TpC-FC0W123
TpC-PC0W123
TpC-PC0L123
TpC-PC0M123

Tapioca TpC-xC0x12x (Wireless to CAN 2.0) Datasheet

Tapioca monitors and modifies variables in a target system by wirelessly connecting to the target's system bus. Tapioca adapters support:

- Wire connection via CAN.
- Wireless connection via NFC, Bluetooth Smart "Low Energy" (BLE), and Wi-Fi (IEE 802.11 b/g/n)
- LoRa and LTE-M/NBIOT LPWAN connections (extension board required).

5 February 2024
Version 0.1

Contents

1 Introduction

Connect existing electronic systems to mobile apps

The Tapioca line is designed to be added on a standard fieldbus or system bus that is already designed into the target system. These specific variants support physical connection on CAN and are available either in the standard DIN rail or the IP67 case.

All Tapiocas offer the following range of standard RF channels:

- NFC
- Bluetooth Smart "Low Energy" (BLE)
- Wi-Fi (IEEE 802.11 b/g/n)

Tapioca extensions are available for the IP67 case to add long-range, low power RF channels:

- LoRa
- LTE-M, NBIOT

NFC and BLE channels allow direct, local connection between the Tapioca and a mobile app that can be automatically generated.

Wi-Fi can be configured for either local connection to mobile apps or connection to networks to send data or alarms to a cloud-based platform using the MQTT protocol.

Long-range, low power RF channels allow the sending of data or alarms to a cloud-based platform using the MQTT or the LoRaWAN protocol.

For connection to cloud platforms, messages and data can easily be formatted using Tapioca's embedded Virtual Machine.

Hierarchy between Tapioca and target electronic equipment

A Tapioca can send and receive messages from the bus.

Depending on it, the variables shared between the Tapioca and the target will be located either in the target's memory or in the Tapioca's memory.

Table of Part Numbers

Part Number	Wireless protocol	Wire protocol	Prefix	Security	Casing	Power
TpC-FC0W123	NFC-BLE-Wi-Fi	CAN 2.0	12	Software	DIN Rail	5V-30V
TpC-PC0W123	NFC-BLE-Wi-Fi	CAN 2.0	12	Software	IP67 Compliant	5V-30V
TpC-PC0M123	NFC-BLE-Wi-Fi and LTE-M / NB-IOT	CAN 2.0	12	Software	IP67 Compliant	5V-30V
TpC-PC0L123	NFC-BLE-Wi-Fi and LoRa	CAN 2.0	12	Software	IP67 Compliant	5V-30V

About IoTize

IoTize is a French company based in Grenoble area:

> 960 chemin de la Croix Verte
> 38330 Montbonnot-Saint-Martin, France

More information at: https://www.iotize.com/visit-iotize.html

2 Summary

The Tapioca is an adapter that replaces a traditional wire connection with a secure wireless link to mobile devices (iOS or Android) or to the cloud.

Radio channels

- Near Field Communication (NFC) Type5 tag (ISO/IEC 15693)
- Bluetooth Low Energy (BLE 4.2)
- Wi-Fi (IEEE 802.11 b/g/n)
- LoRa (LoRaWAN 1.0.3) *(optional with board)*
- LTE-M/NBIOT *(optional extension board)*

Wired communication channels

- The following port is supported on this Tapioca Variant:
    - CAN 2.0

Security features

- User management
- Configurable access profiles
- Configurable, encrypted passwords
- AES-128/256 module-level data encryption
- Configurable secure pairing with NFC

Casing versions

This Tapioca variant is available only in one version:

- Fixed Standard DIN Rail case.
- Fixed IP67 Plastic case.

Electrical characteristics

- Input voltage: 5V to 30V
- Power consumption: from 11mA to 58mA at 12VDC
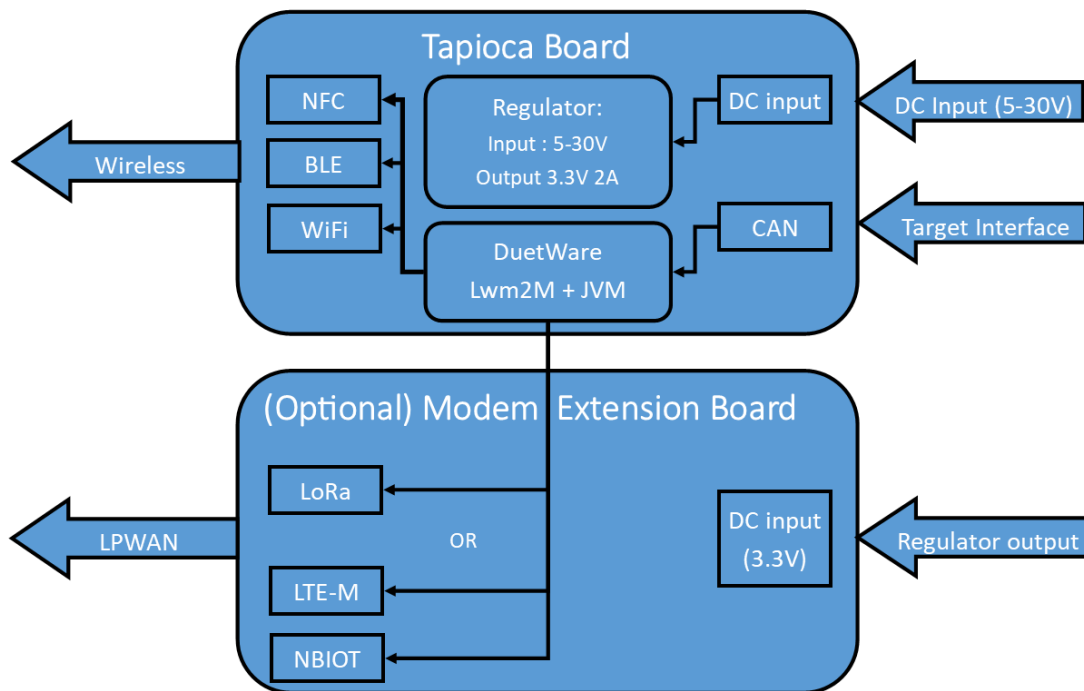- Standby mode: 0.460 mA at 12VDC

Temperature ranges

- Operating temperature: [-25°C, +50°C]
- Storage temperature: [-25°C, +70°C]

Acceptance

- RF certification: *(In testing)* CE (Europe), FCC (USA), IC (Canada).
- Green certification: REACH and RoHS compliant

3 Block diagram

The Tapioca is made up of a standard TapNLink module connected to a CAN transceiver. The firmware of the Tapioca gateways is the standard Duetware for TapNLink, TapNPass and Tapioca.

