WiMOD - iM860A

Datasheet Version V2.0

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Document Information

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Revision History

Version	Description
1.0	Released version.
1.1	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 iM860A.

Table of Contents

1 Summary / Introduction

The iM860A is a compact, low power, bidirectional radio module for the 868 MHz frequency band. Using the iM860A in an application minimizes the need of an expensive and time-consuming RF development. Really fast time to market is possible with this radio module.

Figure 1-1: iM860A

This datasheet includes the hardware specifications and the description of the diverse features of the iM860A as well as the possible RF settings.

1.1 Key Features

- Radio module for 868 MHz
- Output power up to +10 dBm
- Forward Error Correction (FEC)
- RF data rate from 1 kbps to 14.4 kbps
- 2-wire interface (TWI)[1], compatible to Philips I²C protocol
- Master/Slave SPI[1] interface
- UART interface
- Bootloading functionality for firmware update
- Solderable like a SMD component
- Integrated antenna or 50 Ohm pad
- Digital RSSI support

1.2 Applications

- Battery driven wireless sensor and actor systems
- Industrial remote control
- Telemetry systems
- Home-, Building-, Industrial Automation
- Metering systems (data logging)
- ...

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 iM860A is a small radio module for the 868 MHz frequency band. It contains a complete RF/MCU design including a transceiver, a microcontroller with internal RC oscillator, a PCB antenna, and all necessary passive components as depicted in Figure 2-1.

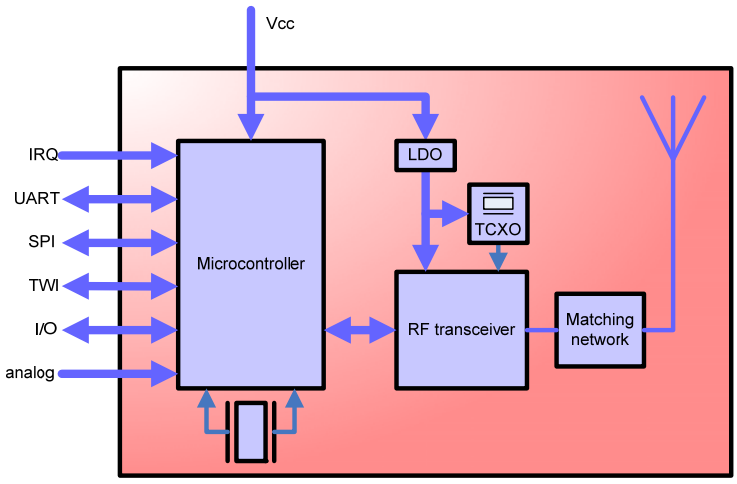

Figure 2-1: Block Diagram - iM860A

The iM860A has several application interfaces[2]. Additionally to a serial UART interface it has a synchronous high-speed interface (SPI) which can be used in master or slave mode and it has a byte-oriented 2-wire interface (TWI) which is compatible to Philips' I²C protocol. Furthermore it offers 14 digital IOs (if not using SPI and TWI), and 2 GPIOs 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 three of them can be external triggered by a (low) level.

The RF data rate of the module is adjustable up to 14.4 kbps, optional with Forward Error Correction (FEC). Decreasing the data rate will increase the sensitivity which results in a longer RF range. To evaluate the radio link quality the iM860A supports a digital RSSI.

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.

