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.
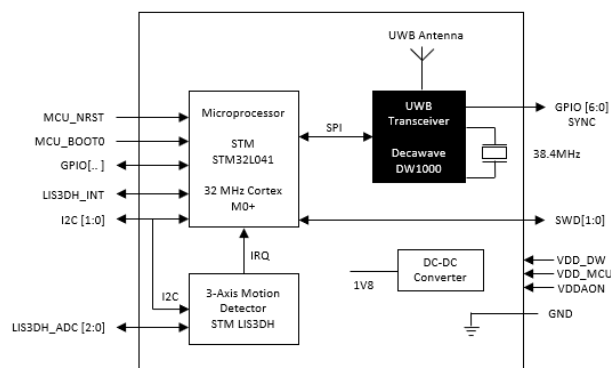
Key Features

- Ranging accuracy to within 10cm.
- Partron UWB chip antenna on module
- IEEE 802.15.4-2011 UWB compliant
- STM 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
- ISED/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 also 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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Caution! ESD sensitive device. Precaution should be used when handling the device in order to prevent permanent damage.

REGULATORY APPROVALS: See Regulatory Information section 10

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 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 during module production. The calibrated values are permanently stored in the DW1000 OTP memory. 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.

2.1.4 DWM1004C One-Time-Programmable (OTP) memory map

Calibrated settings are stored in the DW1000 one-time-programmable memory. The **Table 1** details the architecture and structure of the DWM1004C's OTP memory. In order to adhere to regulations, the DWM1004C must be configured to use the settings from OTP memory, more specifically:

Channel 2:
- Tx Power – Bytes [3:0] from address 0x013
- PG Delay – Byte [3] from address 0x01E

Channel 5:
- Tx Power – Bytes [3:0] from address 0x019
- PG Delay – Byte [2] from address 0x01E

The user should also implement a software routine that will compensate for transmit power and bandwidth variation over temperature and supply voltage level. The temperature and voltage value applied to DWM1004C during its calibration are store in OTP in order to be used as reference for the compensation routine:

- Temperature reference for TVC (Temperature/Voltage compensation) – Bytes [0] from address 0x01D
- Voltage reference for TVC – Bytes [1] from address 0x01D

For Two Way Ranging applications, the DWM1004C should be configured with calibrated antenna delay values in order to achieve the best accuracy when ranging.

- Channel 5: Antenna Delay – Bytes [1:0] from address 0x01C
- Channel 2: Antenna Delay – Bytes [3:2] from address 0x01C

Table 1: DWM1004C OTP memory map

OTP Address	Size (Used Bytes)	Byte [3]	Byte [2]	Byte [1]	Byte [0]	Programmed By
0x000	4	64 bit EUID (These 64 bits get automatically copied over to DW1000 Register file: 0x01 – Extended Unique Identifier on each reset.)				Customer
0x001	4					
0x002	4	Alternative 64bit EUID				Customer
0x003	4					
0x004	4	40 bit LDOTUNE_CAL (These 40 bits can be automatically copied over to *Sub Register File 0x28:30 LDOTUNE* on wakeup)				Decawave Test
0x005	1					
0x006	4	PART ID / CHIP ID (32bits)				Decawave Test
0x007	4	LOT ID (32 bits)				Decawave Test
0x008	2	-	-	V_{meas} @ 3.7 V	V_{meas} @ 3.3 V	Decawave Test
0x009	1 / 1	-	-	T_{meas} @ Ant Cal	T_{meas} @ 23 °C	Decawave Test
0x00A	0	-				Reserved
0x00B	4	-				Reserved
0x00C	2	-				Reserved
0x00D	4	-				Reserved
0x00E	4	-				Reserved
0x00F	4	-				Reserved
0x010	4					Customer
0x011	4					Customer
0x012	4					Customer
0x013	4	CH2 TX Power Level PRF 64				Decawave Test
0x014	4					Customer
0x015	4					Customer
0x016	4					Customer
0x017	4					Customer
0x018	4					Customer
0x019	4	CH5 TX Power Level PRF 64				Decawave Test
0x01A	4					Customer
0x01B	4	PG CNT CH2 [15:8]	PG CNT CH2 [7:0]	PG CNT CH5 [15:8]	PG CNT CH5 [7:0]	Decawave Test
0x01C	4	TX/RX Antenna Delay CH2		TX/RX Antenna Delay CH5		Decawave Test
0x01D	0			VBAT (RAW)	Temp (RAW)	Decawave Test
0x01E	2	PG delay CH2	PG delay CH5	OTP Revision	XTAL_Trim [4:0]	Decawave Test
0x01F	0	-	-	-	-	Customer
:	:	:	:	:	:	Reserved
0x400	4	SR (SPI mode OTP setting).				Customer

3 DWM1004C PIN CONNECTIONS

3.1 Pin Numbering

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

Module
DWM1004_V3.1

1	GND	GND	38
2	RESV	ADC1	37
3	VDD_DW	ADC2	36
4	VDD_MCU	ADC3	35
5	VDD_AON	LIS3DH_SCL	34
6	SYNC	LIS3DH_SDA	33
7	GPIO6	LIS3DH_INT2	32
8	GPIO5	PA4	31
9	GPIO4	PA1	30
10	GPIO3	PA0	29
11	GPIO2	MCU_NRST	28
12	GPIO1	PB7/RX	27
13	GPIO0	PB6/TX	26
14	GND	GND	25

Bottom pins (15–24): RESV, VDDIO, SWDIO/PA13, SWCLK/PA14, PA8, PB3, PB4, PB5, MCU_BOOT0, GND
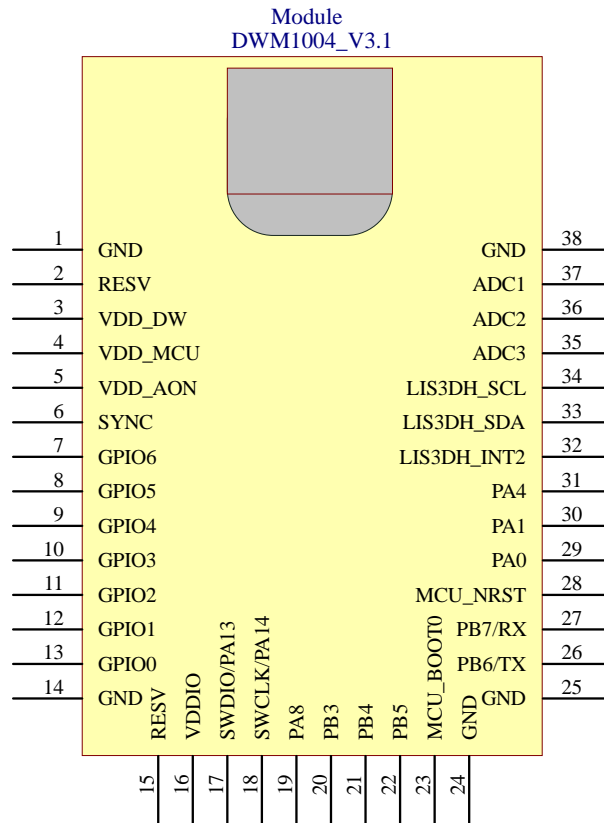
Figure 1: DWM1004C Pin Diagram ↑

↑ 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.

