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**RACOM**
RADIO DATA NETWORKS

## Service manual



# Power Supply MS2000

**version 1.5**
9/30/2014

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# Intelligent Power Supply MS2000

MS2000 is a mains switching power supply (single-acting blocking converter) SELV with back-up. It is used for supplying devices in the industrial environment. The supply is designed for industrial use and installation into switchboards. There are control LEDs and terminal blocks for connection of the mains voltage, battery, terminal for signalizing and terminals for the temperature sensor on the front panel.

The design and construction of this device allows for long-term loading and for this reason it is primarily determined for continuously running applications.

If necessary, the source can be produced in a version MS2000/12-P with output voltage 13.8 V DC / 5 A for MORSE components supply and MS2000/24-P with output voltage 24 V / 3.5 A for 24 V supplying. The buil-in ventilator is switched on/off according to the power supply temperature. The version without ventilator provides reduced output current at higher surrounding temperature, see the table and diagram.

# 1. MS2000 connection to 230 V mains and linking with other devices

There are removable screw connectors for connection to 230 V mains. Cable *NKR9 for MR25* is used for linking between the radio modem and the MS2000 and connection with the battery is done with cable *NKR4 for MS2000*. The cable is protected by a cable fuse F6.3A.

The wire connecting is apparent from the following diagram:
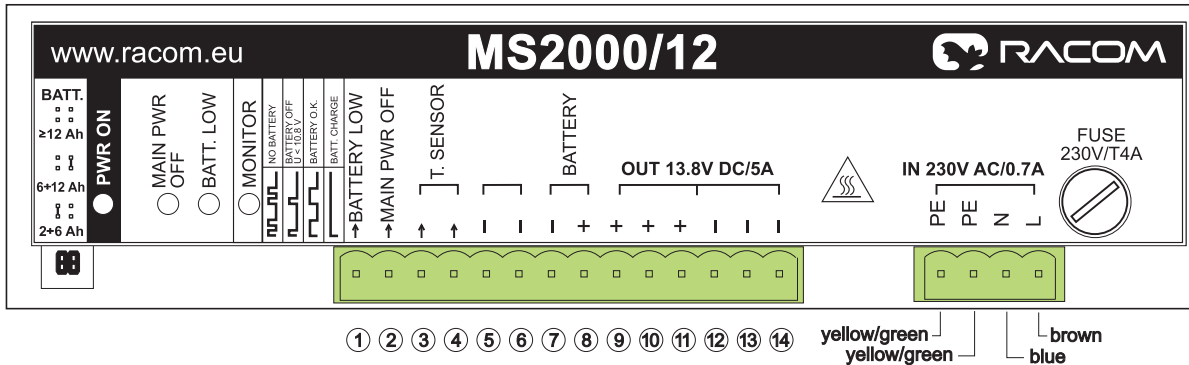


### NKR9 for MR25
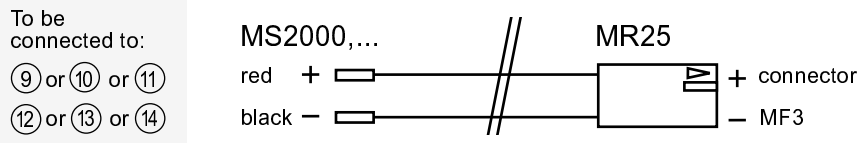


### Simple cable for MR400
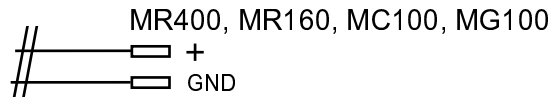


### NKR4 for MS2000
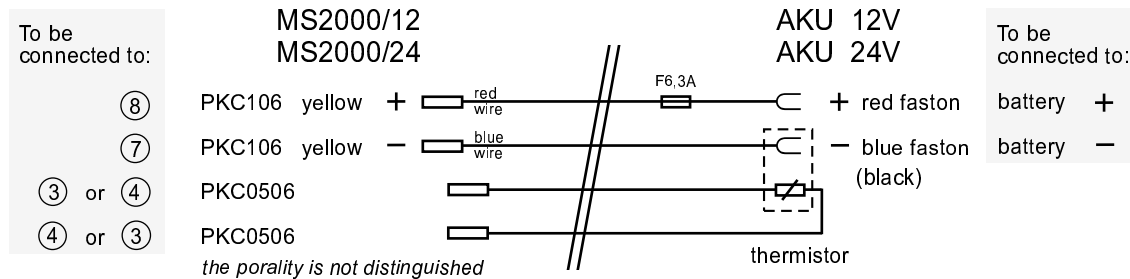


Connection of the terminals 1, 2, 5 and 6, see Section 2.3, "Signalizing of States".

# 2. Function Description, Meaning of Signal LEDs

## 2.1. General Description, Block Diagram

The power supply is a single-acting blocking converter (SELV) with two levels of output voltage. The lower level is for connecting supplied devices and the higher level is used for charging the back-up accumulator. The supply is protected on the input against shorting by safety fuse *T4A*. There is varistor protection against over-voltage on the primary side. The supply is short-circuit proof when powered by mains or from the accumulator. The supply is also resistant to over-voltage on the secondary side.

