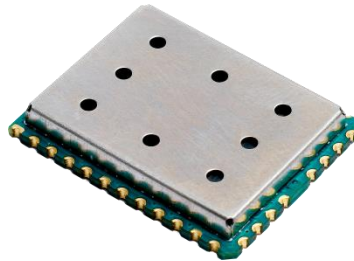# iM980A

Datasheet

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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 iM980A.

Table of Contents

1. Introduction

The iM980A is a compact, low power, bidirectional radio module for the 915 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 iM980A 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.
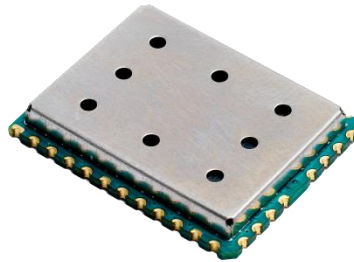
Figure 1-1: Picture of iM980A

1.1 Key Features

- Compact module 20.0 x 25.0 x 3.3 mm
- LoRa™ modulation technology
- Sensitivity down to -138 dBm
- UART, SPI and I²C interface[1]
- Digital inputs and outputs
- Analog inputs
- Supply voltage range from 2.4 to 3.6 V
- RF interface optimized to 50 Ω
- Integrated 20 dBm Power Amplifier
- High link budget up to 155 dB
- Range up to 15000m (Line of Sight)
- STM32L151CxU6Axx
- Certified according to FCC ID: 2AWAL409810

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.mcf88.it for more information.

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

2. Module Overview

The iM980A is an ultra-long range, high-performance, pre-certified module for wireless communication. It operates in the license free 915 MHz ISM frequency band and includes all necessary passive components for wireless communication as depicted in the following figure.
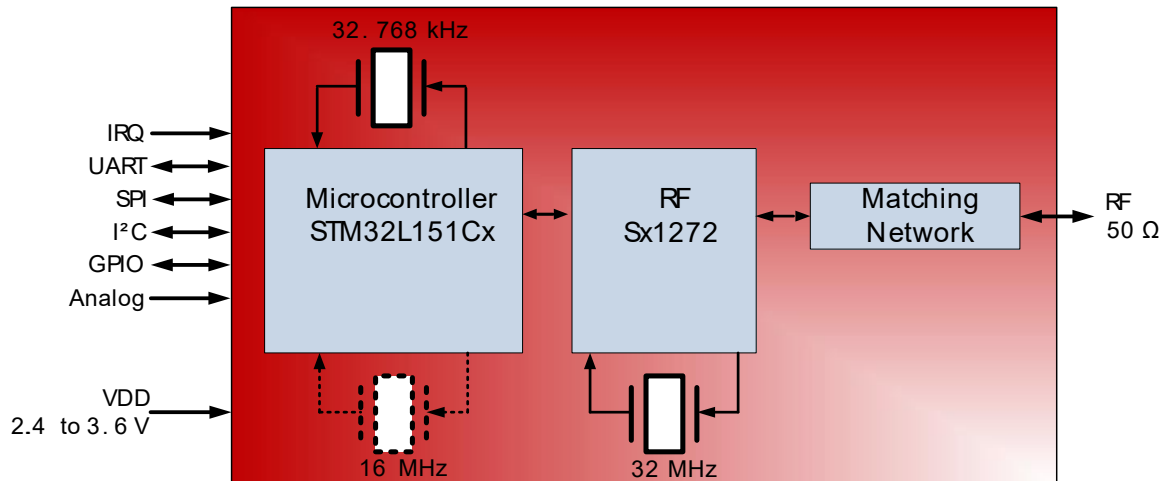
Figure 2-1: Block Diagram of Radio Module iM980A

The iM980A 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 iM980A receive performances are given in the following table.

Signal Bandwidth/[kHz]	Spreading Factor	Sensitivity/[dBm]
125	7	-123.2
125	12	-137.5
250	7	-120.7
250	12	-134.6
500	7	-115.5
500	12	-130.3

Table 2-1: Typically Radio Performance of iM980A

This high sensitivity combined with the integrated 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 qualified in accordance to FCC Part 15.

