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BlueRobin™

Wireless Low-power Body Area Network

BM-MM5 Receiver Module with SPI Interface

User Guide

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Date: **18th of March 2009**
Revision: **1.5**

Confidentiality Statement:
This document shall be considered as Proprietary/Confidential Information.

Interface Hardware

A clock synchronous interface is used to connect the receiver module to the host application. The host works as an SPI master providing the synchronous clock whereas the receiver module operates in SPI slave mode. The host application is not required to receive and transmit data at the same time. Any communication is solely initiated and controlled by the host application, the receiver module is only able to acknowledge received data from the host and to indicate new data received from transmitters belonging to it via a separate signal line. The SPI operation can be halted and the SDO line can be set to high impedance by setting chip select (CSN) to high level, for normal SPI operation CSN has to be set to low level. This allows multiple slaves on the SPI bus.

All transactions on the SPI interface are organized in characters with a length of 8 bits, most significant bit coming first. Bits are written on the falling edge and read on the rising edge of the synchronous clock. Maximum frequency for the synchronous clock is 4 MHz. The receiver module uses a separate pin (CRDY) to indicate with a rising edge to the host it is ready for receiving the next character.
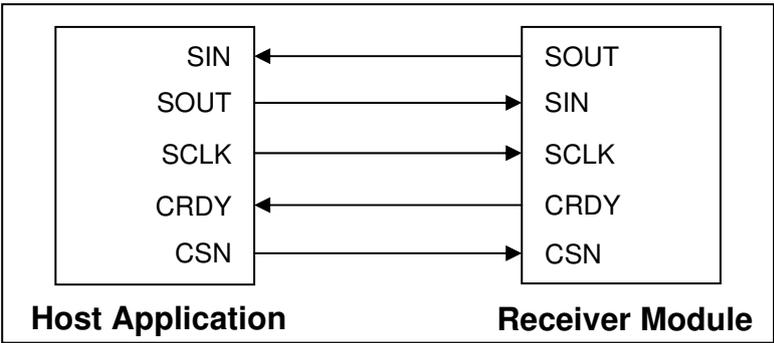

Fig. 1: Interface between host application and receiver module

The size of the receiver module is 32.0 mm x 14.0 mm x 2.2 mm. All interface pins are arranged on one side of the module in a 2.54 mm grid, so standard connectors can be used. The position of the module should be chosen in a way so that no ground plane is located below or above the antenna part.

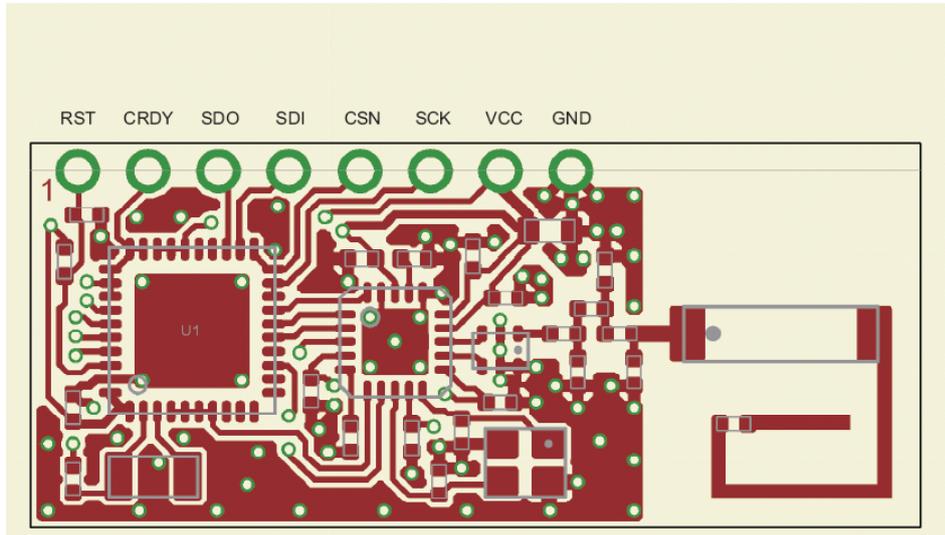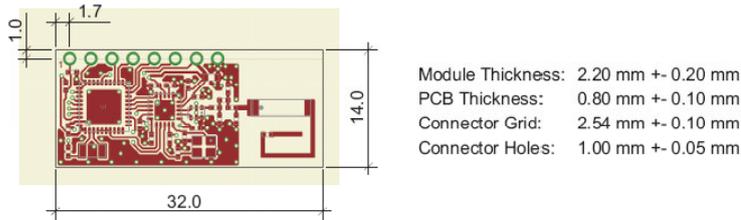|	
Module Thickness:	2.20 mm +- 0.20 mm
PCB Thickness:	0.80 mm +- 0.10 mm
Connector Grid:	2.54 mm +- 0.10 mm
Connector Holes:	1.00 mm +- 0.05 mm

