go on after a short circuit or heavy overload. Removing the short circuit or reducing the connected load resets the overload circuit.

3.4.3 Electronic protection

Fast acting electronic circuits protect the inverter against extreme overloads, low and high battery voltage and overheating of the inverter. The LED overload will be lit when to much load is connected to the inverter. After ± 3s the inverter will switch off and the LED failure will be lit together with the LED overload. The inverter stays switched off for ± 10s
and then starts up again. If the inverter can not start up the load in 5 times it will switch off permanently. The connected load is too much for the inverter. Reduce the load, or reduce the number of consumers. The inverter has to be manually restarted by means of the on/off switch.

3.4.4 Built-in idle circuit
The built-in automatic energy saving feature reduces battery power consumption when no load is present. Response from idle is instant. In most cases the operation is not noticeable. Small loads as clocks in VCR's and micro waves will perform equally whether the inverter is running in idle or is on. The output voltage is the same as in normal operation condition e.g. 230V (or 117V by a 117V model) This is called ‘high energy’ state, which is also the default setting. To obtain an even lower power consumption when a small load is present two options are available. The options can be selected by means of the jumpers S205 and S204. (See fig. 7)
With S205 placed the inverter reduces, below the 300W connected load, the output voltage to 208V (or 104V by a 117V model). This is called ‘economy’ state.
With S204 placed the inverter reduces, below the 80W connected load, the output voltage to 208V (or 104V by a 117V model) This is called ‘low energy’ state.

3.4.5 Power Sharing
The COMBI can automatically reduce the battery charger output, and therefore the AC power consumption, if appliances are turned on that threaten to trip the incoming circuit breaker (i.e. shore power or genset fuse). This feature can be adjusted using the remote control panel. This feature is set to protect a 20A / 40A source by default. With the current control (4MCO) the AC power consumption can be reduced remotely. Power sharing should be set to match the value of the circuit breaker, which protects the incoming AC power. For instance, in most camping or marinas (with 230V AC systems), a 16A shore power circuit is available. When the circuit breaker is set at 15A, the COMBI never exceed this current consumption. Use the 2A settings for small generators, or for charging deeply discharged batteries.

3.4.6 COMBI System Control Panel
An optional remote control panel is available: the COMBI System Control Panel. (CSCP) In addition to providing inverter/charger control, this remote panel is digital and enables precision monitoring of DC voltage, current, and amp hours for up to two battery banks.

Careful!
If the Remote Control Panel is connected, the charger will not respond to the temperature sensor.

The average battery temperature must set on the Panel. Battery charge voltage will be compensated accordingly. The power sharing has to be installed on the panel also. The current values which can be set: 5A, 10A, 15A, 20A for the 230V AC models and 10A, 20A, 30A, 40A for the 117V AC models. For further information we refer to the operating manual that is supplied with this panel. The remote control panel is supplied with an RJ11 remote cable.

Careful!
The COMBI must be switched on!

Careful!
The COMBI System Control Panel is not suitable for the 48V models.
4 INSTALLATION

At installation and commissioning of the COMBI, the Safety Guidelines & Measures are applicable at all times. See chapter 2 of this manual.

4.1 UNPACKING

In the box in which the COMBI is delivered contains, in addition to the COMBI:

- a temperature sensor*;
- a guarantee card;
- this operating manual.

* The temperature sensor is hung up on the right side in the COMBI.

After unpacking, check the COMBI for possible damage.

4.2 ENVIRONMENT

Install the COMBI in a dry, well ventilated dust free room. Locate the COMBI as close as possible to the DC distribution in order to keep the battery cables short. Do not locate the COMBI in the same compartment as the batteries. The heat of the COMBI is discharged by a ventilator with a variable speed.

At assembly of the COMBI be sure that:

- the air flow is not obstructed;
- no water and/or dust can enter the cabinet.

Never use the COMBI at locations where there is gas or explosion danger!

4.3 WIRING

The way of wiring has influence on the EMC behaviour of the system from which the COMBI is a component. This is caused by the fact that wires and cables are excellent reception and transmitter antennas of radio frequency electro magnetic interference. Most problems originate from mutual influencing of wires and cables.

Starting points for wiring with good EMC properties: Lay the cables in metal cable trunking. The metal of the trunking offers a low resistance to interference currents, so that these current run in the trunking. The DC cables are to be in contact with one another, as far as possible. The cables of different groups should not be twisted but run in parallel. If trunking is not possible, lay the cables parallel to a metal bar. If this is not possible, make a cable bunch in which the cables run in parallel.

4.4 MOUNTING OF THE CABINET

M8/M6 bolts can be used for the mounting of the COMBI. Proceed as follows for mounting the cabinet.

1 Screw the topmost bolts somewhat into the wall.
2 Hang the cabinet with its key holes over the two bolts, and screw these bolts finger tight, so that some shifting is still possible.
3 Place the two lowermost bolts.
4 Fasten all bolts securely.
Fig. 4: Dimensions 12/2500-100, 24/3000-100 and 48/3000-50.
Fig. 5: Dimensions 12/1500-50 and 24/1800-35.
4.5 REMOVAL OF THE FRONT PANEL

Steps:

1. Remove the four Philips screws from the corners of the cabinet.
2. Slide the front panel straight forward.
3. The boards with the indicator lamps, terminals and cable glands are now accessible.

4.6 CONNECTIONS OF AC & DC WIRING

Let installation work be done by a licensed electrician. Before beginning with the connection of the wiring, make the AC distribution as well as the DC distribution voltage free.

4.6.1 AC supply

Careful!
Check whether the voltage from the mains or generator are the same as the specified input voltage on the type number plate. Connect the COMBI on an own group of the AC distribution.

