WiMOD – iM891A-XL

Datasheet

Document ID: 4000/40140/0191

IMST GmbH

Carl-Friedrich-Gauß-Str. 2-4

47475 KAMP-LINTFORT

GERMANY

Document Information

File name	iM891A-XL_Datasheet.docx
Created	2024-11-20
Total pages	25

Revision History

Version	Note
1.0	First Release
1.1	Update of chapter 1.1 and Table 3-2

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 iM891A-XL.

Table of Contents

1.   Introduction

The iM891A-XL 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 iM891A-XL 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.

The module will be available in two hardware versions with and without u.fl connector and with different firmware. Please refer to chapter 7.
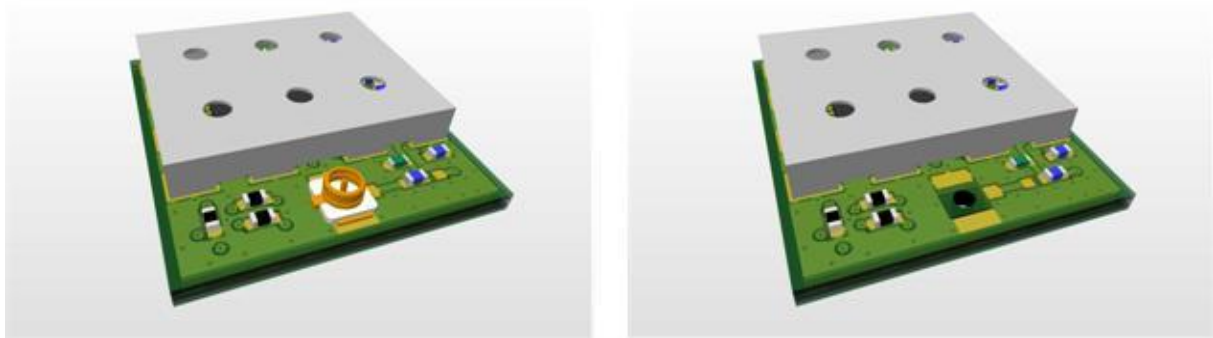

Figure 1-1: Pictures of iM891A-XL (variant "u.fl" on the left, variant "pad" on the right picture)

1.1   Key Features

- Compact size 16.8 x 18.6 x 3.3 mm
- AES256 hardware engine
- LoRa™ (CSS), LR_FHSS, FSK modulation
- Wireless M-Bus S, C, T, C/T
- OMS security modes 5, 7
- Supply voltage range from 1.9 to 3.6 V
- With u.fl connector or 50 Ohm pad
- Output power up to +20.5 dBm
- Sensitivity down to -150 dBm
- Powerful Cortex M4
- UART, SPI and I²C interface
- Digital, analog inputs and outputs
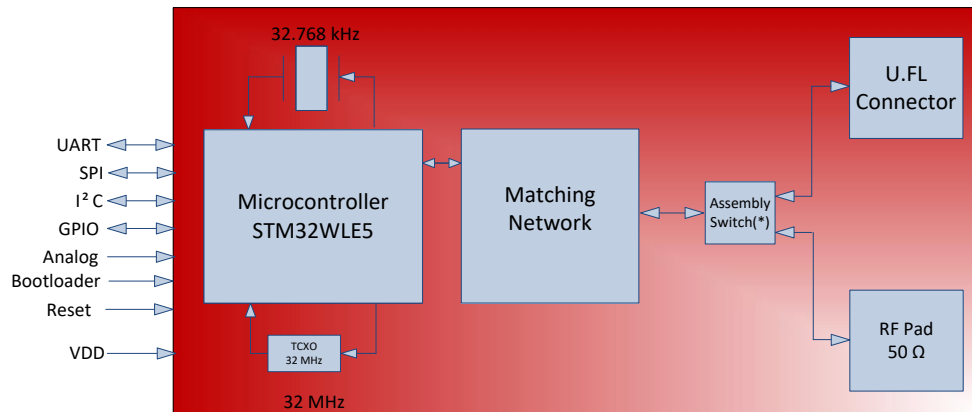- Pre-Certified according to EN 300 220

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 as well as the latest documents and software versions.

2.   Module Overview

The iM891A-XL 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.

(*) switching between u.fl connector or external RF pad is done by assembly variant

Figure 2-1: Block diagram of radio module iM891A-XL

It 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. Additionally to the LoRa modulation it is possible to use (G)FSK modulation.