Two extension boards are available to add long-range, low-power wireless to any Tapioca (only available for Fixed IP67 Casing). The extension board is powered by 3.3V power supply from the Tapioca and is controlled by AT Commands. It is not possible to have LoRa and LTE-M/NBIOT in the same Tapioca, as they require different extension boards.

The communication mode is selected by configuring the module that is embedded in Tapioca.

3.1 CAN 2.0 modes

The CAN 2.0 driver supports the following modes of operations:

- **Normal Mode:** The normal operating mode allows the CAN 2.0 controller to take part in bus activities such as transmitting and receiving messages/error frames. Acknowledgement from another node is required when transmitting a message.

- **No Ack Mode:** The No Acknowledgement mode is similar to normal mode, however acknowledgements are not required for a message transmission to be considered successful. This mode is useful when self-testing the CAN 2.0 controller (loopback of transmissions).

- **Listen Only Mode:** This mode prevents the CAN 2.0 controller from influencing the bus. Therefore, transmission of messages/acknowledgement/error frames will be disabled. However, the CAN 2.0 controller is still able to receive messages but will not acknowledge the message. This mode is suited for bus monitor applications.

4 Features

Tapioca offers no code integration of wireless radio interfaces that connect a target system to a local information appliance (smartphones, PDAs, tablets, PCs, etc.) or to a network gateway (WAN, LPWAN) and the cloud.

Tapioca can communicate directly with mobiles, tablets, and PCs via NFC, BLE or Wi-Fi. Users can use IoTize's app or their own custom apps to read/write target system data. In this case, the local information appliance can also serve as a network gateway to exchange data with the cloud using the MQTT protocol.

The Tapioca Wi-Fi or LPWAN channels (with optional LoRa, LTE-M/NBIOT extensions) can be configured to send data via MQTT to a cloud platform. The LPWAN extensions and the internal Virtual Machine allow the Tapioca to send alarms to the cloud at any time.

IoTize Tap Toolbox (Android or iOS) offers a generic interface app for communicating with the Tapioca-equipped target system. It eliminates the need to code apps in order to communicate with their target system and test connection parameters.

IoTize Tap Manager (Android of iOS) offers a generic interface for basic configuration of the Tapioca and creation of a customized human machine interface directly on the user's mobile. It eliminates the need to use a PC and server-based tools in order to create a customized user interface app.

IoTize Studio and Automatic App Generator, allow advanced configuration of Tapioca and creation of fully personalized, autonomous mobile apps.

4.1 Radio communication channels

4.1.1 Near Field Communication (NFC)

- Data transmission rate[1]:   2 kilobytes per second
- Range[2]:   up to 4 centimeters
- Supports use of NFC for dynamic wakeup and pairing of the BLE interface.

4.1.2 Bluetooth Low Energy (BLE)

- Max power: +9 dBm (conducted power)
- Data transmission rate: *In testing, to be completed.*
- Range[2]:   up to 30 meters

4.1.3 Wi-Fi (IEEE 802.11b/g/n)

- Max power: +20 dBm (conducted power)
- Data transmission rate: *In testing, to be completed.*
- Range[2]:   up to 90 meters

4.1.4 LoRa

- Max power: +22 dBm at 868/915MHz
- Data transmission rate[3]: up to 21.9 kbits/s (SF7, bandwidth 500)
- Range[2]:   up 10 kilometers

4.1.5 LTE-M/NBIOT

- Max power: +23 dBm in each band
- Data transmission rate: *In testing, to be completed.*
- Range[2]:   *In testing, to be completed.*

Notes:

1. *Average speed while acquiring 1000 times 220 bytes from the target.*
2. *Measure line-of-site in an environment free of obstructions and rebound effects.*
3. *Data transmission rate from module specification.*

4.2 Wired communication channel

For Tapioca **TpC-xSC0x123** the following wired communication channel is available.

4.2.1 CAN 2.0

- Compatible with ISO 11898-2
- Baud rate: up to 1 Mbps
- Bus pin fault protection of ±14 V
- Total loop delay < 135 ns
- ESD protection:
  - Human-Body Model (JS-001):
    - All pins except CANH and CANL   +/-4kV
    - Pins CANH and CANL   +/-25kV
  - Charged-device model (JESD22-C101)   +/-1.5kV
  - Air-gap discharge (IEC 61000-4-2):   +/-30kV
  - Contact discharge (IEC 61000-4-2):
    - CANH and CANL on diode   +/-30kV
    - CANH and CANL on transceiver   +/-12kV
- EFT protection:
  - IEC 61000-4-4:   40A (5/50ns)

4.2.2 Communication cables

The communication cable pinout complies with the "CANopen cabling and connector pin assignment".
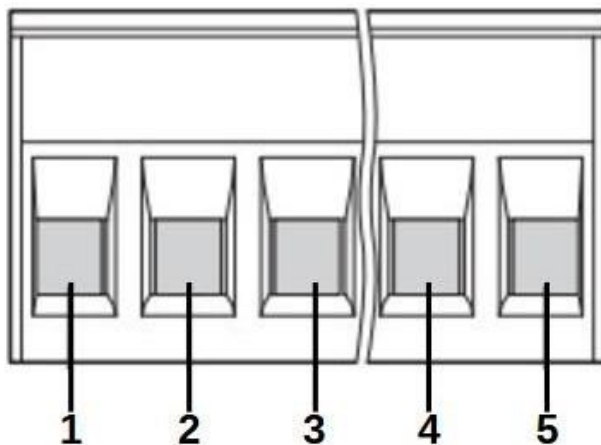
The communication cable is not included.

