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RACOM
RADIO DATA NETWORKS

Operating manual

Controller MC100

version 4.13
4/17/2018

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Introduction

This operator manual serves as the primary document for familiarising users with the parameters of the controller MC100, its properties, modifications and with the parameters of connecting parts. This controller is part of the MORSE system, is fully compatible with other modems, and because it is derived from previously developed types it has similar mechanical parameters to them, as well as all interfaces, the modem part and firmware. For this reason modem MR400 images are often used in other parts of the manual. In order to master all the functions of the radio modem and the MORSE system you should refer to other documents.

In next description is used the notation **modem** or **router** instead of **controller MC100**.

Fig. 1: Controller MC100 with Cannon connectors

Fig. 2: Radio modem MR400 with Cannon connectors, MR300 with Cannon connectors and MR160 with screw clamps

1. Controller MC100

MR 400, MR300and MR160 are conceptually new radio modems designed for transmitting data in the VHF and UHF bands. The radio modem uses 4-state FSK modulation providing for a maximum signalling rate of 21.68 kbit/s.

MC100 controller complements the standard range of MR and MG100 radio modems. The MC100 controller consists of the computer part used in the MR radio modems and it preserves all its advantages - modular concept, one-piece highly-resistant mechanical construction (metal casting), increased number and types of input and output interfaces.

The controller is of modular design with one to four standard RS232 ports (an RS422 or RS485 port can be used in place of two of them) available to the user. The configuration can be extended by an Ethernet interface and also by a module with analog and digital inputs/outputs. It is generally manufactured with two analog inputs and outputs and with two digital inputs and outputs.

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

Software control is compatible with the operation and configuration of the other radio modems of the MORSE system. A description of software control and configuration is available in publications describing MORSE Firmware.

2. Description of Controller MC100 Functions

2.1. Radio part

Unlike MORSE system radio modems the MC100 controller does not have a radio part.

2.2. Modem part

The control microcomputer has 4 MB of FLASH memory and 16 MB of RAM memory available. The battery, real time backup supply, detector of supply voltage failure and watch dog circuits belong amongst the other circuits of this block. If there is a supply voltage failure the fact is recorded into memory with the respective time data thanks to the charge stored in electrolytic capacitors. The user therefore has information available about the time and duration of possible faults caused by power failures. It is possible to connect equipment with signalling rates up to 115.2 kbit/s to the modem via the RS232 data interface. RS232 interface converters are protected against overvoltage with TRANSIL elements. A lithium battery is used for backing up in the modem part.

Note

Owing to the use of lithium batteries in the modem part it is not recommended to store them for a period of longer than 2 years.

2.3. Supplying

Controller is supplied by the DC current 13.8 V. The consumption in the quiet state is from 180 to 290 mA according to module used. Controller can be set in the SLEEP mode when the consumption drops down to 2.5 mA. The return in the active mode can be done by the signal inputting on the serial port or after a preset time.

2.4. Controller Assembly

Controllers are special devices which require skilled assembly. All supplied equipment is assembled by RACOM at the user's site. For subsequent maintenance RACOM specially trains the user's skilled staff and as an additional aid provides them with Operating regulations for radio data networks and MORSE Firmware – Documentation.

Important

CAUTION! Danger of explosion upon replacing the incorrect type of battery. Follow the manufacturers instructions for handling used batteries.

3. Connectors

3.1. Antenna

The cable for connecting the antenna is fitted with an N type connector. Use a connector of the corresponding type and impedance as its mate. We recommend using an RG213 cable for aerial leads up to 25 m in length and a H1000 for longer leads.

Important

CAUTION. The radio modem cannot be connected to the power supply without the antenna connected (or corresponding artificial load). Otherwise this could lead to damage to the radio part of the modem.

The MC100 controller does not have a radio part – it does not use a radio channel for communication which is why it doesn't have an antenna.

3.2. Serial Interface

The router can be equipped with serial ports RS232 or RS422/485, the ports can be optical isolated. According to the configuration it is possible to use a terminal block or DSUB 9 (Canon) connectors for connecting data cables via the serial interface. See Chapter *Dimensional Diagram and Labeling*. Data rate on the serial interface can be from 200 bps to 230,400 bps.

3.2.1. RS232, RS422 and RS485 Connectors

a) Table of data connector RS232 connections

Tab. 3.1: Table of data connector RS232 connections

RS232 signal	Screw terminals	DSUB9F pin
CTS	1	8
RTS	2	7
RxD	3	2
TxD	4	3
GND	5	5
DTR		4
DSR		6
CD		1
RI		9

Fig. 3.1: RS232 DSUB9 female

b) Table of data connector RS422 connections

Tab. 3.2: Table of data connector RS422 connections

RS422 signal	Screw terminals	DSUB9F pin
TxD-	1	7
TxD+	2	3
RxD-	3	8
RxD+	4	2
GND	5	5

c) Connection diagram of data cable RS485

When you are connecting RS485, your “A” has to be connected to TxD+ and RxD+ simultaneously and “B” to TxD- and RxD- simultaneosly.

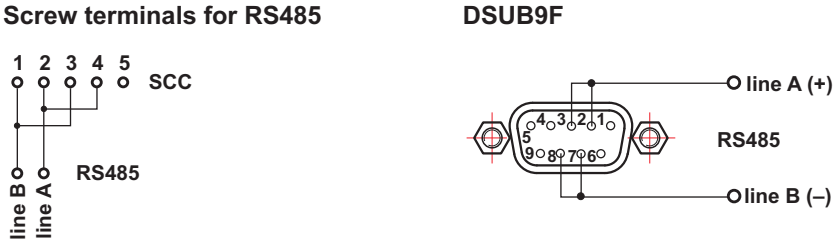


Fig. 3.2: Data cable RS485 connections

Note - For data connector RS485 connection see *Table of data connector RS422 connections*.

Important - For making data cables for connecting the user´s terminal equipment to the serial port we recommend using a shielded cable, particularly in an industrial environment, and connecting the shielding to GND (pin No. 5). When using a multi-core cable all free conductors should be connected to pin No. 5. In the case of a galvanically separate port for RS485 (RS422) only ground one side of the data cable. We recommend using only the necessary minimum length for data cables.

