

## Product Overview

The DWM1004C module is based on Decawave's DW1000 Ultra Wideband (UWB) transceiver IC, which is an IEEE 802.15.4-2011 UWB implementation. It integrates UWB antenna, all RF circuitry, a STM32L041G6U6S Cortex-M0+ and a LIS3DH motion sensor.

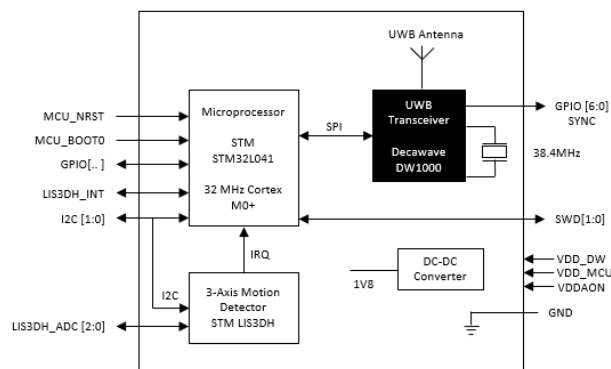


## Key Features

- Ranging accuracy to within 10cm.
- Partron UWB chip antenna on module
- IEEE 802.15.4-2011 UWB compliant
- STM32L041G6U6S microcontroller
  - 32kB flash, 8kB SRAM, RTC, AES, SPI and UART
- STM LIS3DH motion sensor, accelerometer
- On board 1.8V DC-DC
- Supply voltage 2.8V to 3.6V DC
- Optimised low power system design
- Size: 31mm x 16.5mm, 1.27mm castellation pitch
- IC: 23794-DWM1004 CH5 Only
- FCC ID 2AQ33-DWM1004 CH2 and CH5

## Key Benefits

- Hardware:
  - Low cost module for high volume industrial applications
  - Low-power hardware design and software architecture
  - Designed for TDoA but flexible for any UWB applications
  - Full RF design validated, tested and calibrated
- Certification:
  - 2 UWB frequency bands, CH2, 4GHz and CH5, 6.5GHz
  - 6.8 Mbit/s data rate, PRF64MHz, Preamble 128us
- Firmware:
  - TDoA Tag source code, CH2 and CH5, 6.8Mbps data rate
  - Configurable adaptive blink rate accelerometer support
  - Production test and certification source code provided
  - Simple TWR code example provided
  - Keil and Eclipse based projects



Block Diagram

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**DOCUMENT INFORMATION****Disclaimer**

Decawave reserves the right to change product specifications without notice. As far as possible changes to functionality and specifications will be issued in product specific errata sheets or in new versions of this document. Customers are advised to check with Decawave for the most recent updates on this product.

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**LIFE SUPPORT POLICY**

Decawave products are not authorized for use in safety-critical applications (such as life support) where a failure of the Decawave product would reasonably be expected to cause severe personal injury or death. Decawave customers using or selling Decawave products in such a manner do so entirely at their own risk and agree to fully indemnify Decawave and its representatives against any damages arising out of the use of Decawave products in such safety-critical applications.



**Caution!** ESD sensitive device. Precaution should be used when handling the device in order to prevent permanent damage.

**REGULATORY APPROVALS**

See Regulatory Information section

# 1 OVERVIEW

The block diagram on page 1 of this data sheet shows the major sections of the DWM1004C. An overview of these blocks is given below.

## 1.1 UWB Transceiver DW1000

The 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 for more detailed information on device functionality, electrical specifications and typical performance.

## 1.2 Microprocessor STM32L041G6UxS

The STM32L041G6UxS is an ultra-low power Cortex-M0+ CPU with 32kB flash memory and 8kB RAM. It supports SPI, I2C and UART serial interfaces and has an AES hardware block.

See the STM32L041G6UxS Datasheet for more detailed information on device functionality, electrical specifications and typical performance.

