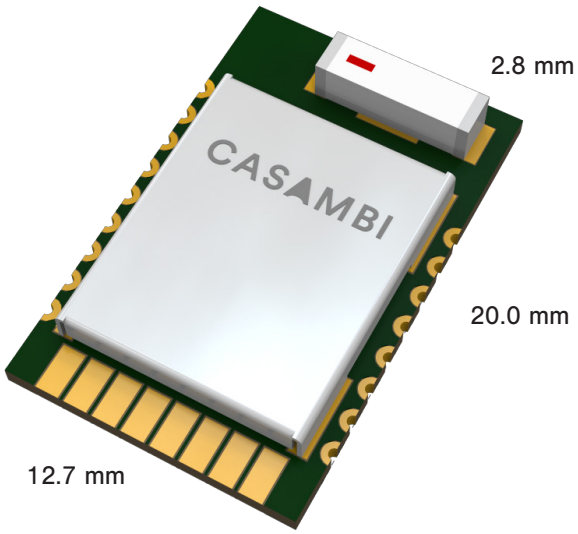
CBM-003B/C DATASHEET



Features

Casambi Lighting Control System:

- Wirelessly controllable with a Bluetooth smart device
- No need for an external gateway device
- Forms automatically a wireless mesh network
- Device firmware can be updated over-the-air
- Casambi cloud service available
- Extremely easy set-up

CBM-003B Features:

- Small form factor, 12.7 mm x 20.0 mm x 2.8 mm
- 12 pcs general-purpose input/output pins
- 4 GPIO can be configured as analog inputs
- SPI, TWI, UART, PWM (max. 8 ch)
- Integrated antenna
- Up to +7 dBm output power and -95 dBm RX sensitivity
- -103 dBm RX sensitivity in long-range mode
- Range up to 400 m in line-of-sight
- Can be mounted in horizontal or vertical position
- Comes with pre-installed Casambi firmware
- Contains an nRF52840 chip.
- DALI-2 (CMOS levels)
- 0-10V support

Applications

- LED drivers, single and multi-channel
- Different lighting control applications
- Light fixtures
- Single and multicolor LED bulbs
- Sensors

Description

CBM-003B/C is a Class 2 embedded Bluetooth module designed for integration into LED drivers, different lighting control applications, light fixtures, and LED bulbs. It comes pre-installed with Casambi proprietary firmware, making it fully compatible with other Casambi-enabled devices.

CBM-003B/C is controlled wirelessly with Casambi smartphone and tablet (“smart device”) applications using Bluetooth protocol. Devices automatically form a self-healing and self-organizing wireless mesh network, allowing a large number of luminaires to be controlled from any point. No external gateway module is required.

CBM-003B/C contains a powerful 32-bit ARM® Cortex® -M4 CPU and a 2.4 GHz transceiver with an onboard antenna. Various external components, such as motion detectors, ambient light sensors, and PWM circuits can be interfaced with the module using its 12 general-purpose I/O pins.

CBM-003B/C can be mounted in both horizontal and vertical positions, making it very versatile for projects with different form factors.

CASAMBI

Table of Contents

1. Operation **3**
2. Block Diagram **3**
3. System blocks **4**
4. Serial Interfaces **5**
5. Pin Assignment **5**
6. Electrical Specifications **7**
7. Radio Characteristics **9**
8. Communication Interface Characteristics **10**
9. PWM Specifications **10**
10. Antenna Versions **11**
11. Mounting **12**
12. Package Outline Drawing **15**
13. Soldering **16**
14. Packaging **17**
15. Federal Communications Commission (FCC) Statement **21**
16. Innovation, Scientific and Economic Development Canada (ISED) Statement **21**
17. End Product Labeling **22**
18. Notes **22**

1. Operation

Casambi CBM-003B/C is an embedded wireless module with a powerful 32-bit ARM® Cortex® -M4 CPU and a 2.4 GHz transceiver with an onboard antenna. For example, it can be integrated into an LED driver, a light fixture, LED bulb, or any sensor.

The CBM-003B/C has a total of 12 GPIO pins that can be configured for various tasks such as: SPI, TWI (I2C compatible), UART, 8 PWM outputs, and 4 channel Analog-to-Digital Converter input. ADC input channels have fixed GPIO pins. Additional functions can be configured to any free GPIO pin. **Note:** The CBM-003B/C is based on the nRF52840 chip, which has some limitations compared to previous models. Many of the nRF52840 pins are recommended to be used only in standard-drive (2 mA) **and** low frequency (≤10kHz) mode. CBM-003B/C has 6 standard and 6 high-drive GPIOs.

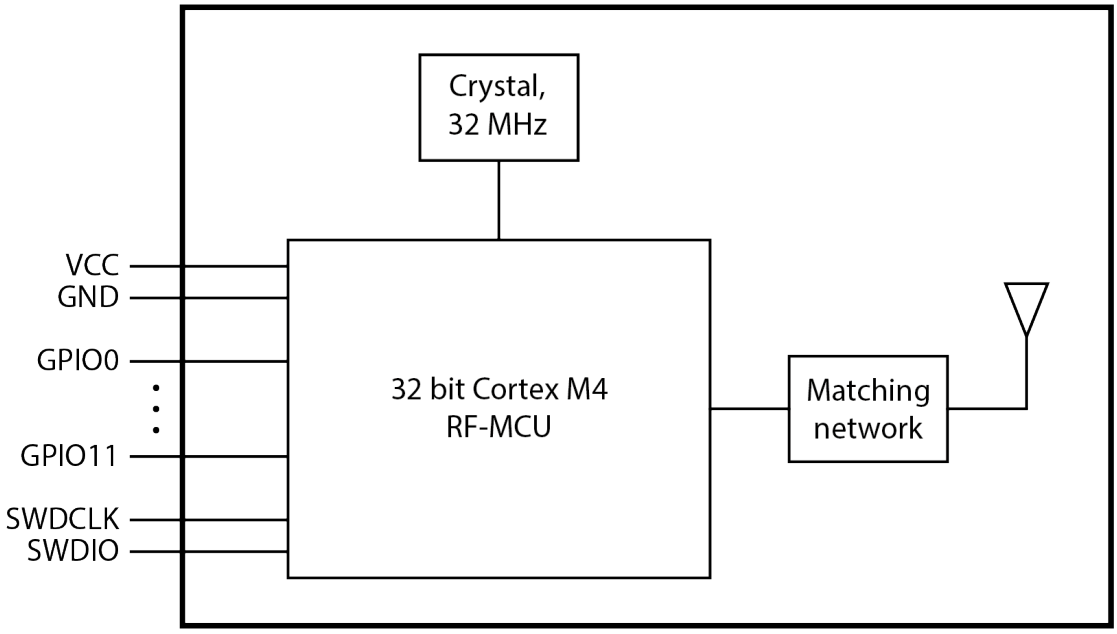
All >10KHz and high-drive IOs shall be connected to high-drive pins, otherwise the radio performance will suffer slightly.

The CBM-003B/C has an integrated 2.4 GHz antenna, so this must be taken into account when integrating the device into any environment. See chapter 7 for further instructions.