The iM891A-XL is available as hardware variant with 50 Ohm pad or with u.fl connector. Differences (mounting of J101 and position of C100) are shown in Figure 2-2.

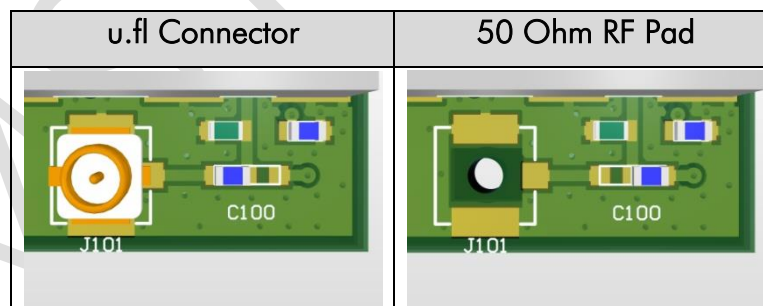
Figure 2-2: Assembly options

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 EN 300 220.

3. Electrical Characteristics

In the following different electrical characteristics of the iM891A-XL are listed. Details and other parameter ranges are available on request.

> **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.

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.

Parameter	Condition	Min	Typ.	Max	Unit
Supply Voltage (VDD)		0	-	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 3-1: 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.

3.2   Global Electrical Characteristics

T = 25°C, VDD = 3.3 V (typ.) if nothing else stated

Parameter	Condition		Min	Typ.	Max	Unit
Supply Voltage (VDD)			1.9	3.3	3.6	V
Current Consumption Low Power Mode	RTC off			1.0		µA
	RTC on			1.4		µA
Current Consumption RECEIVE	TRX receive mode, µC sleep mode	LoRa @ 125 kHz		7.2		mA
Current Consumption TRANSMIT	TRX transmit mode, µC sleep mode	Power Level Setting 14		50		mA
		Power Level Setting 22		121		mA
MCU operation frequency	HSE Clock			32		MHz
	LSE Clock			32.768		kHz
Notes:						

Table 3-2: General characteristics

3.3   RF Characteristics

3.3.1   Conducted Transmitter RF Characteristics

The iM891A-XL has an excellent transmitter performance as given by Table 3-3. For further details, refer to Figure 3-1 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 = 3.3 V (typ.), 866.5 MHz if nothing else stated

Parameter	Condition	Min	Typ.	Max	Unit
Frequency Range		863	-	870	MHz
RF Output Power	Transmitter Power Level Setting 14		12.5		dBm
	Transmitter Power Level Setting 22		20.5		dBm
Modulation Techniques	LoRa™, (G)FSK				
TX Frequency Variation vs. Temperature	-40 to +85°C		± 0.5		ppm
TX Power Variation vs. Temperature			± 0.8		dB
TX Power Variation vs. Frequency	863 MHz - 870 MHz		± 0.5		dB

Table 3-3: Transmitter RF characteristics

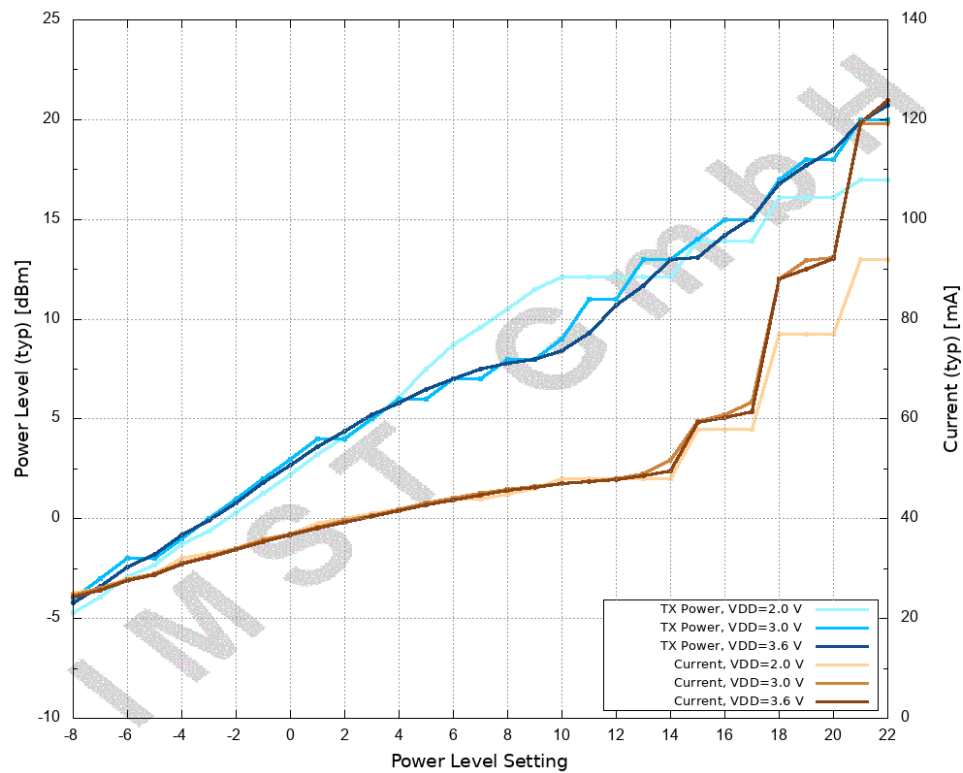**Note:** The antenna has to be matched with a maximum VSWR of 3:1.

