1. Radio Modem MR400 (MR300, MR160)

MR 400, MR300 and 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. The radio modem 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, which is normally provides two analog inputs and outputs and two digital inputs and outputs. The radio data transceiver module can be configured to an arbitrary frequency of the transmitter and receiver within the 3.2 MHz frequency range in a 12.5 kHz channel raster. The receiving and transmitting frequencies are mutually independent and are derived from the frequencies of four Phase-Locked Loops programmed by the transceiver microprocessor. Channel settings are stored in the transceiver EEPROM memory and the FLASH memory module of the modem whose central processor controls the operation of the transceiver microprocessor. The RF output power of the radiomodem transmitter's high frequency signal is software-configurable in sixteen steps from 0.1 to 5 W. The software configuration of MR400 is backward compatible with that of the MR25 radio modem. A description of software control and configuration of the MR25 is available in publications describing MORSE Firmware.

Important

ATTENTION! The radio modem is equipment which can only be operated in the Czech Republic on the basis of Permission to operate transmitting radio stations issued by the Department of Frequency Spectrum Management at the Czech Telecommunication Office.

2. Description of Functions

Radio Part MR400

The architecture of MR400 (MR300, MR160) radio modems resolves most of the requirements placed on a top quality user friendly radio modem with a very short switching time between receiving and transmitting. Frequency synthesis enables software selection of an arbitrary channel from the given frequency range. The operation of the radio part is controlled and diagnosed by the microcontroller. The receiving part of the radio modem is a double-conversion superheterodyne. The overall selectivity is divided between both intermediate frequency levels. The first filter carries out the necessary channel pre-selection which ensures the linear function of the following second mixer and intermediate frequency amplifier. The second filter has the attenuation characteristic necessary for channel selection in the used channel spacing of 25 kHz (12.5 kHz). Logic circuits, switching the radio part between modes of receiving and transmitting, have high noise immunity and switch respective blocks sequentially. This minimises transient parasite states and optimises bandwidth during switching. Switching to the transmitting mode is blocked when the frequency synthesiser is out of lock or the internal temperature exceeds a hardware set limit or the supply voltage falls below the value ensuring proper functioning of the device.

Modem Part

The control microcomputer has 4 MB of FLASH memory and 16 MB of RAM memory available. The battery backup-ed real-time clock, 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 timestamp 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.

Important warning – a risk of explosion!

The lithium battery must not be replaced by an incorrect type. When in doubt, leave the replacement to the manufacturer.

3. MR 400 Connectors

Antenna

The antenna connector is of the N type, female, impedance 50 Ohm. The antenna cable must be fitted with an appropriate mate. We recommend using the RG213 50 Ohm cable. The H1000 cable should be used when the length of the antenna feeder exceeds 25 m.

Important

CAUTION. The radio modem should be powered only when the antenna (or artifical load) is connected. Otherwise it could lead to damage to the radio part of the modem.

Serial Interface

According to the configuration of the radio modem it is possible to use a terminal block or DSUB 9 (Canon) connectors for connecting data cables via the serial interface. See Chapter 6 Labelling radio modems.

RS232, RS422 and RS485 Connectors

Table 3.1. Table of data cable connections

Terminals	RS232	DSUB9F	RS422	Canon RS422
1	CTS	8	TxD-	7
2	RTS	7	TxD+	3
3	RxD	2	RxD-	8
4	TxD	3	RxD+	2
5	GND	5	GND	5

When RS485 interface is needed, the RS422 pin layout applies. It is necessary to shortcut TxD- to RxD- and Txd+ to RxD+ to obtain the respective Data-, Data+ RS485 signals.

Distinguishing Data Modules by Colour

For RS232 RxD is the output from the radio modem (approx. -8V when inactive) and TxD is the input to the radio modem (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.

Table 3.2. Table for distinguishing LEDs for RxD and TxD by colour

Type of interface	Colour (RxD / TxD)
RS232	red / green
RS232 optically coupled	orange / green
RS422/485 optically coupled	orange / yellow

Ethernet

Connector RJ-45 for Ethernet 10BaseT and 100BaseT corresponds to the EIA TIA T568B standard. Informative LED diodes indicate: Tx – output from CU Rx – input to CU 100 – if lit the 100BaseT LINK network is indicated – indicates correctly connected F.D. link – indicates full duplex operation. A “straight” cable is needed for connecting to the Ethernet network via the hub (repeater) or switch-hub (router). A “crossed” cable is mostly used when just two devices are connected “back-to-back”. E.g. MR400 to MC100, MR400 to a PC, etc. 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.

