Annex acc. to FCC Title 47 CFR Part 15
relating to
Würth Elektronik eiSos
2603011021001, 2603011121001

Annex no. 5
User Manual
Functional Description

Title 47 - Telecommunication
Part 15 - Radio Frequency Devices
Subpart C – Intentional Radiators
ANSI C63.4-2014
ANSI C63.10-2013

Deutsche Akkreditierungsstelle D-PL-12053-01-00

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Manual

Release 3.12

For Model

26 03 01 1 0 2 100 1 (alias AMB2220)

26 03 01 1 1 2 100 1 (alias AMB2220-1)

SW-V3.5.0

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Abbreviations and abstract

CS	Checksum	
DC	Duty cycle	Relative frequency reservation period
RF	Radio frequency	Describes everything relating to the wireless transmission
Payload		The real, non-redundant information in a frame/packet
UserSettings		Any relation to a specific entry in the UserSettings is marked in a special font and can be found in the respective chapter
UART		Universal Asynchronous Receiver Transmitter, allows to communicate with the module of a specific interface.
Duty cycle		Transmission time in relation of one hour 1% means, channel is occupied for 36 seconds per hour.
Hexadecimal	[HEX] 0xhh	All numbers beginning with 0x are stated as hexadecimal numbers. All other numbers are decimal.

1 Summary

The AMB2220 module is designed as a radio sub module for wireless communication between devices such as control systems, remote controls, sensors etc. and operates on a frequency of 2.4 GHz, the world-wide free available frequency band.

The AMB2220 can be deployed wherever the wireless exchange of small data packets between two or more parties is required, offering an extremely high range of about 1 km with integrated antenna (2 km with suitable external antenna) at a data rate of 1.5 kbps[1]. Data rates up to 12 kbps are supported, higher data rates can be developed on request.

A serial interface (UART) is available for communicating with the host system. An SPI interface can be developed on request.

The Low Power Mode allows energy consumption in sleep mode of about 1 µA. A special selectable pin can be used for wake-up purposes. If the module is not in Low Power Mode, it is always in reception over both UART and RF.

The AMB2220 has an integrated microcontroller with a specially designed stack from Würth Elektronik eiSos, with exclusive access to an integrated RF chip. The microcontroller offers enough of free space to implement customer specific applications on request.

The control of the module is made over a command interface over UART. Within this, simple commands can be sent to the module, those are processed and acknowledged. The module is operational out of the box.

[1] The effective range is strongly dependent on external circumstances as buildings, walls, general objects in the line of sight and objects in the Fresnel zone, temperature and humidity. But it also depends on the data rate and used antenna solution. The higher the data rate, the poorer the sensitivity, the poorer the range.

2 Electrical parameters

T = 25°C, Vdd = 2.5V, f = 2.4015 GHz unless otherwise specified

2.1 Operating conditions

Description	min	typ	max	unit
Supply voltage	1.9	2.5[2]	3.6	V
Temperature range	-40	25	85	°C

2.2 Current consumption

Description	min	typ	max	unit
TX current consumption at 10 dBm		37		mA
RX current consumption		9		mA
Low Power		1		µA

2.3 Radio parameters

50 Ohm tethered.

Description	min	typ	max	unit
Output power		8.9		dBm
Input sensitivity at 1.5 kbps		-115		dBm
Frequencies channel	2.4015 0		2.4775 19	GHz

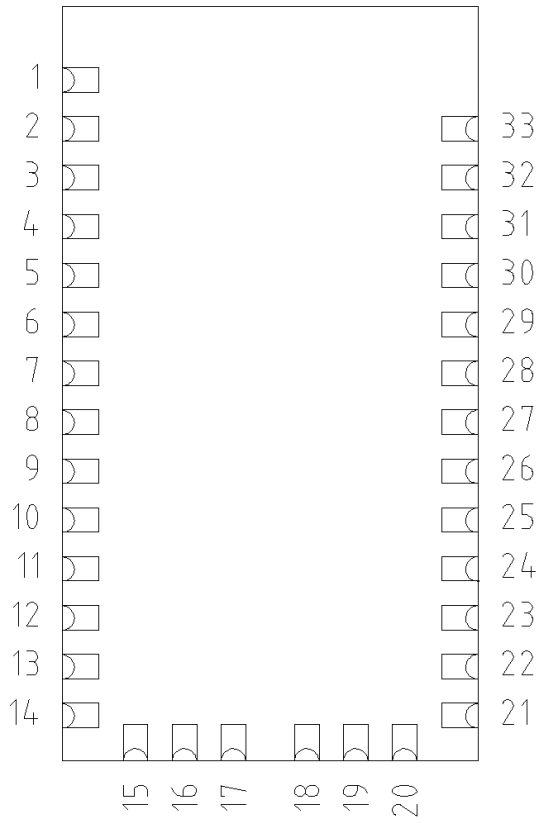
3 Dimensions and weight

Dimensions: 30.8 x 17 x 4 mm

Weight: 3g

[2] For battery powered application the use of 2.5V power supply is recommended. For supply voltages above 2.7V, the current consumption especially for low power modes rises dramatically.

4 Pinout



Pin Nr	I/O	Description
1, 3, 33	I	Ground
2	I/O	RF-Pad, for AMB2220-1, connect with 50 Ohm RF-line
4	I	BOOT0, must be selectable to GND or VCC for manual firmware update over UART. Application start-up when level is low. Has internal 10 kΩ pull down.
7	I	Power Supply, typ. 2.5V
8	I	/Reset, low active, has internal 10 kΩ pull up. Plan to leave open or pull down for HW-reset and manual firmware update.
10, 20	I	Wakeup-Pin, low active See chapter 10.
22	O	UART TX Data, for manual firmware update this line needs to be connected to a PC (using an according usb to serial converter)
23	I	UART RX Data, for manual firmware update this line needs to be connected to a PC (using an according usb to serial converter)
17	O	LED_TX, can be disabled/enabled. See chapter 8.4.6
18	O	LED_RX, can be disabled/enabled. See chapter 8.4.6
19	I	BOOT1, must be selectable to GND or VCC for manual firmware update over UART. Application start-up when level is low. Has internal 10 kΩ pull down.
Others		Reserved for coming features and production, do not connect

Figure 1: Pin Numbers

5 Serial interface

5.1 UART

5.1.1 Supported data rates

The default data rate is 9600 baud. At this data rate the module is always able to wake up from sleep without any data loss. This ensures maximal power and speed efficiency.

Since the UART speed is derived from a digitally calibrated oscillator, this may result in variations of up to ± 2 %.

5.1.2 Supported data format

The following data format is supported: *8 bits, No parity and 1 stop bit ("8N1").*

5.2 SPI

A 3 or 4 wire SPI slave interface can be developed on request.

6 Timing parameters

6.1 Reset behaviour

The module will signalize over UART with a CMD_STATUS_IND when it is ready. Until then, no UART communication should be exchanged.

A full module start-up after CMD_RESET_REQ or using the Reset-Pin can take up to 1s.

6.1.1 Power-on reset

After switching the supply voltage on and releasing the /RESET pin (if wired), the time until the module is ready for operation can last up to 1s.

6.1.2 Reset via /RESET pin

To force a module restart by means of the /RESET pin, it must first be drawn to low level for at least 10 ms and then reverting back to high level (e.g. by the internal pull-up resistor).

After going back to high level the µC will perform the start-up procedure.

During this time, the processor clock-rate will be calibrated, which takes anyway between 2 and 20 ms depending on the supply voltage and temperature.

Recommended procedure: Wait for CMD_STATUS_IND over UART after the /Reset pin is high again.

