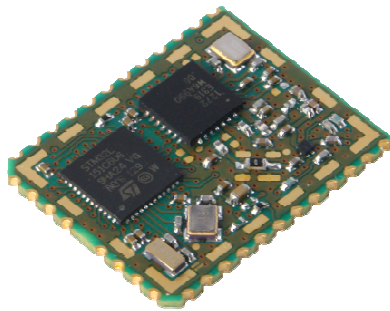


WiMOD iM880B

Datasheet



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| 1.5 | Updated Figure 4-1 |
| 1.6 | Updated Table 4.2 |

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 iM880B.



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1. Introduction

The iM880B is a compact, low power, bidirectional radio module for the 868 MHz frequency band using Semtech's LoRa™ modulation technology. The module provides ultra-long range spread spectrum communication and high interference immunity whilst minimising current consumption. Using the iM880B in an application minimizes the need for an expensive and time-consuming RF development. Fast time to market is possible with this pre-qualified module.

Comparing with the iM880A, the iM880B provides an optimized RF performance for the extreme temperature range. In addition, the iM880B is equipped with a STM32L151 of new "device generation A".



Figure 1-1: Picture of iM880B

1.1 Key Features

- Compact module 20.0 x 25.0 x 2 mm
- LoRa™ modulation technology
- Sensitivity down to -138 dBm
- UART, SPI and I²C interface¹
- Digital inputs and outputs
- Analog inputs
- Supply voltage range from 2.4 to 3.6 V
- RF interface optimized to 50 Ω
- Output power level up to +19 dBm
- High link budget up to 156 dB
- Range up to 15000m (Line of Sight)
- STM32L151CxU6Axx
- Pre-Certified according to EN 300 220

1.2 Applications

- Automated Meter Reading
- Wireless Networks
- Home-, Building-, Industrial automation
- Remote Control
- Wireless Sensors
- Telemetry
- Wireless Alarm and Security Systems
- ...

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

¹ Default host controller interface is UART. SPI and I²C functionality available on request.

2. Module Overview

The iM880B is an ultra-long range, high-performance, pre-certified module for wireless communication. It operates in the license free 868 MHz SRD frequency band and includes all necessary passive components for wireless communication as depicted in the following figure.

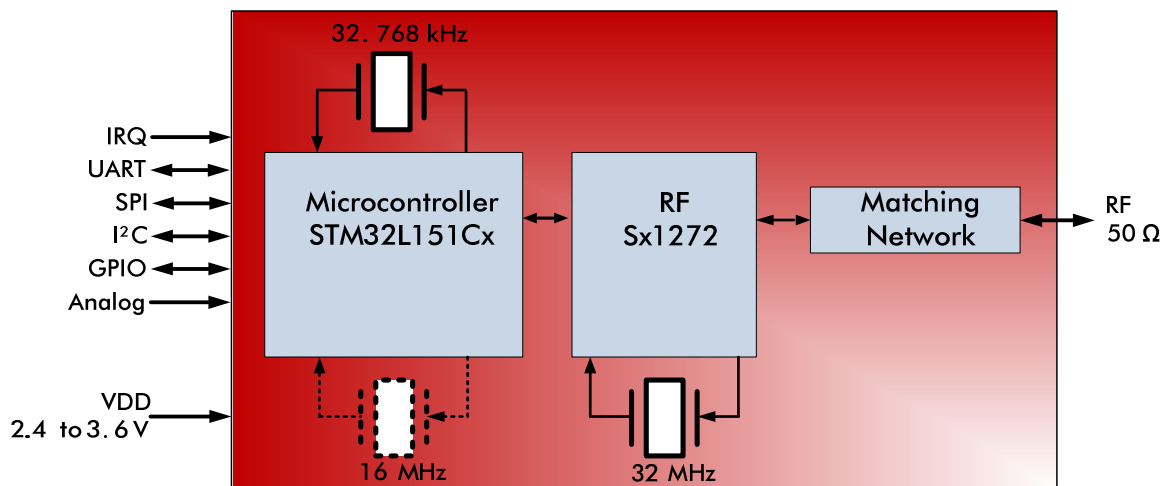


Figure 2-1: Block Diagram of Radio Module iM880B

The iM880B uses Semtech's patented LoRa modulation technique which combines spread spectrum modulation and forward error correction techniques to increase the range and robustness of radio communication links compared with traditional FSK or OOK based modulation. Typically examples of iM880B receive performances are given in the following table.

| Signal Bandwidth/[kHz] | Spreading Factor | Sensitivity/[dBm] |
|------------------------|------------------|-------------------|
| 125 | 7 | -123 |
| 125 | 12 | -138 |
| 250 | 7 | -121 |
| 250 | 12 | -135 |
| 500 | 7 | -116 |
| 500 | 12 | -130 |

Table 2-1: Typically Radio Performance of iM880B

This high sensitivity combined with the integrated +19 dBm power amplifier yields industry leading link budget.