## 1.3 UWB Antenna ACS5200HFAUWB

The fixed UWB antenna mounted on the DWM1004C Module is from Partron, ACS5200HFAUWB.

## 1.4 Three Axis Motion Detector STMicroelectronics LIS3DH

The LIS3DH is an ultra-low-power high performance three-axis linear accelerometer with digital I2C/SPI serial interface standard output. See the LIS3DH Datasheet for more detailed information on device functionality, electrical specifications and typical performance.

## 1.5 Power Supply and Power management

The power management circuit consists of a switch mode regulator. It is a buck convertor or step down convertor. The input voltage to the DWM1004C can be in the range 2.8V to 3.6V. Outputs from the convertor provides 1.8V which is required by the DW1000.

## 1.6 Software

The DWM1004C module is shipped pre-loaded with embedded firmware which provides host selectable TDoA blink format support for UWB CH5 6.5GHz, CH2 4GHz and 6.8Mbps data rates. If relevant, download the appropriate software from Decawave.com to begin developing your own applications. The firmware contains a driver through which host application software can communicate to the DWM1004C device. The firmware offers the following features: Serial communication from a host device to allow adjustment of channel, configuration of blink rate and configuration of accelerometer settings. The firmware translates host command to DWM1004C actions. The firmware ensures that certain regulatory restrictions are adhered to (channel, data rate, PRF, Preamble etc).

**Per KDB 996369 D03, accompanying firmware for the DWM1004C allows customers to place the part in various test modes, for example continuous frame and continuous wave mode. The firmware and detailed test mode description is available as a download from Decawave.com.**

## 2 DWM1004C CALIBRATION

Depending on the end-use applications and the system design, DWM1004C settings may need to be tuned. To help with this tuning several built in functions such as continuous wave transmission and continuous packet transmission can be enabled. See the DW1000 User Manual for further details.

### 2.1.1 Crystal Oscillator Trim

DWM1004C modules are calibrated at production to minimise initial frequency error to reduce carrier frequency offset between modules and thus improve receiver sensitivity. The calibration carried out at module production will trim the initial frequency offset to less than 3 ppm, typically.

### 2.1.2 Transmitter Calibration

The DWM1004C is calibrated in module production, the calibrated values is permanently stored in the DW1000 OTP. This module is calibrated to meet the regulatory power spectral density requirement of less than -41.3 dBm/MHz.

### 2.1.3 Antenna Delay Calibration

In order to measure range accurately, precise calculation of timestamps is required. To do this the antenna delay must be known. The DWM1004C allows this delay to be calibrated and provides the facility to compensate for delays introduced by PCB, external components, antenna and internal DWM1004C delays.

When using the pre-loaded embedded firmware of the DWM1004C module, the Antenna Delay has been pre-calibrated for this configuration. The antenna delay is stored in OTP memory.

To calibrate the antenna delay, range is measured at a known distance using two DWM1004C systems. Antenna delay is adjusted until the known distance and reported range agree.

For best ranging accuracy antenna delay should be carried out as a once off measurement for each DWM1004C design implementation. If required, for greater accuracy, antenna delay calibration should be carried out on a per DWM1004C module basis, see DW1000 User Manual for full details.

