Manual for AMB8420 and AMB2520

Version 3.15

SW-V 3.2

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Abbreviations

CS Checksum

DC Duty cycle Relative frequency reservation period

1 Summary

The AMB8420/AMB2520 module was designed as a radio submodule for wireless communication between devices like controls, remote controls, sensors etc. It offers several addressing modes and relieves the host system of radio-specific tasks such as

- checksum calculation,
- address resolution and
- repetition of unacknowledged telegrams.

It can be deployed wherever the wireless exchange of small data packets (up to 128 bytes) between two or more parties is required.

A serial interface (UART) whose data rate and format can be adjusted flexibly is available for communicating with the host system.

By means of the Windows program "ACC", the HF data rate can be adjusted from 4.8 to 250 kbps.

Thanks to its small size and the integrated antenna, the module can easily be installed in existing systems without any external circuits.

2 Electrical parameters

2.1 Input voltage

The input voltage of the module ranges from 2.7 to 3.6 V.

In order to ensure a constant processor frequency (and UART clock rate) over the entire voltage range, the clock rate is continuously readjusted on the basis of the available watch crystal. Voltage changes during the reception or output over the serial interface can result in a change of the clock rate between two characters.

Caution: A clean supply voltage is needed for the module to function correctly. Using a 100 µF blocking capacitor close to the VCC pin is a useful measure (especially when using RS232 converters or clocked DC-DC converters).

2.2 Power consumption

2.2.1 AMB8420

See data sheet [4].

2.2.2 AMB2520

See data sheet [5].

Caution: To minimize power consumption in Sleep Mode, the input signals of the module (/CONFIG, SLEEP, TRX_DISABLE und /DATA_REQUEST) must be set to the levels defined in Table 1. Open (floating) pins result in increased power consumption.

3 Dimensions and weight

See data sheets [4] and [5].

4 Pinout

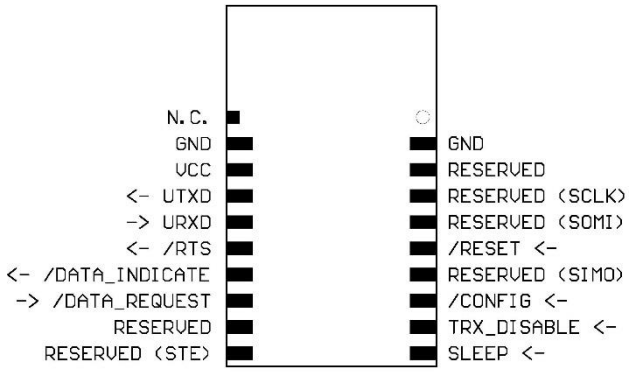


Figure 1 Pinout

Designation	I/O	Description
VCC[1]	Supply	Supply voltage
GND	Supply	Ground
UTXD	Output	Output serial interface
URXD	Input	Input serial interface
/RESET	Input	A low level on this pin performs a restart of the module. Internally, this pin is connected to VCC via a 100 kΩ pull-up resistor. **Leave open if not needed.**
/CONFIG	Input	Used to switch the module to the command mode (falling edge). Alternatively, this can be done by means of a UART break signal. **Connect to GND if not needed.** The function can be disabled (see 9.29).
SLEEP	Input	Activates the Sleep Mode (high level). **Connect to GND if not needed.** The function can be disabled (see 9.29).
TRX_DISABLE	Input	Switches the HF part off (high level) as long as no data is to be sent. **Connect to GND if not needed.** The function can be disabled (see 9.29).
/DATA_REQUEST	Input	Prompts the wireless transmission of the data received via the UART (falling edge). As long as no new data is received via UART or wireless transmission, the buffer content remains valid and can be resent by means of a new signal. **Connect to GND if not needed.** The function can be disabled (see 9.29). Without function in the command mode.
/RTS	Output	Ready to send (active low). When /RTS is low, data can be received via UART. /RTS goes high as soon as the UART buffer is full or when the wireless

[1] 100µF blocking capacitor recommended between VCC and GND in close proximity to the module

		reception of a telegram is detected. From this moment, all data coming in via UART will be ignored. Timeout after falling edge: 100 µs.
/DATA_INDICATE	Output	Goes low as soon as a valid frame is received via wireless transmission and remains low as long as the output via UART continues. Can be used to prepare a "sleeping" host system for the output of data. The delay between the falling edge and the beginning of output via UART can be configured (see `UART_DIDelay`, 9.11). During the transmission process, this pin signals the successful acknowledgement of the wireless telegram (if such was requested, see `MAC_NumRetrys`, 9.12): in this case, /DATA_INDICATE is set to low before the falling edge of the /RTS pin and goes back high when new data is received via wireless transmission or UART, at the latest.
RESERVED		Currently not used. These pins must be left open (do not connect). Some of these pins are used for the optional SPI[2] interface.
N.C.		Open, optional aerial connection; use only after consultation.

Table 1 Pinout

[2] An SPI interface can be implemented upon request.

5 Start-up and minimal configuration

5.1 Minimal configuration

The following pins are required in the minimal configuration: VCC, GND, UTXD, and URXD.

If the module is to be connected to a PC, a level converter (TTL to RS232 or USB) must be used. The development tools AMB8420-EV and AMB2520-EV provide both interfaces on-board.

In the default configuration of the Firmware, all module inputs (SLEEP, TRX_DISABLE, /CONFIG, and /DATA_REQUEST) are activated and must be connected to GND if they are not to be used (see Table 1).

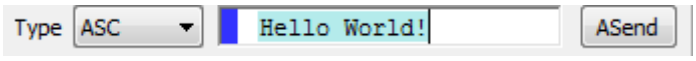
The /RTS signal is recommended to be used by the host.

5.2 Sending & Receiving: “Hello World”

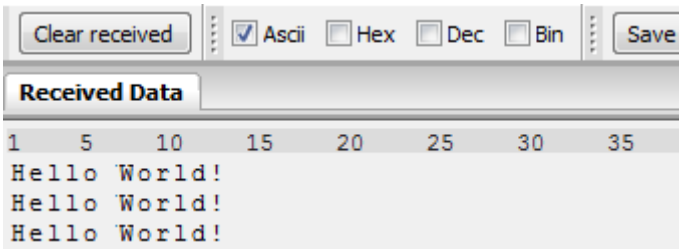
Connect your pair of modules, EV-boards or USB-sticks with the PC as explained in chapter 5. Please make sure you have a minimum distance of 3 meters between the two modules or devices to avoid over modulation. When short distances are needed, you could reduce the PAPower to a minimum.

When the connection to the PC is done, please use a terminal tool of your choice. For convenience we assume you selected the tool “hterm”. Select the two corresponding COM ports and open them with the right configuration (AMB2520: 38.4 kBaud 8n1, AMB8420: 9.6 kBaud 8n1).

Enter the string “Hello World” into the input line of hterm and use the “ASend” button followed by pushing the “start” button to send the data once.



This data will be received by the second module and shows up as received data in the second hterm instance. You may send any string of size 1 to 128 characters from one module to the other.



You just used the so called “transparent mode” of the modules to send your data. The address mode that was used is “0”. Thus all radio frames are broadcasts that can be received by anyone

listening with an AMB8626 in default settings. The frame you send was generated using the timeout method.

Besides the transparent mode, that is suited for transparent data transmission, the so called “command mode” allows both, the module configuration and the data transmission, using a predefined command interface (see chapter 8).

5.3 Adopting parameters to fit your application

The non-volatile parameters (see chapter 9) can only be changed in the command mode by using the CMD_SET_REQ command. This command will need the following parameters:

- memory position of the parameter
- the new value that shall be applied to this parameter

Furthermore, there are volatile settings that can be accessed by explicit commands for each parameter. All available commands are introduced in chapter 8.

5.4 Deployment of several modules, use of addresses

Settings like the module address can only be modified in the command mode. Thus we recommend to permanently operate in command mode by setting the user settings parameter `OpMode` to the value of 0x10 (16).

To use non-broadcast transmissions you need to adopt the following non-volatile settings:

- MAC_AddrMode (mode 1 or 2 should be used depending on the number of addresses you need)
- MAC_DefaultSourceAddrLSB as the local address for each device of your network, each member of the network will need an unique address. A value of 255 is invalid.
- MAC_DefaultSourceNetID, as the local network address for each device of your network, each member of the network will need an unique address. A value of 255 is invalid.

In command mode, the command CMD_DATAEX_REQ, that has the destination address as an own parameter, can be used to send your data to the specified address. A broadcast message can still be achieved when using 0xFF (255) for both destination address LSB and destination net ID.

6 Host connection: Serial interface

6.1 UART

6.1.1 Supported data rates

The data rate is adjusted by directly configuring the respective registers of the utilised microprocessor (see `UART_TCTL`, `UART_MCTL`, `UART_BR0`, and `UART_BR1`; from 9.1). In this way, the data rate can be adjusted freely from 0.5 to 115200 baud.

As the UART speed is derived from the speed of the utilised clock quartz, there may be variations of up to 0.5%.

When using the PC program "ACC", the following data rates can be selected using the data rate calculator. With this selection, the three registers above are automatically set to the optimum value.

The default baud rate of the module is 9600 (AMB8420) / 38400 (AMB2520).

The output of characters on the serial interface takes place with secondary priority. For this reason, short interruptions may occur *between* the output of individual characters (e.g. in the event of an interrupt).