Fig. 2: Receiver module dimensions and connector assignment

The interface pins provide the following signals:

- PIN1: RST   Module reset input (47k pull-up, can be left open)
- PIN2: CRDY   Command ready output
- PIN3: SDO   Serial data output
- PIN4: SDI   Serial data input
- PIN5: CSN   Chip select input
- PIN6: SCK   Serial data clock input
- PIN7: VCC   Supply voltage, positive terminal
- PIN8: GND   Supply voltage, negative terminal

Timing Chart

The following chart shows the timing of all involved signals on the host application side for a transaction with one parameter and one return value. Dependent on the command the host has to maintain the clock signal until all bytes of the reply to the command have been sent by the receiver module, otherwise synchronisation between host application and receiver module gets lost. A resynchronisation is possible at any time by sending NOP commands.
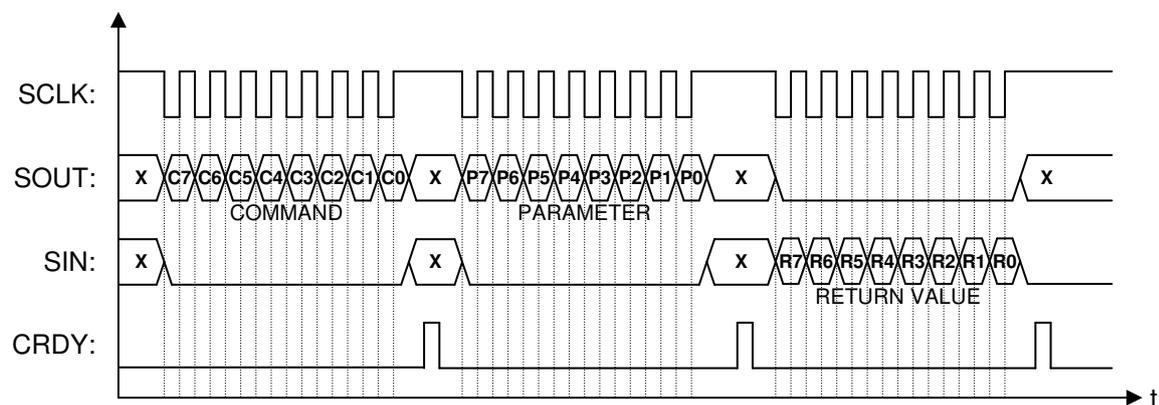

Fig. 3: SPI interface timing chart

Technical Data

Supply voltage: 2.8 V to 3.3 V
Current consumption in Search Mode: max. 30 mA
Current consumption in Normal Mode: typ. 50 uA in average, 25 mA peak
Current consumption in Standby Mode: typ. 1.2 uA
Operating temperature: 10 °C bis +50 °C
Storage temperature: -20 °C bis +80 °C
Data transmission: *BlueRobin*™
Transmission frequency: 868 MHz ISM band with frequency hopping
Transmission distance: min. 10 m free air, dependent on environment
Antenna: chip antenna
Channels: reception of 10 HR transmitters in parallel
Interface to host: 4-pin SPI slave with data ready signal
                                        standard TTL, max. VCC

The supply voltage has to be switched on in less than 10 ms (10% - 90 % level). Spikes may not be allowed. The receiver module needs a settling time of typ. 2 seconds after power on before communication with the host system can be started.

