MOBATT 200
PWM BATTERY CHARGER

DESCRIPTION

The MOBATT 200 Battery Charger is an equipment destined to control the charge process in stationary battery banks, applied in any industrial process, like DC No Brakes, Magnet No Brakes etc.

The MOBATT 200 was conceived by the ultimate knowledge in battery charger principle. It can be applied in lead acid batteries or other technology batteries.

The charge modes follow a special algorithm to get full battery charge, long battery life and 100% of charging available when necessary. The modes are: **1 -** Trickle or Test or Conformal charging. In this mode (depending on application this mode is bypassed) the battery is tested, if full discharged, before to initiate the fast charging, to avoid fast charging batteries with defective cells. **2-** Bulk Charging or fast charging. In this mode the Mobatt 200 sends the full nominal current to battery bank. **3-** Over Charging. In this mode the Mobatt 200 operate in constant voltage and wait the current droop bellow a predefined point, to get the 100% charge assured. 4- Float charging. In this mode the Mobatt 200 operates at constant voltage, sending a low current to battery bank until the voltage is equal to full charge level. If the voltage drops the current can however arises to full nominal current if necessary.

An optional PTC can be fixed in the battery bank to compensate the batteries temperature during the charging assuring optimal performance.

Four relay contacts and frontal LEDs in the control module, provide indications of the actual mode.

One digital input for one dry contact provide inhibition of the charger, for maintenance or other reasons.

There are two types of power control, both PWM. Model T- using IGBT with frequency of 1000 to 3000 hz. Model S - using SCRs with frequency of 360 Hz.

APLICATION

- For charging stationary battery bank in any industrial use as DC No brakes, DC Power Supplies etc.

Charging Modes (Automatic)

- **1- Trickle** - Or test mode or conformal mode or pre charge mode, operate at constant current when the battery is fully discharged.
- **2- Bulk** - or Fast Charging, operate at constant current, with full nominal current.
- **3- Over** - after the bulk period, operates at constant voltage until the current drops below a pre defined level. Assures 100% of the charge availability.
- **4- Float** - After the Over charging, operate at constant voltage, to maintain the full charge for long periods of time, compensating the self discharge. If the voltage drops due to load consumption, the current can arises to the full nominal current in this mode.

Short circuit protection (Model T):

- The IGBT firing module has a short circuit protection mode that disable the firing pulse if the VCE voltage of the IGBT arises one pre defined level.

Inputs an Outputs

- 1 Enable Input by dry contact.
- 4 Dry contact inputs, normally open for mode indication (Trickle, Bulk, Over, Float).
- 1 PTC compensation input for battery temperature.
- 3 Power AC Inputs.
- 2 Power DC outputs.
- 2 Voltage sensing inputs to 4 wires measuring.
- 1 Fan power supply inputs.

Control Mode

- Model T= PWM Bulk circuit with frequency between 1000 Hz and 3000 Hz and LC filtering for low battery current ripple.
- Model S= PWM Bridge circuit with frequency of 360 Hz and LC filtering for low battery ripple.