Many of the different settings of the CBM-003B/C can be configured and used in the Casambi Admin webtool without having to re-programm the module. These settings include, for example, I/O pin mapping, PWM, and push-buttons.

The Casambi CBM-003B/C is based on the Nordic Semiconductor nRF52840 chip, and all technical data can be found in the chip's datasheet.

2. Block Diagram



CBM-003B/C block diagram

3. System blocks

3.1 General Purpose I/O (GPIO)

The CBM-003B/C has 12 General Purpose I/O pins. Some of them are high-drive (9 mA) while some are standard-drive (2 mA). Each GPIO can be accessed individually, and each has the following features:

- Input/output direction
- Configurable output drive strength, standard-drive (6 pcs) or high-drive (6 pcs)
- Configurable internal pull-up and pull-down resistors
- Buffered inputs
- Trigger interrupt on all pins (rising edge, falling edge, any change)
- The serial interface output can be freely configured to any of the 6 high-drive pins
- >10 kHz PWM output can be freely configured to any of the 6 high-drive pins
- ≤10 kHz PWM output can be freely configured to any of the 12 GPIO pins

GPIO pins 0-3 also support analog input signals when using an internal Analog-to-Digital Converter (ADC).

3.2 Analog-to-Digital Converter (ADC)

The Casambi system can use an Analog-to-Digital Converter (ADC), for example, in light level measuring and battery voltage monitoring. The ADC resolution (8-bit or 12-bit) is automatically selected based on the application. The specific functionality available through the ADC inputs is determined by the Casambi Firmware and its configuration.

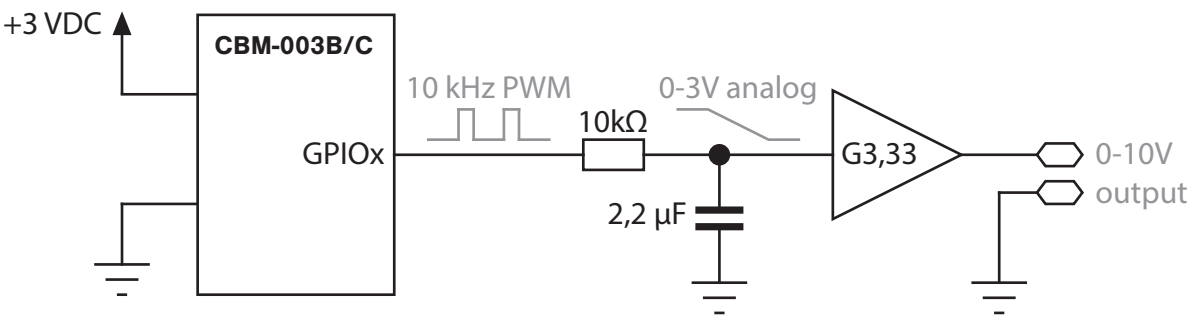
The Analog-to-Digital voltage range for any ADC input is 0-3.6 V, but not above VCC. This means that 0 V gives a zero reading from the ADC, and 3.6 V gives a maximum reading (255 for 8-bit and 4095 for 12-bit resolution).

No pin should be exposed to voltages higher than VCC. The operating voltage of the module, VCC, is the maximum limit for the analog input voltage. While the full range of ADC is 3.6V, if the supply voltage VCC is only 3.3V or 3.0V, the full range cannot be used.

3.3 PWM Output

Each GPIO pin can be configured to output a PWM signal, and up to 8 PWM channels can be used simultaneously. A PWM frequency can be determined freely to up to 40 kHz and is the same for all PWM channels. However, any PWM over 10 kHz requires the use of a high-drive pin. The resolution can be selected in steps in the range of 100 - 5000. The maximum resolution depends on the PWM frequency.

The PWM signal is logic level (max. VCC), and it has a driving capacity of 2 mA (standard) or 9 mA on a high-drive pin. See also the Nordic nRF52840 datasheet for limitations. An adjustable analog voltage (0 V - VCC) can be derived from the PWM signal via an external RC filter.



Adjustable 0–10V output from PWM signal

4. Serial Interfaces

The CBM-003B/C can be connected to an external MCU via its Casambi proprietary interface extension that supports SPI, TWI, and UART. All extension interface signals must be connected to high-drive pins, if the data rate exceeds 10 kHz. Using standard-drive low frequency pins at frequencies higher than 10kHz will degrade the receiver sensitivity by 3-4dB. UART/SPI/TWI interfaces are intended for this purpose and are not suitable for generic use outside of the Extension Interface Protocol without special arrangements from Casambi Technologies. Via this interface it is possible to collect information from sensors within the Casambi network. For detailed serial info, refer to the nRF52840 datasheet. See the Firmware Extension Interface datasheet for detailed information.

4.1 Serial Peripheral Interface (SPI)

The CBM-003B/C supports a 4-wire (SCK, MISO, MOSI, SS) bidirectional SPI bus with fast data transfers to the connected MCU ('client').

The SPI peripheral supports SPI modes 0 - 3.

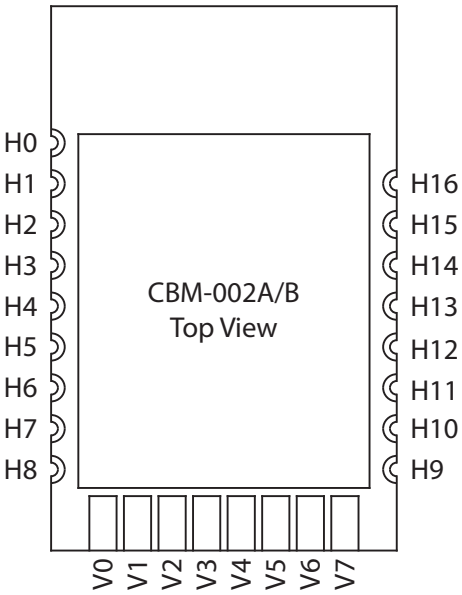
4.2 Two-Wire Interface (TWI)

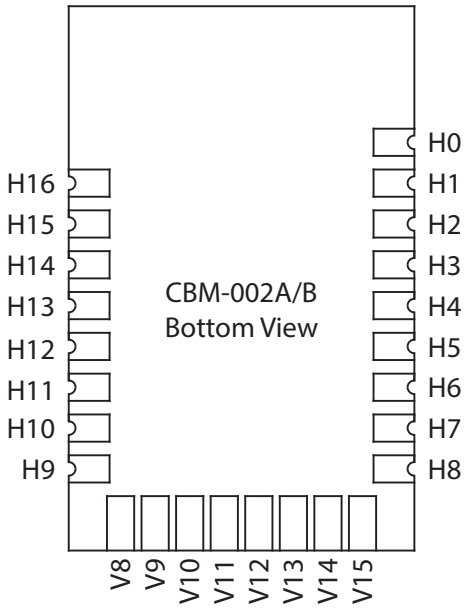
The Two-Wire Interface (I2C compatible) can interface a bidirectional wired-AND bus with two lines (SCL, SDA). The interface is capable of clock stretching, and supports data rates of 100 kbps and 400 kbps. The TWI transmitter and receiver are single buffered.

