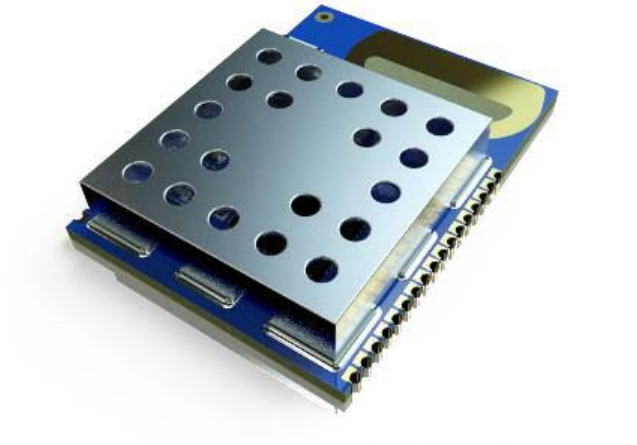


UM-1

RTLS and Communication module

Description

The UM-1 Module is a full-function RTLS / wireless modem subsystem in a compact factor, composed of Qorvo DWM1001 hardware, and WizziLab proprietary firmware. The UM-1 module enables customers to quickly get a RTLS system up-and-running, also provides additional over-the-air communication capabilities through the UWB, BLE and NFC interfaces. The UWB part of the system is designed to operate on 4.493 GHz (IEEE 802.15.4- 2011, Channel 3) and 6.490 GHz (IEEE 802.15.4- 2011, Channel 5) Nominal Centre Frequencies with a 500 MHz Bandwidth and data rates of 110 kbps and 850 kbps. It also features a BLE modem and a passive NFC-A listening device.

Key Features

Low-latency low-power two-way ranging for RTLS systems with up to 10 cm accuracy.

110 / 850 kbps data rate IEEE 802.15.4-2011.

UWB compliant, on channels 3/5.

Embedded PCB UWB antenna.

DASH7 over UWB communication @ 110 / 850 kbps on channels 3/5.

ETSI, FCC, ISED Certified

FCC ID: 2ARZVUM-1, IC:27701-UM1

BLE & NFC-A listening device. Tap-to-connect protocol and secured BLE connectivity

Motion sensor: 3-axis accelerometer

Bluetooth® connectivity & chip antenna Tap-to-connect

Current consumption optimized for low power sleep mode: <5µA

Supply voltage: 2.8 V to 3.6 V

Size: 19.1 mm x 26.2 mm x 2.6 mm

Operating temperature: -40 °C to 85 °C

Applications

Indoor / outdoor high precision RTLS BLE sniffing and beaconing.

BLE / NFC connectivity

D7A over UWB communication

WizziLab product line at www.wizzilab.com/products

Table of Contents

List of tables

1 Overview

The UM-1 Module is a full-function RTLS / wireless modem subsystem in a compact factor, composed of Qorvo DW1000 hardware, and WizziLab proprietary firmware.

1.1 UWB Transceiver DW1000

The UM-1 module has a DW1000 UWB transceiver mounted on the PCB. The DW1000 uses a 38.4 MHz reference crystal. The crystal has been trimmed in production to reduce the initial frequency error to approximately 3 ppm, using the DW1000 IC's internal on-chip crystal trimming circuit. Always-On (AON) memory can be used to retain DW1000 configuration data during the lowest power operational states when the on-chip voltage regulators are disabled. This data is uploaded and downloaded automatically. Use of DW1000 AON memory is configurable.

The on-chip voltage and temperature monitors allow the host to read the voltage on the VDDAON pin and the internal die temperature information from the DW1000.

See the DW1000 Datasheet [2] for more detailed information on device functionality, electrical specifications and typical performance.

1.2 Bluetooth® Microprocessor Nordic nRF52832

The nRF52832 is an ultra-low power 2.4 GHz wireless system on chip (SoC) integrating the nRF52 Series 2.4 GHz transceiver and an ARM Cortex-M4 CPU with 512kB flash memory and 64kB RAM.

See the nRF52832 datasheet [1] for more detailed information on device functionality, electrical specifications and typical performance.

1.3 Power Supply and Power management

The power management circuit consists of a switch mode regulator. It is a buck converter or step down converter. The input voltage to the UM-1 can be in the range 2.8V to 3.6V. Outputs from the converter provides 1.8V which is required by the DW1000 [2] transceiver.

