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RACOM
RADIO DATA NETWORKS

Operating Instructions

Solar power supply MSU120

Version 1.1
9/15/2015

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Introduction

This service manual serves as the primary document for familiarising users with the solar power supply´s parameters and features and the parameters of connecting parts. To assist you in managing all the functions of the power supply and the MORSE system please follow the instructions found in other documents referred to in this document or those which are available on our Internet pages racom.cz[1]
.

Fig. 1: Front panel of solar power supply

[1] http://www.racom.eu

1. Functions of Solar power supply MSU120

The MSU120 solar power supply is a fully automatic source of back-up voltage for supplying equipment in MORSE networks (e.g. MR160, MR300, MR400, MR900, MR25 and MG100 radio modems, MC100 and MCM302ET controllers, MRouter-A, and from MORSE system accessories the SEP technological and measuring unit and OPI optical separator). It is designed for use with a 12 V back-up lead-acid accumulator of capacity 20–150 Ah and with a 50–120 W / 12 V solar panel – the only limitation is in the size of the maximum current from the solar panel (7 A) and the size of the maximum output voltage from the solar panel (25 V).

The voltage at the source output copies the voltage from the accumulator according to the immediate state of accumulator charge. Charging control limits the output voltage to a max. of 14.7 V. If voltage drops below 10.5 V the accumulator is disconnected from the source's output terminals (DC_Out).

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

The charging characteristic ensures a maximum charging speed and overcharge protection, as well as protection against deep discharge (by disconnecting from the load).

1.1. Accumulator Charging Process

Charging occurs in three phases:

1. Charging with the maximum possible current (according to the immediate output of the solar panel) until a voltage of 14.7 V is reached in the accumulator.

2. Charging the accumulator at a constant voltage of 14.7 V until reaching a visible drop in charging current.

3. Switch-over to charging at a constant holding voltage of approx. 13.6 V (according to the immediate accumulator ambient temperature).

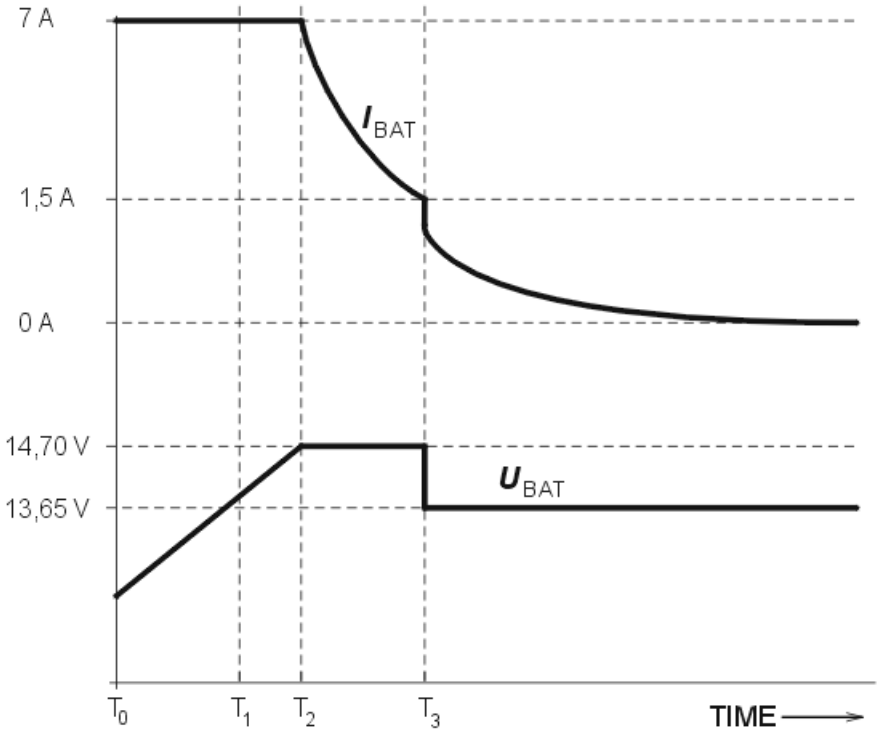

Fig. 1.1: Typical charging characteristic for MSU120

Upon connecting an external temperature sensor the power supply changes the value of the terminal voltage, 13.6 V, according to the current temperature. It follows a typical temperature characteristic of lead accumulator whilst doing this.