When connecting the AC supply cable, proceed as follows:

1. Check whether the relevant group of the AC distribution is voltage free.
2. Remove the front panel from the COMBI if this has not yet been done. The terminals and cable glands are now accessible.
3. Use cable of 3x4 mm² (stranded wire on ships and vehicles) or 3x6 mm² for the 117V models.
4. Lay the cable between the AC distribution and the COMBI.
5. Run the cable to the left terminal block and connect the cable (see fig. 6).
   - the (brown) phase wire on L1;
   - the (blue) neutral in the middle on N;
   - the (yellow/green) earth wire on PE.
6. Tighten the nuts of the cable glands.

Check once again if the 230V AC supply cable is connected to the AC input section. Connecting the 230V AC supply cable to the AC output terminal, will severely damage the COMBI and the warranty will be void (or 117V by the 117V models).

4.6.2 DC wiring

Use 50/70mm² cables. Keep in mind that high current will pass through the DC wiring. Keep the cable length as short as possible, this will keep the system efficiency as high as possible. All wires must be properly sized and all connections clean and tight. Use ring terminals to the ends of the wires. The terminals should be crimped with a proper crimping tool.

- Mark the plus cable red;
- Mark the minus cable black.

Lay the cables in contact with each other to limit the electro magnetic field around the cables. The negative cable should be connected directly to the negative post of the battery bank or the ground side of a current shunt. Do not use the chassis frame as the negative conductor. Tighten securely. The positive battery cable must be fused and connected to the positive post of the battery bank, or through a selector switch to one or more battery banks.
A fuse is required for safety reasons to protect the battery and the cables. The fuse with the fuseholder is available at your Mastervolt service centre.

Recommended fuse:
- 350A for the 12/2500-100
- 250A for the 24/3000-100 & 12/1500-50
- 160A for the 24/1800-35
- 125A for the 48/3000-50

Proceed as follows when connecting the DC cables:

1. Check whether the COMBI fuse is removed.

2. Pull the DC cables through the cable glands:
   - The minus cable (black) on the minus terminal
   - The plus cable (red) on the plus terminal

3. Make both cables the right length and crimp terminals to the cable ends.
   - The minus cable (black) to the minus terminal of the DC distribution;
   - The plus cable (red) to the COMBI fuse.

4. Check the polarity of the above made connections. Loose connections can cause dangerous overheating of the cables and/or terminals. Therefore tighten all connections well, in order to limit as far as possible transition resistance.

**Careful!**
The COMBI is not DC reverse polarity protected. Be very careful to connect the negative and positive cables correctly, otherwise damage will result and the warranty will be void.

### 4.6.3 Connection of the COMBI System Control Panel

The remote control is standard supplied with a 7.5 mtr RJ11 remote cable for connection to the COMBI. Proceed as follows when connecting the remote cable:

1. Check whether the COMBI, AC supply and the DC distribution are switched off.

2. Plug the remote cable connector into the connector CSCP on the COMBI. See Fig. 7.

3. Plug the other end of the remote cable into the remote control panel. Routing the remote cable away from AC and DC wires will minimize the potential for interference which may affect the displays. When the remote cable is too long, coil it up and store it an area away from AC equipment to prevent electrical interference.

4. Place the remote control panel.

5. Switch the COMBI to ‘ON’.
Only for 12/24V models suitable.

PROS and MASTERVISION remote panels can be connected to the terminals 1 to 12. See fig. 7. Switch the COMBI to remote.

4.6.4 Placement of Sensor wires
The voltage drop over battery cables can be compensated by measuring the output voltage at the end of the cables. The measured voltage is offered via the sensor wires to a control circuit in the charger. This decreases the charge time. As sensor wires use wire with a diameter of at least 0.75 mm².

Steps:
1. Check whether the AC supply current of the charger is switched off and the charge fuse has been removed.
2. Connect the positive sensor wire to the plus terminal.
3. Connect the negative sensor wire to the min terminal.

The terminals are located on the connection board right next to the DC connector. See fig. 6.

4.7 COMMISSIONING AFTER INSTALLATION
Remove the COMBI fuse, if placed already.

1. Check once again the polarity of all DC connections. Only when all connections have been made properly, the COMBI fuse can be placed. Switching on the DC power with reversed polarity of the battery cables will cause major damage to the COMBI. The COMBI fuse cannot prevent this. This damage is not covered by the guarantee.

2. Check once again of all AC cables are connected to the right terminals. When the cables or wires are reversed, the COMBI will be damaged.

3. If all connections are made right:
   - Check whether the on/off is switched off;
   - Place the COMBI fuse.

When placing this fuse, a spark can occur, caused by the capacitors used in the COMBI. This is particularly dangerous in places with insufficient ventilation, due to the gassing of the batteries an explosion can occur.

The COMBI is now ready for use.

Fig. 7: Part of control board with remote connections.
5 BATTERIES

5.1 KIND OF BATTERIES

Lead acid batteries are the best choice for general applications. They are easy and uncomplicated to use and the price/performance is superior. So there is no alternative to the lead acid battery.

5.1.1 Open and sealed lead acid batteries

Lead acid batteries are available with open and sealed construction. In the open lead acid battery the lead plates are submerged in diluted sulphuric acid. During charging gas can escape through small holes in the filler caps. The battery can be easily refilled with destilated water. When the battery is not used very intensive, the acid concentration in the lower side of the battery will become higher than the top side (stratification). This causes self discharge and also the change on sulfation becomes larger. This problem is most obvious in high traction cells. In sealed lead acid batteries the sulphuric acid is immobilized in a gel. This battery construction has a number of advantages. Sulphuric acid can never be spilled. Stratification is not possible. The batteries are not very sensitive for sulfatation and can be left without charge for a while. Gas development during charging is recombinend in the battery to water. The batteries have no filler caps, only venting valves, which open under large pressure.

5.2 BATTERY INTERCONNECTION

In most cases you will be using a bank of two or more batteries with your inverter/charger. You may connect batteries together in two configurations, series and parallel.

5.2.1 Series

Connecting 2 batteries in series will double the voltage of the battery bank (see fig. 8).