## 2.2. Charging and Back-up

There is integrated management of charging and back-up in the MS2000, which is all independently controlled by a microprocessor. Microprocessor control allows charging of the battery to full capacity in least time with high efficiency (switch regulator on the secondary side) and maintains it in an optimal mode. Charging works in reference to ambient temperature (a sensor is located on battery terminals). Due to this the battery is protected against overload at higher temperatures. The voltage temperature coefficient on the lead-acid battery is generally 10 mV / °C. MS2000 is produced for using with lead-acid batteries 12 V / 12 Ah (24 V / 12 Ah), but by using the jumper on the front panel it is possible to change the maximum charging current even for another capacity for battery: 2–6 Ah (jumper left) or 6–12 Ah (jumper right). Another type of battery than lead-acid can be used but firmware should be adapted by the manufacturer.
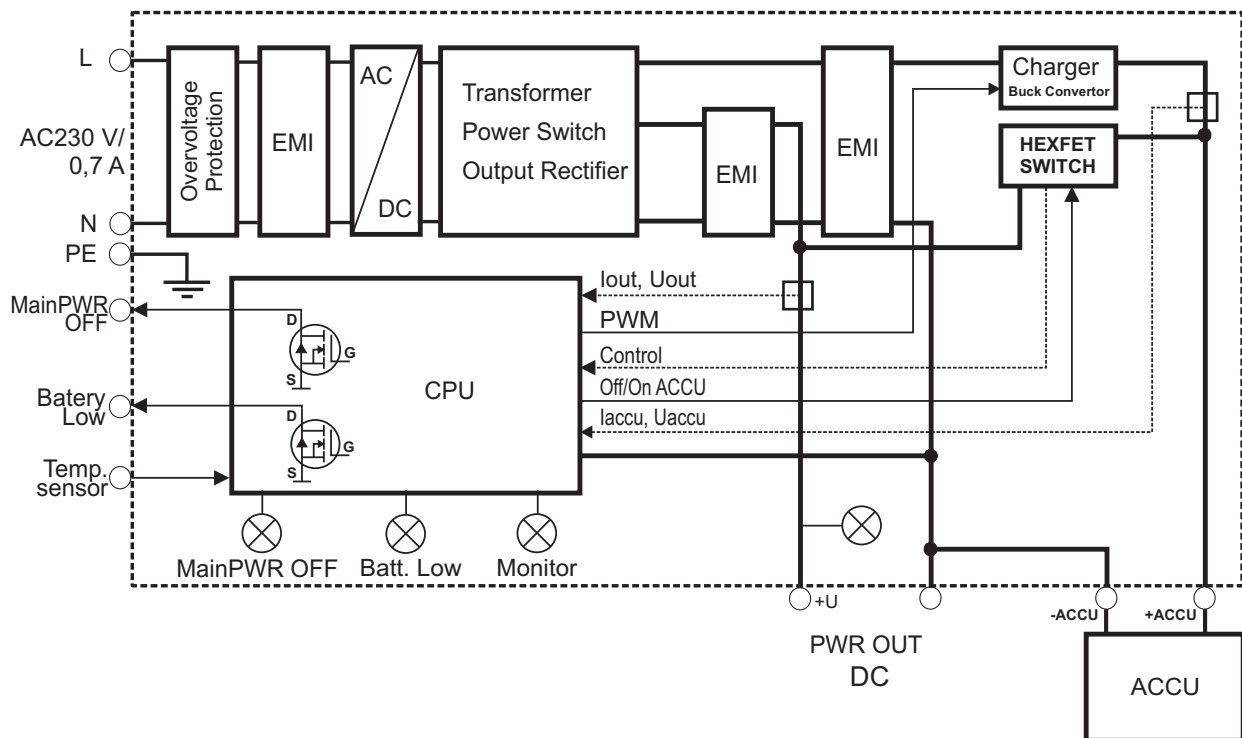


The microprocessor controls connecting of the battery when there is a mains failure and disconnecting of the battery when the minimum manufacturer's allowed voltage on the battery is reached (10.8 V or 21.6 V). An electronic switch also protects the supply with an electronic fuse against overload and surge current when connecting a capacitive load (of the order 6000 µF and larger). The electronic fuse

disconnects the load after a capacitive overload and the MS2000 tries to connect the capacitive load again by PWM modulation with a smooth rise in voltage.

No current needs to be applied to PWR OUT for battery charge control to function correctly.

> **Note**
>
> For MS2000 power supplies manufactured before 09/2008 a minimum current of 300 mA needs to be applied to PWR OUT for battery charge control to function correctly.

## 2.3. Signalizing of States

Information about mains failure **MAIN PWR OFF** and information about low battery voltage **BATTERY LOW**, (e.g. there will be a total voltage failure for a connected device) is linked to the output terminal – open collector. The current through the output transistors is not limited in any way and therefore it is important to connect an external resistor in series with the transistor to limit the current to an acceptable level (the maximum current value is 0.5 A). The following table contains the value of current through the transistor, $I\_D$, the output voltage when the transistor is switched on, $U\_DS$, and the value of the external series resistors, $R\_s$, for a 13.8 V and 24 V power supply.

| I_D[mA] | U_DS [mV] | R_s [Ω] | |
| --- | --- | --- | --- |
| | | $U_{voltage}$ **13.8 V** | $U_{voltage}$ **24 V** |
| 20.8 | 5.5 | 680 | 1200 |
| 89.1 | 24.5 | 150 | 270 |
| 471 | 137.5 | 27 | 56 |

The wires having the low battery voltage information are connected between the screw connectors No.**1** (**BATTERY LOW**) and **5** (**GND**), see the diagram. The information MAIN POWER OFF is given by wires connected to clamps No. **2** (**MAIN PWR OFF**) and **6** (**GND**) and it is evaluated by function `(m)isc (b)att` using the `Setr` utility, see the manual *MORSE firmware documentation*[1].

