
.DECODE

Radio modem PRM4 868MHz
User's manual v1.6

<http://www.decode.rs>

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Document history

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|-----------------|---|
| Date 29.04.2009 | Initial version of the document v1.0 |
| Date 23.06.2009 | Revision v1.1 |
| Date 09.12.2009 | Revision v1.4 Added AT commands EC and ET. Corrected the AM command format. |
| Date 08.02.2010 | Revision v1.5 Bug related to incomplete flushing of transmit buffer when sending data by full-buffer criteria, corrected. Corrected bug related to saving of parameters which haven't been saved with ATWR command while exiting command mode. New function introduced to keep the same bps and data format while entering command mode with +++ sequence. New function that set speed to 9600 bps and data format to 8N1 while entering command mode with SET pushbutton. Bug related to same speed 9600 bps while entering command mode with SET pushbutton, corrected. |
| Date 24.05.2011 | New parameter ReceiverThreshold added for setting of receive level in Sleep mode and averaging RSSI values for arbitration of receiver wakeup. |

1. Introduction

Decode PRM4 modem is used for data transmission in UHF ISM 868MHz band. Through the use of radio interface it procures networking of devices and systems. Easy to use, the PRM 4 provides secure method of connecting computers, PLC devices, measuring devices and SCADA systems.

The device transports the asynchronous serial data between two or more PRM4 devices in point-to-point or point-to-multipoint configuration. The RS-232/485/422 connection enables the implementation of the device into the existing systems without the need for additional equipment.



PRM4 Device

The standard delivery contains the PRM4 device, network power supply adapter for 230V, mini omni-directional antenna for ISM 868MHz band, DB9 M-F serial cable and CD with this manual and necessary software.

2. Modes of operation

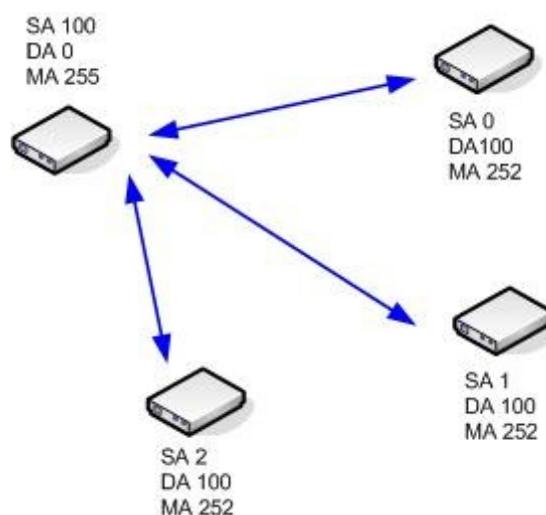
Decode PRM4 device can operate in one of the two modes of operation.

When powered, the device will automatically enter the default, *data transfer* mode. When the device is in the *data transfer* mode, it will listen and receive all the packets intended for it, whereas the transmitter will turn-on only occasionally to send the data acquired from the wire connection.

The mode and parameters of operation are set through the use of AT commands using the *command* mode of operation. The transfer into the *command* mode and the set of supported AT commands is described in chapter 4.

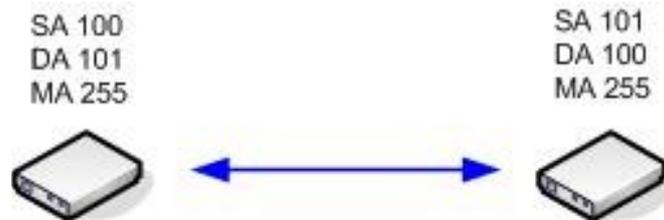
The PRM 4 device supports an addressing scheme. All modems intended for data exchange in a radio network must be set to the same frequency and must have the same *network address* (NA). The NA can be set to any value from the 0 – 65535 range. Each device has its *source address* (SA) used to identify the device inside a network. The SA can take values between 0 and 255 inclusive. Note that the SA must be set uniquely inside a network. If a point-to-multipoint connection is required (e.g. for master-slave protocols used with SCADA software or PLC devices) the *destination address* (DA) masking is used. This way it is possible to mask a number of bits when comparing the DA and SA and, consequently, the packet with one destination address can be sent to multiple devices having the unmasked parts of their SA match the unmasked parts of DA.