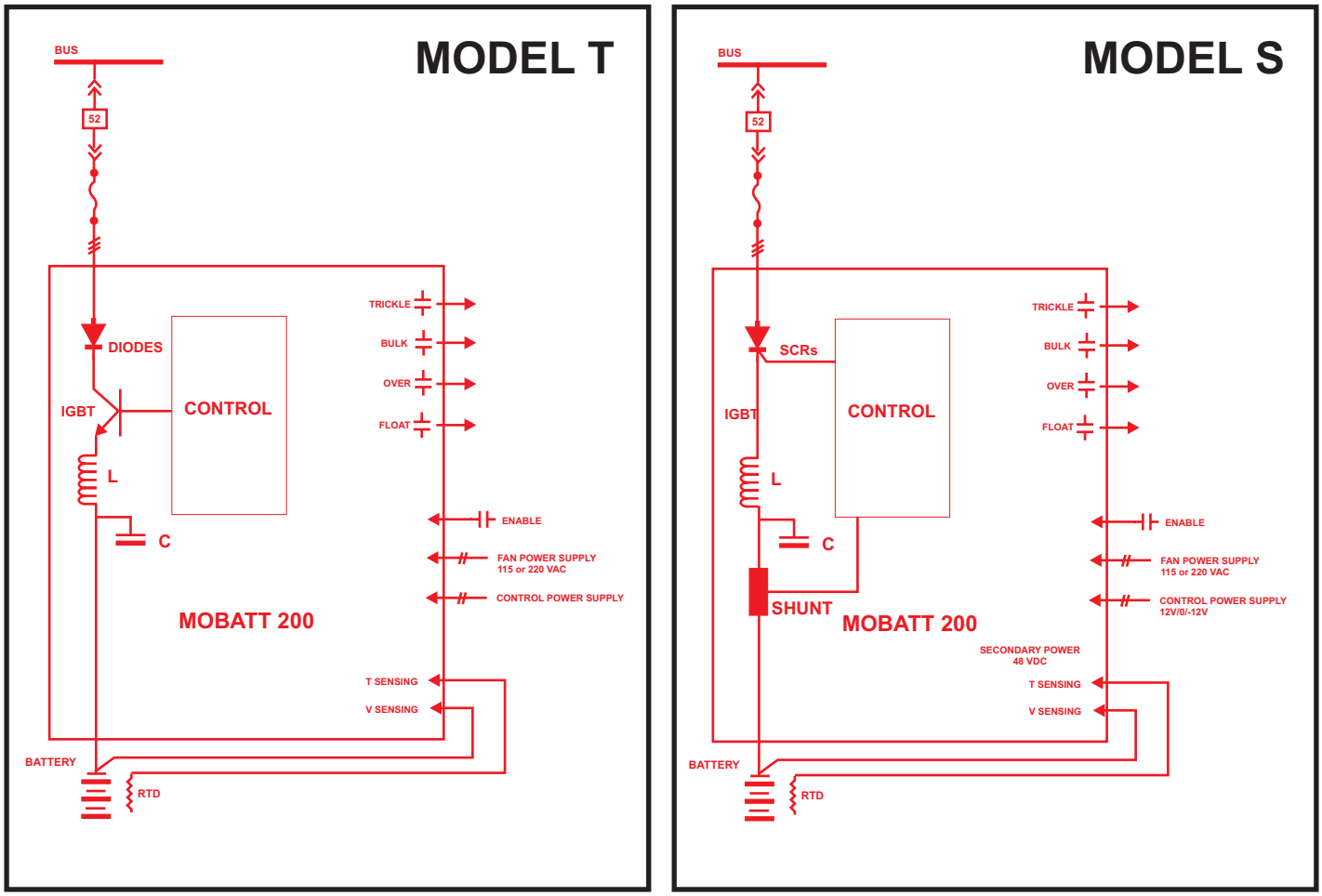
Temperature Measuring

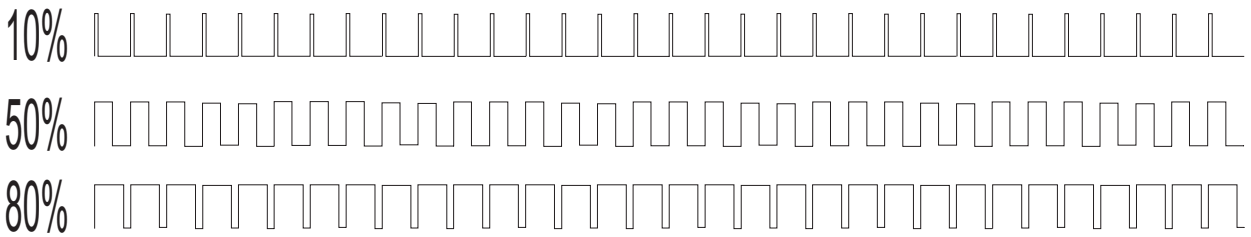
- One optional PTC with 10 Kohm nominal resistance can be attached to the battery bank and connected to control module due to compensate the batteries temperature during the charging process.

Varixx INNOVATION

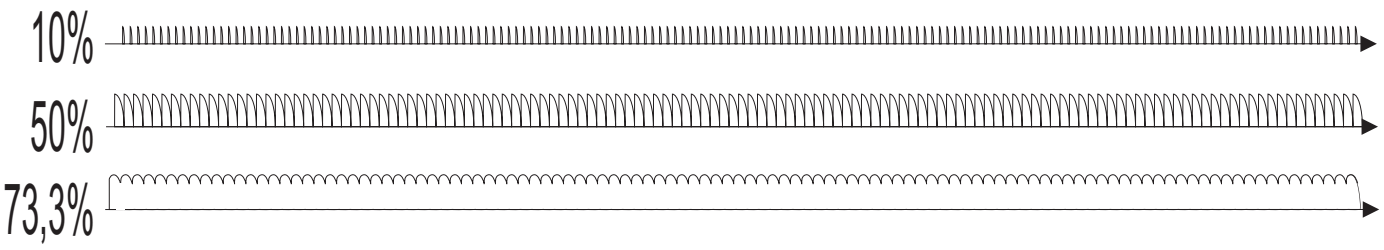
MOBATT 200

SINGLE LINE DIAGRAMS AND WAVEFORMS BEFORE FILTERING





PWM CURVES FOR MODEL T (W/ IGBT)
SHOW 10%, 30% and 80% Duty Cycle



PWM CURVES FOR MODEL S (W/ SCRs)
SHOW 10%, 30% and 73,3% Duty Cycle

Varixx INNOVATION

INTRODUCTION

Applications of lead-acid batteries for primary as well as backup power sources has been increased significantly. The reasons behind this growth are the continuously improving battery technology which provides higher and higher power densities, and the increased demand for wireless operation of different electronic devices and tools. Manufacturers of these equipment are frequently challenged to provide solutions for quick and efficient recharge of the cells and to maximize the capacity and life of the battery. Although the task sounds simple, satisfying the various requirements associated with charging and maintaining lead-acid batteries often requires considerable intelligence from the battery charger circuit.

