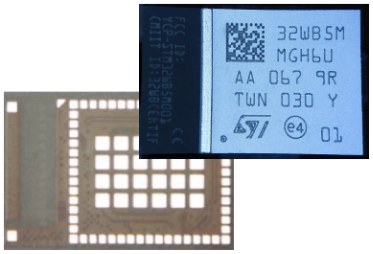
STM32WB5MMG

Datasheet

Bluetooth® Low Energy 5.0 and 802.15.4 module



These pictures are not contractual

Features

- Integrated chip antenna
- Bluetooth® Low Energy 5.0, Zigbee® 3.0, OpenThread certified
- Dynamic and static concurrent modes
- IEEE 802.15.4-2011 MAC PHY
- Supports 2 Mbits/s
- TX output power up to +6 dBm
- RX sensitivity: -96 dBm (Bluetooth® Low Energy at 1 Mbps), -100 dBm (802.15.4)
- Range: up to 75 meters
- 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
- 1-Mbyte Flash memory, 256-Kbyte SRAM
- Fully integrated BOM, including 32 MHz radio and 32 KHz RTC crystals
- Integrated SMPS
- Ultra-low-power modes for battery longevity
- 68 GPIOs
- Integrated IPD for best-in-class and reliable antenna matching
- 1.8 V to 3.6 V V_{DD} range
- -40 °C to 85 °C temperature range
- Built-in security features such as: secure firmware installation (SFI) for radio stack, customer key storage/key management services, PKA, AES 256-bit, TRNG, PCROP, CRC, 96-bit UID, possibility to derive 802.15.4 and Bluetooth® Low Energy 48-bit UEI
- Certifications: CE, FCC, IC, JRF, SRRC, RoHS, REACH, GOST, KC, NCC
- Two layers PCB compatible (using external raw pins only)

Application

- Lighting and home automation
- Wireless audio devices
- Wellness, healthcare, personal trackers
- Gaming and toys
- Smart locks
- Beacons and accessories
- Industrial

Product status link
STM32WB5MMG

Product summary	
Order code	STM32WB5MMG
Temperature range	-40 °C to 85 °C
Package	LGA 86L 10x10
Package dimensions (mm)	7.3 x 11 x 1.342 x 0.435 pitch
Packaging	Tape and reel

CE

R005-102490

CCAN20LP0740T3

1 Introduction

This datasheet provides the ordering information and mechanical device characteristics of the STM32WB5MMG module.

This document should be read in conjunction with the *Multiprotocol wireless 32-bit MCU Arm®-based Cortex®-M4 with FPU, Bluetooth® 5 and 802.15.4 radio solution (DS11929)* and reference manual (RM0434). The reference manual is available from the STMicroelectronics website at *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.

2 Description

The STM32WB5MMG is an ultra-low-power and small form factor certified 2.4GHz wireless module. It supports Bluetooth® Low Energy 5.0, Zigbee® 3.0, OpenThread, dynamic and static concurrent modes, and 802.15.4 proprietary protocols. Based on STMicroelectronics STM32WB55VGY wireless microcontroller, the STM32WB5MMG 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.

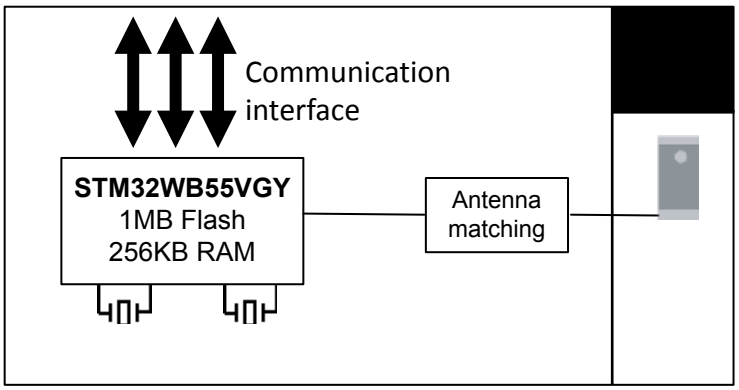
The STM32WB5MMG requires no RF expertise and is the best way to speed-up any development and to reduce associated costs. The module is completely protocol stack royalty-free.

Module overview

The module is an SiP-LGA86 package (system in package land grid array) that integrates the proven STM32WB55VGY MCU with several external components. The package includes:

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

Figure 1. STM32WB5MMG module block diagram



3 Available peripherals

All peripherals available in STM32WB Series microcontrollers based on the WLCSP100 package are available and accessible on this module.

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

- 2× DMA controllers (seven channels each) supporting ADC, SPI, I^2C, USART, QSPI, SAI, AES, timers
- 1× USART (ISO 7816, IrDA, SPI master, Modbus and Smartcard mode)
- 1× LPUART (low power) – Two SPI running at 32 Mbit/s
- 2× I^2C (SMBus/PMBus)
- 1× SAI (dual channel high quality audio)
- 1× USB 2.0 FS device, crystal-less, BCD and LPM
- 1× Touch sensing controller, up to 18 sensors
- 1× LCD 8x40 with step-up converter
- 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 *Multiprotocol wireless 32-bit MCU Arm®-based Cortex®-M4 with FPU, Bluetooth® 5 and 802.15.4 radio solution* (DS11929).

4 Pin description

The following figure shows the module pinout package bottom view.