6.2 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 occurs. Subsequently, the UART reception is interrupted until the response of the module and the payload data is passed to the internal memory of the wireless transceiver.

The wireless transmission starts as soon as the complete data is available in the transceiver memory, which has to be initialized internally. The radio connection itself is a half-duplex channel based connection.

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

7 Operating mode

The module can be used in command. It reacts on commands by the host system connected over UART. The commands follow a strict scheme and mostly return a response, which can be processed by the host for connection control and timing. More information can be found in chapter 8.5.

The command mode allows quick changes of settings with minimal effort and response time.

8 UserSettings

8.1 Difference between volatile and non-volatile UserSettings

The so called UserSettings are stored permanently into the internal flash of the module. At start-up, these UserSettings are loaded into volatile settings, so called runtime settings. The user setting are accessed by the CMD_SET_REQ command. With the CMD_SET_TMP_xxx_REQ command set, these runtime settings can be changed, without changing the default UserSettings in the non-volatile memory. Possible changed values of the runtime settings are lost after the module is powered off or restarted as they are replaced by the UserSettings upon module start-up.

8.2 Factory reset

To allow experimentation and furthermore to reset the module in a known state, the UserSettings can be reset to factory defaults, which means, all UserSettings are set to default value. For the corresponding command, refer to chapter 9.2.

This factory reset must not be mixed up with the factory setting which contain e.g. Hardware Revision of the Module and the serial number and product identifier (PID).

8.3 Available UserSettings

The non-volatile settings listed in the following table can be modified by means of specific commands in the configuration mode (CMD_SET_REQ) of the module. These parameters are stored permanently in the module's flash memory. All available settings are described on the following pages.

After changing the UserSettings parameters, a reset is required before they become applied. After the reset, the new UserSettings will be loaded into the runtime settings.

The validity of the specified parameters is not verified. Incorrect values can result in device malfunction!
If RF settings are not valid, the default values are used without host or user notification.

Designation	Reference chapter	Valid range	Default value	Memory position / Offset	Size [bytes]
RF_Channel	8.4.1	0 - 19	6	0x00	1
RF_Rate	0	1 - 7	1	0x01	1
RF_Subnet	0	1 - 255	169	0x02	1
RF_Address_Source	8.4.4	0 - 255	0	0x03	1
RF_Power_Level	0	0 - 10	10	0x04	1
Cfg_Flags	8.4.6	0 - 255	9	0x05	1
UART_Baudrate	8.5	300 - 115200	9600	0x3C	4

Table 1: Overview of non-volatile UserSettings (all values are decimal)

8.4 Radio parameters

The behaviour of the radio transmitter / receiver can be influenced by selecting and/or changing RF-parameters which can be stored permanently or temporarily.

User setting	Description	Reference chapter
RF_Channel	Operating channel	8.4.1
RF_Rate	Data rate over RF	8.4.2
RF_Subnet	Division of available channels	8.4.3
RF_Address_Source	Address of current module	8.4.4
RF_Power_Level	Output power level	8.4.5

Table 2: Radio parameters description overview

The radio parameters must be chosen with caution, as they may influence conformity and/or performance. That the AMB2220 is certified means, that measured on the EV-Board all requirements of the corresponding norms (see chapter 18.2) are met.

However decisive for the end product is the real radiated power. Using the RF-pad with an external antenna it is obvious, that the radiated power depends on the selected antenna and the wiring toward, and that it is not implemented in the certification of the AMB2220. But also for the on-board chip antenna the radiated output power is influenced by the surroundings, especially metal, and also by the quality of the power supply and possible disturbances. So it has to be pointed out, that certification does only apply for the module itself, the conformity of the end product must be stated by the manufacturer of the end-product.

The frequency channels of the module can be selected from a 4 MHz raster. All channels can be used by parallel networks, as they are not overlapping, see **Figure 2**. Off course

interferences may occur when two devices are comparably close to each other (less than 2 meters)

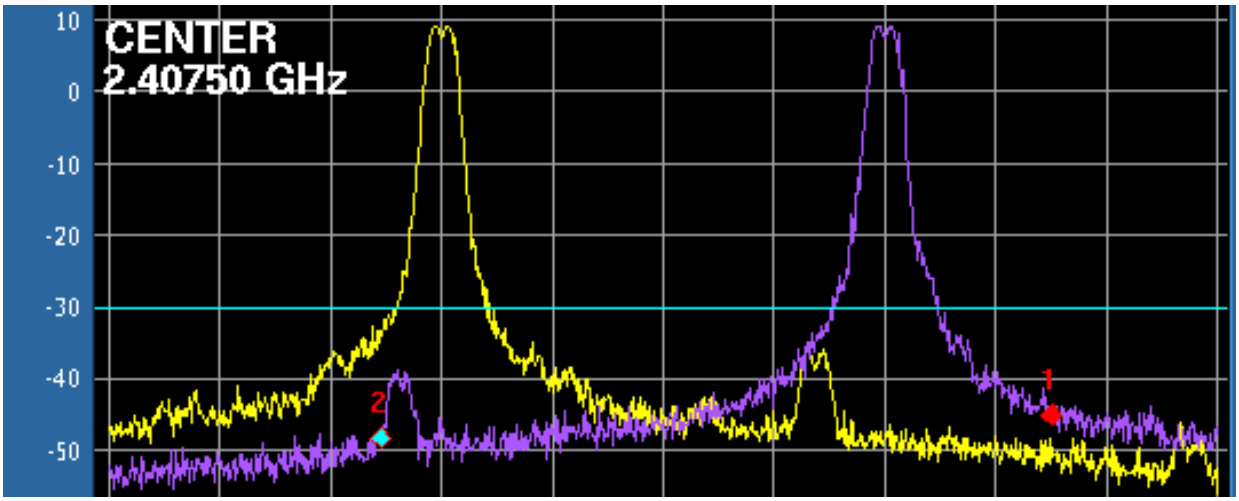


Figure 2: Spectrum of two signals next to each other, 72 kbps data rate (highest possible).

All channels meet the requirements of the EN 300 440 and may be selected with highest power settings. For generic use there are no requirements regarding a duty cycle.

8.4.1 Channel

The channel can be selected by changing the non-volatile user setting `RF_Channel`.
This value can also be temporarily changed.

Band	Channel RF_Channel	Frequency [MHz]
2400 MHz – 2483.5 MHz output power ≤ 10 dBm channel separation ≤ 4 MHz	0	2401.5
	1	2405.5
	2	2409.5
	3	2413.5
	4	2417.5
	5	2421.5
	6 (default)	**2425.5**
	7	2429.5
	8	2433.5
	9	2437.5
	10	2441.5
	11	2445.5
	12	2449.5
	13	2463.5
	14	2457.5
	15	2461.5
	16	2465.5
	17	2469.5
	18	2473.5
	19	2477.5

Table 3: RF Channel overview

8.4.2 Data rate

Data rate [kbps]	RF_Rate	Sensitivity [dBm]
1.5	**1 (default)**	**-115**
3	2	-113
6	3	-111
12	4	-107
24	5	-102
48	6	-98
72	7	-96

Table 4 : Selectable data rates

The sensitivity in the receiver is an essential parameter for the range of the module. A lower sensitivity results in a higher range.

8.4.3 Subnet

In each channel up to 248 different subnets can be defined. Only modules in the same subnet and same `RF_Channel` can communicate with each other. Inter subnet communication (i.e. a communication from one subnet “a” into another subnet “b”, where a != b) is not possible.