### 3 DWM1004C PIN CONNECTIONS

#### 3.1 Pin Numbering

DWM1004C module pin assignments are as follows (viewed from top): -

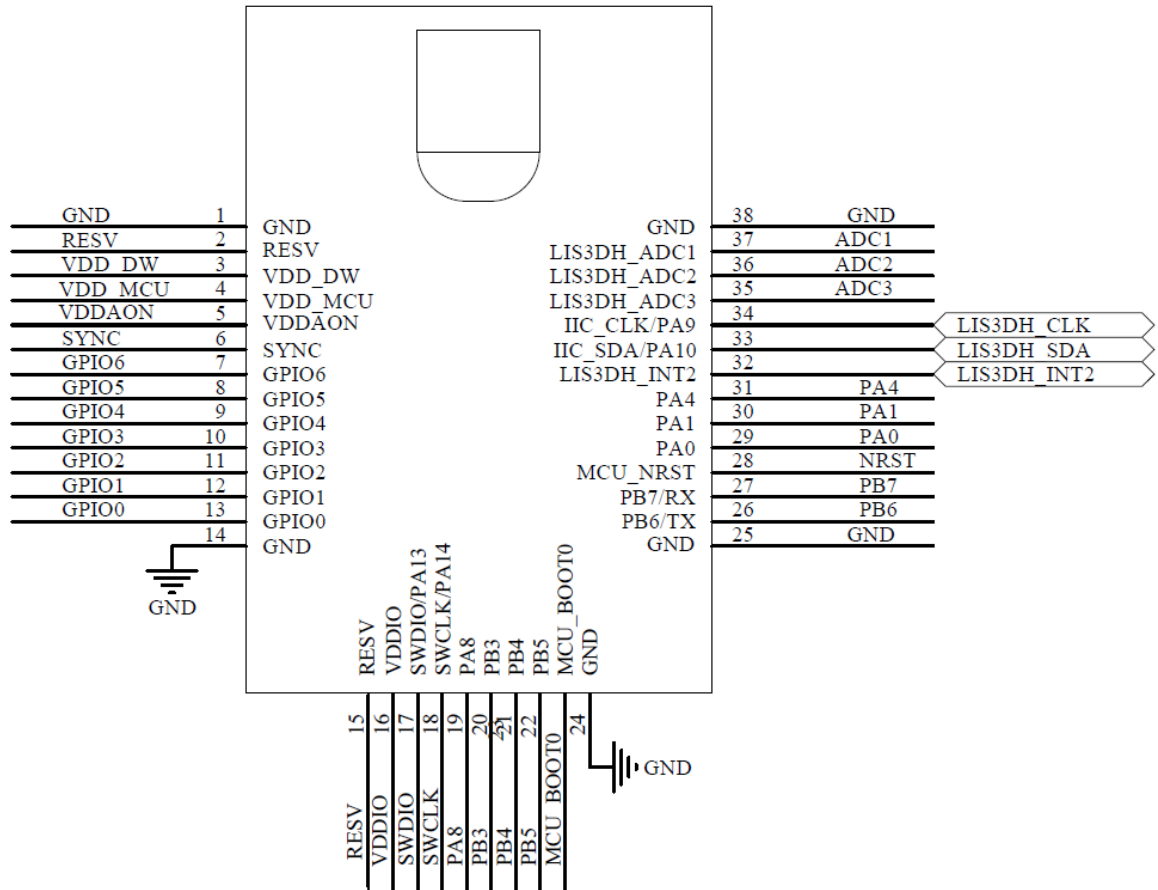


Figure 1: DWM1004C Pin Diagram ↑

↑ Pin 5 is connected to GND on engineering samples (V3) and connected to DW1000 VDDAON on production units (V3.1 onwards). The module version is clearly marked on the right side of the DWM1004 Antenna.

### 3.2 Pin Descriptions

Pin details are shown below.

