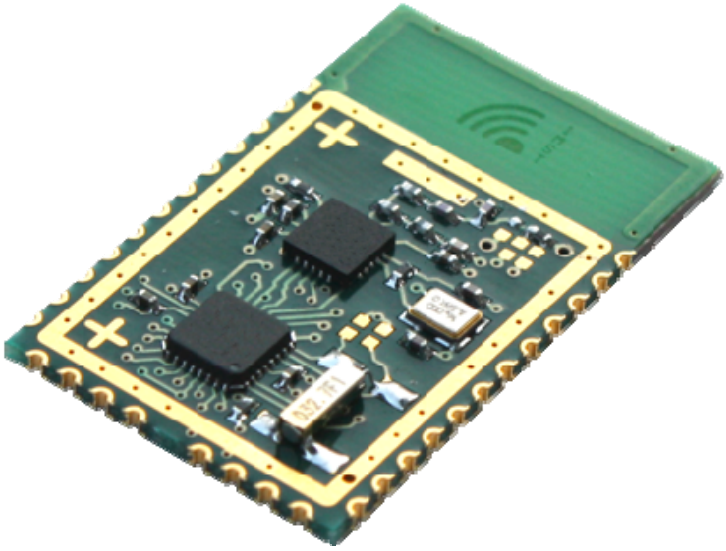
WiMOD - iM201A

Datasheet Version V2.0



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Document Information

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Revision History

Version	Description
1.0	Released version.
1.1	Added information concerning the RC oscillator.
1.2	Updated Chapter 3: - Added/changed information concerning UART, ADC, and Reset. - Updated Table 3-5 (pinout description) - Added information regarding the bootloader. Updated Figure 4-1
2.0	Modifications to document format and layout. Added chapter 4.3, 6, 8, and 9.

Aim of this Document

The aim of this document is to give a detailed product description including interfaces, features and performance of the radio module iM201A.

Table of Contents

1 Summary / Introduction

The iM201A is a compact, low power, bidirectional radio module for the license-free 2.4 GHz Industrial, Science, and Medical (ISM) frequency band. Using the iM201A in an application minimizes the need of an expensive and time-consuming RF development. Really fast time to market is possible with this pre-qualified module.

Figure 1-1: iM201A

This datasheet includes the hardware specifications and a description of the diverse features of the iM201A as well as the possible RF settings.

1.1 Key Features

- Compact radio module for 2.4 GHz
- Output power up to +0 dBm
- High RF data rate up to 2 Mbps
- 2-wire interface (TWI)[1], compatible to Philips I²C protocol
- UART interface
- Sample applications available
- Bootloading functionality for firmware update
- Solderable like a SMD component
- Integrated antenna or 50 Ohm pad

1.2 Applications

- Wireless networks
- Metering systems
- Home-, building-, industrial automation
- Remote control
- Wireless sensors
- Telemetry
- …

Please visit our web site www.wireless-solutions.de for more information.

[1] This functionality is not part of the standard firmware and only available on demand. Please read the appropriate firmware documentation for more information about the currently implemented functionalities.

2 Module Overview

The iM201A is a small radio module for the 2.4 GHz ISM band. It contains a complete RF/MCU design including a 2.4 GHz high data rate transceiver, a microcontroller with internal RC oscillator, a PCB antenna, and all necessary passive components as depicted in Figure 2-1.