Caution: Using different subnets does not avoid radio collisions as it does not avoid overlaying of two signals at the same time in the same radio channel.

The default subnet parameter `RF_Subnet` is 0xA9 (decimal: 169).

This value can also be temporarily changed.

Due to hard- and software resolution, the following subnets are reserved and shall not be selected by the user!

The selected subnets are not checked by the firmware.

Hexadecimal	Decimal
0x00	0
0x30	48
0x33	51
0x63	99
0x66	102
0x92	146
0x99	153
0xCC	204

Table 5: Not allowed subnets

8.4.4 Source address

This address defines the address of the current module and it is copied into sending RF packets to identify the sender. It is also used to filter incoming RF packets (i.e. decide whether an incoming packet is supposed to be received by the current module).

To define the source address, change the user setting `RF_Address_Source` to any address in the available range. A subnet shall not contain multiple modules with the same address and in radio range to each other.

The default address is 0x00 (decimal 0).

This value can also be temporarily changed.

Remember that 0xFF (decimal 255) is the **broadcast address**.
Any module in range on that radio channel and on that same subnet will receive this packet.

8.4.5 Output power level

The output power level can be adapted through the user setting parameter `RF_Power_Level`.

This value can also be temporarily changed.

The default power level is 10 (0x0A). The given DC total current consumption includes radio IC and µC consumption.

Power level `RF_Power_Level`	Output power* [dBm]	DC total current consumption [mA]
10	8.9	33.4
9	8	26.5
8	6.8	22.95
7	5.95	20.69
6	4.59	19.2
5	3.5	18.92
4	2.6	17.39
3	1.5	15.93
2	0.9	14.01
1	-0.04	13.36
0	-1.14	12.65

* Measured in a cable-bound environment. Results may vary in customer application, different antennas and with different VCC values.

8.4.6 Cfg_Flags

8-bit field in which the use of individual pins, functions or signals can be disabled. Table 6 represents a description of the respective flags.
To use multiple settings, add the bit values (logical OR) and choose the result as value for `Cfg_Flags`.

The default value of Cfg_Flags is 0x09 (9 decimal).

Bit no.	Bit value	Description
0	0x0001 (1)	If enabled ('1'), Pin 17 outputs "high" when **transmitting** a packet (LED_TX) and Pin 16 outputs "high" when **receiving** a packet over RF (LED_RX).
1	0x0002 (2)	If enabled ('1'), the fragmentation mode is enabled (see chapter 11).
2	0x0004 (4)	Select either Pin 10 to be the WakeUp-Pin (Bit 2 to '0') or Pin 20 (Bit 2 to '1').
3	0x0008 (8)	If enabled ('1'), the reception of single packet fragments is indicated using the CMD_DATAFRAG_IND. This bit is only active if fragmentation mode is also enabled (Bit 1 of Cfg_Flags = '1').
4 to 15	0x0010 to 0x8000	Reserved, must be set to '0' to prevent conflicts in the future.

Table 6: Config Flags

8.5 UART_Baudrate

This 4-byte field defines the UART baud rate used by the module. In the `CMD_SET_REQ` it has to be entered as LSB first.

At module start-up, the default UART baud rate is used, if the configured baud rate is invalid.

8.5.1 Example: Set the UART baud rate to 115200 baud

Enter the `CMD_SET_REQ` with offset 0x3C and the value 0x0001C200 (=115200). A conversion to LSB first notation gives 0x00C20100 to be used as parameter.

Start Signal	Command	Number of Parameters + 1	Offset	Parameter	CS
0x02	**0x09**	**0x05**	**0x3C**	**0x00 0xC2 0x01 0x00**	**0xF1**

Response: Success

Start Signal	Command | 0x40	Length	Status	CS
0x02	**0x49**	**0x01**	**0x00**	**0x4A**

9 The command interface

With firmware version, 3.0.0 a new more flexible command interface was introduced.

Please note that the module performs a SW-reset if a serious error condition occurs. In this case a `CMD_STATUS_IND` is output by the UART, as it is done after each restart of the module. All volatile (“temporary”, “runtime settings”) parameters are lost and reverted to the their defaults.

9.1 Overview

The commands can be divided into three types, the requests, the responses (to a request) and the indications.
Requests are sent by the host and trigger an answer from the module, which is named “Response”.
Indications are spontaneous data packets from the module to the host, which states i.e. an incoming radio packet, they do not need an acknowledgement from the host.

The communication with the module occurs in form of predefined commands. To improve efficiency, several commands have been reduced to an absolute minimum of processing time. These commands must be sent in telegrams according to the format described in Table 7.

Start signal	Command	Length	Payload	Checksum

Table 7: Telegram format of a command packet

Start signal: 0x02 (1 byte)

Command: One of the predefined commands according to chapter 9.2 (1 byte)

Length: Number of bytes in Payload (1 byte)

Payload: Command specific payload (i.e. data to send, or parameter to configure) (Length bytes)

Checksum: *Byte wise* XOR combination of the preceding fields including the start signal, i.e. 0x02 ^ Command ^ Payload (1 byte)

The Response is stated as shown in **Table 8**.

Start signal	Command | 0x40	Length	Payload	Checksum

Table 8: Telegram format of a response

Start signal: 0x02 (1 byte)

Command | 0x40: 0x40 OR combination with the command of the request (1 byte)

Length: Length of the following Payload (1 byte)

Payload: Contains the requested information (i.e. parameter) or the status (Acknowledgement) of the previous request.

Checksum: *Byte wise* XOR combination of the preceding fields including the Start Signal, i.e. 0x02 ^ Command | 0x40 ^ Payload (1 byte)

9.2 Requests

The command interface indirectly implements a type of flow control:

There must not be two or more active commands at the same time. Therefore, the host must implement the following sequence:

- Send a command.
- Wait for the command's response or till a timeout of 1 second is hit (in case of fragmentation the timeout must be adopted to the RF bitrate thus resulting in a higher timeout of up to 5 seconds).
- A command that does not response but runs into the timeout must be handled as not received by the module. This can happen because of invalid commands, a wrong checksum or bit errors on the UART.
- Receive any `CMD_STATUS_IND` message and handle it accordingly. These spontaneous messages may also occur while waiting for a response of a previous command.

9.2.1 CMD_DATAEX_REQ

This command serves data transfer in a network with several parties. Both, the radio channel to be use and the destination address (depending on the parameterized addressing mode) are specified along with the command. **The number of payload data bytes is limited to 26 bytes.**

The two parameters radio channel and destination address will replace the currently selected temporary value in the runtime settings.

With fragmentation enabled (see chapter 11) a limit of up to 240 bytes is usable.

Format:

Start Signal	Command	Payload length +1	Addr.Target	Payload	CS
0x02	**0x01**	**1 Byte**	**1 Byte**	**Payload length**	**1 Byte**

Response:

Start Signal	Command | 0x40	Length	Status	CS
0x02	**0x41**	**0x01**	**1 Byte**	**1 Byte**

Status:

0x00: Request successfully received and processed, packet has been sent

0x01: Error during processing

9.2.2 CMD_RESET_REQ

This command triggers a software reset of the module. The reset is performed after the last bit of the response was transmitted to the host.

Format:

Start Signal	Command	Length	CS
0x02	**0x05**	**0x00**	**0x07**

Response:

Start Signal	Command | 0x40	Length	Status	CS
0x02	**0x45**	**0x01**	**1 Byte**	**1 Byte**

Status:

0x00: Request successfully received and a reset will follow this response

0x01: Error during processing

9.2.3 CMD_SET_REQ

This command enables direct manipulation of the parameters in the module's non-volatile UserSettings . The respective parameters are accessed by means of the memory positions (Offset) described in Table 1.