Important Note: *It is requested to only use shielded cable to connect the Tapioca to the target device.*

4.2.2.1 Fixed Standard DIN Rail

Following are the main characteristics for the cable:

Type: Open Style cable

CAN 2.0:   5.0mm terminal block plug

Pin Terminal Block	CAN 2.0 signal
1	GND
2	CAN_L
3	CAN_SHLD
4	CAN_H
5	V+

4.2.2.2 Fixed IP67 Casing

Following are the main characteristics for the cable:

Type:	M12 Cable (IP67)
CAN 2.0:	M12 A-Coded Male Cable 5 Contacts

M12 A-Coded Male Connector 5 Pin Pinout
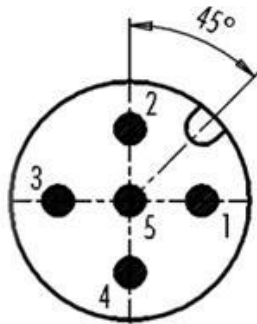
	X	Y
1	2,50	0,00
2	0,00	2,50
3	-2,50	0,00
4	0,00	-2,50
5	0,00	0,00

Pin M12 A-Coded	CAN signal
1	CAN_SHLD
2	V+
3	GND
4	CAN_H
5	CAN_L

4.3 Electrical characteristics

4.3.1 Power supply

- Maximum DC supply voltage: 30V
- Minimum DC supply voltage: 5V
- Standard DC supply voltage: 5V, 12V or 24V
- Tapioca DC internal voltage: 3.3V

Important Note: *For safety reasons, the Tapioca must be powered by a circuit breaker.*

4.3.2 Power consumption

The power consumption depends on the CPU Frequency, three different frequencies can be set: Normal, Fast and Slow. The default is the normal frequency, if needed the frequency can be lowered to minimize the power consumption of the Tapioca. Please note that the CPU Frequency must be carefully changed because it will affect the performance of the CPU.

Please note that the power consumption values below are average values and that brief power consumption peaks of several mA are expected during radio communications.

4.3.2.1   Power consumption with no Extension Board

Bellow the power consumption for the Tapioca **TpC-xC0W123** at normal CPU Frequency with a stable power source of 12VDC:

Normal CPU Frequency				
Operating Mode	NFC Only[1]	Wi-Fi Off[2]	Wi-Fi Hotspot[3]	Wi-Fi Station[3]
CAN 2.0				
Standby	mA	mA	mA	mA
Idle[4]	mA	mA	mA	mA
NFC Tx/Rx	mA	mA	mA	mA
BLE Tx/Rx	-	mA	mA	mA
Wi-Fi Tx/Rx	-	-	mA	mA

Bellow the power consumption for the Tapioca **TpC-xC0W123** at fast CPU Frequency with a stable power source of 12VDC:

Fast CPU Frequency				
Operating Mode	NFC Only[1]	Wi-Fi Off[2]	Wi-Fi Hotspot[3]	Wi-Fi Station[3]
CAN 2.0				
Standby	mA	mA	mA	mA
Idle[4]	mA	mA	mA	mA
NFC Tx/Rx	mA	mA	mA	mA
BLE Tx/Rx	-	mA	mA	mA
Wi-Fi Tx/Rx	-	-	mA	mA

Bellow the power consumption for the Tapioca **TpC-xC0W123** at slow CPU Frequency with a stable power source of 12VDC:

Slow CPU Frequency				
Operating Mode	NFC Only[1]	Wi-Fi Off[2]	Wi-Fi Hotspot[3]	Wi-Fi Station[3]
CAN 2.0				
Standby	mA	mA	mA	mA
Idle[4]	mA	mA	mA	mA
NFC Tx/Rx	mA	mA	mA	mA
BLE Tx/Rx	-	mA	mA	mA
Wi-Fi Tx/Rx	-	-	mA	mA

Notes:

1. *BLE and Wi-Fi disabled by configuration, only NFC available.*
2. *Wi-Fi disabled by conf, NFC and BLE available.*
3. *NFC and BLE are also activated.*
4. *BLE and Wi-Fi in advertising mode.*

4.3.2.2 Power consumption with LoRa Extension Board

In testing, to be completed

4.3.2.3 Power consumption with LTE-M Extension Board

In testing, to be completed

4.4 Radio specifications

4.4.1 Bluetooth Low Energy (BLE 4.2) and Wi-Fi (IEEE 802.11 b/g/n)

For details, see ESP32 specifications.

Parameter	Min	Typ	Max	Unit
Wi-Fi Center frequency range of operating channels	2412	-	2484	MHz
Wi-Fi Rx sensitivity[1]	-70	-93	-98	dBm
Wi-Fi Tx power[1]	+10	-	+20	dBm
BLE RX Sensitivity @30.8% PER	-94	-93	-92	dBm
BLE Tx power	-12	0	+9	dBm

Notes:

1. Typical value, it depends on the type of modulation.

4.4.2 LoRa (LoRaWAN 1.0.3)

For details, see LoRa-E5-HF specifications.

Parameter	Min	Typ	Max	Unit
Frequency range	868	-	915	MHz
LoRa Rx sensitivity at 868MHz	-	-135	-137	dBm
LoRa Tx max power at 868MHz @SF12, BW125kHz	-	+22	-	dBm

4.4.3 LTE-M/NBIOT

For details, see Monarch 2 GM02S specifications.

Parameter	Min	Typ	Max	Unit
Frequency bands		B1, B2, B3, B4, B5, B8, B12, B13, B14, B17, B18, B19, B20, B25, B26, B28, B66, B71, B85		
LTE-M/NBIOT Low Bands[1] Rx sensitivity	-	-105	-	dBm
LTE-M/NBIOT High Bands[2] Rx sensitivity	-	-106	-	dBm
LTE-M/NBIOT max power for each band	+22	+23	+24	dBm

Notes:

1. *Low Bands: B5, B8, B12, B13, B14, B17, B18, B19, B20, B26, B28, B71, B85.*
2. *High Bands: B1, B2, B3, B4, B25, B66.*

4.5 Security features

The communication chain is fully secured using classic techniques based on SCRAM (Salted Challenge Response Authentication Mechanism):

- Authentication: secured passwords or signed tokens
- Encryption: AES-128/256

4.6 Embedded user's memory

Configuration including access control data is stored into a 16KB of FLASH.
Java program and volatile data used for Java must be smaller than 64KB.

4.7 Low power modes

Such as all IoTize products, the Tapioca can be switched to low power mode. For now, only standby mode is available.

When in standby mode, wake-up of the Tapioca is possible by NFC or by a configurable periodic timer.

4.8 Temperature ranges

4.8.1 Operating temperature

The behavior and the radio characteristics have been tested to guarantee a correct operation in the range: **[-25°C, +50°C]**.

All the components used for this device are industrial grade components ([-40°C, +85°C] or better), moreover the main microcontroller has an operating temperature range of [-40°C, +105°C]. Theoretically the Tapioca can operate for temperatures higher than +50°C but

we do not guarantee it for some reasons:

- The operating temperature is the temperature of the component, not the external environment.
- The fixed IP67 housing is hermetically sealed, and the housing temperature can be much higher than the environmental temperature.