The wide range of capabilities provided by the iM860A 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	15	dBm	
DC current	40	mA	Per IO pin (see note 1)
	up to 200	mA	On VCC and GND pins
Operating temperature	-20 to +80	°C	With 8 MHz resonator (default)
	-40 to +85	°C	With RC oscillator
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	2.7 to 3.6	V	
Current consumption	26	mA	Receive with µC active
	40	mA	Transmit @ 10 dBm with µC active
	23	mA	Transmit @ 0 dBm with µC active
	3	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 (f_{MCU})	8	MHz	
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

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	2.5 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	Further data rates are available on demand.
SPI baud rate	max. $f_{MCU}/2$	Mbps	
TWI (2-wire interface) clock	Up to 400	kHz	Compatible to Philips' I²C protocol
ADC resolution	10	Bit	
ADC sample rate	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
	2.33 to 2.79	V	Typ. 2.56 V (see note 1)
Analog ext. reference voltage input (Aref pin).	1 to VCC	V	Currently not supported.
Analog input voltage	GND to Vref	V	Vref depends on used voltage reference
Notes: 1) Only possible if VCC > 2.8V			

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	863 to 870	MHz	See 5.1 for possible RF channels
Number of channels	tbd		The current firmware uses 3 channels
Channel spacing	tbd	kHz	Current channel spacing is 100 kHz
Data rate	1, 2.4, 4.8, 9.6, 14.4	kbps	
RF output power	max. +10	dBm	
Output power range	60	dB	See 5.2 for possible power level
Receiver sensitivity	typ. -118	dBm	PER < 1 % @ 1kbps (with FEC)
Modulation techniques	FSK		
Range	> 2000	m	Outdoor (line of sight) @ 1kbps
Notes: 1) PER = Packet Error Rate 2) FEC = Forward Error Correction			

Table 3-4: RF Characteristics

3.5 Pinout Description

Figure 3-1 depicts the pinout of the iM860A. Its use depends on the programmed firmware.