You can modify individual or multiple consecutive parameters in the memory at the same time. The sum of memory position and forwarded data has to be less than the total size of the UserSettings (max. 64 Bytes). Otherwise the package is not acknowledged or processed.

Parameters of 2 or more bytes (e.g. `UART_Baudrate`) have to be transferred with the least significant byte (LSB) first unless noted otherwise for a specific parameter.

The changed parameters only take effect after a restart or a reset of the module. This can be done by a `CMD_RESET_REQ`.

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

To save the parameters in the flash memory of the module, the particular memory segment must first be flushed entirely and then restored from RAM.
If a reset occurs during this procedure (e.g. due to a supply voltage drop), **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 the JTAG, SWD interface or UART Bootloader.
Recommendation: First verify the configuration of the module by reading the current settings with a `CMD_GET_REQ` and only write a `CMD_SET_REQ` if required.

Format:

Start Signal	Command	Number of Parameters + 1	Offset	Parameter	CS
0x02	**0x09**	**1 Byte**	**1 Byte**	**Num. of Bytes**	**1 Byte**

Response:

Start Signal	Command | 0x40	Length	Status	CS
0x02	**0x49**	**0x01**	**1 Byte**	**1 Byte**

Status:

0x00: Request successfully received and processed

0x01: Error during processing

9.2.4 CMD_GET_REQ

This command can be used to query individual or multiple UserSettings parameters. The requested number of bytes from the specified memory position are returned.

You can query individual or multiple consecutive parameters in the memory at the same time. The sum of the memory position and requested data must not be more than the total size of the UserSettings (max. 64 Bytes). Otherwise no response will be returned.

Parameters of 2 or more bytes will be transmitted LSB first unless noted otherwise in their parameter description.

Format:

Start Signal	Command	Length	Offset	Number of Parameters	CS
0x02	**0x0A**	**0x02**	**1 Byte**	**1 Byte**	**1 Byte**

Response:

Start Signal	Command | 0x40	Number of Parameters +1	Offset	Parameter	CS
0x02	**0x4A**	**1 Byte**	**1 Byte**	**Num. of Parameters**	**1 Byte**

9.2.5 CMD_SERIALNO_REQ

This command can be used to query the individual serial number and product ID (PID) of the module.

Format:

Start Signal	Command	Length	CS
0x02	**0x0B**	**0x00**	**0x09**

Response:

Start Signal	Command | 0x40	Length	PID	Serial Number (MSB first)	CS
0x02	**0x4B**	**0x04**	**1 Byte**	**3 Bytes**	**1 Byte**

9.2.6 CMD_FWVERSION_REQ

This command is used to request the firmware version of the module. The main version number is returned first, followed by the secondary version number and the revision number.

Format:

Start Signal	Command	Length	CS
0x02	**0x0C**	**0x00**	**0x0E**

Response:

Start Signal	Command | 0x40	Length	Firmware Version	CS
0x02	**0x4C**	**0x03**	**3 Bytes**	**1 Byte**

9.2.7 CMD_RSSI_REQ

This command returns the RX level of the last received packet determined by the transceiver IC in the form of a signed two's complement. The relationship between the applied RF power, P_{IN} at the antenna pin and the value given by the RSSI can be expressed as:

P_{IN} [dBm] = -120 dBm + RSSI byte * 8dBm , for -105 dBm < P_{IN} < -60 dBm

If no packet was received yet the return value will be 0x00.

Due to this, the RSSI level has a resolution of 8 dBm. The accuracy of the RSSI is not guaranteed, and is provided for test purpose only.

Format:

Start Signal	Command	Length	CS
0x02	**0x0D**	**0x00**	**0x0F**

Response:

Start Signal	Command | 0x40	Length	RSSI	CS
0x02	**0x4D**	**0x01**	**1 Byte**	**1 Byte**

9.2.8 CMD_FACTORYRESET_REQ

This command resets all UserSettings to its factory settings. This command automatically initiates a restart, which means that all temporary and non-volatile settings are lost.

Format:

Start Signal	Command	Length	CS
0x02	**0x11**	**0x00**	**0x13**

Response:

Start Signal	Command | 0x40	Length	Status	CS
0x02	**0x51**	**0x01**	**1 Byte**	**1 Byte**

Status:

0x00: Request successfully received and processed

0x01: Error during processing (No reset neither)

9.2.9 CMD_BOOTLOADER_REQ

This command resets the module and starts the internal Bootloader, such that a new firmware can be flashed (see chapter 14).

To start the AMB2220 application after this command has been used, a reset is required (using the RESET Pin).

Format:

Start Signal	Command	Length	CS
0x02	**0x12**	**0x00**	**0x10**

Response:

Start Signal	Command | 0x40	Length	Status	CS
0x02	**0x52**	**0x01**	**1 Byte**	**1 Byte**

Status:

0x00: Request successfully received and processed, Bootloader can be accessed after automatic reset

0x01: Error during processing

9.2.10 CMD_SET_TMP_CHANNEL_REQ

This command changes the runtime setting of the RF channel to a specific value.

This will not change the UserSettings which means, this setting is lost when the module is restarted.

The channel byte is valuable from ‘0x00’ (0) to ‘0x13’ (19). Check Table 3 for more information about the channel assignment.

Format:

Start Signal	Command	Length	Channel	CS
0x02	**0x20**	**0x01**	**1 Byte**	**1 Byte**

Response:

Start Signal	Command | 0x40	Length	Status	CS
0x02	**0x60**	**0x01**	**1 Byte**	**1 Byte**

Status:

0x00: Request successfully received and processed

0x01: Error during processing

9.2.11 CMD_SET_TMP_S_ADDR_REQ

This command changes the runtime setting source address to a specific value.

This will not change the UserSettings which means, this setting is lost when the module is restarted.

The address source byte is valuable from ‘0x00’ (0) to ‘0xFE’ (254), 0xFF (255) is the broadcast address which shall not be used as a source address.

Format:

Start Signal	Command	Length	Addr. Source	CS
0x02	**0x21**	**0x01**	**1 Byte**	**1 Byte**

Response:

Start Signal	Command | 0x40	Length	Status	CS
0x02	**0x61**	**0x01**	**1 Byte**	**1 Byte**

Status:

0x00: Request successfully received and processed

0x01: Error during processing

9.2.12 CMD_SET_TMP_SUBNET_REQ

This command changes the runtime setting of the RF subnet to a specific value.

This will not change the UserSettings which means, this setting is lost when the module is restarted.

The subnet byte is valuable from ‘0x00’ (0) to ‘0xFF’ (255), but due to restrictions of the RF chip, the following subnets cannot be used:

0x00 (0), 0x30 (48), 0x33 (51), 0x63 (99), 0x66 (102), 0x92 (146), 0x99 (153) and 0xCC (204).

Format:

Start Signal	Command	Length	Subnet	CS
0x02	**0x22**	**0x01**	**1 Byte**	**1 Byte**

Response:

Start Signal	Command | 0x40	Length	Status	CS
0x02	**0x62**	**0x01**	**1 Byte**	**1 Byte**

Status:

0x00: Request successfully received and processed

0x01: Error during processing

9.2.13 CMD_SET_TMP_PWRLVL_REQ

This command changes the runtime settings of the RF power level to a specific value.

This will not change the UserSettings which means, this setting is lost when the module is restarted.

The power level byte is valuable from ‘0x00’ (0) to ‘0x0A’ (10).