Module
DWM1004_V3.1

Pin	Left		Right	Pin
GND	1	GND	GND	38	GND
	2	RESV	ADC1	37
	3	VDD_DW	ADC2	36
VDD	4	VDD_MCU	ADC3	35
	5	VDD_AON	LIS3DH_SCL	34
	6	SYNC	LIS3DH_SDA	33
	7	GPIO6	LIS3DH_INT2	32
	8	GPIO5	PA4	31
	9	GPIO4	PA1	30
	10	GPIO3	PA0	29
	11	GPIO2	MCU_NRST	28
	12	GPIO1	PB7/RX	27
	13	GPIO0	PB6/TX	26
GND	14	GND	GND	25	GND

Bottom pins (15–24):

15 RESV
16 VDDIO
17 SWDIO/PA13
18 SWCLK/PA14
19 PA8
20 PB3
21 PB4
22 PB5
23 MCU_BOOT0
24 GND

GND

Optional SWD programming

nRST
SWCLK
SWDIO

Figure 2: DWM1004C Application Circuit Diagram – Simple

Figure 3: DWM1004C Application Circuit Diagram – Coin-Cell Battery Tx Only Tag

3.2 Pin Descriptions

Pin details are shown below.

Table 2: DWM1004C Pin functions

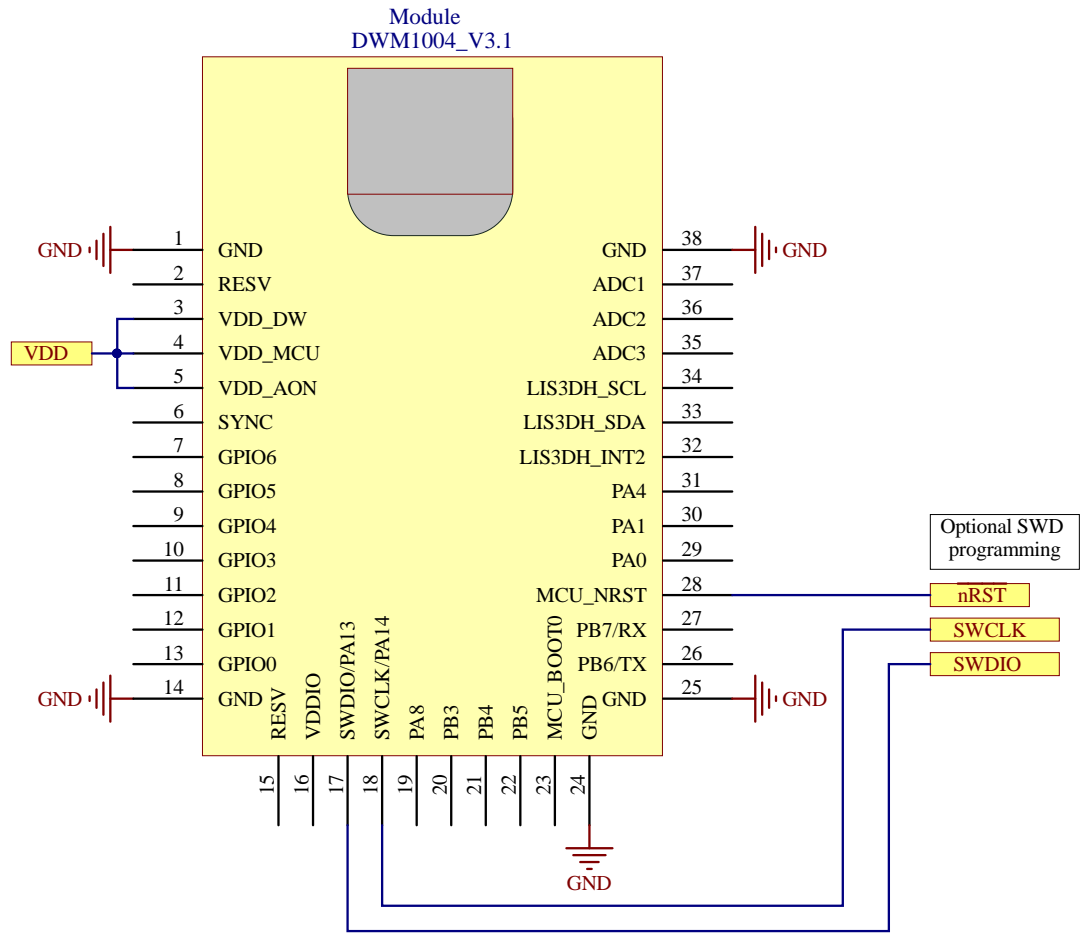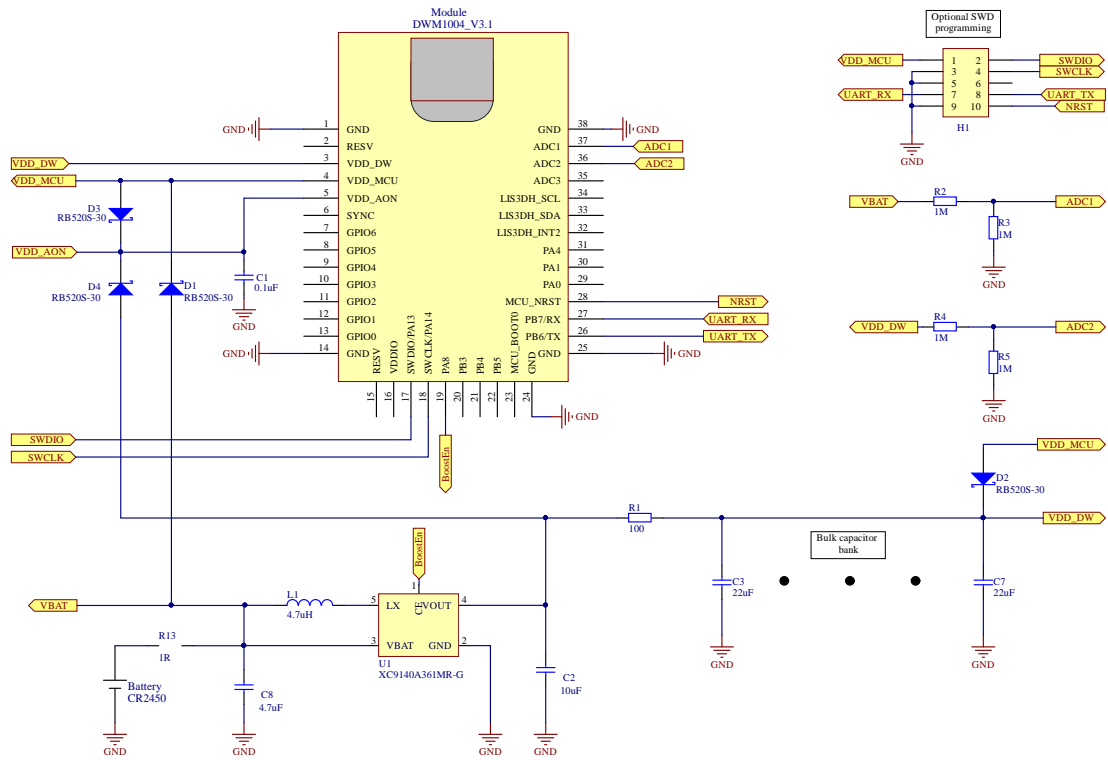| Pin NAME	Number	I/O (Default)	DESCRIPTION	ABBREVIATION
Analog and Digital Interface				
SYNC	6	DI	DW1000 Sync pin	DW
GPIO6	7	DIO	DW1000 General purpose I/O pin. SPI boot mode for DW1000	DW
GPIO5	8	DIO	DW1000 General purpose I/O pin. SPI boot mode for DW1000	DW
GPIO4	9	DIO	DW1000 General purpose I/O 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
Power Supplies				
VDDAON	5	P	DW1000 Pin 25 VDDAON	DW
VDD_DW	3	P	DW1000 Power	DW
VDD_MCU	4	P	MCU Power	STM
OTP Memory Programming Support				
VDDIO	16	PP	Apply 3.8V for OTP Memory programming, DW1000 Pins 31 and 42. These pins are internally decoupled according to the DW1000 Datasheet	DW
Ground				
GND	1,14, 24,25, 38	G	Common ground	