Upon disconnecting the load as a result of a drop in voltage below 10.5 V it will be reconnected again once the voltage rises again to 12 V (or 11.5 V in the case of sufficient voltage from the solar panel).

The power supply records the daily characteristic of voltages and currents to two memories (current day and previous day), which are alternately overwritten. A record of daily figures for individual days (approx. 500 days) is stored in another memory.

The MSU120 solar power supply is fitted with an RS232 serial port allowing basic control and set up during manufacture and installation. Communication takes place at 19200 Bd, 8, n, 1. The power supply reacts to single-character (ASCII) commands, and the reply from the power supply is in the form of text strings (mostly ending in CR/LF). It is possible to communicate with the power supply in this way even after connecting it to a common terminal. Remote access to the power supply is possible via MORSE network devices.

2. Connection of the MSU120 Solar power supply

Connections are made using plug-in terminals according to the description on the power supply´s front name plate:

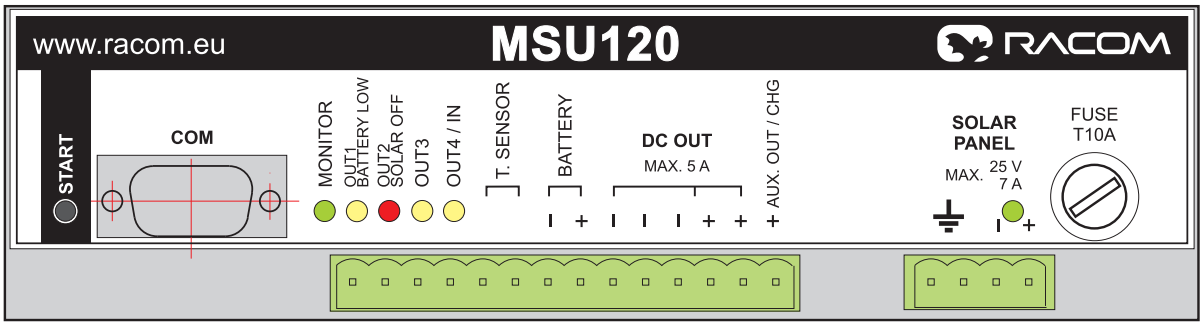

Fig. 2.1: Description on the power supply´s front name plate

SOLAR PANEL
1. + terminal for positive pole
2. – negative terminal (internally connected with negative terminal for connecting battery and with negative terminal for connecting load **DC_OUT**)
3. earth terminals are connected to the metal casing of the source

BATTERY+/- Battery connection to terminals.

DC_OUT The source output has a common negative pole and two terminals with a positive output voltage which are internally disconnected according to the state of the accumulator to prevent deep discharge, or overcharging.

AUX.OUT/CHG Auxiliary source output – not disconnected from the battery upon a drop in its voltage. Where necessary this can also be used as an input of another charging current (e.g. from the MS2000 network charger).

Warning

Output **AUX.OUT/CHG** is not protected with a current protection fuse.

OUT1–OUT4 Outputs with open collector with a common negative pole. The external voltage connected to these terminals cannot exceed the voltage at the output **DC_OUT**! Output switching is indicated by an LED lighting above the respective output.

