Bluetooth® Low Energy 5.3 module

Features

- Integrated chip antenna, and option for external antenna
- Bluetooth Low Energy 5.3 certified
- Supports 2 Mbits/s
- Advertising extension
- TX output power up to +5.5 dBm
- RX sensitivity: -96 dBm (1 Mbps)
- Range: TBD
- Dedicated Arm® Cortex®-M0+ for radio and security tasks
- Dedicated Arm® Cortex®-M4 CPU with FPU and ART (adaptative real-time accelerator), up to 64 MHz speed
- 320 Kbytes flash memory, 48 Kbytes SRAM
- Fully integrated BOM, including 32 MHz radio and 32 kHz RTC crystals
- Integrated SMPS
- Ultra low power modes for battery longevity
- 27 GPIOs
- SWD, JTAG
- Integrated IPD for best-in-class and reliable antenna matching
- V_{DD} range: 1.71 to 3.6 V
- Temperature range: -40 to 85 °C
- Built-in security features, such as secure firmware installation (SFI) for radio stack, PKA, AES 256-bit, TRNG, PCROP, CRC, 96-bit UID, possibility to derive 48-bit UEI
- Planned certifications: CE, FCC, IC, JRF, SRRC (ongoing), RoHS, REACH, KC, NCC, UKCA
- 2-layer PCB

Product status link
STM32WB1MMC

Applications

- Home automation
- Wellness, healthcare, personal trackers
- Gaming and toys
- Beacons and accessories
- Industrial

1   Introduction

This document provides the ordering information and mechanical device characteristics of the STM32WB1MMC module. It must be read in conjunction with DS13258 and RM0473, available on www.st.com.

For information on the Arm® Cortex® cores, refer to the Cortex® Technical Reference Manual, available from the www.arm.com website.

Note: *Arm is a registered trademark of Arm Limited (or its subsidiaries) in the US and/or elsewhere.*

arm

2 Description

The STM32WB1MMC is an ultra-low-power, small form factor, certified 2.4 GHz wireless module. It supports Bluetooth Low Energy 5.3. Based on the STM32WB15CCY wireless microcontroller, it provides best-in-class RF performance thanks to its good receiver sensitivity and a high output power signal. Its low-power features enable extended battery life time, small coin-cell batteries, or energy harvesting.

The STM32WB1MMC requires no RF expertise, and is the best way to speed up the application development and to reduce the associated costs. The module is completely protocol stack royalty-free.

3 Module overview

The module is a SiP-LGA77 package (system in package land grid array), based on the proven STM32WB15CCY MCU. The package includes:

- LSE and HSE crystals
- Passive components for SMPS
- Antenna matching and antenna
- IPD for RF matching and harmonics rejection

Figure 1. Block diagram
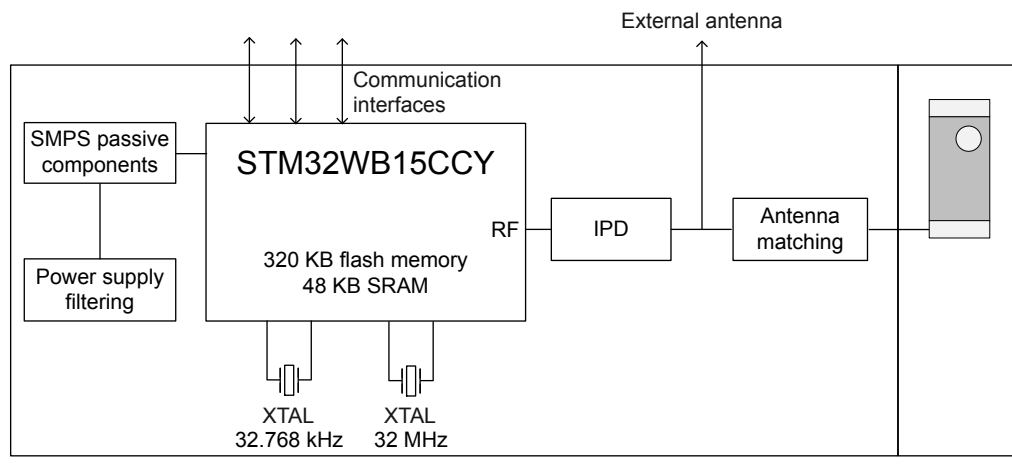
3.1 Power supply

The power supply requirements are identical to those of the STM32WB1x devices, detailed in the datasheet DS13258. Filtering capacitors on power supply pins and components for the SMPS are already integrated into the module.

The SMPS passive components fitted in the module are in configuration-imposing function at 4 MHz, always ON. This is the only available configuration. For additional information on the SMPS, check the reference manual or AN5246, available on www.st.com.

3.2 Clocks

As the crystals are already integrated into the package, it is not possible to use any clock in bypass mode. The module integrates a 32.768 kHz crystal for LSE and a 32 MHz crystal for the HSE clock.

- HSE is already tuned.
  RCC_HSECR_HSETUNE[5:0] value is loaded automatically by HW. The RCC_HSECR register configuration must not be changed by the user to keep the default parameters.
- LSCO and MCO outputs are available.

3.3 Antenna

The rectangular module has one shorter side clearly different from the remaining finish surface. This side is unshielded and the mold cover contains the integrated antenna.

To use the internal antenna, pins 6 (ANT_INT) and 7 (ANT_EXT) must be connected as in Figure 2.

If an external antenna is used, ANT_IN must be shorted to ground, and ANT_OUT connected to the external antenna matching network and to the antenna itself, as in Figure 3.

Note: *Regulatory certifications obtained by ST apply only to the module with its internal antenna. Designs with external antennas require new certifications.*

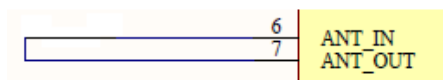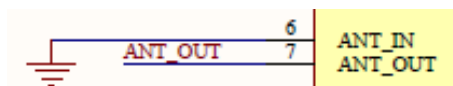**Figure 2. Connections when using the internal antenna**

Figure 3. Connections when using an external antenna

3.4   OTP

The STM32WB1MMC features a 1 Kbyte one time programmable (OTP) memory for use by the end product (see DS13258 and RM0473).