Table 3.3. 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

Analog and Binary Inputs and Outputs

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 From left to right: 1. input / output + 1. input / output - 0. input / output + 0. input / output
- Terminal UP – From left to right: + - if a voltage of +2.4 to 15 V is brought to this terminal the radio modem activates, firmware carries out the pre-programmed step according to settings in configuration (wake up from sleep mode). Sleep mode is resolved by individual SW settings GND.

Parameters

Table 3.4. Table of digital and analog input and output parameters

2 × optically coupled digital output	Bipolar solid state switch (max. 30 V/500 mA)	Passive
2 × optically coupled digital input	2.4 – 15 V log. 1 0 – 2.4 V log. 0	Passive
2 × optically coupled analog output	0 – 20 mA Rz max = 250 Ohm	Passive
2 × optically coupled analog input	0 – 20 mA/4 – 20 mA SW switchable (input impedance 60 Ohm)	Passive

Analog inputs 0 and 1 have connected terminals ”-” (minus), which are galvanically isolated from the modem GND. Analog outputs 0 and 1 have connected terminals ”-” (minus), which are galvanically isolated from the modem GND.

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 to the device. Voltages outside this range may damage the radio modem. Terminal PI (power indicator): if the radio modem is fed from the MS2000 power supply information from this source is

passed to this terminal about the method of supply; level TTL0 – 230 V AC supply, TTL1 – battery supply. If the radio modem is supplied in another manner the method of supply is deduced according to the voltage (the value from which the supply is considered as supply from a battery can be set in SW).

Information LED

Information LED diodes next to the supply connector:

RF Tx — radio modem transmits
RS SYNC — radio modem received message header which was destined for it
Three following LED (signal strength):
ON ON ON — RSS <85 (stronger signal)
OFF ON ON — RSS 85 to 95
OFF OFF ON — RSS 95 to 115
OFF OFF OFF — RSS > 115
POWER ON — radio modem is correctly supplied

Service Connector

The service connector is used for temporary connections of the service cable during local adjustment of radio modem parameters. Upon attaching the connector (connecting to the RS232 link (RxD,TxD, GND)) the radio modem automatically switches to service mode and the SCC0 disconnects.

Important

ATTENTION! The service mode is not suitable for normal operation.

Table 3.5. Table of service connector connections

1	AF_OUT	Output of modulation from radio
2	SER_RxD	RS232 RxD according to standard RS232
3	SER_TxX	RS232 TxD
4	MOD_BSB	Input modulation to radio
5	GND	Ground
6	PTT	Transmitter ON