Figure 3-1: Typical RF output power level and current consumption versus power level settings from -8 to 22 @ 25°C

3.3.2   Conducted Receiver RF Characteristics

Typical example values of iM891A-XL receiver performances are given in Table 3-4 and the following figures.

T = 25°C, VDD = 3.3 V (typ.), 866.5 MHz if nothing else stated

Parameter	Condition	Min	Typ.	Max	Unit
Modulation	LoRa				
Sensitivity [1,2]	DR 7.8 kHz, SF7		-137		dBm
	DR 7.8 kHz, SF12		-150		dBm
	DR 125 kHz, SF7		-125		dBm
	DR 125 kHz, SF12		-138		dBm
Modulation	FSK				
Sensitivity [1,3]	EN13757-4 S1-Mode 868.3 MHz, DR 32.768 kbps, Frequency-Deviation: ±50 kHz		-106		dBm
	EN13757-4 T1-Mode 868.95 MHz, DR 100 kbps, Frequency-Deviation: ±50 kHz		-106		dBm
	EN13757-4 C1-Mode 868.95 MHz, DR 100 kbps, Frequency-Deviation: ±45 kHz		-106		dBm

Notes:
1) based on lab equipment during characterization
2) PER ≤ 1%
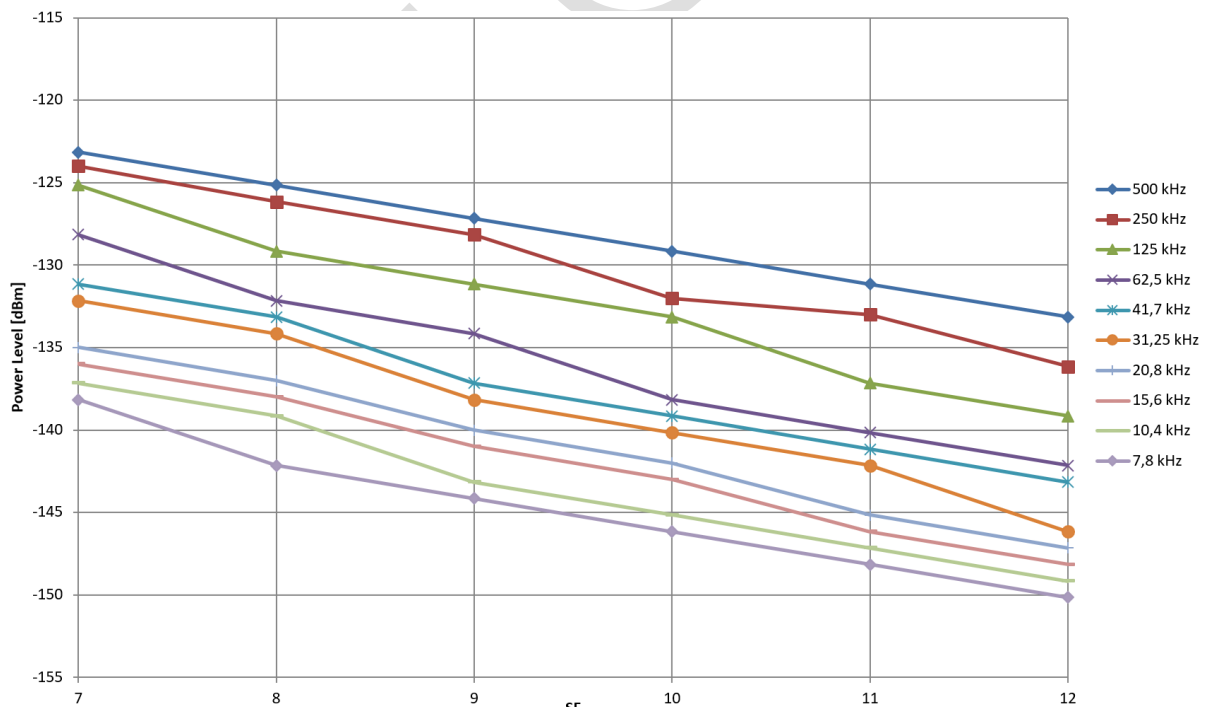3) PER conform to EN13757-4