Some connectors used in the Fixed IP67 Case are designed to operate in [-25°C, +85°C] temperature range.

It is advisable to use the Tapioca in a ventilated area and to not expose it to direct sunlight to minimize the heat in the case.

4.8.2 Storage temperature

The storage temperature range for the Tapioca is: **[-25°C, +70°C]**.

We do not guarantee a storage temperature higher than +70°C because of the sticker on the product.

5 Software environment

All IoTize hardware products are supported by a complete software ecosystem and web applications that simplify and speed their configuration, integration with cloud platforms, and/or creation of mobile apps.

Included in this ecosystem are:

- **Duetware** configurable device firmware pre-implementing all communication, security and data handling features
- **Tap Toolbox** mobile app provides utilities for setting communication parameters, testing the connection with target systems and reading/writing data to fieldbus registers.
- **Tap Manager** mobile app for device management, basic configuration, and user interface creation
- **IoTize Studio** PC software environment for advanced feature configuration
- **Automatic App Generator** for creation of mobile app projects and user interface apps for Android and iOS mobiles.

5.1 Device configuration

Tapioca embeds Duetware on the radio module. This can be initially configured using the Tap Manager app or using IoTize Studio PC software to configure and personalize advanced features.

Tap Manager allows device feature configuration and creation of a user interface app directly from a mobile phone.

IoTize Studio provides a complete interface for customizing the device configuration, writing code for the embedded Virtual Machine (edge data processing, cloud integration) and generating user interface apps with the Automatic App Generator. IoTize Studio provides:

- Drag-and-drop configuration of target data addresses from the target's register file
- Instant configuration transfer without extensive hardware installations
- Immediate configuration verification on the designer's PC and smartphone
- Mobile app and project generation for iOS and Android

5.2 Mobile device support

Tapioca includes radio implementations for NFC, Wi-Fi and BLE, which are compatible with a wide range of mobile devices running Android or iOS operating systems.

Mobile apps running on either iOS or Android can be automatically generated. Each variable can be associated with advanced graphical displays or controls (gauges, charts, bars, pies, …) and various APIs make it possible to enrich the mobile app with external components. The project source files can also be downloaded in order to modify the app at the source level. Traditional (and easy to modify) technology based on HTML, CSS and JS are used for the graphical interface displays and controls.
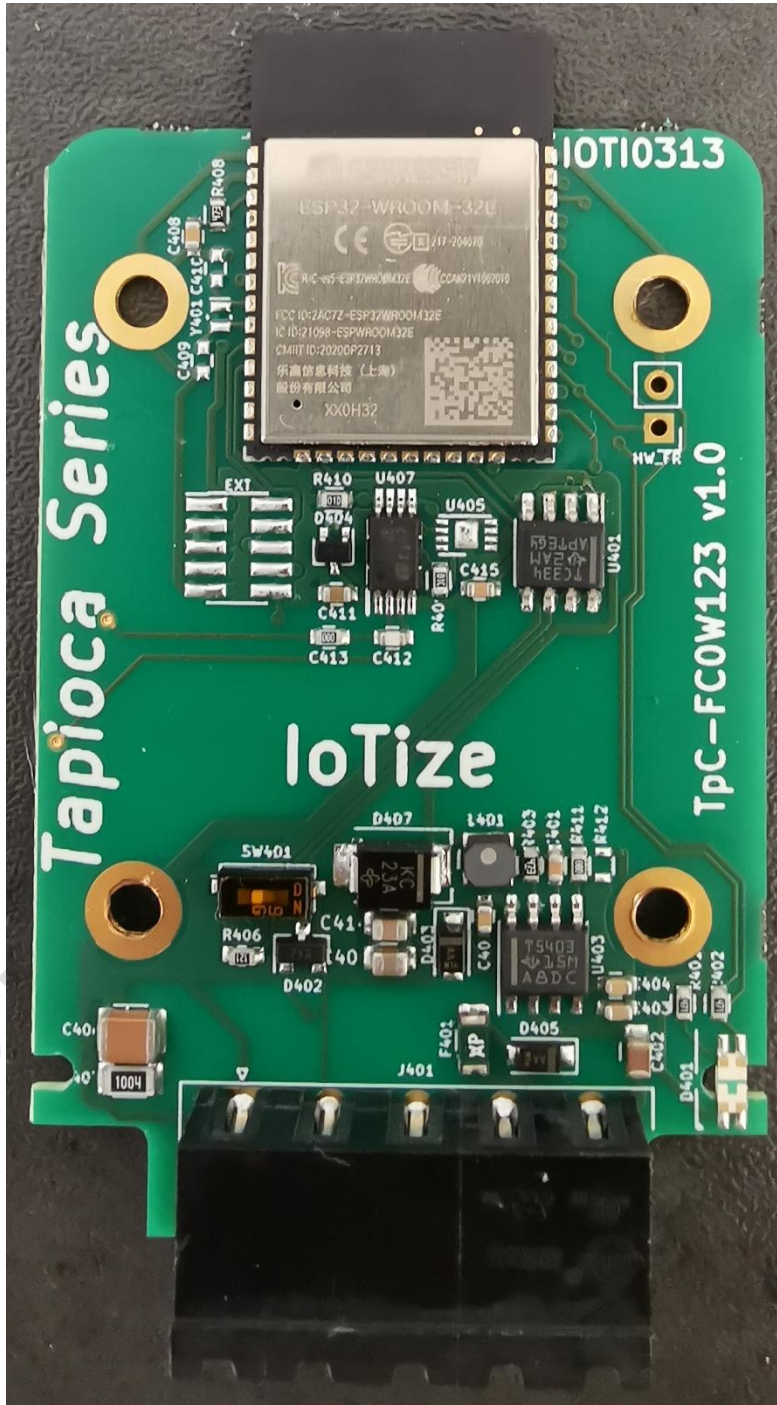
5.3 Cloud support