4.3 Universal Asynchronous Receiver/Transmitter (UART)

The Universal Asynchronous Receiver/Transmitter provides high-speed, full-duplex, asynchronous serial communication with built-in flow control support in HW up to 1 Mbps. Parity checking and generation for the 9th data bit are supported.

5. Pin Assignment





003 pin	Vert pin	MCU pin	Pin name	Pin Function	Description
H0	-	-	GND	Power	Ground
H1	V7	P0.02	GPIO0 AIN0	Digital I/O Analog input	Standard-drive, low frequency I/O only ADC input0 **
H2	V6	P0.29	GPIO1 AIN1	Digital I/O Analog input	Standard-drive, low frequency I/O only ADC input1 **
H3	V5	P0.31	GPIO2 AIN2	Digital I/O Analog input	Standard-drive, low frequency I/O only ADC input2 **
H4	V4	P0.04	GPIO3 AIN3	Digital I/O Analog input	General-purpose I/O pin ADC input3
H5	V3	-	VCC	Power	Power Supply
H6	V2	SWDCLK	SWDCLK	Digital Input	HW debug and flashing
H7	V1	SWDIO	SWDIO	Digital I/O	HW debug and flashing
H8	V0	GND	GND	Power	Ground
H9	V8	P0.09	GPIO4	Digital I/O	Standard-drive, low frequency I/O only NFC antenna (future option)* **
H10	V9	P0.10	GPIO5	Digital I/O	Standard-drive, low frequency I/O only NFC antenna (future option)* **
H11	V10	P0.20	GPIO6	Digital I/O	General-purpose I/O pin
H12	V11	P0.01	GPIO7	Digital I/O	General-purpose I/O pin Connection for 32.768 kHz crystal (future option)
H13	V12	P0.00	GPIO8	Digital I/O	General-purpose I/O pin Connection for 32.768 kHz crystal (future option)
H14	V13	P0.22	GPIO9	Digital I/O	General-purpose I/O pin
H15	V14	P1.00	GPIO10	Digital I/O	General-purpose I/O pin
H16	V15	P1.04	GPIO11	Digital I/O	Standard-drive, low frequency I/O only **

*Leakage current between NFC pads when driven to different states 1 µA (typ) and 10 µA (max).

**Driving low frequency I/Os at frequencies higher than 10kHz will degrade the receiver sensitivity by up to 4dB.

6. Electrical Specifications

6.1 Absolute Maximum Ratings

Maximum ratings are the extreme limits to which CBM-003B can be exposed without permanently damaging it.

Exceeding the maximum ratings will permanently damage the product. Data presented here is from the nRF52840 datasheet revision 1.1.

Absolute Maximum Ratings	Min.	Max.	Units
Supply voltage, VCC	-0.3	+3.9	V
GND		0	V
I/O pin voltage	-0.3	VDD+0.3	V
Storage temperature	-40	+125	°C
Operation temperature, T_A	-40	+85	°C
Relative humidity, storage		90	%
Relative humidity, operating		90	%

6.2 Power Supply Specification

Power Supply Specification	Min.	Typ.	Max.	Units
Supply voltage, VCC	+2.5	+3.0	+3.6	V
Supply rise time (0 to 1.7 V)			60	ms
Supply current, ICC (@3.0V)		7	25 *	mA

*In TX mode.

6.3 General Purpose I/O Specification

GPIO Specification	Min.	Typ.	Max.	Units
Input high voltage, VIH	0.7xVDD		VDD	V
Input low voltage, VIL	GND		0.3xVDD	V
Output high voltage, VOH	VDD-0.4		VDD	V
Output low voltage, VOL	GND		GND+0.4	V
Current at VSS+0.4 V, output set low, standard-drive	1	2	4	mA
Current at VSS+0.4 V, output set low, high-drive, VDD ≥ 2.7 V	6	10	15	mA
Current at VDD-0.4 V, output set high, standard-drive	1	2	4	mA
Current at VDD-0.4 V, output set high, high-drive	6	9	14	mA
Pull-up resistance, RPU	11	13	16	kΩ
Pull-down resistance, RPD	11	13	16	kΩ

*VDD ≥ 2.7V. For details, see nRF52840 datasheet "GPIO Electrical Specification".

7. Radio Characteristics

7.1. General Radio Characteristics

General Radio Characteristics	Min.	Typ.	Max.	Units
Operating frequencies, f_{OP}, 1 MHz chann. spacing	2402		2480	MHz
PLL programming resolution, PLLres		1		MHz
Frequency deviation, Δf_{BLE}	±225	±250	±275	kHz
On-air data rate, bps_{SFSK}	1000	+4	2000	kbps
Maximum output power, P_{RF}		+7		dBm
Sensitivity, P_{SENS} 1 Mbps		-95		dBm
Sensitivity, 125 kbps		-103		dBm

8. Communication Interface Characteristics

8.1. Bit Rates

Bit Rates	Min.	Typ.	Max.	Units
Bit rate for SPI, f_{SPI}	0.125		8	Mbps
Bit rates for TWI, f_{2W}	100		400	kbps
Baud rate for UART, f_{UART}			1000	kbps

9. PWM Specifications

PWM Specification	Min.	Typ.	Max.	Units
PWM frequency, fPWM			40	kHz
PWM resolution	100		5000	steps
PWM resolution @ fPWM 10 kHz			1600	steps
PWM resolution @ fPWM 20 kHz			800	steps
PWM resolution @ fPWM 40 kHz			400	steps

10. Antenna Versions

CBM-003B/C is available in two different antenna versions. CBM-003B is equipped with an on-board SMD ceramic chip antenna and CBM-003C is equipped with a 1/4 wavelength monopole antenna. Due to the bulky installation of the CBM-003C antenna, CBM-003B is the preferred model. In most cases, it offers equal or better RF performance.

CBM-003C comes with the antenna detached, so the antenna needs to be soldered in place before the module can be used. This is because the antenna can be soldered in a vertical or horizontal position. The host device will determine which antenna orientation is more suitable.

The antenna is constructed from 27mm single strand copper wire and can be soldered in a horizontal or vertical orientation to best suit the host application.

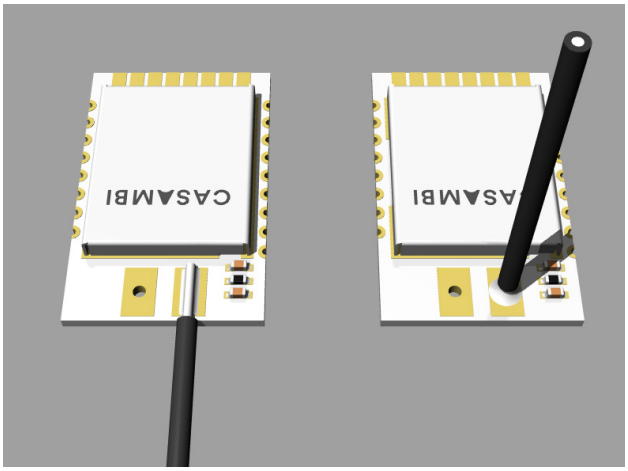
The antenna can be bent to better fit the host application. However, there are some guidelines that must be followed.