For instance, two batteries connected in series will produce 12V. Four 12V batteries of 50 amp hour in series will produce 48V: $12 + 12 + 12 + 12 = 48$.

The amp hour capacity of the battery bank will be the same as each individual battery, namely 50 Ah.

5.2.2 Parallel

Connecting two batteries in parallel will double the amp hour rating of the battery bank, while the voltage will be the same as each individual battery (see fig. 9).

For example, four 12V 50 amp hour batteries in parallel will produce one 12V 200 amp hour battery bank. Only similar batteries should be connected together in one bank. Do not connect old and new batteries together or wet and gel cell batteries together. In the above drawing, note that the load is connected to the positive terminal of the first battery and the negative terminal of the last battery. This practice helps to balance the battery bank. Always use proper terminals for your interconnecting battery cables.
5.2.3 Series / Parallel connection

This is a combination of earlier mentioned connection methods.

For instance, two 12V 50 amp hour batteries connected in series will produce 24V-50Ah. Make another 24V-50Ah set from two 12V 50Ah batteries. Connecting the two 24V-50Ah sets in parallel will produce one 24V 200 amp hour battery bank.

5.2.4 Battery bank ratings and sizing

Deep cycle batteries are usually rated in amp hours. The amp hour rating is based on a 20 hour discharge cycle, therefore a 100 amp hour battery can deliver 5 amps for 20 hours. If the discharge rate is greater than 5 amp, the available amp hours are decreased. If the load is increased to 100 amps, only about 45 amp hours will be available.

Connecting the two 24V-50Ah sets in parallel will produce one 24V 200 amp hour battery bank.

Deep cycle batteries can be discharged about 80% before permanent damage occurs, though shallower cycling will result in much longer battery life.

50% cycling is generally considered to be a good compromise between long battery life and a reasonably sized battery bank.

To achieve 50% cycling you should calculate your amp hour consumption between charging cycles and use a battery bank with twice that capacity. Plan on recharging when 50% discharged.

5.3 DETERMINATION OF SERVICE LIFE

It is common practice to design installations with a service life of the batteries of 5 years. The end of life of most batteries is by definition the point when the capacity is reduced between 60-80% of the new value. The service life depends besides the battery construction on the number of charge/discharge cycles. To get an acceptable service life, the manufacturers have developed several kinds of batteries.

Table 1; Typical power consumption in Ah drawn from a 24V battery bank (divide the power consumption by two for the 48V models):

<table>
<thead>
<tr>
<th>appliance</th>
<th>typical wattage</th>
<th>appliance run times / amp hours*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>5 min. 15 min. 30 min. 1 hr 2 hr 3 hr 8 hr 24 hr</td>
</tr>
<tr>
<td>13” color TV</td>
<td>50</td>
<td>0.17 0.5 1 2 4 6 17 50</td>
</tr>
<tr>
<td>19” color TV</td>
<td>100</td>
<td>0.35 1 2 4 8 13 33 100</td>
</tr>
<tr>
<td>VCR</td>
<td>50</td>
<td>0.17 0.5 1 2 4 6 17 50</td>
</tr>
<tr>
<td>laptop</td>
<td>100</td>
<td>0.35 1 2 4 8 13 33 100</td>
</tr>
<tr>
<td>blender</td>
<td>300</td>
<td>1 3 6 13</td>
</tr>
<tr>
<td>curling iron</td>
<td>50</td>
<td>0.17 0.5 1 2</td>
</tr>
<tr>
<td>3/8 power drill</td>
<td>500</td>
<td>1.74 5 10 21</td>
</tr>
<tr>
<td>icemaker*</td>
<td>200</td>
<td>0.7 1.4 3 6 8 22 67</td>
</tr>
<tr>
<td>coffee maker</td>
<td>1000</td>
<td>3.5 10 21 42 83</td>
</tr>
<tr>
<td>3 cu’ refrigerator*</td>
<td>150</td>
<td>1 2 4 6 17 50</td>
</tr>
<tr>
<td>20 cu’ refrigerator*</td>
<td>750</td>
<td>5 10 21 31 83 250</td>
</tr>
<tr>
<td>compact microwave</td>
<td>750</td>
<td>2.6 8 16 31 63 94</td>
</tr>
<tr>
<td>full size microwave</td>
<td>1500</td>
<td>5.2 16 31 63 125 188</td>
</tr>
<tr>
<td>vacuum cleaner</td>
<td>1100</td>
<td>3.8 11 23 46 92 138</td>
</tr>
</tbody>
</table>

The number in each box represents the total amp hours used based on various continuous run times.

* Note: refrigeration is typically calculated using a 1/3-duty cycle.
### Table 2:
Typical application of batteries and number of cycles.

<table>
<thead>
<tr>
<th>Kind of battery</th>
<th>Typical application</th>
<th>Number of cycles*</th>
</tr>
</thead>
<tbody>
<tr>
<td>cranking battery</td>
<td>very high current</td>
<td>40-60</td>
</tr>
<tr>
<td></td>
<td>very short time</td>
<td></td>
</tr>
<tr>
<td>semi traction batteries</td>
<td>high current</td>
<td>200-300</td>
</tr>
<tr>
<td></td>
<td>long time</td>
<td></td>
</tr>
<tr>
<td>traction batteries</td>
<td>high current</td>
<td>1000-1500</td>
</tr>
<tr>
<td></td>
<td>long time</td>
<td></td>
</tr>
</tbody>
</table>

* cycle = one discharge from 100 to 0% and one charge from 0 to 100%.

From the table it becomes very clear that service life of cranking batteries in cyclic applications can be less than two months. A semi-traction battery can attain a service life of 5 years if the number of cycles is limited to 50 per year. A professional user cycling each day his battery will prefer in most cases a traction battery.