Tapioca includes an open source MQTT interface. Full information about IoTize cloud support for Tapioca is provided in the IoTize Documentation center.
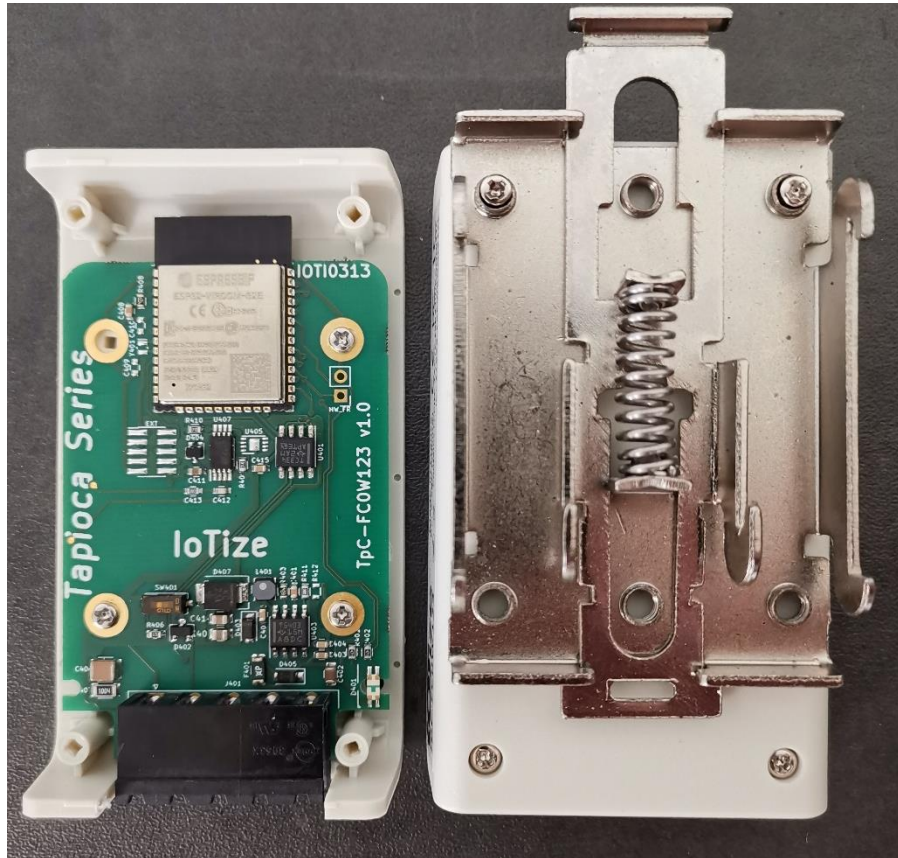
6 Hardware Description

6.1 Overview

The Tapioca **TpC-xC0x123** is available in both Standard DIN Rail and Fixed IP67 Casing.

Below is a picture of the Tapioca CAN 2.0 electronic board:

6.1.1 Standard DIN Rail Case

Below is an overview of this casing:
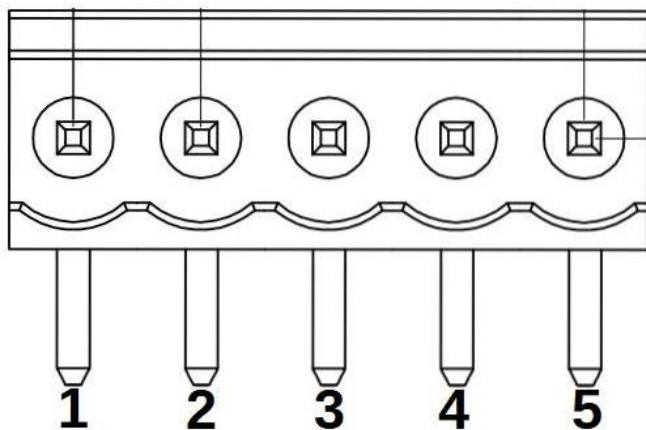

6.1.2 Fixed IP67 Case

Below is an overview of this casing:

6.2 Connectors

6.2.1 Standard DIN Rail Case

Type: Terminal Block (5.0mm)
CAN 2.0 & Power: Five pins pluggable terminal block

Pin Terminal Block	CAN 2.0 signal
1	GND
2	CAN_L
3	CAN_SHLD
4	CAN_H
5	V+

6.2.2 Fixed IP67 Case

Two connector types are available for the Fixed IP67 Case, M12 or Gland connectors.

__Note:__ M12 is the default connector type for Fixed IP67 Case.

6.2.2.1 M12 connector

Type: M12 Connector (IP67)
CAN 2.0 & Power: M12 A-Coded Female Connector 5 Contacts

The pinout of the M12 connector is available in the appendix.
Below is the placement of the M12 connector:

6.2.2.2 Gland connector

Type: Gland Connector (IP67)
CAN 2.0 & Power   PG9 Gland Connector

Gland connector is a low-cost alternative to the M12 connector.

6.3 Hardware factory reset

A Hardware Factory Reset jumper is available on Tapioca, by default this jumper is not solder and must be added if needed. The jumper is marked "HW_FR" on both sides of the PCB.

The instructions for resetting to factory settings are available on the technical documentation.

Note: The hardware factory reset can be disabled by configuration.