1. Make sure the antenna is not in contact with any kind of metal.
2. The antenna should be placed as far as possible from metal structures.
3. The tip of the antenna is particularly sensitive to nearby metals.
4. The less bending there is on the antenna, the less it will affect the range.
5. Do not use any other type of antenna. Do not cut or modify the supplied antenna.

The antenna is soldered to the solder pad on the left (the pad closer to the antenna matching components). When soldering the antenna in a horizontal position, for correct operation, place the antenna so that it fills the entire length of the solder pad. As a result, the antenna protrudes 23.5-24.0 mm over the edge of the module.

When the antenna is soldered in a vertical position, solder it so that the antenna protrudes 23.5-24.0mm above the PCB surface. Cut the antenna wire from the bottom to the desired length. This cutting does not affect the performance or approvals.

Important!
CBM-003C has been certified with the supplied antenna and modification beyond the instructions in this datasheet will void the certification.



CBM-003B on the left and CBM-003C on the right

11. Mounting

CBM-003B/C has two sets of solder pads that allow mounting in horizontal and vertical position. In the vertical position, the module can be installed either via a 2-row pin header with a 1.27 mm pitch or by soldering the module directly into a routed slot on the main PCB.

11.1 Horizontal mounting

When CBM-003B/C is mounted in a horizontal position it is soldered in by using the soldering pads on both long sides of the module. The soldering pads are designed in such a way that the module can be soldered both by hand and by reflow.

When mounted horizontally, there are two mandatory keep-out areas. One is for the antenna and the other for the bottom solder pads on the narrow end of the module. These pads are used for vertical mounting.

For the CBM-003B, the antenna keep-out applies to all layers of the mother board. There must be no components, traces, pads, or areas of copper in any layer within the keep-out area. The same applies to other metals, such as the product's casing, fastening screws, etc.

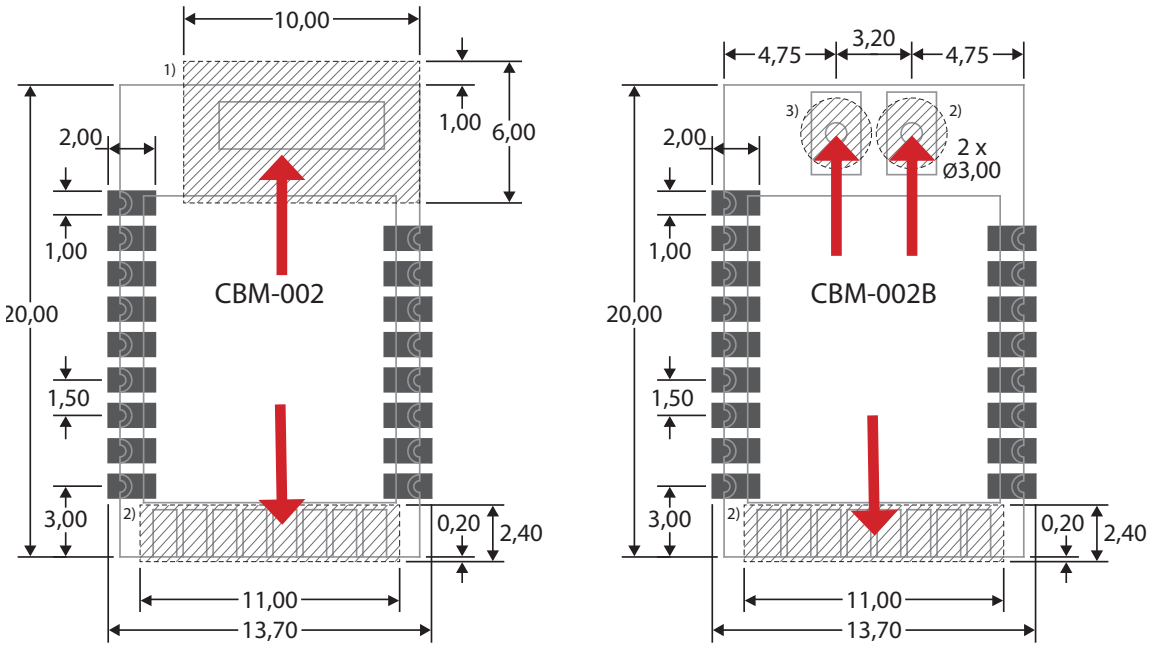
The keep-out area for the solder pads only applies to the outer surface of the motherboard.

11.1.1 Recommended PCB Land Pattern

When CBM-003B/C is mounted in a horizontal position it is soldered in by using the soldering pads on both long sides of the module. The soldering pads are designed in such a way that the module can be soldered both by hand and by reflow.

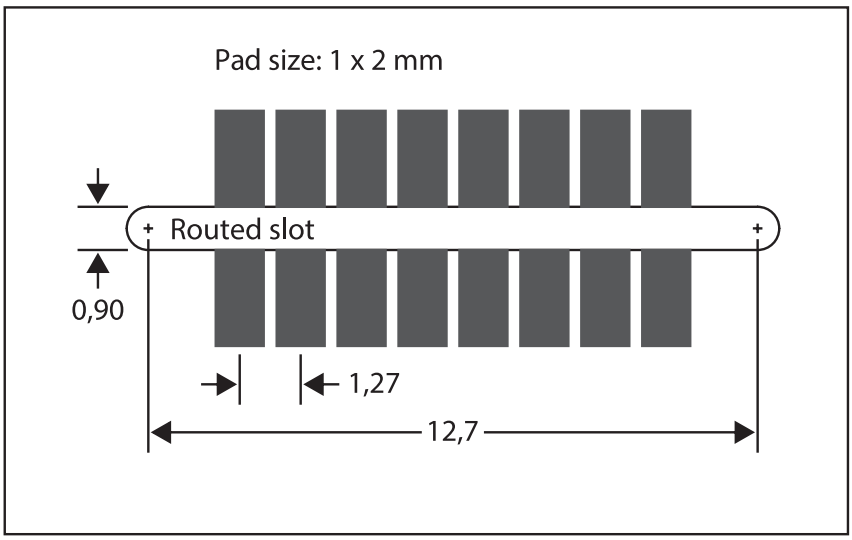
Recommended area pattern for horizontal mounting (required keep-out areas are dashed and marked with arrows in the picture below)

1) This keep-out area must be kept clear of all parts, traces and copper on all layers.
2) This keep-out area only applies to the layer closest to the module.
3) When soldering the CBM-003C antenna vertically, this keep-out area must be a hole. Otherwise, the keep-out area applies only to the layer closest to the module.



11.2 Vertical mounting

CBM-003B/C can be mounted in vertical position by using the solder pads on the narrow end of the module. There are two methods to solder the module in vertical position. It can either be soldered between rows of pins of a 2 row 1.27mm header (2 x 8P) or soldered into a 0.9mm slot routed on the motherboard using solder pads on the edge of the slot. The thickness of the module printed circuit board is 0,85 mm (+/- 0,1mm).