BASICS OF LEAD-ACID BATTERIES

In order to efficiently discuss battery properties, some of the common terms used in the battery industry have to be defined.

Ampere-Hour (Ah) - is a measurement of electric charge computed as the integral product of current (in Amperes) and time (in hours).

Capacity - is the ability of the battery to store and discharge a given quantity of current over a specified period of time. The capacity of the battery is expressed in Ampere-Hours (Ah). A cell's capacity is a function of the discharge current and usually increases with lower current levels. The capacity of the battery listed in the datasheet usually corresponds to the measured capacity at C/10 discharge rate.

C Rate - is the charge or discharge current of the battery expressed in multiples of the rated capacity. For example, a 2.5Ah cell will provide 250mA for 10 hours. The C rate in this particular case is C/10. In the real world, however, a cell does not maintain the same rated capacity at all C rates.

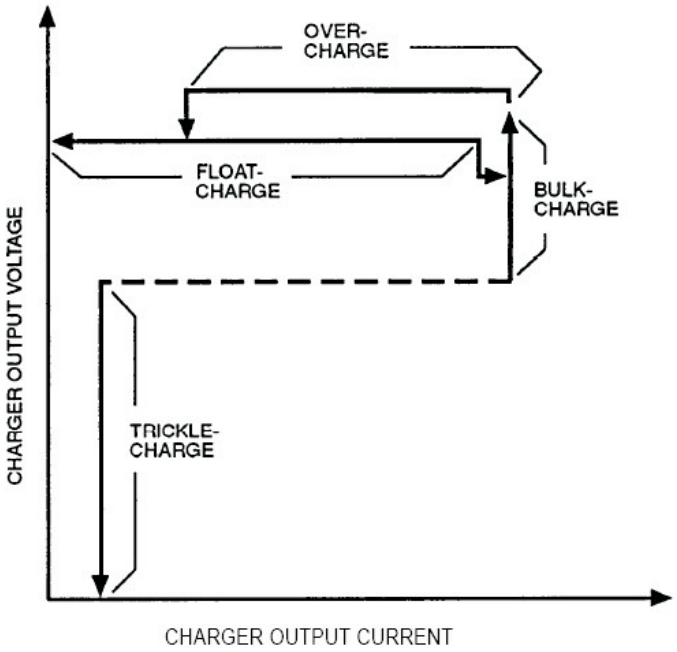
Self Discharge - is the loss of useful capacity of a cell on storage due to internal chemical action.

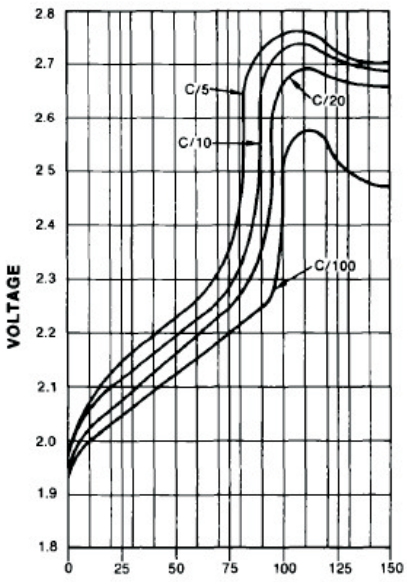
Deep Discharge - is the discharge of the battery below the specified cutoff voltage, typically 1.7V- 1.9V per cell at 25°C depending on the C rate, before the battery is recharged. It happens usually upon withdrawal at least 80% of the rated capacity of the cells.

Constant Voltage Charge - is a charging technique during which the voltage across the battery terminals is regulated while the charge current varies according to the state of charge of the battery.

Constant Current Charge - is a charging method during which the current through the battery is maintained at a steady state value while the cell voltages will vary according to the state of charge of the battery.

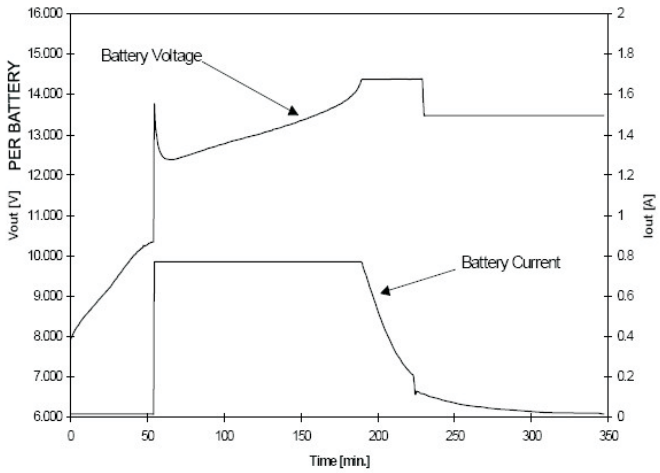
Trickle-Charge - is a constant current charge of the battery. In this mode, a low current, typically in the range of C/100 or lower is applied to the battery to raise the voltage to the deep discharge threshold (cutoff voltage), a level corresponding to





VOLTAGE CURVES FOR CELLS CHARGED AT VARIOUS CONSTANT (CURRENT) RATES AT ROOM TEMPERATURE

PRINCIPLE OF OPERATION continuation...