Below are zoomed-in photos of the "HW_FR" jumper on both sides of the Tapioca **TpC-xC0x123** board:
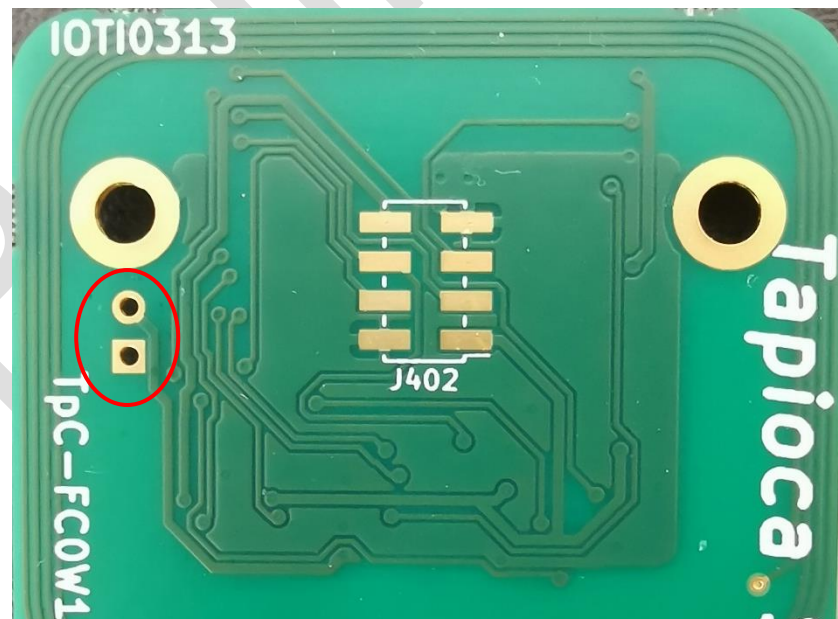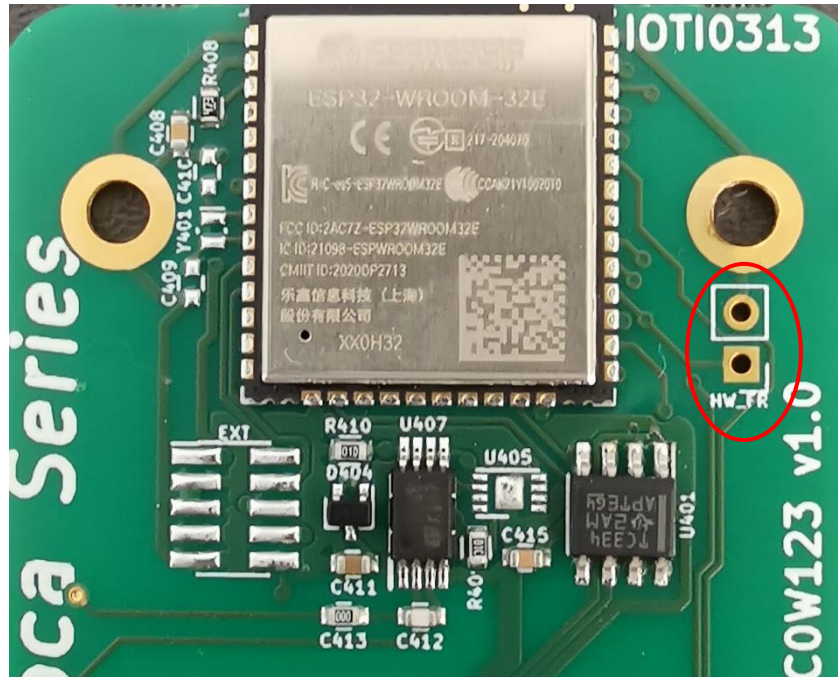
6.4 CAN 2.0 termination

As required by the ISO 11898-2 specification the end devices of a CAN 2.0 bus must have a 120ohm resistor at each end. To respect this standard, every Tapioca device includes a 120ohm resistor and a hardware switch to connect it between the two signals.

The switch is not directly accessible from the top of the product, the two boards must be disassembled.

Important Note: *In a polluted environment such a factory it is recommended to enable the CAN 2.0 termination resistor. By default, the switch is off.*

Below is a zoomed-in view of the Tapioca **TpC-xC0x123** board with the 120ohm resistor switch circled:
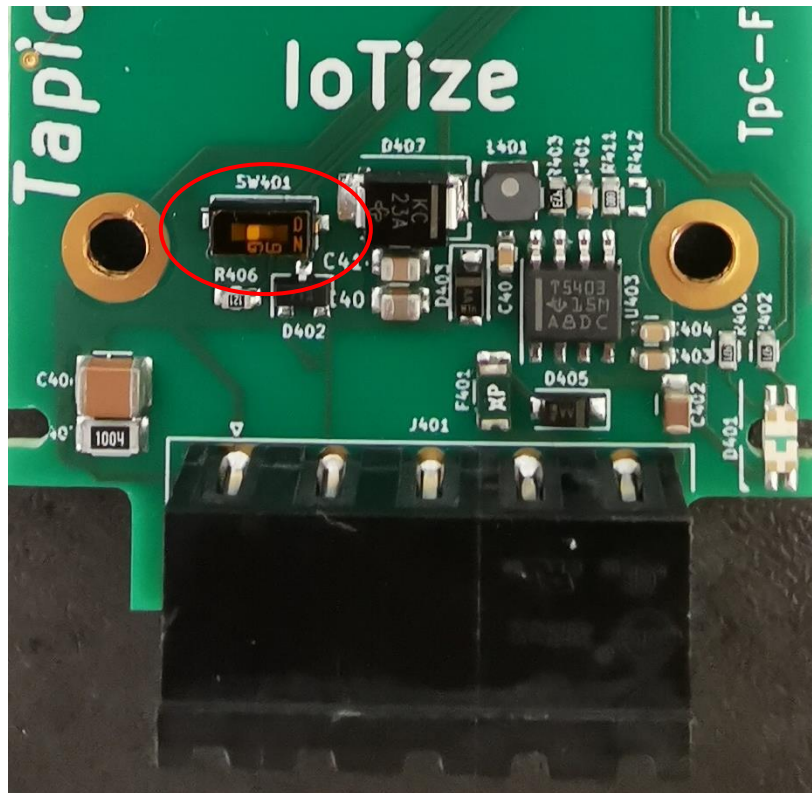
6.5 Configurable RGB LED

A RGB LED is available on Tapioca. This LED is not controlled by the firmware but fully configurable from the embedded Java Virtual Machine.

Some examples are available in IoTize Studio installation files. Moreover, when setting up a new project a template (adapted to the selected Tapioca) is used to generate the Java code of the project. This template contains all peripherals or pins configuration and the basic functions to control the LED on the desired Tapioca.

Note: On early versions of Tapioca boards, the led is bicolor (red and green). Please read the readme file in IoTize Studio example directories to select the right java file.