LEDs indicate the state of voltage on the power supply output (green LED **PWR ON**), mains failure (red LED **MAIN PWR OFF**), low battery voltage (orange LED **BATTERY LOW**). The last orange LED indicates the state of the battery charging cycle. The meaning of each state is shown on the front panel.

| ○ MONITOR | |
| --- | --- |
| ⊓⊓_⊓⊓_ | NO BATTERY |
| ⊓__⊓_ | BATTERY OFF $U_{BATT}$ < 10,8 V |
| ⊓_⊓_ | BATTERY O.K. |
| ⊓___ | BATTERY CHARGE |

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[1] https://www.racom.eu/en/support/firmware/mr400/misc.html

# 3. Basic Technical Parameters

## 3.1. Parameters for MS2000, version without ventilator

**Tab. 3.1:**

|  | **MS2000/12** | **MS2000/24** |
|---|---|---|
| Rated supply voltage | 230 V AC / 50 Hz, ±10 % | 230 V AC / 50 Hz, ±10 % |
| Rated supply current | 0.7 A | 0.6 A |
| Maximum working range of feed voltage | 140–275 V | 140–275 V |
| Safety fuse in the primary circuit | T4A | T4A |
| Rated output voltage | 13.6 V (-0.3 V; +0.3 V) | 24 V (-0.3 V; +0.3 V) |
| Rated output current at 20 °C | 5 A | 3.5 A |
| Rated output current at 55 °C | 3 A | 1.8 A |
| Output voltage ripple when $I_{OUT} = I_{nom}$ | max. 150 mV | max. 150 mV |
| MTBF (mean time between failures) | > 100 000 hours | > 100 000 hours |
| Maximum charging current according to the internal switch: |  |  |
| – for accu 2 Ah | 0.7 A | 0.7 A |
| – for accu 6 Ah | 1.5 A | 1.5 A |
| – for accu 12 Ah | 2.5 A | 2.0 A |
| The charging current cannot exceed the limit: | (rated output current) - (actual current on OUT DC) | |
| Recommended type of battery | Panasonic 12 V / 12  Ah | 2× Panasonic 12 V / 12 Ah |
| Minimum accumulator voltage | 10.8 V | 21.6 V |
| Current drain from battery after disconnecting | 1.5 mA | 1.5 mA |
| Operating range of temperature | -30 to + 65 °C | -30 to + 65 °C |
| Relative humidity | 10–90 % | 10–90 % |
| Dimensions | 104×50×186.5 mm | 104×50×186.5 mm |
| Weight | 0.8 kg | 0.8 kg |

## 3.2. Parameters for MS2000, version equipped by ventilator

Tab. 3.2:

| | MS2000/12-P | MS2000/24-P |
|---|---|---|
| Rated supply voltage | 230 V AC / 50 Hz, ±10 % | 230 V AC / 50 Hz, ±10 % |
| Rated supply current | 0.7 A | 0.6 A |
| Maximum working range of feed voltage | 140–275 V | 140–275 V |
| Safety fuse in the primary circuit | T4A | T4A |
| Rated output voltage | 13.6 V (-0.3 V; +0.3 V) | 24 V (-0.3 V; +0.3 V) |
| Rated output current at 20 °C | 5 A | 3.5 A |
| Rated output current at 55 °C | 5 A | 3.5 A |
| Output voltage ripple when $I_{OUT} = I_{nom}$ | max. 150 mV | max. 150 mV |
| MTBF (mean time between failures) | > 100 000 hours | > 100 000 hours |
| Maximum charging current cannot exceed the limit: | | |
| – for accu 2 Ah | 0.7 A | 0.7 A |
| – for accu 6 Ah | 1.5 A | 1.5 A |
| – for accu 12 Ah | 2.5 A | 2.0 A |
| The charging current cannot exceed the limit: | (rated output current) - (actual current on OUT DC) | |
| Recommended type of battery | Panasonic 12 V / 12 Ah | 2× Panasonic 12 V / 12 Ah |
| Minimum accumulator voltage | 10.8 V | 21.6 V |
| Current drain from battery after disconnecting | 1.5 mA | 1.5 mA |
| Operating range of temperature | -30 to + 65 °C | -30 to + 65 °C |
| Relative humidity | 10–90 % | 10–90 % |
| Dimensions | 104×50×186.5 mm | 104×50×186.5 mm |
| Weight | 0.8 kg | 0.8 kg |