Format:

Start Signal	Command	Length	Power Level	CS
0x02	**0x23**	**0x01**	**1 Byte**	**1 Byte**

Response:

Start Signal	Command | 0x40	Length	Status	CS
0x02	**0x63**	**0x01**	**1 Byte**	**1 Byte**

Status:

0x00: Request successfully received and processed

0x01: Error during processing

9.2.14 CMD_SET_OPMODE_REQ

This command lets the module enter the Low Power Mode (LPM). For further information about the LPM, see chapter 10.

Format:

Start Signal	Command	Length	LPM	CS
0x02	**0x28**	**0x01**	**0x01**	**0x2A**

Response:

Start Signal	Command | 0x40	Length	Status	CS
0x02	**0x68**	**0x01**	**0x01**	**0x6A**

9.3 Indications

9.3.1 CMD_DATAEX_IND

This indication occurs when a valuable radio packet has been received, successfully processed and assigned. It returns all information of the RF packet. No validation from the host is needed. This indication represents the opposite of `CMD_DATAEX_REQ`.

The received RSSI byte has to be interpreted as followed:

P_{IN} [dBm] = -120 dBm + RSSI byte * 8dBm , for -105 dBm < P_{IN} < -60 dBm

Due to restrictions of the RF chip, the RSSI level has a resolution of 8 dBm.

The field Addr. Source contains the source address from the radio frame, that was selected by the sender of this frame.

Format:

Start Signal	Command	Payload Length + 2	Addr. Source	Payload	RSSI	CS
0x02	**0x81**	**1 Byte**	**1 Byte**	**Payload Length**	**1 Byte**	**1 Byte**

9.3.2 CMD_DATAFRAG_IND

This indication occurs when a valuable radio packet fragment has been received successfully. It returns the address of the sending device (Addr. Source), the sequence number of the RF packet, the fragment number of the current RF packet and the fragment number of the last RF packet that has to be received to complete the full RF packet.

This message can enabled or disabled using the `Cfg_Flags`.

The full RF packet is indicated using the `CMD_DATAEX_IND` as soon as the last packet fragment has been received.

Format:

Start Signal	Command	Length	Addr. Source	Sequence Number	Fragment Number	Number of last Fragment	CS
0x02	**0x82**	**0x04**	**1 Byte**	**1 Byte**	**1 Byte**	**1 Byte**	**1 Byte**

If a `CMD_DATAFRAG_IND` has been received, we strongly recommend to wait for the packet completion before performing other actions with the module. The module reception has been completed as soon as `CMD_DATAEX_IND` was sent to the host or the timeout occurred.

In case of error, e.g. if one or several packet fragments have been lost during transmission and thus no `CMD_DATAEX_IND` was sent, the module reverts to operate in normal mode after 500ms.

9.3.3 CMD_STATUS_IND

This indication shows the current state of the module, when module enters or leaves Low Power Mode (LPM).

Format:

Start Signal	Command	Payload Length	Status	CS
0x02	**0xC0**	**0x01**	**Payload Length**	**1 Byte**

Status:

0x00: Run mode

0x01: Low Power Mode

10 Low power mode (LPM)

This mode sets the module into a sleep deep mode, where it consumes as few as possible energy. To enter this mode, it is necessary to give the module the right command `CMD_SET_OPMODE_REQ`. In this mode, the module is completely unresponsive to external influences. The only way to wake up the module is by giving *a falling edge* to the WakeUp-pin, which is either Pin 10, or Pin 20, depending on the user setting `Cfg_Flags`.

When the module is not in Low Power Mode, it is in Run Mode.

11 Fragmentation mode

In normal mode the payload of a data packet can be maximal 26 bytes. To allow the transmission of larger data packets the fragmentation mode was introduced (enabling via `Cfg_Flags`, see Chapter 8.4.6). Using this mode data packets up to 240 bytes can be transmitted by splitting the data packet into fragments and sending the fragments of appropriate size one after each other. On the receiver side, the packet fragments are detected and combined to the full packet after all data fragments have been received successfully.

To experience maximum flexibility the user shall prefer implementing the fragmentation in his host and use the 26 byte MTU (maximum transfer unit).

Sender:

The time needed to send a fragmented packet consists of the time the single fragments are transmitted (see τ in chapter 12) plus the timeouts between the single transmissions. After the successful transmission a response on the `CMD_DATAEX_REQ` is printed via UART.

Receiver:

Depending on the `Cfg_Flags` a `CMD_DATAFRAG_IND` message is sent via UART indicating the reception of single packet fragments to inform the user to wait for the packet completion.

To be able to send and receive fragmented packets over RF both the sending and receiving device have to operate in fragmentation mode. Devices not in fragmentation mode will discard RF packets that are fragmented.

In fragmentation mode there is a much higher probability of RF packet collisions. If one or several fragments are lost during transmission, the whole data packet is discarded.

12 Duty cycle

The fragmentation mode allows the transmission of larger data packets over RF. Thus there is an increased risk of exceeding the duty cycle, if existent. The time τ [s] the channel is blocked when sending a complete packet containing ρ bytes using the data rate δ [kbps] can be calculated as:

$$\tau = \left(\left\lceil \frac{\rho}{24} \right\rceil \times 40 \times 8\right) / (1000 \times \delta)$$

A packet with maximum size of 240 bytes would need 2.13 s, when sending it in fragmentation mode using the lowest data rate of 1.5 kbps. This means, with a duty cycle of 1% (36s per hour), only 16 packets of maximum size could be sent without violation of the duty cycle restrictions.

13 Quick Start

Please note that the AMB2220 (firmware version 3.0 or newer) are not RF-compatible with modules using older firmware versions (2.x or 1.x).

13.1 Setup

To start communication between network participants, make sure the participants are set up equally (but the setting of source address in case directed messages shall be used):

- Out of the box, all the modules are set up in factory settings and are ready to use. To reset to factory settings, use the command `CMD_FACTORYRESET_REQ`.
- The send procedure can be started using the command `CMD_DATAEX_REQ`. The receiving module/s will state the incoming packet with a `CMD_DATAEX_IND`.
- To change settings temporarily (until next reset of module), use the command `CMD_SET_TMP_xxx_REQ`. Make sure, receiver and sender are using the same channel and the same subnet. Make sure, the sending packet has the right receiving address.
- Use the following examples to start the communication.

13.2 Start-up example

The following set up is needed:

- Both network partners are out of the box set to default settings, so that both modules have the same default address. This should be changed at start-up.
- Both modules are connected to a respective host over UART. This can for example be a PC which has a terminal program running and the respective COM port opened (in case that the module is attached to the right converter as in the AMB2220-EV). Otherwise, this can be a separate microcontroller.
- Both modules must be set up in a valid range, at least with a distance of 1 meter, and power supplied.

UART parameters need to be set to 9600 baud 8n1 (see chapter 5).

As the module is reacting on commands, both AMB2220 are now in receiving mode (both RF and UART). We first give the receiver the new address “2”, changing the respective user setting with offset 3 and the size of 1 byte (see **Table 1**).

- Use `CMD_SET_REQ` with the parameters: (see 9.2.3) from Host 2 to receiver

Start Signal	Command	Number of Parameters + 1	Offset	Parameter	CS

0x02	**0x09**	**0x02**	**0x03**	**0x02**	**0x08**

- Over UART to Host 2, we get the response

Start Signal	Command | 0x40	Length	Status	CS
0x02	**0x49**	**0x01**	**0x00**	**0x4A**

which states that the transmission over UART was right and the user setting has been set right.