The module is solderable like a SMD component and can easily be mounted on a simple carrier board with a minimum of required external connections. It is RoHS compliant and pre-qualified in accordance to ETSI EN 300 220.

The wide range of capabilities provided by the iM880B can be tested by using the WiMOD Demo Board (part of the WiMOD Starter Kit).



3. LoRa Modulation Technique

The iM880B uses Semtech's LoRa proprietary spread spectrum modulation technique. This modulation, in contrast to conventional modulation techniques, permits an increase in link budget and increased immunity to in-band interference. It achieves sensitivities 8 dB better than FSK modulation.

LoRa also provides significant advantages in both blocking and selectivity, solving the traditional design compromise between range, interference immunity and energy consumption.

In LoRa mode the iM880B offers three bandwidth options of 125 kHz, 250 kHz, and 500 kHz with spreading factors ranging from 7 to 12.

The spread spectrum LoRa modulation is performed by representing each bit of payload information by multiple chips of information. The rate at which the spread information is sent is referred to as the symbol rate (R_s), the ratio between the nominal symbol rate and chip rate is the spreading factor and represents the number of symbols sent per bit of information. The range of parameters which can be configured are given in the following tables.

| Spreading Factor | Chips/Symbol | SNR/[dB] |
|------------------|--------------|----------|
| 7 | 128 | -7.5 |
| 8 | 256 | -10 |
| 9 | 512 | -12.5 |
| 10 | 1024 | -15 |
| 11 | 2048 | -17.5 |
| 12 | 4096 | -20 |

Table 3-1: Spreading Factors of Sx1272

Note that the spreading factor must be known in advance on both transmit and receive sides of the radio link as different spreading factors are orthogonal to each other. Note also the resulting signal to noise ratio (SNR) required at the receiver input. It is the capability to receive signals with negative SNR that increases the sensitivity, so link budget and range, of the LoRa receiver.

To further improve the robustness of the radio link iM880B provides cyclic error coding with different coding rates. With using this coding scheme forward error detection and correction can be applied.

| Coding Rate | Cyclic Coding Rate | Overhead Ratio |
|-------------|--------------------|----------------|
| 1 | 4/5 | 1.25 |
| 2 | 4/6 | 1.5 |
| 3 | 4/7 | 1.75 |
| 4 | 4/8 | 2 |

Table 3-2: Coding Rate of iM880B

4. Electrical Characteristics

In the following different electrical characteristics of the iM880B are listed. Furthermore details and other parameter ranges are available on request.

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

4.1 Absolute Maximum Ratings

| Parameter | Condition | Min | Typ. | Max | Unit |
|---|-----------|------|------|-----|------|
| Supply Voltage (VDD) | | -0.3 | - | 3.9 | V |
| Storage Temperature | | -40 | - | +85 | °C |
| Operating Temperature | | -40 | - | +85 | °C |
| RF Input Power | | | | +10 | dBm |
| ESD (Human Body Model) | | | 2000 | | V |
| ESD (Charge Device Model) | | | 500 | | V |
| | | | | | |
| Notes: 1) Unless otherwise noted, all voltages are with respect to GND | | | | | |

Table 4-1: Absolute Maximum Ratings

Note: With RF output power level above +16 dBm a minimum distance between two devices should be 1 m for avoiding too large input level.

4.2 Global Electrical Characteristics

T = 25°C, VDD = 3.0 V (typ.) if nothing else stated

| Parameter | Condition | Min | Typ. | Max | Unit |
|---|--|------|--------|------|---------------------------|
| Supply Voltage (VDD) | | 2.4 | 3.0 | 3.6 | V |
| Current Consumption Low Power Mode | RTC off | | 800 | | nA |
| | RTC on | | 1.85 | | μA |
| Current Consumption System IDLE | TRX idle mode, μC idle mode | | 5 | | mA |
| Current Consumption RECEIVE LoRa | TRX receive mode, μC sleep mode | | 11.2 | | mA |
| Current Consumption TRANSMIT _(Note 3) | TRX transmit mode, μC sleep mode, all μC units off, max. RF power level | | 128 | | mA |
| MCU operation frequency | | | 32 | | MHz |
| | | | 32.768 | | kHz |
| Memory (Flash) | iM880B-L | | 128 | | kByte |
| Flash Memory Endurance | Program memory | 10k | | | Erase/ Write Cycles |
| | Data memory | 300k | | | |
| Memory (RAM) | iM880B-L | | 32 | | kByte |
| Internal Capacitance | | | | 7.4 | μF |
| Internal Inductance | | | | 60.6 | nH |