**Table 1: DWM1004C Pin functions**

Pin NAME	Number	I/O (Default)	DESCRIPTION	ABBREVIATION
<b>Analog and Digital Interface</b>				
SYNC	6	DI	DW1000 Sync pin	DW
GPIO6	7	DIO	DW1000 General purpose I/O pin. SPI boot mode for DW1000	DW
GPIO5	8	DIO	DW1000 General purpose I/O pin. SPI boot mode for DW1000	DW
GPIO4	9	DIO	DW1000 General purpose I/O pin.	DW
GPIO3	10	DIO	DW1000 General purpose I/O pin.	DW
GPIO2	11	DIO	DW1000 General purpose I/O pin.	DW
GPIO1	12	DIO	DW1000 General purpose I/O pin.	DW
GPIO0	13	DIO	DW1000 General purpose I/O pin.	DW
SWDIO/PA13	17	DIO	Serial wire debug I/O for debug and programming of STM Processor. STM PA13	STM
SWDCLK/PA14	18	DI	Serial wire debug clock input for debug and programming of STM Processor. STM PA14	STM
PA8	19	DIO	MCU General purpose I/O pin	STM
PB3	20	DIO	MCU General purpose I/O pin	STM
PB4	21	DIO	MCU General purpose I/O pin	STM
PB5	22	DIO	MCU General purpose I/O pin	STM
MCU_BOOT0	23	DIO	STM Boot pin. Pulled low with 4.7K internally	STM
PB6/TX	26	DIO	MCU General purpose I/O pin	STM
PB7/RX	27	DIO	MCU General purpose I/O pin	STM
MCU_NRST	28	DI	Module Reset pin. Active Low Input.	STM
PA0	29	DIO	MCU General purpose I/O pin	STM
PA1	30	DIO	MCU General purpose I/O pin.	STM
PA4	31	DIO	MCU General purpose I/O pin.	STM
LIS3DH_INT2	32	DIO	LIS3DH Accelerometer INT2 Pin	LIS
IIC_SDA/PA10	33	DIO	I2C SDA MCU connection to LIS3DH	STM/LIS
IIC_CLK/PA9	34	DIO	I2C CLK MCU connection to LIS3DH	STM/LIS
LIS3DH_ADC3	35	AI	LIS3DH ADC3 input	LIS
LIS3DH_ADC2	36	AI	LIS3DH ADC2 input	LIS
LIS3DH_ADC1	37	AI	LIS3DH ADC1 input	LIS
<b>Power Supplies</b>				
VDDAON	5	P	DW1000 Pin 25 VDDAON	DW
VDD_DW	3	P	DW1000 Power	DW
VDD_MCU	4	P	MCU Power	STM
VDDIO	16	P	Module IO power, also for OTP programming, DW1000 Pin 42	
<b>Ground</b>				
GND	1,14, 24,25, 38	G	Common ground	



Pin NAME	Number	I/O (Default)	DESCRIPTION	ABBREVIATION
<b>Reserved</b>				
RESV	2, 15	N/A	Reserved pins. Do not connect.	

Table 2: Explanation of Abbreviations

ABBREVIATION	EXPLANATION
DI	Digital Input
DIO	Digital Input / Output
G	Ground
P	Power Supply
STM	STM MCU pin
DW	DW1000 pin
LIS	LIS3DH pin
AI	LIS3DH ADC Input

*Note: Any signal with the suffix 'n' indicates an active low signal.*

## Notes:

The accelerometer I2C read address is 0x33.

The STM MCU PB1 controls the reset pin of the DW1000.

DW1000's GPIOs 5,6 control the DW1000 SPI mode configuration. Within the DWM1004C module, those GPIOs are unconnected and will be internally pulled down in the DW1000 IC. Consequently, the DW1000 SPI block will be set to mode 0. For more details, please refer to DW1000 data sheet.

## 4 ELECTRICAL SPECIFICATIONS

The following tables give detailed specifications for the DWM1004C module.  $T_{amb} = 25\text{ }^{\circ}\text{C}$  for all specifications given.

### 4.1 Nominal Operating Conditions

Table 3: DWM1004C Operating Conditions

Parameter	Min.	Typ.	Max.	Units	Condition/Note
Operating temperature	-40		+85	$^{\circ}\text{C}$	
Supply voltage VCC	2.8	3.3	3.6	V	Normal operation
Voltage on VDDIO for programming OTP	3.7	3.8	3.9	V	Note that for programming the OTP in the DWM1004C this supply is connected to the VDDIO test point which is underneath the PCB. (See Figure 36)