Note: *The device uses the first and last words of this area for trimming and identification purposes. As a consequence, addresses 0x1FFF7000h to 0x1FFF7007h and 0x1FFF73F8h to 0x1FFF73FFh cannot be changed.*

4   Available peripherals

All peripherals available in STM32WB Series microcontrollers based on the WLCSP49 package are available and accessible on this module.

The pins on the module offer access to the following system peripherals:

- 1× DMA controllers (seven channels each) supporting ADC, SPI, I2C, USART, AES, timers
- 1× USART (ISO 7816, IrDA, SPI master, Modbus and Smartcard mode)
- 1× LPUART (low power)
- SPI running at 32 Mbit/s
- I²C (SMBus/PMBus)
- 1× touch sensing controller, up to 8 sensors
- 1× 16-bit, four channels advanced timer
- 2× 16-bit, two channels timers
- 1× 32-bit, four channels timer
- 2× 16-bit ultra-low-power timers
- 1× independent Systick
- 1× independent watchdog
- 1× window watchdog.

The full pin description is available in DS13258.

5 Pin description

Figure 4 shows the module pinout package bottom view.

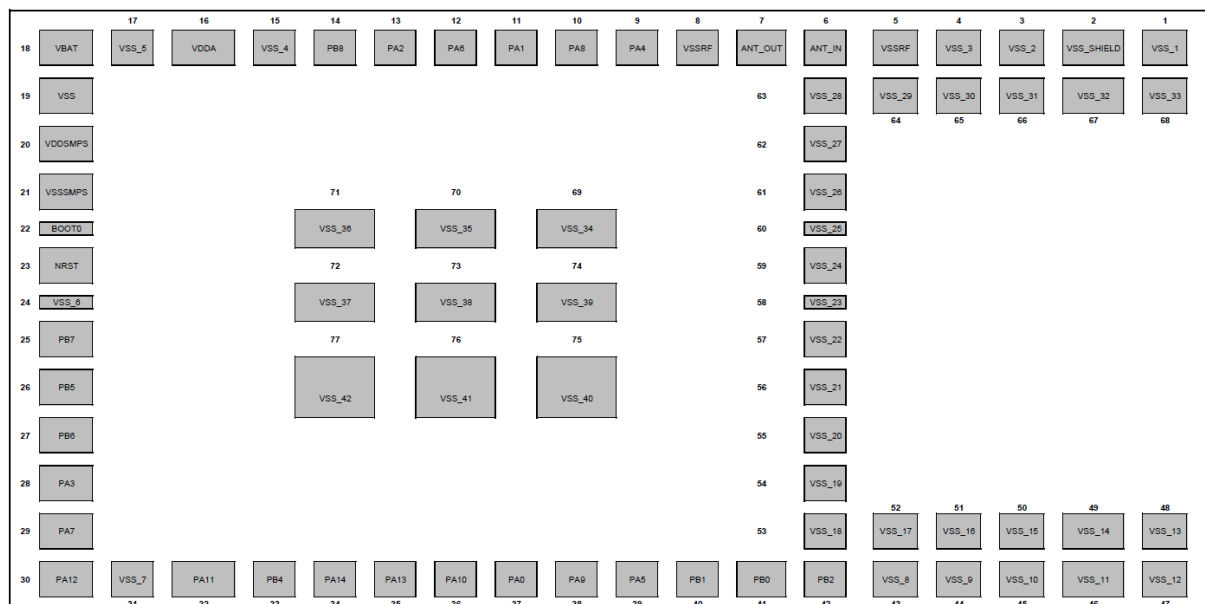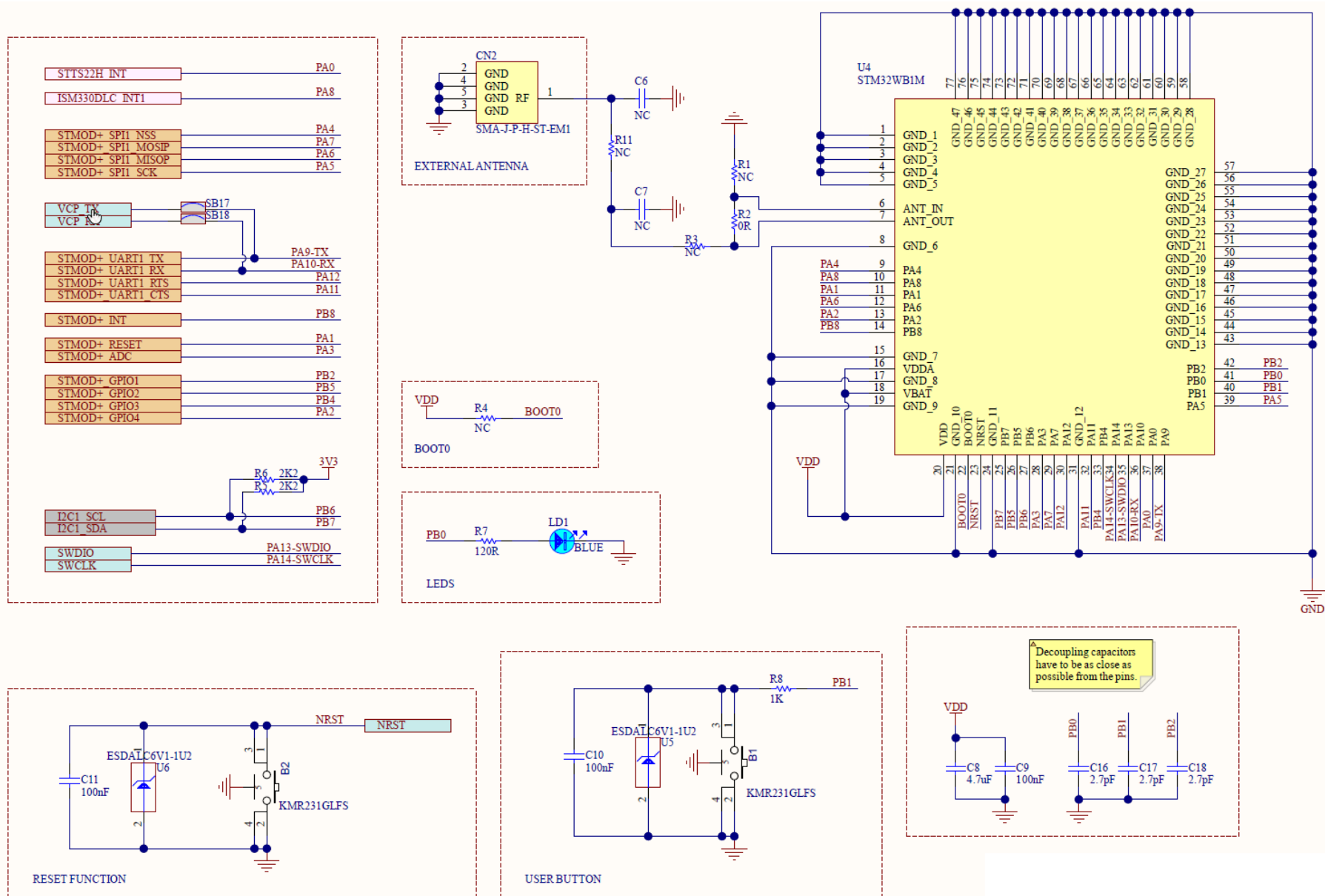**Figure 4. STM32WB1MMC module pinout: bottom view**