Table 4-2: General Characteristics

4.3 Module Interface Characteristics

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

| Parameter | Condition | Min | Typ. | Max | Unit |
|---|---|---------------|-------|----------|------|
| Digital output voltage (high level) | 2.4 V < VDD < 2.7 V, 4 mA (max) | VDD -0.45 | - | - | V |
| | 2.7 V < VDD < 3.6 V, 8 mA (max) | VDD -0.4 | | | |
| Digital output voltage (low level) | 2.4 V < VDD < 2.7 V, 4 mA (max) | - | - | 0.45 | V |
| | 2.7 V < VDD < 3.6 V, 8 mA (max) | - | | 0.4 | |
| Digital input voltage (high level) | VDD = 2.4 V to 3.6 V, CMOS | 0.45 VDD+0.38 | - | - | V |
| | VDD = 2.4 V to 3.6 V, CMOS, 5 V tolerant | 0.39 VDD+0.59 | - | - | V |
| | BOOT0 | 0.15 VDD+0.56 | - | - | V |
| Digital input voltage (low level) | VDD = 2.4 V to 3.6 V | - | - | 0.3 VDD | V |
| | BOOT0 | - | - | 0.14 VDD | V |
| UART baud rate | | | 115.2 | | kbps |
| Notes: 1) Unless otherwise noted, all voltages are with respect to GND | | | | | |

Table 4-3: Module Interface Characteristics

4.4 RF Characteristics

4.4.1 Applicable Frequency Bands and Sub-Bands

Following table depicts the applicable frequency bands within the 868 MHz band for “Non-Specific Short Range Devices” specified in the ERC Recommendation 70-03, [2].

| Band | Edge Frequencies | | Field Power | Spectrum Access | Band Width |
|---|------------------|------------|--------------------|-----------------|------------|
| g (Note1,2) (Note2) (Note2) | 863 MHz | 870 MHz | +14 dBm | 0.1% or LBT+AFA | 7 MHz |
| | 863 MHz | 870 MHz | -4.5 dBm / 100 kHz | 0.1% or LBT+AFA | 7 MHz |
| | 865 MHz | 870 MHz | -0.8 dBm / 100 kHz | 0.1% or LBT+AFA | 5 MHz |
| | 865 MHz | 868 MHz | +14 dBm | 1% or LBT+AFA | 3 MHz |
| g1 | 868.0 MHz | 868.6 MHz | +14 dBm | 1% or LBT+AFA | 600 kHz |
| g2 | 868.7 MHz | 869.2 MHz | +14 dBm | 0.1% or LBT+AFA | 500 kHz |
| g3 | 869.4 MHz | 869.65 MHz | +27 dBm | 10% or LBT+AFA | 250 kHz |
| g4 | 869.7 MHz | 870 MHz | +14 dBm | 1% or LBT+AFA | 300 kHz |
| g4 | 869.7 MHz | 870 MHz | +7 dBm | No requirement | 300 kHz |
| Note1: Modulation bandwidth ≤ 300 kHz is allowed. Preferred channel spacing is ≤ 100 kHz. | | | | | |
| Note2: Sub-bands for alarms are excluded (see ERC/REC 70-03 Annex 7). | | | | | |

Table 4-4: Applicable Frequency Bands for Non-Specific Short Range Devices

Note: 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.

For further information about frequency and RF power setting please refer to [4].

4.4.2 Transmitter RF Characteristics

The iM880B has an excellent transmitter performance as given by Table 4-5. For further details, refer to Figure 4-1 which gives an overview of RF output power levels versus power level settings and its current consumption with microcontroller in sleep mode.

T = 25°C, VDD = 3 V (typ.), 866.5 MHz if nothing else stated

| Parameter | Condition | Min | Typ. | Max | Unit |
|--|--------------|-----|------|-----|------|
| Frequency Range | | 863 | - | 870 | MHz |
| RF Output Power | 868 MHz Band | | 19.0 | | dBm |
| Modulation Techniques | LoRa™ | | | | |
| TX Frequency Variation vs. Temperature | -40 to +85°C | - | ±10 | - | kHz |
| TX Power Variation vs. Temperature | | - | ±0.5 | - | dB |

Table 4-5: Transmitter RF Characteristics

Note: The duty cycle of transmission at maximum output power is limited to 1%. The antenna has to be matched with a maximum VSWR of 3:1.