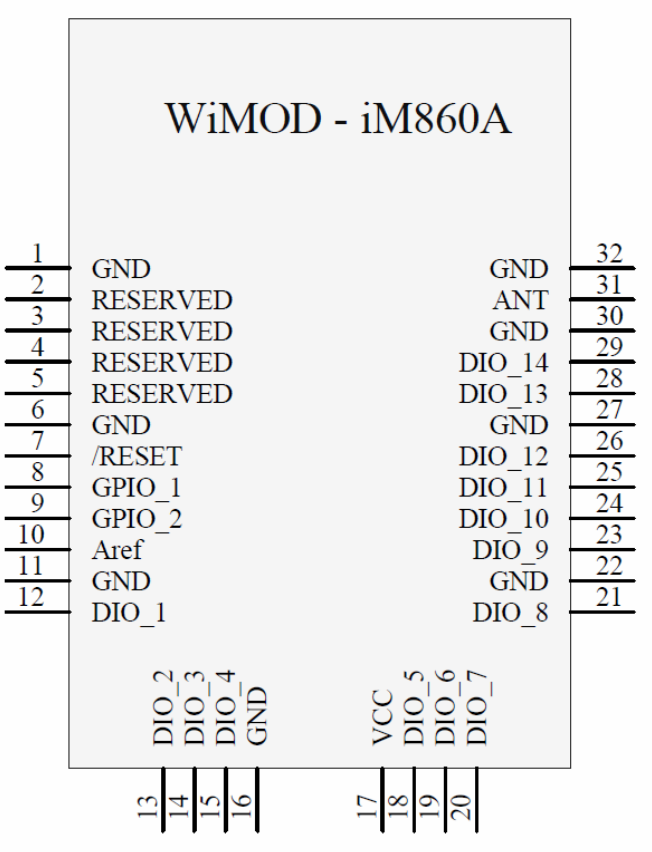

Figure 3-1: Pinout

Pin 8 and 9 can be used as digital IO or as analog inputs. Most of the other pins can be used as digital IO or for some alternate digital 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	GPIO_1	Digital input or output / analog input	IN/OUT
9	GPIO_2	Digital input or output / analog input	IN/OUT
10	Aref	External reference voltage for ADC	ANALOG REF
11	GND	Ground connection	Supply
12	DIO_1	Digital input or output / SPI MISO see Note 1	IN/OUT
13	DIO_2	Digital input or output / SPI MOSI see Note 1	IN/OUT
14	DIO_3	Digital input or output / SPI SCK see Note 1 / (Bootloader pin) see Note 2	IN/OUT
15	DIO_4	Digital input or output / SPI SS see Note 1	IN/OUT
16	GND	Ground connection	Supply
17	VCC	Supply voltage (typ. 3V)	Supply
18	DIO_5	Digital input or output / INT0 / UART RXD (UART receive pin)	IN/OUT
19	DIO_6	Digital input or output / INT1 / UART TXD (UART transmit pin)	IN/OUT
20	DIO_7	Digital input or output / (typical use as status indicator)	IN/OUT
21	DIO_8	Digital input or output / SCL (2-wire serial bus clock) see Note 1	IN/OUT
22	GND	Ground connection	Supply
23	DIO_9	Digital input or output / SDA (2-wire serial bus data) see Note 1	IN/OUT
24	DIO_10	Digital input or output / INT2	IN/OUT
25	DIO_11	Digital input or output	IN/OUT
26	DIO_12	Digital input or output	IN/OUT
27	GND	Ground connection	Supply
28	DIO_13	Digital input or output	IN/OUT
29	DIO_14	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 demand.
2) Set this pin to low level during/after a reset to switch into bootloader mode for a firmware update.

Table 3-5: Pinout

The GPIOs can be used as digital input, digital output or analog input pin. Furthermore all digital pins have a pin change interrupt functionality and can serve as external interrupt source. Additionally DIO_5, DIO_6 and DIO_10 have a (low) level interrupt functionality.

3.5.1 Pin usage for bootloader functionality

DIO_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_5 and DIO_6). DIO_7 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

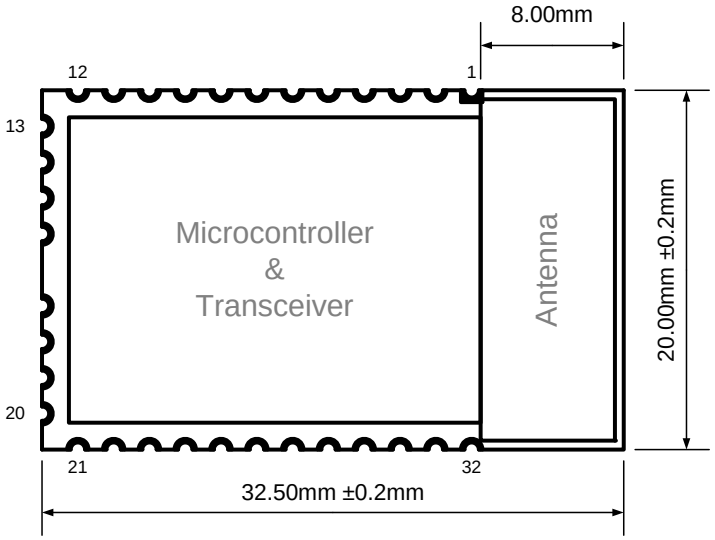

Figure 3-2: Dimension

3.7 Recommended Footprint

The pin pitch is 2.0 mm.