Table 3-4: Receiver RF characteristics

Figure 3-2: Typical sensitivities[1] for different bandwidth and spreading factors of iM891A-XL

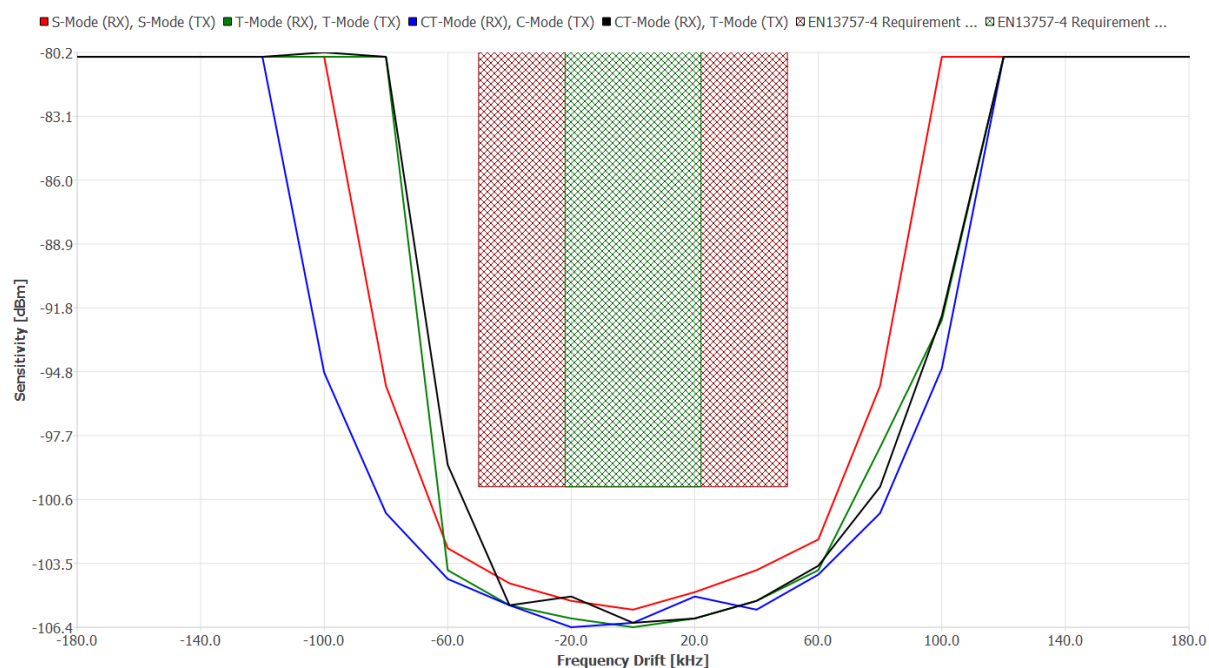
[1] based on lab equipment during characterization.

Figure 3-3: Typical sensitivities[1] for S1-, T1- and C1- and combined T1/C1 configuration of iM891A-XL

---

[1] based on lab equipment during characterization.