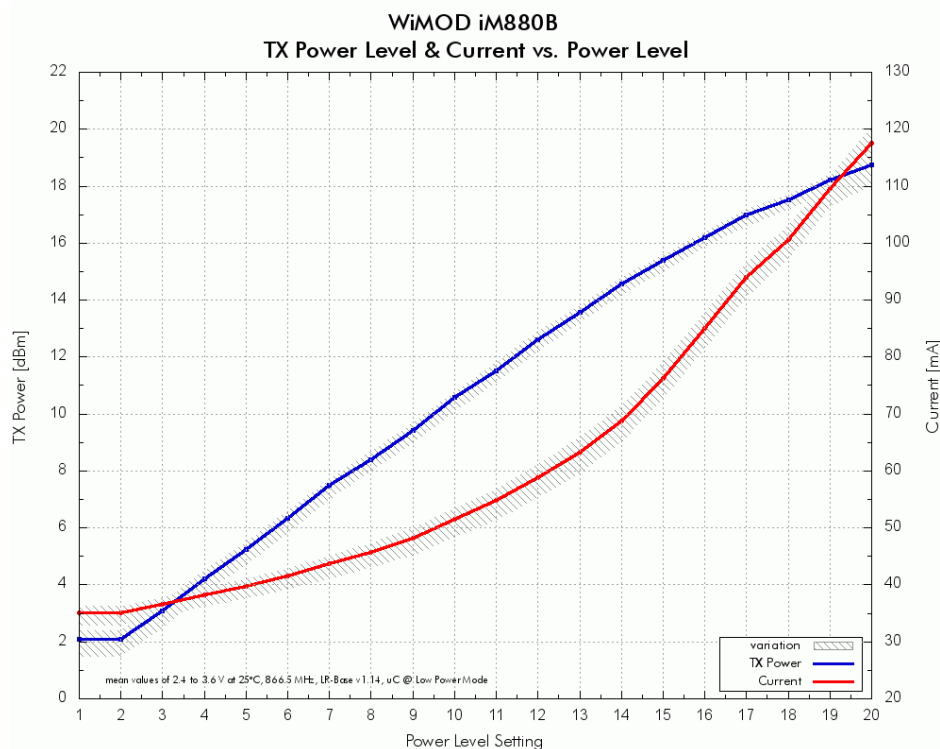


Figure 4-1: RF output power level and current consumption versus power stages from 1 to 20 @ room temperature



5. Module Package

In the following the iM880B module package is described. This description includes the iM880B pinout as well as the modules dimensions. Furthermore a recommendation for a suitable footprint is given, which should be used for further mounting on appropriate carrier boards.

5.1 Pinout Description

Figure 5-1 depicts a description of the iM880B's pads on the bottom side. The figure shows the module with its pinout in top view (right figure). A detailed description of the individual pins can be found in Table 5-1: iM880B Pinout Table.