Suggested land pattern for vertical mounting in a slot

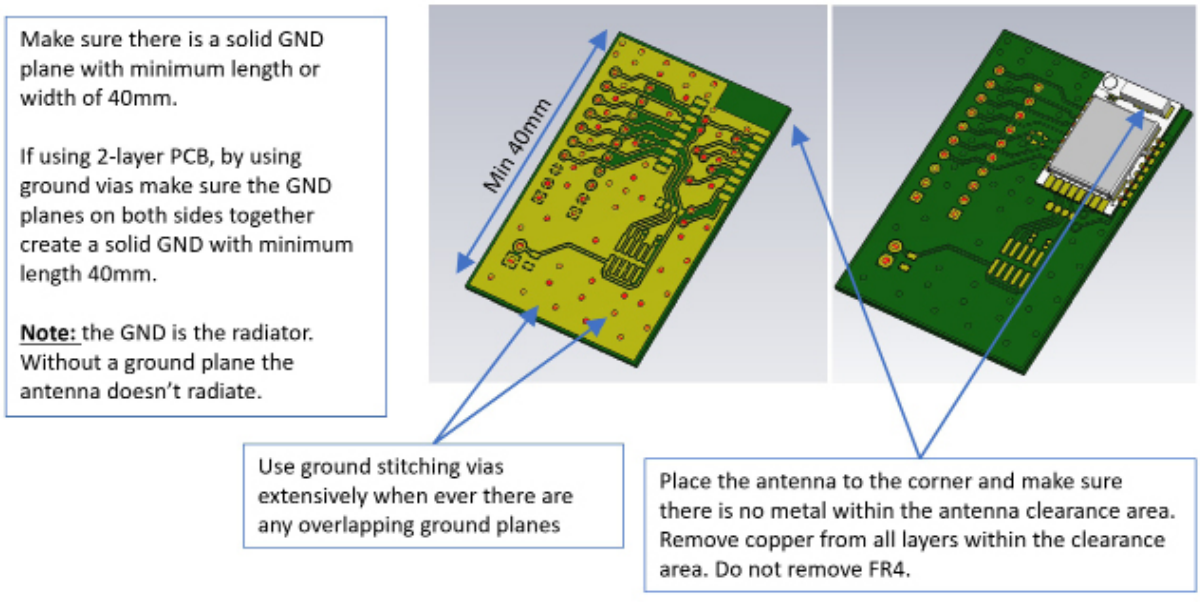
11.3 CBM-003B Installation Guide

Since the GND plane of the host PCB is the actual radiator, the size and shape of the host PCB affects the antenna's radiation patterns, peak gain and radiation efficiency. Optimum performance is achieved when the host PCB is (50 x 25) mm. If the host PCB is smaller than 40mm, it will have a significant impact on the radiation.

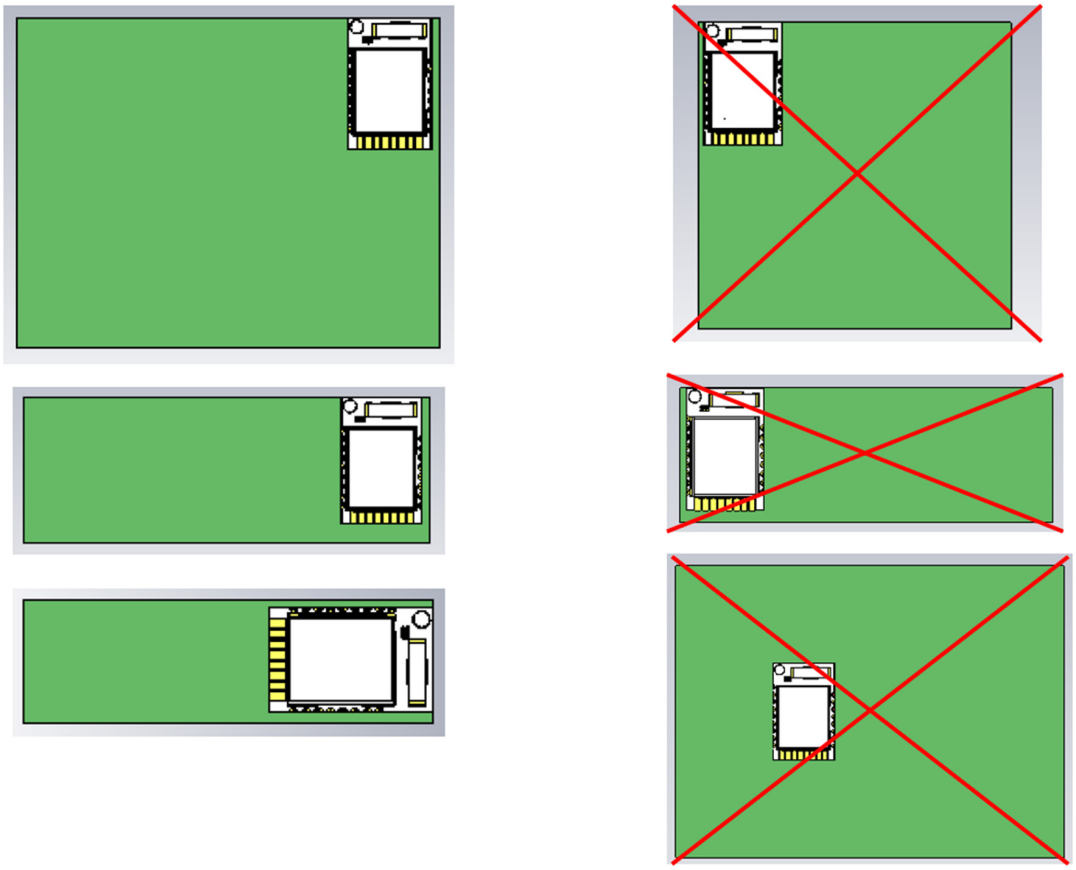
Antenna layout check list:

1. Place the antenna in the top right corner of the host PCB.
2. Make sure the antenna keep-out area is free of metal, and do not place any metal in front of the antenna.
3. Keep all metal > 10mm away from the antenna. Any metal closer than 10mm will affect the antenna impedance matching and thus reduce the antenna performance.
4. Use GND stitching vias extensively on overlapping GND planes.
5. Do not shield the antenna with a metal case. The RF signal does not penetrate metal.