For example, if assumed that the radio frequency and the NA are the same for all the devices in the following figure, the device with the SA equal to 100 will send its packets to the remaining three devices, whereas the devices with the SA 1,2 and 3 will send data only to the SA 100 device. This is because the *Address Masks* (AM) on devices with SA 1,2 and 3 have been set to 252 (binary 11111100) so that they match the higher (unmasked) six bits of the DA (binary 000000).



Point-to-multipoint connection

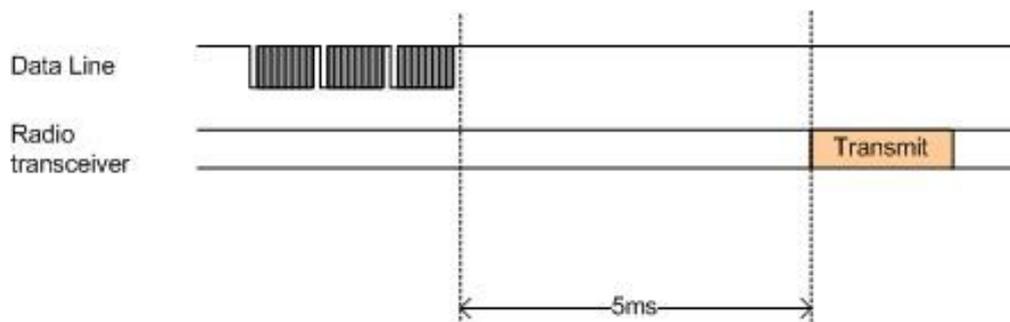
The below figure illustrates the point-to-point connection. The AM is set to 255 so all the bits are compared and only the exact match of the SA and DA would lead to receipt of the packets. The NAs as well as the radio frequencies are set as with the previous example.



Point-to-point connection

The PRM 4 device receives over the serial interface and buffers the data that needs to be sent until the condition for sending the data is met. The data is sent when there are no new data for a specified time interval after the last data has been received on the serial interface. This time interval can be set by using the AT commands and it is referred to as the packetization timeout. The default value of this parameter is set to 5ms. In other words, if communicating on 9600bps, a 5 character pause will induce the modem to send the entire memory content within one packet. The transmit data buffer size is 512 bytes.

The following figure shows the example of three-character packet generation and sending on 9600bps with default packetization timeout.



Packet generation and sending

In cases when there is a need for low power consumption of the device (i.e. solar or battery power) the device can be set into one of the three reduced power consumption modes by using the ATSM command. When in the reduced power consumption mode, the receiver is not constantly turned on. It is turned on and off 8 times per second. Therefore, when using this mode, waiting for all the receivers to become active may induce the additional transport delay. By using the ATSM command the reduced power consumption mode of operation can be adjusted to fit the various field configurations. If the devices with the reduced power consumption are

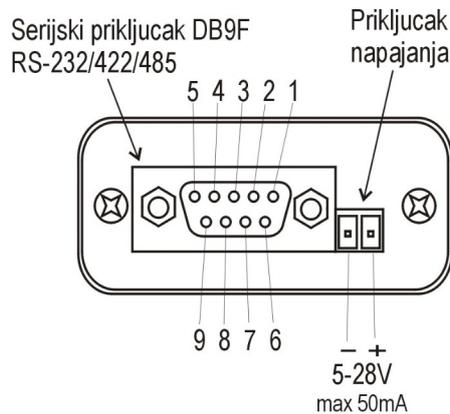
communicating only with a device in a normal mode, the first group of devices is set to ATSM2 whereas the device operating in normal mode is set with ATSM1. On the other hand, if all the devices are operating in low power consumption mode, they ought to be set with ATSM3.

Important note: When calculating the power budget for the reduced power consumption mode, the RS232 signal lines should not be omitted. It is recommended that, in these cases, the transmit/receive signals of the RS232 interface should be switched off when not actively communicating.