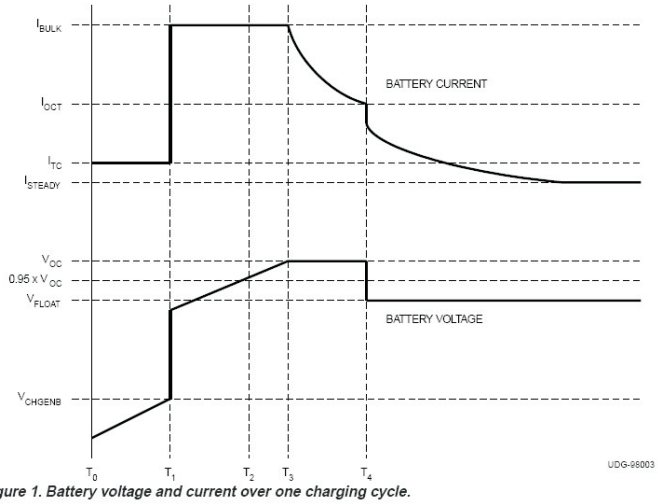


Figure 1. Battery voltage and current over one charging cycle.

near zero capacity. The trickle charge current has to be determined to assure continuous operation without damaging the cells.

Bulk-Charge - is also a constant current mode of operation, to quickly replenish the charge to the battery. The battery manufacturers define the bulk charge current as the maximum charge current allowed for the cells. It can be applied to the batteries if their voltage is between the deep discharge and the over-charge limits. Typical bulk charge current varies between C/5 and 2×C depending on manufacturers and battery types.

Over-Charge - the term describes the chemical reactions taking place when the majority of the lead-sulfate has already been converted to lead, resulting in the generation of hydrogen and oxygen. The beginning of the over charge reactions depends on the C rate, and it is indicated by the sharp rise in cell voltage.

For over-charge to coincide with the 100% return of capacity, the charge rate must be less than C/100. For higher charge rates, over-charge of lead-acid batteries is necessary to return the full capacity. In a controlled over-charge mode, a constant voltage is applied. Its value is typically set between 2.45 V/cell and 2.65 V/cell, again depending on the C rate. Improper selection of the over-charge voltage will eventually result in dehydration of the battery and reducing its useful life span.

Float-Charge - is a constant voltage charge of the battery, after completing the charging process. This voltage maintains the capacity of the battery against self discharge. Even though providing a fixed output voltage is a simple task, to find the precise value of the float voltage has a profound effect on battery performance. For instance, 5% deviation from the optimum cell voltage in float mode, could result approximately 30% difference in the available capacity of the battery. Furthermore, the battery's temperature coefficient of typically 3.9mV/°C per cell, adds complication. If the float voltage is not compensated according to the battery temperature, loss of capacity will occur below the design temperature, and uncontrolled over-charging with degradation in life will happen at elevated temperature.

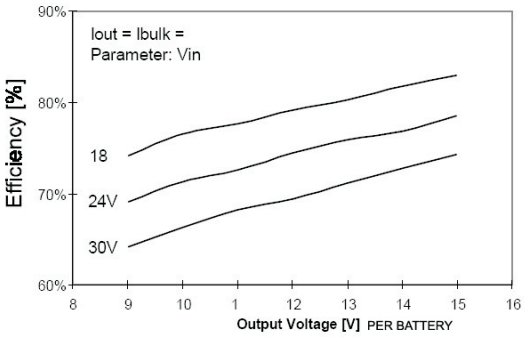
BATTERY CHARGER BASICS

What differentiates a battery charger from a conventional power supply is the capability to satisfy the unique requirements of the battery. Lead-acid battery chargers typically have two tasks to accomplish. The most important is to restore capacity as quickly as possible.

The second one is to maintain capacity by compensating for self discharge and ambient temperature variations. There are two fundamentally different charging methods for lead-acid batteries. In constant voltage charge, the voltage across the battery terminals is constant and the condition of the battery determines the charge current. Constant voltage charge is mostly used in float mode application.

PRINCIPLE OF OPERATION continuation...