Figure 3.1. Service connector connections

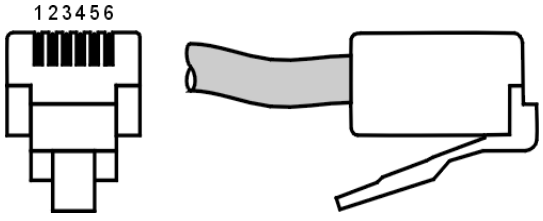
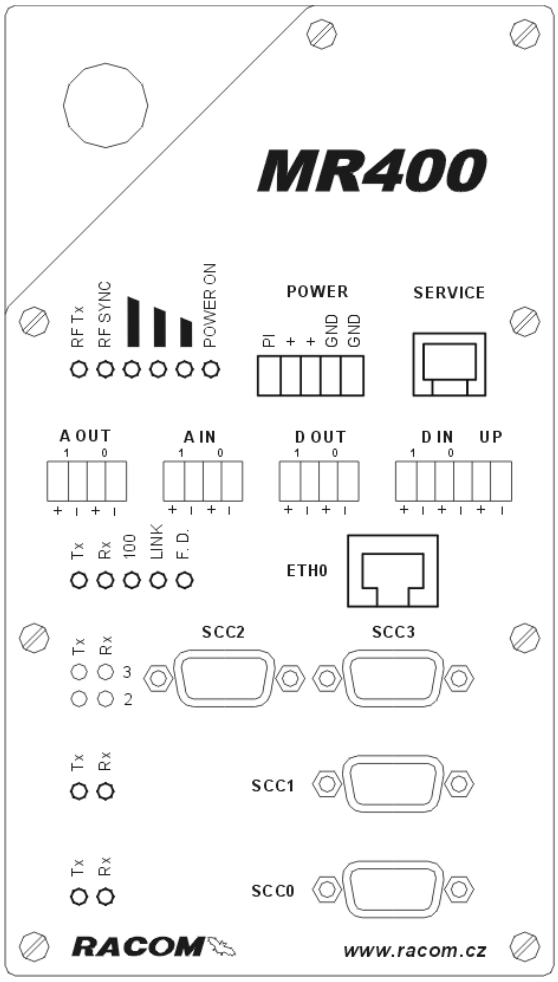
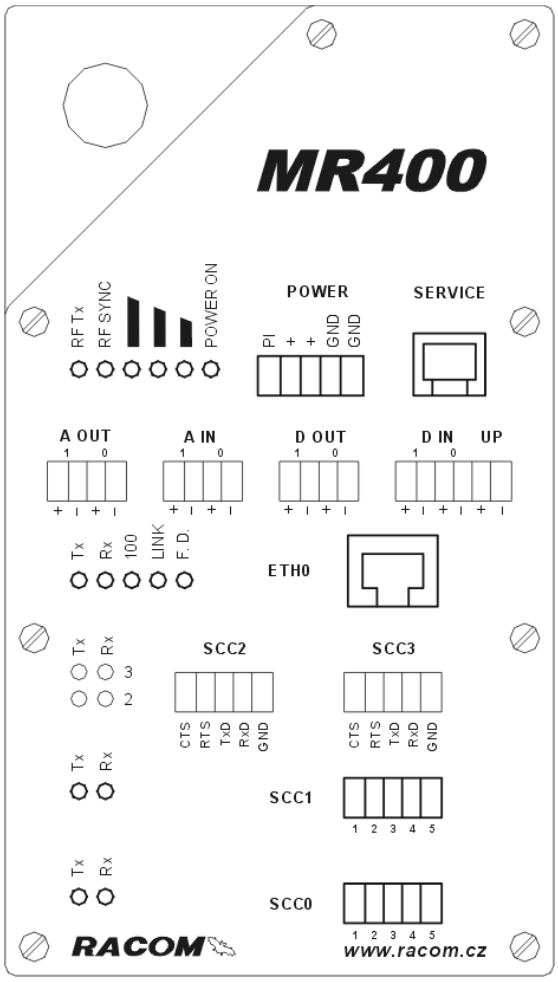


Figure 3.2. View of radio modem — description of connectors, model with DSUB (Canon) connectors and with terminalsO





4. Table of Technical Parameters

Table 4.1. Table of technical parameters

TYPE	EU	USA
Frequency range	MR400: 380 – 470 MHz MR300: 290 – 380 MHz MR160: 136 – 180 MHz	406 – 412 MHz, 421 – 512 MHz
Channel spacing	25 kHz or 12.5 kHz	
Method of setting the working frequency	Software in the range 3.2 MHz	
MTBF (mean time between failures)	60 000 hours	
Switching time transmitting/receiving	< 1.5 ms	
Operating range of temperature	-25 to +55 °C	
Nominal supply voltage	13.8 V	
Supply voltage range	10.8 to 15.6 V	
Consumption	Receiving 380 mA (eth. module +40 mA, I/O module +50 mA) Transmitting 1.6 A / 1 W, 2.0 A / 5 W	
Mechanical dimensions	208 × 108 × 63 mm (including DIN rails 71 mm) 184 × 108 × 63 mm (short version)	
Weight	1.30 kg	
Antenna connector	N – female	
Receiver sensitivity for BER 10-3	Better than -107 dBm	
Output performance software adjustable	0.1 – 5 W	
Max. speed of modulation for transmitting	21.68 kbit/s in channel 25 kHz 10.84 kbit/s in channel 12.5 kHz	
Optional modules	1. a 2. slot – 1×RS232 galv. sep. or unseparated, or 1×RS422/RS485 galvanically separated 3. slot – 2×RS232 4. slot – Ethernet 10/100 Mbps 5. slot – input outputs (analog and digital)	
COMPLIES WITH STANDARDS		
Radio parameters	FCC PART90 RSS119 ETSI EN 300 113-1 V1.4.1:2002	406 – 412 MHz, 421 – 512 MHz 406 – 412 MHz, 421 – 512 MHz 380 – 470 MHz
EMC (electromagnetic compatibility)	ETSI EN 301489-5 V1.2.1:2000	
Electrical safety	CSN EN 60 950:2001	
Use in mobile environments	UN Regulation No.10 (EHK No.10)	

5. Dimensional Diagram

Figure 5.1. Mechanical dimensions of MR400