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

Table 3: Explanation of Abbreviations

ABBREVIATION	EXPLANATION
DI	Digital Input
DIO	Digital Input / Output
G	Ground
P	Power Supply
PP	OTP Memory programming voltage
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. $T_{amb} = 25\ °C$ for all specifications given.

4.1 Nominal Operating Conditions

Table 4: DWM1004C Operating Conditions

Parameter	Min.	Typ.	Max.	Units	Condition/Note
Operating temperature	-40		+85	˚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 module pin 16 VDDIO, see **Table 2**

4.2 DC Characteristics

Table 5: DWM1004C DC Characteristics

Parameter	Min.	Typ.*	Max.	Units	Condition/Note
Supply current in DEEP SLEEP mode		4		µA	All peripherals in lowest power consumption mode. Achievable where RTC and accelerometer are disabled with custom firmware.
Supply current in DEEP SLEEP mode		7		µA	RTC and accelerometer operational, all other peripherals in lowest power consumption mode.
Supply current in IDLE mode		16		mA	MCU and DW1000 awake
TX peak current		114		mA	
TX mean current		95		mA	
RX peak current		155		mA	
RX mean current		131		mA	
Digital input voltage high	0.7 x VCC		VCC	V	
Digital input voltage low	GND		0.3 x VCC	V	
Digital output voltage high	0.7 x VCC		VCC	V	
Digital output voltage low	GND		0.3 x VCC	V	

* All typical current measurements are taken at 3.3 Volts supply level

4.3   Receiver AC Characteristics

Table 6: 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

4.4   Receiver Sensitivity Characteristics

T_{amb} = 25 °C, 20 byte payload. These sensitivity figures assume an antenna gain of 0 dBi and should be modified by the antenna characteristics, depending on the orientation of the DWM1004C.

Table 7: DWM1004C Typical Receiver Sensitivity Characteristics

Packet Error Rate	Data Rate	Receiver Sensitivity	Units	Condition/Note	
1%	6.8 Mbps	-98*(-92)	dBm/500 MHz	Preamble 128	All measurements performed on Channel 5, PRF 64 MHz. Channel 2 is approximately 1 dB less sensitive.
10%	6.8 Mbps	-99*(-93)	dBm/500 MHz	Preamble 128	Carrier frequency offset ±10 ppm

*equivalent sensitivity with Smart TX Power enabled. This is enabled in the onboard firmware.

4.5   Transmitter AC Characteristics

Table 8: DWM1004C Transmitter AC Characteristics

Parameter	Min.	Typ.	Max.	Units	Condition/Note
Frequency range	3244		6740	MHz	
Output power spectral density			-41.3*	dBm/MHz	See DW1000 Datasheet [1]
Output Channel Power		-17		dBm/500MHz	
Output power variation with temperature*	-1		+1	dB	Using on board compensation.

* When using the Decawave supplied embedded firmware for the DWM1004C module

4.5.1 Absolute Maximum Ratings

Table 9: 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
MSL (Moisture Sensitivity Level)	-	3	-
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 TDoA Tag Current Profile

Figure 4 presents the current consumption of the DWM1004 when running a typical TDoA tag application. In such an application, the module will mainly be in low-power consumption mode (sleep).

It will wake up periodically in order to transmit a unique frame over UWB. The device will return to sleep after the transmission. This scheme is ideal for very low power tag application, as well as very high capacity RTLS systems.
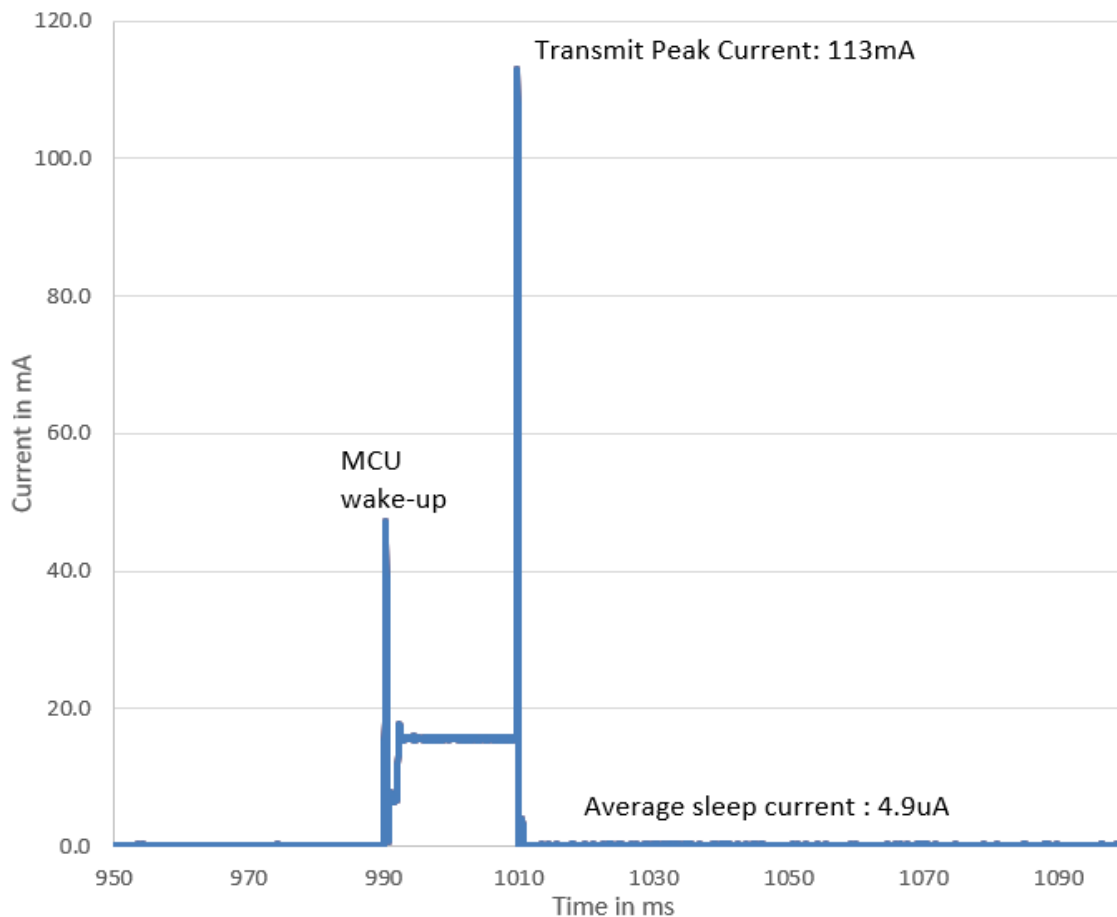