Table 1. STM32WB1MMC pin/ball definition

Pin name		Pin name (function after reset)	Pin type
STM32WB1MMC	STM32WB15CCY		
1	-	VSS	S
2	-	VSS	S
3	-	VSS	S
4	-	VSS	S
5	G1	VSSRF	S
6	-	ANT_IN	I
7	-	ANT_OUT	O
8	G3	VSSRF	S
9	G7	PA4	I/O
10	G6	PA8	I/O
11	F7	PA1	I/O
12	F6	PA6	I/O
13	E6	PA2	I/O
14	C6	PB8	I/O
15	-	VSS	S
16	E7	VDDA	S
17	-	VSS	S
18	C5	VBAT	S
19	-	VSS	S

Pin name		Pin name (function after reset)	Pin type
STM32WB1MMC	STM32WB15CCY		
20	A1	VDDSMPS	S
21	C1	VSSSMPS	S
22	B6	BOOT0	I/O
23	C7	NRST	I/O
24	-	VSS	S
25	A6	PB7	I/O
26	A5	PB5	I/O
27	B5	PB6	I/O
28	D5	PA3	I/O
29	E5	PA7	I/O
30	A3	PA12	I/O
31	-	VSS	S
32	A2	PA11	I/O
33	B4	PB4	I/O
34	B3	PA14	I/O
35	B2	PA13	I/O
36	C2	PA10	I/O
37	C4	PA0	I/O
38	D3	PA9	I/O
39	D4	PA5	I/O
40	E1	PB1	I/O
41	E2	PB0	I/O
42	E4	PB2	I/O
43	-	VSS	S
44	-	VSS	S
45	-	VSS	S
46	-	VSS	S
47	-	VSS	S
48	-	VSS	S
49	-	VSS	S
50	-	VSS	S
51	-	VSS	S
52	-	VSS	S
53	-	VSS	S
54	-	VSS	S
55	-	VSS	S
56	-	VSS	S
57	-	VSS	S
58	-	VSS	S
59	-	VSS	S

Pin name		Pin name (function after reset)	Pin type
STM32WB1MMC	STM32WB15CCY		
60	-	VSS	S
61	-	VSS	S
62	-	VSS	S
63	-	VSS	S
64	-	VSS	S
65	-	VSS	S
66	-	VSS	S
67	-	VSS	S
68	-	VSS	S
69	-	VSS	S
70	-	VSS	S
71	-	VSS	S
72	-	VSS	S
73	-	VSS	S
74	-	VSS	S
75	-	VSS	S
76	-	VSS	S
77	-	VSS	S

Figure 5. Reference board schematics

STTS22H_INT — PA0
ISM330DLC_INT1 — PA8

STMOD+_SPI1_NSS — PA4
STMOD+_SPI1_MOSIP — PA7
STMOD+_SPI1_MISOP — PA6
STMOD+_SPI1_SCK — PA5

VCP_TX — SB17
VCP_RX — SB18

STMOD+_UART1_TX — PA9-TX
STMOD+_UART1_RX — PA10-RX
STMOD+_UART1_RTS — PA12
STMOD+_UART1_CTS — PA11

STMOD+_INT — PB8

STMOD+_RESET — PA1
STMOD+_ADC — PA3

STMOD+_GPIO1 — PB2
STMOD+_GPIO2 — PB5
STMOD+_GPIO3 — PB4
STMOD+_GPIO4 — PA2

R6 2K2
R5 2K2
3V3

I2C1_SCL — PB6
I2C1_SDA — PB7

SWDIO — PA13-SWDIO
SWCLK — PA14-SWCLK

CN2
2 GND
4 GND
5 GND RF
3 GND
1
SMA-J-P-H-ST-EM1
EXTERNAL ANTENNA

C6 NC
C7 NC
R11 NC
R1 NC
R2 0R
R3 NC

VDD
R4 NC — BOOT0
BOOT0

LEDS
VDD
PB0 — R7 120R — LD1 BLUE

U4
STM32WB1M

77 GND_47
76 GND_46
75 GND_45
74 GND_44
73 GND_43
72 GND_42
71 GND_41
70 GND_40
69 GND_39
68 GND_38
67 GND_37
66 GND_36
65 GND_35
64 GND_34
63 GND_33
62 GND_32
61 GND_31
60 GND_30
59 GND_29
58 GND_28

1 GND_1
2 GND_2
3 GND_3
4 GND_4
5 GND_5

6 ANT_IN
7 ANT_OUT
8 GND_6

PA4 9 PA4
PA8 10 PA8
PA1 11 PA1
PA6 12 PA6
PA2 13 PA2
PB8 14 PB8

15 GND_7
16 VDDA
17 GND_8
18 VBAT
19 GND_9

GND_27 57
GND_26 56
GND_25 55
GND_24 54
GND_23 53
GND_22 52
GND_21 51
GND_20 50
GND_19 49
GND_18 48
GND_17 47
GND_16 46
GND_15 45
GND_14 44
GND_13 43

PB2 42 PB2
PB0 41 PB0
PB1 40 PB1
PA5 39 PA5

VDD

20 BOOT0
21 GND_10
22 BOOT0
23 NRST
24 GND_11
25 PB7
26 PB5
27 PB6
28 PA3
29 PA7
30 PA12
31 GND_12
32 PA11
33 PB4
34 PA14-SWCLK
35 PA13-SWDIO
36 PA10-RX
37 PA0
38 PA9-TX

GND

RESET FUNCTION
NRST — NRST
C11 100nF
ESDALC6V1-1U2 U6
B2 KMR231GLFS

USER BUTTON
R8 1K — PB1
C10 100nF
ESDALC6V1-1U2 U5
B1 KMR231GLFS

Decoupling capacitors have to be as close as possible from the pins.