Figure 2. STM32WB5MMG module pinout: bottom view

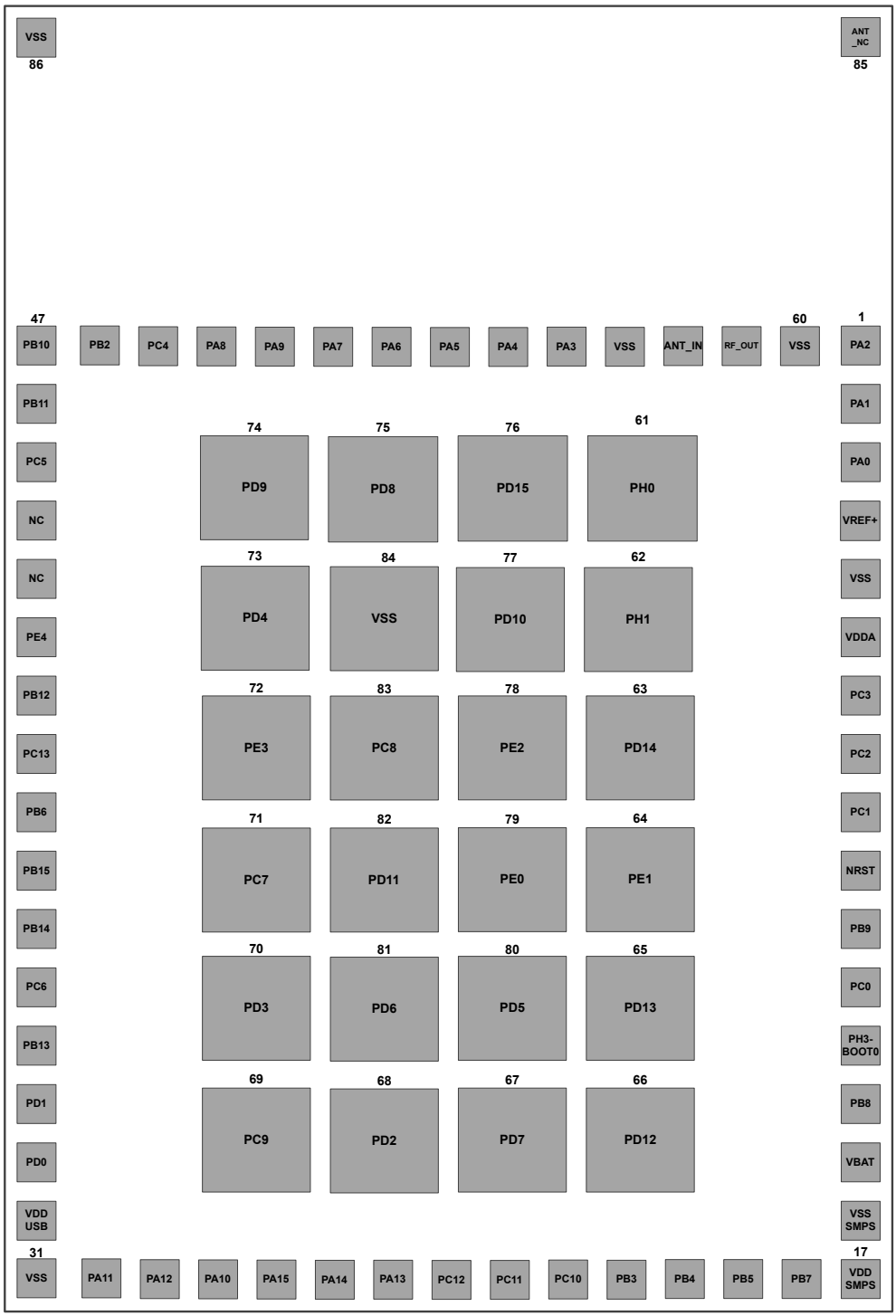


Table 1. **STM32WB5MMG pin/ball definition**

Pin name		Pin name (function after reset)	Pin type
STM32WB5MMG	STM32WB55VGY		
1	F6	PA2	I/O
2	G6	PA1	I/O
3	G7	PA0	I/O
4	H8	VREF+	S
5	J9	VSS	S
6	H9	VDDA	S
7	G10	PC3	I/O
8	G9	PC2	I/O
9	G8	PC1	I/O
10	F9	NRST	I/O
11	F10	PB9	I/O
12	F8	PC0	I/O
13	E8	PH3-BOOT0	I/O
14	F7	PB8	I/O
15	C10	VBAT	S
16	F1	VSSSMPS	S
17	D1	VDDSMPS	S
18	D7	PB7	I/O
19	D6	PB5	I/O
20	C7	PB4	I/O
21	A9	PB3	I/O
22	A6	PC10	I/O
23	B6	PC11	I/O
24	C5	PC12	I/O
25	A5	PA13	I/O
26	A3	PA14	I/O
27	A4	PA15	I/O
28	B5	PA10	I/O
29	A2	PA12	I/O
30	A1	PA11	I/O
31	-	VSS	S
32	B3	VDDUSB	S
33	C4	PD0	I/O
34	C3	PD1	I/O
35	C1	PB13	I/O
36	D2	PC6	I/O
37	E2	PB14	I/O
38	F3	PB15	I/O
39	F5	PB6	I/O
40	G5	PC13	I/O
41	G3	PB12	I/O
42	G1	PE4	I/O
45	H5	PC5	I/O
46	J6	PB11	I/O

Pin name		Pin name (function after reset)	Pin type
STM32WB5MMG	STM32WB55VGY		
47	K6	PB10	I/O
48	K7	PB2	I/O
49	G4	PC4	I/O
50	J7	PA8	I/O
51	K8	PA9	I/O
52	H6	PA7	I/O
53	H7	PA6	I/O
54	K9	PA5	I/O
55	K10	PA4	I/O
56	J8	PA3	I/O
57	-	VSS	S
58	-	ANT_IN	-
59	-	RF_OUT	-
60	-	VSS	S
61	E10	PH0	I/O
62	E9	PH1	I/O
63	D8	PD14	I/O
64	B10	PE1	I/O
65	C9	PD13	I/O
66	B8	PD12	I/O
67	A8	PD7	I/O
68	A7	PD2	I/O
69	B4	PC9	I/O
70	C2	PD3	I/O
71	E3	PC7	I/O
72	G2	PE3	I/O
73	D3	PD4	I/O
74	D5	PD9	I/O
75	D4	PD8	I/O
76	E7	PD15	I/O
77	E4	PD10	I/O
78	E6	PE2	I/O
79	C8	PE0	I/O
80	B7	PD5	I/O
81	C6	PD6	I/O
82	E5	PD11	I/O
83	F4	PC8	I/O
84	-	VSS	S
85	-	ANT_NC	-
86	-	VSS	S
-	D10	PC14-OSC32_IN	I/O
-	D9	PC15-OSC32_OUT	I/O
-	H10	VSSA	S
-	J10	VDD	S
-	K5	VDD	S

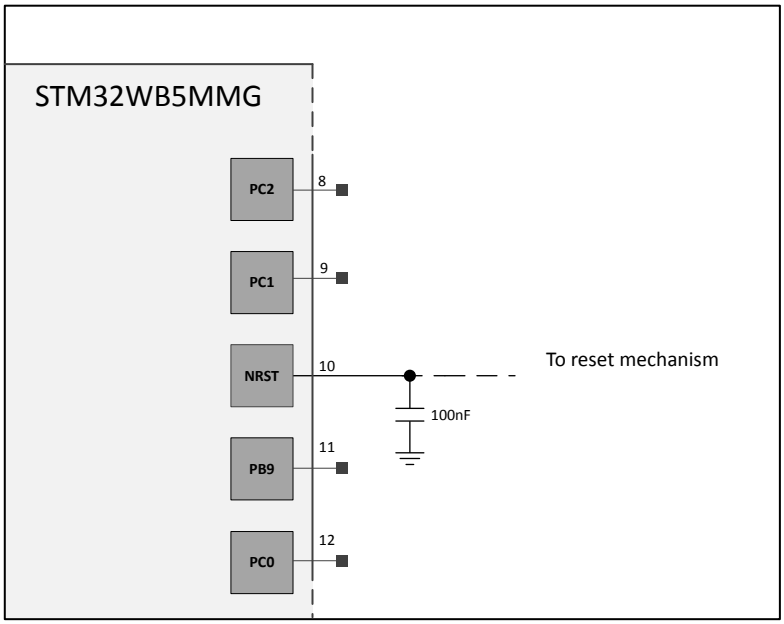
Pin name		Pin name (function after reset)	Pin type
STM32WB5MMG	STM32WB55VGY		
-	J4	VSSRF	S
-	K4	RF1	I/O
-	K3	VSSRF	S
-	K2	VSSRF	S
-	J3	VDDRF	S
-	K1	VSSRF	S
-	J2	OSC_OUT	O
-	J1	OSC_IN	I
-	H3	AT0	O
-	H4	AT1	O
-	H2	PB0	I/O
-	H1	PB1	I/O
-	J5	VSS	S
-	F2	VFBSMPS	S
-	E1	VLXSMPS	S
-	B1	VDD	S
-	B2	VSS	S
-	B9	VSS	S
-	A10	VDD	S

5 Recommendations

5.1 Pin recommendations

- ANT_IN and RF_OUT pins must be connected to GND. This module already integrates an antenna, so no external antenna required.
- The ANT_NC is only used for soldering planarity purposes. So this pin must be soldered to an unconnected pin on the customer board.
- A reset pull-up is already implemented in the STM32WB Series microcontrollers. The reset circuitry only requires an external capacitor for filtering purpose (see Figure 3).