Figure 4:TDoA Tag application current profile

6 ANTENNA PERFORMANCE

This section details antenna radiation patterns for the DWM1004C. **Figure 5** presents the dimensions of the small carrier board on which the module is mounted during radiation pattern measurements as well as a view of the measurement planes considered in this document.

Table 10 and **Table 11** show antenna radiation patterns for the DWM1004C module mounted on the DWM1004C-Dev board. Three planes in the spherical space about the centre of the board are measured, with theta and phi plots representing perpendicular polarisations.

The DWM1004C antenna is vertically polarised, meaning that the module is intended to be positioned vertically upright when used in an RTLS system. An omnidirectional radiation pattern is seen in the XZ plane when observed by another antenna which is also vertically polarised. This is shown in the XZ plane antenna patterns, where the vertically polarised plot, phi, has a circular, or omnidirectional shape.

If the antennas are oriented perpendicular relative to each other, then the polarisation changes. In this case, the horizontally polarised pattern, theta, applies and there are nulls at certain angles which can limit range and introduce location inaccuracy.
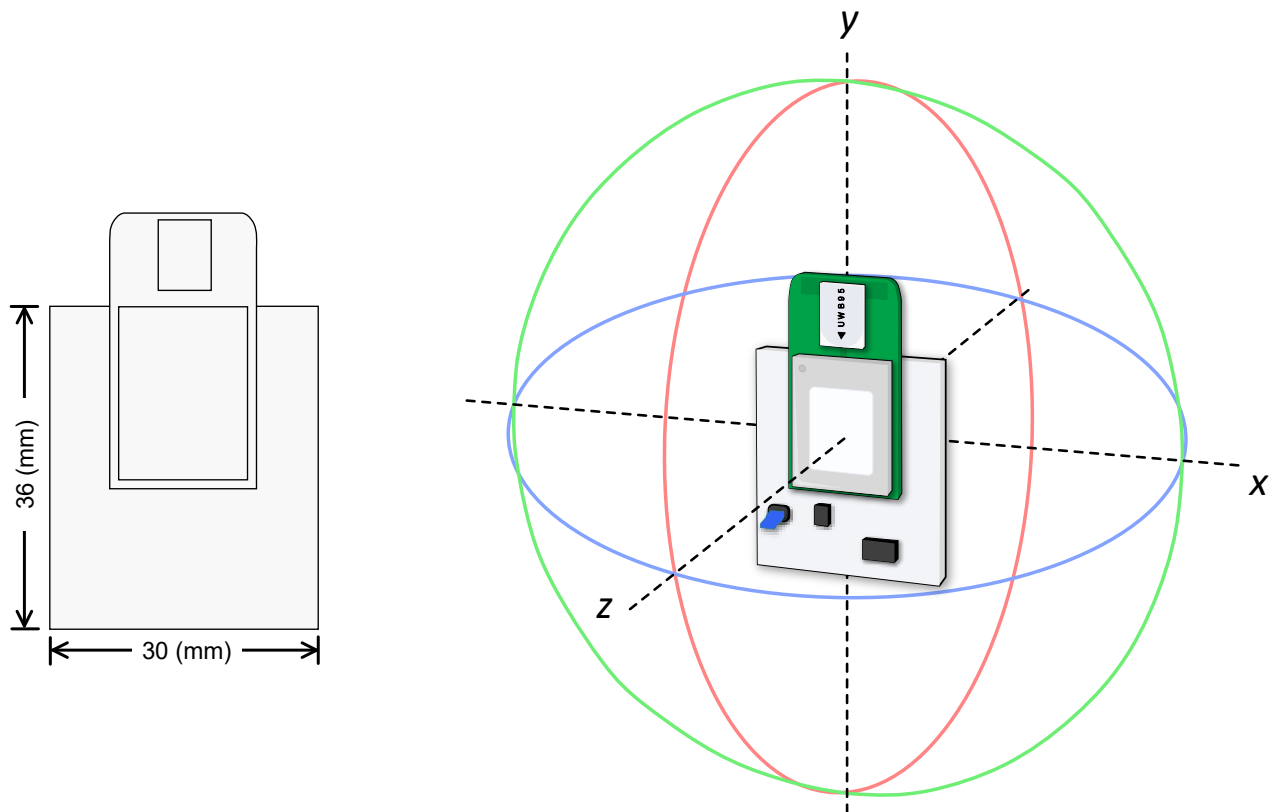