3. Installing the device

3.1. Power supply

The PRM 4 is powered by 5 to 28 VDC or 3.3 to 12VDC in battery powered version of the product. The standard current drain is less than 50mA with the transmitter turned on constantly and drops to 2-3mA in the reduced power consumption mode (excluding the RS232 consumption). The power is supplied through the detachable screw connector with 3.5mm gap on the back plate of the device. Mind the polarity of the power connector pins. The power connector has reverse polarity and over-voltage protections.



PRM4 back plate

3.2. Serial connector

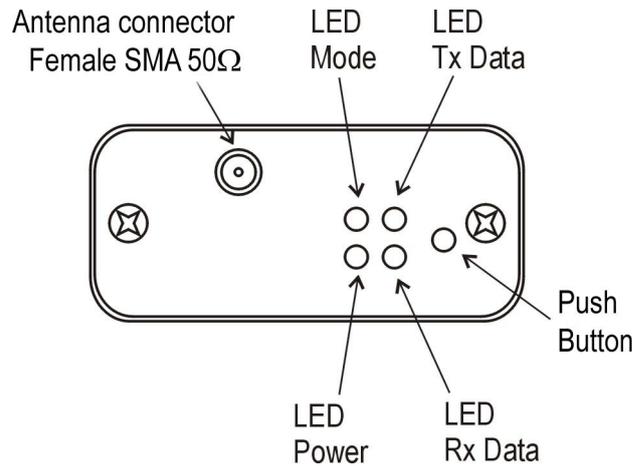
The connection of a serial interface is achieved by 9-pin female connector (DB9F). Depending on the position of the jumpers located on the circuit board, the device can be connected with the following interfaces: RS-232C, RS-422 and RS-485. If the jumpers are set for RS-232C, the signal layout matches the DCE side. The following table shows the DB9F connector signal layout for different serial connections.

| Pin DB9F connector | RS-232 signals | RS-422 signals | RS-485 signals |
|--------------------|-------------------|-----------------------|----------------|
| 1 | DCD | output | |
| 2 | RD | output | -TX/RX |
| 3 | TD | input | -RX |
| 4 | DTR | input | |
| 5 | GND | - | GND |
| 6 | DSR | output | |
| 7 | RTS | input | +RX |
| 8 | CTS | output | +TX |
| 9 | RI ⁽¹⁾ | output ⁽¹⁾ | +TX/RX |

1. By altering the J7 jumper state it is possible to change the function of this pin to the power supply input.
2. On some devices with RS485/422 connection, the signals have been denoted as A and B. In that case, the A signals should be connected to the + signals of the modem. *Vice versa*, the B signals should be connected to the – signals of the modem.

3.3. The antenna connector

The antenna is connected on a SMA female connector on the front plate of the device. The antenna should be for 863 to 870MHz band with an impedance of 50Ω. The antenna included in the product pack has a 0dBi gain. In case the additional range ought to be achieved the higher gain antennas must be used.



PRM4 front plate

3.4. Signaling lights

The above figure illustrates the layout of the LED signaling lights. The LED functions are shown in the following table.

| Indicator | Colour | Description |
|--------------------|--------|---|
| LED Power | Green | Constantly on when the power supply is connected, the device's processor is active and if the reduced power consumption mode is set to 0 or 2. If this parameter is set to 1 or 3 this indicator flashes with the frequency of 8Hz. |
| LED Mode | Red | On when the device is in special modes. |
| LED Rx Data | Green | On when receiving data. |
| LED Tx Data | Red | On when sending data. |