3. LoRa Modulation Technique

The iM980A 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.

3.1 Channel Frequencies

The iM980A uses the following channel set up specified by LoRaWAN [2]:
- Uplink (Tx) – 64 channels numbered 0 to 63 utilizing LoRa 125 kHz BW varying from DR0 to DR3, using coding rate 4/5, starting at 902.3 MHz and incrementing linearly by 200 kHz to 914.9 MHz
- Uplink (Tx) – 8 channels numbered 64 to 71 utilizing LoRa 500 kHz BW at DR4 starting at 903.0 MHz and incrementing linearly by 1.6 MHz to 914.2 MHz
- Downlink (Rx) – 8 channels numbered 0 to 7 utilizing LoRa 500 kHz BW at DR8 to DR13) starting at 923.3 MHz and incrementing linearly by 600 kHz to 927.5 MHz

3.2 Data Rates and Spreading Factors

The iM980A uses the following data rates and spreading factors specified by LoRaWAN [2]:

Data Rate	Settings	Indicative Physical Bit Rate [bit/s]
0	LoRa: SF10 / 125 kHz	980
1	LoRa: SF9 / 125 kHz	1760
2	LoRa: SF8 / 125 kHz	3125
3	LoRa: SF7 / 125 kHz	5470
4	LoRa: SF8 / 500 kHz	12500
5:7	For future use	
8	LoRa: SF12 / 500 kHz	980
9	LoRa: SF11 / 500 kHz	1760
10	LoRa: SF10 / 500 kHz	3900
11	LoRa: SF9 / 500 kHz	7000
12	LoRa: SF8 / 500 kHz	12500
13	LoRa: SF7 / 500 kHz	21900
14:15	For future use	

Table 3-1: Data Rates and Spreading Factors

4.   Electrical Characteristics

In the following different electrical characteristics of the iM980A 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 @500kHz	TRX receive mode, µC sleep mode		13.2		mA
Current Consumption TRANSMIT	TRX transmit mode, µC sleep mode, all µC units off, max. RF power level		122		mA
MCU operation frequency			32		MHz
			32.768		kHz
Memory (Flash)	iM980A		128		kByte
Flash Memory Endurance	Program memory	10k			Erase/ Write Cycles
	Data memory	300k			
Memory (RAM)	iM980A		32		kByte

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

Please refer to chapter 3.1

4.4.2   Transmitter RF Characteristics

The iM980A has an excellent transmitter performance as given by Table 4-4. 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.), 915 MHz if nothing else stated

Parameter	Condition	Min	Typ.	Max	Unit
Frequency Range		902	-	915	MHz
RF Output Power (conducted)	915 MHz Band (125 kHz BW) (500 kHz BW)		17.5	18.07 18.26	dBm
Modulation Techniques	LoRa®				
TX Frequency Variation vs. Temperature	-40 to +85°C	-	±10	-	kHz
TX Power Variation vs. Temperature		-	±0.5	-	dB