Figure 5. Carrier Board Dimensions and Radiation Pattern Planes

Table 10:Antenna Radiation Patterns – Channel 2

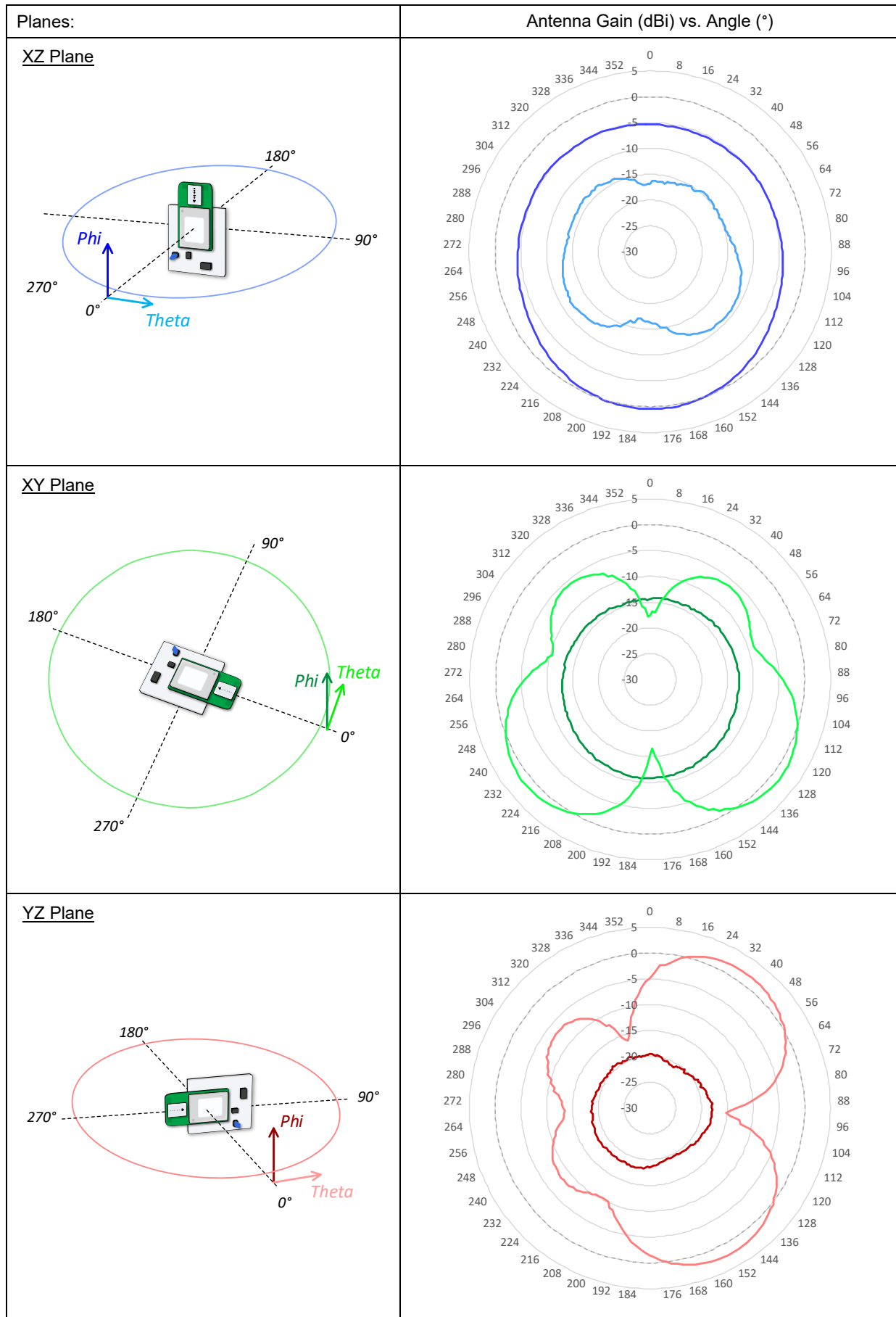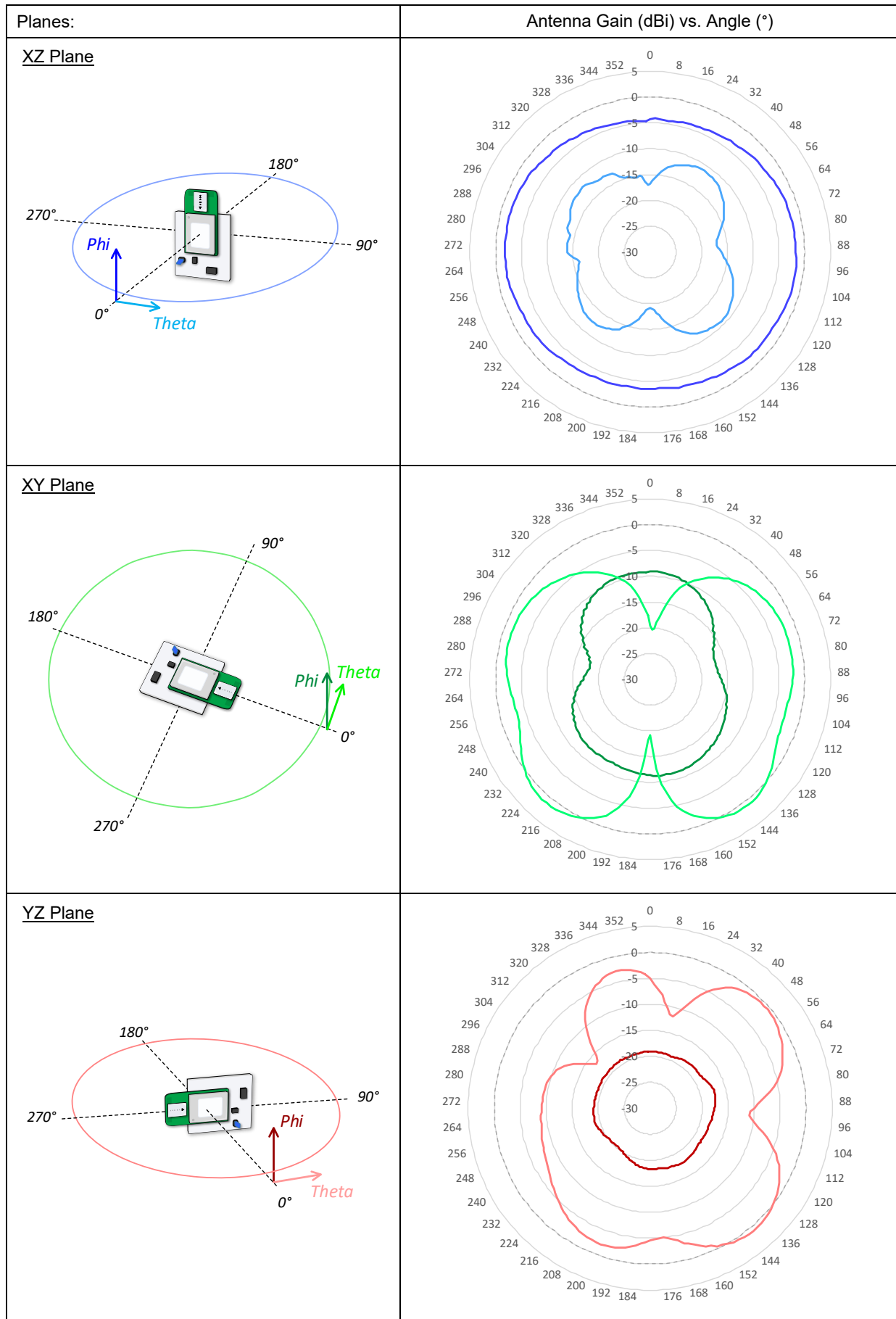| Planes:	Antenna Gain (dBi) vs. Angle (°)
XZ Plane	
XY Plane	
YZ Plane	