### 4.2 DC Characteristics

Table 4: DWM1004C DC Characteristics

Parameter	Min.	Typ.	Max.	Units	Condition/Note
Digital input voltage high	$0.7 \times \text{VCC}$		VCC	V	
Digital input voltage low	GND		$0.3 \times \text{VCC}$	V	
Digital output voltage high	$0.7 \times \text{VCC}$		VCC	V	
Digital output voltage low	GND		$0.3 \times \text{VCC}$	V	

\* Using a ranging update rate of 1 Hz

### 4.3 Receiver AC Characteristics

Table 5: DWM1004C Receiver AC Characteristics

Parameter	Min.	Typ.	Max.	Units	Condition/Note
Frequency range CH5	6240		6739.2	MHz	Centre Frequency 6489.6 MHz
Frequency range CH2	3774		4243.2	MHz	Centre Frequency 3993.6 MHz

### 4.3.1 Absolute Maximum Ratings

Table 6: DWM1004C Absolute Maximum Ratings

Parameter	Min.	Max.	Units
Supply voltage	2.8	3.9	V
Receiver power		0	dBm
Storage temperature	-40	+85	°C
Operating temperature	-40	+85	°C
ESD (Human Body Model)		2000	V
DWM1004C pins other than VCC, VDDIO and GND		3.6	Note that 3.6 V is the max voltage that may be applied to these pins

Stresses beyond those listed in this table may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions beyond those indicated in the operating conditions of the specification is not implied. Exposure to the absolute maximum rating conditions for extended periods may affect device reliability.

## 5 PACKAGE INFORMATION

### 5.1 Module Drawings

All measurements are given in millimetres.