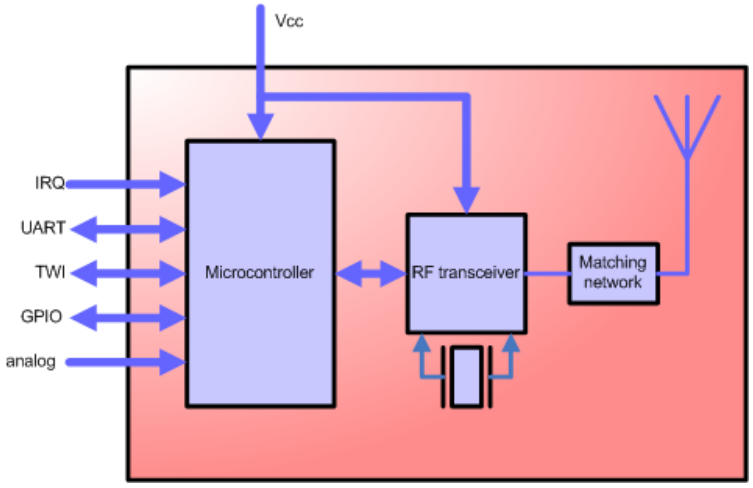

Figure 2-1: Block Diagram - iM201A

The iM201A has several application interfaces[2]. Additionally to a serial UART interface it has a byte-oriented 2-wire interface (TWI) which is compatible to Philips' I²C protocol. Furthermore it offers 6 digital IOs, 2 ADC inputs, and 6 GPIOs (4 GPIOs if using TWI) which can be used as digital inputs/outputs or as ADC inputs. The ADC resolution is 10 bit. All digital pins are interrupt capable (pin change interrupt) whereas two of them can be external triggered by a (low) level.

Integrated bootloading functionality enables the user to upgrade the firmware over the UART interface. More information about the bootloader and its usage can be found in chapter 3.5.1.

The module is solderable like a SMD-component and can be mounted easily on a simple carrier board with a minimum of required external connections. It is RoHS compliant and pre-qualified in accordance to ETSI EN 300 440-2 V1.3.1.

The wide range of capabilities provided by the iM201A can be tested by using our Demo Board (part of the WiMOD Starter Kit) together with several sample applications.

[2] Not all can be used at the same time.

3 Specification

3.1 Absolute Maximum Ratings

Parameter	Range	Unit	Condition
Voltage on any pin except /RESET	(-0.5) to (VCC + 0.5)	V	Voltage with respect to GND
Voltage on /RESET	-0.5 to 13	V	Voltage with respect to GND
Input RF level	0	dBm	
DC current	40	mA	Per IO pin (see Note 1)
	up to 200	mA	On VCC and GND pins
Operating temperature	-20 to +70	°C	
Storage temperature	+15 to +35	°C	
Notes: 1) The total current of all IO pins should not exceed 100mA.			

Table 3-1: Absolute Maximum Ratings

Note: Stress exceeding of one or more of the limiting values listed under "Absolute Maximum Ratings" may cause permanent damage to the radio module.

3.2 General Characteristics

T = 25°C, VDD = 3V (typ.) if nothing else stated

Parameter	Range	Unit	Condition
Supply voltage	2.0 to 3.6	V	See Note 1
Current consumption	typ. 14	mA	Receive with µC active
	typ. 12.7	mA	Transmit @ 0 dBm with µC active
	typ. 4	mA	µC active, TRX off
	typ. 18	µA	Power down with BOD enabled
	typ. 1	µA	Power down with BOD disabled
Dimension (L x W x H)	20 x 32.5 x 2.7	mm	
MCU operation frequency	1 or 8	MHz	Typ. 8 MHz; RC oscillator; see Note 2)
Real time oscillator frequency	32.768	kHz	
Memory (Flash)	32	KB	Max. 10000 write/erase cycles
Memory (RAM)	2	KB	
Memory (EEPROM)	1	KB	Max. 100000 write/erase cycles
Notes: 1) The supply voltage has to be in minimum 2.5 V for 8 MHz MCU operating frequency. 2) To assure a good accuracy it is necessary to recalibrate the RC oscillator initial after power up, which takes up to 1.2s. If it is necessary to recalibrate it during operation again (for example if the UART is used continuously during temperature variation), it takes up to 400 ms per recalibration.			