**The supply fulfils following standards:**

*   safety: CSN EN 60 950

*   EMC: CSN EN 50 081-1, CSN EN 55 022 class B, CSN EN 61 000-6-2

## 3.3. Allowed output current in dependence on the surrounding temperature
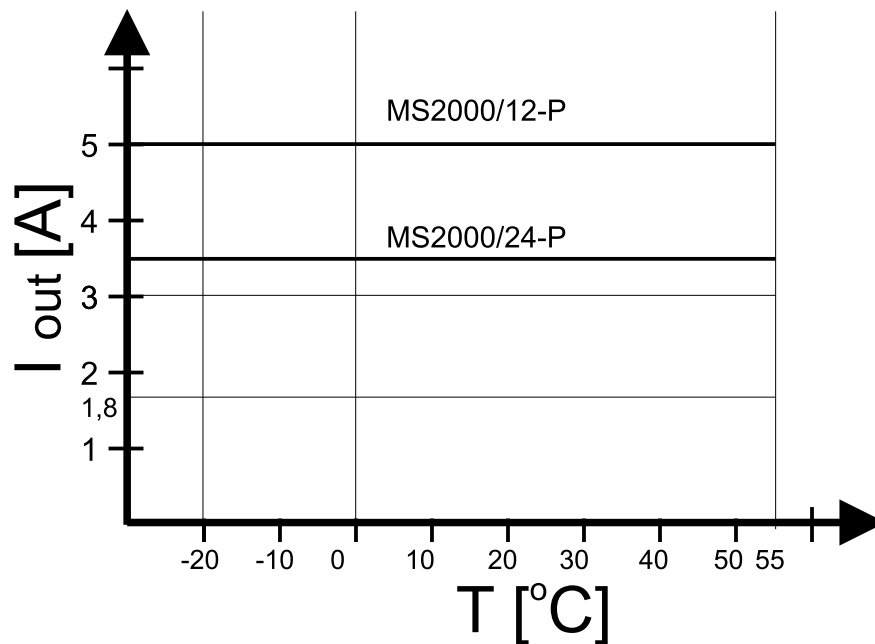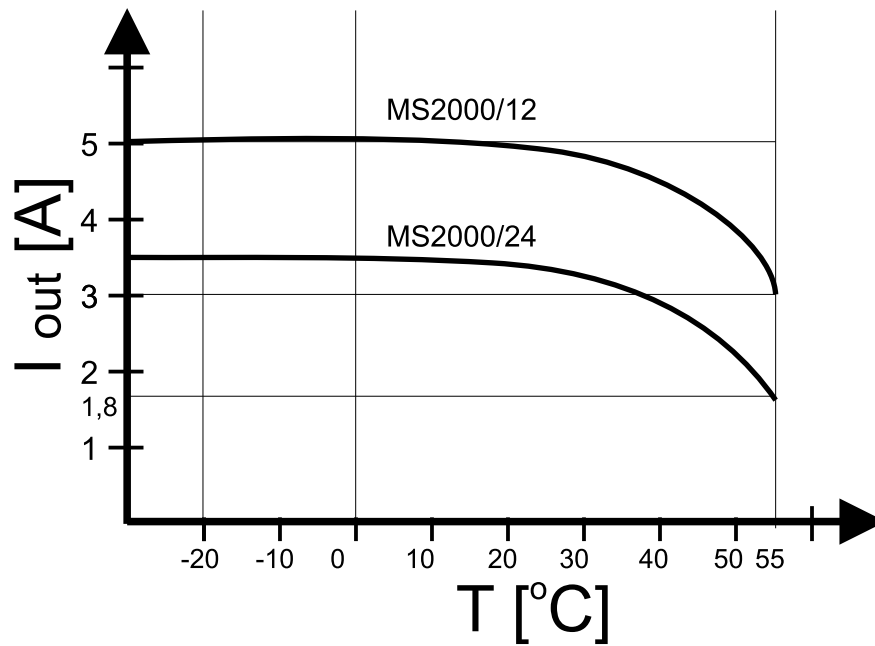
# 4. MS2000 Installation instructions

• The device is designed for industrial use for assembly into premises with limited access (electrical switchboard).

• Wiring up must be carried out by an individual with knowledge of the regulation No. 50/78 Coll.

• The supply is designed for assembly into switchboards by attaching either to a mounting plate by means of M3 screws or on to a DIN rail. The mounting plate and DIN rail must be properly grounded in accordance with valid standards. The source must be located in such a way so as not to prevent air circulation necessary for cooling purposes.

• Conductors must be wired into labelled terminals in accordance with valid standards. Terminals are only designed for connecting cooper conductors of max. diameter 2.5 mm$^2$ and do not serve for switching devices under voltage.

• For accumulator connection is recommended using only connection conductors producted by RA-COM. This conductors contain temperature sensor and safety fuse F6,3 A. Without the original connection conductor will not be optimized charging process depending on ambient temperature!

• The producer does not recommend to change accumulator poles when wiring up.

• Color cording of low voltage conductors must comply with the requirements of respective standards.

• The producer recommends to protect the 230 V AC input by circuit breaker of 6 A rated current with characteristics C.

• The source must be disconnected from the battery when replacing fuses. Only the same types of fuses with the same current rating can be used for replacement.

• When using the device as a source of SELV voltage the extra low voltage side must be electrically and spatially separated from low voltage conductors.
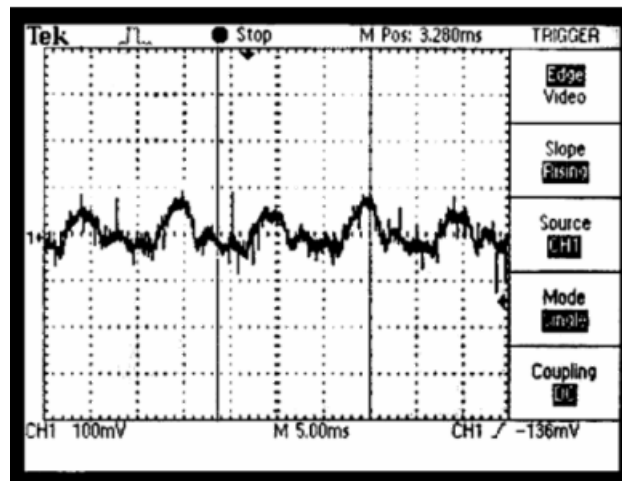
# 5. Electric Characteristics



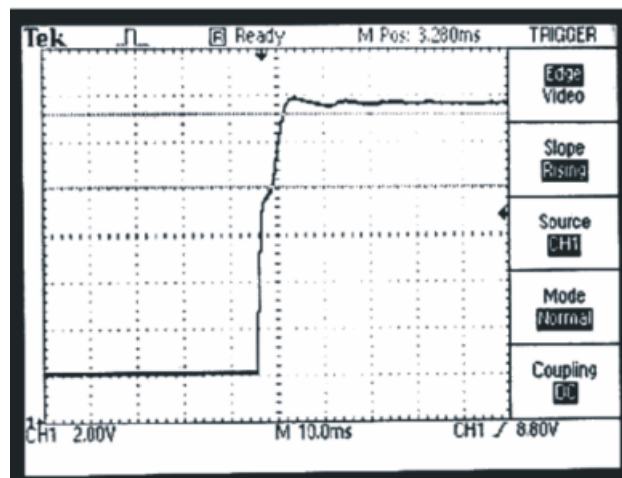*Fig. 5.1: Voltage ripple in output at rated current output*