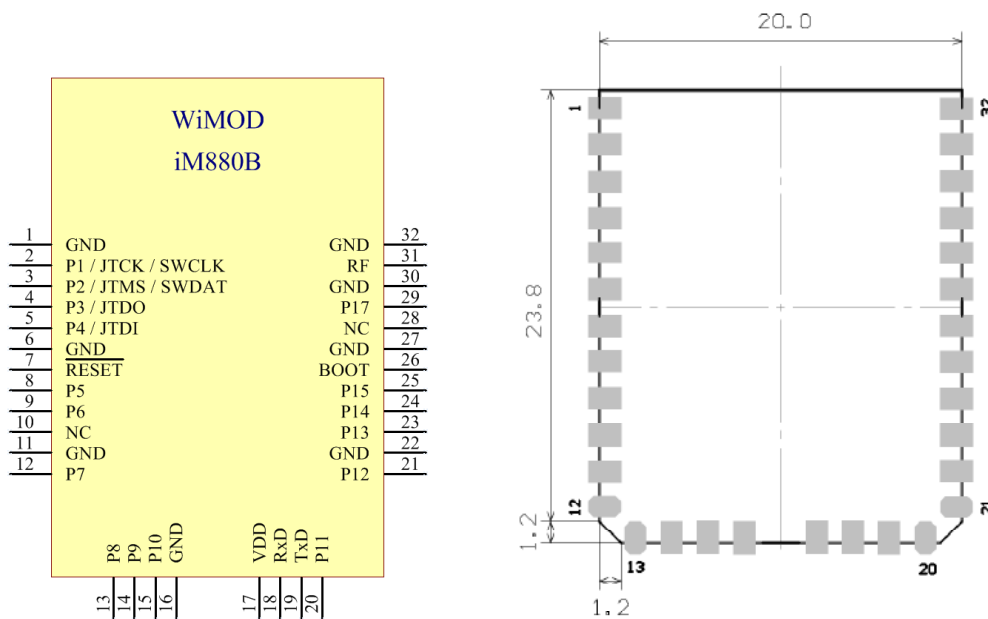


Figure 5-1: Description of iM880B module pins and top view

| PIN | PIN Name | PIN Type | MCU Pin (number) | 5 V Tolerance | Description |
|-----|----------|----------------|---------------------------|---------------|---|
| 1 | GND | Supply | | - | Ground connection |
| 2 | P1 | D IN/OUT | PA_14 (P37) | Yes | Digital IO / JTCK / SWCLK |
| 3 | P2 | D IN/OUT | PA_13 (P34) | Yes | Digital IO / JTMS / SWDIO |
| 4 | P3 | D IN/OUT | PB_3 (P39) | Yes | Digital IO / JTDO |
| 5 | P4 | D IN/OUT | PA_15 (P38) | Yes | Digital IO / JTDI |
| 6 | GND | Supply | | - | Ground connection |
| 7 | nReset | D IN | NRST (P7) | No | NReset, internally pulled-up by 47 k Ω |
| 8 | P5 | D IN/OUT | PA_11 (P32) | Yes | Digital IO / USART1-CTS |
| 9 | P6 | D IN/OUT | PA_12 (P33) | Yes | Digital IO / USART1-RTS |
| 10 | NC | NC | | - | Should be NC |
| 11 | GND | Supply | | - | Ground connection |
| 12 | P7 | D IN/OUT, A IN | PB_14 (P27) | Yes | Digital IO / SPI2_MISO / ADC_IN20 |
| 13 | P8 | D IN/OUT, A IN | PB_15 (P28) | Yes | Digital IO / SPI2_MOSI / ADC_IN21 |
| 14 | P9 | D IN/OUT, A IN | PB_13 (P26) | Yes | Digital IO / SPI2_CLK / ADC_IN19 |
| 15 | P10 | D IN/OUT, A IN | PB_12 (P25) | Yes | Digital IO / SPI2_NSS / ADC_IN18 |
| 16 | GND | Supply | | - | Ground connection |
| 17 | VDD | Supply | | - | Supply voltage |
| 18 | RxD | D IN/OUT | PA_10 (P31) PB_6 (P42) | Yes | Digital IO / USART1-RX |
| 19 | TxD | D IN/OUT | PA_9 (P30) | Yes | Digital IO / USART1-TX |
| 20 | P11 | D IN/OUT | PA_8 (P29) | Yes | Digital IO |
| 21 | P12 | D IN/OUT | PB_8 (P45) | Yes | Digital IO / I2C1-SCL |
| 22 | GND | Supply | | - | Ground connection |
| 23 | P13 | D IN/OUT | PB_9 (P46) | Yes | Digital IO / I2C1-SDA |
| 24 | P14 | D IN/OUT, A IN | PA_1 (P11) | Yes | Digital IO / ADC_IN1 |
| 25 | P15 | D IN/OUT, A_IN | PA_0 (P10) | Yes | Digital IO / WKUP1 / ADC_IN0 |
| 26 | P16 | D IN | BOOT0 (P44) | No | Bootloader Pin 0, internally pulled-down by 47 k Ω |
| 27 | GND | Supply | | - | Ground connection |
| 28 | NC | NC | | - | This pin should be left unconnected |
| 29 | P17 | D IN/OUT, A IN | PA_3 (P13) | No | Digital IO / ADC_IN3 |
| 30 | GND | Supply | | - | Ground connection |
| 31 | RF | A IN/OUT | | - | External 50 Ω port for monostatic antenna connection |
| 32 | GND | Supply | | - | Ground connection |

Table 5-1: iM880B Pinout Table

5.2 Module Dimensions

The outer dimensions of the iM880B are given by Figure 5-2 and Figure 5-3.