1.4 Three Axis Motion Detector

The LIS2DH12 is an ultra-low-power high performance three-axis linear accelerometer with digital I2C/SPI serial interface standard output. The LIS2DH12 has user selectable full scales of ±2g/±4g/±8g/±16g and is capable of measuring accelerations with output data rates from 1 Hz to 5.3 kHz. The self-test capability allows the user to check the functionality of the sensor in the final application. The device may be configured to generate interrupt signals by detecting two independent inertial wake-up/free-fall events as well as by the position of the device itself.

The LIS2DH12 is guaranteed to operate over an extended temperature range from -40 °C to +85 °C.

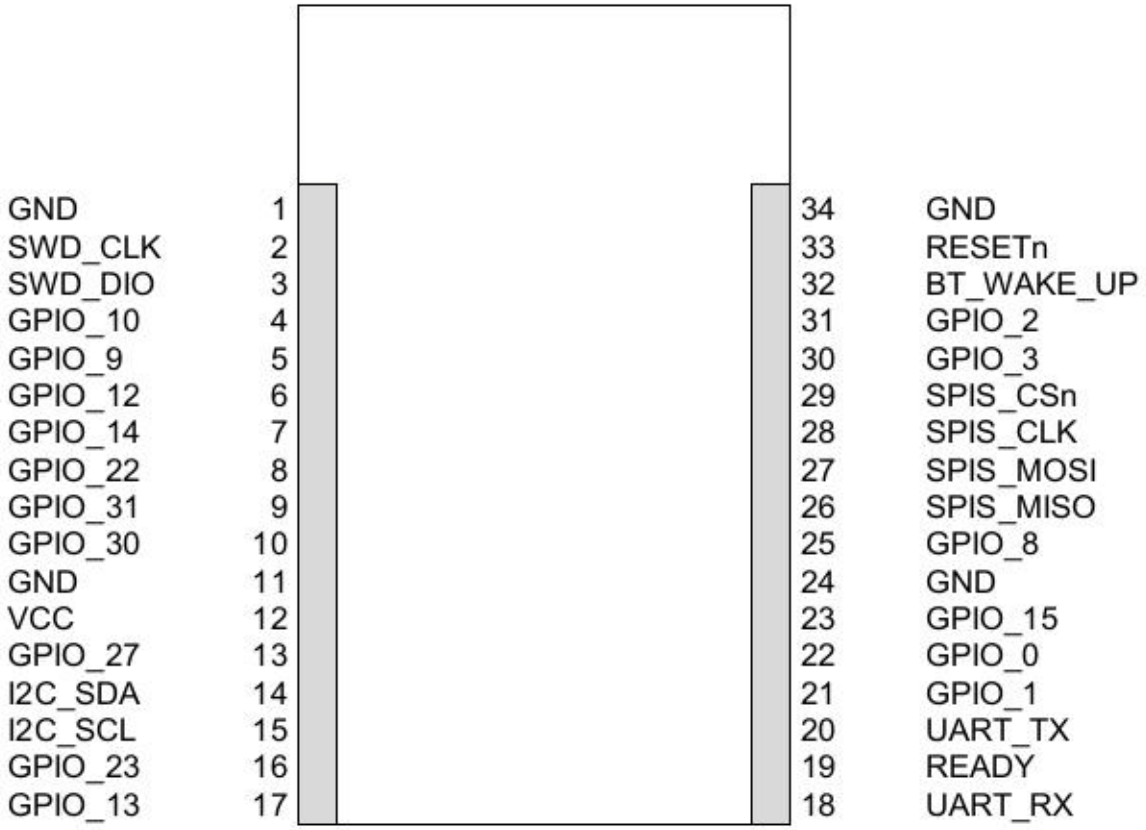
See the LIS2DH12TR Datasheet [4] for more detailed information on device functionality, electrical specifications and typical performance.

1.5 Software on board

The UM-1 module comes loaded with embedded firmware which provides two-way ranging (TWR), D7A over UWB communication and BLE (tap-to-connect, beaconing and sniffing in Eddystone and IBeacon format) functions. The module can be configured and controlled via its API, accessible thorough its serial (UART or SPI) port. The API is based on the open ALP specification, elaborated by the D7A Alliance [6]. For further information, contact WizziLab.