### 5.4 CALCULATION OF THE CAPACITY OF THE BATTERIES

Estimate the Ah’s that will be used from the battery without recharging. Do not discharge the battery complete but maintain a capacity of 20%. At the end of life the capacity will be reduced to approx. 70%. From this follows that 50% of the capacity cannot be used. This leads to the practical rule of thumb calculation:

\[
\text{battery capacity} = 2 \times \text{consumption}
\]

### 5.5 SUGGESTIONS TO ATTAIN A LONG SERVICE LIFE

A cool place for the batteries is best (10-20°C). The service life of a battery is besides the number of charge/discharge cycles determined by the temperature. The temperature affects the chemical activity of the acid. The acid in the battery oxidizes the plates of the battery, gradually destroying the battery. The speed of this process is higher with higher ambient temperature. A battery with a service life of 5 years in 20°C ambient temperature, will have a service life of 2.5 years in 30°C ambient temperature.

**Charge after deep discharge:**

Charge batteries as soon as possible after a deep discharge. Special in high ambient temperature sulfation starts fast. Sealed gel batteries have the least problems with sulfation. By charging and discharging recovery of the lost capacity is (partial) possible dependant how strong the sulfatation has been. Use only Deep cycle batteries with your inverter/charger combination. These fall into two broad categories, wet cell and gel cell.
6  BATTERY CHARGING

6.1  THE BATTERY CHARGER OF THE COMBI

The Mastervolt inverter/charger combinations are designed to overcome the limitations of conventional chargers by utilizing 3 distinct stages, each designed for optimal recharging of both wet cell and gel cell deep cycle batteries. The benefits of the Mastervolt COMBI charger versus the traditional taper charger: quicker, more complete recharging, safe long term charging. Each time the battery charger is engaged, the 3 stages proceed automatically, resulting in an efficient, complete recharge and safe battery maintenance.

The battery charger stages are:

6.1.1  Main charge, “BULK”

The main charge starts after the COMBI is switched on. The charger supplies during this phase the maximum current. The current charges the batteries and gradually the voltage rises to the absorption voltage of 14.25V (12V), 28.5V (24V), 57V (48V) models @ 20°C. When the absorption voltage is reached the absorption phase is starting. The yellow lamp “BULK” on the front of the COMBI is lit during bulk charging. The bulk charging will take a few hours. The time is dependent on the capacity and charge of the batteries and how much current is supplied direct to the load. In general the electrical system is so designed that the batteries are recharged for 80% after the bulk charge.

6.1.2  Post charge, “ABSORPTION”

Absorption charging is starting when the voltage on the batteries has been increased to 14.25 / 28.5V / 57V @ 20°C. During the absorption phase the voltage is maintained. The charge current is decreasing slowly dependent on the absorption capacity of the batteries. The absorption phase lasts 4 hours and during this time the batteries are charged to 100%. The yellow lamp “ABSORPTION” is lit during the absorption phase.

6.1.3  Trickle charge, “FLOAT”

The third phase, trickle charging, starts after the absorption phase. The COMBI switches to 13.25V / 26.5V / 53V @ 20°C and stabilizes this voltage. This voltage is high enough to maintain the batteries fully charged and low enough to prevent wear out. This is the reason why the COMBI can be continuously switched on. The current to the batteries is very low, enough to compensate the self discharge. At the same time the COMBI can supply current direct to the consumers. The yellow lamp “FLOAT” on the front of the COMBI is lit during the float phase. The COMBI starts a new cycle if is switched off for more then 10 seconds or when the current reaches the maximum charge current for more then 10 seconds.

Fig. 10: Charge characteristic.
6.2 TEMPERATURE COMPENSATED CHARGING

The charge voltages of the combi are so adjusted that with a battery temperature of 20°C optimal results are obtained. Often the batteries, however, are used in environments where the temperature is much lower or much higher than 20°C. The batteries become also warmer from charging. The charge voltages can be automatically adapted for deviating temperatures by installing the supplied battery temperature sensor. When the battery temperature is low, the charge voltage is increasing, to compensate the decreased chemical activity in the battery. Full charge is still possible in an acceptable charge time. When the battery temperature is high, the charge voltage is decreased, to compensate the increased chemical activity in the battery. Overcharge and gassing are prevented this way. The charge voltage is limited to 14.5 V / 29V / 58V, to prevent an unacceptable high voltage on the consumers battery. Below 20°C and above 50°C the charger regulates the output voltage to 12V / 24V / 48V and the lamp “FAILURE” will be lit. Connect the temperature sensor to the terminals 13 and 14. See fig. 7.

6.3 COMPENSATION OF THE DC CABLE LOSSES

The COMBI can compensate the voltage drop occurring over the DC cables of the charger. For this purpose the COMBI is provided with terminals for sense wires. It is not necessary to use both sense wires. See § 4.6.4 for the connection of the sensor wires.

6.4 BATTERY CHARGING WITH COMBI SYSTEM REMOTE PANEL CONNECTED

When the COMBI system remote panel (CSCP) is connected to the COMBI, the panel will overrule the internal regulation. For example, the charge characteristic from CSCP differs from the COMBI characteristic. See § 3.4.6 and the operating manual from the COMBI system remote panel itself for more information about this subject.

Careful!
Switch the COMBI to ‘ON’

Careful!
CSCP only available for the 12V and 24V models.
7  THE MOST FREQUENTLY ASKED QUESTIONS ABOUT INVERTERS & BATTERY CHARGERS

7.1  CONNECTING AC EQUIPMENT ON THE INVERTER

1  What battery capacity do I need when I want to use an inverter?
Rule of thumb: with a 12V installation, the minimum battery capacity should be around 20% of the inverter capacity. With a 24V inverter this can be 10%. In other words, the minimum battery capacity for a MASS 12/1200 is 200Ah and for a MASS 24/1500 it is 150Ah.

2  How much energy does an inverter use (what is the efficiency)?
The efficiency of a MASS inverter is between 90-97%. The average energy loss that occurs by converting DC to AC will be 3-10%.