Table 3-2: General Characteristics

3.3 Module Interface Characteristics

T = 25°C, VDD = 3V (typ.) if nothing else stated

Parameter	Range	Unit	Condition
Digital output voltage	2.3 to VCC	V	High level; I_{OH} = -10 mA
	GND to 0.6	V	Low level ; I_{OL} = 10 mA
Digital input voltage	0.7 x VCC to VCC + 0.5	V	High level
	-0.5 to 0.3 x VCC	V	Low level
/RESET pin threshold voltage	0.2 x VCC to 0.9 x VCC	V	Low active pin
Pulse width on /RESET pin	min. 2.5	µs	
Power-On-Reset (POR) threshold	1.6	V	Rising edge
	0.6	V	Falling edge
UART baud rate	typ. 38.4	kbps	See Note 1) Further data rates are available on demand.
TWI (2-wire interface) clock	Up to 400	kHz	Compatible to Philips' I²C protocol
ADC resolution	10	Bit	
ADC sample rate	Up to 76.9	ksps	15 ksps @ 10 bit resolution
ADC input resistance	100	MΩ	
Analog int. reference voltage (Vref)	1.0 to 1.2	V	Typ. 1.1 V
Analog ext. reference voltage input (Aref pin).	1 to VCC	V	Currently not supported.
Analog input voltage	GND to Vref	V	

Notes:
1) If the UART is used continuously at different temperatures, it is necessary to recalibrate the MCU clock during operation, which takes up to 400 ms per recalibration. During this time no UART communication is possible.

Table 3-3: Module Interface Characteristics

Note: Additional to the reset pin the module has a Power-On-Reset (POR) functionality which holds the module in reset state until supply voltage increase above the POR threshold (rising edge). It will not work unless VCC has been below POR threshold (falling edge). See chapter 3.5 for additional information to the POR feature.

All radio module IOs are tri-stated when a reset condition becomes active.

3.4 RF Characteristics

T = 25°C, VDD = 3V (typ.) if nothing else stated

Parameter	Range	Unit	Condition
Frequency range	2401 to 2482	MHz	See 5.1 for possible RF channels
Number of channels	82		
Channel spacing	1	MHz	
RF data rate	250, 1000, 2000	kbps	
RF output power	max. 0	dBm	
RF output power range	18	dB	See 5.2 for possible power level
RF receiver sensitivity	typ. -93	dBm	PER < 1 % @ 250 kbps
	typ. -82	dBm	PER < 1 % @ 2000 kbps
Modulation techniques	GFSK		
Range	Up to 400	m	Outdoor (line of sight) @ 250 kbps
Range	Up to 100	m	Outdoor (line of sight) @ 2000 kbps
Notes: 1) PER = Packet Error Rate			

Table 3-4: RF Characteristics

3.5 Pinout Description

Figure 3-1 depicts the pinout of the iM201A. Its use depends on the programmed firmware.