Table 4-4: Transmitter RF Characteristics

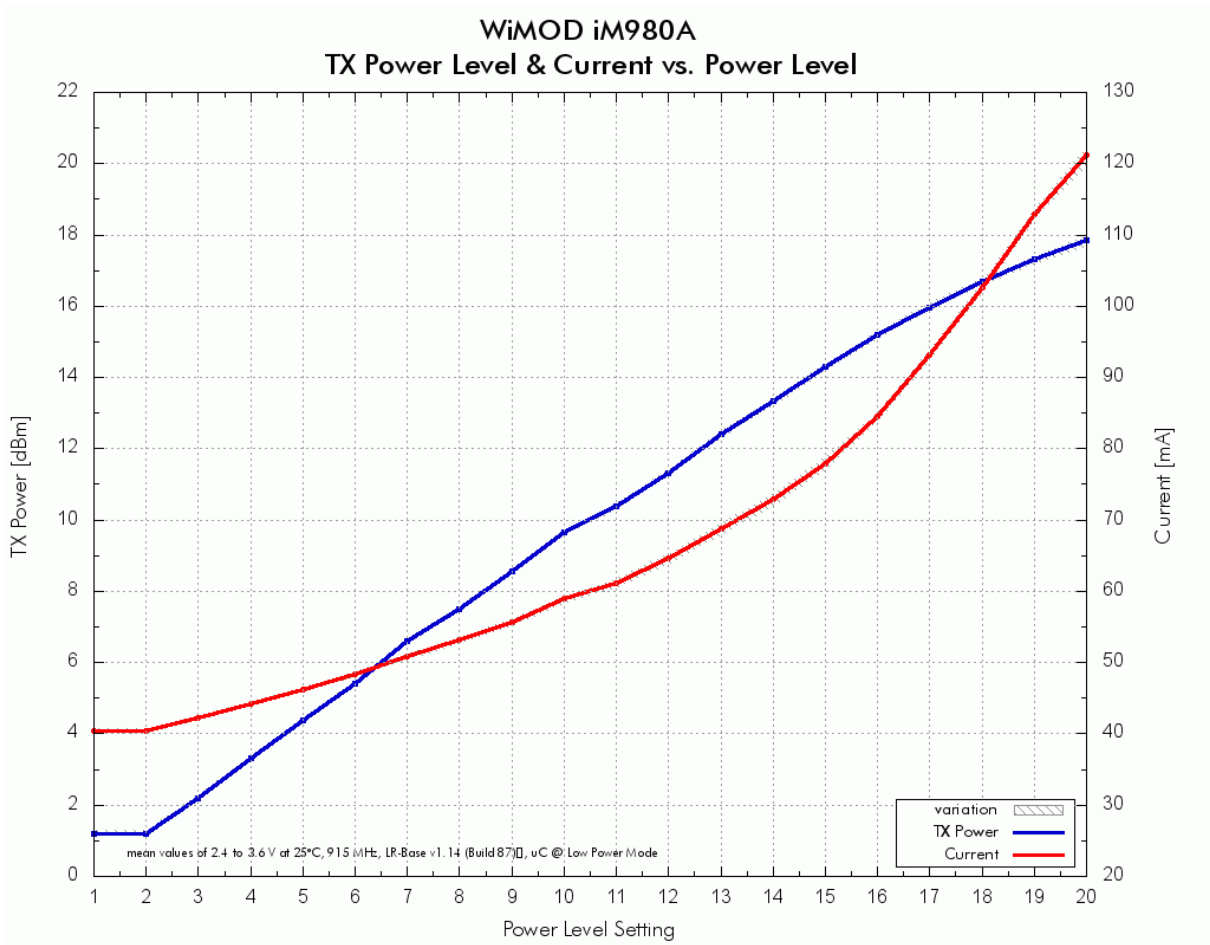**Note:** The antenna has to be matched with a maximum VSWR of 3:1.

Figure 4-1: RF output power level and current consumption versus power stages from 1 to 20 @ room temperature and 915 MHz

5.   Module Package

In the following the iM980A module package is described. This description includes the iM980A 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 iM980A'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.
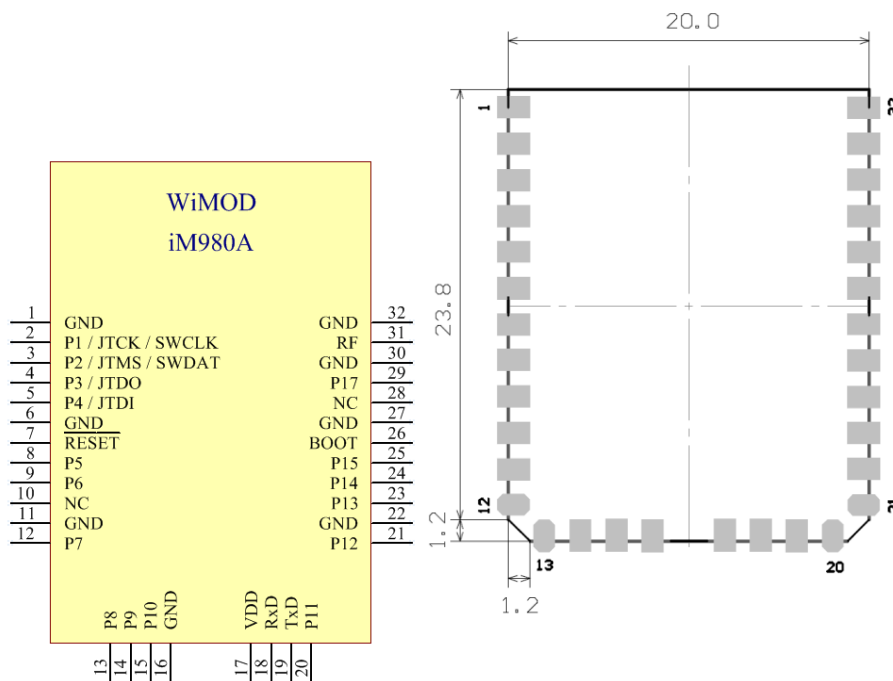