VDD
C8 4.7uF
C9 100nF
PB0 C16 2.7pF
PB1 C17 2.7pF
PB2 C18 2.7pF

7 PCB

Figure 6. **Top layer**

Figure 7. **Bottom layer**
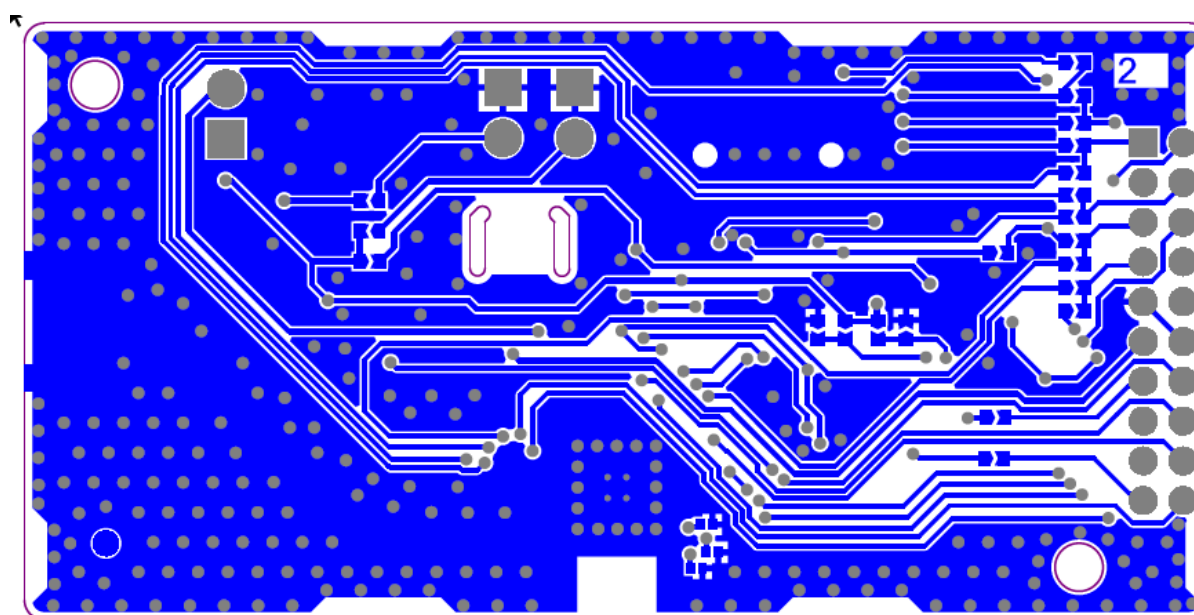
Sensitive GPIOs

The board has three sensitive GPIOs, namely PB0, PB1, and PB2. For each of these pins, if used, a 2.7 pF capacitor in a small package (such as the 0201 or smaller) must be placed as close as possible to the output pin. Also, border the GPIO tracks with the ground plane.

Layout recommendations

Decoupling capacitors must be placed as close as possible to the pins.

100 nF capacitors on external supplies must be placed as close as possible to the supply pads of the MEMs.

8 Electrical characteristics

8.1 Operating conditions

Table 2. STM32WB1MMC operating conditions

Parameter	Min	Typ	Max	Unit
V_{DD}	1.71	3.3	3.6	V
Operating ambient temperature range	-40	-	85	°C
Storing temperature range	-40	-	125	

8.2 Power consumption

The power consumption is identical to the regular STM32WB15. For full details refer to DS13258.

8.3 RF characteristics

Refer to DS13258.

8.4 Antenna radiation patterns and efficiency

The following figures present the radiation patterns, taken from certification measurements.