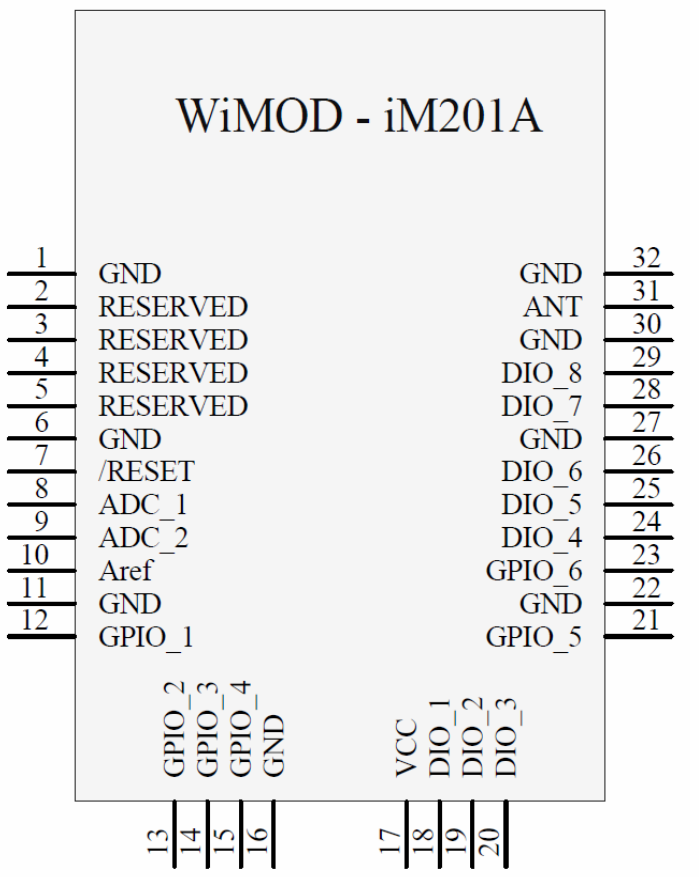

Figure 3-1: Pinout

Pin 8 and 9 can only be used as analog inputs. Most of the other pins can be used as digital IO or for some alternate functions (UART, ADC, Interrupt) as described in Table 3-5.

Note: The POR functionality does not work correctly if the I/O-pins are connected to a second power supply while the radio module is powered up.

For example, if connecting the radio module to a host controller (e.g. RXD and TXD to another microcontroller) with separate power supply, it is strictly recommended to set all I/O-pins of this controller to high impedance or to GND potential when the radio module is powered down. If do not so, it is possible that the radio module is powered by the host controller over its I/O-pins with the result that the POR feature does not work correctly and the module status is undefined.

PIN #	PIN Name	Description	PIN Type
1	GND	Ground connection	Supply
2	Reserved	Internally used. It must be left open	
3	Reserved	Internally used. It must be left open	
4	Reserved	Internally used. It must be left open	
5	Reserved	Internally used. It must be left open	
6	GND	Ground connection	Supply
7	/RESET	Low active RESET input pin	
8	ADC_1	Analog input pin 1	ANALOG IN
9	ADC_2	Analog input pin 2	ANALOG IN
10	Aref	External reference voltage for ADC	ANALOG REF
11	GND	Ground connection	Supply
12	GPIO_1	Digital input or output / analog input	IN/OUT
13	GPIO_2	Digital input or output / analog input	IN/OUT
14	GPIO_3	Digital input or output / analog input / (Bootloader pin) see Note 2	IN/OUT
15	GPIO_4	Digital input or output / analog input	IN/OUT
16	GND	Ground connection	Supply
17	VCC	Supply voltage (typ. 3V)	Supply
18	DIO_1	Digital input or output / UART RXD (UART receive pin)	IN/OUT
19	DIO_2	Digital input or output / UART TXD (UART transmit pin)	IN/OUT
20	DIO_3	Digital input or output / INT0 / (typical use as status indicator)	IN/OUT
21	GPIO_5	Digital input or output / analog input / SCL (2-wire serial bus clock)see Note 1	IN/OUT
22	GND	Ground connection	Supply
23	GPIO_6	Digital input or output / analog input / SDA (2-wire serial bus data)see Note 1	IN/OUT
24	DIO_4	Digital input or output / INT1	IN/OUT
25	DIO_5	Digital input or output	IN/OUT
26	DIO_6	Digital input or output	IN/OUT
27	GND	Ground connection	Supply
28	DIO_7	Digital input or output	IN/OUT
29	DIO_8	Digital input or output	IN/OUT
30	GND	Ground connection	Supply
31	ANT	Ext. antenna connection. Use only after consultation	
32	GND	Ground connection	Supply

Notes:
1) This functionality is not part of the standard firmware and only available on request.
2) Set this pin to low level during/after a reset to switch into bootloader mode for a firmware update.

Table 3-5: Pinout

All GPIOs can be used as digital input, digital output or analog input pin. Furthermore all digital pins have pin change interrupt functionality and can serve as external interrupt source. Additionally DIO_3 and DIO_4 have a (low) level interrupt functionality.

3.5.1 Pin usage for bootloader functionality

GPIO_3 is used as bootloader pin. It has to be set to low level during/after a reset to enter the bootloader for a firmware update over the UART interface (DIO_1 and DIO_2). DIO_3 indicates the status and is set to high level if the bootloader mode is entered and a firmware update is in progress. All not used module IOs are tri-stated in this mode.

To perform a firmware update by a PC, we provide the WiMOD Studio (part of the WiMOD Starter Kit) which contains a simple update tool. Please read the appropriate documentation of the WiMOD Studio for more information about its update functionality.