3  Is there a “stand by” or “wait” switch on the inverter?
No, the zero load is so low that a “stand by” switch is not necessary. There is no difference between small or large inverters. The zero load intake is the same on every MASS inverter: 300 mA for 12V inverters and 150 mA for 24V inverters. All COMBI units are equipped with an automatic switch (“stand by” or “search”).

4  Can a microwave oven be connected to an inverter?
Yes, but please consider that a microwave oven with a capacity of e.g. 750W takes in between 1200-1300W from the 230V. Connected to the MASS inverter with its trapezoidal output, cooking time will be on average 10-15% longer compared with the mains.

5  How much power does an inverter use from my batteries?
Naturally, this depends on the connected capacity on the inverter. This is simple to calculate: divide the connected capacity by 10 for 12V inverters and by 20 for 24V inverters. Example: how much power does the inverter use when connected to a load of 400W. With a 12V inverter (e.g. the MASS 12/1200) this is 400:10 = ± 40A. With a 24V inverter like the 24/1000, this is ± 20A.

6  How thick should my battery cables be?
First we calculate the electricity that has been taken in by the inverter while the inverter is functioning at its maximum (for example 100A for a MASS 12/1000, see above). Then we calculate the 3A per mm². For the MASS 12/1000 (as mentioned earlier) this is 100:3 = 33 mm².
This ground rule applies to cables up to 3 metres long. If the inverter has to be placed further than the battery, choose the cables a size bigger (50 mm²).

7  Does the inverter need ventilation?
Not a lot but it does need some. In general two ventilation holes of ± 60 cm each are sufficient. When using an inverter with a larger capacity (from 1500W) the hole should be twice as large. In case of high temperatures or long term function in fully-operative conditions, the ventilation hole should be as large as possible.
8 **Can an inverter be used parallel to a generator or shore power?**

No!!! If there is shore or generator power on board the ship, a MASTERSWITCH transfer system or manual switch has to be installed. If 230V is connected to the output of the inverter, it could be badly damaged.

### 7.2 INFORMATION ON BATTERY CHARGERS

1 **I have a 200 Ah battery capacity and a 100 Ah starter battery, what size should my charger be?**

When calculating the charger capacity the starter battery is usually not included. The starter battery is loaded by the alternator, and we can assume the alternator is never empty. We maintain that 25% of the battery capacity as charge capacity is sufficient to load the battery quickly and safely. In the example, this is 25% of 200 Ah, which is 50A.

2 **10% of my battery capacity as charge capacity, is that enough?**

No!! The 10% rule dates from the time when chargers were not current and voltage regulated. These days, the modern chargers are even equipped with a temperature sensor that regulates the tension according to the temperature of the battery. 25% of the load capacity can be maintained. With gel batteries it is even possible to use up to 50% of the battery capacity as charge capacity.

3 **Can a Mastervolt battery or COMBI charger stay connected all winter?**

Yes, this is actually better for the battery.

4 **I have a limited shore connection, can I still apply a reasonably large battery charger?**

Yes, due to the fact that Mastervolt chargers are equipped with the most advanced electronics, the power consumption is approx. 40% less than the more conventional chargers. Every charger >25A can be equipped with a current control (4MCC) with which the output power can be reduced, which causes the input power to decline as well.

5 **Can I install a battery charger in the engine room?**

Yes, every MASS charger can be fitted in the engine room. However, the charge capacity decreases (> 40°C) at high ambient temperatures.

6 **Can I charge several battery sets with a Mastervolt charger?**

Every Mastervolt charger except the Dakar COMBI can charge several battery sets by use of a diode splitter. To compensate the voltage drop over the diode splitter, a small jumper in the charger can be removed. The 12/15, 12/25 & 12/40 models are equipped with a second (resp. third) output for the maintenance charge of the starter battery. The MASS 12/40 is equipped with three equal outputs. For the Dakar an optional slave charger is available.
7 **What size of cables between the charger and the battery do I need?**  
When we divide the max. charger power by 3, we get the thickness of the cables. Please round up for safety. For example, a MASS 12/40 battery charger needs: 40:3=13: rounded up this is 16 mm².

8 **What's the maximum distance between battery charger and battery?**  
Generally, the maximum length of a cable is 3 metres. 6 metres is possible, but the cables would have to be one size thicker.

9 **How long does it take for my batteries to be fully charged?**  
The time it takes a battery to be charged depends on the sort and type of battery, and how long it took to be discharged (slow or fast). Rule of thumb is to divide the battery capacity by the maximum charge capacity and add 4 hours. For example: battery 200 Ah, battery charger 40A. The charge duration is 200:40 = 5+4 = 9 hours.


8 TROUBLE SHOOTING

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>POSSIBLE CAUSE</th>
<th>POSSIBLE SOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>No inverter output voltage. The inverter does not work, or just for a few seconds.</td>
<td>Battery voltage may be to low. Low voltage cutout will come in at 10V (12V), 20V (24V) or 40V (48V). Battery connection corroded.</td>
<td>Recharge battery bank for a period of 24 hrs. Check for corrosion, and replace bad section(s).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Check if the inverter is overheated. In case of overheating LED temp + failure will be lit.</td>
<td>Remove connected load. Improve ventilation.</td>
</tr>
<tr>
<td></td>
<td>An overload or short circuit. LED overload + failure will be lit.</td>
<td>Remove excessive load. Remove short circuit condition</td>
</tr>
<tr>
<td>The COMBI battery charger does not function.</td>
<td>AC input voltage not present. Input voltage too low. The COMBI battery charger will not function below 160/80V.</td>
<td>Check installation. The green LED ‘AC in’ should be lit if mains is present. Check fuses or circuit breakers. Check the generator output voltage remove connected load, output voltage should come up.</td>
</tr>
<tr>
<td></td>
<td>Mains frequency could be too high or too low. The frequency must be within 35-66 Hz.</td>
<td>Check the generator output frequency. Check generator RPM.</td>
</tr>
</tbody>
</table>

If you can not correct a problem with the aid of trouble shoot list, contact your Mastervolt Service Center, or Mastervolt Amsterdam for an extended service list, tel.: INT+31-20-3422130.
9 MAINTENANCE

For reliable and optimal function of the COMBI the following is required:

• Check at least once a year if all cable and wire connections are still firmly connected.