6.1.2 Supported data formats

All data formats offered by the processor are supported:

- 7 or 8 bits
- No, even, or odd parity
- 1 or 2 stop bits

In ACC, the following data formats can be selected directly via the drop-down menu:

8n1, 8o1, 8e1, 8n2, 8o2, 8e2, 7n1, 7o1, 7e1, 7n2, 7o2, 7e2.

The data format, too, can be set by directly configuring the respective microprocessor registers (see `UART_CTL`, 9.1).

The default and recommended data format is 8 data bits, no parity, 1 stop bit ("8n1").

7 Operating modes

The module can be used in the following operating modes:

1. Transparent mode (transparent data transmission)
2. Command mode (module configuration and data transmission using the predefined command interface)

The operating mode after power-up can be configured by means of the OpMode parameter. By default, the module operates in transparent mode.

Starting in the command mode, the module responds with a CMD_SET_MODE_CNF telegram.

7.1 Switching from transparent to command mode

The command mode can be entered by applying a falling edge on the /CONFIG pin or when a break signal is detected on the UART. A break condition exists if the RX input of the module is kept low for at least 10 more bits after an absent stop bit. Detection of both the falling edge on the /CONFIG pin and of the break signal can be disabled using the user setting CfgFlags.

The successful switchover is acknowledged by a CMD_SET_MODE_CNF telegram.

The switchover can only occur when no data is being received by wireless transmission or UART interface (approximately 100 µs after /RTS goes low and indicates readiness).

7.2 Switching from command to transparent mode

The transparent mode can be entered by applying a falling edge on the /CONFIG pin, by using the command CMD_SET_MODE_REQ or on detection of another break signal on the UART. Detection of both the falling edge on the /CONFIG pin and of the break signal can be disabled using the user setting CfgFlags.

The successful switchover is acknowledged by a CMD_SET_MODE_CNF telegram.

The switchover can only occur when no data is being received by wireless transmission or UART interface (approximately 100 µs after /RTS goes low and indicates readiness).

7.3 Transparent, buffered data transfer

In this mode, data is received via the serial interface and initially buffered. As soon as a specific condition is met (see Table 2), the RF telegram is generated with a preamble, checksum, and address information (optional).

The number of characters transmitted in the wireless telegram in addition to the actual payload data depends on the selected addressing method and the data rate, and varies between 12 and 16 bytes (packet overhead).

If required, the RF telegram can be acknowledged by the recipient module (see 9.12). If no acknowledgement is received, the telegram will automatically be repeated upon expiry of a timeout (see 9.18).

The buffer size at the UART interface is 128 bytes, i.e. the maximum size of transmitted data packets is 128 bytes (payload data only, without packet overhead).

To initiate an RF transmission, several options are available, listed in Table 2.

Start Condition	Description:	Dependent usersettings
Timeout	Transmission starts if no new character is detected within a configurable time period after receiving a character via UART. The timeout is reset every time a new character is received.	UART_Timeout UART_PktMode
End-Of-Text-Character	Transmission begins when the preconfigured character is transmitted via UART.	UART_PktMode UART_ETXChar
Fixed Packet Size	Transmission starts when the preconfigured number of bytes is reached in the RX buffer of the UART.	UART_PktSize UART_RTSLimit UART_PktMode
/Data Request Pin	The transmission starts as soon as a falling edge is detected on the /DATA_REQUEST pin.	CfgFlags

Table 2 Communication in transparent mode

The `UART_PktMode` parameter (see 9.6) can be used to determine which of the listed combinations is to be used.

Caution: As long as the receiver module is busy sending characters via the serial interface, wireless data reception is not possible. For example, this effect is noticeable when sending a long data packet and subsequently a short data packet. In this case, the receiver module may still be busy sending the first packet via UART, and the second packet may be lost.

7.3.1 /RTS signal, busy processor

/RTS signalizes a busy UART buffer which means, when /RTS is set, no more UART bytes will be accepted nor processed.
/RTS is set when any of the events in the prior chapter has occurred.

7.4 Command mode

This operating mode primarily serves module configuration. The module acts as a slave and can be fully controlled by an external host using the commands of the command interface (see chapter 8).
It can also be used for wireless transmission of payload data providing a feedback dependent on the transmission success.

8 The command interface

In the command mode, communication with the module occurs in the form of predefined commands. These commands must be sent in telegrams according to the format described in Table 3.

Start signal	Command	No. of data	Data (var.)	Checksum

Table 3 Telegram format in the command mode

Start signal: STX = 0x02

Command: One of the predefined commands according to section 13 (1 byte)

No. of data: Specifies the number of data in the following field of variable length and is limited to 128 in order to prevent buffer overflow (1 byte)

Data: Variable number of data or parameters (maximum 128 byte, LSB first)

Checksum: XOR relation of the preceding fields including the start signal STX, i.e. 0x02 ^ command ^ no. of data ^ data byte 0 ... (1 byte)

Using a specific command, data can also be sent via HF, i.e. the module can be operated entirely in the command mode. This is useful for realising quick channel changes, for example.

If no new signal is received for `UART_Timeout` milliseconds (see 9.10) after receiving the STX signal, the unit will wait for a new start signal.

8.1 Data transfer & reception in the command mode

This chapter describes the commands to directly control the module, particular the data transmission over the radio link (when the module is in the command mode).

8.1.1 CMD_DATA_REQ

This command serves the simple data transfer in the command mode. Transmission takes place on the configured channel (see 8.3.2) to the previously parameterised destination address (see 8.3.3 and 8.3.4).

This command is especially suitable for transmission on a point-to-point connection. The number of payload data bytes is limited to 128 in order to prevent buffer overflow.

Format (limit 128 payload data bytes):

0x02 ***0x00*** < number of payload data bytes > < payload data bytes > < CS >

Return:

0x02 ***0x40*** 0x01 < status > < CS >

Status:

0x00: ACK received, only possible if MAC_NumRetrys is not 0; see 9.12

0x01: no ACK received or requested

8.1.2 CMD_DATAEX_REQ

This command serves data transfer in a network with several parties. Both the channel to use and the destination address (depending on the parameterised addressing mode) are specified along with the command. The number of payload data bytes is limited to 127, 126, or 125 in order to prevent buffer overflow.

Format in addressing mode 0 (limit 127 payload data bytes):

0x02 ***0x01*** < number of payload data bytes + 1 > < channel > < payload data bytes > < CS >

Format in addressing mode 1 (limit 126 payload data bytes):

0x02 ***0x01*** < number of payload data bytes + 2 > < channel > < destination address > < payload data bytes > < CS >

Format in addressing mode 2 (limit 125 payload data bytes):

0x02 ***0x01*** < number of payload data bytes + 3 > < channel > < destination network ID > < destination address > < payload data bytes > < CS >

Return:

0x02 ***0x40*** 0x01 < status > < CS >

Status:

0x00: ACK received, only possible if MAC_NumRetrys is not 0; see 9.12

0x01: no ACK received or requested

0x02: invalid channel selected

8.1.3 CMD_DATAEX_IND

This telegram indicates the reception of data bytes and represents the counterpart to the commands CMD_DATA_REQ and CMD_DATAEX_REQ. Apart from the RX field strength (RSSI value), this telegram also specifies the sender address (depending on the parameterised addressing mode).

Format in addressing mode 0 (maximum 127 bytes payload data):

0x02 ***0x81*** < number of data bytes + 1 > < data bytes > < field strength > < CS >

Format in addressing mode 1 (maximum 126 bytes payload data):

0x02 ***0x81*** < number of data bytes + 2 > < sender address > < data bytes > < field strength > < CS >

Format in addressing mode 2 (maximum 125 bytes payload data):

0x02 ***0x81*** < number of data bytes + 3 > < sender network ID > < sender address > < data bytes > < field strength >< CS >

Concerning the interpretation of the field strength, see 8.2.2.

8.1.4 CMD_DATARETRY_REQ

This command relaunches the transmission of the data submitted earlier on with CMD_DATA_REQ or CMD_DATAEX_REQ. Thus, the data does not need to be transmitted again via the serial interface.

The buffered data is lost as soon as new data is sent via UART or data is received via wireless transmission.

Format:

0x02 ***0x02*** 0x00 0x00

Return:

0x02 ***0x40*** 0x01 < status > < CS >

Status:

0x00: ACK received, only possible if MAC_NumRetrys is not 0; see 9.12

0x01: no ACK received or requested

0x03: no data available (e.g., overwritten by wireless data reception)

8.2 Requesting parameters and actions

This group includes all commands that will return read-only parameters or request actions in the module.

8.2.1 CMD_SERIALNO_REQ

This command can be used to query the individual serial number of the module.

Format:

0x02 ***0x0B*** 0x00 0x09

Return:

0x02 ***0x4B*** 0x04 < 4-byte serial number > < CS >

Contrary to most other mulit-byte parameters this function returns MSB first. Which means that the first returned byte of the Serial number is the Product-ID (PID).

Let's imagine the 4-byte return value was "0x11 00 31 01" then the corresponding decimal serial number is (as printed on the label of the module): 017. 012545.

The conversion will use PID 0x11 to create the decimal 17 with a prepended 0. Followed by 0x003101 which is 12545 in decimal. A "0" is prepended as the label is always using 6 decimal places for the second part of the serial number and 3 decimal places for the PID.