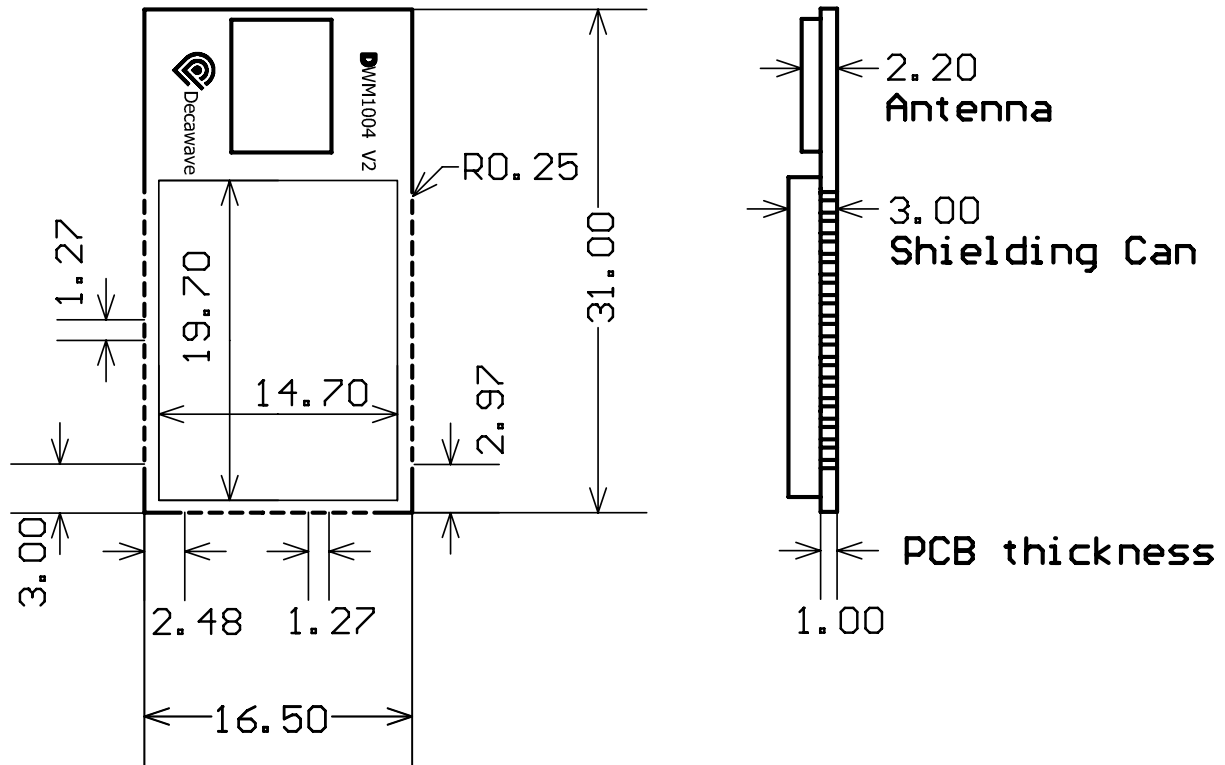


Figure 2: Module Package Size (units: mm)

## 5.2 Module Land Pattern

The diagram below shows the DWM1004C module land pattern.

### Recommended landing pattern

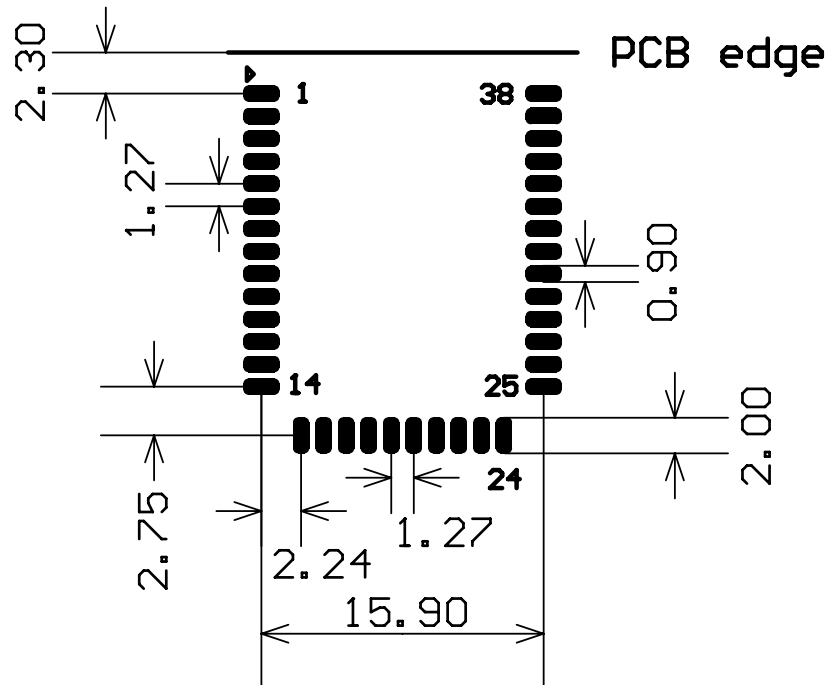


Figure 3: DWM1004C Module Land Pattern (units: mm)

## 5.3 Module Marking Information

Each module has a label on the shield with a serial number in the following format:

YY WW 4 SSSSS

Where:

YY	indicates the year
WW	indicates the week of the year
4	indicates the DWM1004C module
SSSSS	indicates the module manufacturing number

## 6 REGULATORY INFORMATION

US FCC ID: 2AQ33-DWM1004, Canada ISED/IC: 23794-DWM1004

This equipment has been tested and found to comply with the following directive(s) and standard(s):  
Radio Equipment Directive (RED) 2014/53/EU. Standards applied: EN301 489-1 V2.1.1, EN301 489-33 V2.2.1, EN 302 065 V2.1.1, EN62479:2010

FCC 47 CFR Part 15F (15.519 UWB), ISED RSS-220 (UWB). FCC and ISED Integration instructions according to KDB996369 D03 OEM V01 manual section.

The latest datasheet version can be downloaded from [www.decawave.com](http://www.decawave.com).