Below is a picture highlighting the location of the led on the Tapioca **TpC-FC0W123**:
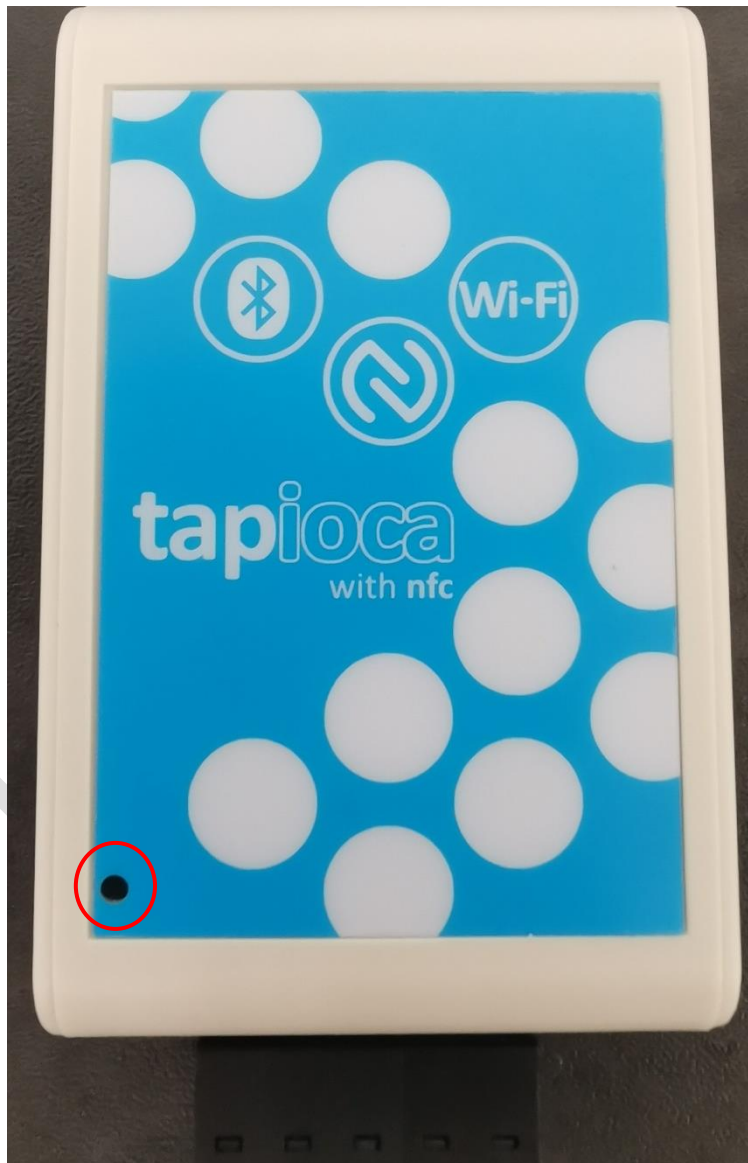
7 Mechanical characteristics

The Tapioca **TpC-xC0x123** is available in both Fixed Standard DIN Rail and IP67 Casing.

7.1 Standard DIN Rail Case

Dimensions (plastic case only):	L = 80 mm x W = 50 mm x H = 19 mm
Height with DIN Rail:	H = 33 mm
Weight (plastic case only):	40g (+/- 2g)
Weight with DIN Rail:	95g (+/- 2g)
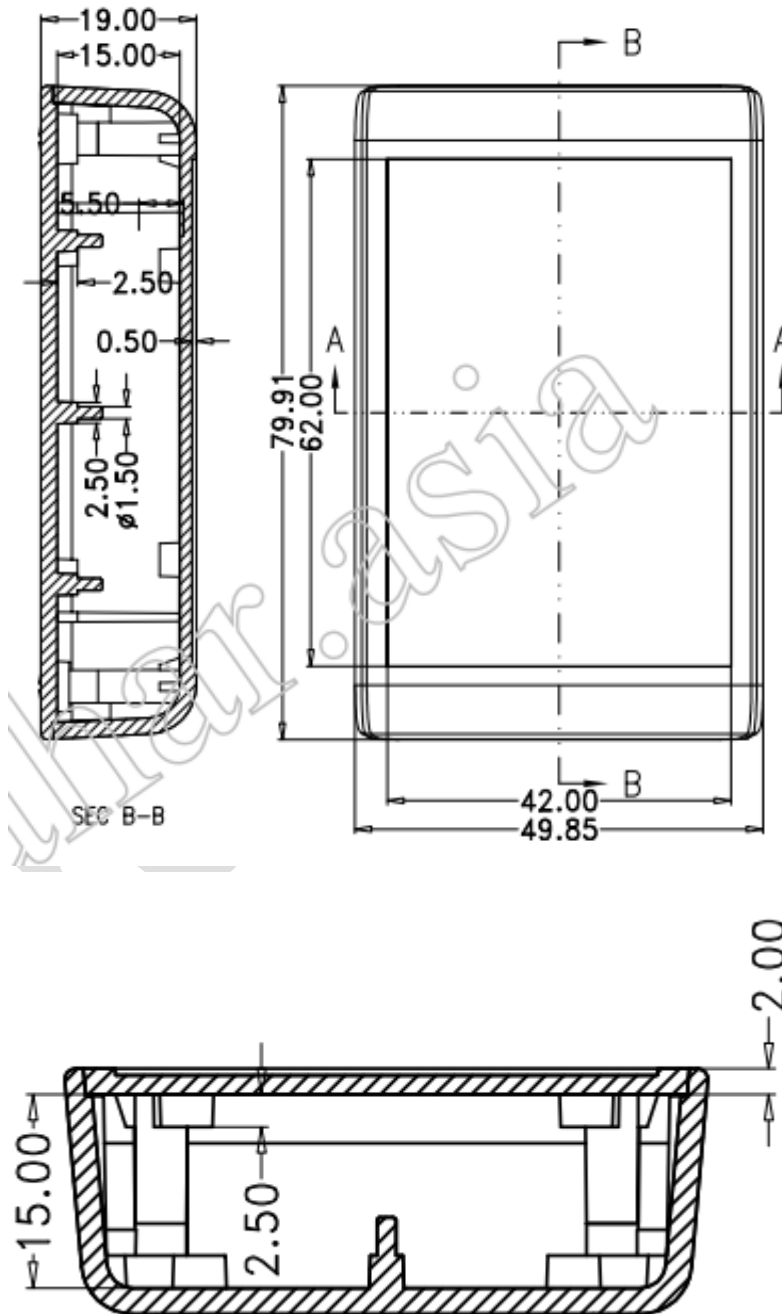
7.2 Fixed IP67 Case

This case is IP67 certified.