Figure 3. Reset circuit

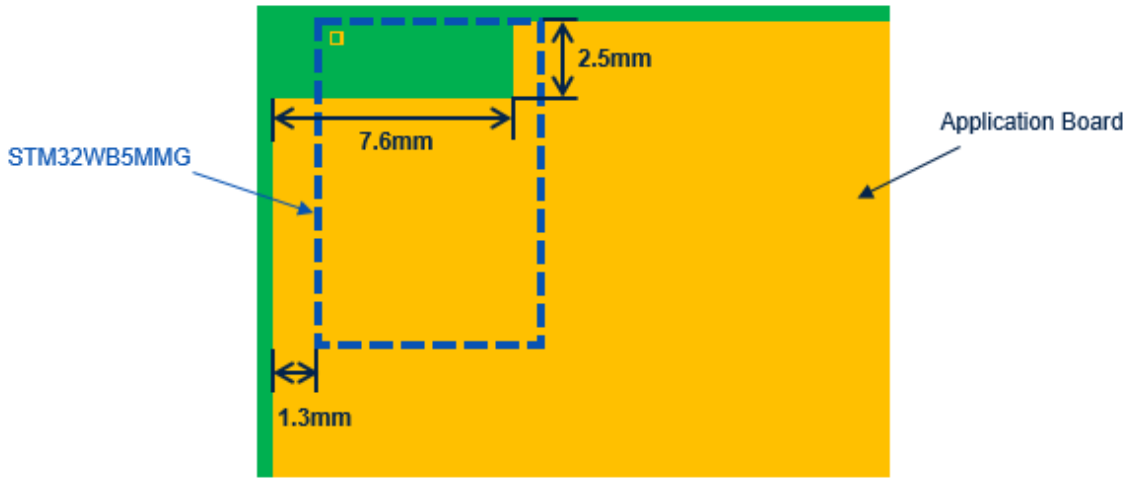


5.2 Layout recommendations

5.2.1 STM32WB5MMG placement

The embedded antenna manufacturer of the STM32WB5MMG recommends to place the module on the application board as shown below.

Figure 4. STM32WB5MMG board placement



This position allows the antenna to work to its maximum performance. If it cannot be placed as recommended above, the application board performance is be reduced. This does not, however, prevent correct operation.

5.2.2 Enclosure effects

Product casing properties must be also considered when designing an RF-enabled product as the following list illustrated;

- Conductive enclosure in close proximity (in far-field) of the antenna reflects the radiating signal and thus decreases the transmitting / receiving power. If there has to be a metal part in the enclosure, consider a frame rather than a box.
- Conductive enclosure in the near field affects the impedance of the antenna, also the resonant frequency. A metal case must not be in the near field. The threshold between near and far-field is provided in Figure 5.
- Plastic enclosures can be close to the antenna, but must not touch it. Contact between the casing and the antenna may influence the tuning of the resonant frequency and impedance matching.
- The proximity of the human body attenuates the TX and RX signals due to a certain amount of water content. Any contact may untune frequency and impedance matching.

Figure 5. **Conductive enclosure around the antenna**

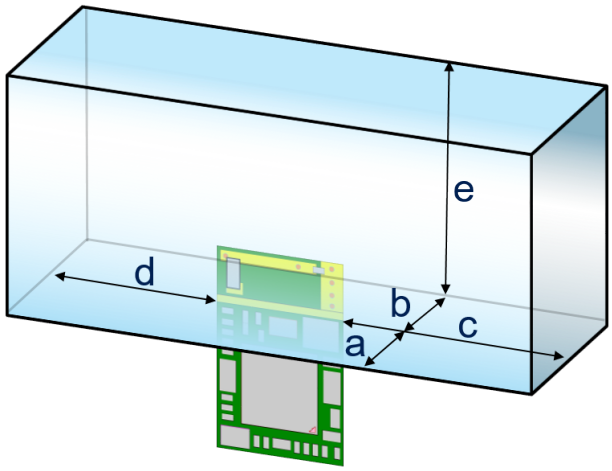


Table 2. **Minimum enclosure dimensions (mm)**

Impact level	a	b	c	d	e
Impact threshold	46	60	27	23	17
High impact	13	24	3	8	5

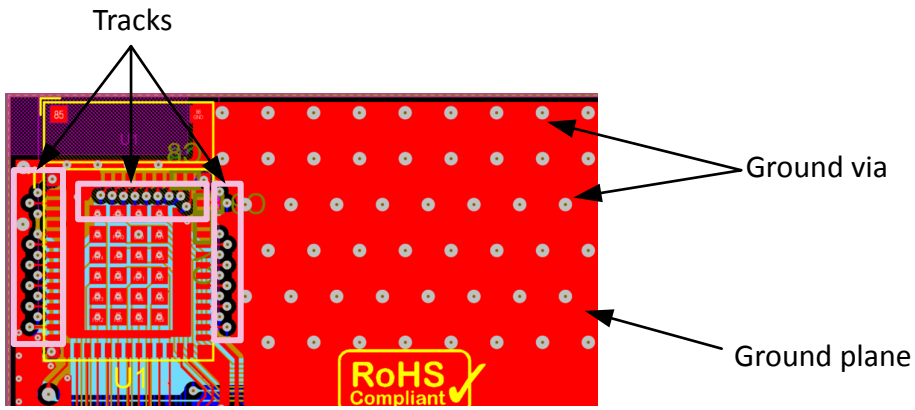
Note: Impact is determined by measuring the reflection losses in the appropriate direction. In case conductive material is present from other directions, the distances mentioned in Table 2 become larger. It means the same impact is observed further from module.

5.2.3 Ground plane

Here are some recommendations with respect to the ground plane design:

- Do not route any tracks to the right of the STM32WB5MMG and keep a large ground plane with the associated ground via.
- Route the tracks down directly on the top layer or with via to the other layers.
- The ground plane must include the presence of vias (distance between two vias = 2 mm).