### 6.1 European Union requirements

#### 6.1.1 Radio Equipment Directive

The DWM1004C Module has been certified for use in European Union countries. A copy of the EU Declaration of Conformity is available for download on our website.

If these modules are incorporated into a product, the manufacturer must ensure continuing compliance of the final product to the Radio Equipment Directive 2014/53/EU. The manufacturer must then draw up a new written EU Declaration of Conformity as per RED Article 18.

Furthermore, the manufacturer must ensure the final product does not exceed the specified power ratings, antenna specifications, and/or installation requirements as specified in this document. If any of these specifications are exceeded in the final product, the manufacturer must assess whether additional compliance testing is required.

**IMPORTANT:** The "CE" marking must be in compliance with the RED Article 19. It must be affixed to a visible location on the OEM product. The CE mark shall have a height of at least 5mm except where this is not possible on account of the nature of the apparatus. The CE marking must be affixed visibly, legibly, and indelibly.





## 6.2 Innovation, Science and Economic Development Canada (ISED), formerly Industry Canada (IC), Compliance Statements

The IC certification applies to Channel 5 only.

This device complies with ISED 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'ISDE applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit 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.

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

The OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.). This Module is labelled with its own IC ID. If the IC ID Certification Number is not visible while installed inside another device then the final end product should display a label on it referring to the enclosed module in a visible area with the following:

“Contains Transmitter Module IC: 23794-DWM1004” OR “Contains IC: 23794-DWM1004”

Ce module est étiqueté avec son propre ID IC. Si le numéro de certification IC ID n'est pas visible lorsqu'il est installé à l'intérieur d'un autre appareil, l'appareil doit afficher l'étiquette sur le module de référence ci-joint. Dans ce cas, le produit final doit être étiqueté dans un endroit visible par le texte suivant :

“Contains Transmitter Module IC: 23794-DWM1004” OR “Contains IC: 23794-DWM1004”

## 6.3 Regulatory Module Integration Instructions

*This module has been granted modular approval for portable applications.* OEM integrators for host products may use the module in their final products without additional FCC / ISED certification if they meet the following conditions. Otherwise, additional FCC / ISED approvals must be obtained.

- The host product with the module installed must be evaluated for simultaneous transmission requirements.
- The user's manual for the host product must clearly indicate the operating requirements and conditions that must be observed to ensure compliance with current FCC/ISED RF exposure guidelines.
- A label must be affixed to the outside of the host product with the following statements:

This device contains FCC ID: 2AQ33-DWM1004

This equipment contains equipment certified under IC: 23794-DWM1004

The final host / module combination may also need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device. If the final host / module combination is intended for use as a portable device the host manufacturer is responsible for separate evaluations/approvals for the SAR requirements from FCC Part 2.1093 and RSS-102.

## 6.4 FCC Operating Requirements and Conditions

The design of DWM1004C complies with U.S. Federal Communications Commission (FCC) guidelines respecting safety levels of radio frequency (RF) exposure for Portable devices.

**FCC ID:** This product contains FCC ID: 2AQ33-DWM1004

### CFR §15.19 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 harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

### CFR §15.21 Information to user

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

### RF Exposure compliance statement

This Module 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.

### Labelling Instruction for Host Product Integrator

Please notice that if the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: "Contains FCC ID: 2AQ33-DWM1004" any similar wording that expresses the same meaning may be used.

*CFR § 15.19* Labelling requirements shall be complied on end user device. Labelling rules for special device, please refer to *CFR §2.925*, *CFR § 15.19 (a)(5)* and relevant KDB publications. For E-label, please refer to *CFR §2.935*.

### Installation Notice to Host Product Manufacturer

The OEM integrator is responsible for ensuring that the end-user has no manual instruction to remove or install module. This module has been evaluated stand alone to meet portable use without restriction, however, if a host product also contains other transmitter(s) and antenna(s), necessary test or evaluation needs to be performed in order to meet the requirement.