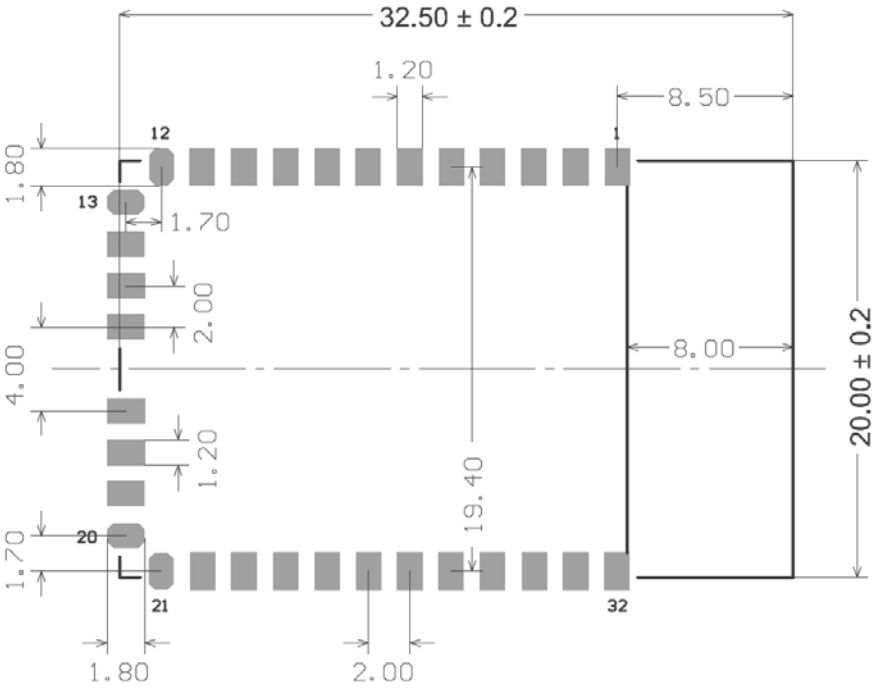

Figure 3-3: Footprint

All dimensions are in millimeters.