3.2.2. Distinguishing Data Modules by Colour

For RS232 RxD is the output from the router (approx. -6V when inactive) and TxD is the input to the router (according to the RS 232 standard). Hardware versions of the interface can be distinguished according to the colours of LED diodes next to the connector.

Tab. 3.3: Table for distinguishing LEDs for RxD and TxD by colour

Type of interface	Colour (RxD / TxD)
RS232	red / green
RS232 opt. separated	orange / green
RS422/485 opt. separated	orange / yellow

3.2.3. Labelling of SCC terminals

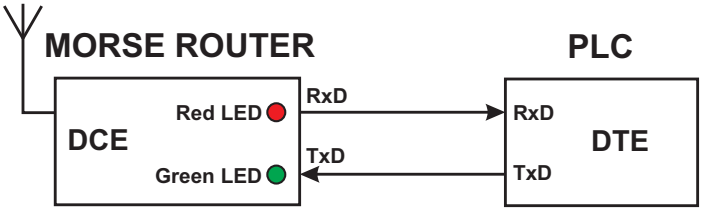


Fig. 3.3: Labelling of serial interface terminals

The SCC ports of the router are DCE type devices. Based on standards the receiver terminal RxD of the connected DTE device is connected to the transmitting terminal of the router's SCC port which is also labelled RxD. Similarly the red LED indicating transmission from SCC is labelled RxD.

3.3. Ethernet

- Connector RJ-45 for Ethernet 10BaseT and 100BaseT corresponds to the EIA TIA T568B standard.
- Informative LED diodes indicate:
  - Tx – yellow - output or input active (*Tx - red - output from ETH channel)
  - Rx – yellow - output or input active (*Rx - green - input to ETH channel

    Note

    Green LED **Tx** and yellow LED **Rx** flash simultaneuosly. The informations marked (*) are valid for hw version produced until 07/2008.

  - 100 – yellow - if lit the 100Base-TX net is indicated otherwise is 10Base-T
  - LINK – green - indicates correctly connected link
  - F.D. – green - indicates full duplex operation
- The direct cable serves for connecting to the Ethernet network via the hub (repeater) or switch-hub (router).
- A crossed cable serves for connecting only two devices - MR400-MC100, MR400-PC, etc.

The ETH module consumption is 30 mA (60 mA until 07/2008).

The following table contains connector connections and colours of conductors. For the crossed cable the order of conductors on one side is the same as for the direct cable.

Tab. 3.4: Table of Ethernet to cable connector connections

PIN	Signal	Direct cable	Crossed cable
1	TX+	white - orange	white - green
2	TX-	orange	green
3	RX+	white - green	white - orange
4	—	blue	blue
5	—	white - blue	white - blue
6	Rx-	green	orange
7	—	white - brown	white - brown
8	—	brown	brown

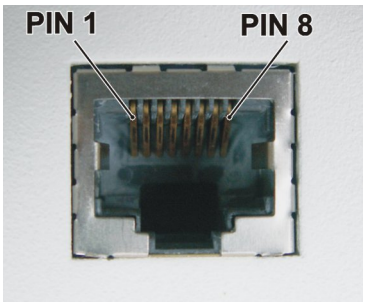


Fig. 3.4: RJ-45F

3.4. Analog and Digital Inputs and Outputs

The module of analog and digital inputs and outputs (ADIO) is designed for :

- creating 20 mA current loops
- switching loads supplied with DC and AC current
- scanning digital signals

Each functional group of terminals is galvanically separated from the rest of the device as shown on the internal layout diagram for the ADIO module on the image below:

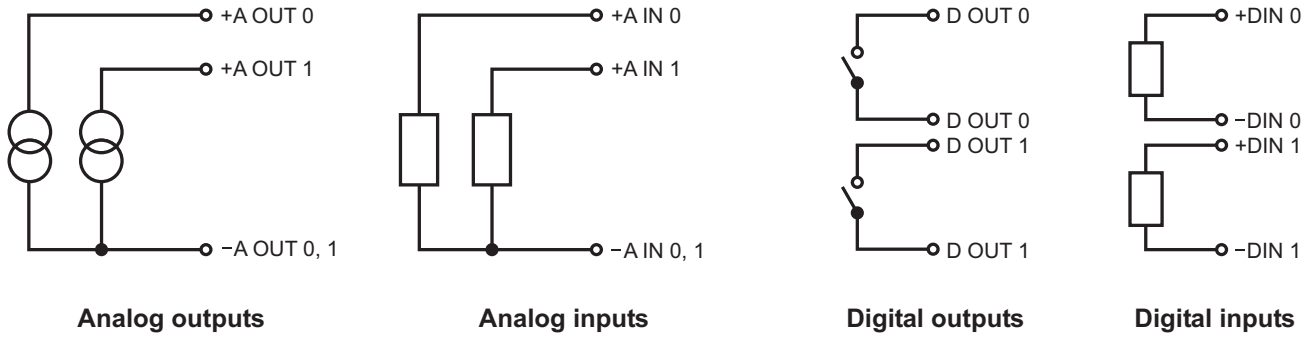


Fig. 3.5: Wiring diagrams for analog and digital inputs and outputs

3.4.1. Labelling

Individual terminals of terminal blocks are labelled:

Connector A OUT - analog outputs

Connector A IN - analog inputs

Connector D OUT - digital outputs

Connector D IN - digital inputs

Terminal UP this clamps pair is not used

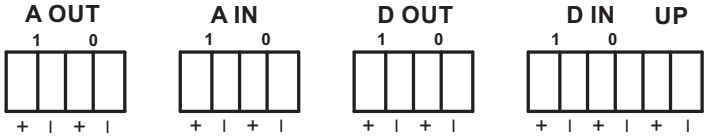


Fig. 3.6: Description of analog and digital inputs and outputs

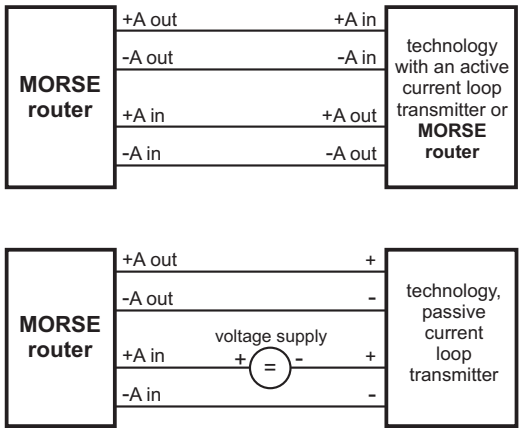
3.4.2. Parameters

Tab. 3.5: Table of digital and analog input and output parameters

2 × optically separated digital output	– bipolar SSR switch design – voltage for supplying load max. 30 V DC, 24 V AC – switched current typically 300 mAresistance in on state max. 1 Ω – protection against current overload in on state – protection against overvoltage in off state	passive
2 × optically separated digital input	– passive optical element design – input voltage 0–2,3 V will be evaluated as log. 0 – input voltage 2–30 V will be evaluated as log. 1 – max. value of input voltage 30 V	passive
2 × optically separated analog output	– current source 4–20 mA – load resistance max. 250 Ω – settings accuracy better than 0.1 %	active
2 × optically separated analog input	– sensitivity 0–20 mA (or after sw configuration 4–20 mA) – accuracy of measured values better than 0.1 % – input resistance 60 Ω – no protection against current overload – max. value of input current 50 mA	passive

Analog inputs 0 and 1 have **-** (minus) terminals connected and galvan. separated from router GND.

Analog outputs 0 and 1 have **-** (minus) terminals connected and galvan. separated from router GND.



The MORSE router used in the diagram showing examples of wiring can, of course, be replaced by any MORSE system equipment (e.g. MD160, MX 160, MWxxx, MRxxx, MC100, MG100i, ...)

Fig. 3.7: Examples of wiring analog inputs and outputs

3.5. Supply Connector

Terminals of this connector are labelled in the standard manner. Only DC voltage in the range from 10.8 to 15.6 V can be connected. Connecting higher voltage may damage the radio modem.

Terminal PI (power indicator) - if the radio modem is fed from the MS2000 power supply information about supply method from source clamp MAIN PWR OFF can be lead:

- level TTL1 or unconnected clamp - network supply
- level TTL0 or grounded clamp - battery supply

Maximal supply cable length is 3 m.

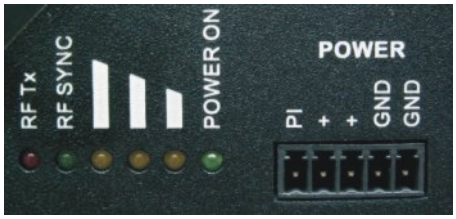


Fig. 3.8: Power connector & information LED

3.6. Service Connector

The service connector RJ-12 serves for short-term connections of the service cable during local adjustment of MORSE router parameters. Upon attaching the connector (connecting to the RS232 link (RxD,TxD, GND)) the router automatically switches to service mode and the module slot 1 disconnects. Slots numbering see section Section 3.7, “View of Controller”.

Tab. 3.6: Table of service connector connections

1	AF_OUT	output of modulation from RF part of router
2	SER_RxD	RS232 RxD output from router
3	SER_TxD	RS232 TxD input to router
4	MOD_BSB	input modulation to radio part of router
5	GND	ground
6	PTT	keying of TX carrier waves for service purposes

Fig. 3.9: Service connector

Warning

Be careful, RJ-12 pin numbering is not standardized.

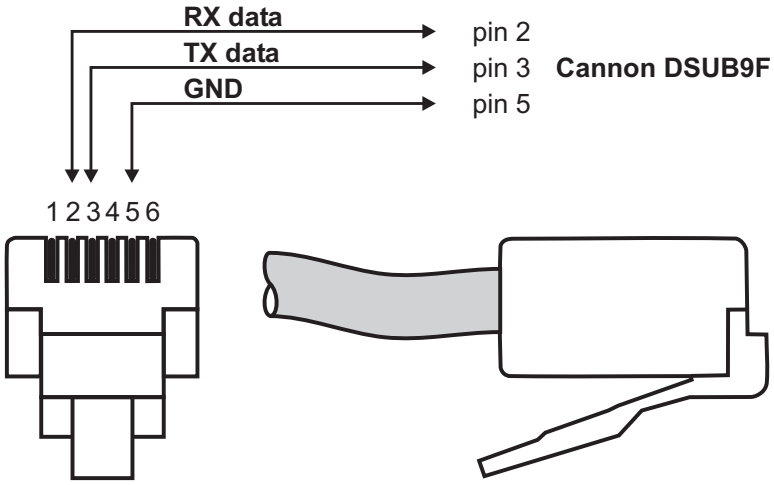


Fig. 3.10: Service cable connector connections

Important

ATTENTION! The service mode is not suitable for normal operation

3.7. View of Controller

The only difference in appearance between the controller and the radio modem is the type designation badge and the absence of an antenna connector - see the following image.