4. Module Package

In the following the iM891A-XL module package is described. This description includes the iM891A-XL 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.
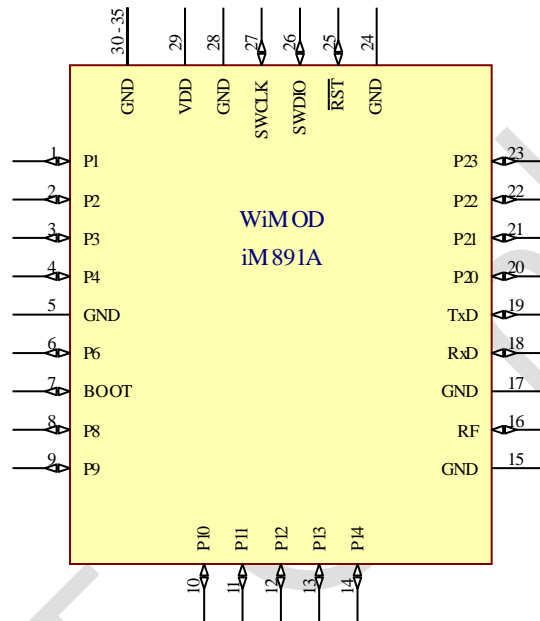
4.1 Pinout Description

Figure 4-1: iM891A-XL pinout

The figure shows the module with its pinout in top view. A detailed description of the individual pins can be found in Table 4-1: iM891A-XL pinout table.

PIN	Name	MCU Pin (number)	Description
1	P1	PA12	DIO / ADC_IN8 (see note 1)
2	P2	PB12	DIO (see note 1)
3	P3	PC13	DIO (see note 1)
4	P4	PA15	DIO (see note 1)
5	GND		Ground connection
6	P6	PB3	DIO / ADC_IN2 (see note 1)
7	BOOT	PH3-BOOT0	High active Bootloader Pin 0, internally pulled-down by 47 kΩ
8	P8	PB8	DIO / I2C1_SCL (see note 1)
9	P9	PB7	DIO / I2C1_SDA (see note 1)
10	P10	PB4	DIO / ADC_IN3 (see note 1)
11	P11	PA0	DIO / WKUP1 (see note 1)
12	P12	PA1	DIO (see note 1)
13	P13	PA2	DIO / USART2_TX (see note 1)
14	P14	PA3	DIO / USART2_RX (see note 1)
15	GND		Ground connection
16	RF		External 50 Ω port for monostatic antenna connection
17	GND		Ground connection
18	RxD	PA11 PA10	USART1_RX
19	TxD	PA9	USART1_TX
20	P20	PA5	DIO / SP11_SCK (see note 1)
21	P21	PA6	DIO / SP11_MISO (see note 1)
22	P22	PA7	DIO / SP11_MOSI (see note 1)
23	P23	PA4	DIO / SP11_NSS (see note 1)
24	GND		Ground connection
25	nRST	NRST	Low active Reset with 100 nF block capacitor and pulled-up by 40 kΩ
26	SWDIO	PA13	SWDIO
27	SWCLK	PA14	SWCLK
28	GND		Ground connection
29	VDD		Supply voltage
30-35	GND		Ground connection
Notes: 1) depends on used firmware, available on request.			