4 Integration Guide

4.1 Typical Application Schematic

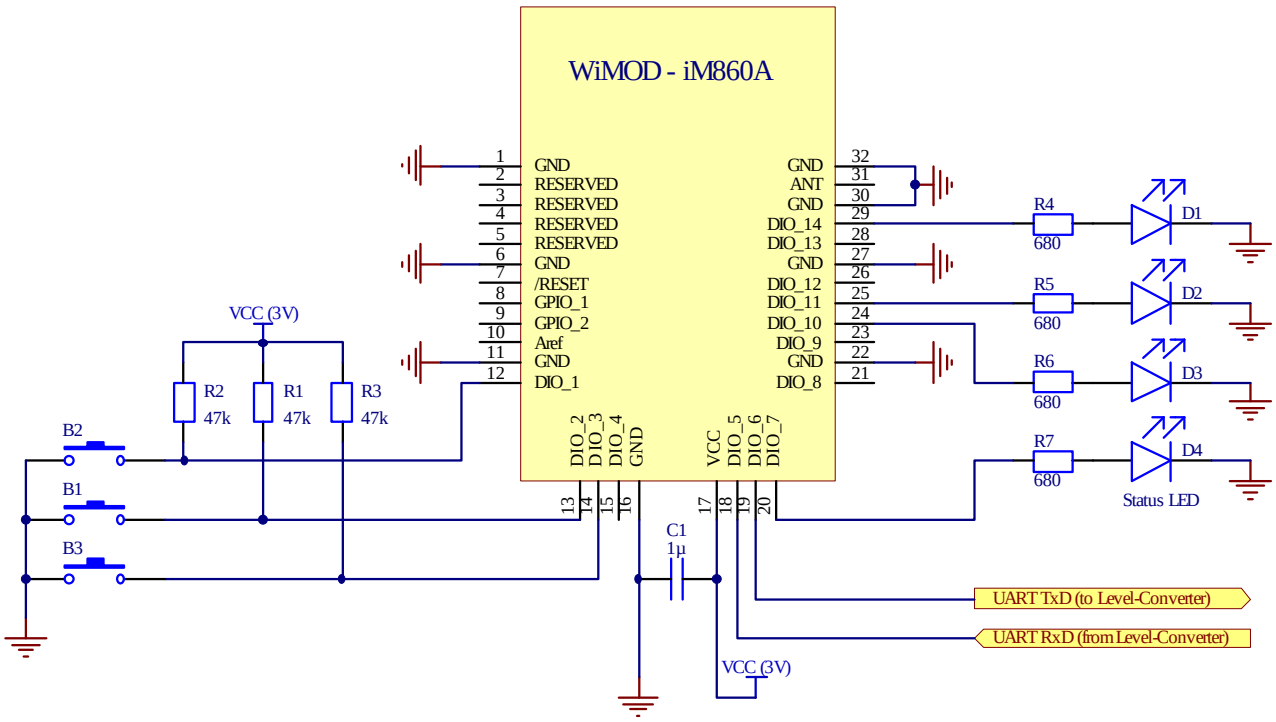

Figure 4-1: Schematic of an Example Application

Figure 4-1 shows a schematic of a typical application (e.g. Starter Kit Application). DIO_5 and DIO_6 are used as serial interface and must be connected to a host controller or to a host PC (via a level converter). DIO_7, DIO_10, DIO_11, and DIO_14 are used as outputs. It must be ensured that the maximum DC current per output pin (see Table 3-1) is not exceeded. DIO_1, DIO_2 and DIO_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

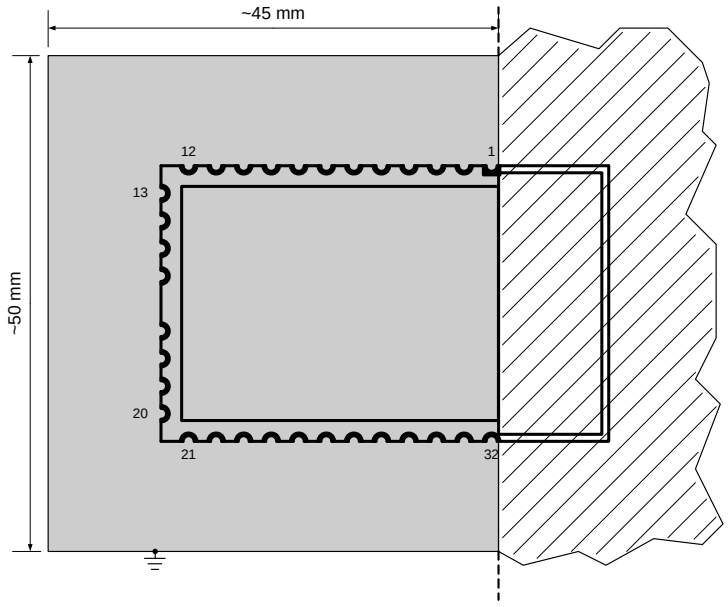

Figure 4-2: Recommended Environment

When designing a carrier board layout for the iM860A the following design considerations are recommended:

- The Top Layer of the carrier board should be kept free of tracks and vias under the iM860A 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 868 MHz it is approximately 173 mm.

4.3 Recommended Soldering Conditions

An example of the temperature profile for the reflow soldering process of the iM860A is depicted in Figure 4-3 with the corresponding values as given by Table 4-1. The temperature values should not exceed the limits.