3.6 Module Dimension

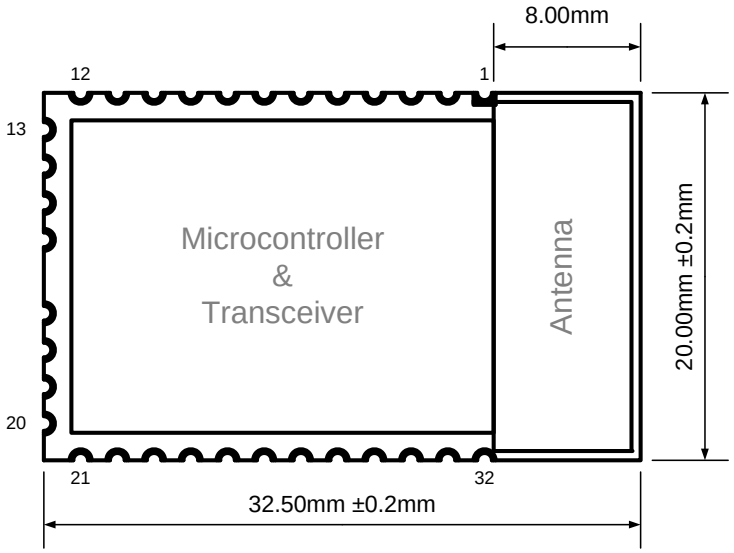

Figure 3-2: Dimension

3.7 Recommended Footprint

The pin pitch is 2.0 mm.

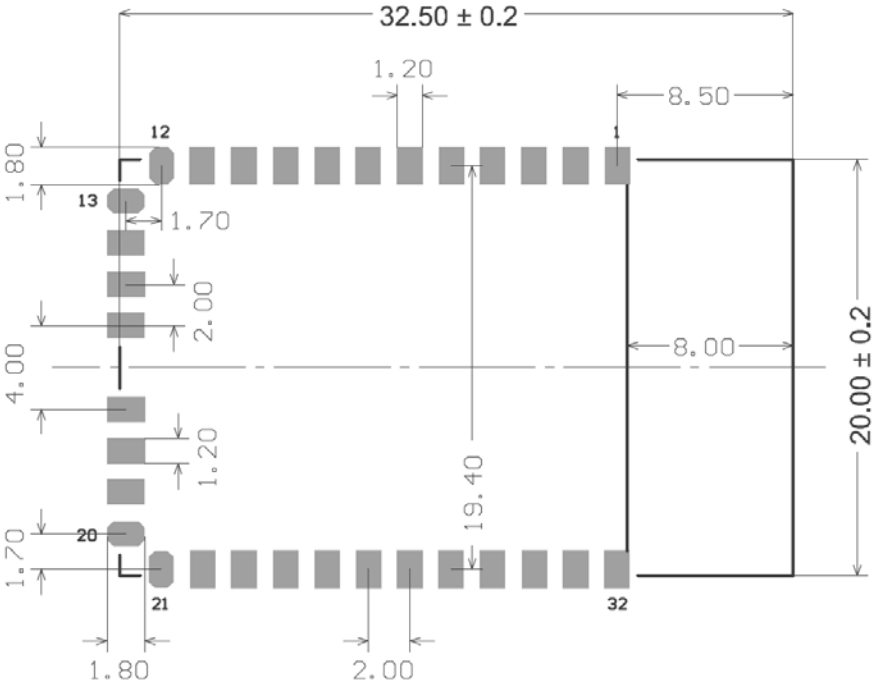

Figure 3-3: Footprint

All dimensions are in millimeters.