Table 4-1: iM891A-XL pinout table

4.2 Module Dimensions

The outer dimensions of the iM891A-XL are given by Figure 4-2 and Table 4-2. The height of the iM891A-XL is typically 3.3 mm.
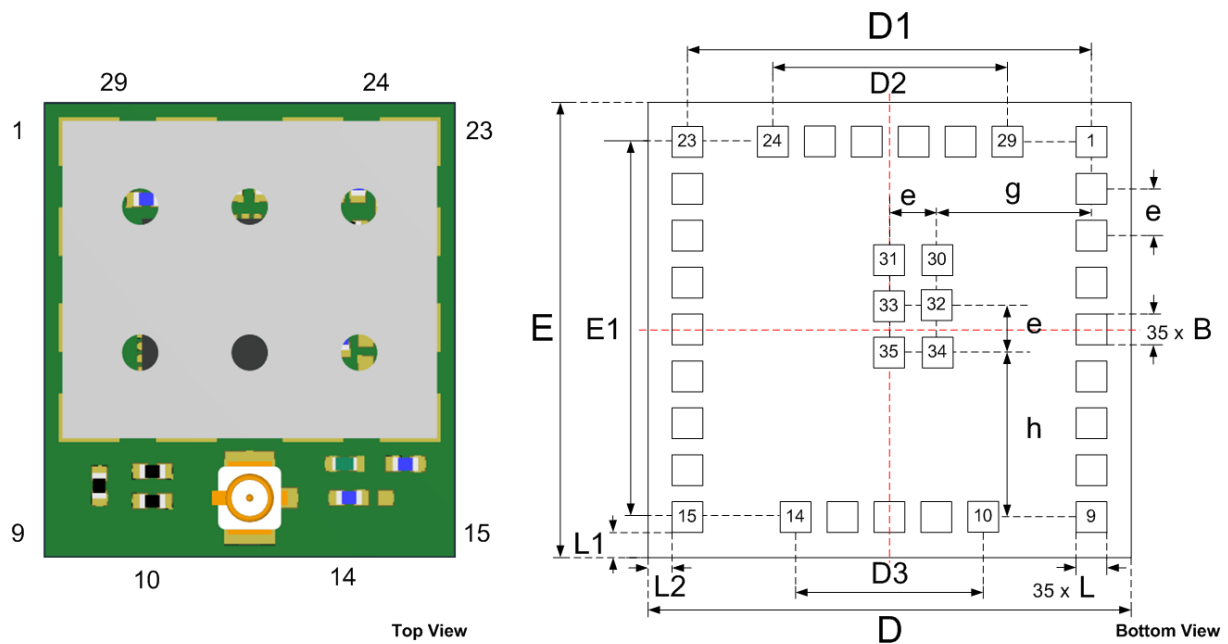

Figure 4-2: iM891A-XL package drawing in top (left) and bottom view (right)

Dimension	Min	Typ.	Max.
B	0.75	0.8	0.85
D	16.6	16.8	17.0
D1		15.0	
D2		10.5	
D3		8.4	
e		2.1	
g		5.4	
h		7.35	
E	18.4	18.6	18.8
E1		16.8	
L	0.75	0.8	0.85
L1		0.5	
L2		0.5	
H	-	3.3	-
Notes: 1) All dimensions are in mm, unless otherwise noted 2) All pitches are represented by (e) unless otherwise noted			

Table 4-2: iM891A-XL module dimensions

5. 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
- a bootloader-interface, for updating the modules firmware via UART-interface

5.1.1 SWD Interface

The module can be programmed based on the SWD Interface (signal pins SWCLK, SWDIO and nRST (see Table 4-1)). Therefore, a debugging adapter is required, e.g. STM ST-LINK/V2.

5.1.2 Bootloader Interface

The bootloader interface requires the nRST and BOOT pins to be controlled to enter the bootloader mode. BOOT signal needs to be pulled externally to high level during module reset (see Table 4-1). Afterwards the new firmware can be loaded into the module via the UART RxD and TxD using appropriate tools.

6. Integration Guide

The iM891A-XL provides 35 pads as described in Chapter 4.

For integrating the iM891A-XL into an environment, a typically circuit as given in Chapter 6.1 can be used. While designing the PCB Layout, the recommendations of Chapter 6.2 should be applied, as well as the recommendation for soldering in Chapter 6.3.
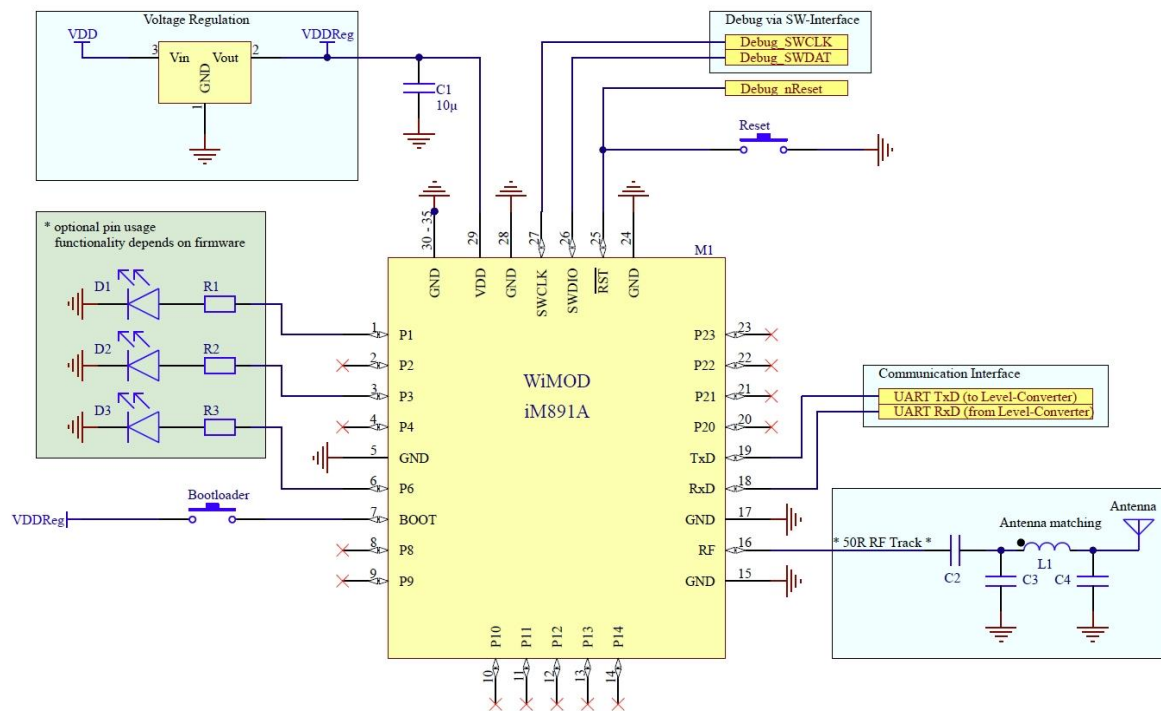
6.1 Typical Application Schematic