• Keep the COMBI dry, clean and dust free, in order to secure a good heat discharge.

• Check fan operation, the fan has a life time of at least 10 years under normal conditions.

10 STORAGE & TRANSPORTATION

Mastervolt equipment must be stored dry and dust free, preferably in the original packing. See packing guidelines.

10.1 PACKING GUIDELINES FOR MASTERVOLT EQUIPMENT

• Request before shipment a RMA (Return Materials Authorization) number.

• Do not forget to mention: return address, phone number and person to be contacted.

• Effect a transport Insurance.

• Ship equipment only, without operating manual and temperature sensor.

• Use preferably the original packing to prevent transport damage.

• Summarize the nature of the malfunction.

• If possible also sent a installation diagram.
### 11 TECHNICAL DATA

#### GENERAL

<table>
<thead>
<tr>
<th>Description</th>
<th>sinewave inverter/charger combination with automatic transfer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Models</td>
<td>DAKAR COMBI 12/2500, 24/3000 &amp; 48/3000 and 12/1500 &amp; 24/1800</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Mastervolt, Amsterdam</td>
</tr>
<tr>
<td>Technology</td>
<td>mixed HF/LF hybrid switching technique</td>
</tr>
<tr>
<td>Conformity</td>
<td>CE</td>
</tr>
<tr>
<td>Environmental class</td>
<td>IP 22</td>
</tr>
<tr>
<td>Enclosure</td>
<td>DAKAR</td>
</tr>
<tr>
<td>Weight</td>
<td>± 37 kg (without box) and 23 kg for the 12/1500 and 24/1800</td>
</tr>
<tr>
<td>Colour</td>
<td>RAL 7035</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-25°C to 70°C</td>
</tr>
<tr>
<td>Humidity</td>
<td>95% non condensing</td>
</tr>
<tr>
<td>Altitude</td>
<td>5000 m, power derating !</td>
</tr>
<tr>
<td>Battery capacity</td>
<td>&gt; 400 Ah</td>
</tr>
<tr>
<td>Cooling</td>
<td>three temperature controlled fans</td>
</tr>
</tbody>
</table>

#### CONNECTIONS

<table>
<thead>
<tr>
<th>AC in</th>
<th>Phoenix on connection board</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC out</td>
<td>Phoenix on connection board</td>
</tr>
<tr>
<td>AC cable size</td>
<td>2.5 mm² .. 6 mm²</td>
</tr>
<tr>
<td>Battery connections</td>
<td>on connection board with Master© Connect</td>
</tr>
<tr>
<td>Battery cable size</td>
<td>&gt; 50 mm²</td>
</tr>
<tr>
<td>Remote connections</td>
<td>telephone jack / Phoenix</td>
</tr>
<tr>
<td>Sense connections</td>
<td>Phoenix</td>
</tr>
<tr>
<td>DC fuse</td>
<td>external</td>
</tr>
<tr>
<td>AC fuse</td>
<td>external</td>
</tr>
</tbody>
</table>

#### CONTROLS

<table>
<thead>
<tr>
<th>Display led on cabinet</th>
<th>charge status, inverter status, mains status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote panel</td>
<td>COMBI System Control Panel</td>
</tr>
</tbody>
</table>

#### TRANSFER SYSTEM

<table>
<thead>
<tr>
<th>Relay</th>
<th>2 pole switching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rating</td>
<td>25A (230V) / 50A (117V)</td>
</tr>
<tr>
<td>Transfer speed</td>
<td>30 ms after synchronization</td>
</tr>
<tr>
<td>Separate generator input</td>
<td>no</td>
</tr>
<tr>
<td>Power sharing</td>
<td>20A (230V), 40A (117V)</td>
</tr>
</tbody>
</table>
### TECHNICAL DATA

<table>
<thead>
<tr>
<th><strong>MODEL</strong></th>
<th><strong>12/2500-100A</strong></th>
<th><strong>24/3000-100A</strong></th>
<th><strong>48/3000-50A</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CHARGER</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Input voltages</strong></td>
<td>230V AC</td>
<td>117V AC</td>
<td>230V AC</td>
</tr>
<tr>
<td><strong>Input voltage range</strong></td>
<td>160V ≤ U ≤ 245V</td>
<td>80V ≤ U ≤ 122V</td>
<td>160V ≤ U ≤ 245V</td>
</tr>
<tr>
<td><strong>Frequency range</strong></td>
<td>35Hz ≤ f ≤ 66Hz</td>
<td>35Hz ≤ f ≤ 66Hz</td>
<td>35Hz ≤ f ≤ 66Hz</td>
</tr>
<tr>
<td><strong>Power factor</strong></td>
<td>&gt; 0.95</td>
<td>&gt; 0.95</td>
<td>&gt; 0.95</td>
</tr>
<tr>
<td><strong>Efficiency</strong></td>
<td>&gt; 85%</td>
<td>&gt; 85%</td>
<td>&gt; 85%</td>
</tr>
<tr>
<td><strong>Temperature compensation</strong></td>
<td>30mV/°C</td>
<td>60mV/°C</td>
<td>120mV/°C</td>
</tr>
<tr>
<td><strong>Battery sense</strong></td>
<td>yes, two wire</td>
<td>yes, two wire</td>
<td>yes, two wire</td>
</tr>
<tr>
<td><strong>Revers polarity protection</strong></td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td><strong>Second output</strong></td>
<td>optional</td>
<td>optional</td>
<td>n.a.</td>
</tr>
<tr>
<td><strong>Remote current control</strong></td>
<td>yes, optional</td>
<td>yes, optional</td>
<td>yes, optional</td>
</tr>
<tr>
<td><strong>Discharge cycle</strong></td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td><strong>Usable as power supply</strong></td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>