- Now we reset the module for applying this change (see chapter 8.1). For the reset, we either use the Reset-Pin or the command `CMD_RESET_REQ`

Start Signal	Command	Length	CS
0x02	**0x05**	**0x00**	**0x07**

- As response, we get the acknowledgement

Start Signal	Command | 0x40	Length	Status	CS
0x02	**0x45**	**0x01**	**0x00**	**0x46**

- To make sure that the user setting has been set correctly, we can check this using the CMD_GET_REQ (see 9.2.4)

Start Signal	Command	Length	Offset	Number of Parameters	CS
0x02	**0x0A**	**0x02**	**0x03**	**0x01**	**0x08**

- So we get the response:

Start Signal	Command | 0x40	Number of Parameters +1	Offset	Parameter	CS
0x02	**0x4A**	**0x02**	**0x03**	**0x02**	**0x4B**

and we know that the parameter on offset 0x03 is “2”, the source address we wanted to plant.

- We can now start the communication with the module named sender over Host 1 using `CMD_DATAEX_REQ` with the parameters “2” for the target address which we just set, and a payload up to 26 byte, for example “HELLO”. It should be remarked that the packet over RF is always 26 bytes of size as the RF chip only supports fixed size packets.
Of course we have to convert ASCII letters “HELLO” in a binary way which gives the following bytes:
0x48 0x45 0x4C 0x4C 0x4F

Start Signal	Command	Payload length +1	Addr.Target	Payload	CS
0x02	**0x01**	**0x06**	**0x02**	**0x48 45 4C 4C 4F**	**0x45**

- As a result, we get an response from the sender (Host 1)

Start Signal	Command | 0x40	Length	Status	CS
0x02	**0x41**	**0x01**	**0x00**	**0x42**

- At the same time, the receiver (Host 2) gets the packet, evaluates it, checks the address checksums and states the incoming packet over UART with an `CMD_DATAEX_IND`:

Start Signal	Command	Payload Length + 2	Addr. Source	Payload	RSSI	CS
0x02	**0x81**	**0x07**	**0x00**	**0x48 45 4C 4C 4F**	**0x09**	**0xCF**

Note: the RSSI value is dependent on your setup such as the used RF output power distance between Host 1 and Host 2 and antenna setup.

14 Firmware update

To update the firmware of the AMB2220 the internal Bootloader of the STM32 microcontroller or the SWD interface (together with an according Flasher hardware) has to be used.

The memory area of the factory settings must not be deleted or overwritten during a firmware-update:

```
Factorysetting start address (in EEPROM) 0x0808 0000
Factorysetting stop address (in EEPROM)  0x0808 001F
```

14.1 Using the STM32 UART bootloader

Please refer to ST Microelectronic Application Notes AN3155 and AN2606 for Bootloader commands and syntax in case you plan your own implementation of accessing the Bootloader. The UART baud rate in Bootloader mode can be selected between 1200 and 115200 baud, “8E1”. We recommend 115200 baud.

To use the internal Bootloader the following pins need to be accessible with different logic levels:

- **BOOT0** (can be neglected for firmware 2.0.0)
- **BOOT1** (can be neglected for firmware 2.0.0)

BOOT0	BOOT1	Function
0 (GND)	**0 or 1**	**Normal start-up, the firmware starts**
1 (VCC)	0 (GND)	Bootloader starts after a reset, a new firmware can be flashed over UART1 and the ST Bootloader Protocol.

- **RESET** needs to be pulled to GND for a short time (>10ms) to perform a reset of the device
- **UART1_RX**, needs to be connected to a PC by means of a TTL to USB-Converter, e.g. “FTDI TTL-232R-3V3”
- **UART1_TX**, needs to be connected to a PC by means of a TTL to USB-Converter

If a firmware 2.0.0 or newer is currently running on the AMB2220 the command `CMD_BOOTLOADER_REQ` is available and can be used to reboot the internal microcontroller so that the Bootloader is selected without using BOOT0 and BOOT1 and the RESET pins. After receiving the confirmation bytes the Bootloader is selected and can be started using the so called “USART Bootloader code sequence” (see AN3155).

You can find the reference PC implementation of ST on the ST Homepage under the part number **“**STSW-MCU005”.

An easy-to-use AMBER implementation of STM32 Firmware Updater optimized for AMB2220 is available through our homepage (account needed). This software will prevent the factory settings to be changed as well as it supports access to the UserSettings over a GUI.

14.2 Firmware update using SWD

Please refer to the AMB2220 evaluation board manual for a reference design with SWD connector.

We recommend using a SEGGER J-Link hardware for flashing the device.

The microcontroller-type to be connected to is a ST Microelectronics STM32L151CB.

14.3 Risks of a firmware update

If the firmware update procedure fails the microcontroller can end in a state where the application (in our case the AMB2220 firmware) is no longer working (due to erased or wrong written memory segments).

In this case only a firmware-update using BOOT0 + BOOT1 + RESET or the SWD update can be performed to access the module's Bootloader again.

This is the reason why we strongly recommend to have the BOOT0, BOOT1, RESET, UART_TX and UART_RX pins accessible to be switched to alternative levels or functions.

15 Hardware integration

15.1 Measures

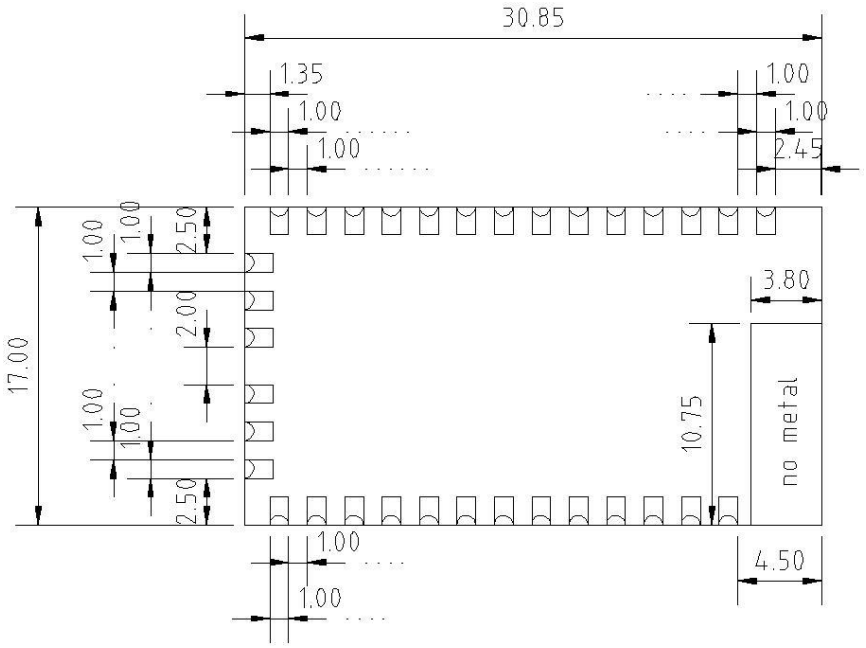


Figure 3: Dimensions [mm]