8.2.2 CMD_RESET_REQ

This command triggers a software reset of the module. The reset is performed after the acknowledgement is issued.

Format:

0x02 ***0x05*** 0x00 0x07

Return:

0x02 ***0x45*** 0x01 < status > < CS >

Status:

0x00: success

8.2.3 CMD_RSSI_REQ

This command delivers the current RX level determined by the transceiver IC in the form of a two's complement.

Format:

0x02 ***0x0D*** 0x00 0x0F

Return:

0x02 ***0x4D*** 0x01 < RX level > < CS >

The value obtained in this way delivers the RX level $RSSI_{dBm}$ in dBm as follows:

1. Conversion of the hexadecimal value to a decimal $RSSI_{dec}$
2. If $RSSI_{dec} \geq 128$: $RSSI_{dBm} = (RSSI_{dec} - 256) / 2 - RSSI_{Offset}$

3. Otherwise ($RSSI_{dec}$ < 128): $RSSI_{dBm} = RSSI_{dec} / 2 - RSSI_{Offset}$

$RSSI_{Offset}$ is a data-rate-dependent correction factor according to Table 4 (AMB8420) and Table 5 (AMB2520).

The relation between the calculated value and the physical RX level in dBm is not linear across the entire operating range and is displayed in Figure 2 and Figure 3 .

Data rate	RSSI offset
1.2 kbps	74
38.4 kbps	74
250 kbps	78

Table 4 Data rate-dependent RSSI offset for **AMB8420** (from [2])

Data rate	RSSI offset
2.4 kbps	71
10 kbps	69
250 kbps	72
500 kbps	72

Table 5 Data rate-dependent RSSI offset for **AMB2520** (from [3])

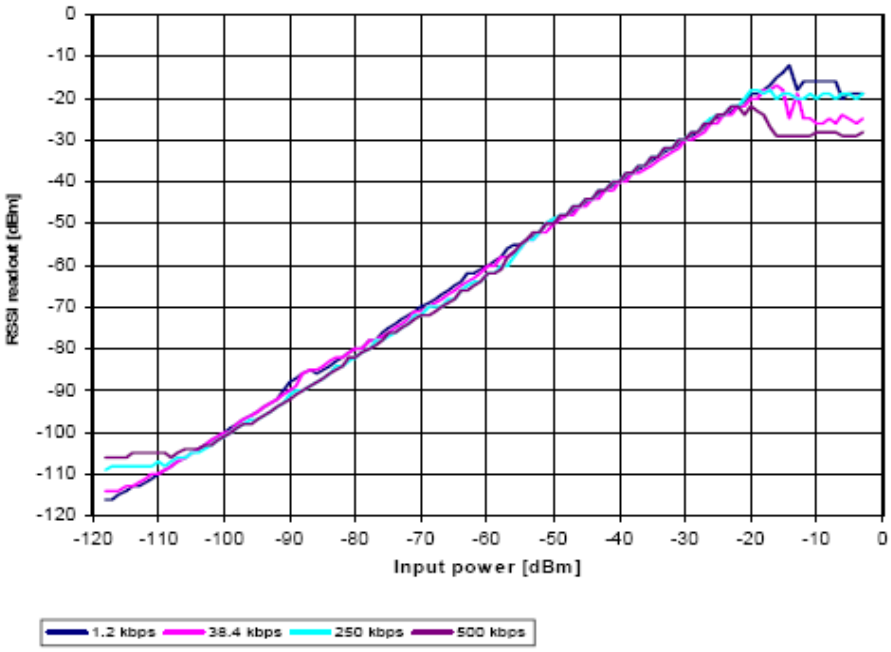


Figure 2 Relation between the RX level and the RSSI value read out for **AMB8420** (from [2])

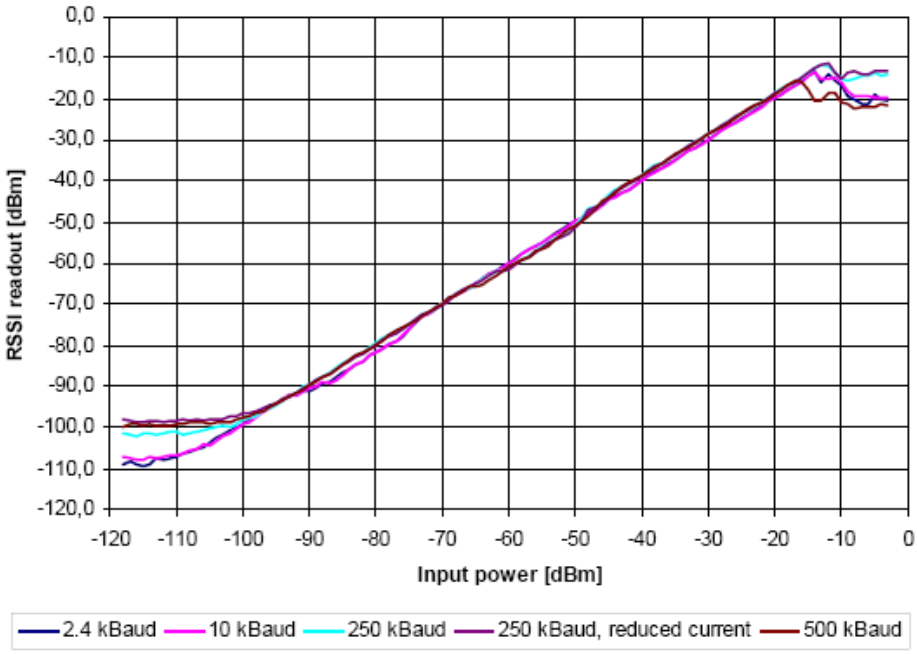


Figure 3 Relation between the RX level and the RSSI value read out for **AMB2520** (from [3])

8.2.4 CMD_ERRORFLAGS_REQ

This command returns internal error states.

Format:

0x02 ***0x0E*** 0x00 0x0C

Return:

0x02 ***0x4E*** 0x02 < error flags MSB > < error flags LSB >< CS >

An error flag return value of "0" indicates that no error has occurred. The value is set back after the query and in the event of a reset.

The meaning of the error flags is not described in detail in this context.

8.3 Modification of volatile parameters

This group contains all functions that will modify runtime settings while the module is running. These settings are all volatile and will be reset to defaults on a reset of the module.

8.3.1 CMD_SET_MODE_REQ

This command is used to toggle the operating mode, e.g. to exit the command mode (this is currently the only application). The return value will also be used as a start up indication if OpMode is set to 0x10 or if a change of the mode using the /config pin was requested (when changing into command mode).

Format:

0x02 ***0x04*** 0x01 < desired operating mode > < CS >

Example (exit command mode):

0x02 *0x04* 0x01 0x00 0x07

Return:

0x02 ***0x44*** 0x01 < newly configured operating mode > < CS >

Return for above example:

0x02 0x44 0x01 0x00 0x47

The following operating modes are defined:

- Mode 0 (0x00): transparent data transfer
- Mode 16 (0x10): command mode

8.3.2 CMD_SET_CHANNEL_REQ

This command is used to toggle the wireless channel. Unlike the non-volatile parameter `PHY_DefaultChannel` (see 9.21), this is a volatile runtime parameter.

Format:

0x02 ***0x06*** 0x01 < 1-byte channel > < CS >

Example (selection of channel 108):

0x02 0x06 0x01 0x6C 0x69

Return:

0x02 ***0x46*** 0x01 < new channel > < CS >

Return for above example:

0x02 0x46 0x01 0x6C 0x29

The number of the newly set channel is returned. If the permissible frequency range is exceeded, the lowest and highest permissible channels are configured and returned.

8.3.3 CMD_SET_DESTNETID_REQ

This command serves to configure the destination network ID in addressing mode 2. Unlike the non-volatile parameter `MAC_DestNetID`, this is a volatile runtime parameter.

Format:

0x02 ***0x07*** 0x01 < 1-byte destination network ID > < CS >

Return:

0x02 ***0x47*** 0x01 < status > < CS >

Status:

0x00: success

8.3.4 CMD_SET_DESTADDR_REQ

This command serves to configure the destination address in addressing modes 1 and 2. Unlike the non-volatile parameter `MAC_DestAddrLSB` (see 9.15), this is a volatile runtime parameter.

Format:

0x02 0x08 0x01 < 1-byte destination address > < CS >

Return:

0x02 0x48 0x01 < status> < CS >

Status:

0x00: success

8.4 Modification of non-volatile parameters

The non-volatile parameters are also called user settings and are stored in a special flash location.

8.4.1 CMD_SET_REQ

This command enables direct manipulation of the parameters in the module's non-volatile memory. The respective parameters are accessed by means of the memory position described in Table 6. Access outside these memory positions is not possible by means of this function.

You can modify individual or multiple consecutive parameters in the memory at the same time.

Parameters of 2 or more bytes have to be transferred LSB first. The list and description of all accessible non volatile parameters follows in chapter 8.4.2.

A CMD_SET_REQ shall always be preceded by a CMD_GET_REQ to check whether any parameter needs a change. This is recommended to reduce the number erase-cycles on the flash which are as a matter of fact limited.

Caution: The validity of the specified parameters is not verified. Incorrect values can result in device malfunction!