*Fig. 5.2: Smooth rise in output voltage when supply starts (without battery)*
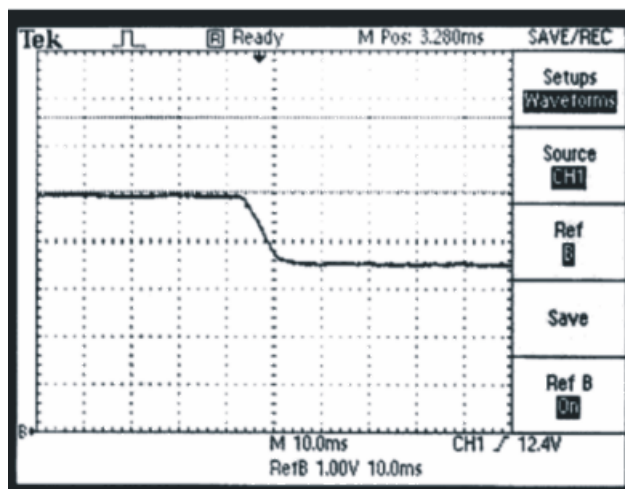
*Fig. 5.3: Voltage characteristic at the output of the MS2000 supply when changing over to back-up (battery 12 V / 12 Ah, I = 2 A)*
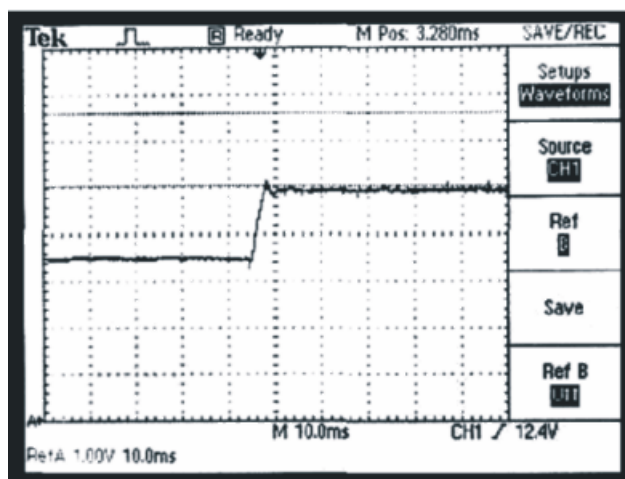


*Fig. 5.4: Voltage characteristic at the output of the MS2000 supply when changing over from back-up to feeding from mains 230 V (battery 12 V / 12 Ah, I = 2 A)*

# 6. Parameters of Recommended Batteries

The supplied battery is PANASONIC 12 V / 12 Ah (type *LC-RA*). The following characteristics are taken from Panasonic documentation.
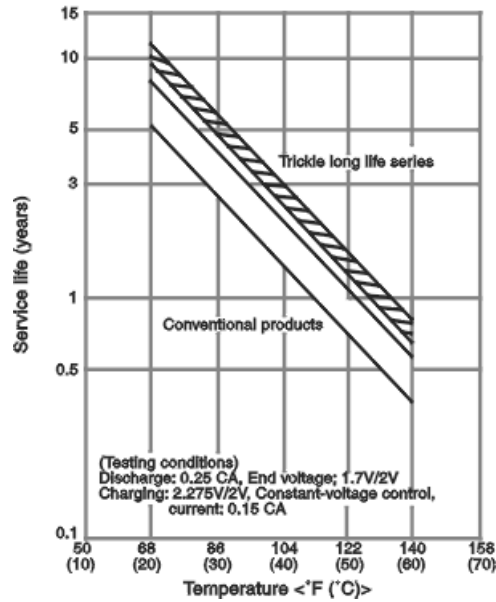


*Fig. 6.1: Influence of temperature on trickle life*
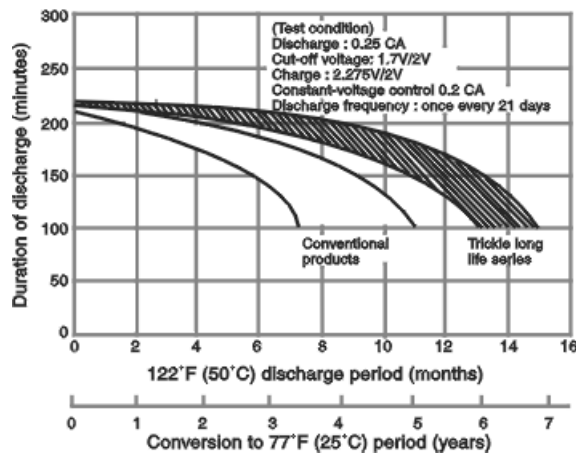


*Fig. 6.2: Influence of self-discharging to remain battery capacity*

(Test condition)
Discharge : 0.25 CA
Cut-off voltage: 1.75V/cell
Capacity check by every 3 months
Charge :2.30V/cell
Constant-voltage control
Maximum current: 0.4 CA
Temperature : 68°F to 73.4°F (20°C to 23°C)

*Fig. 6.3: Trickle (Float) life characteristic (LC-T, LC-R and LC-L)*
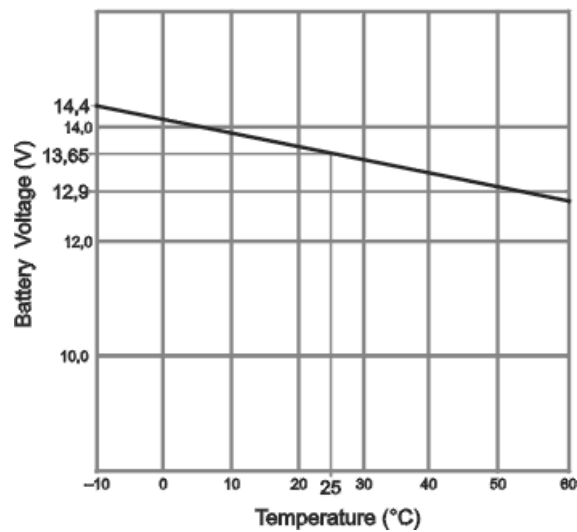
*Fig. 6.4: Influence of battery voltage on temperature*