4 Integration Guide

4.1 Typical Application Schematic

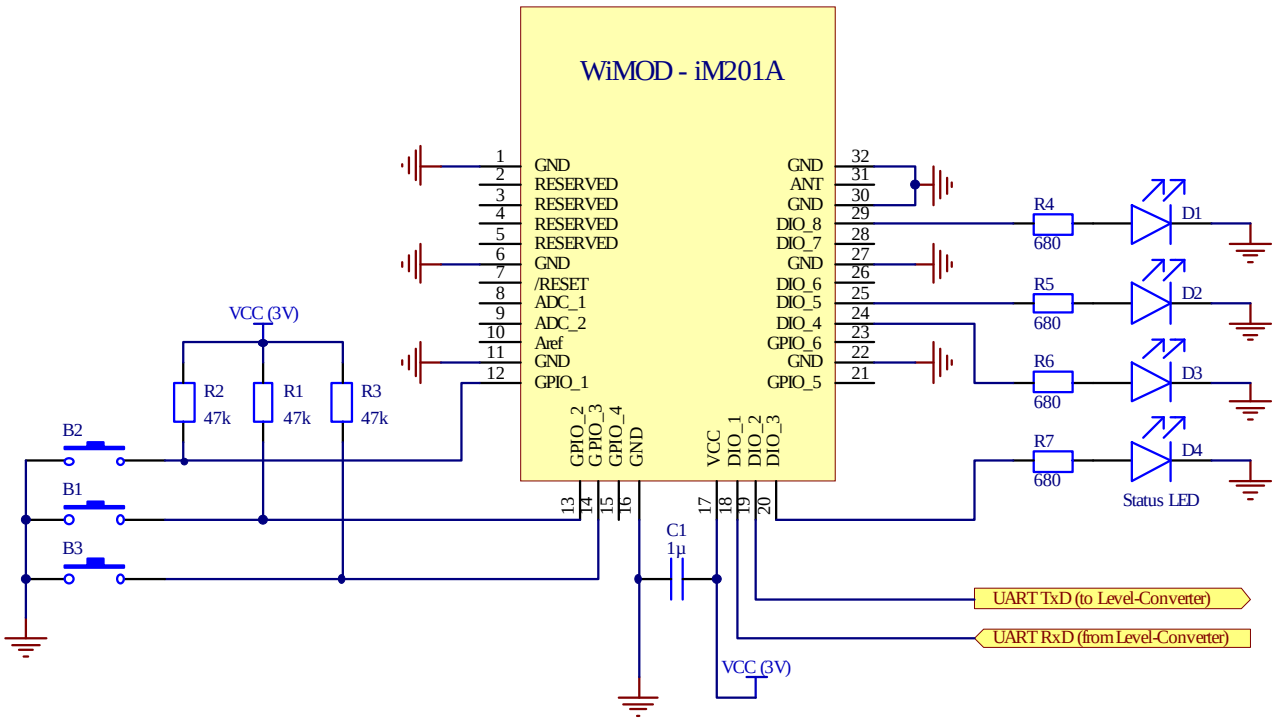

Figure 4-1: Schematic of an Example Application

Figure 4-1 shows a schematic of a typical application (e.g. Starter Kit Application). DIO_1 and DIO_2 are used as serial interface and must be connected to a host controller or to a host PC (via a level converter). DIO_3, DIO_4, DIO_5 and DIO_8 are used as outputs. It must be ensured that the maximum DC current per output pin (see Table 3-1) is not exceeded. GPIO_1, GPIO_2 and GPIO_3 are used as digital inputs. Therefore B3 can be used to activate the integrated bootloader after a reset. Between VCC and GND a blocking capacitor is recommended.

