TapNLink TnL-FIW10x (Wi-Fi, BLE, NFC) Datasheet

12 November 2019
Version 1.3

Contents

1 Introduction

IoTize™ offers a complete solution for instant integration of wireless connectivity that links electronics to mobile devices and the Cloud. This solution is inspired by the advantages of adding network connectivity without redesigning existing systems or recoding their firmware. It supports integrators with software and features for instant creation of customized Human Machine Interfaces (HMI) that run on mobile devices, configurable access control, security and Cloud integration.

The **TapNLink™** line uses technologies and techniques that are typically reserved for system programming and debugging to connect directly the target system's microcontroller. This unique approach makes it possible to add connectivity without redesigning the system. It speeds integration, eliminates risks and delivers design flexibility through encapsulation of complex wireless communication, network and security technologies. This facilitates the initial integration, but also makes it possible to easily evolve the wireless connection to meet future needs or technology evolutions... and still without ever recoding the system's original software.

TapNLink provides fully qualified wireless implementations. These allow local connection to mobile devices (smartphones, PDAs, tablets, PCs, etc.) allowing users to monitor or update a system and transfer data to the Cloud if/when necessary. Depending on the connectivity channels on the module, TapNLink can also enable connection to WAN or LPWAN for remote supervision and remote access control from the Cloud.

For the embedded application, TapNLink enables:

- Mobile device-based HMI
- Data transfer to the internet

TapNLink provides software and hardware encapsulation of the mobile device / target application communication. It manages communication with:

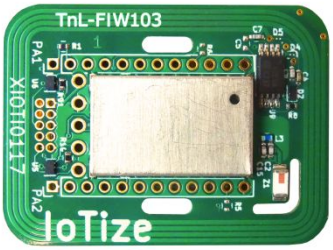
- Target application via hardware module RF interface(s) and communication co-processor
- Mobile devices via a low-level service application

2 Summary

The TapNLink Wi-Fi, Bluetooth Low Energy (BLE), NFC module (Part N°: TnL-FIW103) offers instant integration of contactless/radio interfaces to enable the connection of a microcontroller-based target system to a local information appliance (smartphones, PDAs, tablets, PCs, etc.).

TapNLink connects directly the microcontroller of the target system and allows non-intrusive read and/or write access to variables in the target microcontroller's memory. The data addresses and access parameters for the target system are configured in the TapNLink. No coding of the target system's native functionality is required to connect TapNLink to the target microcontroller.

TapNLink supports local connection to mobile devices (Android or iOS, Windows 10), where data can be viewed and modified via a graphical user interface created by the target system designer. The solution includes MQTT infrastructure to enable data transmission via the local mobile device to any Cloud-based IoT platform. Data that is read by the TapNLink can be transmitted via the mobile device's data or network connection when available. For this, IoTize provides an MQTT-base relay with IoT Cloud platform translators. This MQTT infrastructure is open source software that target system designers can install on servers and adapt to any private or public IoT Cloud platform.



Communication Channels

- Near Field Communication (NFC) Type5 tag (ISO/IEC 15693)
- Wi-Fi 802.11b/g/n
- Bluetooth Low Energy (BLE) 4.2

Target system interface protocols

- SWD debugging/programming interface protocol
- Software Secure Serial Port (S3P)

Security features

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

Configurable target memory access controls

- Accessible data addresses: up to ~ 500
- User profiles: up to ~ 100
- Access capabilities: Read or Write or Read/Write

Electrical characteristics

- Input voltage: 2.3V to 3.6V
- Low power consumption:
  - Standby: 100 µA
  - NFC: 7 mA
  - Wi-Fi Rx: 50 mA
  - Wi-Fi Tx: 110 mA (802.11g)
  - BLE Tx/Rx: 65 mA

Mechanical characteristics

- Dimensions: 28 x 38 x 3 mm

Package options

- Bare board
- Plastic casing (IP44)
- Silicone resin (IP65)