The charging process is usually terminated after a certain time limit is reached. Another technique is constant current charge, which is often used in cyclic applications because it recharges the battery in a relatively short time. As opposed to constant voltage charge, the constant current charge automatically equalizes the charge in the series cells. There are many variations of the two basic methods, well suited for switchmode battery charger circuits. Considering that well designed switchmode power converters are inherently current limited, the combination of constant current and constant voltage charge is an obvious choice.
The best performance of the lead-acid cells can be achieved using a four state charge algorithm. This method integrates the advantages of the constant current charge to quickly and safely recharge and equalize the lead-acid cells, with the constant voltage charge to perform controlled over-charge and to retain the battery's full charge capacity in float mode applications. The carefully tailored charging procedure maximizes the capacity and life expectancy of the battery.
The four states of the charger's operation are trickle charge, bulk charge, over-charge and float charge. Assuming a fully discharged battery, the charger sequences through the states as follows:



State 1: Trickle Charge - If the battery voltage is below the cutoff voltage, the charger will apply the preset trickle charge current (ITRICKLE). In case of a healthy battery, as the charge is slowly restored, the voltage will increase towards the nominal range until it reaches the cutoff voltage. At that point the charger will advance to the next state, bulk charging. In case of a damaged battery, e.g. One or more cells are shorted or the internal leakage current of the battery is increased above the trickle current value, the low value of the trickle charge current ensures safe operation of the system. In this case the battery voltage will stay below the deep discharge threshold (VCUTOFF) preventing the charger from proceeding to the bulk charge mode. When the battery voltage is above the cutoff voltage at the beginning of the charge cycle, the trickle charge state is skipped and the charger starts with the bulk charge mode.
State 2: Bulk Charge - In this mode the maximum allowable current (IBULK) charges the battery. During this time, the majority of the battery capacity is restored as quickly as possible. The bulk charge mode is terminated when the battery voltage reaches the over-charge voltage level (VOC).
State 3: Over-Charge - Controlled over-charge follows bulk charging to restore full capacity in a minimum amount of time. During the over-charge period, the battery voltage is regulated. The initial current value equals the bulk charge current, and as the battery approaches its full capacity the charge current tapers off. When the charge current becomes sufficiently low (IOCT), the charging process is essentially finished and the charger switches over to float charge. The current threshold, IOCT, is user programmable and is typically equals IBULK/5.
State 4: Float Charge - This mode is only applicable when the battery is used as a backup power source. The charger will maintain full capacity of the battery by applying a temperature compensated DC voltage across its terminals. In the float mode, the charger will deliver whatever current is needed to compensate for self discharge and might supply the prospective load up to the bulk charge current level. If the primary power source is lost or if the load current exceeds the bulk current limit, the battery will supply the load current. When the battery voltage drops to 90% of the desired float voltage, the operation will revert to the bulk charge state.
The ultimate lead-acid battery charger will combine the above described four state charge algorithm, and particularly at higher output currents, a switchmode power converter.

MOBATT 200

MAIN CHARACTERISTICS

Load Type	Battery Bank.
Line Voltage (Power)	220, 380, 440 VAC - 15% a +20% for external transformer.
Frequency	50 / 60Hz
Control Module Power Supply	VCC -7 Watts +12V/0/-12V
Fans Power Supply	115 or 220 VAC - 20 W Max (see TAG and Data Sheet)
Load Connection	* 2 Power Cables and 2 Sensing Cables.
Nominal Battery Bank Voltages	12 to 240 VDC (See TAG and Data Sheet)
Nominal Currents	20 to 100 A (See TAG and Data Sheet)
Maximum Riplle at Bulk charge	15%
Minimum Eficiency at Bulk	80%
Power Circuits Model T	6 Rectifier Diodes and 1 IGBT With Free Wheeling Diode.
Power Circuits Model S	6 SCRs (Silicon Controlled Rectifiers) and one Free Wheeling Diode.
Surge Protection	Snubber Circuit
Diodes or SCRs PIV	1200 V
IGBT VCE	600 V
Coooling	Forced - With axial fans. Fans turn on automatically over 45ºCin the heathsinkss.
Environment	0 - 40 ºC / to 95% relative air moisturizing (Not condensing) Level to 2000 m W/O derating - 1% derating each 100m.
Digital input (Enable)	1 Dry contact
Digital Outputs - Relays	4 Outputs N.O. All 240 VAC - 2A maximum or 125 VDC/0,1 A maximum
PWM Frequency model T	1000 to 3000 Hz depending on model (see TAG and Data Sheet)
PWM Frequency model S	360 Hz
Internal CTs	Thoroid type, high performance, not saturable to 10 x IN.
Control module	Plug In
Power Connectors	With live parts protected and screw driver or philips for connection of cable or copper bars.
Control Module	One model for the entire range in plastic case.
Firing Module	Full isolation between power and control. Included load short circuit protection by VCE mensuration in model T.
Charge Modes	* Tricke (for precharge Test - Can be bypassed depending to the application). * Bulk (for fast charging). * Over (for garanty full charge). * Float (for garanty full charge maintenance).
Power Bars	Internally with electrolitic tin electroplating coppers bars.
LEDs Status	5 LEDS in the control module for Power On / Trickle / Bulk / Over / Float.
Finishing	Steel sheets w/ epoxi painting, Plastic control module case. Heatsinks in anodized alluminium.
ISO 9001 - 2000	ANSI - NAB