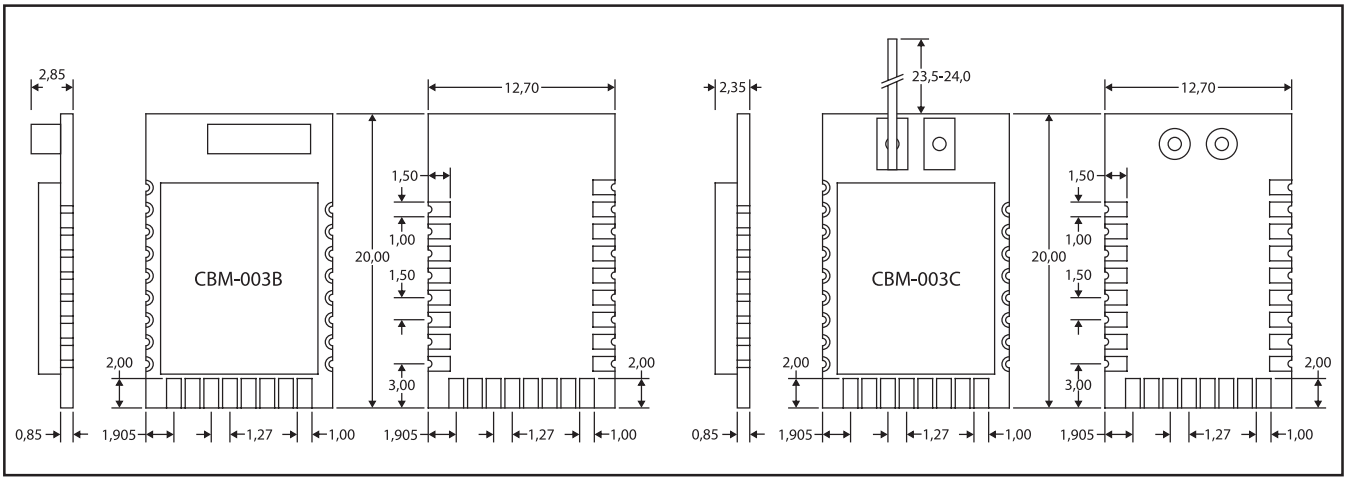
Picture: Example Layout



Picture: Good and Bad Layout Examples



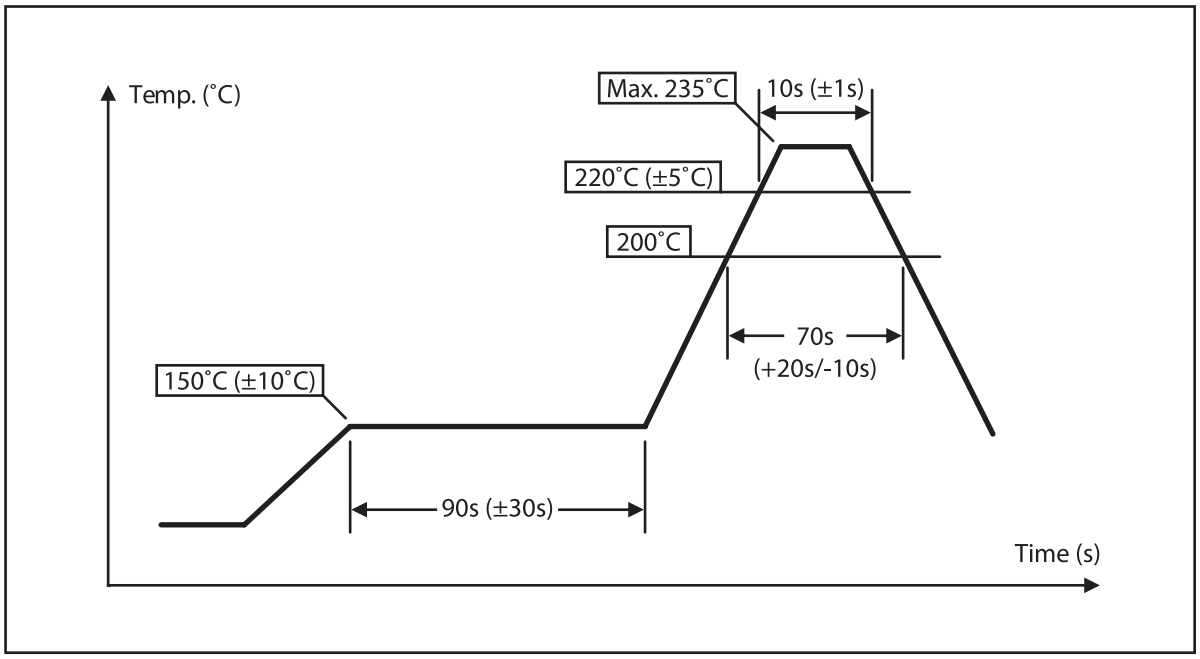
12. Package Outline Drawing



Mechanical dimensions.
Outline dimension tolerance typ ± 0,3mm, max ± 0,5mm. L 20±0.5mm W 12.7±0.3mm H 2.85±0.2mm

13. Soldering

13.1 Lead Free Reflow Soldering



Recommended temperature profile for lead free reflow soldering

Maximum number of reflow cycles: 2

During the reflow the module shall be on the TOP side of the host PCB to prevent it from dropping..

13.2 Hand Soldering

Hand soldering is possible. When using a soldering iron, follow IPC recommendations (reference document IPC-7711).

13.3 Rework

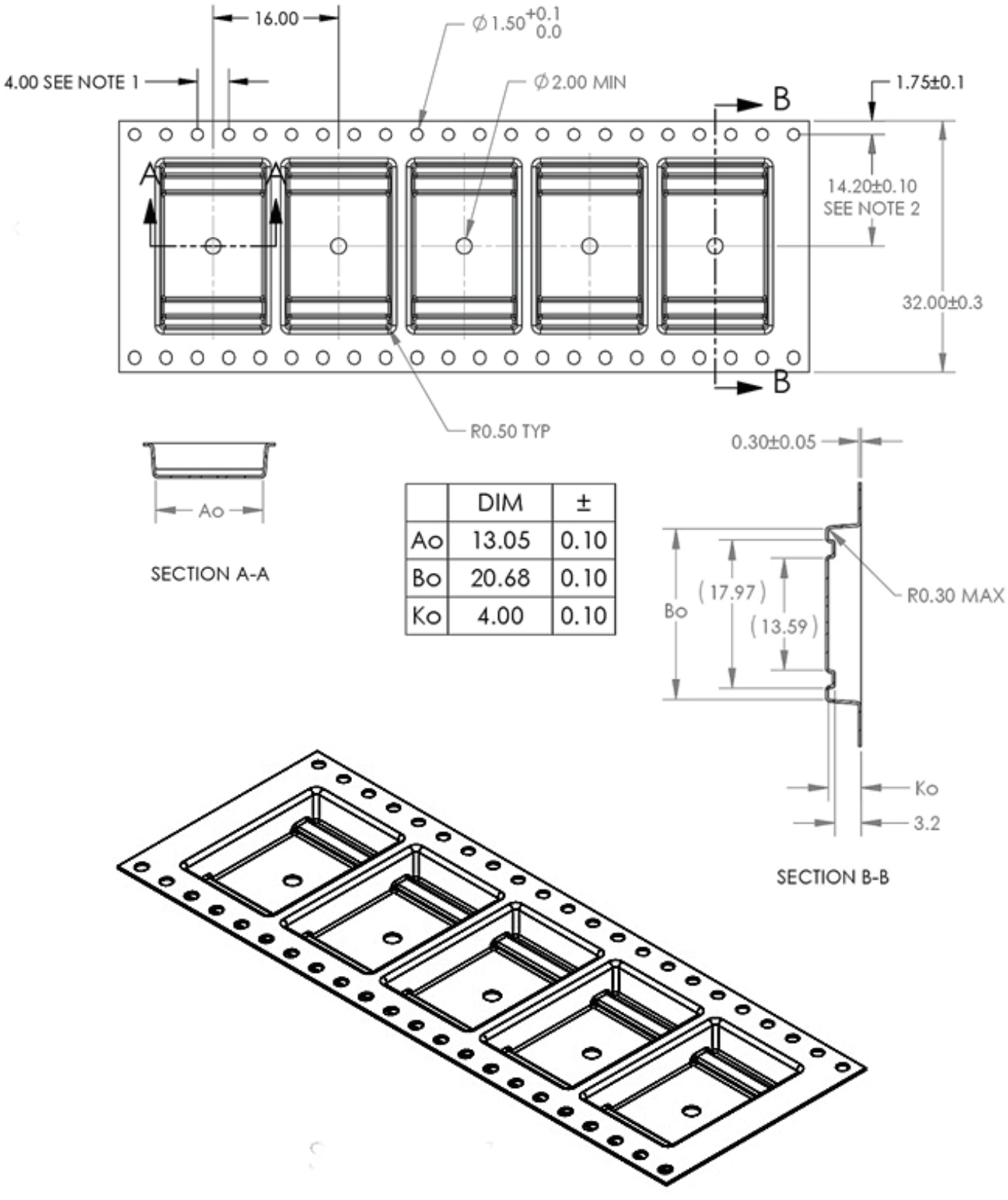
The module can be unsoldered from the host board. The use of a hot air rework tool should be programmable and the solder joint and module should not exceed the maximum peak reflow temperature of 250°C. When temperature ramps exceed the reflow temperature profile, module and component damage can occur due to thermal shock. Avoid overheating. Never attempt to rework (repair? change?) the module itself (e.g. replacing individual components).