By default:

OUT1 = BATTERY LOW Warning when battery voltage drops below 11.5 V

OUT2 = SOLAR OFF Low voltage from the solar panel

COM The serial port of the power supply is wired to a D-SUB connector (description of terminal like a DCE end device):

Pin. 1: DCD (* internally connected DCD, DSR, DTR)

Pin 2: RXD Data output from the power supply

Pin 3: TXD Date input to the power supply

Pin 4: DTR (* internally connected DCD, DSR, DTR)

Pin 5: Gnd Signal ground – internally connected to the negative terminal of the power supply

Pin 6: DSR (* internally connected DCD, DSR, DTR)

Pin 7: RTS (** internally connected RTS, CTS)

Pin 8: CTS (** internally connected RTS, CTS)

Pin 9: Unassigned

FUSE T10A The fuse on the front panel is connected into the battery circuit – it protects the battery and power supply against fault conditions whilst discharging and charging. In addition the source is protected by an electronic fuse which disconnects the source output (**DC_OUT**) if the source output current exceeds 6 A. After disconnecting the output as a result of overloading the power supply tries to connect the output every 20 s whilst testing whether any conditions for disconnecting the output still exist.

START By pressing the START button the battery connection to the source output is left disconnected. However, if conditions for output disconnection persist this condition is automatically reversed (immediately in the case of overloading, and no later than within 2 minutes in the case of a low battery voltage).

T.SENSOR Terminals for connecting an external temperature sensor. The sensor should be positioned, where possible, on the case of the charging accumulator. If installed with the accumulator simply connect the sensor to the power supply terminals. A KTY10 (2000 Ω/25 °C) temperature sensor is used.

Warning

The terminals cannot be connected through to other power supply terminals !!!

Temperature sensor characteristic:

3. Table of Technical Parameters

Tab. 3.1: Technical Parameters

Regulation of power supply output voltage	10.5 V–14.7 V depending on the accumulator
Back-up accumulator voltage	12 V nominal
Back-up accumulator capacity	20–150 Ah
Solar panel output power	50–120 W
Solar panel voltage	25 V max.
Max. current from solar panel	7 A max.
Temperature compensation range of end charging voltage	-10 °C – +60 °C