Figure 8. Radiaton pattern - 2402 MHz

2D Diagram
Plan measured C_{min}: 2402 MHz
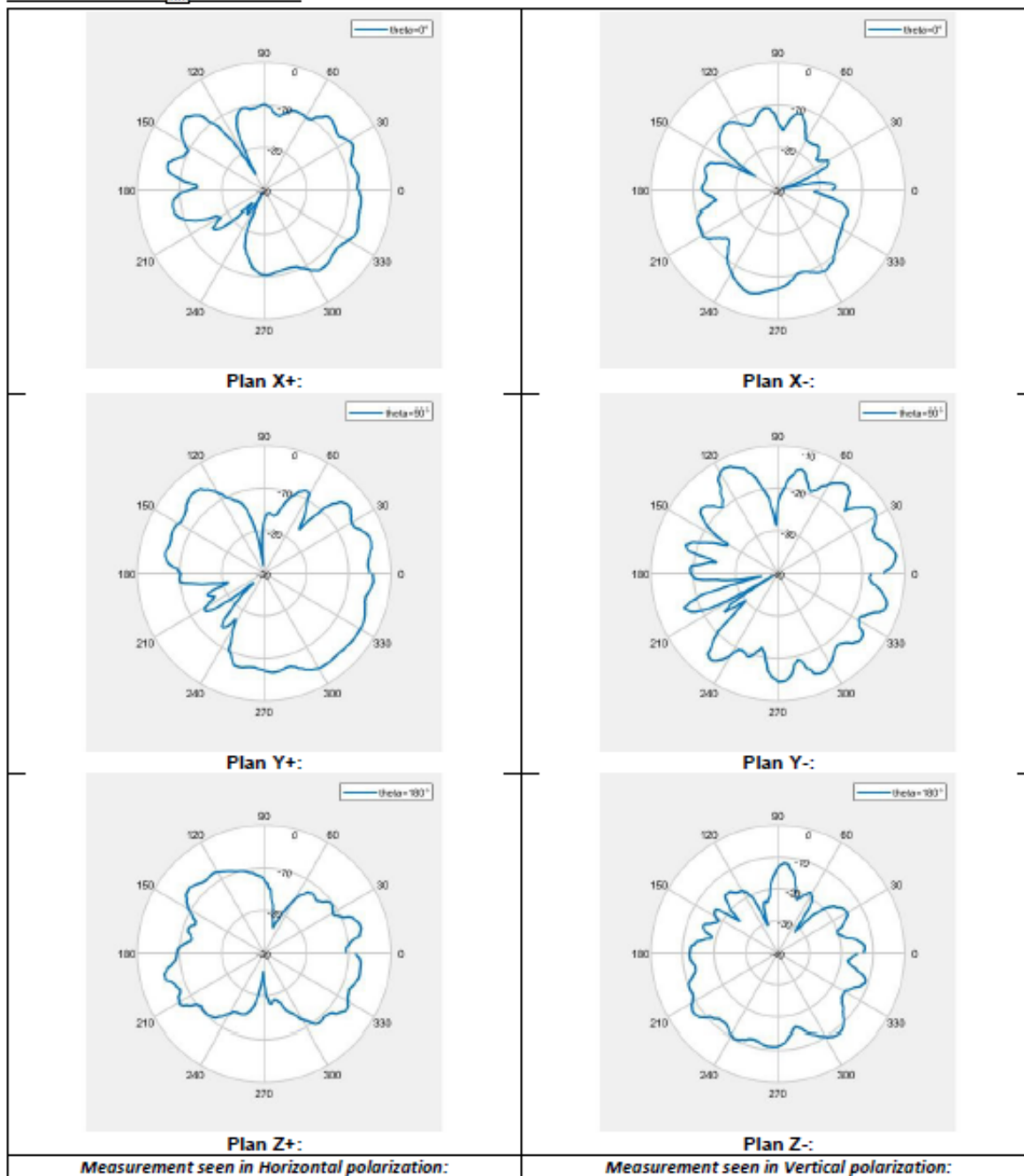
Figure 9. Radiaton pattern - 2440 MHz

Plan measured C~mid~: 2440 MHz

Plan X+:

Plan X-:

Plan Y+:

Plan Y-:

Plan Z+:

Plan Z-:

Measurement seen in Horizontal polarization:

Measurement seen in Vertical polarization:
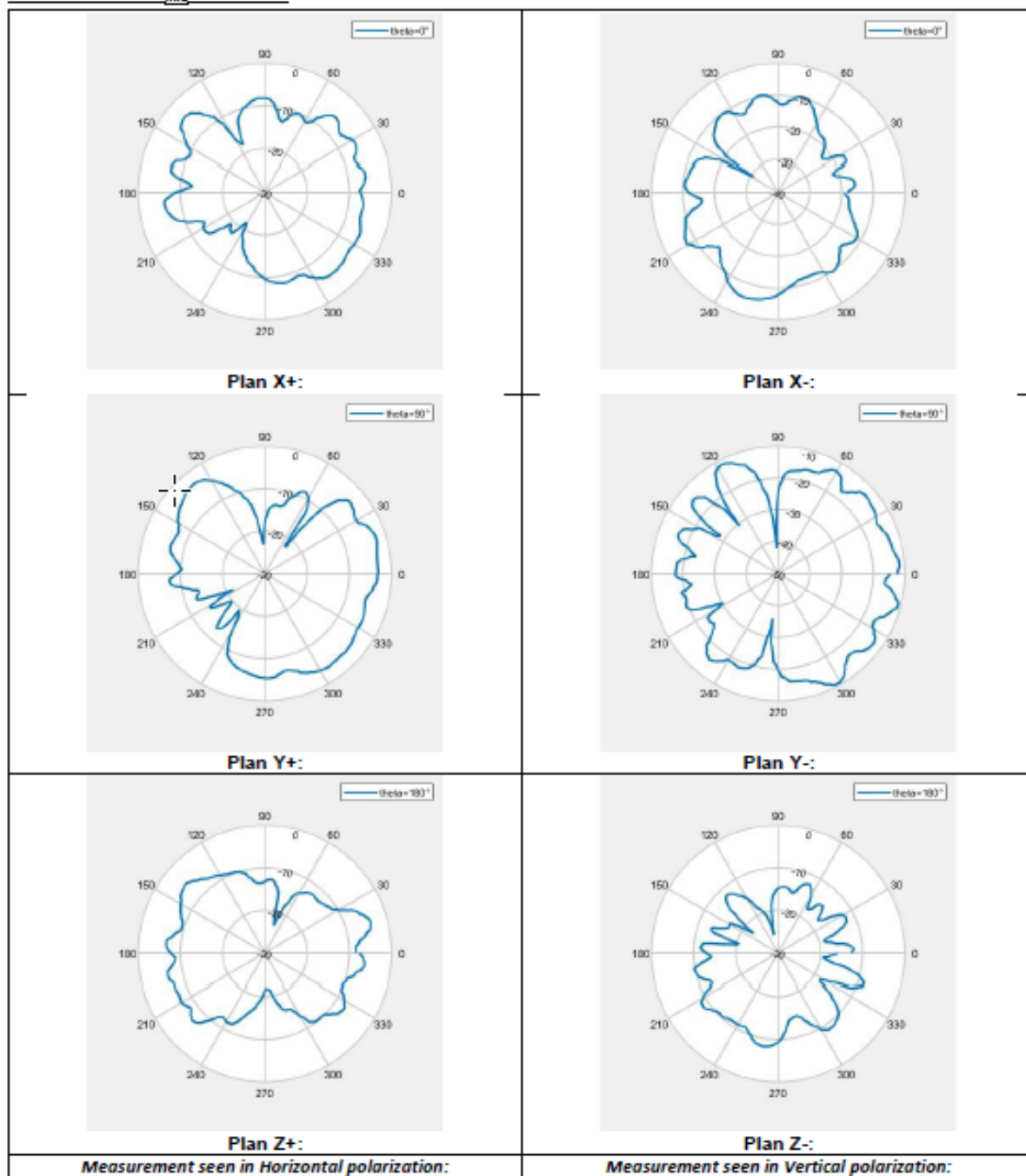
Figure 10. Radiaton pattern - 2480 MHz