Caution: To save the parameters in the flash memory of the module, the particular memory segment must first be flushed entirely and then restored from the RAM. If a reset occurs during this procedure (e.g. due to supply voltage fluctuations), the entire memory area may be destroyed. In this case, the module may no longer be operable, which means that the firmware must be re-installed via "ACC". Recommendation: First verify the configuration of the module with CMD_GET_REQ; write only if necessary.

Format:

0x02 ***0x09*** < number of bytes + 2 > < memory position > < number of bytes > < parameter > < CS >

Return:

0x02 ***0x49*** 0x01 < status > < CS >

Status:

0x00: success

0x01: invalid memory position (write access to unauthorised area > 79 / 0x4F)

0x02: invalid number of bytes to be written (write access to unauthorised area > 0x4F)

Example 1: Setting the number of wireless retries (parameter `MAC_NumRetrys`, memory position 20 according to Table 6):

0x02 ***0x09*** 0x03 0x14 0x01 < MAC_NumRetrys > < CS >

Example 2: Setting the 3 registers for the baud rate configuration (`UART_MCTL`, `UART_BR0`, and `UART_BR1`). According to Table 6, UART_MCTL has the memory position 2:

0x02 ***0x09*** 0x05 0x02 0x03 < UART_MCTL > < UART_BR0 > < UART_BR1 > < CS >

8.4.2 CMD_GET_REQ

This command can be used to query individual or multiple non-volatile parameters (see 8.4). The requested number of bytes starting from the specified memory position are returned.

You can query individual or multiple consecutive parameters in the memory at the same time. Parameters consisting of 2 or more bytes will typically be transferred LSB first order.

Format:

0x02 ***0x0A*** 0x02 < memory position > < number of bytes > < CS >

Example (query of all parameters):

0x02 ***0x0A*** 0x02 0x00 0x80 0x8A

Return:

0x02 ***0x4A*** < number of bytes + 2 > < memory position > < number of bytes > < parameter > < CS >

Write or Read access to the memory area after the parameters documented in Table 6 is blocked. The memory position and the number of bytes are limited accordingly. Thus, the last memory position that can be read out is 79 (0x4F).

9 User settings

The non-volatile parameters listed in the following table can be modified by means of specific commands in the configuration mode (CMD_SET_REQ, see 8.4) of the module or by using the Windows software "ACC". These parameters are stored permanently in the module's flash memory.

Caution: The validity of the specified parameters is not verified. Incorrect values can result in device malfunction!

Designation Designation in ACC	Summary	Permissible values	Default AMB8420 / AMB2520	Memory position	Number of bytes
UART_CTL Data format	Control register for UART data format	See description	16	0	1
UART_TCTL	Control register for the baud rate (change only after consultation)	32	32	1	1
UART_MCTL MCTL	Control register for fine-adjusting the UART baud rate; concerning the calculation, see [1]	0 - 255	0 / 68	2	1
UART_BR0 BR0	Prescaler for setting the baud rate (LSB); concerning the calculation, see [1]	0 - 255	113 / 156	3	1
UART_BR1 BR1	Prescaler for setting the baud rate (MSB); concerning the calculation, see [1]	0 - 255	2 / 0	4	1
UART_PktMode Packetizing mode	Selects the packet generation method	0 or 1	0	5	1
UART_PktSize Packet size	Number of characters for transmission start with set packet size	1 - 128	128	7	1
UART_RTSLimit /RTS limit	Number of received characters after which /RTS responds	1 - 128	112	8	1
UART_ETXChar ETX character	End-of-text character used to mark data packets; reception of this character triggers wireless transmission	0 - 255	10	9	1

Designation Designation in ACC	Summary	Permissible values	Default AMB8420 / AMB2520	Memory position	Number of bytes
UART_Timeout Timeout	Timeout after the last character before the data received via UART are transmitted via wireless transmission (in milliseconds)	0 – 65535	5	12	2
UART_DIDelay Data indication delay	Delay between the signalling by the /DATA_INDICATION pin and the start of the output via UART	0 – 65535	0	14	2
MAC_NumRetrys Retrys	Number of wireless retries	0 – 255	0	20	1
MAC_AddrMode Addressing mode	Addressing mode to use	0/1/2	0	21	1
MAC_DestNetID Dest. net ID	Default destination network ID	0 – 255	0	24	1
MAC_DestAddrLSB Dest. device address	Default destination address (LSB)	0 – 255	0	25	1
MAC_SourceNetID Local net ID	Own network ID	0 – 254	0	28	1
MAC_SourceAddrLSB Local device address	Own address (LSB)	0 – 254	0	29	1
MAC_ACKTimeout ACK timeout	Waiting time for wireless acknowledgement in milliseconds	0 – 65535	10	32	2
PHY_FIFOPrecharge FIFO precharge	Fill level of the FIFO before the transmission is launched (change only after consultation)	8 – 64	8	40	1
PHY_PAPower PA power	Transmission output; value range depends on HF configuration	0 - 255	195 / 255	41	1
PHY_DefaultChannel Default channel	Utilised wireless channel after reset; value range depends on HF configuration	0 - 255	106 / 79	42	1
PHY_CCARSSILevel CCA RSSI level	Field strength level for "channel free"	0 - 255	0	43	1

Designation Designation in ACC	Summary	Permissible values	Default AMB8420 / AMB2520	Memory position	Number of bytes
	detection (not yet supported)				
OpMode Mode	Operating mode	0.16	0	60	1
MSP_RSELx DCO resistor sel.	Start value for control loop DCO calibration after system reset (change only after consultation)	0 - 7	7	61	1
MSP_DCOCTL DCO control	Start value for control loop DCO calibration after system reset (change only after consultation)	0 - 255	110	62	1
WOR_Prescaler Prescaler	Duration of a wake-up cycle for periodic wake-ups in WOR mode	0 – 65535	4096	64	2
WOR_Countdown Countdown	Number of wake-up cycles before waking up in WOR mode	0 – 65535	5	66	2
WOR_RXOnTime RX on time	Duration of RX readiness in WOR mode	0 – 65535	1000	68	2
CfgFlags Configuration flags (hex.)	Flags for setting various properties; see 9.29	0 – 65535	0 (0x0000)	72	2
Synch1 Synch1	Synch word MSB for transceiver (change only after consultation!)	0 - 255	211	76	1
Synch0 Synch0	Synch word LSB for transceiver (change only after consultation)	0 - 255	145	77	1

Table 6 Overview of non-volatile configuration parameters

9.1 UART_CTL

The UART data format can be configured with the help of the upper 4 bits in this register. The meaning of these bits is described in Table 7.

Bit no.	Description
0 to 3 (0x0F)	Reserved, must always be set to 0.
4 (0x10)	If this bit is set, the ***character length*** will be 8 bits, if not, it will be 7 bits.
5 (0x20)	This bit selects the ***number of stop bits***. If this bit is set, 2 stop bits will be used, if not, 1 will be used.
6 (0x40)	If this bit is set, ***even parity*** will be used, if not, ***odd parity*** will be used. This bit is only used if bit 7 is set to '1'.
7 (0x80)	This bit enables the use of ***parity*** (if set).

Table 7 Setting the data format

9.2 UART_TCTL

This register selects the source for generating the UART clock speed. Currently, the only permissible value is 32.

9.3 UART_MCTL

The registers UART_MCTL, UART_BR0, and UART_BR1 can be used to set the UART baud rate. Concerning the calculation of the corresponding settings, see [1].

9.4 UART_BR0

The registers UART_MCTL, UART_BR0, and UART_BR1 can be used to set the UART baud rate. Concerning the calculation of the corresponding settings, see [1].

9.5 UART_BR1

The registers `UART_MCTL`, `UART_BR0`, and `UART_BR1` can be used to set the UART baud rate. Concerning the calculation of the corresponding settings, see [1]

9.6 UART_PktMode

Selects the method used for generating packets for the transparent operating mode. Two methods have been implemented:

0. Mode 0: Sends when
    a. the timeout defined with `UART_Timeout` is reached, or
    b. the number of bytes defined with `UART_PktSize` is reached, or
    c. the transmission of the data is requested by means of the /DATA_REQUEST pin.
1. Mode 1: Sends when

a. the character defined with `UART_ETXChar` is detected, or

b. the number of bytes defined with `UART_PktSize` has been received, or

c. the transmission of the data is requested by means of the /DATA_REQUEST pin.

Not used in the command mode.

9.7 UART_PktSize

Maximum number of bytes after which the wireless transmission of the data received via UART starts. Used in packet mode 0 as well as in packet mode 1.

Not used in the command mode.

9.8 UART_RTSLimit

Number of bytes after which the host system is prompted to interrupt the data transfer over /RTS. Necessary, because an immediate response to the /RTS signal may not take place (UART FIFO), depending on the host system.

9.9 UART_ETXChar

End-of-text character that triggers the transmission of the data received via UART. Only used in packet mode 1. During the wireless transmission, the ETX character is treated like a normal character.

Not used in the command mode.

9.10 UART_Timeout

Timeout in milliseconds after the last character has been received on UART before the wireless transmission of the data received via UART starts. Only used in packet mode 0.

In command mode, start of transmission is triggered by the well defined end of the command. The parameters UART_Timeout is used in this case to define the maximum delay between two consecutive characters. If this delay is reached (after detection of the STX character), the input buffer will be flushed.

9.11 UART_DIDelay

This parameter determines the delay in milliseconds between the signalling of incoming wireless data over the /DATA_INDICATION pin and the output of the data via UART. For example, this delay can be used to prepare a "sleeping" host system for receiving the data. From software version 3.2 also valid in the command mode.