Figure 6. STM32WB5MMG ground plane layout



5.2.4 Sensitive GPIOs

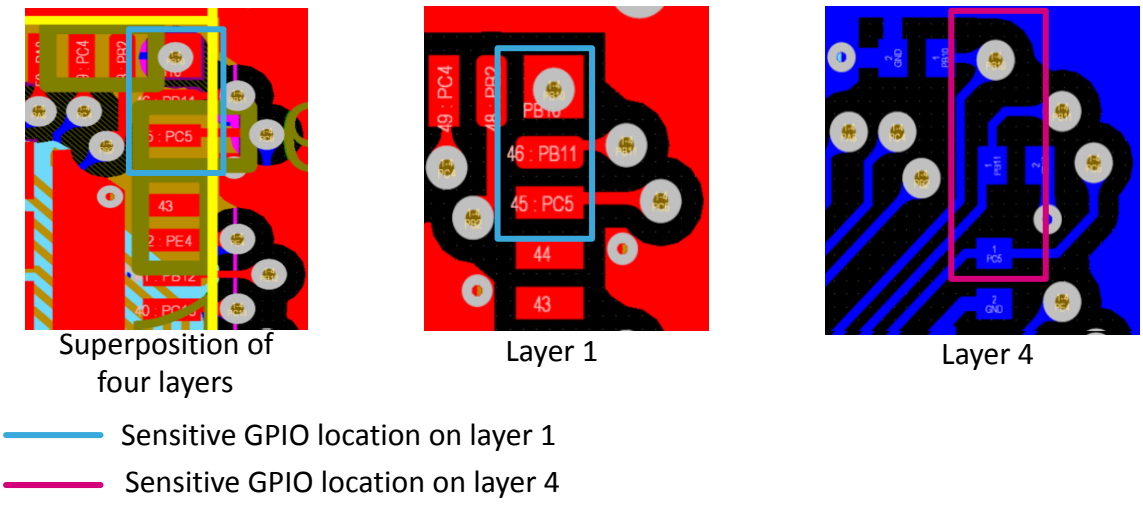
This board contains three sensitive GPIOs as defined below:

- PB10
- PB11
- PC5

The GPIO locations are illustrated in Figure 7

It is recommendedl to add a 3.3 pF capacitor in a small package (0201 or smaller) as close as possible to PB10, PB11 and PC5 outputs of the STM32WB5MMG and also to border the GPIO tracks with ground.

Figure 7. Sensitive GPIO location



5.2.5 Four layer reference board design

The reference schematics are illustrated in Figure 8 and the associated PCB layout is illustrated in Figure 9

By using the first external pad ring, the mother board on which the module is soldered may be designed with only two layers. Using all the pads, the mother board must be designed with 4 layers.

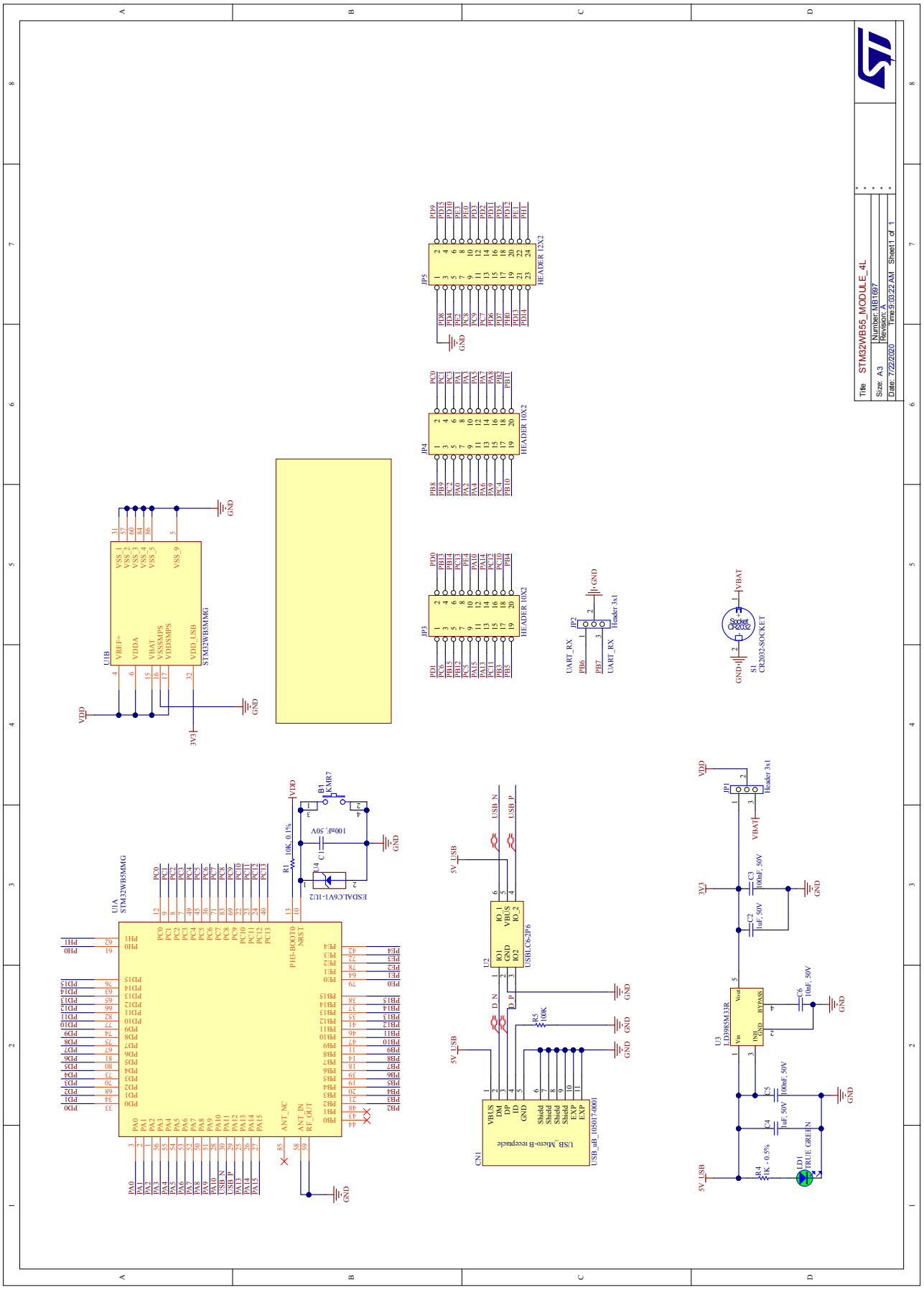
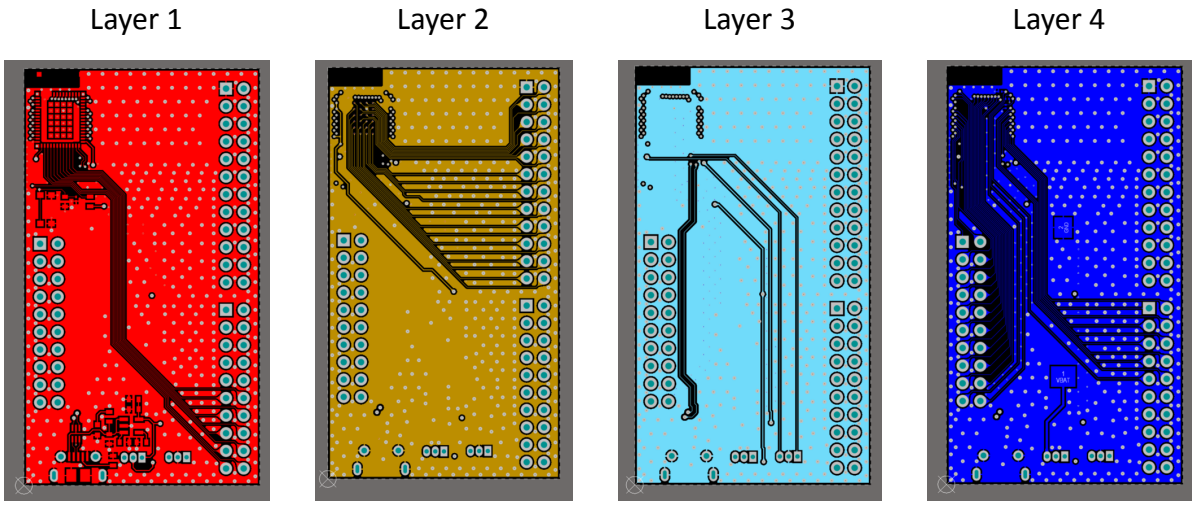