Operating temperature range

- -20°C, +55°C

Acceptance

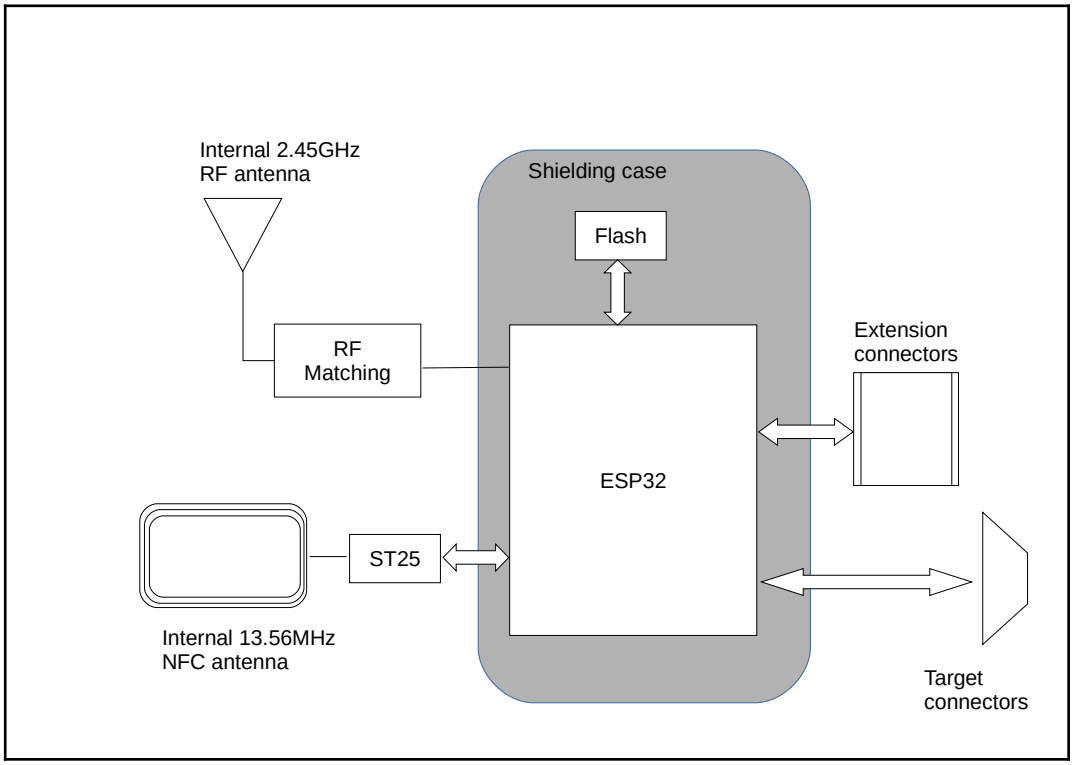
- CE (Europe), FCC (USA), IC (Canada).
- REACH and RoHS compliant

3 Block schematic

The TapNLink Wi-Fi, BLE, NFC module is equipped with an ESP32 microcontroller that executes:

1. The main program
2. Manages the upper level protocols
3. Manages the configuration and access control
4. Manages the Wi-Fi or BLE stack and acts as a simple transmitter.

The circuitry for both the NFC and the Wi-Fi/BLE antennas are outside of the shielding case. The NFC antenna is a trace at the periphery of the printed circuit board. The 2.45 GHz antenna is a ceramic device located close to the L slot in the printed circuit board.



4 Development environment

4.1 TapNLink module configuration

TapNLink is implemented by configuration only using the free IoTize Studio software environment, which is available on the IoTize website.

IoTize Studio provides a simple yet complete interface for managing the configuration of IoTize radio modules so that they interface correctly with the target system. IoTize Studio provides:

- Drag-and-drop configuration of target data addresses using the target system's source code (ELF files)
- Instant configuration transfer without extensive hardware installations
- Immediate configuration verification on the designer's PC and mobile device

When creating the TapNLink configuration, the designer imports the target system's firmware source (ELF file). Designating the addresses to access via TapNLink is as easy as dragging-and-dropping them into the configuration project. All variable information (address, type, etc.) is copied directly from the firmware source file, greatly reducing the risk of configuration errors. IoTize Studio also notifies the designer if the firmware source file is modified after the configuration has been created.

IoTize Studio allows users to transfer their configuration for testing and deployment with just the click of a button. No complicated or expensive hardware is required.

After configuration, the designer can connect to the module and visualize in IoTize Studio the results of the configuration. The integrated app viewer in IoTize Studio shows the resulting user app exactly as it would display on a mobile device. When the designer is satisfied with the configuration, visualizing the result on a mobile device requires only that the designer connect it to the TapNLink via one of the supported radio interfaces.