13.4 Cleaning

In general, we strongly advise against cleaning the populated modules. Residues under the module cannot be easily removed with any cleaning process. The use of "No Clean" solder paste is strongly recommended as it does not require cleaning after the soldering process.

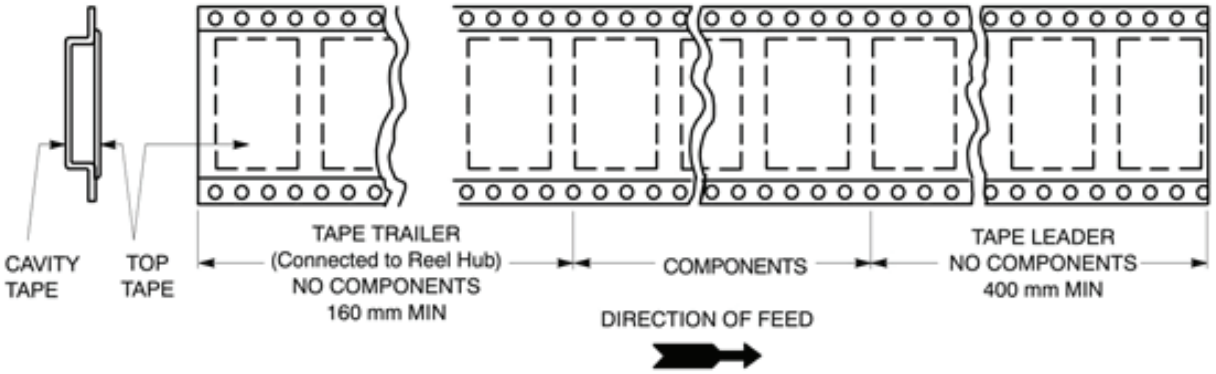
14. Packaging

14.1 Tape Dimensions



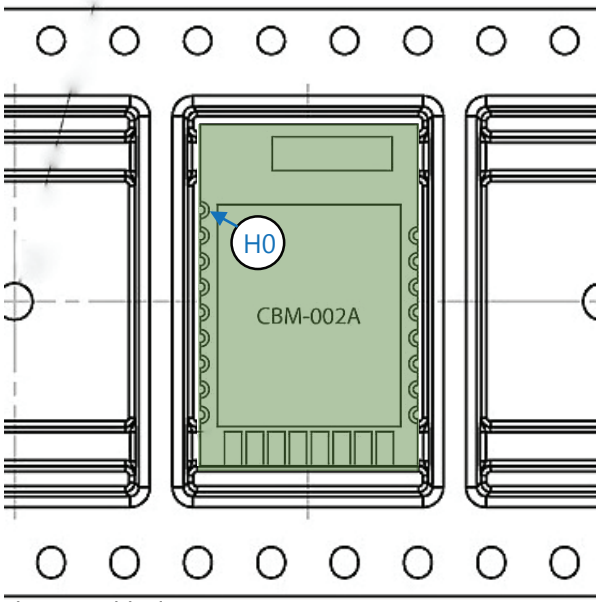
	DIM	±
Ao	13.05	0.10
Bo	20.68	0.10
Ko	4.00	0.10