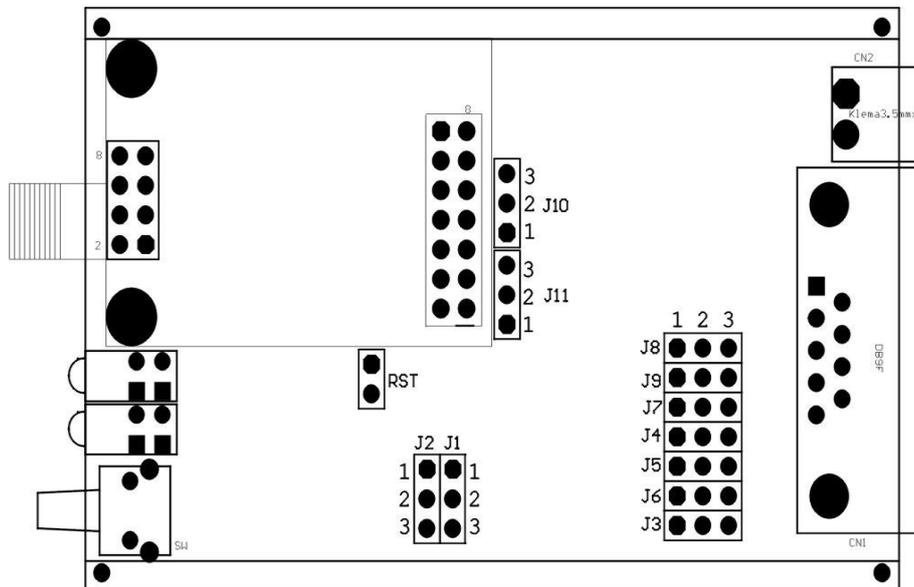
3.5. Jumpers

The jumpers are located on the printed circuit board of the PRM4 device. By altering the state of the jumpers, the serial interface on DB9 port can be set.

| Serial interface | State | Jumpers |
|--|-------|----------------------------------|
| RS-232C | 1-2 | J3, J4, J5, J6, J10 |
| | 2-3 | |
| RS-485 2-wire, no termination | 1-2 | J11, J8 |
| | 2-3 | J3, J4, J5, J6, J10 |
| RS-485 2-wire, 120Ω termination | 1-2 | J11 |
| | 2-3 | J3, J4, J5, J6, J8, J10 |
| RS-422/485 4-wire, no termination | 1-2 | J8, J9 |
| | 2-3 | J3, J4, J5, J6, J10, J11 |
| RS-422/485 4-wire, R termination 120Ω | 1-2 | J8 |
| | 2-3 | J3, J4, J5, J6, J9, J10, J11 |
| RS-422/485 4-wire, T termination 120Ω | 1-2 | J9 |
| | 2-3 | J3, J4, J5, J6, J8, J10, J11 |
| RS-422/485 4-wire, T and R- termination 120Ω | 1-2 | |
| | 2-3 | J3, J4, J5, J6, J8, J9, J10, J11 |

The following figure illustrates the device's circuit board with the layout of the jumpers.

The jumpers J1 and J2 are used to set the device into the firmware upgrade mode. Otherwise, they ought to be in 2-3 state.



The layout of the jumpers on the printed circuit board

4. AT command set

The device's parameters can be altered by using the AT command set. The commands are sent to the device by using the terminal program (HyperTerminal or similar) over the serial RS232 port at the speed 9600bps with 8 data bits, no parity, 1 stop bit. The modem device accepts the commands only in *command* mode. Changing the mode of the device from *data transfer* to *command* can be achieved in two ways:

- While turning on the modem, press and hold the SET button on the front panel, – the device will start-up in the *command* mode.
- If the device is already turned on and in the *data transfer* mode, the *command* mode is entered by sending the array that consists of the character repeated three times within the given time frame. Before and after the array, the pause in sending must be made. The pause intervals before and after the sequence must be of the same duration. The default character for this purpose is ASCII plus sign. Therefore, to enter the *command* mode “+++” sequence ought to be sent. The pause time interval is set in ms by using the ET command. The default value is 1000 (or 1s). Bearing in mind the default setting, the *command* mode is entered by sending the following sequence:

| |
|--------------------------------|
| pause 1s "+++” pause 1s |
|--------------------------------|

In both cases the modem will respond with OK when the *command* mode is entered.

If SET button is used for entering *command* mode, serial port parameters will be fixed: speed 9600 b/s, format 8 data, no parity, 1 stop bit. If sequence "+++" is used for the same task, modem will keep data formats used during *data transfer* mode.

Each AT command consists of the command itself and, optionally, additional parameters. At the end of each AT command, the Carriage Return (CR) character must be sent. On keyboards, it is usually the new line or Enter key. The modem will also accept the Line Feed (LF) character as well as CR LF and LF CR combinations.

The parameters can be entered in both the decimal and hexadecimal numeric systems. For example, to set a network address both **ATNA10779** and **ATNA0x2A1B** can be used.