# 7. Charging process
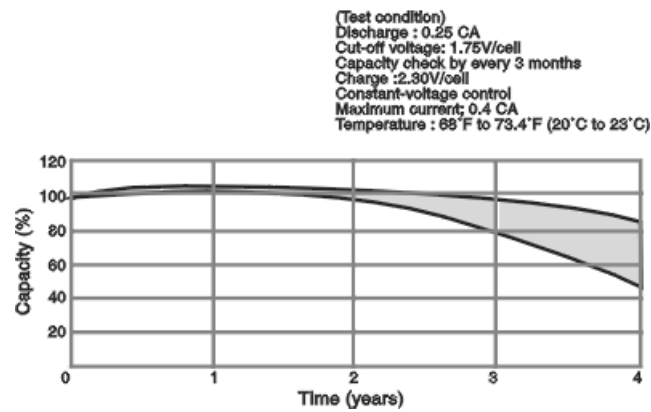
**Battery 12V / 12 Ah PANASONIC**
Characteristic at 20 °C



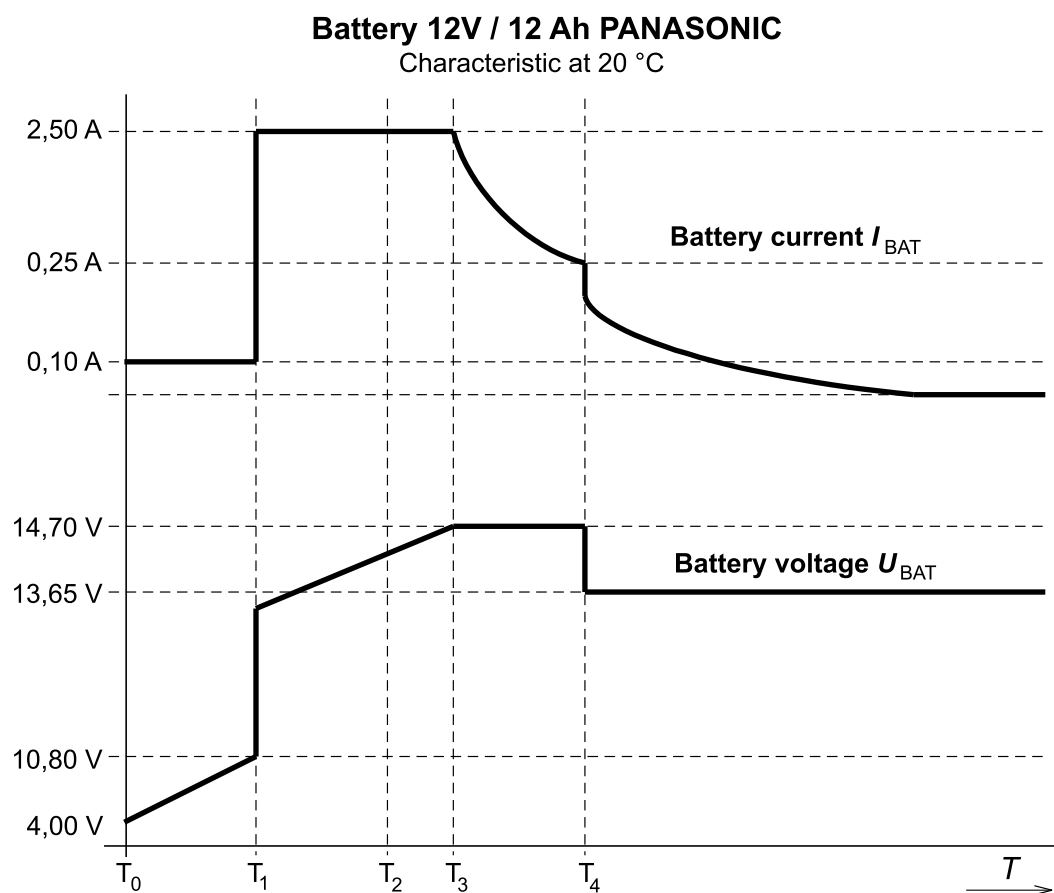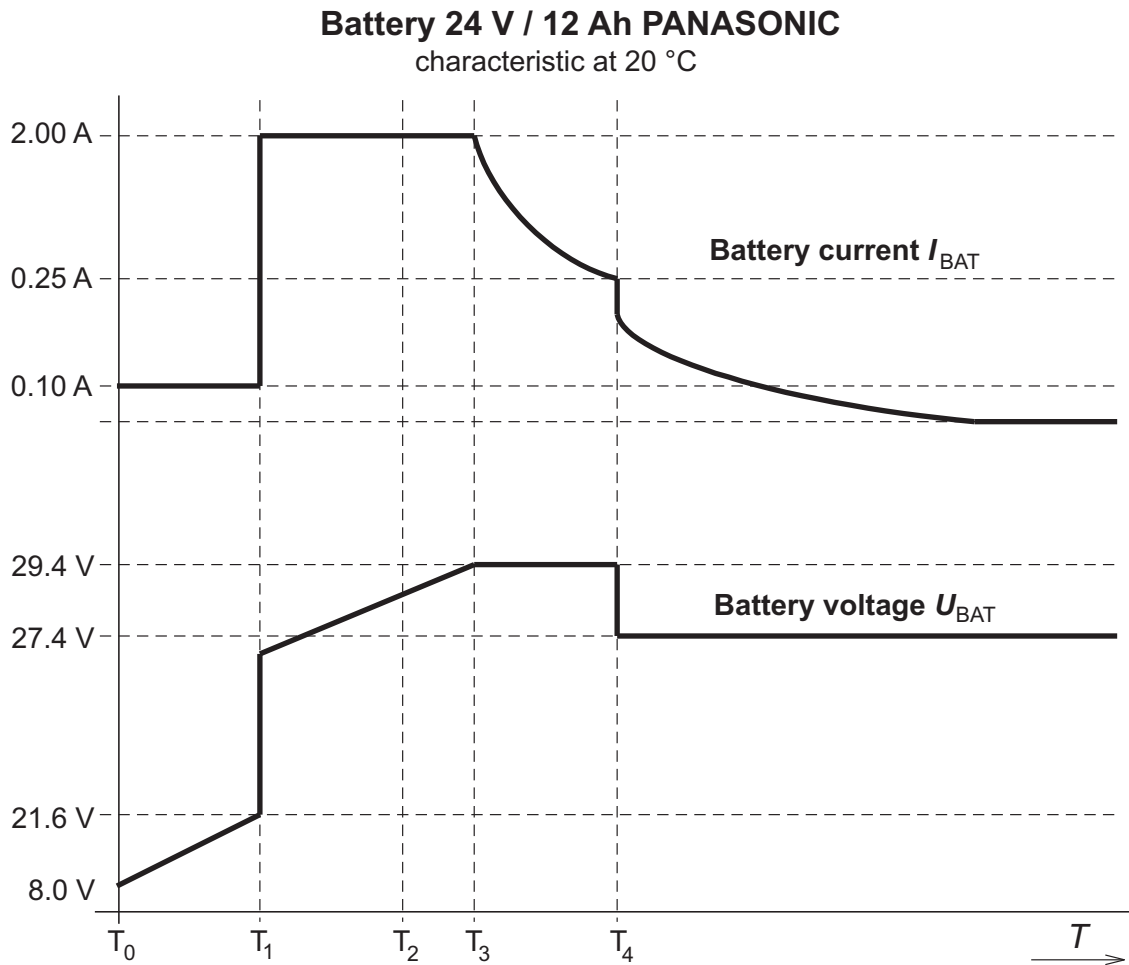*Fig. 7.1: Typical characteristic of recharging cycle for MS2000/12-P*