Plan measured C$_{max}$: 2480 MHz

Plan X+:

Plan X-:

Plan Y+:

Plan Y-:

Plan Z+:

Plan Z-:

Measurement seen in Horizontal polarization:

Measurement seen in Vertical polarization:
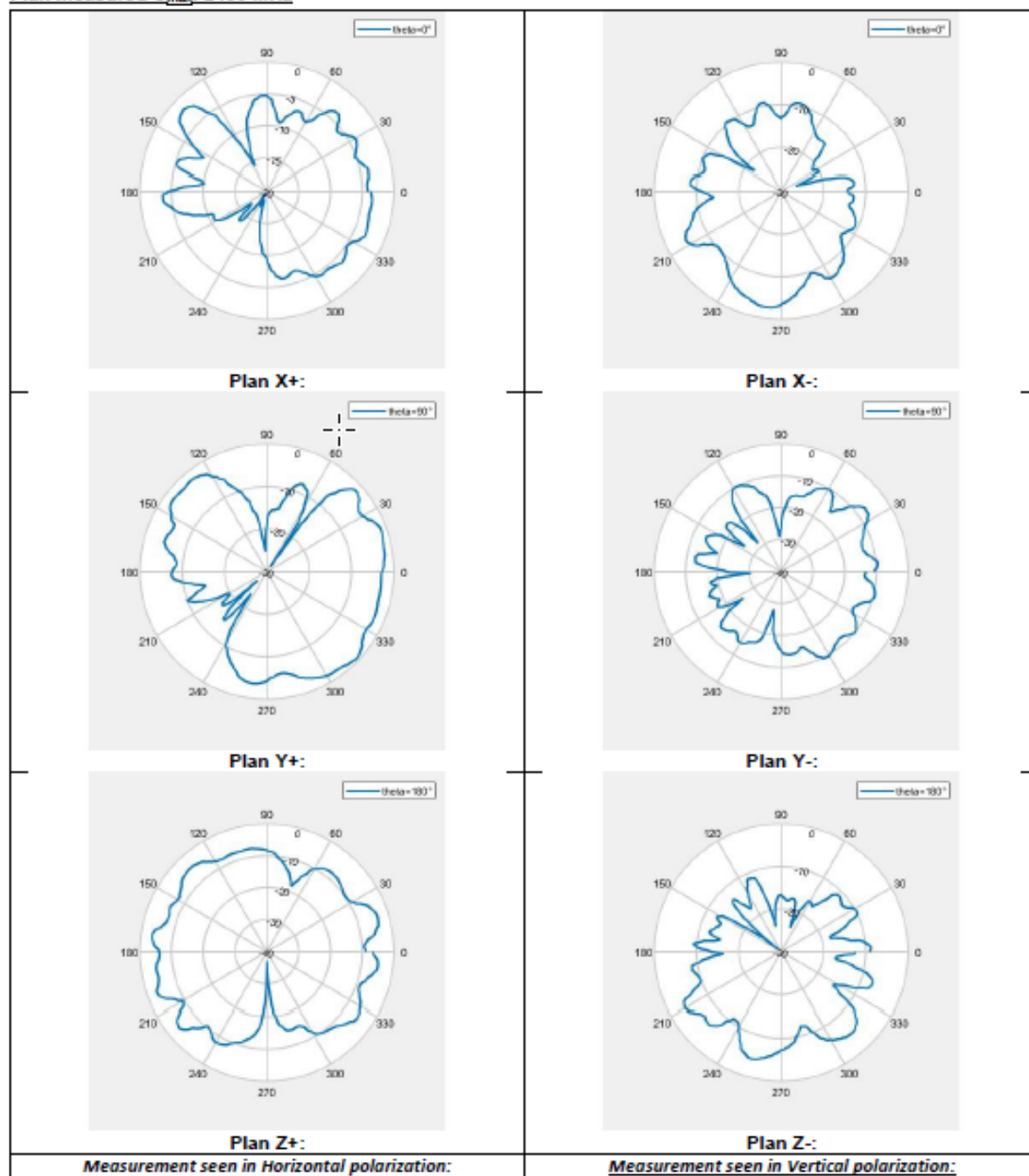
9 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: www.st.com. ECOPACK is an ST trademark.

9.1 LGA77 package information

This LGA is a 77-lead, 10 x 6.5 mm, 0.45/0.50 mm pitch, land grid array package.