Command Overview

The following command set is available for configuring and controlling the receiver module from the host application and for getting received data:
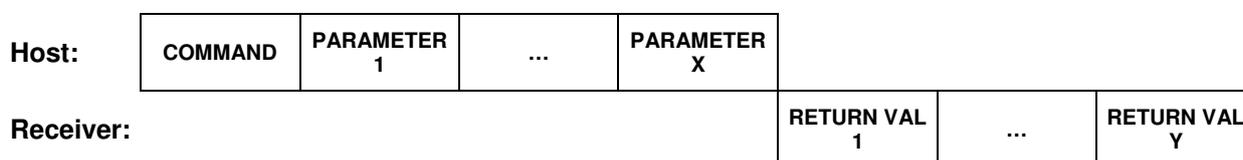
Command	Code	Description
NOP	00h	Resynchronize configuration transaction
InitModule	01h	Initialise module hardware and software and set default values
GetModuleInfo	02h	Get module information (software revision and number of available channels)
SetPowerdownDelay	03h	Set delay for entering powerdown mode after transmitter got lost
SetSearchTimeout	04h	Set timeout when searching for a transmitter
SetLearnSensitivity	05h	Set receiver sensitivity reduction for transmitter learn mode (ID set to 0)
StartChannel	10h	Start search for a HR transmitter on a channel (ID to be set to 0 for learn mode)
StopChannel	11h	Stop HR transmitter reception on a channel (enter powerdown mode)
SetChannelID	12h	Set identification of HR transmitter to be received on a channel
GetChannelInfo	13h	Get information about HR transmitter (ID, powerdown counter) received on a channel
GetChannelData	14h	Get state and if available received data from the HR transmitter received on a channel

Command codes not listed are reserved and should not be used.

Command Format

All commands available to be sent from the host application to the receiver module begin with the command identifier byte followed by the number of parameter bytes belonging to the command. In case the command causes the receiver module to return values the host application has to provide the synchronous clock signal and set SDO to low state until all bytes have been sent by the receiver module.

If the command requires to send back return values the receiver module starts to write the return value bytes as soon as all parameters have been sent by the host application.

Host:	COMMAND	PARAMETER 1	...	PARAMETER X			

Receiver:					RETURN VAL 1	...	RETURN VAL Y

Command Description

NOP (00h)

This command does not cause any operation or return value. It can be used to (re)synchronize the communication between host application and receiver module.

Command: | 00h |

InitModule (01h)

To initialise the receiver module hardware and software this command has to be sent once to the module after power-up and before any further communication with the module. It results in the following default settings:

State of HR channel: powerdown mode
ID of HR channel: 0 (learn mode when starting the channel)
Powerdown delay: after 10 lost data packets
Search timeout: no timeout, automatic search start when transmitter gets lost
Sensitivity reduction in learn mode: 20 dB

Command: | 01h |

Reply: | RETURN VAL 1 |

RETURN VAL 1:   0: initialised receiver module successfully
                  1: initialisation of receiver module failed

GetModuleInfo (02h)

This command returns the hardware and software revision of the receiver module.