9.12 MAC_NumRetrys

Determines the maximum number of wireless transmission retries. If this parameter is set to a value other than 0, the receiver module will automatically be prompted to send a wireless acknowledgement.

9.13 MAC_AddrMode

The following addressing modes are available:

1. No addressing (mode 0): Each module receives the transmitted HF telegram and delivers the received data to the host system via UART. No address information is transmitted in the wireless telegram.
2. 1-byte address (mode 1): The receiving module will only deliver the data to the host system via UART if the destination address configured at the sender (`MAC_DestAddrLSB`, see 9.15) corresponds to the source address (`MAC_SourceAddrLSB`, see 9.17) or the address 255 (broadcast address) was specified as destination address. Both the destination address and the source address are transmitted in the wireless telegram (total = 2 bytes).
3. 2-byte address (mode 2): The receiving module will only deliver the data to the host system via UART if both the destination network ID and the destination address correspond to the source addresses (`MAC_SourceNetID` and `MAC_SourceAddrLSB`, see 9.16 and 9.17) or the broadcast address 255 was specified as destination address. A total of 4 bytes of address information are transmitted in the wireless telegram.

Caution: The receiver and transmitter modules must be operated in the same addressing mode!

Caution: In addressing mode 0, the use of wireless acknowledgement may cause problems if several wireless modules are addressed simultaneously. In this case, all modules will simultaneously acknowledge the receipt of the package. Thus, the wireless acknowledgement cannot be received by the sending module due to the collision, and the maximum number of retries will be sent.

9.14 MAC_DestNetID

Destination network address to use in addressing mode 2 after a reset. Can be modified with the command CMD_SET_DESTNETID_REQ at runtime (volatile). If the special broadcast ID and the broadcast address are set to 255, the sender will be received by all.

9.15 MAC_DestAddrLSB

Destination address to use in addressing modes 1 and 2 after a reset. Can be modified with the command CMD_SET_DESTADDRESS_REQ at runtime (volatile). If the special broadcast

address is set to 255 (in the case of addressing mode 2, broadcast ID also 255), the sender will be received by all.

9.16 MAC_SourceNetID

Source network ID in addressing mode 2.

9.17 MAC_SourceAddrLSB

Source device address in addressing modes 1 and 2.

9.18 MAC_ACKTimeout

Time to wait for a wireless acknowledgement before a wireless retry is triggered. The values are automatically set in "ACC" depending on the configured HF data rate.

HF data rate	ACK timeout recommended
1.2 kbps	85 ms
2.4 kbps	45 ms
4.8 kbps	25 ms
10.0 kbps	15 ms
38.4 kbps	8 ms
76.8 kbps	6 ms
100.0 kbps	5 ms
250.0 kbps	5 ms

Table 8 Recommended timeouts

9.19 PHY_FIFOPrecharge

Number of bytes that are stored in the transceiver FIFO before actual transmission is launched. Required to prevent a buffer underrun for HF baud rates of more than 200 kbps. The values are automatically set in "ACC" depending on the configured HF data rate.

9.20 PHY_PAPower

HF output of the module. The maximum permissible output depends on the utilised HF configuration. The default value already represents the maximum possible output.

9.21 PHY_DefaultChannel

Determines the wireless channel to use after a module reset.

9.22 PHY_CCARSSILevel

Field strength used for "channel-free" detection (not implemented).

9.23 OpMode

Operating mode to be used after power up. Modes 0 (transparent data transfer) and 16 (command mode) can be selected here.

9.24 MSP_RSELx

Start value for a register used to set the processor speed. The speed is controlled continuously in the background. The frequency of the clock quartz is used for the calibration. The system start-up time can be optimised by means of a suitable configuration of this register (change only after consultation).

9.25 MSP_DCOCTL

Start value for a register used to set the processor speed. The speed is controlled continuously in the background. The frequency of the clock quartz is used for the calibration. The system start-up time can be optimised by suitably configuring this register (change only after consultation).

9.26 WOR_Prescaler

Defines the intervals in which the module in the sleep mode wakes up for a countdown (`WOR_Countdown`) until actual RX readiness. The interval (in seconds) is calculated as follows:

$$T_{\mathrm{Pr}escaler} = \frac{WOR\_\mathrm{Pr}escaler}{4096}$$

9.27 WOR_Countdown

Number of prescaler cycles (countdown) until the module in the WOR mode enters the RX state. The duration until automatic RX readiness is calculated as follows:

$$T_{WOR} = \frac{WOR\_NumCyles \cdot WOR\_\mathrm{Pr}escaler}{4096}$$

9.28 WOR_RXOnTime

Defines the duration in milliseconds for which the module in the WOR is RX-ready after waking up before it returns to the sleep mode.

9.29 CfgFlags

16-bit bit field in which the use of individual pins or signals can be disabled. Table 9 presents a description of the respective flags.

Bit no.	Description
0 (0x0001)	If this bit is set, the function of the ***/CONFIG*** pin will be disabled. Subsequently, the unit can no longer be switched to the command mode via this pin.
1 (0x0002)	If this bit is set, the function of the ***/DATA_REQUEST*** pin will be disabled. Subsequently, data can no longer be sent using this pin.
2 (0x0004)	If this bit is set, the detection of the ***break signal*** on the UART interface will be suppressed. Subsequently, the unit can no longer be switched to the command mode by means of such a signal.
3 (0x0008)	If this bit is set, the status of the ***SLEEP*** and ***TRX_DISABLE*** pins will be ignored. Thus, the module can no longer be set to the various power-saving modes via these pins.
4 (0x0010)	Reserved
5 (0x0020)	If this bit is set, any character will be accepted as valid ***checksum*** in the command mode.
6 (0x0040)	Reserved
7 (0x0080)	If this bit is set, the address will not be resolved. The particular module can be used as packet sniffer to monitor a wireless link (from version 3.2).
9 to 15 (0xFF00)	Reserved

Table 9 Configuration flags

Warning: If both bit 0 and bit 2 are set, the module can no longer be set to the configuration mode. In this case, access to the operating parameters is only possible with the "ACC" program.

10 Device addressing and wireless monitoring

To connect several modules to networks or to send data to specific devices, the module supports the so called address mode. The corresponding user setting parameter MAC_AddrMode determines whether all modules in range, or all modules in a network or a single module with a fixed address is supposed to receive a certain message.

The address resolution can be disabled ("packet sniffer") with bit 7 in the CfgFlags. A module configured in this way will receive all data packets and forward them to the serial interface, regardless of the addressing mode. In sniffer mode, the module does not send any acknowledgement.

11 Radio parameters

The RF parameters (data rate, usable frequency range, etc.) can be configured with the PC program "ACC". Depending on the configured data rate, it can also be used to change additional non volatile parameters, e.g. `MAC_ACKTimeout`, `PHY_DefaultChannel`, or `PHY_FIFOPrecharge`.

11.1 AMB8420

The following sections describe the permissible data rates and frequency ranges. In the factory state, the HF data rate is 38.4 kbps.

Caution: The maximum channel reservation period in the 868 MHz frequency band is subject to regulations. This period is also referred to as duty cycle (DC) and designates the maximum transmission time of a device in relation to one hour. A 1% DC, for example, permits the use of a channel for 36 seconds per hour.

11.1.1 "g1" band

This frequency band ranges from 868.0 to 868.6 MHz (channel 100 to 112) and permits a 1% duty cycle.

Channel no. \ data rate	100	101	102	103	104	105	106	107	108	109	110	111	112
4.8 kbps	868.00	868.05	868.10	868.15	868.20	868.25	868.30	868.35	868.40	868.45	868.50	868.55	868.60
10 kbps	868.00	868.05	868.10	868.15	868.20	868.25	868.30	868.35	868.40	868.45	868.50	868.55	868.60
38.4 kbps	868.00	868.05	868.10	868.15	868.20	868.25	868.30	868.35	868.40	868.45	868.50	868.55	868.60
76.8 kbps	868.00	868.05	868.10	868.15	868.20	868.25	868.30	868.35	868.40	868.45	868.50	868.55	868.60
100 kbps	868.00	868.05	868.10	868.15	868.20	868.25	868.30	868.35	868.40	868.45	868.50	868.55	868.60

Table 10 Channel table "g1" band. Permissible channels are highlighted in green

By default, the module operates at a data rate of 38.4kps.

11.2 AMB2520

In the factory state, the HF data rate is 250 kbps.

The module AMB2520 uses a channel spacing of approximately 500 kHz; the carrier frequency can be determined with the following formula:

$$F_C[MHz] = 2400.5 + (N_{Channel} \cdot 0.500)$$

Here, the channels 0 to 165 are permissible. See Table 11 for an overview of usable frequencies.

Caution: Avoid the channels/frequencies (2405 MHz + n x 13MHz) marked in red, which merely provide a reduced range due to a property of the wireless IC.