Figure 5-1: Description of iM980A module pins and top view

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 kΩ
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 kΩ
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 50Ω port for monostatic antenna connection
32	GND	Supply		-	Ground connection

Table 5-1: iM980A Pinout Table

5.2 Module Dimensions

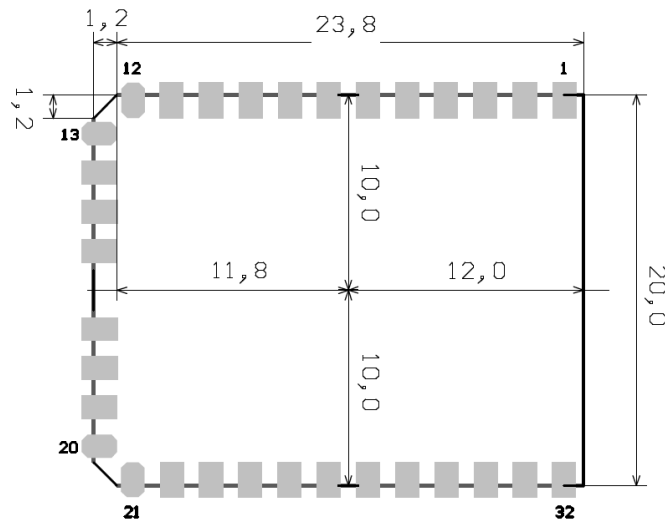The outer dimensions of the iM980A are given by Figure 5-2 and Figure 5-3.

Figure 5-2: Outer Dimensions of the iM980A (top view)

5.3 Recommended Footprint

According to Chapter 5.2, a recommendation for the footprint of the iM980A is given by Figure 5-3.
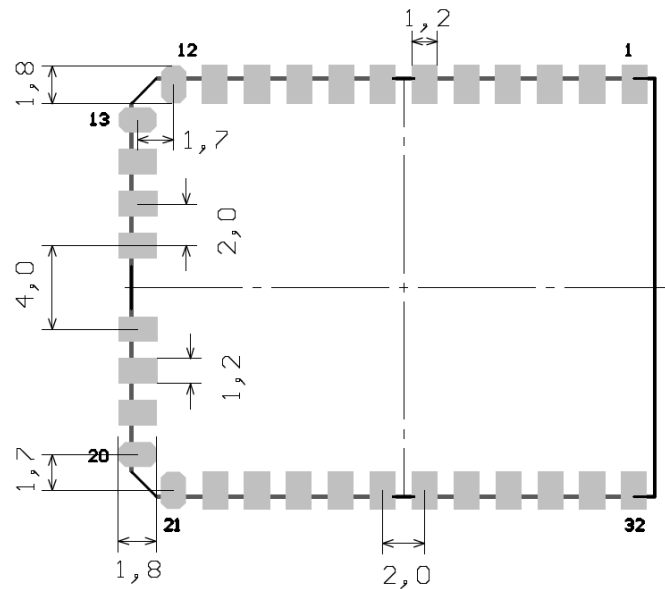

Figure 5-3: Recommended footprint of the iM980A (top view)

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.

Note: The module offers some IOs that are connected to the JTAG On-chip Debug system. Currently this interface is unavailable[1].