Table 11: Antenna Radiation Patterns – Channel 5

Planes:	Antenna Gain (dBi) vs. Angle (°)
XZ Plane	
XY Plane	
YZ Plane	

7 APPLICATION INFORMATION

7.1 Application Board Layout Guidelines

When designing the PCB onto which the DWM1004C will be soldered, the proximity of the DWM1004C on-board antenna to metal and other non-RF transparent materials needs to be 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 6** 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 DWM1004C antenna radiation pattern. There must be a minimum spacing of 10 mm (d) without metal either side of the module antenna.
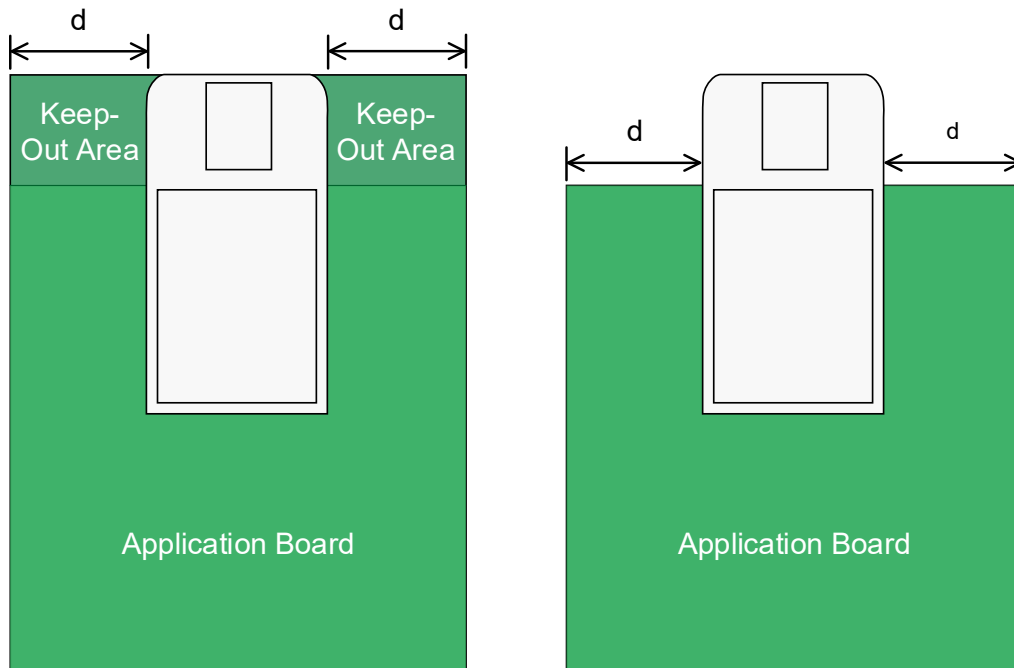

Figure 6: DWM1004C Application Board Keep-Out Areas

8 PACKAGE INFORMATION

8.1 Module Drawings
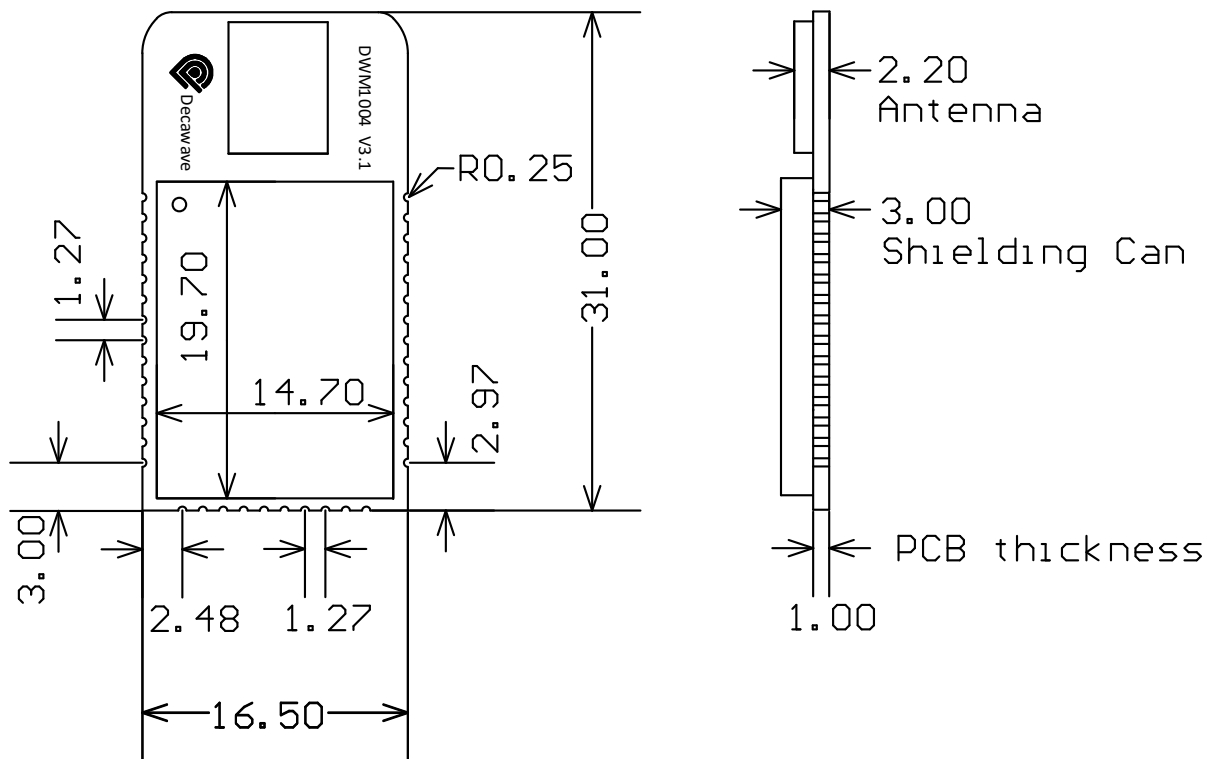
All measurements are given in millimetres.

Figure 7: Module Package Size (units: mm)