Channel no.	Freq. [MHz]	Channel no.	Freq. [MHz]	Channel no.	Freq. [MHz]	Channel no.	Freq. [MHz]
0	2400.5	41	2421.0	82	2441.5	123	2462.0
1	2401.0	42	2421.5	83	2442.0	124	2462.5
2	2401.5	43	2422.0	84	2442.5	125	2463.0
3	2402.0	44	2422.5	85	2443.0	126	2463.5
4	2402.5	45	2423.0	86	2443.5	127	2464.0
5	2403.0	46	2423.5	87	2444.0	128	2464.5
6	2403.5	47	2424.0	88	2444.5	129	2465.0
7	2404.0	48	2424.5	89	2445.0	130	2465.5
8	2404.5	49	2425.0	90	2445.5	131	2466.0
9	2405.0	50	2425.5	91	2446.0	132	2466.5
10	2405.5	51	2426.0	92	2446.5	133	2467.0
11	2406.0	52	2426.5	93	2447.0	134	2467.5
12	2406.5	53	2427.0	94	2447.5	135	2468.0
13	2407.0	54	2427.5	95	2448.0	136	2468.5
14	2407.5	55	2428.0	96	2448.5	137	2469.0
15	2408.0	56	2428.5	97	2449.0	138	2469.5
16	2408.5	57	2429.0	98	2449.5	139	2470.0
17	2409.0	58	2429.5	99	2450.0	140	2470.5
18	2409.5	59	2430.0	100	2450.5	141	2471.0
19	2410.0	60	2430.5	101	2451.0	142	2471.5
20	2410.5	61	2431.0	102	2451.5	143	2472.0
21	2411.0	62	2431.5	103	2452.0	144	2472.5
22	2411.5	63	2432.0	104	2452.5	145	2473.0
23	2412.0	64	2432.5	105	2453.0	146	2473.5
24	2412.5	65	2433.0	106	2453.5	147	2474.0
25	2413.0	66	2433.5	107	2454.0	148	2474.5
26	2413.5	67	2434.0	108	2454.5	149	2475.0
27	2414.0	68	2434.5	109	2455.0	150	2475.5
28	2414.5	69	2435.0	110	2455.5	151	2476.0
29	2415.0	70	2435.5	111	2456.0	152	2476.5
30	2415.5	71	2436.0	112	2456.5	153	2477.0
31	2416.0	72	2436.5	113	2457.0	154	2477.5
32	2416.5	73	2437.0	114	2457.5	155	2478.0
33	2417.0	74	2437.5	115	2458.0	156	2478.5
34	2417.5	75	2438.0	116	2458.5	157	2479.0
35	2418.0	76	2438.5	117	2459.0	158	2479.5
36	2418.5	77	2439.0	118	2459.5	159	2480.0
37	2419.0	78	2439.5	119	2460.0	160	2480.5
38	2419.5	**79**	**2440.0**	120	2460.5	161	2481.0
39	2420.0	80	2440.5	121	2461.0	162	2481.5

Channel no.	Freq. [MHz]	Channel no.	Freq. [MHz]	Channel no.	Freq. [MHz]	Channel no.	Freq. [MHz]
40	2420.5	81	2441.0	122	2461.5	163	2482.0
						164	2482.5
						165	2483.0

Table 11 Frequency assignment AMB2520

12 Battery powered operation

By way of the SLEEP and TRX_DISABLE pins, the module can be set to various power-saving operating states. These states are described below. Table 12 presents an overview of the available options.

	TRX_DISABLE low	TRX_DISABLE high
SLEEP low	***Active mode***, wireless and UART communication possible	***Stand-by***, only UART communication possible
SLEEP high	***WOR mode***, module wakes up and is ready to receive	***Sleep mode***, neither UART nor wireless communication possible

Table 12 Power consumption control

12.1 Active mode

In this operating state, the module is permanently ready to receive and forward data via UART or wireless transmission. The module will only switch to one of the other power-saving modes after processing any pending data transmission, i.e. /RTS must be low.

12.2 Stand-by

In this operating state, the module's transceiver is disabled. Wireless reception is not possible, but transmission of data is possible.

12.3 WOR mode

The module automatically wakes up at configurable intervals and remains ready to receive for a configurable time. In this connection, refer to the parameters `WOR_Prescaler`, `WOR_Countdown`, and `WOR_RXOnTime` (from 9.26).

12.4 Sleep mode

This is the module state with the lowest power consumption. Wireless and UART communication are not possible. The module switches to one of the other operating modes when it detects a falling edge on the SLEEP pin.

Concerning the power consumption in this operating mode, refer to the note in section 0.

13 Timing parameters

13.1 Reset behaviour

Following a reset, a low level on the /RTS pin signals that the module is ready for operation. However, the level is only valid after the time required for the internal initialisation of the processor (a couple of µs).

After this initialisation, /RTS is first set to high. Then the processor rate is calibrated on the basis of the watch crystal. Only after this procedure is the module ready for operation.

13.1.1 Power-on reset

After setting the supply voltage and releasing the /RESET pin (if wired), the period until the module is ready for operation greatly depends on the build time of the clock quartz. This procedure may take up to 1 second; typical values range from 200 to 400 ms.

Recommended procedure: Check for low level on /RTS pin 2 ms after setting the prescribed supply voltage. Subsequently, an additional 100 µs is required until readiness.

13.1.2 Reset via /RESET pin

To force a module restart by means of the /RESET pin, it must first be set to low for at least 10 ms.

After the pin is released, /RTS will switch to high after 100 µs at the latest. As the build-up time for the clock quartz does not apply in this case, the time until the module is ready for operation is reduced to a couple of ms. During this time, the processor rate will be calibrated, which takes anywhere between 2 and 20 ms depending on the supply voltage and temperature.

Recommended procedure: After the /RESET pin is released, wait for 2 ms for low level on the /RTS pin. Subsequently, an additional 100 µs are required until readiness.

13.2 Wake-up from the sleep mode

The switch-over to and from the sleep mode is also acknowledged via the /RTS signal.

Recommended procedure: After the SLEEP pin is released, wait for low level on the /RTS pin. Subsequently, an additional 100 µs are required until readiness.

13.3 Latencies during data transfer / packet generation

The data transfer is always buffered, i.e. data received via UART is buffered in the module until a specific event (see Table 2) occurs. Subsequently, the UART reception is interrupted (flow control with /RTS signal), and the payload data is passed to the internal memory of the wireless transceiver (FIFO).

The wireless transmission starts as soon as the first data is available in the transceiver memory; during the ongoing wireless transmission, the remaining payload data is transmitted piece by piece.

On the receiver side, the FIFO is read as soon as an incoming packet is detected.

In combination with a suitable packet generation method, this procedure enables the minimisation of the latencies resulting from buffering.

14 Firmware update

The firmware of the module can be updated with the PC utility "ACC" via the serial interface. If the module is not connected to a PC, the UART of the module should be made accessible, e.g. by means of suitable connectors. Only the UTDX and URXD signals are needed for this procedure.

A level converter (TTL to RS232) is required for PC connection.

14.1 Update of earlier firmware versions (< 3.0.0)

To update firmware versions prior to 3.0.0, activate the option "Update factory settings" when using "ACC". This approach ensures that the new parameters added to the factory settings of the module are also overwritten. See Figure 4.

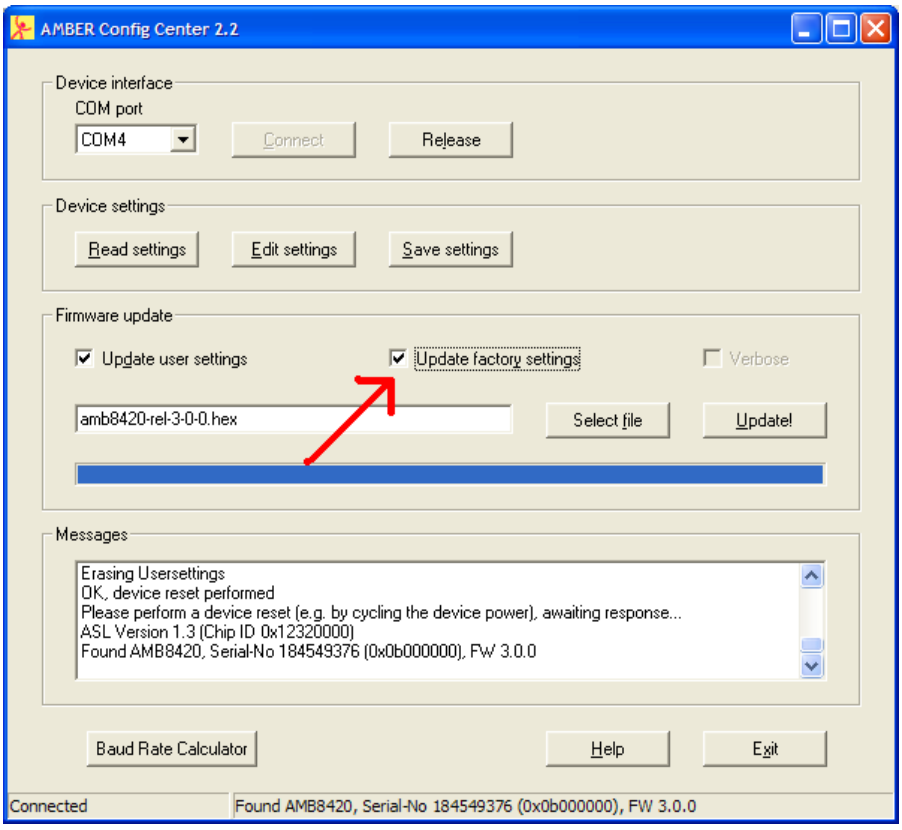


Figure 4 Firmware update for versions < 3.0.0

15 Firmware history

Version 3.0

- Product release

Version 3.1

- Bug fix "break detection"