15.2 Footprint

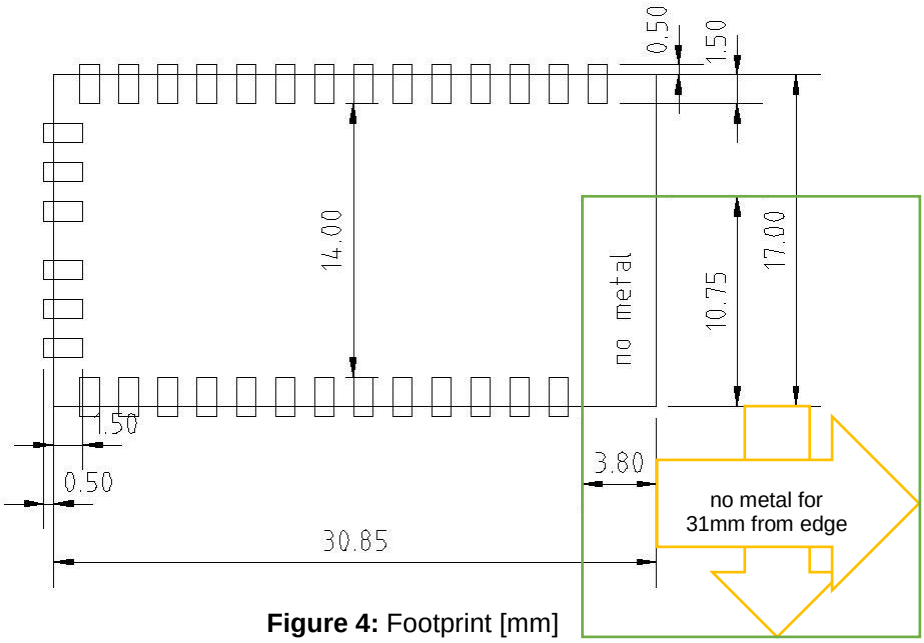


Figure 4: Footprint [mm]

To avoid the risk of short circuits between VCC (or signal lines) and GND, a minimum clearance of at least 14 mm between the opposing pad rows has to be maintained respectively the pads must not be elongated underneath the module.

Underneath the radio module the top layer of the motherboard should be kept free from tracks and vias due to the fact that the module's bottom side is only covered with solder resist with no specified isolation properties, and the vias are not covered at all.

15.3 General advice for schematic and layout

For less experienced RF users 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 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.).

- 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.

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

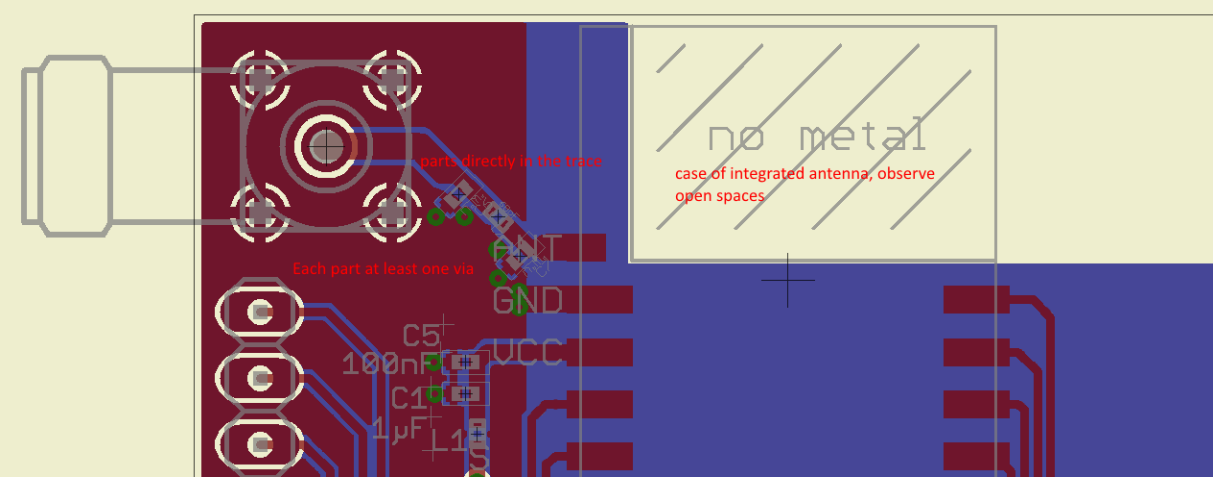


Figure 1: Layout

- To avoid the risk of short circuits and interference there should be no routing underneath the module on the top layer of the printed circuit board.
- 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 be placed directly on top of a 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 being placed 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 and 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.

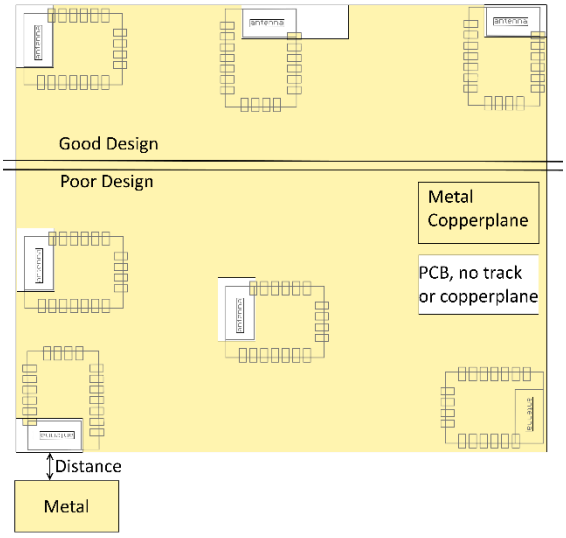


Figure 2: Placement of the module

15.4 Antenna connection

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

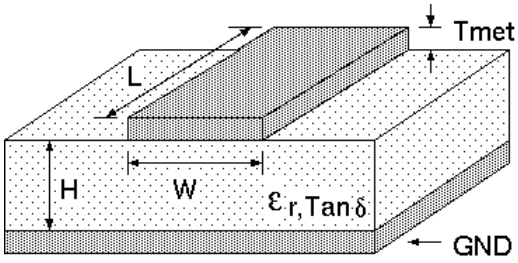


Figure 5 Dimensioning the antenna feed line as micro strip

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 micro strip 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 micro strip refers to ground, therefore there has to be the ground plane underneath the trace.
- Keep the feeding line as short as possible.

15.5 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 λ /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 behaviour of the antenna, but will never the less 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.

15.5.1 Lambda/4 radiator

An effective antenna is a λ/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 λ/4 radiator has approximately 40 Ohm input impedance, therefore matching is not required.

15.5.2 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.

15.5.3 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 minimal (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.

15.5.4 Antennas provided by AMBER

15.5.4.1 AMB1926

The AMB1926 is a 2.4 GHz antenna with SMA connection and swivel base.

16 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). Jedec J-STD-020 should be considered.
- **Figure 6** shows a soldering curve that had been used for a 31 cm^2 carrier board for single-side assembly.

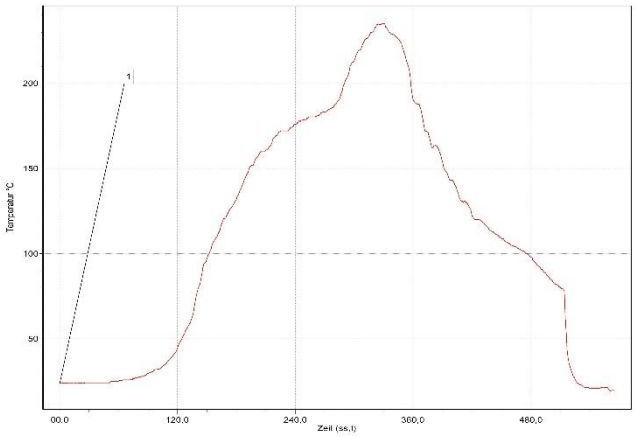


Figure 6 Example of a temperature profile –
Caution: Must be adjusted to the characteristics of the carrier board!

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

Caution! ESD sensitive device.

Precaution should be taken when handling the device in order to prevent permanent damage.

MSL 3

Caution! This assembly contains moisture sensitive components.