14.2 Packing in Tape



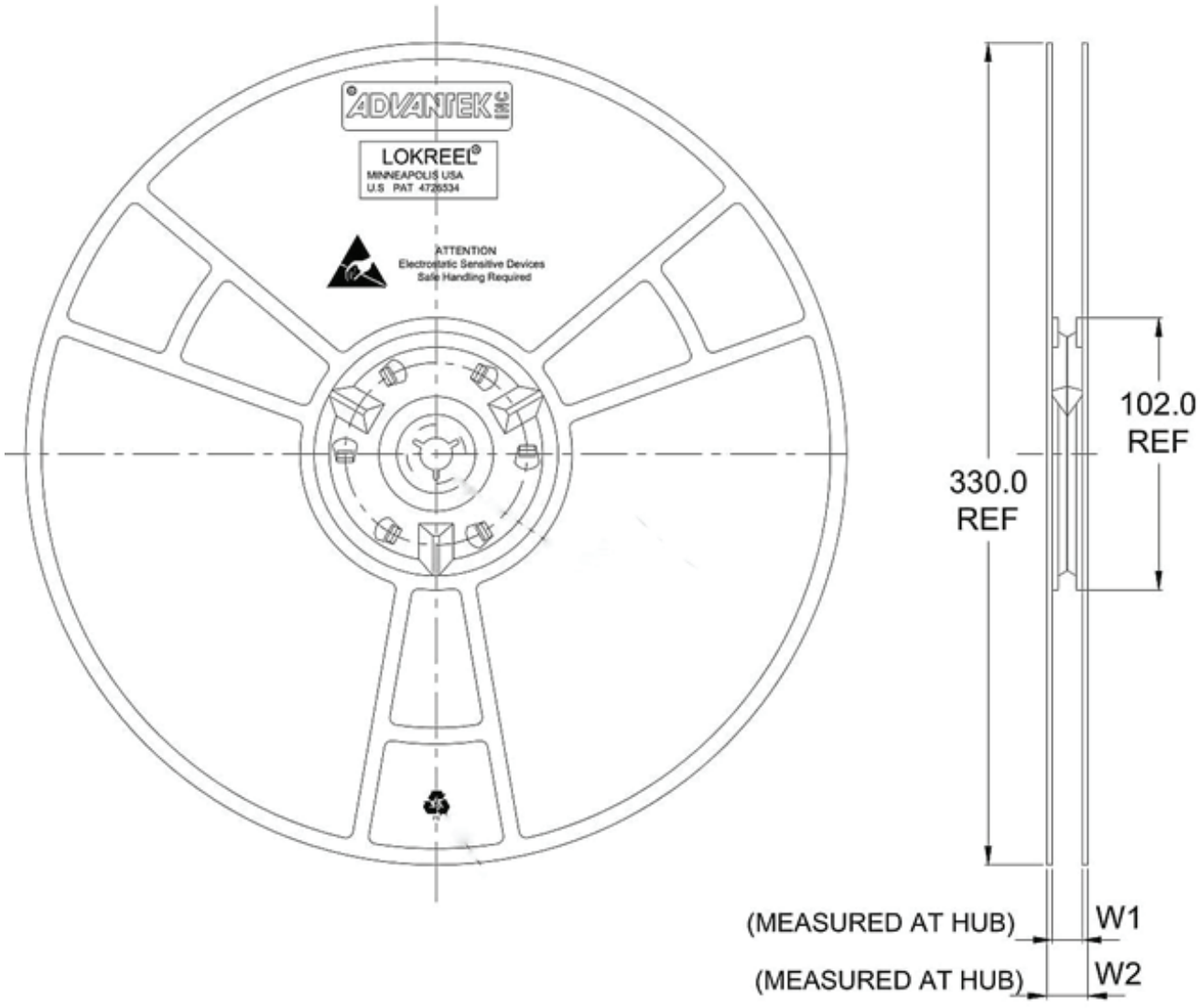
14.3 Component Direction

Round holes

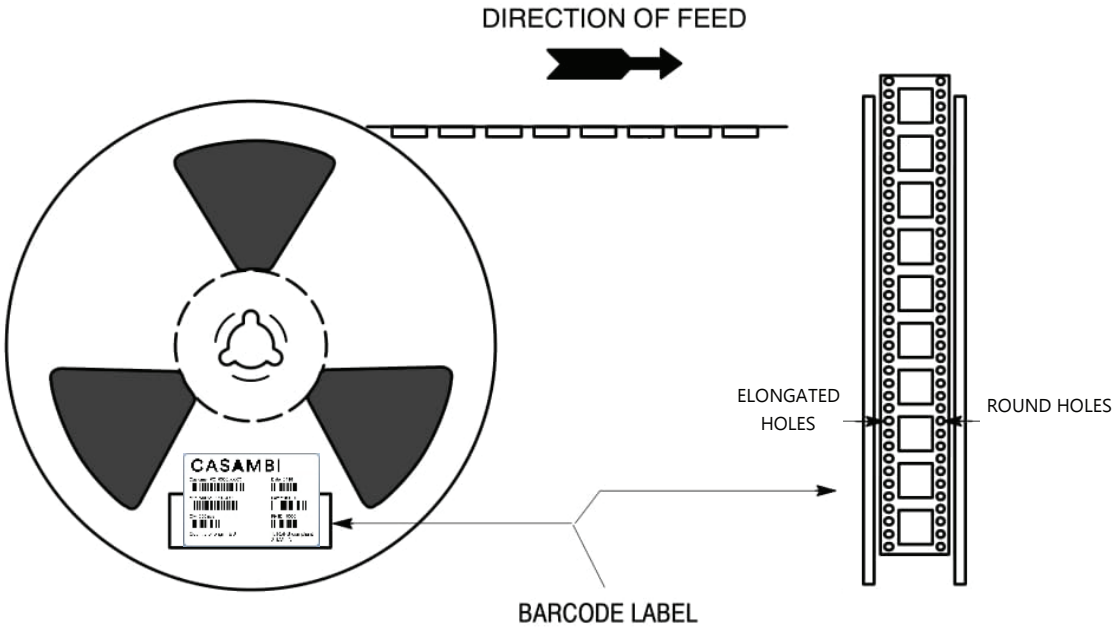


Elongated holes

14.4 Reel Dimensions



14.5 Reel Winding Direction



14.6 Label Information

CASAMBI

Casambi Technologies Oy
Alberga Business Park
Bertel Jungin Aukio 1 E
02600 Espoo Finland

Customer PO: 0000/XXXX

Date: WWYY

Mfr. part no: CBM-003B/C

Batch: #0000

Qty: 000 pcs

Fix ID: XXXX

Country of origin: XX

1. ROHS compliant
2. MSL 3

15. Federal Communications Commission (FCC) Statement

Warning

Changes or modifications to this unit not expressly approved by Casambi Technologies Oy could void the user's authority to operate the equipment.

Compliance 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.

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 equipment and receiver.

To comply with FCC RF exposure guidelines, the transmitter and your body must be separated from each other by a minimum of 20 cm and fully supported by the operating and installation configurations of the transmitter and its antenna(s).

- 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.

16. Innovation, Scientific and Economic Development Canada (ISED) Statement

Radiation Exposure Statement for Canada

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada 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.

The device has been evaluated as meeting general RF exposure requirements. To maintain compliance with RSS-102 radio frequency (RF) exposure guidelines, this equipment should be installed and operated with a minimum distance of 20 cm between the radiator (transmitter?) and your body.

Le dispositif de a été évalué à répondre général rf exposition exigence. Pour maintenir la conformité avec les directives d'exposition du RSS-102-Radio Fréquence (RF). Ce matériel doit être installé et exploité à une distance minimale de 20 cm entre le radiateur et votre corps.

17. End Product Labeling

CBM-003B/C has been marked with its own FCC ID and IC Certification number. The manufacturer of the end product is responsible for ensuring that FCC and ISED labeling requirements are met. If the FCC ID and IC Certification Number of 2ALA3-CBM003B/2ALA3-CBM003C are not visible when the module is installed in another device, the device must have a clearly visible label with the following information:

CBM-003B/C a été identifié avec son propre numéro d'identification de la FCC ainsi que son numéro de certification IC. Le fabricant du produit final doit assurer que les obligations d'identification de la FCC et des indicateurs du développement énergétique durable soient satisfaites. Si le numéro d'identification de la FCC et lenuméro de certification IC pour 2ALA3-CBM003B/2ALA3-CBM003C ne sont pas visibles lors de l'installation du module dans un autreappareil, une étiquette claire et visible avec les informations ci-après devra alors être apposée sur l'appareil:

Contains FCC ID: 2ALA3-CBM003B
Contains IC: 22496-CBM003B

Contains FCC ID: 2ALA3-CBM003C
Contains IC: 22496-CBM003C

18. Notes

Note 1: This module meets RF exposure requirements under mobile or stationary conditions. This module may only be installed in mobile or stationary applications. A separate permit is required for all other operational configurations, including portable configurations according to part 2.1093 and deviating antenna configurations. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Note 2: Any modifications made to the module will void the Grant of Certification. This module is limited to OEM installation only and may not be sold to end users. The end user has no manual instructions to remove or install the device, only the software or operation procedure shall be included in the end-user operating manual of final products.

Note 3: Additional testing and certification may be necessary when using multiple modules.

Note 4: The module may only be operated with the authorized antenna(s). Additional antennas that are equivalent may be substituted, and then marketed without a Class II Permissive Change. Equivalent antennas must be of the same type (e.g., yagi, dish, etc.), must be of equal or less gain than an antenna previously authorized and must have similar in-band and out-of-band characteristics (consult specification sheet for cutoff frequencies).
New non-equivalent antennas are allowed by applying a Class II Permissive Change to the module certification.

Casambi Technologies Oy
Bertel Jungin aukio 1, 02600 Espoo, Finland