Version 3.2

- Bug fix `UART_DIDelay` in command mode
- Sniffer mode via CfgFlags

16 Manufacturing information

16.1 Footprint dimensioning proposal

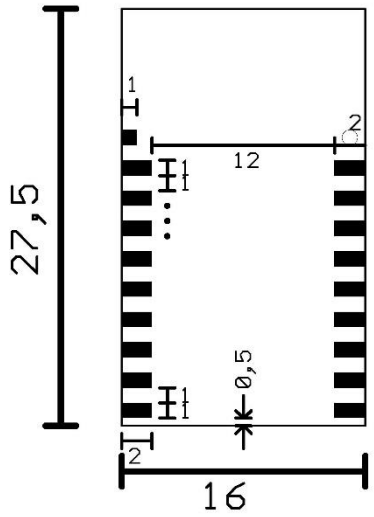


Figure 5
Dimensional drawing AMB8420

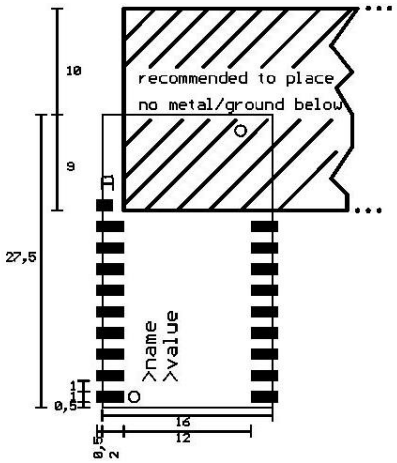


Figure 6
Proposal for footprint

Dimensions in mm. When designing the carrier board layout for AMB8420, the following must be taken into consideration:

- As shown in Figure 6, avoid having any ground or metal in the ceramic aerial area (none at all on the right side and at least 10 mm distance above if it cannot be avoided).
- The top layer of the carrier board should be kept free of tracks/vias underneath the AMB8420, as it is merely coated with solder mask (poor insulation properties) and the bottom of the AMB8420 has uncovered vias.
- Tracks should only be laid under the AMB8420 in multi-layer structures in which layer 2 serves as ground layer that shields the underlying layers.

Caution: If the spacing of 12 mm between the pad rows is not complied with, there will be a substantial short-circuit risk of VCC against GND!

17 Design in Guide

17.1 Advice for Schematic and Layout

For users with less RF experience it is advisable to closely copy the relating evaluation board with respect to schematic and layout, as it is a proven design. The layout should be conducted with particular care, because even small deficiencies could affect the radio performance and its range or even the conformity.
The following general advice should be taken into consideration:

- A clean power supply is strongly recommended. Interference, especially oscillation can severely restrain range and conformity.
- Variations in voltage level should be avoided.
- LDOs, properly designed in, usually deliver a proper regulated voltage.
- Blocking capacitors and a ferrite bead in the power supply line can be included to filter and smoothen the supply voltage when necessary.

No fixed values can be recommended, as these depend on the circumstances of the application (main power source, interferences etc.).

Frequently switching the module on and off, especially with a slowly changing voltage level of the power supply, can lead to erratic behavior, in rare cases even as far as damaging the module or the firmware. The use of an external reset IC can solve this matter.

- Elements for ESD protection should be placed on all Pins that are accessible from the outside and should be placed close to the accessible area. For example, the RF-Pin is accessible when using an external antenna and should be protected.
- ESD protection for the antenna connection must be chosen such as to have a minimum effect on the RF signal. For example, a protection diode with low capacitance such as the LXES15AAA1-100 or a 68 nH air-core coil connecting the RF-line to ground give good results.
- Placeholders for optional antenna matching or additional filtering are recommended.
- The antenna path should be kept as short as possible.

Again, no fixed values can be recommended, as they depend on the influencing circumstances of the application (antenna, interferences etc.).

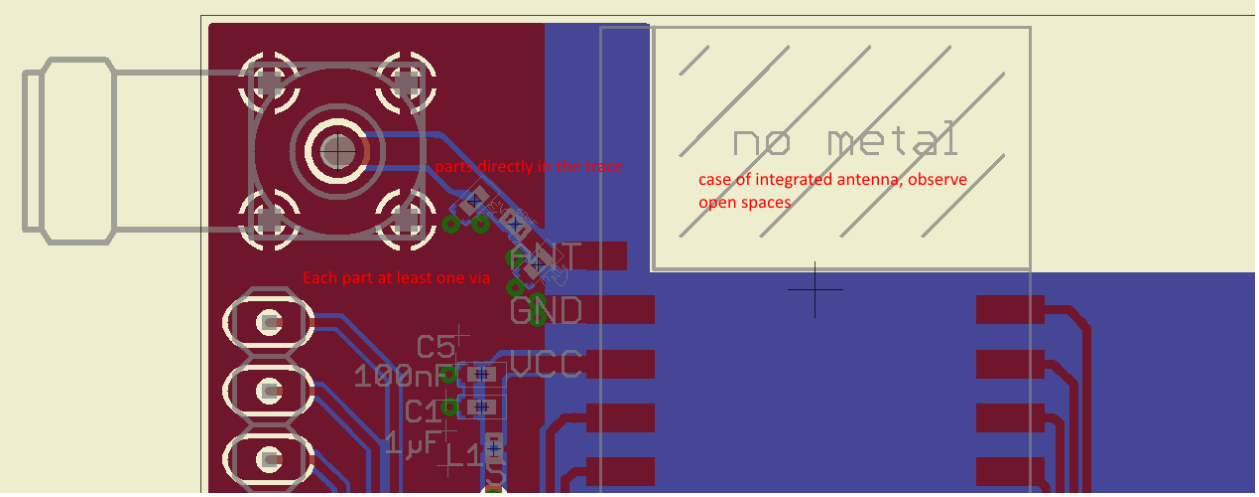


Figure 7**:** Layout

- To avoid the risk of short circuits and interference there should be no routing underneath the module on the top layer of the baseboard.

On the second layer, a ground plane is recommended, to provide good grounding and shielding to any following layers and application environment.

- In case of integrated antennas it is required to have areas free from ground. This area should be copied from the evaluation board.
- The area with the integrated antenna must overlap with the carrier board and should not protrude, as it is matched to sitting directly on top of a 1.5 mm thick PCB.
- Modules with integrated antennas should be placed with the antenna at the edge of the main board. It should not be placed in the middle of the main board or far away from the edge. This is to avoid tracks beside the antenna.
- Filter and blocking capacitors should be placed directly in the tracks without stubs, to achieve the best effect.
- Antenna matching elements should be placed close to the antenna / connector, blocking capacitors close to the module.
- Ground connections for the module and the capacitors should be kept as short as possible and with at least one separate through hole connection to the ground layer.
- ESD protection elements should be placed as close as possible to the exposed areas.

17.2 Dimensioning of the 50 Ohm microstrip

The antenna track has to be designed as a 50 Ohm feed line.

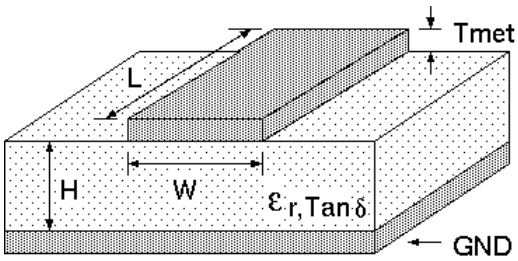


Figure 8 Dimensioning the antenna feed line as micro strip

The width W for a micro strip can be calculated using the following equation:

$$W = 1.25 \cdot \left(\frac{5.98 \cdot H}{e^{\frac{50 \cdot \sqrt{\varepsilon_r + 1.41}}{87}}} - T_{met} \right)$$

Equation 1 Parameters of the antenna feeding line

Example: a FR4 material with ε_r = 4.3, a height H = 1000 µm and a copper thickness of T_{met}= 18 µm will lead to a trace width of W ~ 1.9 mm. To ease the calculation of the Microstrip line (or e.g. a coplanar) many calculators can be found in the internet.

- As rule of thumb a distance of about 3 x W should be observed between the micro strip and other traces / ground.
- The Microstrip refers to ground, therefore there has to be the ground plane underneath the trace.
- Keep the feeding line as short as possible.

17.3 Antenna solutions

There exist several kinds of antennas, which are optimized for different needs. Chip antennas are optimized for minimal size requirements but at the expense of range, PCB antennas are optimized for minimal costs, and are generally a compromise between size and range. Both usually fit inside a housing. Range optimization in general is at the expense of space. Antennas that are bigger in size, so that they would probably not fit in a small housing, are usually equipped with a RF connector. A benefit of this connector may be to use it to lead the RF signal through a metal plate (e.g. metal housing, cabinet).
As a rule of thumb a minimum distance of Lambda/10 (3.5 cm @ 868 MHz, 1.2 cm @ 2.44 GHz) from the antenna to any other metal should be kept. Metal placed further away will not directly influence the behavior of the antenna, but will anyway produce shadowing.

Keep the antenna away from large metal objects as far as possible to avoid electromagnetic field blocking.

In the following chapters, some special types of antenna are described.