By using the **ATDC** command, all set parameters and their values can be listed. Below the manufacturer name and type of the device, the frequency range and firmware release date are listed. The device output, as a result of **ATDC** command, is given in the following frame:

DECODE PRM4 MODEM
FREQUENCY BAND: 868MHz
FIRMWARE: V1.4 09.12.2009

BAUD RATE: 3
CHARACTER FORMAT: 3
STOP BITS: 0
PACKETIZATION TIMEOUT: 5
RF FREQUENCY: 4000
RF POWER: 63
SOURCE ADDRESS: 0 (0x0)
DESTINATION ADDRESS: 0 (0x0)
NETWORK ADDRESS: 0 (0x0)
ADDRESS MASK: 255 (0xFF)
ECHO MODE: 1
SLEEP MODE: 0
ESCAPE CHARACTER: 43
ESCAPE TIMEOUT: 1000

OK

4.1. Setup of the serial interface parameters

| AT Command | Description | Parameter | Default value |
|------------|---|---|---------------|
| BR | Baud Rate This command sets the data transmission speed on the serial interface for the <i>data transfer</i> mode. The transmission speed in the <i>command</i> mode is fixed at 9600 bps if mode was entered by SET button . | 0 - 1200 b/s 1 - 2400 b/s 2 - 4800 b/s 3 - 9600 b/s 4 - 19200 b/s 5 - 38400 b/s 6 - 57600 b/s 7 - 115200 b/s | 3 |
| CF | Character Format This command sets the data and parity bit number on serial interface for the <i>data transfer</i> mode. In the <i>command</i> mode the format is always 8N1 if mode was entered by SET button . | 0 – 7 no par. 1 – 7 odd par. 2 – 7 even par. 3 – 8 no par 4 – 8 odd par. 5 – 8 even par. | 3 |
| SB | Stop Bits This command sets the number of stop bits on the serial interface for the <i>data transmission</i> mode. | 0 - 1 stop bit 1 - 2 stop bits | 0 |
| PT | Packetization Timeout Time (in ms) from the last received data on the serial interface till the data in the output buffer is sent on the radio interface. | 1 – 1000 | 5 |
| EC | Escape Character ASCII character that is sent to signalize the device to enter the <i>command</i> mode. Default value corresponds to ASCII "+" character. | 0-255 | 43 |
| ET | Escape Timeout Defines the required pause time (ms) inserted before and after the "+++" sequence, while "+++" sequence should be entered during the same interval (ms) . | 10-3000 | 1000 |

4.2. Setup of the radio interface

| AT Command | Description | Parameter | Default value |
|------------|--|-------------|---------------|
| FR | Frequency This command sets the working radio frequency of the modem. The parameter is given in kHz added to the 860MHz. For example, the frequency 865.425MHz is set by entering the parameter value of 5425. | 3000 - 7000 | 4000 |
| PW | Power This commands sets the output power of the transmitter ranging from -16dBm to +13dBm. The quantifying step is roughly 0.45dB. | 0 – 63 | 63 |
| SA | Source Address The source address is the modem's own address. The modem will regard all packets where the significant bits of the destination address match its source address. The source address bits on positions where there are “1” in address mask are considered as significant bits. | 0 – 255 | 0 |
| DA | Destination Address The destination address is the source address of the modem to which the data is intended. | 0 – 255 | 0 |
| NA | Network Address The network address describes the group of modems, or network. The modem can only communicate with another modems from the same network. | 0 – 65535 | 0 |
| AM | Address Mask Address mask determines the significant bits used to determine the destination of the packet. | 0 – 255 | 255 |

4.3. Command mode setup

| AT Command | Description | Parameter | Default value |
|------------|---|-----------|---------------|
| EX | EXit This command is used to exit the <i>command</i> mode and enters the <i>data transfer</i> mode. | none | - |
| E0 | Echo 0 This command turns off the echoing of the characters sent in the <i>command</i> mode. | none | - |
| E1 | Echo 1 This command turns on the echoing of the characters sent in the <i>command</i> mode. | none | E1 |
| WR | WRite This command saves the set parameters into the permanent, EEPROM memory. | none | - |
| RE | Restore defaults This command restores the default configuration of the device. | none | - |
| DC | Display Configuration This command displays the current configuration. | none | - |