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[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 iM980A provides 32 pins as described in Chapter 5. For integrating the iM980A into an environment, a typically circuit as given in Chapter 0 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 7.3.
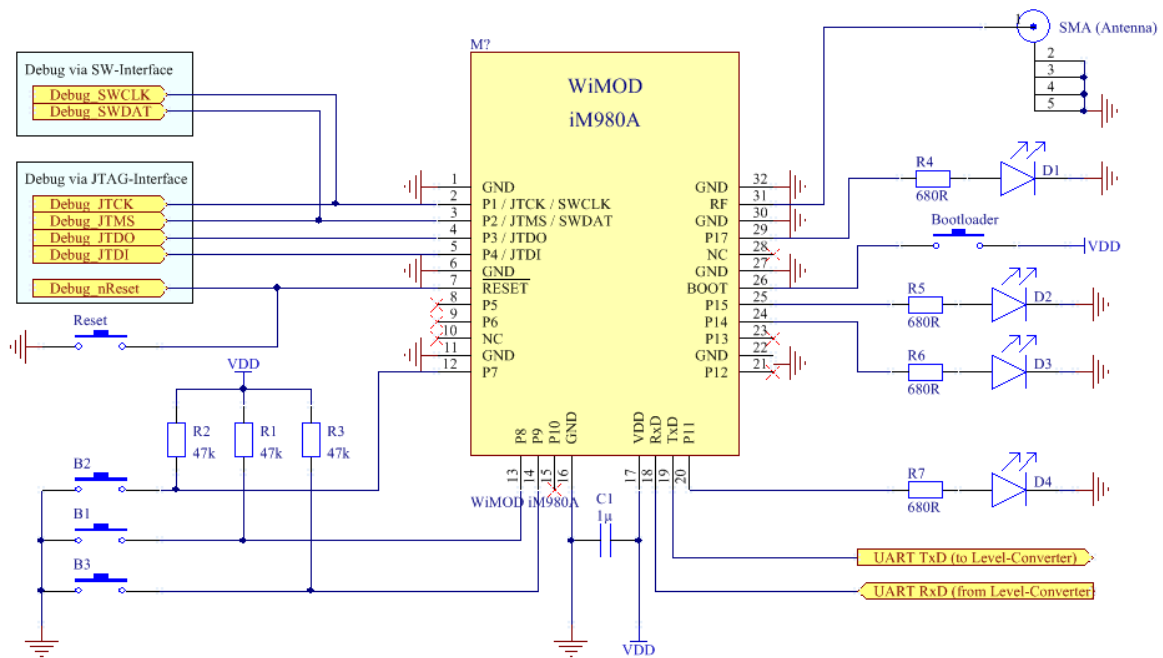
7.1   Typical Application Schematic

Figure 7-1: Typical Application Schematic for iM980A

7.2   PCB Design Recommendation

The Top Layer of the carrier board should be kept free of Tracks and Vias under the iM980A 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 iM980A's RF interface is already matched to 50 Ω. By using an adequate 50 Ω antenna, no additional matching components are required[1]. For an ideal signal transmission between the modules RF pad and the antenna, the transmission line should be as short as possible and represent an impedance of 50 Ω.

> **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).
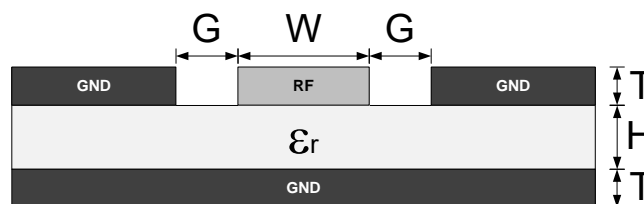

Figure 7-2: Structure of a grounded CPWG

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[1] In other case a special matching network is required

Assuming a frequency of approx. 915 MHz, FR4 ($\varepsilon_r \approx 4.8$) as substrate material, copper as conductor material, $G = 0.4\,mm$ and $T = 35\,\mu m$, the width of transmission line is given by Table 7-1.