17.3.1 Lambda/4 radiator

An effective antenna is a Lambda/4 radiator. The simplest realization is an 8.6 cm long piece of wire for 868 MHz, respectively a 3.1 cm long piece of wire for 2.44 GHz. This radiator needs a ground plane at its feeding point. Ideally, it is placed vertically in the middle of the ground plane. As this is often not possible because of space requirements, a suitable compromise is to bend the wire away from the PCB respective to the ground plane. The Lambda/4 radiator has approximately 40 Ohm input impedance, therefore matching is not required.

17.3.2 Chip antenna

There are many chip antennas from various manufacturers. The benefit of a chip antenna is obviously the minimal space required and reasonable costs. However, this is often at the expense of range. For the chip antennas, reference designs should be followed as closely as possible, because only in this constellation can the stated performance be achieved.

17.3.3 PCB antenna

PCB antenna designs can be very different. The special attention can be on the miniaturization or on the performance. The benefits of the PCB antenna are their small / not existing (if PCB space is available) costs, however the evaluation of a PCB antenna holds more risk of failure than the use of a finished antenna. Most PCB antenna designs are a compromise of range and space between chip antennas and connector antennas.

17.3.4 Antennas provided by AMBER

17.3.4.1 AMB1981 – 868 MHz dipole antenna

Ideally suited for applications where no ground plane is available.

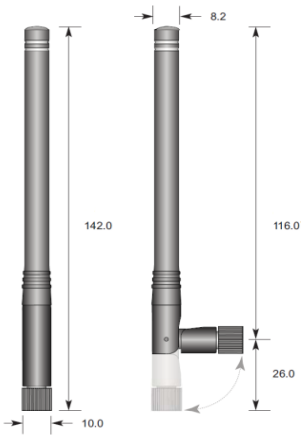


Figure 9 AMB1981:
868 MHz dipole-antenna

17.3.4.2 AMB1982 – 868 MHz magnetic base antenna

Well suited for applications where the RF is lead through a metal wall that could serve as ground plane to the antenna.

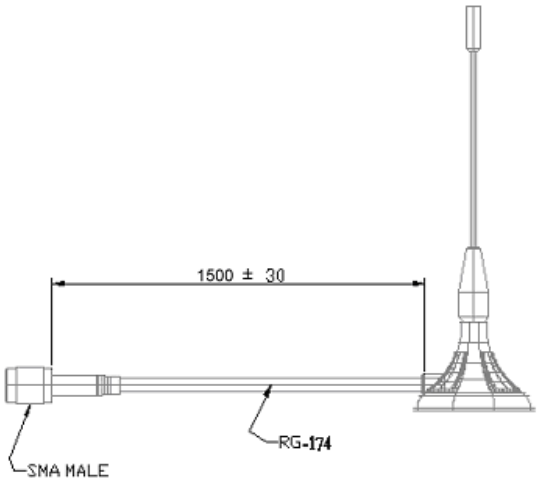


Figure 10 AMB1982: 868 MHz magnet foot antenna with 1.5 m antenna cable

The AMB1982 is a kind of Lambda/4 radiator and therefor needs a ground plane at the feeding point.

18 Manufacturing information

- The assembly contains moisture sensitive devices of the MSL classification 3. Only the dry packed Tape & Reel devices are suitable for the immediate processing in a reflow process.
- Further information concerning the handling of moisture sensitive devices, (e.g. drying) can be obtained from the IPC/ JEDEC J-STD-033.
- Recommendations for the temperature profile for the soldering furnace cannot be made, as it depends on the substrate board, the number and characteristics of the components, and the soldering paste used (consult your EMS).

Fehler! Verweisquelle konnte nicht gefunden werden. shows a soldering curve that had been used for a 31 cm2 carrier board for single-side assembly.

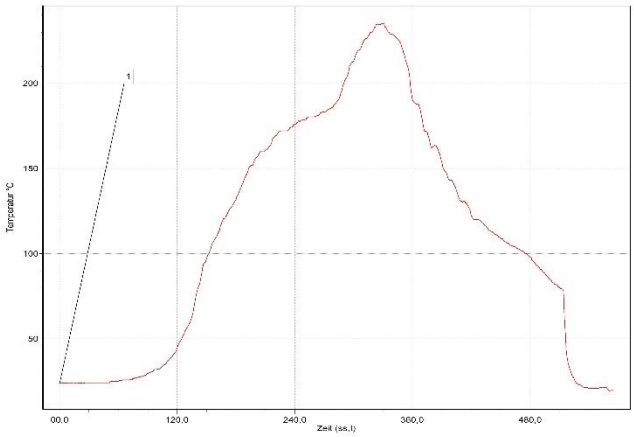


Figure 11 Example of a temperature profile

Caution: Must be adjusted to the characteristics of the carrier board!

To ensure the mechanical stability of the modules it is recommended to solder all pads of the module to the base board, even if they are not used for the application.

Caution! ESD sensitive device.
Care should be taken when handling the device in order to prevent permanent damage.

Caution! This assembly contains moisture sensitive components.
Care should be taken when processing the device according to IPC/JEDEC J-STD-033.

MSL 3

Since the module itself is not fused the voltage supply shall be fed from a limited power source according to clause 2.5 of EN 60950-1.

19 References

[1] To calculate the baud rate registers UART_MCTL, UART_BR0, and UART_BR1, the "Baud Rate Calculator" tool is integrated in ACC. To configure a standard baud rate, ACC provides a drop-down field with automatic calculation and parameterisation of the baud rate registers.

[2] "CC1101 Single-Chip Low-Cost Low-Power RF Transceiver (Rev. B)", Texas Instruments

[3] "CC2500 Single-Chip Low-Cost Low-Power RF Transceiver (Rev. B)", Texas Instruments

[4] "AMB8420 Data Sheet", AMBER wireless GmbH

[5] "AMB2520 Data Sheet", AMBER wireless GmbH

20 Regulatory compliance information

20.1 Important notice

The use of RF frequencies is limited by national regulations. The AMB8420 / AMB2520 has been designed to comply with the R&TTE directive 1999/5/EC of the European Union (EU).

The AMB8425 / AMB2520 can be operated without notification and free of charge in the area of the European Union. However, according to the R&TTE directive, restrictions (e.g. in terms of duty cycle or maximum allowed RF power) may apply.

Conformity assessment of the final product

The AMB8420 / AMB2520 is a subassembly. It is designed to be embedded into other products (products incorporating the AMB8420 / AMB2520 are henceforward referred to as "final products").

It is the responsibility of the manufacturer of the final product to ensure that the final product is in compliance with the essential requirements of the European Union's Radio & Telecommunications Terminal Equipment (R&TTE) directive.

The conformity assessment of the subassembly AMB8425 / AMB2520 carried out by AMBER wireless GmbH does not replace the required conformity assessment of the final product in accordance to the R&TTE directive!

Exemption clause

Relevant regulation requirements are subject to change. AMBER wireless GmbH does not guarantee the accuracy of the before mentioned information. Directives, technical standards, procedural descriptions and the like may be interpreted differently by the national authorities. Equally, the national laws and restrictions may vary with the country. In case of doubt or uncertainty, we recommend that you consult with the authorities or official certification organizations of the relevant countries. AMBER wireless GmbH is exempt from any responsibilities or liabilities related to regulatory compliance.

20.2 Declaration of conformity AMB8420

DECLARATION OF CONFORMITY
Directive 1999/5/EG (R&TTE)

The manufacturer: AMBER wireless GmbH
Albin-Köbis-Straße 18
51147 Köln
Tel. +49-2203-699195-0

Declares on its sole responsibility, that the following product:

Type-designation: **AMB8420 & AMB8420-1**

Intended purpose: 868MHz transceiver module
Transfer of digital messages

Satisfies all the technical regulations applicable to the product within the scope of council directives 2006/95/EC, 2004/108/EC and 99/5/EC if used for its intended purpose and in accordance with the manufacturers operating instructions and that the following norms, standards or documents have been applied:

EN 300 220-1 V2.4.1 (2012-05)
EN 300 220-2 V2.4.1 (2012-05)
EN 301 489-1 V1.9.2 (2012-10)
EN 301 489-3 V1.4.1 (2002-08)
EN 60950-1 : 2006 + A11 : 2009 + A1 : 2010
EN 62479 : 2010

Trier, 2nd of February 2014
Place and date of issue

Manufacturer/Authorized representative
Gudrun Eckhardt

20.3 Declaration of conformity AMB2520

AMBER WIRELESS

CE

DECLARATION OF CONFORMITY
Directive 1999/5/EG (R&TTE)

The manufacturer: AMBER wireless GmbH
Albin-Köbis-Straße 18
51147 Köln
Tel. +49-2203-699195-0

declares on its sole responsibility, that the following products:

Type-designation: **AMB2520**
AMB2520-1

Intended purpose: 2,4GHz wireless data modem
Transfer of digital messages

satisfie all the technical regulations applicable to the product within the scope of council directives 2006/95/EC, 2004/108/EC and 99/5/EC if used for its intended purpose and that the following norms, standards or documents have been applied:

EN 300 440-1 V1.6.1 (2010-08)
EN 300 440-2 V1.4.1 (2010-08)
EN 301 489-1 V1.9.2 (2011-09)
EN 301 489-3 V1.4.1 (2002-08)
EN 60950-1 : 2006 + A11 : 2009 + A1 : 2010
EN 62479 : 2010

Trier, 13th of September 2013
Place and date of issue

G. Eckhardt
Manufacturer/Authorized representative
Gudrun Eckhardt

21 Important information

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