8.2 Module Land Pattern

The diagram below shows the DWM1004C module land pattern.
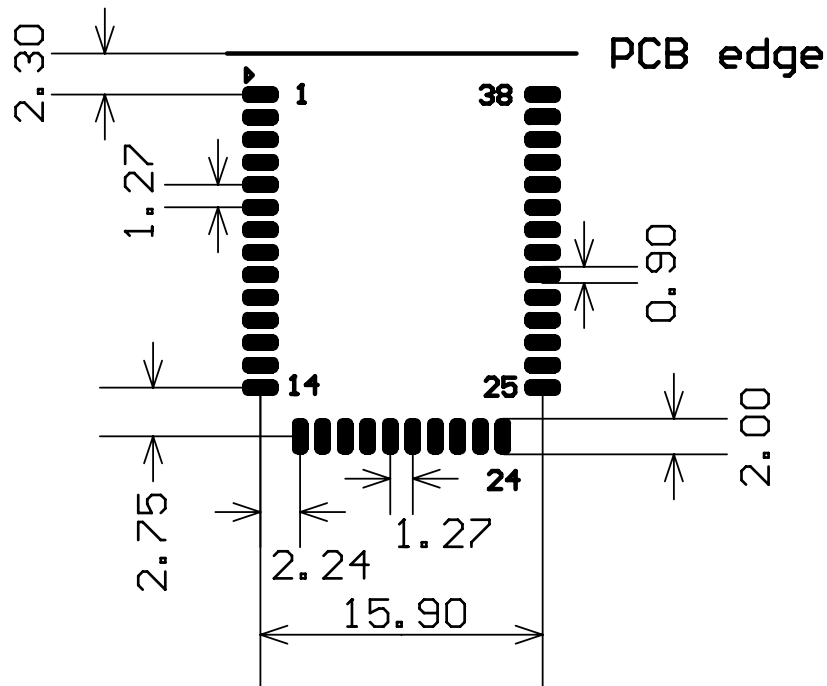

Figure 8: DWM1004C Module Land Pattern (units: mm)

8.3 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

8.4   Module Solder Profile

Temperature Profile ➔ Process Management
Completely and Professionally Achieve Zero Defect of Soldering

Client name DWM1004C		Product name 39K-08-T-S3		Product line name Line3			Process Formula ROHS-NB		
Sampling time(ms) 500		Welding furnace model 1060N		Process specification RoHS-1			Chain speed 75CM/MIN		
Test time 2019-12-11 21:14:43									

Remark

Oven settings	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8	Z9	Z10
Upper temp. zone setting	160	180	180	180	180	190	210	225	250	240
Lower temp. zone setting	160	180	180	180	180	190	210	225	250	240
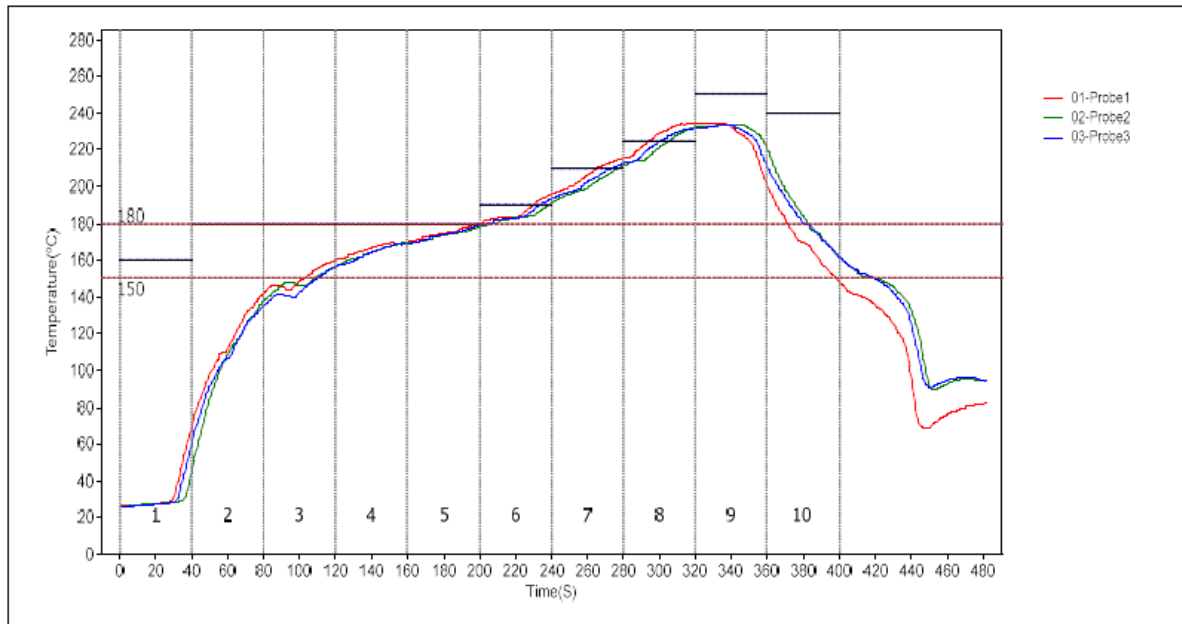
Probe #	Tag #	Preheating temperature rise	Immersion time 1	Peak temperature
1	Probe1	1.3 [1~3℃/s]@[25~150℃]	96.5 [60~120s]@[150~180℃]	234.9 [230~240℃]
2	Probe2	1.2 [1~3℃/s]@[25~150℃]	98.5 [60~120s]@[150~180℃]	233.9 [230~240℃]
3	Probe3	1.2 [1~3℃/s]@[25~150℃]	94.0 [60~120s]@[150~180℃]	233.7 [230~240℃]

Probe #	Tag #	time over ℃	Cooling rate 1	
1	Probe1	69.0 [45~90s]@[217℃]	-2.4 [-4~-1℃/s]@[217℃]	
2	Probe2	66.0 [45~90s]@[217℃]	-2.3 [-4~-1℃/s]@[217℃]	
3	Probe3	67.0 [45~90s]@[217℃]	-2.2 [-4~-1℃/s]@[217℃]	