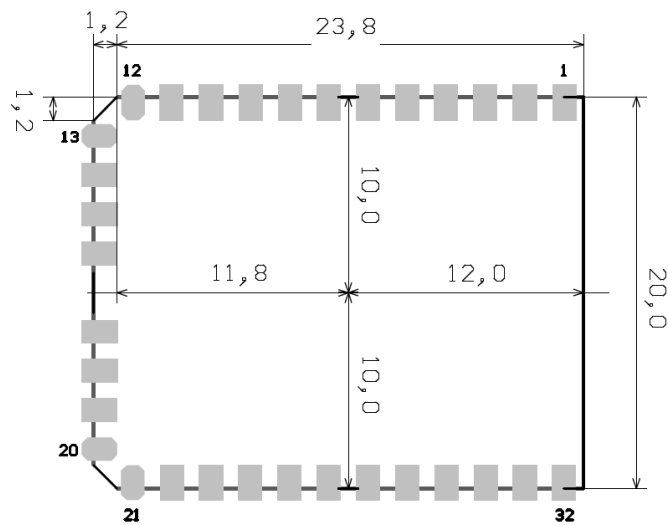


Figure 5-2: Outer Dimensions of the iM880B (top view)

5.3 Recommended Footprint

According to Chapter 5.2, a recommendation for the footprint of the iM880B is given by Figure 5-3.

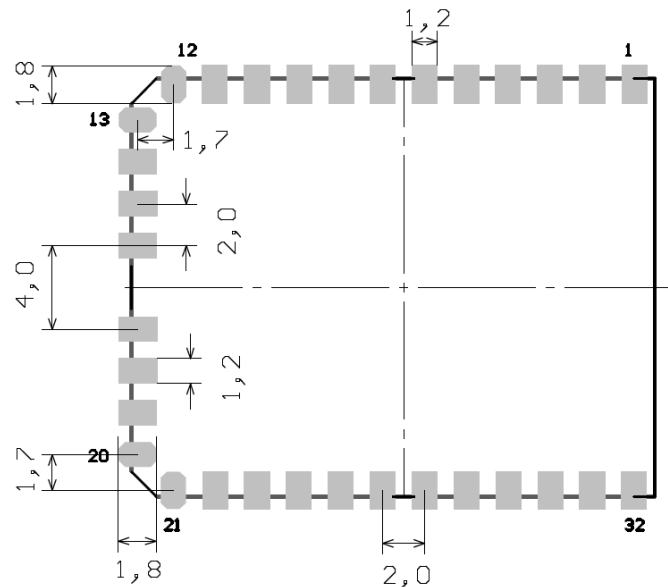


Figure 5-3: Recommended footprint of the iM880B (top view)

6. Module Interface Characteristics

6.1 Programming Interface

For programming the module with special firmware versions, there are two types of interfaces supported: A SWD-interface, which require a special programmer, as well as a bootloader-interface, for updating the modules firmware via UART-interface. For more details refer to [3].

Note: The module offers some IOs that are connected to the JTAG On-chip Debug system. Currently this interface is unavailable¹.

¹ Currently there is a silicon limitation for the MCU of the module. For more information please see: http://www.st.com/resource/en/errata_sheet/dm00097022.pdf (ES0224, V7.0, chapter 2.1.2)

7. Integration Guide

The iM880B provides 32 connectors as described in Chapter 5. For integrating the iM880B into an environment, a typically circuit as given in Chapter 7.1 can be used. While designing the PCB Layout, the recommendations of Chapter 7.2 should be applied, as well as the recommendation for soldering in Chapter 0.