Varixx INNOVATION

TYPE SPECIFICATION

MOBATT 200/20/xxx/y to MOBATT 200/100/xxx/y				
MODEL	SIZE	MAX CURRENT (A)	AVERAGE CURRENT (A)	VOLTAGE DC (V)
20	1	30	20	12 to 240
30	1	45	30	12 to 240
40	2	60	40	12 to 240
50	2	75	50	12 to 240
60	3	90	60	12 to 240
70	3	105	70	12 to 240
80	4	120	80	12 to 240
90	4	135	90	12 to 240
100	4	150	100	12 to 240
DATA CAN BE CHANGED AT ANY MOMENT WITHOUT NOTICE - PLEASE, ASK FACTORY. xxx= Nominal Volttage y = T for model w/ IGBT or S for model w/ SCRs				

Data necessary to buy.

To buy an appropriate model to your application it is enough to follow some simple rules:
It is necessary to inform the following data

- Battery type and capacity (A/H)
- Number of cell per battery,
- Number of batteries in the bank.
- Nominal charging current.
- Load current.
- Line Voltage.
- If available supply the battery data sheet.

ORDERING

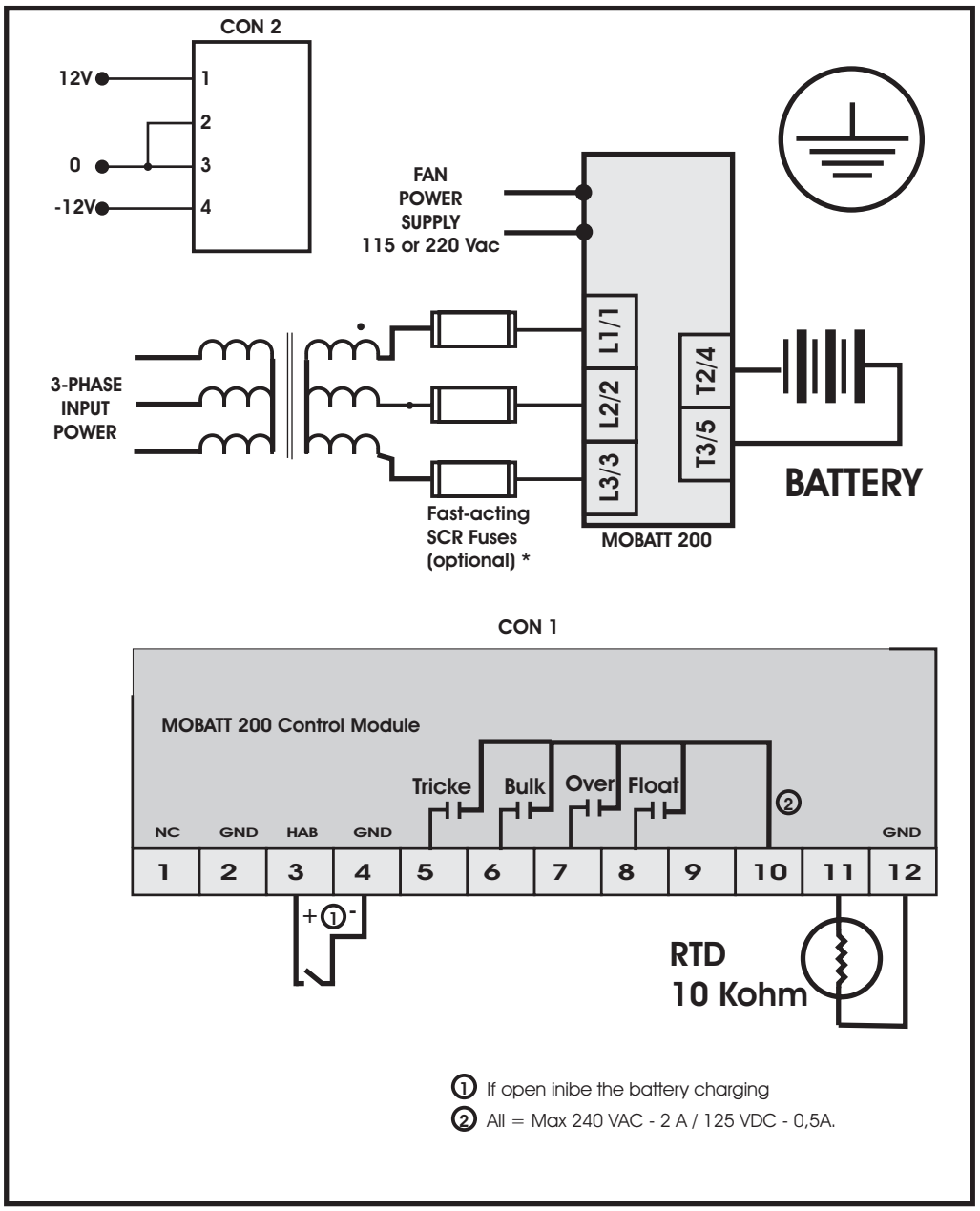
MODELS

MOBATT 200 / T / XXX / YYY