Figure 8. Reference board schematics

Figure 9. **PCB layout**



6 Electrical characteristics

6.1 Operating conditions

Table 3. STM32WB5MMG operating conditions

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

6.2 Power consumption

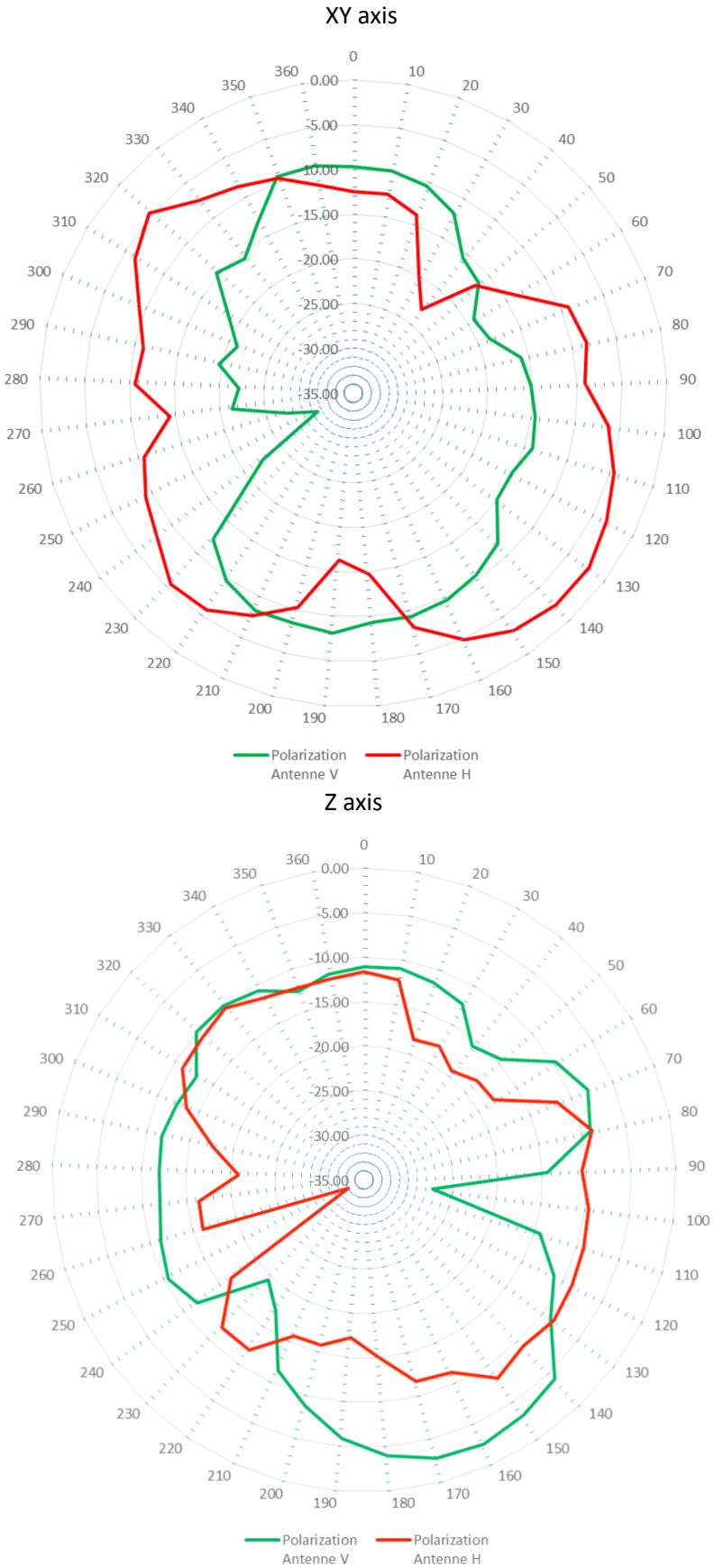
The power consumption is identical to the regular STM32WB55. For full details refer to *Multiprotocol wireless 32-bit MCU Arm®-based Cortex®-M4 with FPU, Bluetooth® 5 and 802.15.4 radio solution* (DS11929).

6.3 RF characteristics

Refer to *Multiprotocol wireless 32-bit MCU Arm®-based Cortex®-M4 with FPU, Bluetooth® 5 and 802.15.4 radio solution* (DS11929) for more details.

6.4 Antenna radiation patterns and efficiency

Figure 10. Antenna radiation patterns



7 Thermal characteristics

The thermal characterics of the STM32WB5MMG are defined below and the constant values are given in Table 4

- $\Theta_{JA,}$ Junction-to-ambient thermal resistance (EIA/JESD51-2 and EIA/JESD51-6):

  $\Theta_{JA,} = (T_J\text{-}T_A) / P_{H,}$

  where T_J= junction temperature, T_A= ambient temperature, P_H= power dissipation.

  $\Theta_{JA,}$ represents the resistance to the heat flows from the chip to ambient air. It is an indicator of package heat dissipation capability. Lower $\Theta_{JA,}$ means better overall thermal performance.
- Ψ_{JT}, Junction-to-top-center thermal characterization parameter (EIA/JESD51-2 and EIA/JESD51-6):

  $\Psi_{JT} = (T_J\text{-}T_T) / P_{H,}$

  where T_T= temperature at the top-center of the package.

  Ψ_{JT} is used for estimating the junction temperature by measuring T_T in an actual environment.
- Θ_{JC}, Junction-to-case thermal resistance :

  $\Theta_{JC} = (T_J–T_C) / P_H,$

  where T_C= case temperature attached with a cold plate.