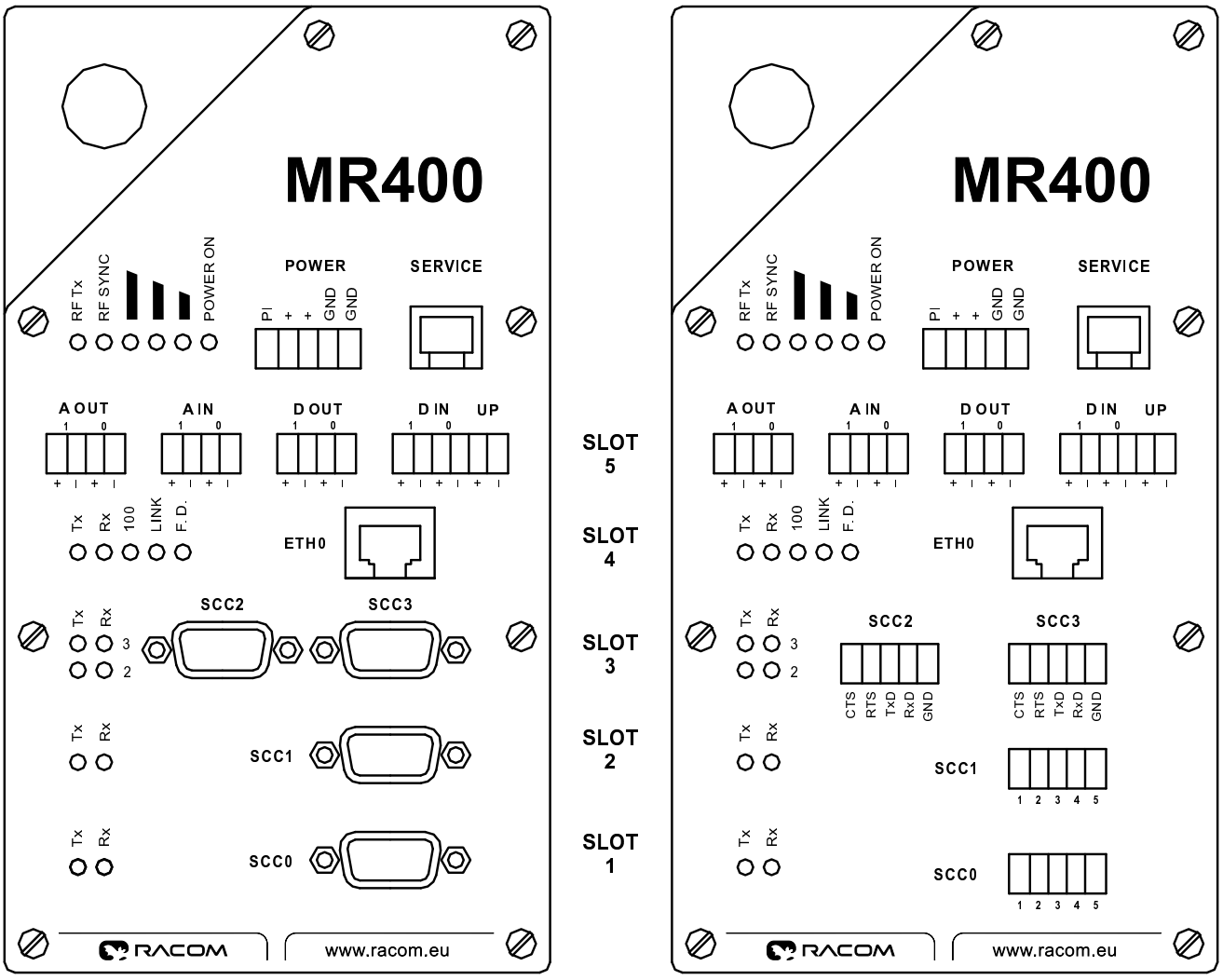


Fig. 3.11: View of radio modem — description of connectors, model with DSUB (Canon) connectors and with terminals, numbering of slots

See the table of technical parameters for the options available for occupying individual slots with various modules.

4. Table of Technical Parameters

Tab. 4.1: Table of technical parameters MC100

Optional modules	
slot 5	ADIO (analog and digital inputs and outputs)
slot 4	Ethernet 10/100 Mbps
slot 3	2×RS232
slot 2	RS232 or galv.sep. RS232 or RS422/RS485
slot 1	
MTBF(Mean Time Between Failure)	> 100 000 hours
Supply nominal voltage	13.8 V
Supply voltage range	10.8–15.6 V
Idle consumption (Rx)	180 mA + modules: (Eth. 30 mA, ADIO 50 mA, SCC 5 mA)
Consumption in SLEEP mode	2.5 mA
Operating range of temperature	-30 to +70 °C (-22 to +158 °F)
Humidity	5 to 95% non-condensing
Storage range of temperature	-40 to +85 °C (-40 to +185 °F)
Mechanical dimensions	208×108×63 mm (71 mm DIN rail including)
	184×108×63 mm (short version)
Spacing of fastening holes	198×65 mm, ø 4.8 mm
Weight	1.1 kg

Tab. 4.2: Standards complied

EMC (Electromagnetic Compatibility)	ETSI EN 301 489-5 V 1.3.1; ETSI EN 300 113-1 V 1.5.1
Electrical safety	CSN EN 60 950:2001
Wheeled vehicle usage	UN Regulation No.10 (EHK No.10)
Human exposure electromagnetic fields	CSN EN 50 385, CSN EN 50 383

Tab. 4.3: Railway Safety Appliance Standards Regulations

Electronic appliances in railway vehicles	CSN EN 50155 ed. 2nd: 2002. art. 10.2.8.2 CSN EN 50121 art. 7: tab. 3 and 4
EMC (Electromagnetic Compatibility)	CSN EN 50121-3-2 art. 8
Vibrations and beats	CSN EN 61373

Upon installation in railway vehicles, where there is a high level of interference, special attention should be given to the communication interface. In such cases it is necessary to use shielded cables and correctly grounded twisted pairs.

Note

The standard CSN EN 50155 (Electronic equipment in railway vehicles) does not apply to analog inputs and outputs and to the interface in the 1st slot. Therefore they are not recom-

mended for use, and in an environment specified according to this standard no warranty applies to their use.