4.2 PCB Design Recommendation

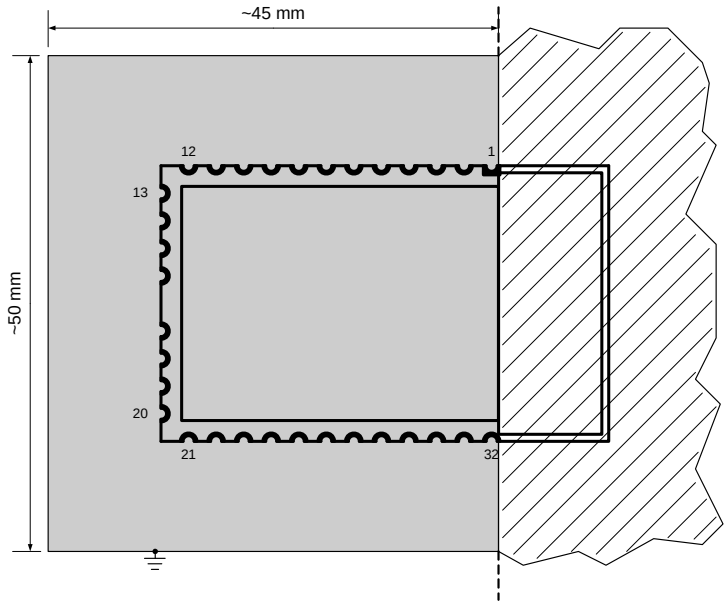

Figure 4-2: Recommended Environment

When designing a carrier board layout for the iM201A the following design considerations are recommended:

- The Top Layer of the carrier board should be kept free of tracks and vias under the iM201A because there are some testpads on the bottom side of the module which are not covered by solder resist.

- As shown in Figure 4-2, the solid grey area must be a ground-plane on the Bottom Layer (or Layer 2 in a multi-layer structure) of the carrier board. Antenna matching and all other measurements were done with these dimensions.

  Info: Other dimensions can affect the RF performance respective RF output power, sensitivity, and unwanted emissions. Maybe the matching network of the integrated PCB antenna must be renewed.

- All radio module ground pads must be directly connected to the ground-plane by vias next to each ground pad.

- The hatched area shown in Figure 4-2 has to be free of material (e.g. PCB, metal, housing). If possible, the distance from the antenna area to any material should be at least λ/2 [see 3].

[3] At 2.4 GHz it is approximately 62.5 mm.

4.3 Recommended Soldering Conditions

An example of the temperature profile for the reflow soldering process of the iM201A is depicted in Figure 4-3 with the corresponding values as given by Table 4-1. The temperature values should not exceed the limits.