MOBATT 200 / S / XXX / YYY

XXX = Nominal Current
YYY = Nominal Voltage

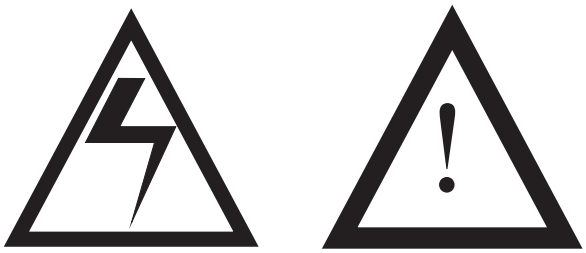
MOBATT 200

TYPICAL SCHEMATIC



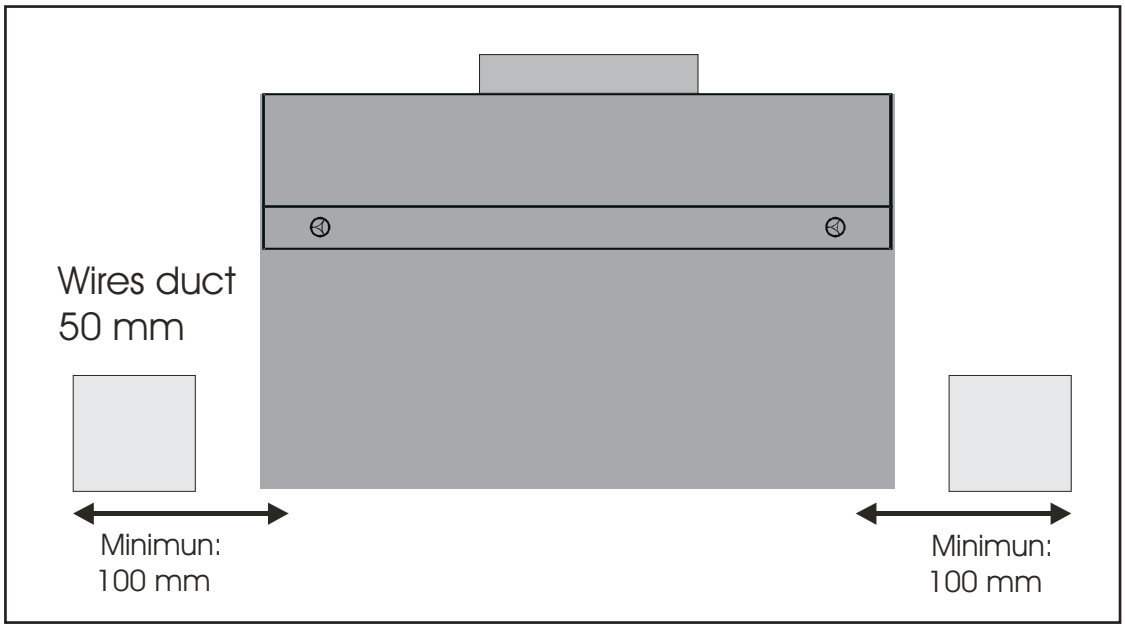
Details

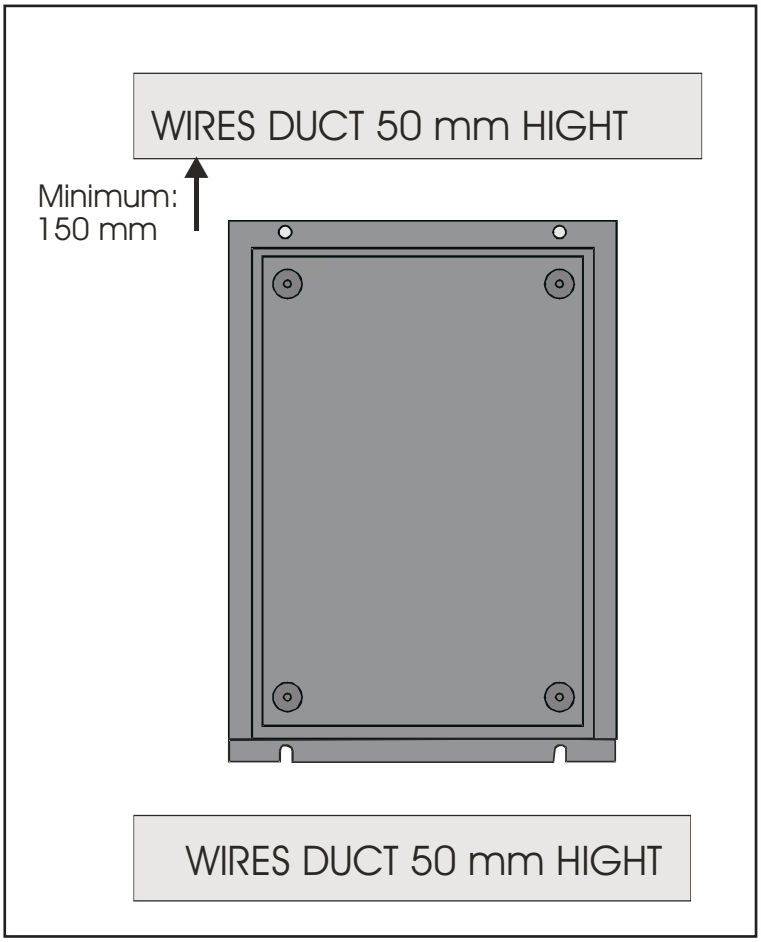
Note that The power transformer is an external component an is necessary to adapt the power line voltage to the voltage necessary to the battery bank.
the option Block will be useful.
With the Mobatt 200 is supplied the power module and the power transformer.
The PTC RTD is optional. If not used connect a 10 Kohm resistor in its place(B11 and B12).
The Disable contact (B5 and B12) if closed interrupts the charging and can be used for maintenance and other purposes.
The ultra fast fuses are optional at the power input and must have the nominal current 1.5 x the Mobatt 200 nominal current as a simplified rule. For precise specification contact the factory to get the appropriate i2t value.