Command: | 02h |

Reply: | RETURN VAL 1 | RETURN VAL 2 | RETURN VAL 3 |

RETURN VAL 1:   number of supported channels
RETURN VAL 2:   software main revision
RETURN VAL 3:   software sub revision

SetPowerdownDelay (03h)

This command sets the number of consecutive lost data packets after which an active channel will be switched automatically to powerdown mode. The actual number of lost packets in a row for an active channel, represented by its powerdown counter, can be determined using the GetChannelState command.
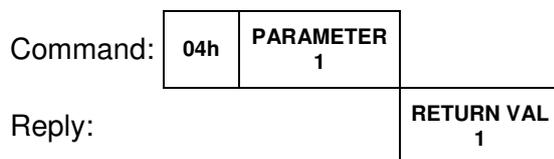
Command: | 03h | PARAMETER 1 |

Reply: | RETURN VAL 1 |
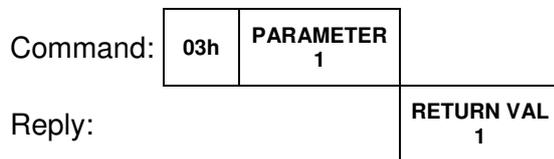
PARAMETER 1:   powerdown delay to be set, valid range is 1 to 200

RETURN VAL 1:   0: command executed successfully
                    1: powerdown delay out of range

SetSearchTimeout (04h)

The time for trying to find a transmitter when starting a channel in both learn and normal search mode can be set with this command. It is specified in seconds. If the transmitter could be found within this time the channel changes from search to active mode, otherwise it switches back to powerdown mode. Setting the timeout value to 0 results in an infinite search and an automatic search start if a transmitter gets lost.
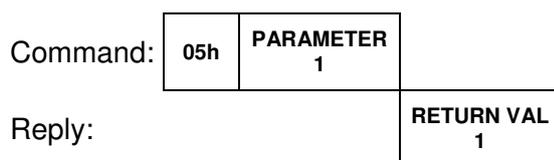
Command: | 04h | PARAMETER 1 |

Reply: | RETURN VAL 1 |

PARAMETER 1:   search timeout to be set, valid range is 3 to 20

RETURN VAL 1:   0: command executed successfully
                    1: search timeout out of range

SetLearnSensitivity (05h)

This command has to be used to reduce the receiver sensitivity for a channel in learn mode to be able to only get transmitters close to the receiver module. As soon as a transmitter could be found the sensitivity of the corresponding channel will be set back automatically to its maximum value.

Command: | 05h | PARAMETER 1 |

Reply: | RETURN VAL 1 |

PARAMETER 1:   learn sensitivity reduction to be set, valid range is 0 to 40
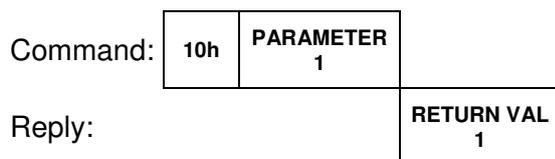
RETURN VAL 1:   0: command executed successfully
                    1: learn sensitivity out of range

StartChannel (10h)

To start the search for a HR transmitter on a channel this command has to be used. If the channel is already in search or active state, the command will not be executed.

If the ID for the channel is set to 0 any HR transmitter will be accepted. As soon as a transmitter could be found the channel state changes to "active" and the ID of the found transmitter can be read. In this so called learn mode the receiver sensitivity can be reduced with the SetLearnSensitivity command to be able to only get transmitters close to the receiver application. As soon as a HR transmitter could be found the corresponding channel sensitivity will be set back automatically to its maximum value.

If the ID is set to any value except 0 only a HR transmitter having exactly this ID will be accepted. A preset ID always causes maximum channel sensitivity.

Command: | 10h | PARAMETER 1 |

Reply: | RETURN VAL 1 |

PARAMETER 1:   channel index (starts from 0)

RETURN VAL 1:   0: command executed successfully
                    1: command not executed because channel not in powerdown mode

StopChannel (11h)

While searching for a HR transmitter or if a channel is in active mode it can be stopped respectively set to powerdown mode with this command. If the channel already is in powerdown mode this command does not have any effect.