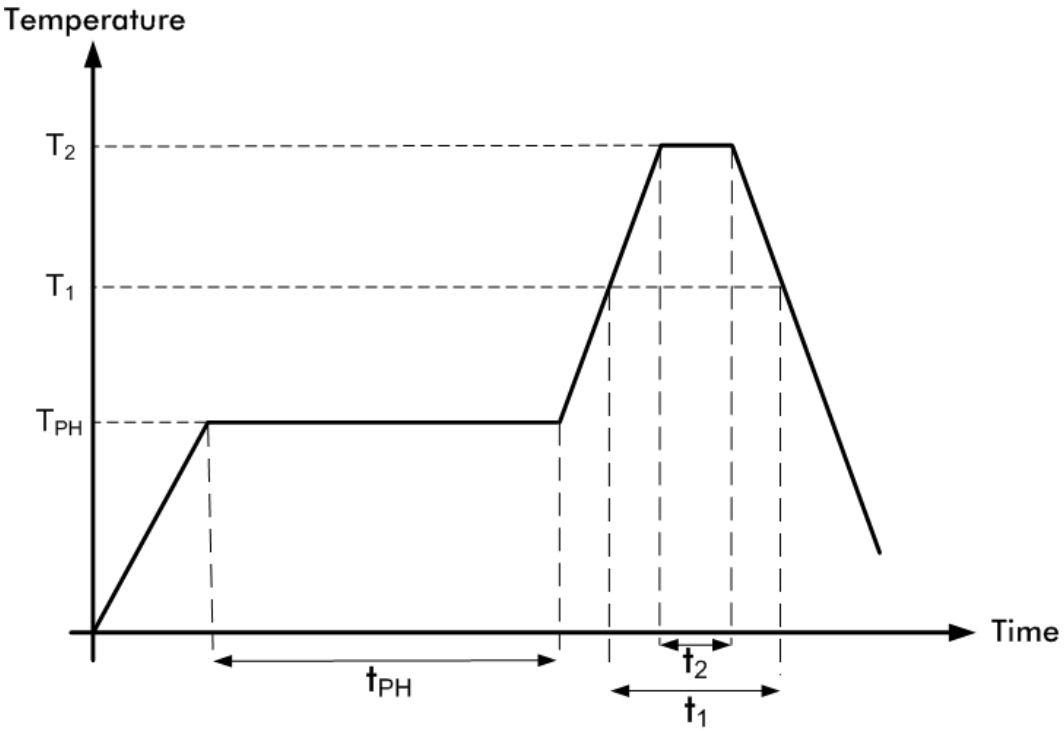

Figure 4-3: Recommended Solder Reflow Profile

Phase	Pb-Free Conditions
Preheating	t_{PH} = 120s T_{PH} = 155~160°C
Primary heat	t_1 = 60s T_1 = 220°C
Peak	t_2 = 10s (max) T_2 = 255°C

Table 4-1: Recommended Soldering Parameter for Temperature and Timing

Note: The quality of the soldering process depends on several parameters, e.g. soldering paste, carrier board design, fabrication equipment,...

5 General Radio Settings

In this chapter the possible radio configurations of the iM201A are described. How to configure these settings when using our sample applications is described in the appropriate user guide of the applications.

5.1 Channel Setup

Table 5-1 shows the RF channel setup.

Channel	Frequency	Unit	Description
1	2401	MHz	Lowest channel
2	2402	MHz	
…	…		1 MHz channel spacing
81	2481	MHz	
82 (MAX_CH)	2482	MHz	Highest channel

Table 5-1: Possible Frequency Channel Settings

5.2 Power Level Setup

Table 5-2 shows the possible power level setup.

Power Level	TX power	Unit	Description
0	-18	dBm	Minimum output power
1	-12	dBm	
2	-6	dBm	
3 (MAX_PWR)	0	dBm	Maximum output power

Table 5-2: Possible Output Power Settings

5.3 Data Rate Setup

Table 5-3 shows the possible RF data rates.

Value	RF data rate	Unit	Description
0	250	kbps	Lowest data rate
1	1000	Kbps	
2 (MAX_DR)	2000	kbps	Highest data rate

Table 5-3: Possible RF Data Rates

6 Packaging Information

6.1 Carrier Tape Information

6.2 Reel Information

7 Ordering Information

Ordering Part Number	Description	Distributor
iM201A	Radio Module iM201A	tekmodul GmbH wimod@tekmodul.de
SK – iM201A	Starter Kit for the iM201A. See Notes.	tekmodul GmbH wimod@tekmodul.de
AB – iM201A	2x Adapter Board with iM201A	tekmodul GmbH wimod@tekmodul.de
Notes: The Starter Kit contains two Demo Boards, two Adapter Boards with iM201A, two antennas, and a CD or USB memory stick with sample applications and documentation.		

Table 7-1; Ordering Information

For orders, please contact our distributor.

8 Appendix

8.1 List of Abbreviations

AB = Adapter Board

ADC = Analog-to-Digital Converter

BOD = Brown Out Detection

DIO = Digital Input/Output

GPIO = General Purpose Input/Output

IEEE = Institute of Electrical and Electronics Engineers

I^2C = Inter-Integrated Circuit

MCU = Microcontroller Unit

PCB = Printed Circuit Board

PER = Packet Error Rate

RAM = Random Access Memory

RF = Radio Frequency

RSSI = Received Signal Strength Indication

SPI = Serial Peripheral Interface

TWI = 2-Wire Interface

UART = Universal Asynchronous Receiver/Transmitter

USB = Universal Serial Bus

8.2 List of Figures

8.3 List of Tables

8.4 References

9 Regulatory Compliance Information

The use of radio frequencies is limited by national regulations. The radio module has been designed to comply with the European Union's R&TTE (Radio & Telecommunications Terminal Equipment) directive 1999/5/EC and can be used free of charge within the European Union. Nevertheless, restrictions in terms of maximum allowed RF power or duty cycle may apply.

The radio module has been designed to be embedded into other products (referred as "final products"). According to the R&TTE directive, the declaration of compliance with essential requirements of the R&TTE directive is within the responsibility of the manufacturer of the final product. A declaration of conformity for the radio module is available from IMST GmbH on request.

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