Fig. 7.2: Typical characteristic of recharging cycle for MS2000/24-P

- In the interval $T_0$–$T_1$ until the voltage 10.8 V (21.6 V for 24 V) is reached the battery is charged by little current to prevent any battery damage at possible failure (shortcut at any battery cell).

- In the interval $T_1$–$T_3$ until the voltage 14.7 V (29.4 V) is reached the battery is charged by constant current 2.5 A (2.0 A).

- In the interval $T_3$–$T_4$ until the charging current drops under 0.25 A is charged by constant voltage 14.7 V (29.4 V).

- In the interval over $T_4$ is charged by constant voltage 13.65 V (27.4 V) with the charging current drops gradually to zero.

- The maximum charging current for various versions is written in the table Basic Technical Parameters. For each case this current cannot exceed the limit (Rated output current) - (Actual current on OUT DC).

# 8. Mechanical parameters
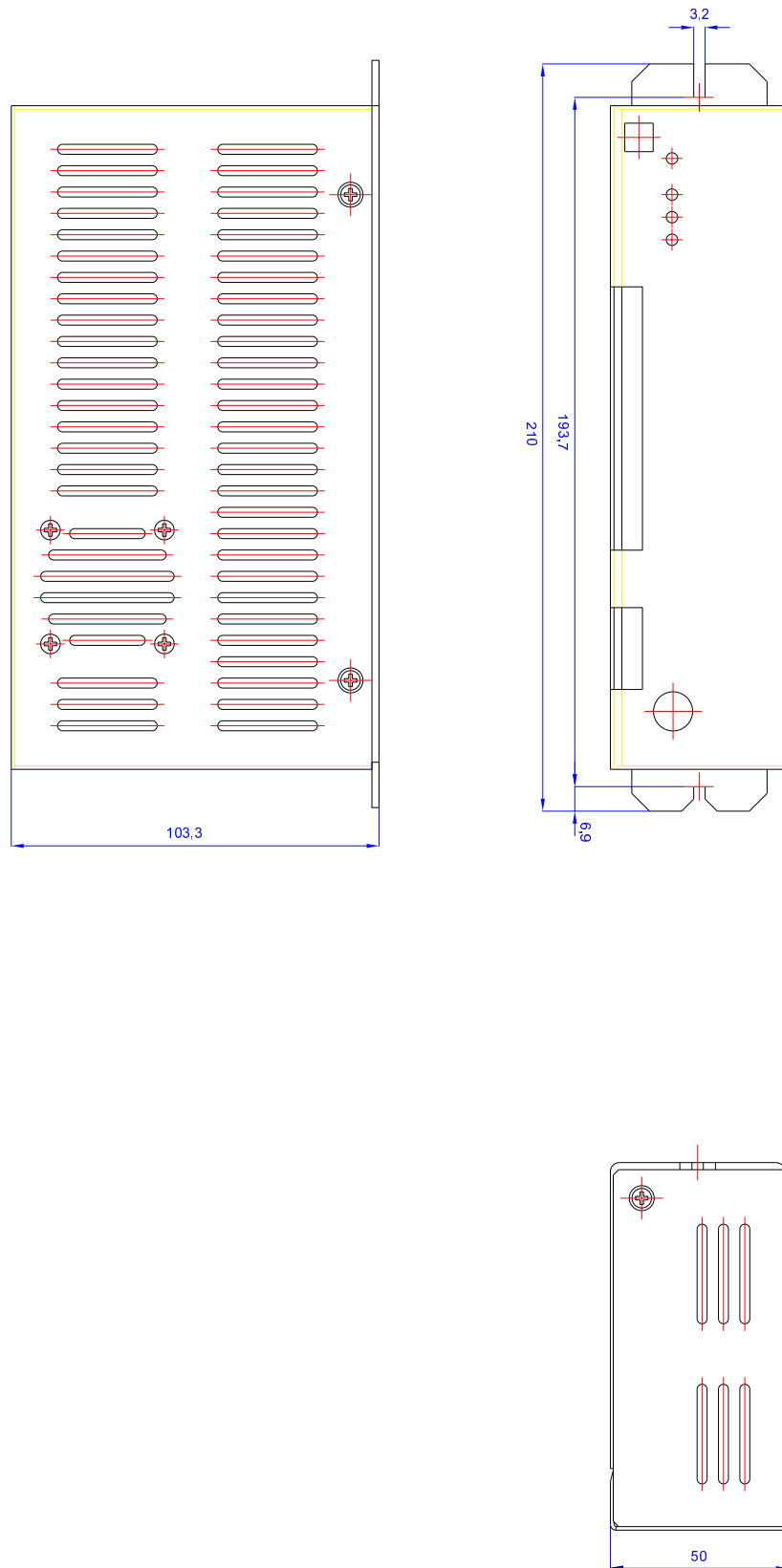
# 9. Conditions for MS2000 Operation

## 9.1. Important Warning

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## 9.2. Conditions of Liability for Defects and Instructions for Safe Operation of Equipment.

Please read these safety instructions carefully before using the product:

• Liability for defects does not apply to any product that has been used in a manner which conflicts with the instructions contained in this operator manual, or if the case in which the equipment is located has been opened, or if the equipment has been tampered with.

• Equipment mentioned in this operator manual may only be used in accordance with instructions contained in this manual. Error-free and safe operation of this equipment is only guaranteed if this equipment is transported, stored, operated and controlled in the proper manner. The same applies to equipment maintenance.

• Only undermentioned manufacturer is entitled to repair any devices.

# 10. Declaration of conformity

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## Declaration of Conformity – MS2000

- in accordance with **73/23/EEC** Directive of 19th of February 1973 on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits and **89/336/EEC** Directive of 3th of May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility.

| | |
|---|---|
| **Producer:** | **RACOM s.r.o.** |