  Θ_{JC} represents the resistance to the heat flows from the chip to package top case. Θ_{JC} is important when external heat sink is attached on package top.
- Θ_{JB}, Junction-to-board thermal resistance (EIA/JESD51-8):

  $\Theta_{JB} = (T_J–T_B) / P_H,$

  where T_B= board temperature with ring cold plate fixture applied.

  Θ_{JB} represents the resistance to the heat flows from the chip to PCB. JBis used in compact thermal models for system-level thermal simulation.

Table 4. STM32WB5MMG thermal characteristics

Symbol	T_J(°C)	T_C(°C)	Ψ_{JT}(°C/W)	Θ_{JA}(°C/W)	Θ_{JB}(°C/W)	Θ_{JC}(°C/W)
Value	97.36	96.98	37.36	0.38	24.58	16.21

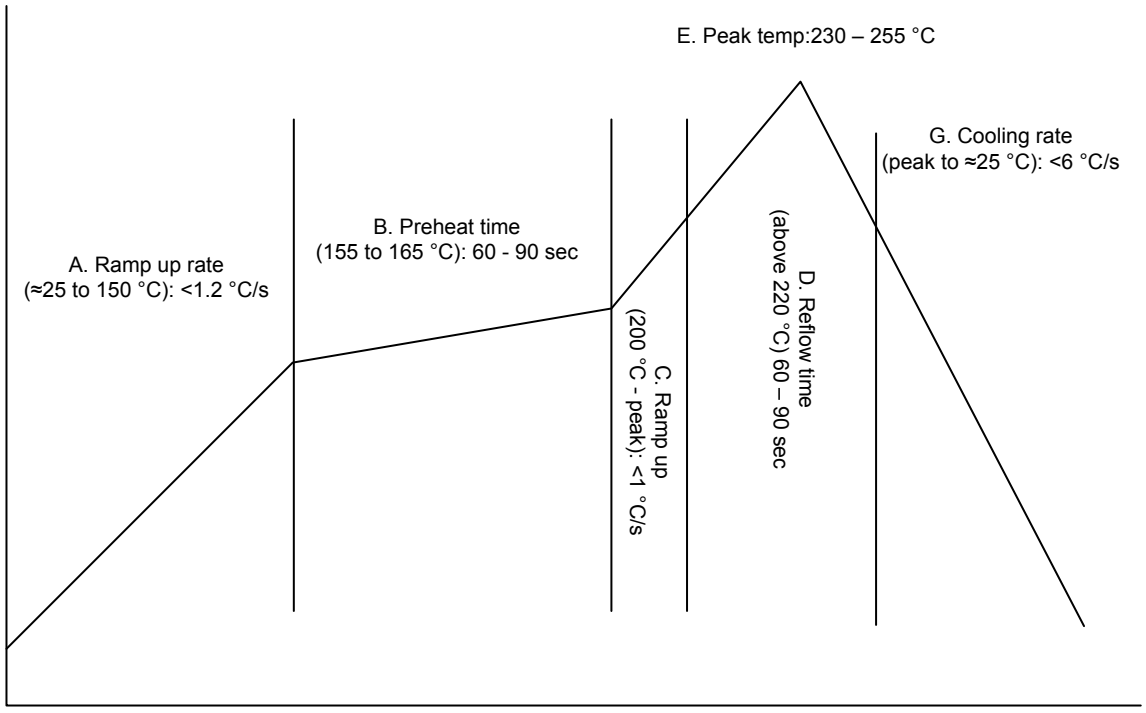
8 Solder re-flow recommendation

A recommended soldering profile is shown below. The re-flow profile is based on using specific solder paste SAC305.

Table 5. Solder re-flow specification

A. Ramp up rate (25-150 ºC)	B. Pre-heat time (155-165 ºC)	C. Ramp up (200 ºC - peak)	D. Re-flow time (above 220 ºC)	E. Peak temperature (230-255 ºC)	G. Cooling rate (peak-25 ºC)
<1.2 °C/s	60-90 sec	<1 °C/s	60-90 sec	230-255 °C	<6 °C/s

Figure 11. Recommended re-flow profile



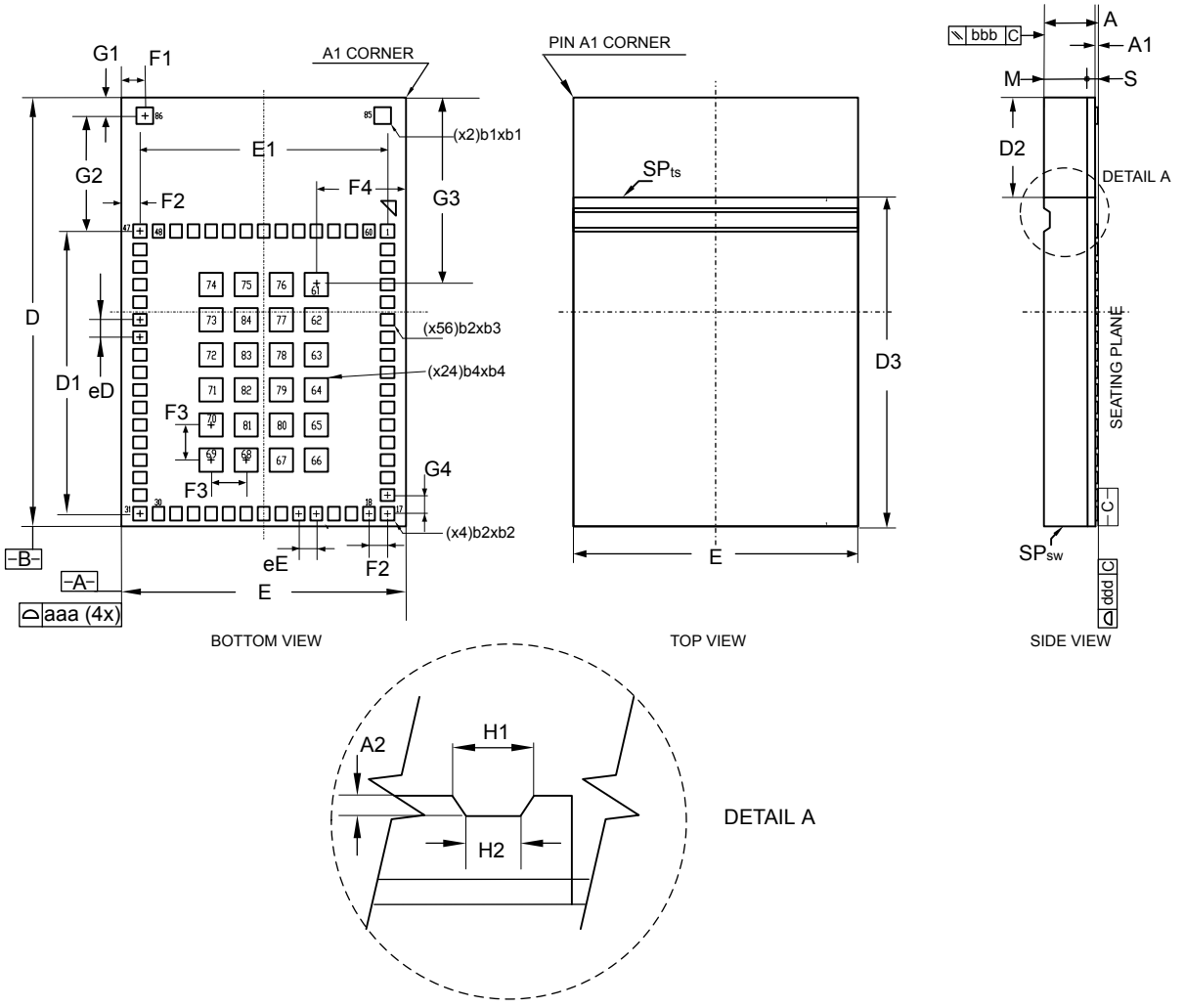
9 Package information

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 SiP-LGA86 package information