4. MSU120 Dimensional Drawing

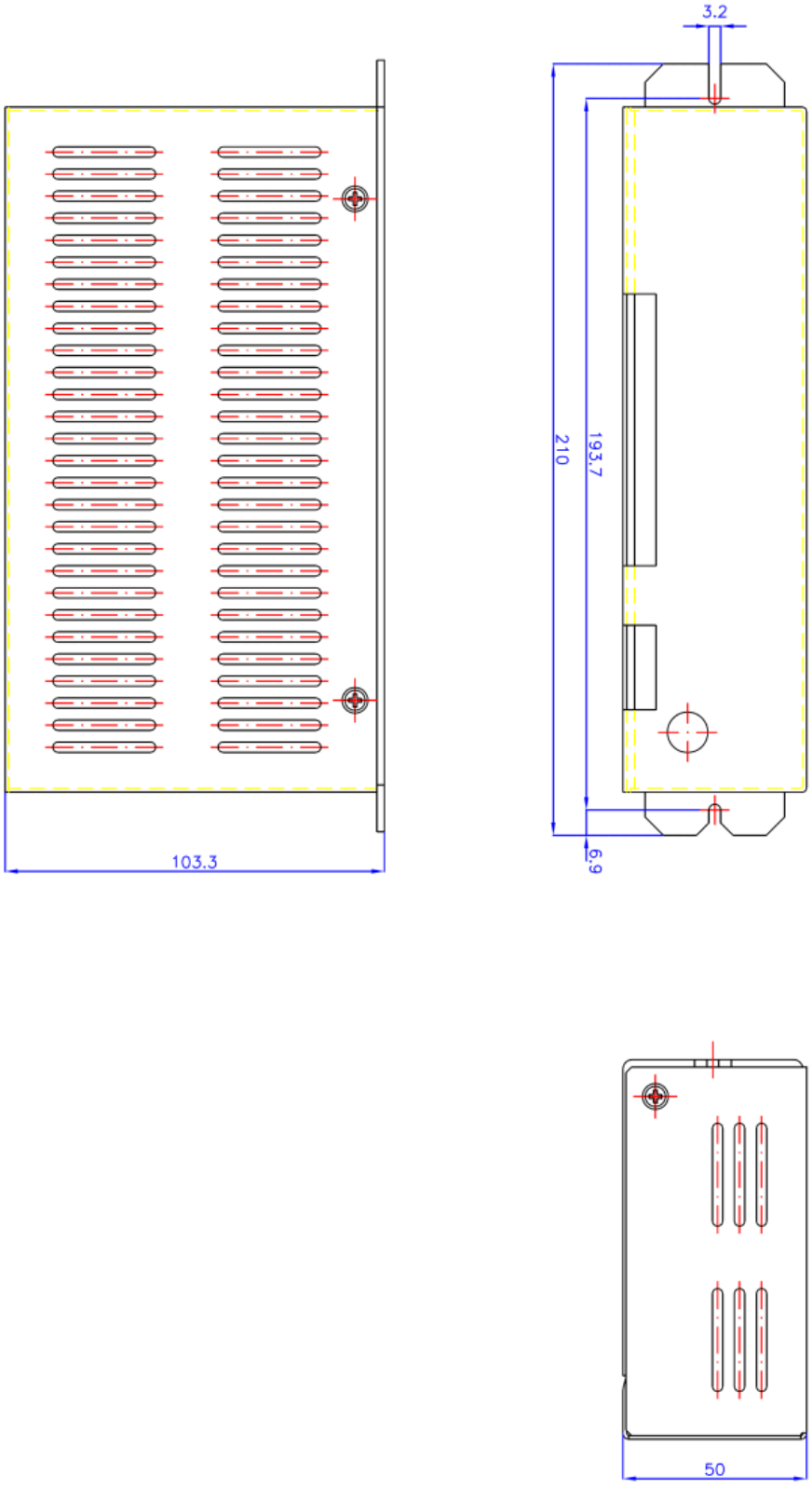

Fig. 4.1: MSU120 Dimensional Drawing

5. Declarations

5.1. Declaration of Conformity

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Declaration of Conformity – MSU120

- 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:	**MSU120**
Purpose of use:	**Solar 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:
6440-464/2006	EN 61204-3:2000 art. 7.2.1.	05.09. 2006	VTUPV Vyskov
6440-475/2006	EN 61204-3:2000, Class B	05.09. 2006	VTUPV Vyskov

Nove Mesto na Morave, 15th of January 2007
Jiri Hruska, Managing Director

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Fig. 5.1: Declaration of conformity

5.2. Country of Origin

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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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Fig. 5.2: Country of Origin declaration for MS2000

6. MSU120 Installation Instructions

- The device is designed for industrial use for assembly into premises with limited access (electrical switchboards).
- Wiring up must be carried out by an individual with knowledge of the regulation No. 50/78 Coll. The source 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 copper conductors of max. diameter 2.5 mm^2 and do not serve for switching devices under voltage. If there is a larger distance from the power supply to the solar panel or to the accumulator, where installation leads longer than 3m would be required, we recommend wiring in conductors with a greater diameter from the shortest possible distance from the power supply in order to limit power losses in the circuit when it is at maximum charging current.
- We do not recommend changing accumulator poles when wiring up.
- Colour coding of low voltage conductors must comply with the requirements of respective standards.
- The source must be disconnected from the battery and solar panel 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 LV conductors.

6.1. Assembly of the Solar power supply

The MSU120 power supply is a special device requiring special assembly. RACOM´s own employees assemble all supplied devices at the user's premises. For subsequent maintenance RACOM shall train the user's specialists who will have the *Operating regulations for radio data networks* and *MORSE Firmware - Documentation* available to help them.

7. Warranty and Servicing

The manufacturer assumes liability for defects for a period of 24 months. Only the manufacturer, RACOM s.r.o. Mírová 1283, 592 31 Nové Město na Moravě, Czech Republic, Tel.: +420 566 618 578, is entitled to repair any devices.