Command: | 11h | PARAMETER 1 |
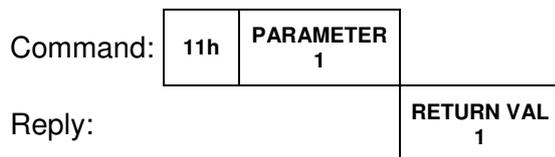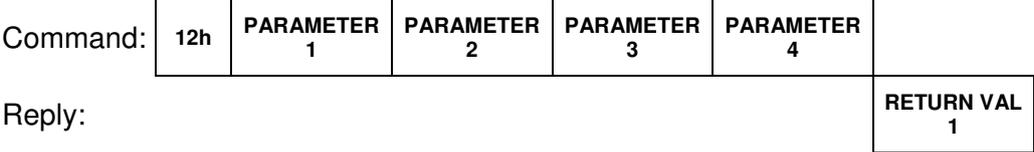
Reply: | RETURN VAL 1 |

PARAMETER 1:   channel index (starts from 0)

RETURN VAL 1:   0: command executed successfully
                    1: command not executed because channel in powerdown mode

SetChannelID (12h)

Setting the ID of a channel to a value not equal to zero causes the channel to only search for HR transmitters having this ID. An ID set to 0 results in searching for a HR transmitter with any ID. The ID can only be changed if the channel is in powerdown mode.

Command:	12h	PARAMETER 1	PARAMETER 2	PARAMETER 3	PARAMETER 4	
Reply:						RETURN VAL 1

PARAMETER 1: channel index (starts from 0)

PARAMETER 2-4: ID of the HR transmitter to be received; 0 causes learn mode when starting; high byte of ID first, low byte last

RETURN VAL 1: 0: command executed successfully
1: command not executed because channel not in powerdown mode

GetChannelInfo (13h)

This command returns the ID (either set or found during learn mode) and the powerdown counter for a channel.

Command:	13h	PARAMETER 1		
Reply:		RETURN VAL 1	...	RETURN VAL 4
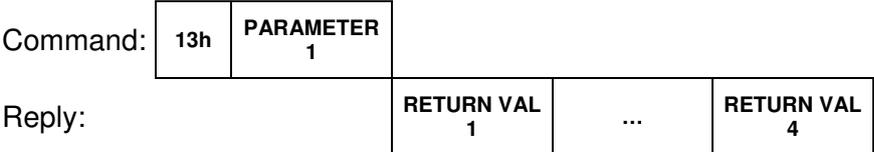
PARAMETER 1: channel index (starts from 0)

RETURN VAL 1-3: ID set for this channel; if ID was set to 0 (learn mode) and a transmitter could be found it contains the ID of the found transmitter; high byte of ID first, low byte last

RETURN VAL 4: number of lost packets in a row on the channel. Reset whenever a valid packet could be received.

GetChannelData (14h)

To get the current state of the HR channel and if available the latest data received this command can be used.

Command:	14h	PARAMETER 1		

Reply:		RETURN VAL 1	RETURN VAL 2	RETURN VAL 3

PARAMETER 1:   channel index (starts from 0)

RETURN VAL 1:   state of channel in lower 4 bits:
0: powerdown mode (no data will follow)
1: active mode (2 data bytes will follow)
2: search or learn mode (no data will follow)
state of HR transmitter in upper 2 bits:
0: normal operation
1: low battery

RETURN VAL 2:   signal level of last data packet (0 for lost packet) if channel in active mode, otherwise no return value is available

RETURN VAL 3:   last received average heart rate (unit bpm) if channel in active mode otherwise no return value is available

Change Log

Revision	Content	Made by	Date
0.1	Preliminary revision for customer evaluation	Richard Mayerhofer	16.12.2008
1.0	Fixed module dimensions for chip antenna	Richard Mayerhofer	05.12.2008
1.1	Corrected module dimensions, added module enable (ME) signal	Richard Mayerhofer	08.01.2009
1.2	Changed document formatting	Richard Mayerhofer	31.01.2009
1.3	Changed pin order and module enable (ME) to chip select (CSN)	Richard Mayerhofer	12.02.2009
1.4	Removed hardware revision from GetModuleInfo command	Richard Mayerhofer	11.03.2009
1.5	Reduced transmission distance and changed module thickness	Richard Mayerhofer	18.03.2009