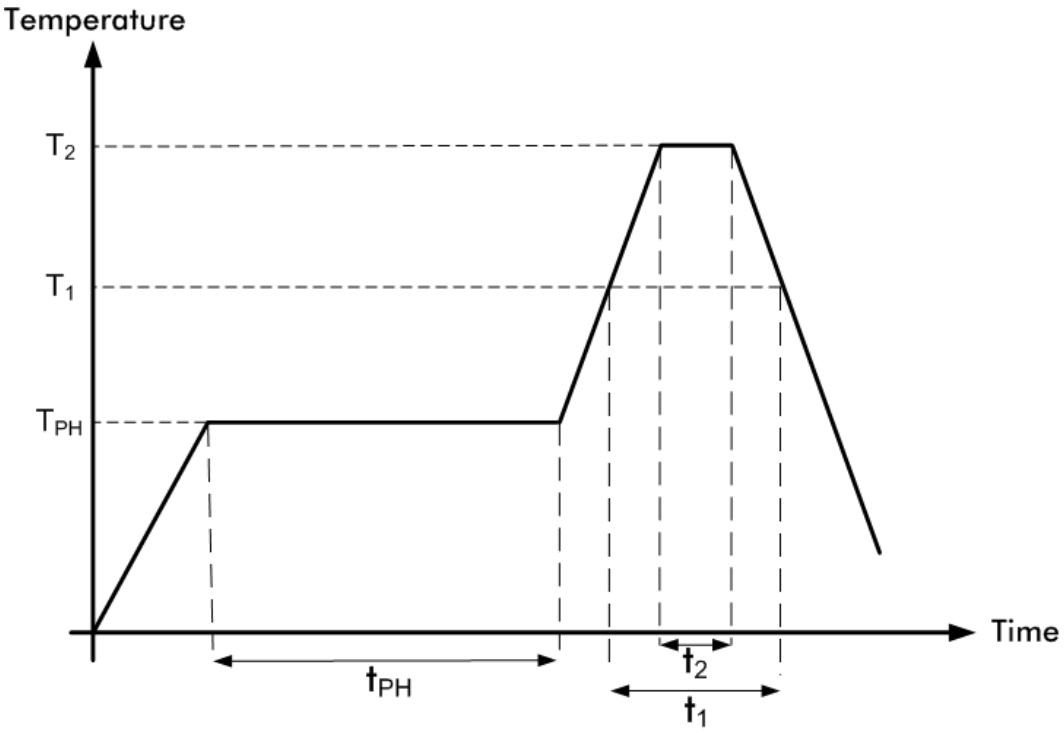

Figure 4-3: Recommended Solder Reflow Profile

Phase	Pb-Free Conditions
Preheating	t_{PH} = 120s T_{PH} = 160~180°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 iM860A 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. Currently three RF channels from 868.2 MHz to 868.3 MHz can be used.

Channel	Frequency	Unit	Description
1	868.1	MHz	Currently not available
2	868.2	MHz	Currently lowest frequency channel
3	868.3	MHz	
4	868.4	MHz	Currently highest frequency channel
5	868.5	MHz	Currently not available

Table 5-1: Possible Frequency Channel Settings

5.2 Power Level Setup

Table 5-3 shows the possible power level setup relating to the 50Ω connector (pin ANT).

Power Level	TX power	Unit	Description
1	-50	dBm	Minimum output power
2	-14	dBm	
3	-8	dBm	
4	-4	dBm	
5	-1	dBm	
6	0.5	dBm	
7	+2	dBm	
8	+3	dBm	
9	+4	dBm	
10	+5	dBm	
11	+6	dBm	
12	+7	dBm	
13	+8	dBm	
14	+8.5	dBm	
15	+9	dBm	
16	+10	dBm	Maximum output power.
Notes:			

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
1	1	kbps	Lowest data rate
2	1	kbps	Lowest data rate with FEC
3	2.4	kbps	
4	2.4	kbps	with FEC
5	4.8	kbps	
6	4.8	kbps	with FEC
7	9.6	kbps	
8	9.6	kbps	with FEC
9	14.4	kbps	Highest data rate
10	14.4	kbps	Highest data rate with FEC

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
iM860A	Radio Module iM860A	tekmodul GmbH wimod@tekmodul.de
SK – iM860A	Starter Kit for the iM860A. See Notes.	tekmodul GmbH wimod@tekmodul.de
AB – iM860A	2x Adapter Board with iM860A	tekmodul GmbH wimod@tekmodul.de
Notes: The Starter Kit contains two Demo Boards, two Adapter Boards with iM860A, 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

DIO = Digital Input/Output

FEC = Forward Error Correction

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.

The applicable regulation requirements are subject to change. IMST GmbH does not take any responsibility for the correctness and accuracy of the aforementioned information. National laws and regulations, as well as their interpretation can vary with the country. In case of uncertainty, it is recommended to contact either IMST's accredited Test Center or to consult the local authorities of the relevant countries.

10 Important Notice

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10.2 Contact Information

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