Figure 11. LGA77 - Outline
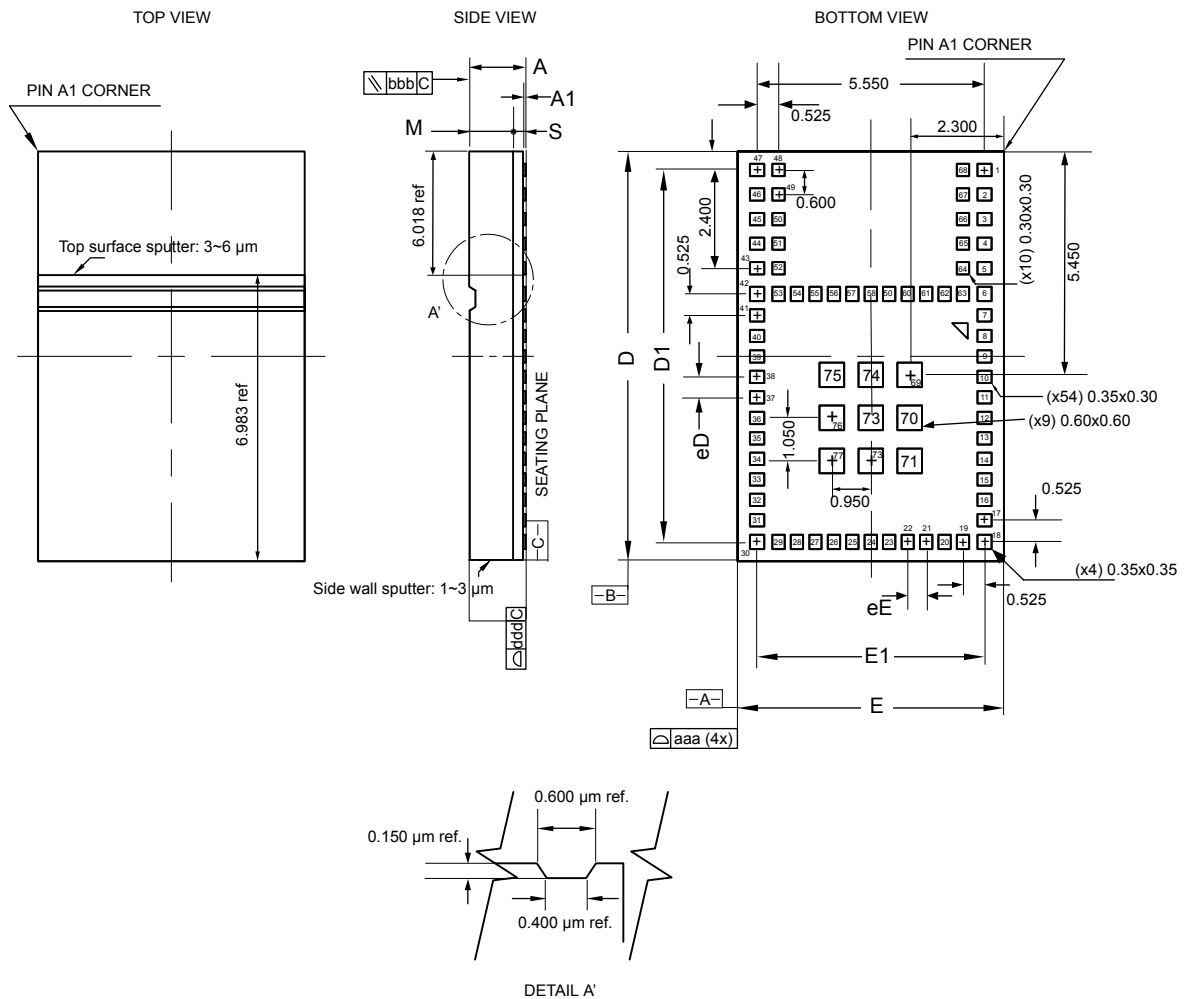
1. All dimensions, except where are indicated, are in millimeters.
2. Drawing is not in scale.

Table 3. LGA77 - Mechanical data

Symbol	millimeters			inches		
	Min	Typ	Max	Min	Typ	Max
A	1.372 ± 0.046			0.0540 ± 0.0018		
A1	0.030 ± 0.020			0.0012 ± 0.0008		
D	9.900	10.000	10.100	0.3898	0.3937	0.3976
E	6.400	6.500	6.600	0.2520	0.2559	0.2598
D1	9.075			0.3573		
E1	5.550			0.2185		
eD	0.500			0.0197		
eE	0.450			0.0177		
M	1.100 REF			0.0433 REF		
S	0.24 REF			0.0094 REF		
Lead width	0.300 x 0.300			0.118 x 0.0118		
	0.350 x 0.300			0.0138 x 0.0118		
	0.350 x 0.350			0.0138 x 0.0138		
	0.600 x 0.600			0.0236 x 0.0236		
aaa	0.100			0.0039		
bbb	0.100			0.0039		
ddd	0.100			0.0039		

1. Values in inches are converted from mm and rounded to four decimal digits.

9.2 Thermal characteristics

The device thermal characteristics are defined below, and the constant values are given in Table 4:

- Θ_{JA} is the junction-to-ambient thermal resistance (EIA/JESD51-2 and EIA/JESD51-6)
  Θ_{JA} represents the resistance to the heat flowing from the chip to ambient air. It is an indicator of package heat dissipation capability, a lower Θ_{JA} means better overall thermal performance. It is calculated as follows:
  $\Theta_{JA} = (T_J - T_A) / P_H$,
  where:
  - T_J = junction temperature
  - T_A = ambient temperature
  - P_H = power dissipation.

- Ψ_{JT} is the junction-to-top-center thermal characterization parameter (EIA/JESD51-2 and EIA/JESD51-6).
  Ψ_{JT} is used for estimating the junction temperature by measuring T_T in an actual environment. It is calculated as follows:
  $\Psi_{JT} = (T_J - T_T) / P_H$
  where T_T = temperature at the top-center of the package.

- Θ_{JC} is the junction-to-case thermal resistance.
  Θ_{JC} represents the resistance to the heat flowing from the chip to package top case. Θ_{JC} is important when an external heat sink is attached on package top. It is calculated as follows:
  $\Theta_{JC} = (T_J – T_C) / P_H$
  where T_C = case temperature attached with a cold plate.

- Θ_{JB} is the junction-to-board thermal resistance (EIA/JESD51-8).
  Θ_{JB} represents the resistance to the heat flowing from the chip to PCB. Θ_{JB} is used in compact thermal models for system-level thermal simulation. It is calculated as follows:
  $\Theta_{JB} = (T_J – T_B) / P_H$
  where T_B = board temperature with ring cold plate fixture applied.

Table 4. Thermal characteristics

Symbol	Max T_J (° C)	T_T (° C)	Ψ_{JT} (° C/W)	Θ_{JA} (° C/W)	Θ_{JB} (° C/W)	Θ_{JC} (° C/W)
Value	99.65	99.53	0.26	37.36	16.96	14.41

9.3 Device marking for SiP-LGA77

Refer to technical note "*Reference device marking schematics for STM32 microcontrollers and microprocessors*" (TN1433) available on www.st.com, for the location of pin 1 / ball A1, as well as the location and orientation of the marking areas versus pin 1 / ball A1.