8. Conditions for MSU120

8.1. Important Warning

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8.2. 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 power supply 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.
- In order to prevent damage to the power supply and other terminal equipment the supply must always be disconnected upon connecting or disconnecting the cable to the radio modem data interface. It is necessary to ensure that connected equipment has been grounded to the same potential. Before connecting the supply cable the output source voltage should be disconnected.

Appendix A. Description of Commands for Communication with the power supply via the Serial Port

The MSU120 solar power supply is fitted with an RS232 serial port allowing basic control and set up during manufacture and installation. Communication takes place at 19200 Bd, 8, n, 1. The power supply reacts to single-character (ASCII) commands, and the reply from the power supply is in the form of text strings (mostly ending in CR/LF). It is possible to communicate with the power supply in this way even after connecting it to a common terminal. For remote access to the power supply in the MORSE network the program SOLTERM (Win-application) is available.

Description of certain commands

[command] Command description

```
<response>
```

[i] ID source + firmware version

```
<|S/N:001>
<|SOL28 (2005-06-27)>
```

[t] current time

```
<2004-12-11*02:34:59>
```

[m] Displays the header of the printout of measured values

```
<|Ub     Ib      Us    Is    Ismax  Pwr   Tep>
```

[a] Printout of measured values – battery voltage, battery current, solar panel input voltage, current from solar panel, max. measured current from the previous minute, current delivered power, temperature…

```
<|11.6  -0.4    16.2    0.7    0.7    8    41>
```

[a] Printout of measured values – battery voltage, battery current, solar panel input voltage, current from solar panel, max. measured current from the previous minute, current delivered power, temperature…

```
<|11.6  -0.4    16.2    0.7    0.7    8    41>
```

[b] Same values in binary internal values

[ENTER] Switches power supply to state of readiness for receiving a multicharacter command

```
<Ready - waiting…>
```

– If another command is not received within 2 seconds the power supply reports a Timeout

```
<TimeOut>
```

[d + time] For setting the power supply´s internal time in format : **[d2005-08-31*21:54:06]** it sends the current time to the power supply (necessary directly after pressing ENTER)

```
<Date OK 2005-08-31 21:54:06>
```

(Program SOLTERM automatically sends the current time after pressing **[d]**)

[f] Switches the source to the solar panel full power mode

```
<Full Power Mode ON/OFF>
```

[v] Switches the source to/from the Verbose mode

```
<Verbose Mode ON/OFF>
```

In this mode the power supply reports:

- disconnection of battery from output (approx. 1 minute before disconnection)

```
<|Battery Low->Switch output OFF! Ubat=10.7 2004-12-12*20:19:59
```

- when connecting the battery to the output (approx. 20 seconds after connection)

```
<|Output ON Ubat=12.0  2004-12-12*20:19:59
```

- transition to sleep mode (Ubat < 10 V, or USol < Ubat in SLEEP MODE)

```
<|Sleep  Ubat=9.9  2004-12-12*23:19:59
```

- transition from sleep mode (USol>Ubat) or the moment the battery is connected to the output (Ubat>12V)

```
<|Wake-Up  Ubat=10.1  2004-12-13*08:19:59
```

- on the turn of a new day – total for the previous day

```
<
|S/N:001
|Day status:2004-12-10*00:00:00
|Battery Voltage max.(V):11.9     at 14:58
|Battery Voltage min.(V):10.7     at 05:41
|Max. charge current (A):2.8      at 11:43
|Max. Solar current (A):3.5       at 11:44
|Total charge  (Ah):8.7
|Total dischg. (Ah):11.9
|Actual dischg (Ah):8.0
|Solar energy used (Ah):15.6
|Solar energy poss.(Ah):15.6
```

```
|Temperature max. (^C):46
|Temperature min. (^C):22
|Last Out-ON  12-31*23:59
|Last Out-OFF 08-09*07:22
>
```

[s] sends the current sum from the beginning of the day

```
<
|S/N:001
|Day status:2005-08-09*15:24:39
..
..
|Last Out-OFF 08-09*07:22
>
```