Figure 6-1: Typical application schematic for iM891A-XL

In general, the optional LED functionality can be enabled or disabled via firmware.

6.2   PCB Design Recommendation

The Top Layer of the carrier board should be kept free of tracks and vias under the iM891A-XL 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 iM891A-XL'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 module's 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 coplanar waveguide with lower ground plane (CPWG) structure, to reduce effects of electromagnetic fields. The impedance of transmission lines 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 6-2).
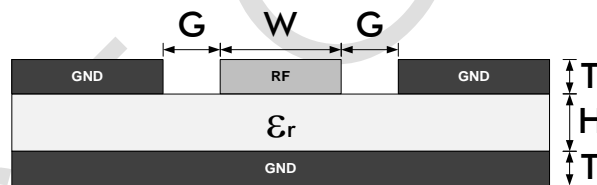

Figure 6-2: Structure of a grounded CPWG

Assuming a frequency of approx. 868 MHz, FR4 ($\varepsilon_r \approx 4.8$) as substrate material, copper as conductor material, G = 0.4 mm and T = 35 μm, the width of transmission line is given by Table 6-1.

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

Table 6-1: Recommended width of transmission line[2] for CPWG and 868 MHz

For exact dimension definition please contact your PCB supplier.

---

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

[2] The calculation is only valid if the transmission line is not under the M891A-XL

6.3   Recommended Soldering Conditions

An example of the temperature profile for the soldering process of the iM891A-XL is depicted in Figure 6-3 with the corresponding values as given by Table 6-2. The temperature values should not exceed the limits.
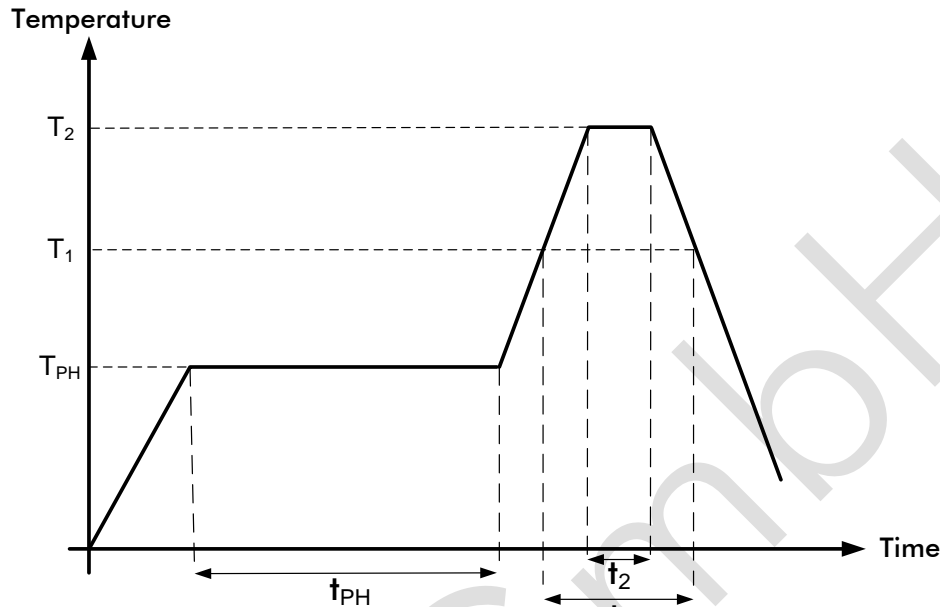