Precaution should be taken when processing the device according to IPC/JEDEC J-STD-033.

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

17 Firmware history

Version	Date	Description
1.0.0	02/15	• First release
2.0.0	09/15	• Better transmission reliability, thus payload size decreased to 26 bytes • New command CMD_BOOTLOADER_REQ • Firmware version 2.0.0 is not RF-compatible to 1.0.x
3.0.0	10/15	• New command interface, incompatible to firmware before 3.0.0 • Introduced the fragmentation mode to send larger packets • CFG Flags updated • Broadcast address changed from 0x01 to 0xFF
3.1.1	11/16	• New power levels (default is still maximum) • Bugfix in length field of CMD_DATAEX_IND
3.2.2	1/17	• Added the user setting `UART_Baudrate` that determines the UART baud rate of the module
3.3.0	3/17	• Added higher RF data rates • Improved internal timings resulting in faster data processing • Reduced sleep current to about 1µA
3.5.0	9/17	• Ported to default firmware design scheme • Optimisations in RAM requirements and timings • Minor bug fixes • Added temperature calibration for the radio tx power and radio frequency

18 Regulatory compliance information

18.1 Important notice

The use of RF frequencies is limited by national regulations. The AMB2220 has been designed to comply with the Radio Equipment Directive 2014/53/EU of the European Union (EU).

The AMB2220 can be operated without notification and free of charge in the area of the European Union. However, according to the RED, restrictions (e.g. in terms of duty cycle or maximum allowed RF power) may apply.

Conformity assessment of the final product

The AMB2220 is a subassembly. It is designed to be embedded into other products (products incorporating the AMB2220 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 Equipment Directive.

The conformity assessment of the subassembly AMB2220 carried out by Würth Elektronik eiSos does not replace the required conformity assessment of the final product in accordance to the RED.

Exemption clause

Relevant regulation requirements are subject to change. Würth Elektronik eiSos 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. Würth Elektronik eiSos is exempt from any responsibilities or liabilities related to regulatory compliance.

18.2 Declaration of Conformity

AMBER WIRELESS

CE

EU DECLARATION OF CONFORMITY

Radio equipment: **AMB2220**

The manufacturer: AMBER wireless GmbH
Rudi-Schillings-Straße 31
54296 Trier
+49 651 99355 0

This declaration of conformity is issued under the sole responsibility of the manufacturer.

Object of the declaration: **AMB2220**

Intended purpose: 2.4GHz wireless data module
Transfer of digital messages

The object of the declaration described above is in conformity with the relevant Union harmonisation legislation: Directive 2014/53/EU and 2011/65/EU.
Following harmonised norms or technical specifications have been applied:

EN 300 440 V2.1.1 (2017-03)
EN 301 489-1 V2.2.0 (draft)
EN 301 489-3 V2.1.1 (final draft)
EN 62479: 2010
EN 60950-1: 2006 + A11: 2009 + A1: 2010 + A12: 2011
+ AC : 2011 + A2 : 2013

Trier, 22th of November 2017
Place and date of issue

18.3 FCC Compliance statement

FCC ID: R7TAMB2220

This device complies with Part 15 of the FCC Rules.

Operation is subject to the following two conditions:

(1) this device may not cause harmful interference, and

(2) this device must accept any interference received, including interference that may cause undesired operation.

(FCC 15.19)

Modifications (FCC 15.21)

Caution: Changes or modifications for this equipment not expressly approved by Würth Elektronik eiSos may void the FCC authorization to operate this equipment.

18.4 IC Compliance statement

Certification Number: 5136A-AMB2220

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

18.5 FCC and IC Requirements to OEM integrators

This module has been granted modular approval. OEM integrators for host products may use the module in their final products without additional FCC / IC (Industry Canada) certification if they meet the following conditions. Otherwise, additional FCC / IC approvals must be obtained.

The host product with the module installed must be evaluated for simultaneous transmission requirements.

- The users manual for the host product must clearly indicate the operating requirements and conditions that must be observed to ensure compliance with current FCC / IC RF exposure guidelines.
- To comply with FCC / IC regulations limiting both maximum RF output power and human exposure to RF radiation, the maximum antenna gain including cable loss in a mobile-only exposure condition must not exceed 2dBi.
- A label must be affixed to the outside of the host product with the following statements:

This device contains FCCID: R7TAMB2220

This equipment contains equipment certified under ICID: 5136A-AMB2220

The final host / module combination may also need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device.

If the final host / module combination is intended for use as a portable device (see classifications below) the host manufacturer is responsible for separate approvals for the SAR requirements from FCC Part 2.1093 and RSS-102.

OEM Requirements:

The OEM must ensure that the following conditions are met.

- End users of products, which contain the module, must not have the ability to alter the firmware that governs the operation of the module. The agency grant is valid only when the module is incorporated into a final product by OEM integrators.
- The end-user must not be provided with instructions to remove, adjust or install the module.
- The Original Equipment Manufacturer (OEM) must ensure that FCC labeling requirements are met. This includes a clearly visible label on the outside of the final product. Attaching a label to a removable portion of the final product, such as a battery cover, is not permitted.

The label must include the following text:

Contains FCC ID: R7TAMB2220

The enclosed device complies with Part 15 of the FCC Rules. Operation is subject to

the following two conditions: (i.) this device may not cause harmful interference and

(ii.) this device must accept any interference received, including interference that may cause undesired operation.

When the device is so small or for such use that it is not practicable to place the statement above on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

The user manual for the end product must also contain the text given above.

- Changes or modifications not expressly approved could void the user's authority to operate the equipment.
- The OEM must ensure that timing requirements according to 47 CFR 15.231(a-c) are met.
- The OEM must sign the OEM Modular Approval Agreement with xxxxx
- The module must be used with only the following approved antenna(s).

18.6 AMB2220 & AMB2220-1

The module variants HVIN AMB2220 and AMB2220-1 collected in the PMN AMB2220 are identical in enclosure, appearance, PCB design and bands/technologies.

The only difference is, that in AMB2220 an integrated Chip Antenna is used and for the AMB2220-1 an external λ/4 Antenna is used.

19 Important information

19.1 Exclusion of liability

Würth Elektronik eiSos presumes that the information in this document is correct at the time of publication. However, Würth Elektronik eiSos reserves the right to modify technical specifications or functions of its products or discontinue the production of these products or the support of one of these products without any written announcement or notification to customers. The customer must make sure that the information used is valid. Würth Elektronik eiSos does not assume any liability for the use of its products. Würth Elektronik eiSos does not grant licenses for its patent rights or for any other of its intellectual property rights or third-party rights. Customers bear responsibility for compliance of systems or units in which Würth Elektronik eiSos products are integrated with applicable legal regulations.

19.2 Trademarks

- AMBER wireless® is a registered trademark of Würth Elektronik eiSos.

All other trademarks, registered trademarks, and product names are the exclusive property of the respective owners.

19.3 Usage restriction

Würth Elektronik eiSos products are not approved for use in life-supporting or life-sustaining systems or units or other systems whose malfunction could result in serious bodily injury to the user. Moreover, Würth Elektronik eiSos products are not approved for use as key components of any life-supporting or life-sustaining system or unit whose malfunction could result in the failure of the life-supporting system or unit or could affect its safety or effectiveness. Würth Elektronik eiSos customers who use these products in such applications or sell them for such usage act at their own risk and must relieve Würth Elektronik eiSos from all damages that may result from the sale for unsuitable purposes or unsuitable usage.

By using Würth Elektronik eiSos products, the user agrees to these terms and conditions.

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