This SiP-LGA is a 86 pin, 7.3 x 11mm, system in package land grid array package.

Figure 12. SiP-LGA86 - Outline



1. Drawing is not to scale.

Table 6. SiP-LGA86 - Mechanical data

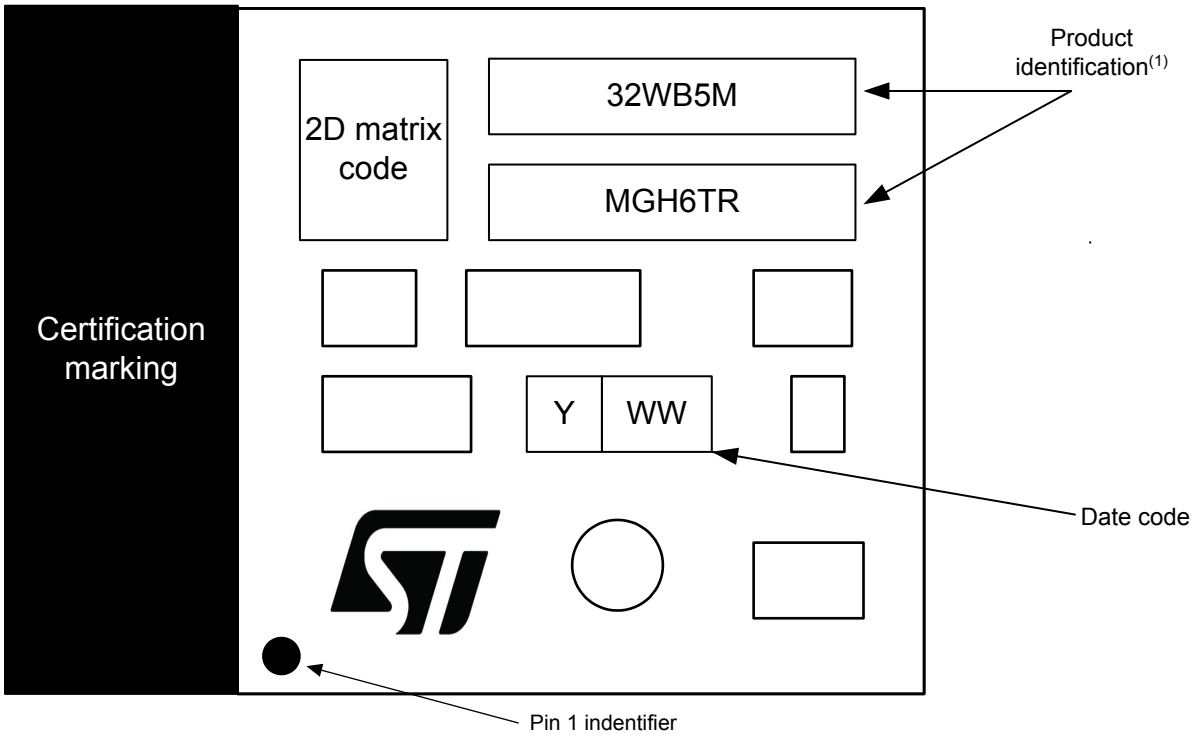
Symbol	Min	Typ	Max	Unit
A		1.382±0.046		mm
A1		40±20(1)		
		30±20(2)		
A2		0.150		µm
M		1.100		mm
S		0.242		
D	10925	11.000	11.075	
D1		7.250		
D2		2.563		
D3		8.438		
eD		0.450		
E	7.225	7.300	7.375	
eE		0.450		
b1		0.430		
b2		0.350		
b3		0.300		
b4		0.600		
F1		0.600		
F2		0.475		
F3		0.900		
F4		2.300		
G1		0.465		
G2		2.960		
G3		4.800		
G4		0.475		
H1		0.600		µm
H2		0.400		µm
SP_{ts}(3)	3	-	6	µm
SP_{sw}(4)	1	-	3	µm
aaa		0.075		mm
bbb		0.100		
ddd		0.100		

1. *Peripheral pads*
2. *Inner pads*
3. *Top surface sputter*
4. *Side wall sputter*