7.1 Typical Application Schematic

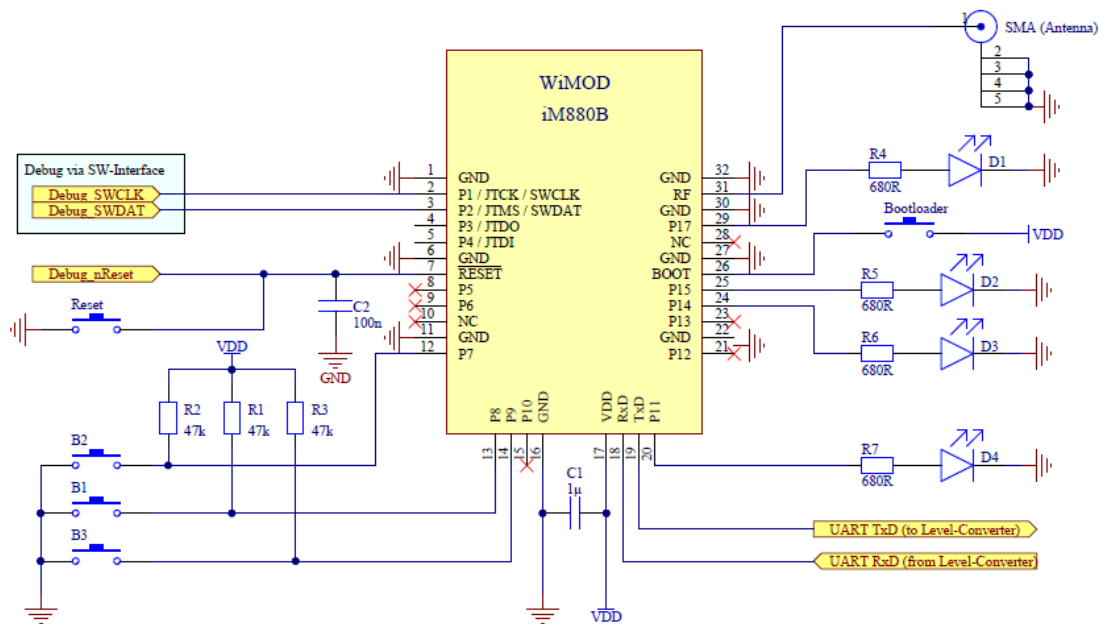


Figure 7-1: Typical Application Schematic for iM880B

7.2 PCB Design Recommendation

The Top Layer of the carrier board should be kept free of Tracks and Vias under the iM880B because there are some test pads on the bottom side of the module which are not covered by solder resist.

All GND pads of the module should be connected via low impedance path to GND.

The iM880B's RF interface is already matched to $50\ \Omega$. By using an adequate $50\ \Omega$ antenna, no additional matching components are required¹. For an ideal signal transmission between the module's RF pad and the antenna, the transmission line should be as short as possible and represent an impedance of $50\ \Omega$.

Note: Disregarding this recommendation can affect the RF performance respective RF output power, sensitivity, and unwanted emissions.

This impedance depends on frequency and PCB structure. It is recommended to use a grounded coplanar waveguide (CPWG) structure, to reduce effects of electromagnetic fields. The impedance of transmission line for grounded CPWG is basically affected by height H and material of the substrate, gap G between transmission line and ground on the top layer, as well as width W and thickness T of the transmission lines (Figure 7-2).

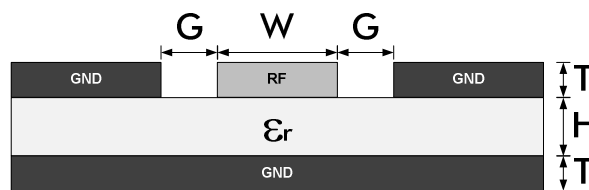


Figure 7-2: Structure of a grounded CPWG

Assuming a frequency of approx. 868 MHz, FR4 ($\epsilon_r \approx 4.8$) as substrate material, copper as conductor material, $G = 0.4\ \text{mm}$ and $T = 35\ \mu\text{m}$, the width of transmission line is given by Table 7-1.

| H [mm] | W [mm] |
|--------|--------|
| 1.0 | 1.37 |
| 1.6 | 1.85 |

Table 7-1: Recommended width of transmission line² for CPWG and 868 MHz

¹ In other case a special matching network is required

² The calculation is only valid if the transmission line is not under the iM880B

7.3 Recommended Soldering Conditions

An example of the temperature profile for the soldering process of the iM871A is depicted in Figure 7-3 with the corresponding values as given by Table 7-2. The temperature values should not exceed the limits.