[y] sends the stored sum from the previous day

```
|Day status:08-08
|Battery Voltage max.(V):11.9     at 14:58
..
..
|Last Out-OFF 08-09*07:22
>
```

[N] sends the 1st block of the measured values record from the previous day

```
<
t    005    008    009    000    000    000    060
D    130    000    027    000    004    152    000
D    130    000    027    000    004    152    000
…
…
D    130    000    027    000    004    152    000
D    130    000    027    000    004    152    000        000
>
```

– the last figure represents the block number

[n] Sends another block of the measured values record the previous day. The meaning of values in individual columns is as follows:

t row representing the date and time of the beginning of the daily record (the last value determines the period of the record of measured values in seconds = 60 s)

D row with recorded data (all values represent internal values of the power supply without conversion to real values):

UBat battery voltage

IBat+ positive battery current

IBat-	negative battery current
USol	voltage on the solar panel terminals
ISol	current from the solar panel
UTermExt	temperature of external temperature sensor
ISolMax	maximum current that can be drawn from the solar panel (test at max. current)

[L] sends the first block of the daily sums record

```
<
s 031 012 127 014 114 023 059 012 023 028 014 008 026 025 075
..
..
s 013 003 125 012 089 010 052 011 023 024 008 007 020 019 075
s 014 003 128 013 087 008 048 013 022 025 022 001 042 041 074
s 015 003 136 014 120 007 060 011 021 025 029 000 032 031 073
s 016 003 144 013 126 006 052 013 020 024 022 000 024 024 057
s 017 003 147 010 129 007 048 012 023 026 022 000 024 025 062
s 018 003 147 011 129 007 040 011 023 026 015 000 017 021 062
s 019 003 147 012 128 006 025 013 022 024 013 000 015 017 066  096
>
```

– the last figure represents the block number

[l] sends the next block of the daily sums record. The meaning of values in individual columns is as follows:

SumHdr	“s” header for field of stored values
SumDay	day record made/sumday
SumMonth	month
DmaxUBat	max. battery voltage during the day [0.1 V]
TmaxUbH	time of record/write time of max. voltage [hours]
DminUBat	min. battery voltage during the day [0.1 V]
TminUbH	time of record/write time [hours]
DMaxIBat	max. recorded value of current Ibat [0.1 A]
TmaxIbH	time of record/write time [hours]
DmaxUThext	max. temperature [ºC]
DminUThext	min. temperature [ºC]
DSIBatP	energy supplied to the battery [Ah]
DSIBatM	energy drawn from the battery [Ah]

DSISol energy drawn from the solar panel [Ah]

DISolMax max. energy that can be taken from the solar panel [Ah]

DmaxISol highest daily value of current from the solar panel [0.1 A]

[r] repeats transmission of the last sent block of the daily sums record or measured values record from the previous day

[w] MSU120 sends a 1 byte status with the following meaning:

Bit 0 **_BatLL** Lowe battery voltage (Ubat < 10 V) – transition to SLEEP mode

Bit 1 **_BatteryLow** Low battery voltage UBat < 11.5 V

Bit 2 **_BatOff** indication of disconnected output

Bit 3 **_USolOK** Sufficient voltage USol (= USol > UBat)

Bit 4 **_NegIb** Negative current to the battery = discharging

Bit 5 **_GoVyp** Notified switching off = disconnection of the battery from the output DC-OUT of the power supply

Bit 6 **_Foc** running phase of overcharge charging

Bit 7 **_Ffl** running phase of float charging

[g] switches the source to automatic sleep mode if there is a lack of solar energy

```
<SLEEP Mode ON/OFF>
```

– in this mode the actual consumption of the power supply is reduced, transition back to full operation is automatic upon reaching a sufficient voltage from the solar panel

Appendix B. Temperature curve of sensor KTY10

Tab. B.1: Temperature dependence of KTY10 sensor resistivity

°C	Ω
-10	1496
-5	1562
0	1630
5	1700
10	1772
15	1846
20	1922
25	2000
30	2080
35	2161
40	2245
45	2331
50	2418
55	2508
60	2599