The same firmware is also available as a stand alone, non modifiable library, which provides a function API. This allows to execute the host firmware directly on the MCU of the UM-1.

2 Pin Connections



2.1 Pin Descriptions

Table 1. Pin Description

NAME	PIN	I/O	DESCRIPTION	REFERENCE
SWD_CLK	2	DI	Serial wire debug clock for nRF52 debug and programming	SWDCLK
SWD_DIO	3	DIO	Serial wire debug I/O for nRF52 debug and programming	SWDIO
GPIO_10	4	DIO	General purpose I/O pin.	P0.10
GPIO_9	5	DIO	General purpose I/O pin.	P0.09
GPIO_12	6	DIO	General purpose I/O pin.	P0.12
GPIO_14	7	DIO	General purpose I/O pin.	P0.14
GPIO_22	8	DIO	General purpose I/O pin.	P0.22
GPIO_31	9	DIO	General purpose I/O pin. ADC function of nRF52	P0.31
GPIO_30	10	DIO	General purpose I/O pin. ADC function of nRF52	P0.30
GPIO_27	13	DIO	General purpose I/O pin.	P0.27

I2C_SDA	14	DIO	Master I2C Data Line.	P0.29
I2C_SCL	15	DO	Master I2C Clock Line	P0.28
GPIO_23	16	DIO	General purpose I/O pin.	P0.23
GPIO_13	17	DIO	General purpose I/O pin.	P0.13
UART_RX	18	DO	UART_RX	P0.11
READY	19	DO	Generated interrupt from the device.	P0.26
UART_TX	20	DIO	UART_TX, This is also the ADC function of the nRF52	P0.05
GPIO_1	21	DIO	General purpose I/O pin.	GPIO1
GPIO_0	22	DIO	General purpose I/O pin.	GPIO0
GPIO_15	23	DIO	General purpose I/O pin.	P0.15
GPIO_8	25	DIO	General purpose I/O pin.	P0.08
SPIS_MISO	26	DI	SPI data output	P0.07
SPIS_MOSI	27	DO	SPI data input	P0.06
SPIS_CLK	28	DI	SPI clock	P0.04
SPIS_CSn	29	DI	SPI chip select	P0.03
GPIO_3	30	DO	General purpose I/O pin.	GPIO3
GPIO_2	31	DO	General purpose I/O pin.	GPIO2
BT_WAKE_UP	32	DIO	General purpose I/O pin.	P0.02
RESETn	33	DI	Reset pin. Active Low Input.	P0.21
VCC	12	P	External supply for the module. 2.8V - 3.6V	
GND	1 11 24 34	G	Common ground	

Table 2. I2C slave devices address I2C

I2C slave device	**Address**
LIS2DH12	0x19

3 Electrical specification

The following tables give detailed specifications for the UM-1 module. T amb = 25 ˚C for all specifications given.

3.1 Nominal operating conditions

Table 3. Recommended operating conditions

Symbol	Parameter	Min.	Typ.	Max.	Units
T_A	Operating ambient temperature range	-40	25	85	°C
V_{cc}	Supply voltage	2.8	3.3	3.9	V
V_{DIH}	Digital input voltage high	0.7 x V_{cc}		V_{cc}	V
V_{DIL}	Digital input voltage low	GND		0.3 x V_{cc}	V
V_{DOH}	Digital output voltage high	0.7 x V_{cc}		V_{cc}	V
V_{DOL}	Digital output voltage low	GND		0.3 x V_{cc}	V

4 Wireless Specification

4.1 UWB

Table 5. UWB transceiver operating conditions

Symbol	Parameter	Min.	Typ.	Max.	Units
B_{UWB}	RX/TX frequency range	4493(FCC)		6490(FCC/IC)	MHz

4.2 BLE

Table 6. BLE transceiver operating conditions

Symbol	Parameter	Min.	Typ.	Max.	Units
B_{BLE}	RX/TX frequency range	2402		2480	MHz
P_{TX}	Maximum Conducted Peak Output Power			2.41	dBm

5 Functionality

5.1 General Purpose

The UM-1 Module is a full-function RTLS / wireless modem subsystem in a compact factor, composed of Qorvo DW1000 hardware, and WizziLab proprietary firmware. The UM-1 module enables customers to quickly get a RTLS system up-and-running, also provides additional over-the-air communication capabilities through the UWB, BLE and NFC interfaces. The UWB part of the system is designed to operate on 4.493 GHz (IEEE 802.15.4- 2011, Channel 3) and 6.490 GHz (IEEE 802.15.4- 2011, Channel 5) Nominal Centre Frequencies with a 500 MHz Bandwidth and data rates of 110 kbps and 850 kbps. It also features a BLE modem and a passive NFC-A listening device.