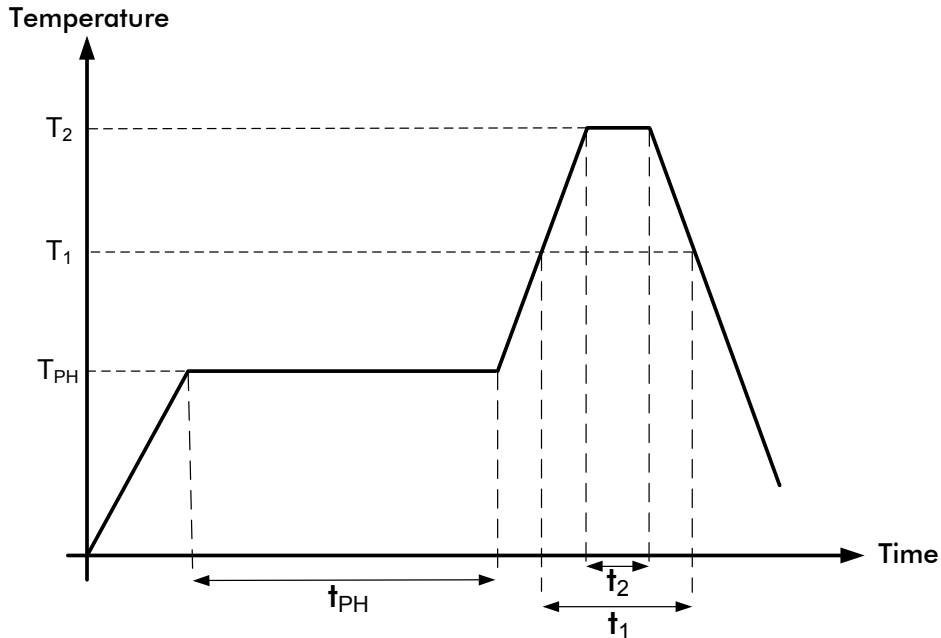


Figure 7-3: Soldering Profile

| Phase | Pb-Free Conditions |
|--------------|--|
| Preheating | $t_{PH} = 120s$ $T_{PH} = 160\sim 180^{\circ}C$ |
| Primary heat | $t_1 = 60s$ $T_1 = 220^{\circ}C$ |
| Peak | $t_2 = 10s (max)$ $T_2 = 255^{\circ}C$ |

Table 7-2: 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,...



8. Ordering Information

| Ordering Part Number | Description | Distributor |
|--|--|--|
| iM880B-L | Radio Module 128 KB Flash, 32 KB RAM, 16 MHz MCU crystal | sales@imst.de |
| SK – iM880B | Starter Kit for the iM880B. See Notes. | sales@imst.de |
| AB – iM880B | 2x Adapter Board with iM880B | sales@imst.de |
| Notes: The Starter Kit contains two Demo Boards, two Adapter Boards with iM880B, two antennas, and a CD or USB memory stick with documentation. | | |

Table 8-1: Ordering Information

9. Appendix

9.1 List of Abbreviations

| | |
|------------------|-------------------------------|
| ADC | Analog-to-Digital Converter |
| BER | Bit Error Rate |
| BSC | Basic Spacing between Centers |
| CPWG | Coplanar Waveguide |
| CW | Continuous Wave |
| GND | Ground |
| GPIO | General Purpose Input/Output |
| I ² C | Inter-Integrated Circuit |
| MCU | Microcontroller Unit |
| PCB | Printed Circuit Board |
| RAM | Random Access Memory |
| RF | Radio Frequency |
| SMBus | System Management Bus |
| SMT | Surface Mounted Technology |
| SPI | Serial Peripheral Interface |
| TRX | Transceiver |
| USB | Universal Serial Bus |

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9.4 References

- [1] Semtech Sx1272 Data Sheet from www.semtech.com
- [2] REC Recommendation 70-03 "Relating to the use of Short Range Devices (SRD)", Tromsø 1997, CEPT ECC subsequent amendments 9 th October 2012
- [3] iM880A_AN010_SW-Development from www.wirelss-solutions.de
- [4] iM880A_AN012_RFSettings from www.wirelss-solutions.de

10. Restrictions and Limitations

10.1 Hardware Restrictions and Limitations

The characteristic values given by the present document are typically obtained by measurements based on evaluation kits of the entitled device. Using other carrier boards or connected equipment might lead to different characteristics. Subject to given measurement results the characteristic values might show the best performance of the entitled device, independent from any compliancy restriction of final operation purposes.

10.2 Software Restrictions and Limitations

The present document is a datasheet of the entitled device which intentional use is to provide information about basic characteristics related to the device hardware. Typically all described characteristic values require software for obtaining them accordingly. All features of the available software are subject to changes without claim to be complete at any time. Characteristically values might also be provided based on datasheets of the appropriate key components unless there are test results available based on the available software. For more information regarding current supported features of the available software refer to www.wireless-solutions.de.

10.3 Compliancy Restrictions and Limitations

The entitled device has been designed to comply with the standards namely given in the present document. The intentional operation shall be in so called ISM bands, which can be used free of charge within the European Union and typically licences free all over the world. Nevertheless, restrictions such as maximum allowed radiated RF power or duty cycle may apply which might result in a reduction of these parameters accordingly.

In addition, the use of radio frequencies might be limited by national regulations which requirements also need to be met.

In case the entitled device will be embedded into other products (referred as "final products"), the manufacturer for this final product is responsible to declare the conformity to required standards accordingly. A proof of conformity for the entitled device is available from IMST GmbH on request. Beside the entitled device the conformity also considers software as well as supporting hardware characteristics which might also have an impact accordingly.

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.

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