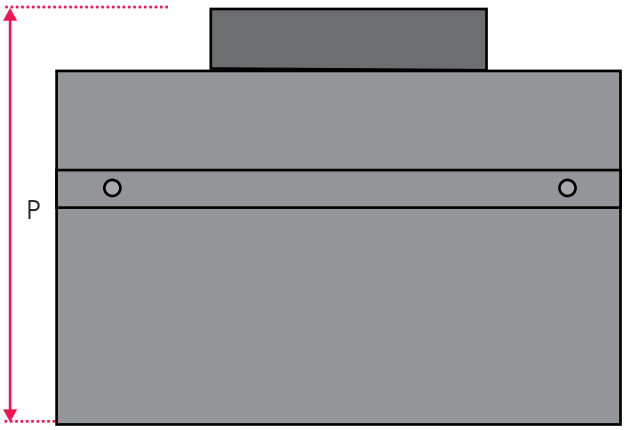
Take maximum care when servicing battery bank or charger.
High voltage levels are present and can cause serious personal injury or death.

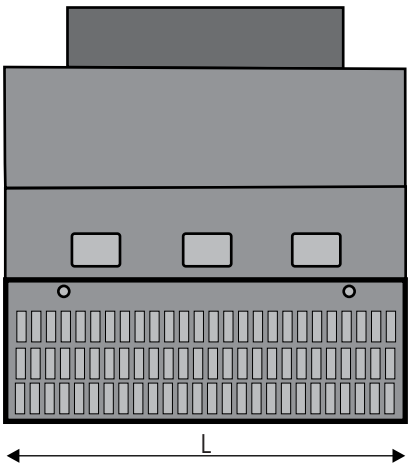
MOUNTING INSIDE A PANEL

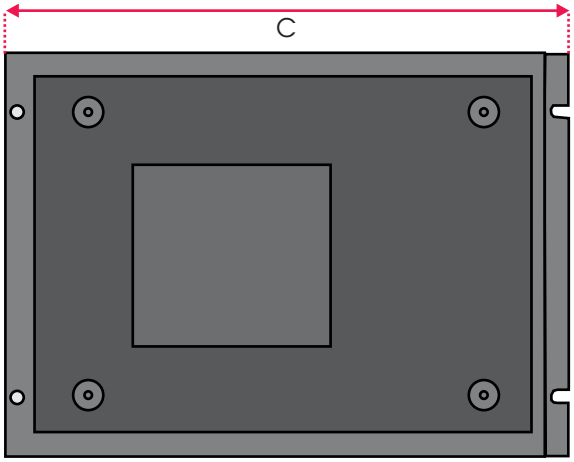




MOBATT 200







MOBATT 200/---/xxx/y				
MODEL	SIZE	WIDHT mm	LENGHT mm	DEPHT mm
20 A	1	ASK	ASK	ASK
30 A	1	ASK	ASK	ASK
40 A	2	ASK	ASK	ASK
50 A	2	ASK	ASK	ASK
60 A	3	ASK	ASK	ASK
70 A	3	ASK	ASK	ASK
80 A	4	ASK	ASK	ASK
90 A	4	ASK	ASK	ASK
100 A	4	ASK	ASK	ASK
DATA CAN BE CHANGED AT ANY MOMENT WITHOUT NOTICE - ASK FACTORY				

NOTES

MOBATT 200

Varixx Indústria Eletrônica
Rua Phelippe Zaidan Maluf 450 - Distrito Industrial Unileste
Piracicaba - SP - CEP13.422.190 - Fone: (55) (19) 3301.6900 - Fax: (55) (19) 3424.4001
www.varixx.com.br info@varixx.com.br