### Antenna Change Notice to Host manufacturer

If you desire to increase antenna gain and either change antenna type or use same antenna type certified, a Class II permissive change application is required to be filed by us, or you (host manufacturer) can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application.

### FCC other Parts, Part 15B Compliance Requirements for Host product manufacturer

This modular transmitter is only FCC authorized for the specific rule parts listed on our grant, host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification.

Host manufacturer in any case shall ensure host product which is installed and operating with the module is in compliant with Part 15B requirements.

Please note that For a Class B or Class A digital device or peripheral, the instructions furnished the user manual of the end-user product shall include statement set out in *CFR §15.105 Information to the user* or such similar statement and place it in a prominent location in the text of host product manual. Original texts as following:

For Class B

*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.*

For Class A

*Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.*

## 7 GLOSSARY

**Table 7: Glossary of Terms**

Abbreviation	Full Title	Explanation
ETSI	European Telecommunication Standards Institute	Regulatory body in the EU charged with the management of the radio spectrum and the setting of regulations for devices that use it
FCC	Federal Communications Commission	Regulatory body in the USA charged with the management of the radio spectrum and the setting of regulations for devices that use it
GPIO	General Purpose Input / Output	Pin of an IC that can be configured as an input or output under software control and has no specifically identified function
IEEE	Institute of Electrical and Electronic Engineers	Is the world's largest technical professional society. It is designed to serve professionals involved in all aspects of the electrical, electronic and computing fields and related areas of science and technology
PLL	Phase Locked Loop	Circuit designed to generate a signal at a particular frequency whose phase is related to an incoming "reference" signal.
PPM	Parts Per Million	Used to quantify very small relative proportions. Just as 1% is one out of a hundred, 1 ppm is one part in a million
RF	Radio Frequency	Generally used to refer to signals in the range of 3 kHz to 300 GHz. In the context of a radio receiver, the term is generally used to refer to circuits in a receiver before down-conversion takes place and in a transmitter after up-conversion takes place
RTLS	Real Time Location System	System intended to provide information on the location of various items in real-time.
SFD	Start of Frame Delimiter	Defined in the context of the IEEE 802.15.4-2011 standard.
SPI	Serial Peripheral Interface	An industry standard method for interfacing between IC's using a synchronous serial scheme first introduced by Motorola
TWR	Two Way Ranging	Method of measuring the physical distance between two radio units by exchanging messages between the units and noting the times of transmission and reception. Refer to Decawave's website for further information
TDoA	Time Difference of Arrival	Method of deriving information on the location of a transmitter. The time of arrival of a transmission at two physically different locations whose clocks are synchronized is noted and the difference in the arrival times provides information on the location of the transmitter. A number of such TDOA measurements at different locations can be used to uniquely determine the position of the transmitter. Refer to Decawave's website for further information.
UWB	Ultra Wideband	A radio scheme employing channel bandwidths of, or in excess of, 500MHz
ISED	Innovation, Science and Economic Development Canada (ISED)	See <a href="http://www.ic.gc.ca/eic/site/icgc.nsf/eng/home">http://www.ic.gc.ca/eic/site/icgc.nsf/eng/home</a>

## 8 DOCUMENT HISTORY

**Table 8: Document History**

Revision	Date	Description
1.2	15 <sup>th</sup> October 2019	Updated block diagram, added required FCC text
1.1	25 <sup>th</sup> July 2019	Added Block diagram and regulatory information. Updated footnote on page 7 referring now to modules v3.1 onwards
1.0	9 <sup>th</sup> July 2019	Initial release

## 9 FURTHER INFORMATION

Decawave develops semiconductors solutions, software, modules, reference designs - that enable real-time, ultra-accurate, ultra-reliable local area micro-location services. Decawave's technology enables an entirely new class of easy to implement, highly secure, intelligent location functionality and services for IoT and smart consumer products and applications.

For further information on this or any other Decawave product, please refer to our website [www.decawave.com](http://www.decawave.com).