H [mm]	W [mm]
1.0	1.4
1.6	1.9

Table 7-1: Recommended width of transmission line for CPWG and 915 MHz

7.3   Recommended Soldering Conditions

An example of the temperature profile for the soldering process of the iM980A is depicted in Figure 7-3 with the corresponding values as given by Table 7-2. The temperature values should not exceed the limits.
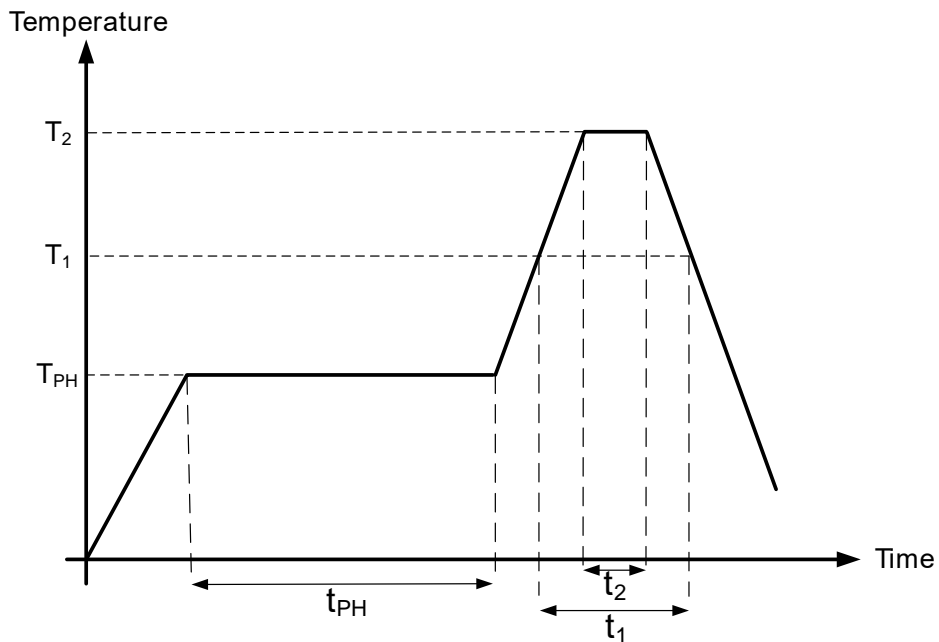

Figure 7-3: Soldering Profile

Phase	Pb-Free Conditions
Preheating	t_{PH} = 120s T_{PH} = 160~180°C
Primary heat	t_1 = 60s T_1 = 220°C
Peak	t_2 = 10s (max) T_2 = 255°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
iM980A	Radio Module 128 KB Flash, 32 KB RAM, 16 MHz MCU crystal	www.mcf88.it

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

I²C   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

9.2   List of Figures

9.3   List of Tables

9.4   References

[1]   Semtech Sx1272 Data Sheet from www.semtech.com

[2]   LoRaWAN_Regional_Parameters from www.lora-alliance.org

10.   Regulatory Compliance Information

The iM980A module has received Federal Communications Commission (FCC) CFR47 Telecommunications, Part 15 Subpart C modular approval in accordance with Part 15.212 Modular Transmitter Statement about FCC.

10.1   FCC Regulatory Notices

Modification Statement

mcf88 srl has not approved any changes or modifications to this device by the user. Any changes or modifications could void the user's authority to operate the equipment.

Interference Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Wireless notice

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. The antenna should be installed and operated with minimum distance of 20 cm between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Permitted Antenna

This radio transmitter iM980A has been approved by FCC to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Type	Max Gain
Planar inverted F-antenna[1]	4.0 dBi
SMD antenna PRO-OB-471	2.4dBi
Quarter wavelength monopole antenna	3.0dBi
Custom wire antenna	0 dBi

---

[1] Please refer to the Mote II data sheet for further information.

FCC Class B Digital Device Notice

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Labelling Requirements for Host Device

The host device shall be properly labelled to identify the modules within the host device. The certification label of the module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labelled to display the FCC ID of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning, as follows:

Contains FCC ID: 2AWAL409810

The applicable regulation requirements are subject to change. mcf88 srl 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 consult the local authorities of the relevant countries.

11. Important Notice

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11.2 Contact Information

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