9.1.1 Device marking for SiP-LGA86

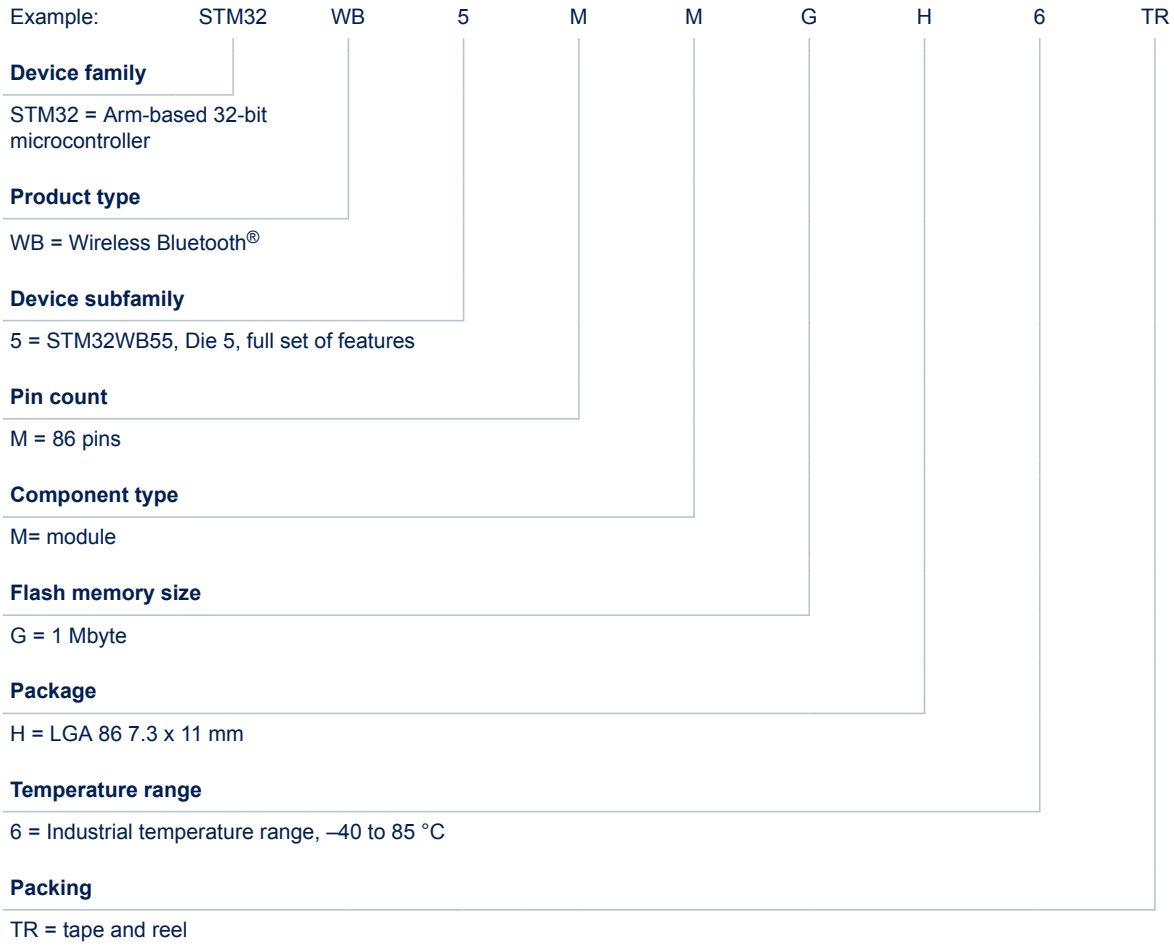
The following figure gives an example of topside marking versus pin 1 position identifier location.
The printed markings may differ depending on the supply chain.
Other optional marking or inset/upset marks, which depend on supply chain operations, are not indicated below.

Figure 13. SiP-LGA86 marking example



1. 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.

10 Ordering information

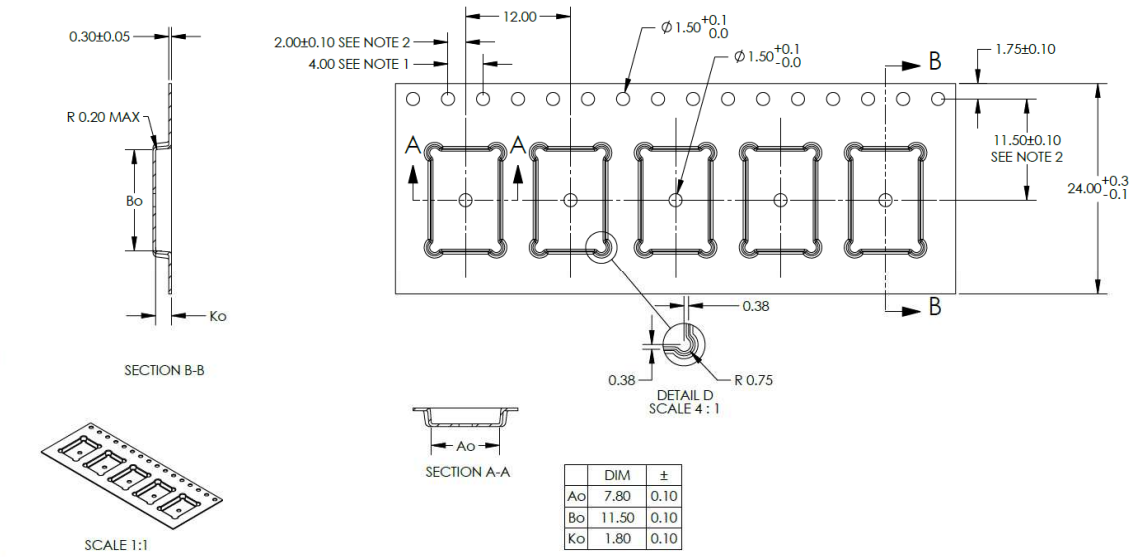


For a list of available options (such as speed and package) or for further information on any aspect of this device, contact your nearest ST sales office.

11 Tape and reel packing

The module tape and reel orientation and dimension are described in the figure below.

Figure 14. STM32WB5MMG packing drawing



	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 Certification

The STM32WB5MMG module passed the following certifications:

- ZigBee (802.15.4-4PHY)
- BLE (RF_PHY)
- CE
- FCC-TCB (USA)
- ISED-FCB (Canada)
- JRF (Japan)
- KC or MSIP (Korea)
- NCC (Taiwan)
- ROHS
- REACH
- GOST (Russia).

SRRC (China) certification is ongoing.

The following sections detail some of the module certifications from sample regions.

12.1 CE certification

The STM32WB5MMG module has obtained CE certification.

The module is provided with CE marking.

Figure 15. CE certification logo

12.2 FCC certification

The STM32WB5MMG module complies with part 15 of the FCC Rules.

The module is labeled with its own FCC ID: YCP-STM32WB5M001

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 FCC ID: YCP-STM32WB5M001

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.

12.3 ISED certification

The STM32WB5MMG module has been tested and found compliant with the ISED RSS-247 and RSS-Gen rules. The IC ID is 8976A-STM32WB5M01.

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.

RF radiation exposure statement caution

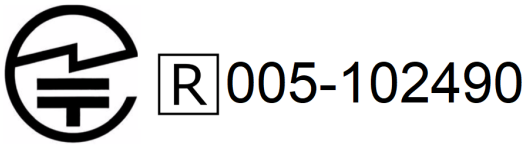
This Transmitter must be installed to provide a separation distance of at least 20 cm from all persons.

12.4 JRF certification

The STM32WB5MMG is certified in Japan with certification number: 005-102490

The JRF logo is the following:

Figure 16. JRF certification logo



12.5 NCC certification

The STM32WB5MMG is certified in Taiwan with NCC certification number: **CCAN20LP0740T3**.

The NCC log is the following:

Figure 17. NCC certification logo

Low-power radio wave radiation equipment management measures:

- Article 12: For low-power radio frequency equipment that has passed the type certification, the company, trade name, or user shall not change the frequency, increase the power, or change the characteristics and functions of the original design without permission.
- Article 14: The use of low-power radio frequency equipment must not affect flight safety and interfere with legal communications; if interference is found, it should be stopped immediately, and it can only be used when there is no interference. Legal communications in the preceding paragraph refers to radio communications operated in accordance with the Telecommunications Law. Low-power radio frequency equipment must endure interference from legal communications or industrial, scientific, and medical radio wave radiation electrical equipment.

12.6 SRRC certification

The Chinese SRRC certification is ongoing.

Note: CMIIT ID is temporarily replaced with 32WBCERTIF. This code is updated with the code assigned by the China Ministry of Industry and Information Technology after SRRC certification is completed.

Revision history

Table 7. **Document revision history**

Date	Revision	Changes
12-Nov-2020	1	Initial release.

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