5. Dimensional Diagram and Labeling Modems

Dimensional Diagram

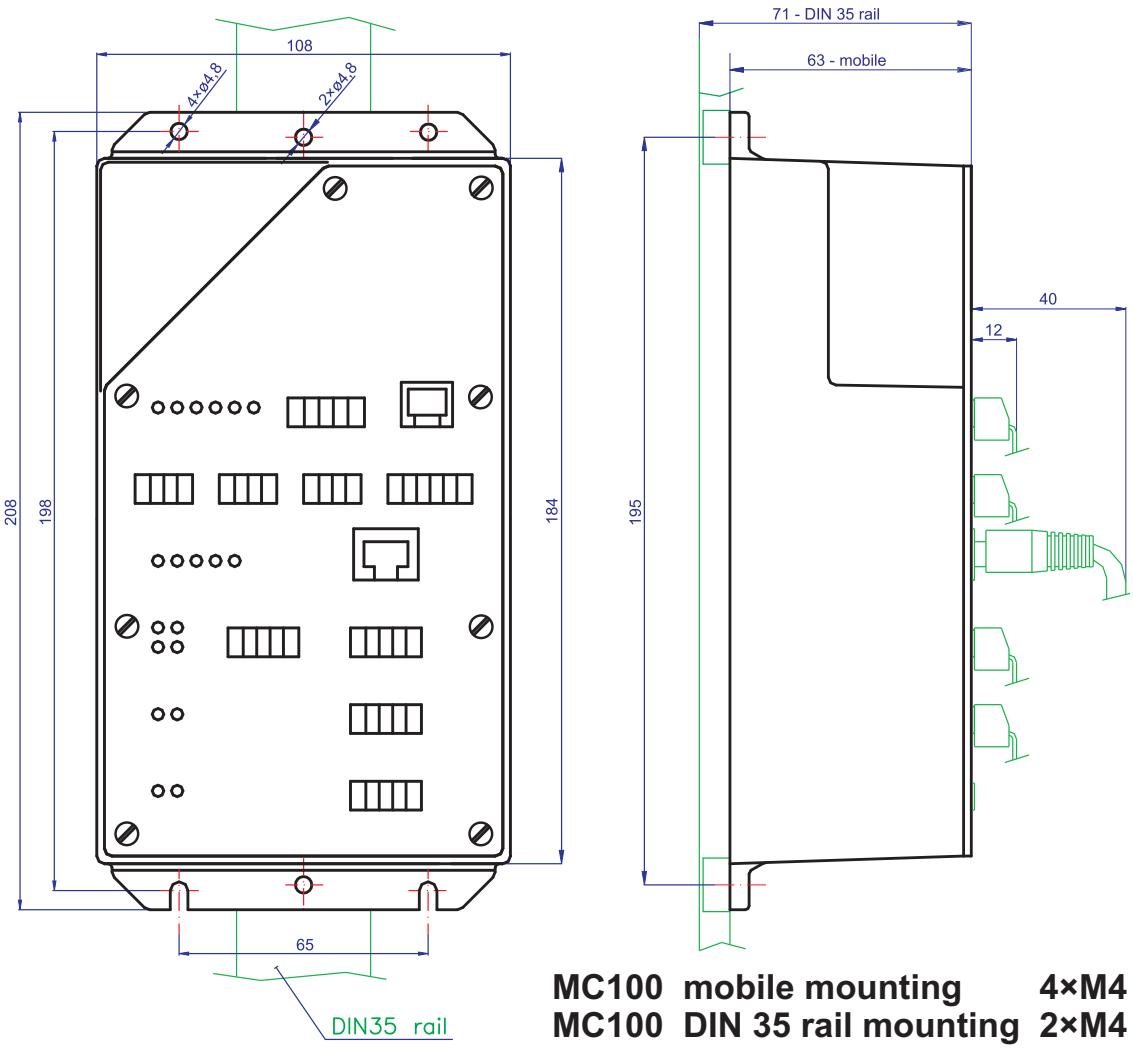


Fig. 5.1: Mounting dimensions of the controler MC100

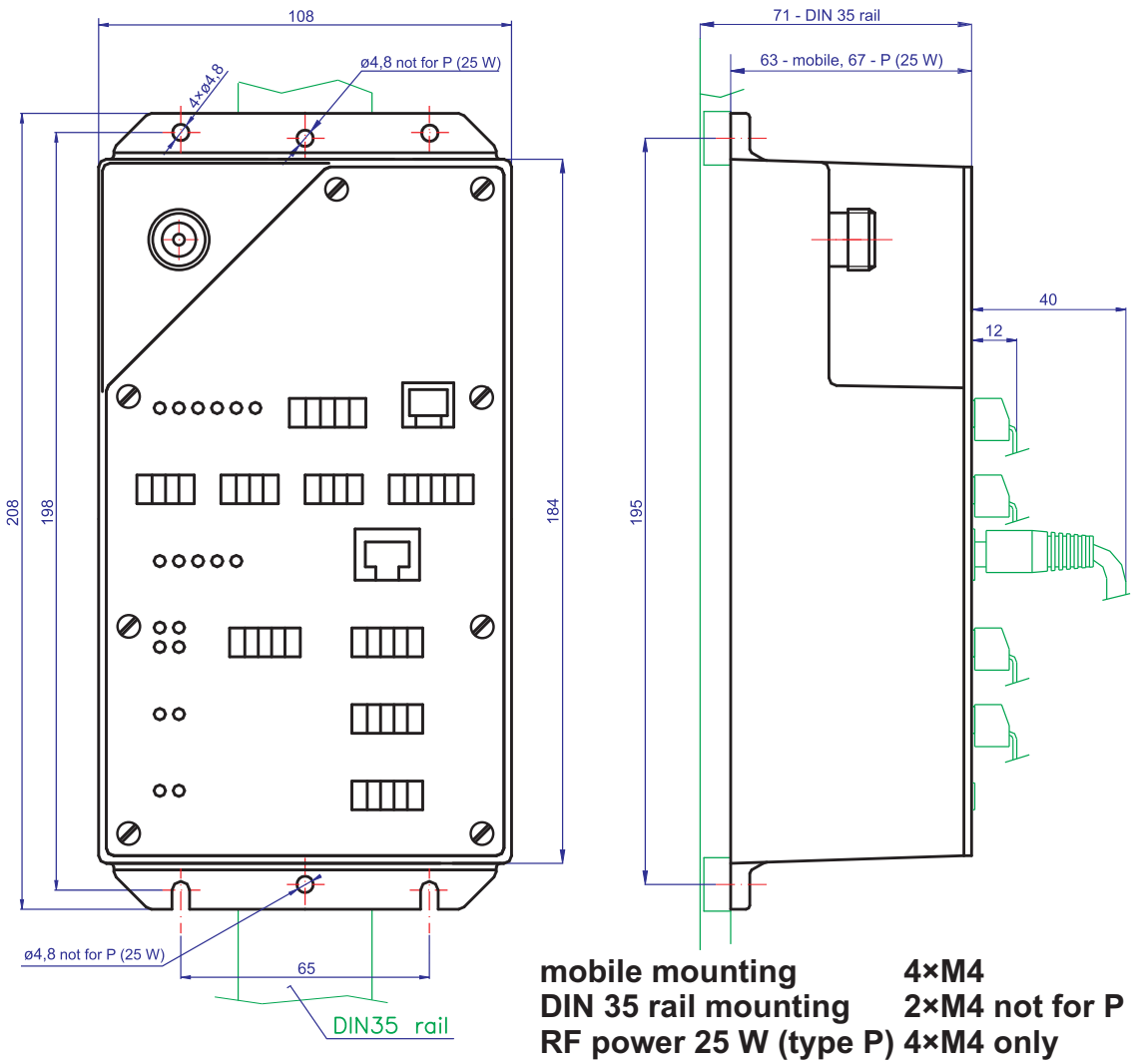


Fig. 5.2: Mounting dimensions of the radiomodem MR400, MR300 and MR160

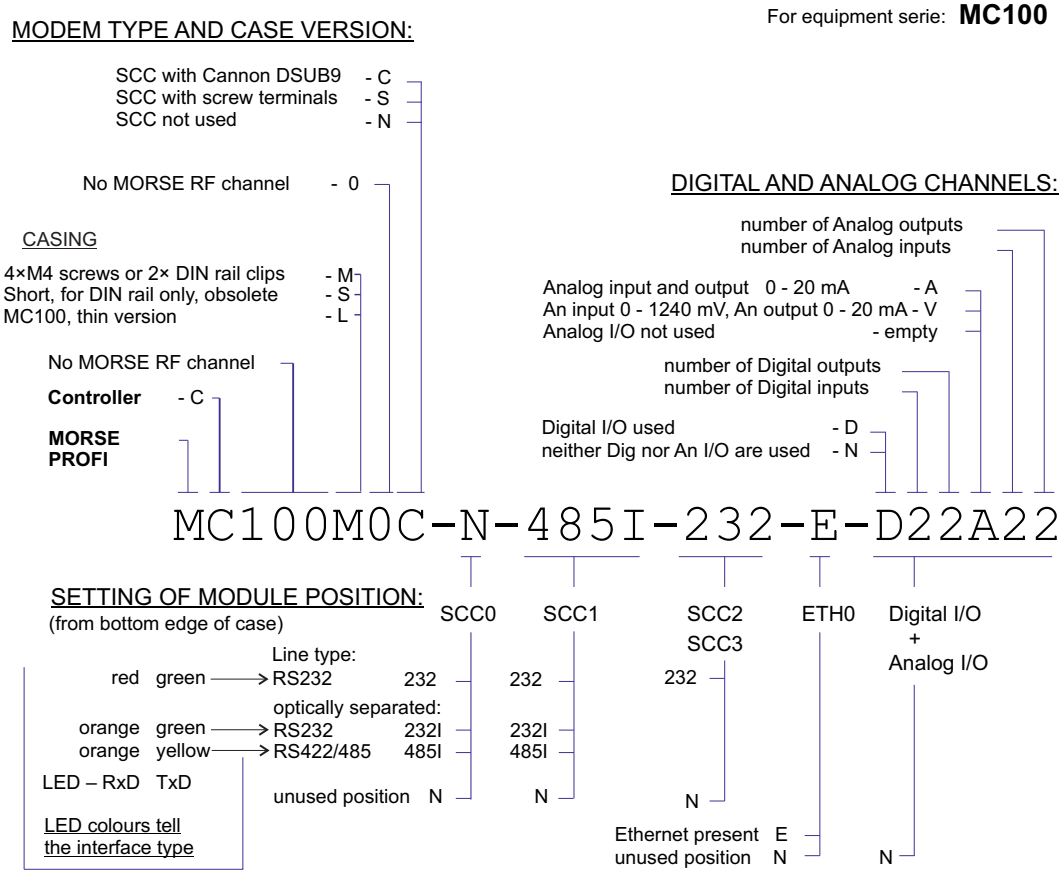
The modem can be fasten by four screws M4 (for mobile application especially) or by the mounting rail DIN35 (stable applications). The flexile clamps mounted in the central holes are used for fastening on the DIN35 rail.

Labelling Controllers

is described in next table.

MORSE components production code controllers

For equipment serie: **MC100**



Comment - modem is the DCE equipment - both data output RS232 pin and LED are labeled RxD

Example:

MC100M0C-N-485I-232-E-D22A22

= MORSE controller
casing with flanges for screws and/or DIN rail clips, SCC with Cannon connectors,
SCC1 - RS485, optically separated,
SCC2 - RS232,
SCC3 - RS232,
Ethernet,
Digital input 2×, Digital output 2×, An input 20mA 2×, An output 20mA 2×

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6. Modem installation

6.1. General description of installation

Racom routers are built into a robust metal case and are suitable for applications which place them in various environments from air-conditioned offices to heavy industry factories. To a certain extent the method of installation needs to be adapted to this. All information in this chapter describes the standard method of installation for normal industrial applications, which has been derived from valid regulations for such equipment and also from the long-term experience of our engineers. In the case of larger-scale networks and more complicated applications we recommend that users order a project assessment from Racom, or a partner company, which should consist of careful measurements of the strength and quality of a signal and an assessment of the conditions for the propagation of radio waves.

6.2. Power supply

A power supply meeting the specified parameters (see the table of technical parameters) needs to be used for supplying radio routers. We recommend using an MS2000[1] power supply or other power supply of MORSE system[2] , which has been developed specially for these purposes, and where necessary is capable of switching to a back-up battery, as well as monitoring its state of charge, and also charging.

6.3. Technology connection

The Data Terminal Equipment, a programmable controller, a PC or any other device communicating over the radio network, has to be connected to the router by a data cable to the serial or the Ethernet interface according to the respective standard. These interfaces are described in detail in the chapter Connectors.