Parts marked as "ES", "E" or accompanied by an Engineering Sample notification letter, are not yet qualified and therefore not approved for use in production. ST is not responsible for any consequences resulting from such use. In no event will ST be liable for the customer using any of these engineering samples in production. ST's Quality department must be contacted prior to any decision to use these engineering samples to run a qualification activity.

9.4 Board design

For information and recommendations related to board design, landing pads, stencils and the solder reflow profile for LGA packages, refer to AN 5886 "*Guidelines for design and board assembly of land grid array packages*", available on www.st.com.

10 Ordering information

Table 5. Ordering information scheme

Example: STM32   WB   1   M   M   C   H   6   TR

Device family

STM32 = Arm-based 32-bit microcontroller

Product type

WB = wireless Bluetooth

Device subfamily

1 = STM32WB15 die 1, full set of features

Pin count

M = 77 pins

Component type

M = module

Flash memory size

C = 320 Kbytes

Package

H = LGA77 6.5 x 10 mm

Temperature range

6 = industrial temperature range, −40 to 85 °C

Packing

TR = tape and reel

For a list of available options (such as speed and package) or for further information on any aspect of this device, contact your nearest ST sales office.

11   Tape and reel

The module tape, the reel orientation, and the dimensions are shown in Figure 12.

Figure 12. STM32WB1MMC tape and reel

	DIM	±
Ao	7.80	0.10
Bo	11.50	0.10
Ko	1.80	0.10
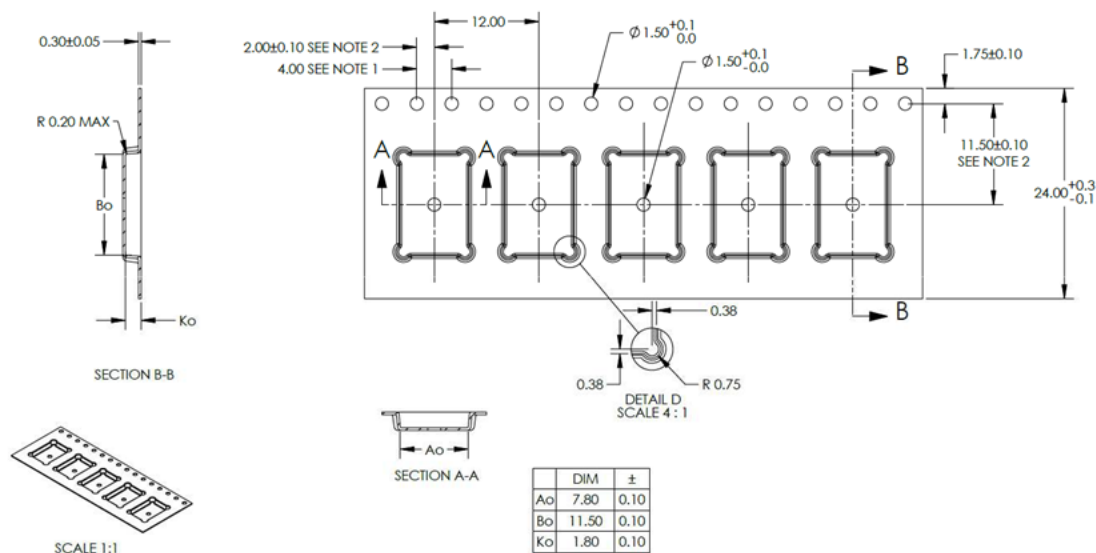
NOTES:
1.   10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE ±0.2
2.   POCKET POSITION RELATIVE TO SPROCKET HOLE MEASURED AS TRUE POSITION OF POCKET, NOT POCKET HOLE.
3.   Ao AND Bo ARE MEASURED ON A PLANE AT A DISTANCE "R" ABOVE THE BOTTOM OF THE POCKET.

12 Certifications

The STM32WB1MMC module, with its internal antenna, has passed the following certifications:

- BLE (RF_PHY)
- CE (RED)
- FCC
- ISED
- REACH
- ROHS

Certifications for UK, Japan, Korea, Taiwan and China (SRRC) are in progress. All certification reports are available on the STM32WB1MMC webpage.

12.1 BLE(RF_PHY) certification

The module has obtained BLE RF_PHY certification.

The module is published under BLE SIG web site.

12.2 CE certification

The STM32WB1MMC module has obtained CE certification.

The module is provided with CE marking.

Figure 13. CE certification logo

12.3 FCC certification

The STM32WB1MMC module complies with part 15 of the FCC Rules.

The FCC ID is YCP-32WB1MMCH01.

The module label includes the corresponding FCC ID.

The operation is subject to the following two conditions:

- This device may not cause harmful interference
- This device must accept any interference received, including interference that may cause undesired operation.

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.*

Label requirements

If the 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 label must contain the FCC ID that matches the one on the module.

RF radiation exposure statement caution

The module antenna must be installed to meet the RF exposure compliance separation distance of "20 cm" and any additional testing and authorization processes as required.

Documentation requirements

The users manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Integration requirements

Co-location of this module with other transmitters that operate simultaneously are required to be evaluated using the multi-transmitter procedures.

The host integrator must follow the integration instructions provided in this document and ensure that the composite-system end product complies with the requirements by a technical assessment or evaluation to the rules and to KDB Publication 996369.

The host integrator installing this module into their product must ensure that the final composite product complies with the requirements by a technical assessment or evaluation to the rules, including the transmitter operation and should refer to guidance in KDB 996369.

12.4 ISED certification

The STM32WB1MMC module has been tested and found compliant with the ISED RSS-247 and RSS-Gen rules. The IC ID is 8976A-32WB1MMCH01.

This module contains license-exempt transmitter(s) that comply with Innovation, Science and Economic Development Canada's license-exempt RSS(s). Operation is subject to the following two conditions:

• This module may not cause interference
• This module must accept any interference, including interference that may cause undesired operation of the module.

L'émetteur exempt de licence contenu dans 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 :

• L'appareil ne doit pas produire de brouillage.
• L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

RF radiation exposure statement caution

This Transmitter must be installed to provide a separation distance of at least 20 cm from all persons.

Revision history

Table 6. Document revision history

Date	Version	Changes
03-Mar-2023	1	Initial release.

Contents

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List of figures

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  [STM32WB1MMCH6TR](#)