4.4. Reduced power consumption mode setup

| AT Command | Description | Parameter | Default value |
|------------|--|-----------|---------------|
| SM | Sleep Mode By using this command the reduced power consumption mode of operation can be adjusted to fit the various field configurations. If the devices with the reduced power consumption are communicating only with a device in a normal mode, the first group of devices is set to ATSM2 whereas the device operating in normal mode is set with ATSM1. On the other hand, if all the devices are operating in low power consumption mode, they ought to be set with ATSM3. | 0 – 3 | 0 |
| RT | Receiver Threshold This command sets threshold of receiving signal which decides on receiver turn-on during the reduced power consumption mode. Parameter is expressed in -dBm. Example: 115 value determines that all signals above -115dBm should turn the receiver on, to be received at the same time. Signals weaker than -115dBm will be rejected. | 110 – 125 | 115 |

5. Firmware update

The following is needed to load the new version of the firmware into the PRM4 device:

- **MSPFET software** – Can be located on the CD that is included in the PRM4 product pack. Otherwise, the latest software version can be downloaded from http://kurt.on.ufanet.ru/files/MspFet_16007_devel.zip
- **RS232 cable for programming** the PRM 4 device, and
- **File containing the new firmware.**

5.1. The procedure for writing the new firmware

- Open the casing of the device and take out the printed circuit board.
- Connect the serial port of the PC to RS232 port of the modem via DB9 cable and programming cable. The adapter for PRM 4 is DB9 female to DB9 male cable with the following pin connections:

| DB9 female | DB9 male |
|-------------------|-----------------|
| pin 2 ----- | pin 8 |
| pin 3 ----- | pin 7 |
| pin 4 ----- | pin 4 |
| pin 5 ----- | pin 5 |
| pin 7 ----- | pin 3 |

- Set the J1 and J2 into the 1-2 state. The rest of the jumpers should be in a state corresponding for RS-232C serial connection according to the aforementioned table.
- Connect the power supply.
- Start the MSPFET, load the prm4xxx.hex, using the setup of the program adjust the BSL and serial port to which the device is connected. Press AUTO. Confirm that the modem's microcontroller has been programmed and verified.
- Disconnect the power supply.
- Set the J1 and J2 into the 2-3 state.
- Return the circuit board into the casing and close it.
- Check the modem operation with the new firmware.

6. Technical specifications

| | |
|---------------------------------|--|
| Frequency range | ISM 868MHz, according to EN 300 220 |
| Channel range and number | 25kHz, 80 channels |
| Transmit power | +13dBm, 20mW |
| Modulation | 2FSK with Gaussian filtration |
| Deviation | ±4kHz |
| Occupied bandwidth | 25kHz |
| Frequency control | synthesizer |
| Frequency stability | ±2 ppm, -10°C to +60°C |
| Tx – Rx transition time | ≤1ms |
| Error detection | CRC16 |
| Radio signaling rate | 9600bps |
| Receiver sensitivity | better than -115dBm for 10^{-3} BER |
| Channel occupation time | less than 1% |
| Range | up to 2km with rod antenna, 16km with high gain antenna |
| Antenna connector | SMA female |
| Antenna impedance | 50Ω |
| Serial interface | 8 data, None parity, 1 stop bit 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 |
| Serial connector DB9 DCE | RS-232: Tx, Rx, RTS, CTS, DTR, DSR, DCD, RI, GND RS-422: Tx+, Tx-, Rx+, Rx-, GND (2W/4W selectable) RS-485: Tx+, Tx-, Rx+, Rx-, GND (2W/4W selectable) Termination 120 Ohm for RS-422 and RS-485 selectable |
| Settings | through AT command set |
| Addressing scheme | 65536 network addresses, 256 source addresses |
| Network configuration | Point-to-point, point-to-multipoint |
| Power supply | 8-32Vdc, 2W or battery option 3.3-12Vdc |
| Power consumption | <50mA |
| LED indications | power supply, receive, transmit, error in channel |
| Temperature range | -20°C to +75°C, 0 to 95% RH (non condensing) |
| Protection | IP50 |
| Dimensions | 86 x 57 x 26 mm |
| Weight | 110g |
| Mounting | desktop or optional mounting for 35mm DIN rail |

Contact

Decode Data Communications

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