6.4. Mechanical mounting

Radio routers can be mounted either to a mounting plate using screws or by mounting on a DIN rail. See the table of technical parameters for the dimensions and spacing separation of mounted parts. Generally for industrial applications[3] the radio routers are mounted together with the overvoltage protection, power supply, and back-up battery into a switchboard with IP54 protection.

[1] http://www.racom.eu/eng/products/ms2000.html
[2] http://www.racom.eu/eng/products/supplies.html
[3] https://www.racom.eu/eng/references/references.html

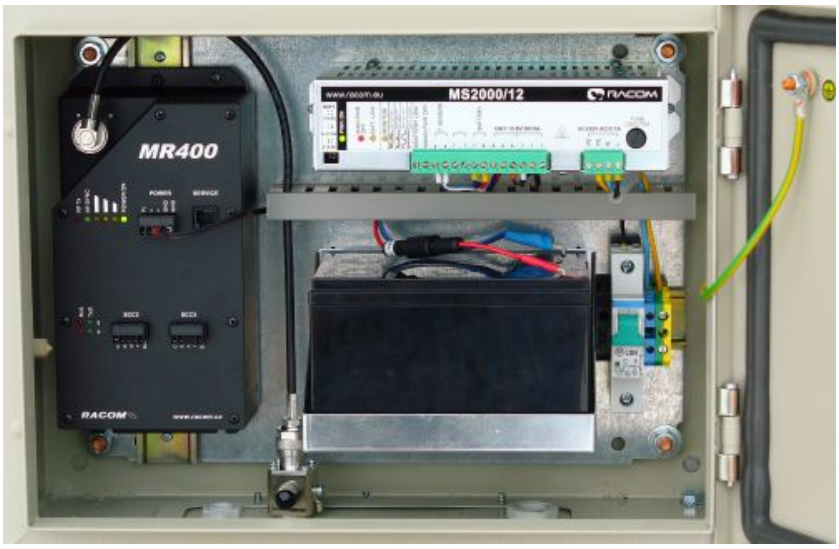

Fig. 6.1: Example of the layout of equipment in a switchboard

7. Conditions for MC100 Operation

7.1. Important Warning

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Under no circumstances is the Racom or any other company or person responsible for incidental, accidental or related damage arising as a result of the use of this product. The manufacturer shall not provide the user with any form of guarantee containing assurance of the suitability and applicability for its application. RACOM products are not developed, designed or tested for use in equipment which directly affects the health and life functions of humans or animals and neither as part of other important equipment, and RACOM does not provide a guarantee if company products are used in such equipment.

7.2. 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 radio modem is located has been opened, or if the equipment has been tampered with.
- The radio modem can only be operated on frequencies stipulated by the body authorised by the radio operation administration in the respective country and cannot exceed the maximum permitted output power. RACOM is not responsible for products used in an unauthorised way.
- 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 radio modem 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.
- Only undermentioned manufacturer is entitled to repair any devices.
- CAUTION ! Risk of explosion on replacing the incorrect type of battery in the modem part. Dispose of used batteries in accordance with their manufacturer's instructions. We recommend that lithium back-up batteries are replaced by RACOM service agents.
- For ensuring the appropriate protection the manufacturer recommends powering the radio modem from an MS2000 power supply with short circuit current protection which acts as means of current

protection for output circuits. If another power supply is used fuses, overcurrent protection or similar protective components should be used.

- In threshold mode the radio modem is capable of operation at an ambient temperature of up to 70 °C. In such cases the temperature of the surface of the radio modem may reach high values, particularly in the case of the high end model "P" – the modem temperature may be up to several tens of degrees hotter than the ambient temperature, and therefore under these conditions the equipment needs to be protected against accidential contact. We recommend that operators who plan on using this threshold mode stick a warning sticker, in accordance with IEC 60417-5041 (DB:2002-10), on a visible part of the radio modem, or attach a sticker with the following text:

```
 CAUTION!
HOT SURFACE
DO NOT TOUCH
```

Fig. 7.1: Warning sticker IEC 60417-5041 (DB:2002-10)

7.3. RoHS and WEEE compliance

The routers are fully compliant with the European Commission"s RoHS (Restriction of Certain Hazardous Substances in Electrical and Electronic Equipment) and WEEE (Waste Electrical and Electronic Equipment) environmental directives.

RoHS Restriction of hazardous substances (RoHS)

The RoHS Directive prohibits the sale in the European Union of electronic equipment containing these hazardous substances: lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyls (PBBs), and polybrominated diphenyl ethers (PBDEs).