5.2 Two-way ranging

The UM-1 provides two-way ranging function (TWR), as described in the DW1000 Datasheet [2]. The ranging is performed through the exchanges of 4 timestamped packets allowing to compute a time of flight estimation. The initiating device and the target device are awoken though an out-of-band event, so the TWR does not involve any polling, repetition, or any other transmission activity aimed to maintain a link between the devices. The TWR routine does not exceed 100 ms, transmission periods do not exceed 10 ms.

5.3 DASH7 over UWB

The UM-1 embeds a D7A protocol stack for the purpose of exchanging data between nodes. The stack is an implementation of the open specification elaborated by the D7A Alliance [7], which is by construction connectless (it is based on an asynchronous MAC). Transmission of data is initiated by the application. A DASH7 transaction is a single request followed by a single per-device response. The DASH7 protocol does not involve any polling, or any other continuous transmission activity in aimed to maintain a link between the devices. The DASH7 routine does not exceed 100 ms, transmission periods do not exceed 10 ms.

5.4 BLE beaconing and sniffing

The UM-1 embeds a BLE protocol stack, based on the Nordic Semiconductors SoftDevice library. The device supports tap-to-connect, beaconing and sniffing functions, in Eddystone and Ibeacon format.

5.5 Tap-to-connect

A device, supporting the tap-to-connect protocol, can establish BLE connection with the tag. The

format.

A device, supporting the tap-to-connect protocol, can establish BLE connection with the tag. The procedure is initiated by an NFC access event that triggers the immediate exit from monitoring mode and disabling of all DASH7 (sub-GHz) and UWB interfaces. The tag start blinking in blue.

The tap-to connect is meant to be used as an alternative for configuration and report dumping.

6 How to use

6.1 Serial API

The device can be controlled by a separate host over the UART or SPI serial port. The API is based on the open ALP specification, elaborated by the D7A Alliance [6]. Please contact WizziLab for a detailed description.

6.2 Function API

The same firmware is also available as a stand alone, non modifiable library, which provides a function API. This allows to execute the host firmware directly on the MCU of the UM-1. Please contact WizziLab for a detailed description.

7 FCC Caution

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

7.1 Compliance

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

IMPORTANT NOTE: 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.

7.2 Radiation Exposure

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.This device may not be employed for the operation onboard an aircraft, a ship or a satellite is prohibited.

7.3 UWB Operation Restriction

The module UM-1 meets general requirements specified in FCC§15.519 (a)

Host devices intended for indoor use must comply with the requirements of §15.517 (a). The host's user manual shall bear a statement on the device or in the instruction manual stating, "This equipment may only be operated indoors. Operation outdoors violates 47 U.S.C. 301 and could subject the operator to serious legal penalties.

- Host devices with any potential for outdoor usage shall comply with the handheld limitations of § 15.519 (a).
- For both an indoor or primarily handheld host, the module integration manual shall state that under § 15.521 (a) UWB devices may not be employed to operate toys. Operation on board an aircraft, a ship, or a satellite is prohibited

This device may not be employed for the operation onboard an aircraft, a ship or a satellite is prohibited.To avoid any installation mistake or any harm to user since lack of technical knowledge, it has to be installed by professional person.

8 ISEDC Warning

This device complies with Innovation, Science, and Economic Development Canada licence-exempt RSS standard(s). 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.

Le présent appareil est conforme aux CNR d' Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

(1) l'appareil nedoit pas produire de brouillage, et

(2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

The device is compliance with RF exposure guidelines, users can obtain Canadian information on RF exposure and compliance.

Le présent appareil est conforme Après examen de ce matériel aux conformité ou aux limites d'intensité de champ RF, les utilisateurs peuvent sur l'exposition aux radiofréquences et la conformité and compliance d'acquérir les informations correspondantes.