Figure 6-3: Soldering profile

Phase	Pb-Free Conditions
Preheating	$t_{PH} = 120s$ $T_{PH} = 160\sim180°C$
Primary heat	$t_1 = 60s$ $T_1 = 220°C$
Peak	$t_2 = 10s$ (max) $T_2 = 255°C$

Table 6-2: 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, ...

7.   Ordering Information

Hardware	Software	Part Number	Description
iM891A-XL	LoRaWAN ProLink	404925	iM891A-XL with 50 Ohm pad and LoRaWAN ProLink firmware
	Wireless M-Bus	404921	iM891A-XL with 50 Ohm pad and wireless M-Bus firmware
iM891A-XL u.fl	LoRaWAN ProLink	404923	iM891A-XL with u.fl connector and LoRaWAN ProLink firmware
	Wireless M-Bus	404922	iM891A-XL with u.fl connector and wireless M-Bus firmware
Contact : sales@imst.de			

Table 7-1: Ordering information

8.   Appendix

8.1   List of Abbreviations

ADC   Analog-to-Digital Converter

BER   Bit Error Rate

BSC   Basic Spacing between Centers

CPWG   Coplanar Waveguide with Lower Ground Plane

CW   Continuous Wave

CSS   Chirp Spread Spectrum

FEC   Forward Error Correction

FLRC   Fast Long Range Communication

FSK   Frequency Shift Keying

GFSK   Gaussian Frequency Shift Keying

GMSK   Gaussian Minimum Shift Keying

GND   Ground

GPIO   General Purpose Input/Output

I^2C Inter-Integrated Circuit

LR_FHSS Long Range Frequency Hopping Spread Spectrum

MCU   Microcontroller Unit

MSK   Minimum Shift Keying

OMS   Open Metering Specification

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

wM-Bus   wireless Meter Bus

8.2 List of Figures

8.3 List of Tables

8.4 References

[1]   STMicroelectronics STM32WLE5 data sheet from www.st.com

9.   Restrictions and Limitations

9.1   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. All given values are subject to changes without prior notice.

9.2   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.

9.3   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.

9.4   Disclaimer

IMST GmbH points out that all information in this document is given on an "as is" basis. No guarantee, neither explicit nor implicit is given for the correctness at the time of publication. IMST GmbH reserves all rights to make corrections, modifications, enhancements, and other changes to its products and services at any time and to discontinue any product or service without prior notice. It is recommended for customers to refer to the latest relevant information before placing orders and to verify that such information is current and complete. All products are sold and delivered subject to "General Terms and Conditions" of IMST GmbH, supplied at the time of order acknowledgment. IMST GmbH assumes no liability for the use of its products and does not grant any licenses for its patent rights or for any other of its intellectual property rights or third-party rights. It is the customer's duty to bear responsibility for compliance of systems or units in which products from IMST GmbH are integrated with applicable legal regulations. Customers should provide adequate design and operating safeguards to minimize the risks associated with customer products and applications. The products are not approved for use in life supporting systems or other systems whose malfunction could result in personal injury to the user. Customers using the products within such applications do so at their own risk.

Any reproduction of information in datasheets of IMST GmbH is permissible only if reproduction is without alteration and is accompanied by all given associated warranties, conditions, limitations, and notices. Any resale of IMST GmbH products or services with statements different from or beyond the parameters stated by IMST GmbH for that product/solution or service is not allowed and voids all express and any implied warranties. The limitations on liability in favor of IMST GmbH shall also affect its employees, executive personnel and bodies in the same way. IMST GmbH is not responsible or liable for any such wrong statements.

10. Contact Information

IMST GmbH

Carl-Friedrich-Gauß-Str. 2-4
47475 Kamp-Lintfort
Germany

T +49 2842 981 0
F +49 2842 981 299
E sales@imst.de
I www.wireless-solutions.de