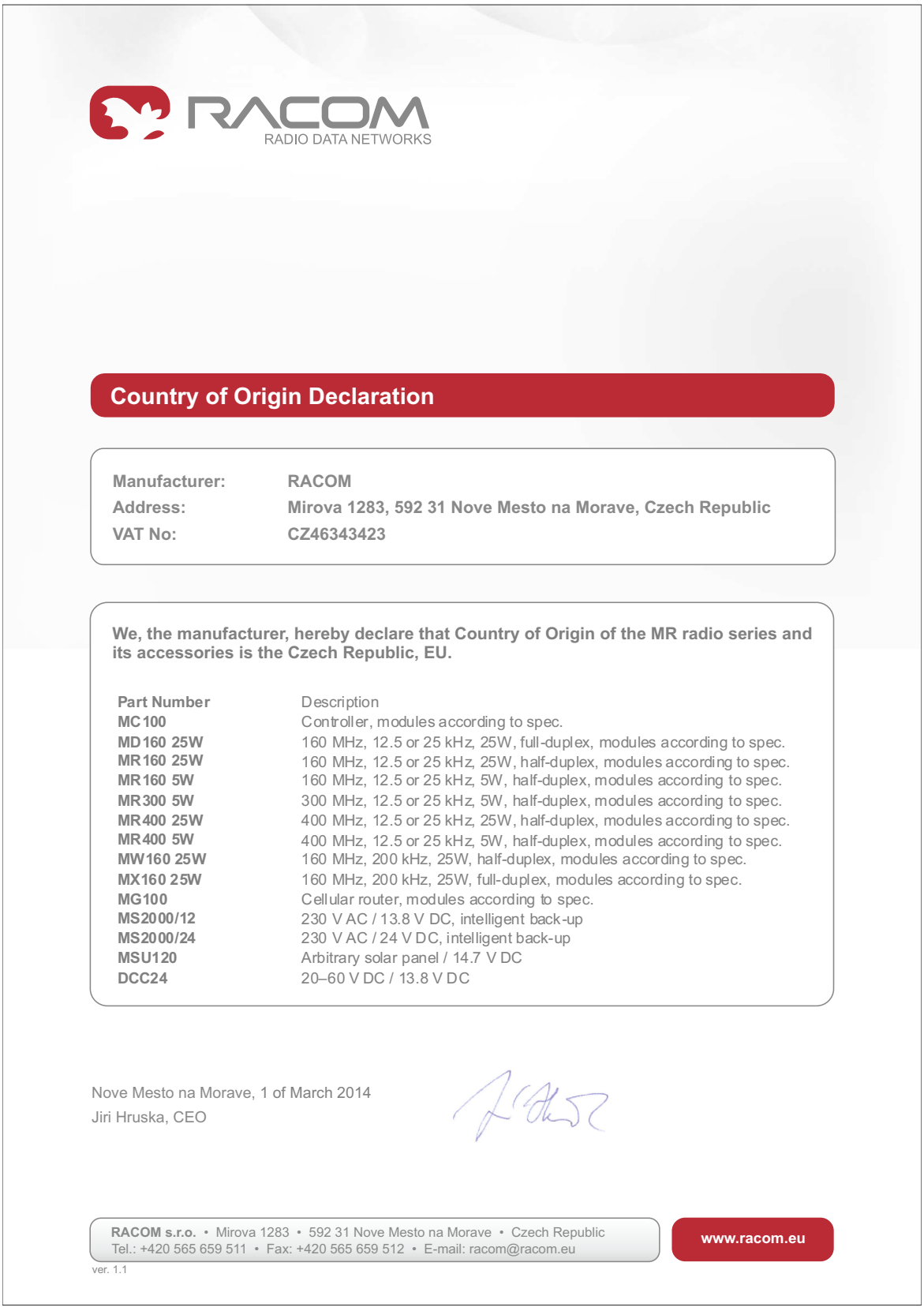
End-of-life recycling programme (WEEE)

The WEEE Directive concerns the recovery, reuse, and recycling of electronic and electrical equipment. Under the Directive, used equipment must be marked, collected separately, and disposed of properly. Racom has instigated a programme to manage the reuse, recycling, and recovery of waste in an environmentally safe manner using processes that comply with the WEEE Directive (EU Waste Electrical and Electronic Equipment 2002/96/EC).

Battery Disposal—This product may contain a battery. Batteries must be disposed of properly, and may not be disposed of as unsorted municipal waste in the European Union. See the product documentation for specific battery information. Batteries are marked with a symbol, which may include lettering to indicate cadmium (Cd), lead (Pb), or mercury (Hg). For proper recycling return the battery to your supplier or to a designated collection point.

7.4. EU Declaration of Conformity

7.5. Country of Origin



RACOM
RADIO DATA NETWORKS

Country of Origin Declaration

Manufacturer:	**RACOM**
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 MR radio series and its accessories is the Czech Republic, EU.

Part Number	Description
MC100	Controller, modules according to spec.
MD160 25W	160 MHz, 12.5 or 25 kHz, 25W, full-duplex, modules according to spec.
MR160 25W	160 MHz, 12.5 or 25 kHz, 25W, half-duplex, modules according to spec.
MR160 5W	160 MHz, 12.5 or 25 kHz, 5W, half-duplex, modules according to spec.
MR300 5W	300 MHz, 12.5 or 25 kHz, 5W, half-duplex, modules according to spec.
MR400 25W	400 MHz, 12.5 or 25 kHz, 25W, half-duplex, modules according to spec.
MR400 5W	400 MHz, 12.5 or 25 kHz, 5W, half-duplex, modules according to spec.
MW160 25W	160 MHz, 200 kHz, 25W, half-duplex, modules according to spec.
MX160 25W	160 MHz, 200 kHz, 25W, full-duplex, modules according to spec.
MG100	Cellular router, modules according to spec.
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. 7.2: Country of Origin declaration

Appendix A. Revision History

Revision 2.1 2005-03-11
Document converted to the XML format

Revision 2.2 2005-04-08
Overall review of document

Revision 2.3 2006-05-18
GPS module description supplemented

Revision 3.1 2006-10-12
Manuals for modems MR series and controller MC100 merged in common source XML file

Revision 4.0 2007-05-22
25 kHz bandwidth modems renamed to Narrowband
High-performance (25 W) radiomodems supplemented
Standards complied including Railway Safety Appliance Standards Regulations supplemented, Limitations of Use supplemented

Revision 4.1 2008-01-15
Manual renamed to Narrowband modems – PROFI MR400, MR300, MR160

Revision 4.2 2008-09-12
M-Bus module description supplemented

Revision 4.3 2008-11-07
The new version of the image „Mounting dimensions“– type of construction P (25 W), a separate version of this image for the controller MC100

Revision 4.4 2008-11-12
T-port module description supplemented

Revision 4.5 2008-05-27
The introduction of more general term "Morse router" in the documentation (together with the term "Radiomodem")
Revision history attached

Revision 4.6 2009-12-22
Radiomodem MR070 supplemented

Revision 4.7 20012-03-19
Removed the T-port, patch temperature specifications table

Revision 4.8 20014-01-21
Removed the M-Bus, MR070

Revision 4.9 20014-03-27
Added section Section 7.5, “Country of Origin”

Revision 4.10 2014-07-17
Removed GPS module, completed MORSE code

Revision 4.11 2015-03-30
Added section Section 7.3, “RoHS and WEEE compliance”

Revision 4.12 2017-06-12
EU declaration of conformity

Revision 4.13 2018-04-16
Power supply MSU120 is no longer offered - EOL.