### INVERTER

<table>
<thead>
<tr>
<th><strong>MODEL</strong></th>
<th><strong>12/2500-100A</strong></th>
<th><strong>24/3000-100A</strong></th>
<th><strong>48/3000-50A</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wave form</strong></td>
<td>sine wave</td>
<td>sine wave</td>
<td>sine wave</td>
</tr>
<tr>
<td><strong>Output voltages</strong></td>
<td>230V ± 5%</td>
<td>117V ± 5%</td>
<td>220V ± 5%</td>
</tr>
<tr>
<td><strong>Frequency</strong></td>
<td>0.1 lagging, 0.9 leading</td>
<td>0.1 lagging, 0.9 leading</td>
<td>0.1 lagging, 0.9 leading</td>
</tr>
<tr>
<td><strong>Power factor</strong></td>
<td>0.1 lagging, 0.9 leading</td>
<td>0.1 lagging, 0.9 leading</td>
<td>0.1 lagging, 0.9 leading</td>
</tr>
<tr>
<td><strong>Output power</strong></td>
<td>peak 5000 VA</td>
<td>peak 4000 VA</td>
<td>peak 4500 VA</td>
</tr>
<tr>
<td><strong>Input voltages</strong></td>
<td>low shut down 10V, reset 11V</td>
<td>low shut down 10V, reset 11V</td>
<td>high shut down 40V, reset 42V</td>
</tr>
<tr>
<td><strong>Efficiency</strong></td>
<td>90% max., 86% nominal</td>
<td>90% max., 86% nominal</td>
<td>90% max., 86% nominal</td>
</tr>
<tr>
<td><strong>Protections</strong></td>
<td>overload, low batt, high batt</td>
<td>overload, low batt, high batt</td>
<td>overload, low batt, high batt</td>
</tr>
</tbody>
</table>
## ORDERING INFORMATION

### CHARGER

<table>
<thead>
<tr>
<th>Model</th>
<th>12/1500-50A</th>
<th>24/1800-35A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input voltages</strong></td>
<td>230V AC</td>
<td>117V AC</td>
</tr>
<tr>
<td><strong>Input voltage range</strong></td>
<td>160V ≤ U ≤ 245V</td>
<td>80V ≤ U ≤ 122V</td>
</tr>
<tr>
<td><strong>Frequency range</strong></td>
<td>35Hz ≤ f ≤ 66Hz</td>
<td>35Hz ≤ f ≤ 66Hz</td>
</tr>
<tr>
<td><strong>Power factor</strong></td>
<td>&gt; 0.95</td>
<td>&gt; 0.95</td>
</tr>
<tr>
<td><strong>Efficiency</strong></td>
<td>85%</td>
<td>85%</td>
</tr>
<tr>
<td><strong>Charge characteristics</strong></td>
<td>three stage</td>
<td>three stage</td>
</tr>
<tr>
<td><strong>Charge current</strong></td>
<td>50A</td>
<td>50A</td>
</tr>
<tr>
<td><strong>Temperature compensation</strong></td>
<td>yes, 30mV/°C</td>
<td>yes, 30mV/°C</td>
</tr>
<tr>
<td><strong>Battery sense</strong></td>
<td>yes, two wire</td>
<td>yes, two wire</td>
</tr>
<tr>
<td><strong>Revers polarity protection</strong></td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td><strong>Second output</strong></td>
<td>optional</td>
<td>optional</td>
</tr>
<tr>
<td><strong>Remote current control</strong></td>
<td>yes, optional</td>
<td>yes, optional</td>
</tr>
<tr>
<td><strong>Discharge cycle</strong></td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td><strong>Usable as power supply</strong></td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>

### INVERTER

<table>
<thead>
<tr>
<th>Model</th>
<th>12/1500-50A</th>
<th>24/1800-35A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wave form</strong></td>
<td>sine wave</td>
<td>sine wave</td>
</tr>
<tr>
<td><strong>Output voltages</strong></td>
<td>230V, ± 5%</td>
<td>117V, ± 5%</td>
</tr>
<tr>
<td><strong>Frequency</strong></td>
<td>you can adjust the frequency in 50 or 60 Hz by means of a jumper on the control board, S202 (see fig. 7)</td>
<td></td>
</tr>
<tr>
<td><strong>Power factor</strong></td>
<td>0.1 lagging, 0.9 leading</td>
<td>0.1 lagging, 0.9 leading</td>
</tr>
<tr>
<td><strong>Output power</strong></td>
<td>peak 2800 VA</td>
<td>peak 2800 VA</td>
</tr>
<tr>
<td><strong>25°C</strong></td>
<td>P30 1500 VA</td>
<td>P30 1500 VA</td>
</tr>
<tr>
<td><strong>40°C</strong></td>
<td>cont. 1200 VA</td>
<td>cont. 1200 VA</td>
</tr>
<tr>
<td><strong>Input voltages</strong></td>
<td>low shut down 10V, reset: 11V</td>
<td>low shut down 10V, reset: 11V</td>
</tr>
<tr>
<td><strong>Efficiency</strong></td>
<td>90% max., 86% nominal</td>
<td>90% max., 86% nominal</td>
</tr>
<tr>
<td><strong>Protections</strong></td>
<td>over temperature, overload, low batt, high batt</td>
<td></td>
</tr>
</tbody>
</table>

### 12 ORDERING INFORMATION

Please contact your nearest Mastervolt SERVICE center for ordering.