Manual v01

2.2 List of applicable FCC rules

CFR 47 FCC PART 15 SUBPART C&F has been investigated. It is applicable to the modular.

2.3 Specific operational use conditions

This module is stand-alone modular. If the end product will involve the Multiple simultaneously transmitting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module manufacturer for the installation method in end system.

2.4 Limited module procedures

Not applicable

2.5 Trace Antenna designs

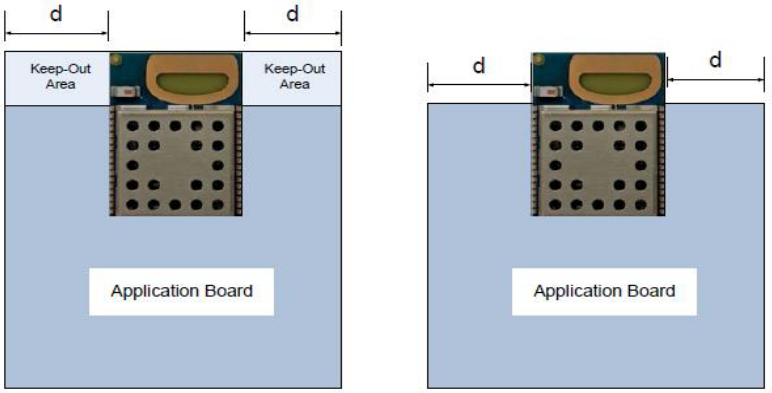
We supply the internal PCB antenna with UWB and Ceramic Antenna with BLE.

When designing the PCB onto which the DW1000 will be soldered, the proximity of the DW1000 on-board antenna to metal and other non-RF transparent materials needs to considered carefully. Two suggested placement schemes are shown below.

For best RF performance, ground copper should be flooded in all areas of the application board, except in the areas marked “Keep-Out Area”, where there should be no metal either side, above or below (e.g. do not place battery under antenna).

The two placement schemes in Figure 4 show an application board with no metallic material in the keep-out area. The diagram on the right is an application board with the antenna projecting off of the board so that the keep out area is in free-space. The diagram on the left shows an application board which does not have the module in free space but has the pcb copper removed on either side (and behind) the module antenna. (Note: the rectangular area above the shield on the module is the antenna area)

It is also important to note that the ground plane on the application board affects the DW1000 antenna radiation pattern. There must be a minimum spacing of 10 mm (d) without metal either side of the module antenna.



2.6 RF exposure considerations

To maintain compliance with FCC's RF Exposure guidelines.

2.7 Antennas

This radio transmitter FCC ID: 2ARZVUM-1 has been approved by Federal Communications Commission to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Antenna Description	Antenna Type	Frequency Range (MHz)	Impedance (Ω)	Maximum antenna gain(dBi)
Bluetooth/UWB Antenna	Ceramic Antenna /PCB Antenna	2402-2480/4493-6490	50	-4.3/0.8

2.8 Label and compliance information

The final end product must be labeled in a visible area with the following" Contains FCC ID: 2ARZVUM-1"

2.9 Information on test modes and additional testing requirements

Host manufacturer is strongly recommended to confirm compliance with FCC requirements for the transmitter when the module is installed in the host.

2.10 Additional testing, Part 15 Subpart B disclaimer

Host manufacturer is responsible for compliance of the host system with module installed with all other applicable requirements for the system such as Part 15 B

The manufacturers, or their authorized sales agents, must inform purchasers and users of their systems of the requirement to undertake detailed coordination of operational areas with the FCC prior to the equipment being operated.

Users of authorized, coordinated UWB systems may transfer them to other qualified users and to different locations upon coordination of change of ownership or location to the FCC and coordination with existing authorized operations.

9 Revision history

Table 7. Document revision history

Date	Revision	Changes
2021-11-30	0.1	Document creation.
2022-04-15	0.2	Updates after ATC review

10References

[1] nRF52832 Product Specification v1.3 www.nordicsemi.com

[2] Decawave DW1000 Datasheet www.decawave.com

[3] Decawave DW1000 User Manual www.decawave.com

[4] STMicroelectronics LIS2DH12TR www.st.com

[5] ALP specification v1.2 www.dash7-alliance.org

[6] D7A specification v1.2 www.dash7-alliance.org