Dimensions (body):	L = 115 mm x W = 65 mm x H = 55 mm
Total length:	145 mm
Weight (without cables):	240g (+/- 5g)
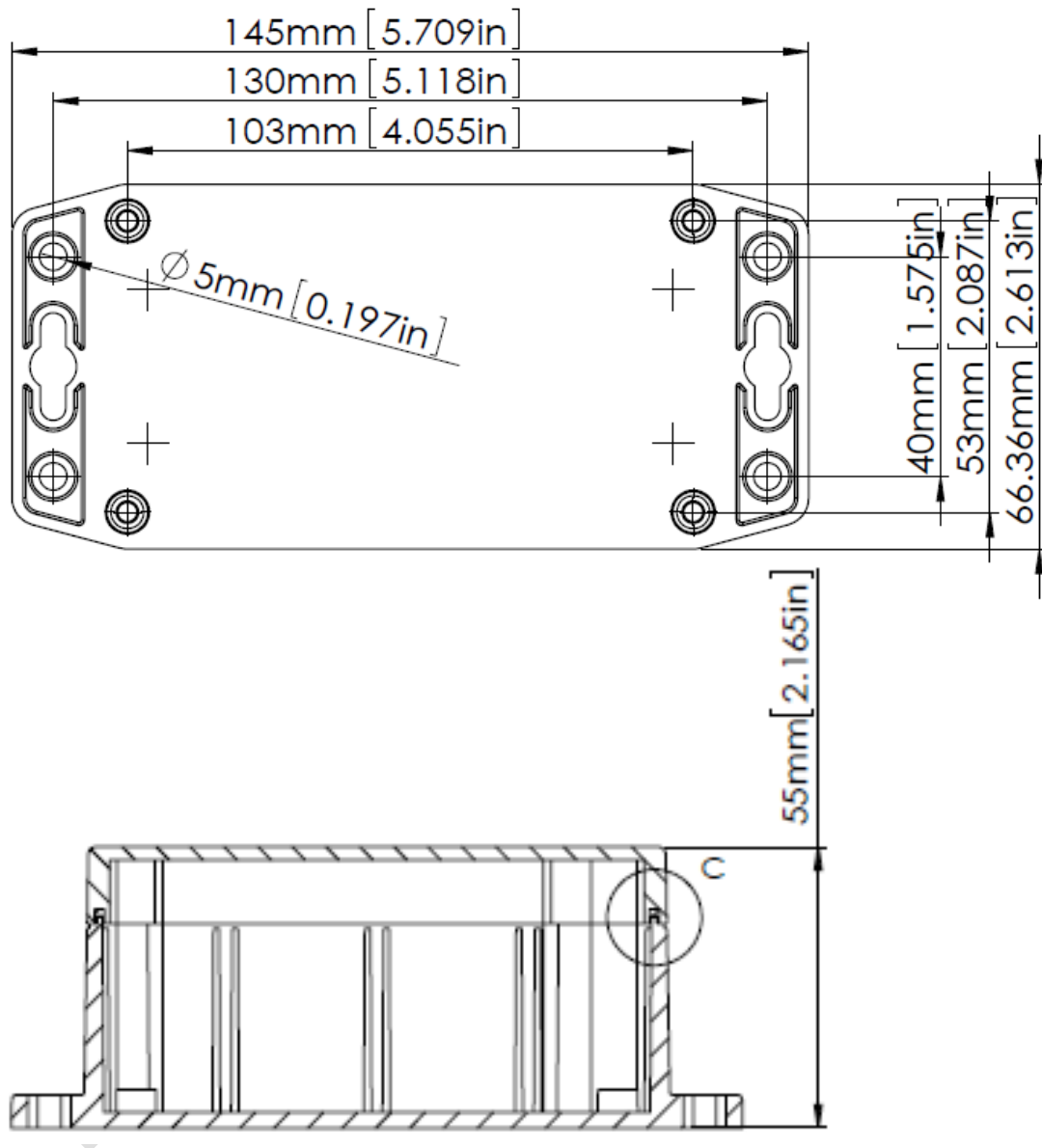
8 Regulatory compliance

8.1 CE certification (Europe)

The communication module used in Tapioca is tested for the following standards:
- EN 300 328 (V2.2.2)
- EN 301 489-1 (V2.2.3)
- EN 62368-1 (2014+A11/2017
- EN 62311 (2008)

Tapioca has been tested for the following standards:
- *In testing, to be completed.*

8.2 RoHS and WEEE

Tapioca complies with:
- Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances (ROHS) in electrical and electronic equipment.
- Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE).

8.3 FCC (USA)

This product contains a transmitter module **FCCID: 2AC7Z-ESP32WROOM32E**.

To comply with FCC RF exposure compliance requirements, the antenna used for this transmitter must not be collocated or operating in conjunction with any other antenna or transmitter.

LoRa and LTE-M variants are in testing, to be completed.

8.4 IC (CANADA)

This product contains a transmitter module **IC: 21098-ESPWROOM32E**.
Ce produit contient un module transmetteur **IC: 21098-ESPWROOM32E**.

LoRa and LTE-M variants are in testing, to be completed.

9 Ordering information

Example part number: **TpC-FC0W123**[1]

Product Line	Use Mode	Physical Interface	Radio Interface[1]	Product Prefix	Security
TpC	**F**	**C0**	**W**	**12**	**3**

Product Lines: **TpC = Tapioca**

Use Mode:
    P   = Fixed IP67 casing
    F   **= Fixed Standard DIN rail casing**
    N[2]   *= Nomad (not available for Tapioca)*

Physical interface: E1   = Ethernet & RS485
    E0   = Ethernet
    S4   = Serial RS485
    S2   = Serial RS232
    S0   = USB 2.0
    C0   **= CAN 2.0**

Radio interface[3]:
    T[4]   *= NFC Only*
    R[4]   *= BLE*
    W   **= Wi-Fi, BLE**
    L   = LoRa, Wi-Fi, BLE
    M   = LTE-M, NBIOT, Wi-Fi, BLE

Security:
    3   **= software-based security**
    5[5]   *= hardware-based security with embedded secure element*

Notes:

1. *The features of the part number shown in the table are indicated in bold.*
2. *This case is not available for Tapioca.*
3. *All products include NFC by default for advanced functionalities such as secure wake-up and pairing.*
4. *These radio interfaces are not available for Tapioca.*
5. *Secure element management is not implemented on Tapioca.*

10 Appendices

10.1   EU Declaration of Conformity (DoC)

In testing, to be completed.

10.2   Recycling

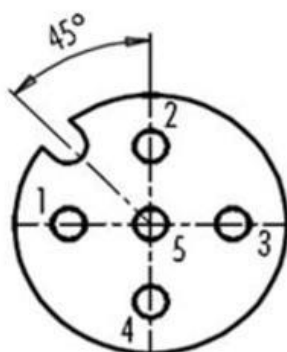|	This symbol of the crossed out wheeled bin indicates that the product (electrical and electronic equipment) should not be placed in municipal waste. Check local regulation for disposal of electronic products.

10.3 CAN 2.0 M12 connector pinout

IP67 Tapioca – Standard CAN 2.0 M12 Connector Pinout

M12 A-Coded Female Connector 5 Contacts Pinout

	X	Y
1	-2,50	0,00
2	0,00	2,50
3	2,50	0,00
4	0,00	-2,50
5	0,00	0,00

PIN	Wire Color	Signal
1	TBD	CAN_SHLD
2	TBD	V+
3	TBD	GND
4	TBD	CAN_H
5	TBD	CAN_L

11 History

Date	Version	Author	Modification
Feb. 2024	0.1	ES	Preliminary version for TpC-xC0x123.