See table below for accessories and part numbers

<table>
<thead>
<tr>
<th>Accessories</th>
<th>MV part number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AC cable with connector, length 2 m</strong></td>
<td>12-01-00910</td>
</tr>
<tr>
<td><strong>Battery clamp minus, luxury design with clever winged nut M8</strong></td>
<td>12-01-00020</td>
</tr>
<tr>
<td><strong>Battery clamp positif, luxury design with clever winged nut M8</strong></td>
<td>12-01-00010</td>
</tr>
<tr>
<td><strong>Cable for connecting remote panels, eight wires (please specify length when ordering)</strong></td>
<td>12-01-00800</td>
</tr>
<tr>
<td><strong>COMBI System Control Panel (CSCP)</strong></td>
<td>03-31-00100</td>
</tr>
<tr>
<td><strong>DC cable set 25 mm²</strong></td>
<td>12-01-00300</td>
</tr>
<tr>
<td><strong>DC cable set 50 mm²</strong></td>
<td>12-01-00500</td>
</tr>
<tr>
<td><strong>DC cable set 70 mm²</strong></td>
<td>12-01-00500</td>
</tr>
<tr>
<td><strong>Current control potmeter (4 MCO)</strong></td>
<td>04-15-00150</td>
</tr>
<tr>
<td><strong>Temperature sensor (standard with chargers or COMBI'S)</strong></td>
<td>04-15-00300</td>
</tr>
</tbody>
</table>
13 DEFINITIONS

Alternating current (AC):
Also referred to as shore power, utility power, inverter output power, generator power or household current.

Ampere (Amp, A):
The unit of measure of electron flow rate of current through a circuit.

Ampere-hour (Amp-hr, Ah):
A unit of measure for a battery’s electrical storage capacity, obtained by multiplying the current in amperes by the time in hours of discharge. Example: a battery which delivers 5 amperes for 20 hours delivers 5 amperes times 20 hours, or 100 Amp-hours of capacity.

mm$^2$:
A standard used to measure the size of wire.

AH capacity:
The ability of a fully charged battery to deliver a specified quantity of electricity (Amp-hour) at a given rate (Amps) over a definite period of time (hours).

Circuit:
An electric circuit is the path of an electric current. A closed circuit has a complete path. An open circuit has a broken or disconnected path.

Circuit (series):
A circuit which has only one path for the current to flow. Batteries arranged in series are connected with the negative of the first to the positive of the second, negative of the second to the positive of the third, etc. If two 12V batteries of 50 ampere-hours capacity are connected in series, the circuit voltage is equal to the sum of the two battery voltages, or 24 volts, and the ampere-hour capacity of the combination is 50 ampere hours.

Circuit (parallel):
A circuit which provides more than one path for current flow. A parallel arrangement of batteries (of like voltage and capacity) would have all positive terminals connected to a conductor and all negative terminals connected to another conductor. If two 12V batteries of 50 ampere-hour capacity each are connected in parallel, the circuit voltage is 12 volts and the ampere-hour capacity of the combinations is 100 ampere-hours.

Current:
The rate of flow of electricity or the movement rate of electronics along a conductor. It is comparable to the flow of a stream of water. The unit of measure for current is the ampere.

Current (alternating) (AC):
A current that varies periodically in magnitude and direction. A battery does not deliver alternating current. Also referred to as shore power, utility power, inverter power, generator power, etc.

Cycle:
In a battery, one discharge plus one recharge equals one cycle.

Direct current (DC):
Current that flows continuously in one direction such as that from batteries, photovoltaics, alternators, chargers and DC generators.

Discharging (discharge):
When a battery is delivering current it is said to be discharging.

Gel cell battery:
A type of battery that uses a gelled electrolyte solution. These batteries are sealed and are virtually maintenance free. Not all sealed batteries are the gel cell type.
Ground:
The reference potential of a circuit. In automotive use, the result of attaching one battery cable to the bode or frame which is used as a path of completing a circuit in lieu of a direct wire from a component. This method is not suitable for connecting the negative cable of the inverter to ground, instead route the cable directly to negative terminal of the battery.

Led (light emitting diode):
Indicator light.

Negative:
Designating or pertaining to electrical potential. The negative terminal is the point from which electrons flow during discharge.

Ohm:
A unit for measuring electrical resistance.

Ohm’s law:
Express the relationship between volt (V), amperes (A) in an electrical circuit with resistance (R). It can be expressed as follows: V = AR. If any two of the three values are known, the third value can be calculated by using the above formula.

Positive:
Designating or pertaining to electrical potential; opposite of negative. The positive battery terminal is the point where electrons return to the battery during discharge.

Power sharing:
The ability of the charger to reduce its output when the AC power being consumed by the charger and external AC loads connected to the output of the inverter are in excess of the input breaker rating.

RCCB:
Residual current circuit breaker (earth leakage).

Volt:
The unit of measure for electric potential.

Volt Amps (VA):
See Watt.

Watt:
The unit for measuring electrical power, i.e. the rate of doing work, in moving electrons by or against an electric potential.

Watt-Hour (Watt-Hr, WH):
The unit for measuring electrical energy which equals Watts x Hours.

Wet cell battery:
A type of battery that uses liquid as an electrolyte. This type of battery requires periodic maintenance such as cleaning the connections and checking the electrolyte level.
14 EC DECLARATION OF CONFORMITY

Manufacturer: Mastervolt
Address: Snijdersbergweg 93
1105 AN Amsterdam
The Netherlands

Herewith declares that:

Product: DAKAR COMBI inverter/charger combination

Model: COMBI 12/2500-100, 230V & 117V
COMBI 24/3000-100, 230V & 117V
COMBI 48/3000-50, 230V & 117V
COMBI 12/1500-50, 230V & 117V
COMBI 24/1800-35, 230V & 117V

Is in conformity with the provision of the EC EMC directive 89/336/EEC and amendments 92/31/EEC, 93/68/EEC.

The following harmonized standards have been applied:

Radio interference EN 55022, class B
Electrostatic discharge IEC 801-2:1984, 8kV AC, performance B
Electromagnetic field IEC 801-3:1984, 3V/m, performance A
Fast transients IEC 801-4:1988, AC supply 1kV, other ports 0.5kV, perf. B
Low voltage directive EN 60950

Amsterdam,

Dr. F.J. ter Heide,
Managing director Mastervolt