| **Address:** | **Mirova 1283, 592 31 Nove Mesto na Morave, Czech Republic** |
| **VAT:** | **46343423** |
| **Product:** | **MS2000** |
| **Purpose of use:** | **Power Supply** |

CE

**We, the manufacturer of the above mentioned product, hereby declare that this product:**

- conforms to the essential requirements of the European Union directives **73/23/EEC** and **89/336/EEC**;
- is safe on condition of usage mentioned in the operating manual.

**This Declaration of Conformity is based on the following documents:**

| Test specification: | Document No.: | Date of issue: | Laboratory: |
|---|---|---|---|
| 730-595/2001 | CSN EN 61000-3-2:2001 | 03.08. 2001 | VTUPV Vyskov |
| 730-595/2001 | CSN EN 61000-3-3:1997 | 03.08. 2001 | VTUPV Vyskov |
| 730-590/2001 | CSN EN 61000-3-11:1996 | 02.08. 2001 | VTUPV Vyskov |
| 730-591/2001 | CSN EN 61000-4-2:1997+A1:1999 | 02.08. 2001 | VTUPV Vyskov |
| | CSN EN 61000-4-3:1997 | | |
| | CSN EN 61000-4-4:1997 | | |
| | CSN EN 61000-4-5:1997 | | |
| | CSN EN 61000-4-6:1997 | | |
| | CSN EN 61000-6-2:2000 | | |
| | ENV 50204 :1995 | | |
| EMC-462/00 | CSN EN 50081-1 | 20.07. 2000 | TESTCOM Praha |
| EMC-467/00 | CSN EN 55022 class B | 28.07. 2000 | TESTCOM Praha |
| 740-14/02 | CSN EN 60950:2001 | 25.03. 2002 | VTUPV Vyskov |

Nove Mesto na Morave, 22nd of August 2006
Jiri Hruska, Managing Director

**RACOM s.r.o.** • Mirova 1283 • 592 31 Nove Mesto na Morave • Czech Republic
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**www.racom.eu**

*Fig. 10.1: Declaration of conformity*

# 11. Country of Origin

**RACOM**
RADIO DATA NETWORKS

## Country of Origin Declaration

| | |
|---|---|
| **Producer:** | **RACOM s.r.o.** |
| **Address:** | **Mirova 1283, 592 31 Nove Mesto na Morave, Czech Republic** |
| **VAT No:** | **CZ46343423** |

**We, the manufacturer, hereby declare that Country of Origin of the RAy microwave links and its accessories is the Czech Republic, EU.**

| Part Number | Description |
|---|---|
| **MS2000/12** | 230 V AC / 13.8 V DC, intelligent back-up |
| **MS2000/24** | 230 V AC / 24 V DC, intelligent back-up |
| **MSU120** | Arbitrary solar panel / 14.7 V DC |
| **DCC24** | 20-60 V DC / 13.8 V DC |

Nove Mesto na Morave, 1 of March 2014
Jiri Hruska, CEO

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**www.racom.eu**

*Fig. 11.1: Country of Origin declaration for MS2000*