Figure 9: DWM1004C Module Solder Profile

9 ORDERING INFORMATION

9.1 Tape and Reel Information

9.1.1 Tape Specification
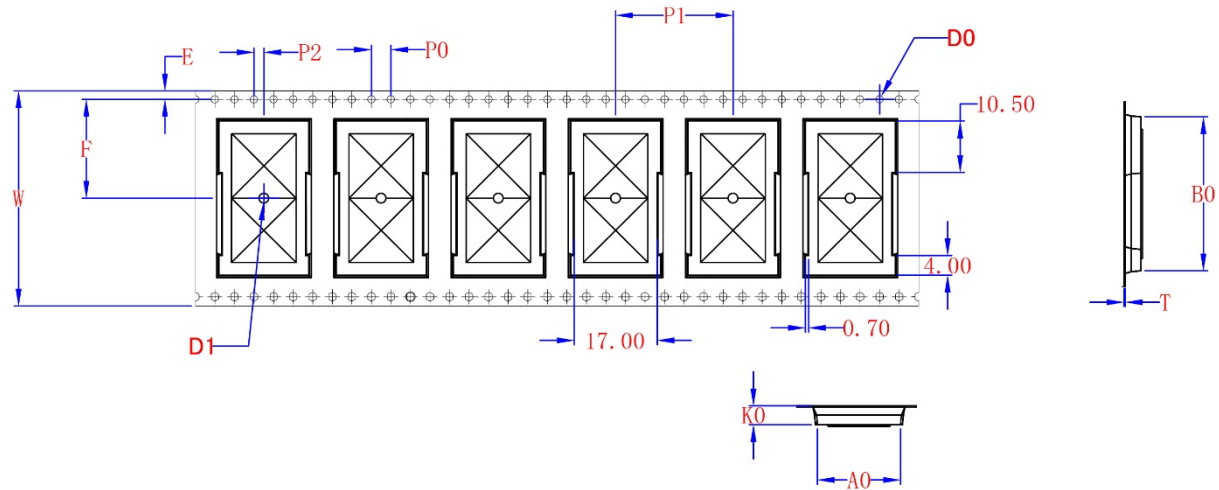
	D₀ ⑧	D₁ ⑧	P₀ ⑧	P₂ ⑧	E ⑧
	1.50 $^{+0.10}_{-0.00}$	2.00 $^{+0.10}_{-0.00}$	4.00 ±0.10	2.00 ±0.10	1.75 ±0.10

ITEM	W ⑧	A₀ ⑧	A₁ ⑧	B₀ ⑧	B₁ ⑧	K₀ ⓒ	K₁ ⓒ	P₁ ⑧	F ⑧	T ⑧
DIM	44.00 ±0.30	17.0 ±0.10	±0.10	31.50 ±0.10	±0.10	3.90 ±0.10	±0.10	24.0 ±0.10	20.2 ±0.10	0.30 ±0.05
ALTERNATE										

Figure 10: DWM1004C Tape Dimensions

9.1.2   Reel Specification
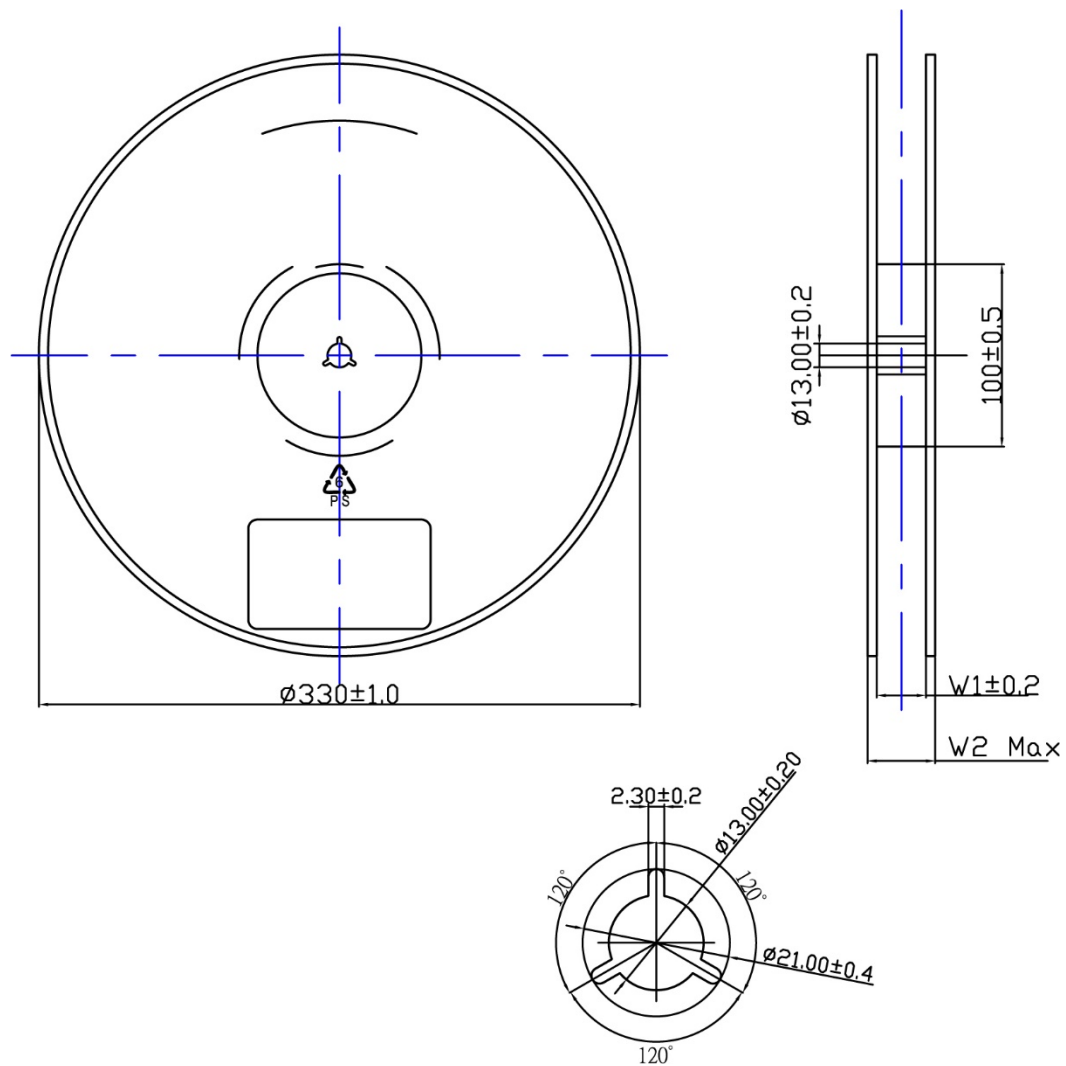
Width	8mm	12mm	16mm	24mm	32mm	44mm	56mm	72mm	88mm
W1±0.2	8.8	12.8	16.8	24.8	32.8	44.8	56.8	72.8	88.8
W2Max	14.4	18.4	22.4	30.4	38.4	50.4	62.4	78.4	94.4

Figure 11: DWM1004C Reel Dimensions

10 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.

10.1 European Union requirements

10.1.1 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.

$$ C \, \epsilon $$

10.2 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"

10.3 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.

10.4 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.

11 GLOSSARY

Table 12: 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 http://www.ic.gc.ca/eic/site/icgc.nsf/eng/home

12 REFERENCES

[1] Decawave DW1000 Datasheet www.decawave.com

13 DOCUMENT HISTORY

Table 13: Document History

Revision	Date	Description
1.4	27th October 2020	Updated DWM1004 image on first page. Added idle and Tx/Rx mode current specifications. Added application circuit diagrams and board keep-out area diagrams. Updated tape and reel images.
1.3	27th December 2019	Added Antenna information, Solder profile and current consumption figures
1.2	15th October 2019	Updated block diagram, added required FCC text
1.1	25th July 2019	Added Block diagram and regulatory information. Updated footnote on page 7 referring now to modules v3.1 onwards
1.0	9th July 2019	Initial release

14 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.