IoTize Studio and TapNLink are designed to allow the transfer of the Designer's configuration using a direct Wi-Fi or BLE connection with the designers PC, or via a mobile device connection either directly with the designer's PC or IoTize's Cloud-based MQTT relay. Thanks to this implementation no additional hardware is required during the design phase.

4.2 Mobile device software

Various application notes are available at the IoTize website to describe how to design HTML pages to monitor the TapNlink from a mobile device. APIs for native programs are also available.

5 Features

The TapNLink NFC, Wi-Fi, BLE module (root part number: TnL-FIW103) offers instant integration of contactless/wireless radio interfaces to enable the connection of a microcontroller-based target system to a local mobile device (smartphone, PDA, tablet, PC, etc.).

TapNLink connects directly to two GPIOs on the microcontroller in the target system. These GPIOs can be either the target microcontroller's debugging/programming port (ex. SWD) or any pair of GPIOs enabled by the IoTize S3P protocol (application relinking is required). The connection to the target microcontroller is non-intrusive and allows read and/or write access to variables in the target microcontroller's memory. The data addresses and access parameters for the target system are configured in the TapNLink using the IoTize Studio configuration environment.

TapNLink communicates with local mobile devices via their NFC and/or Wi-Fi or BLE interfaces. The Tap Manager app (Android or iOS) on the mobile device manages its communication interfaces, thus eliminating the need for the target-system designers to code or validate these mechanisms. Designers instead focus on creating the user interface for the target system.

With TapNLink NFC, Wi-Fi, BLE modules, a local mobile device can serve as a network gateway to bring data to or retrieve data from the Cloud. Data that is read by the TapNLink can be transmitted via the mobile device's data or network connection when available. For this, IoTize provides an MQTT-based relay with IoT Cloud platform translators. This MQTT infrastructure is open source software that designers can install on servers and adapt to any private or public IoT Cloud platform.

5.1 Communication channels

5.1.1 Near Field Communication (NFC)

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

5.1.2 Wi-Fi

- Max power: 16 dBm (Conducted power)
- Data transmission rate[1]: DSSS, 1Mbps ; OFDM, 54 Mbps ;
- Range[2]: to 30 meters

5.1.3 Bluetooth Low enrgy (BLE)

- Max power: 3 dBm (Conducted power)
- Data transmission rate[1]: 0.5 kilobytes per second
- Range[2]: to 30 meters

Notes:

1. *Average speed while acquiring 1000 times 220 bytes from the target.*
2. *Measured line-of-site in an environment free of obstructions and rebound effects.*

5.2 Target system interface

Requires 2 GPIO enabled by the target microcontroller's debug protocol or IoTize Simulated Secure Serial Port (S3P).

5.3 Security features

Customized firmware allows differentiated algorithms for each application. The communication chain is fully secured using classic techniques such as:

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

When implementing on GPIO that are enabled by the target microcontroller's debug protocol, data encryption is enabled to the level of the TapNLink module.

When implementing with S3P protocol, security features can be implemented on the target microcontroller. Features include data encryption and filtering of accessible addresses in the target's memory space.

5.3.1 Access control configuration

IoTize stores access control data in 2KB of E²PROM:

- Accessible data addresses: up to ~ 500
- User profiles: up to ~ 100
- Access rights: Read/Write
- Plus 3 predefined profiles of up to 96 characters.

5.4 Electrical characteristics

5.4.1 Power supply

- Maximum DC supply voltage 3.6V
- DC supply voltage 2.3V to 3.6V
- Low power consumption:
  - Standby: 100 µA
  - NFC: 7 mA
  - Wi-Fi Rx: 50 mA
  - Wi-Fi Tx: 110 mA (802.11g)
  - BLE Tx/Rx: 65 mA

When in standby mode, wake up of the Tap is possible using NFC.

5.4.2 Digital levels

- Maximum voltage on input/output Vcc + 0.3V
- Minimum voltage on input/output - 0.3V
- Input low voltage (max) 0.25 x Vcc
- Input high voltage (min) 0.75 x Vcc

5.5 RF specifications

For details, see ESP32 specifications.

Parameter	Min	Typ	Max	Unit
Frequency range	2402	-	2480	MHz
Rx sensitivity[(1)] Wi-fi		-93		dBm
Output power[(1)] range Wi-fi		16.0	17.0	dBm
RX sensitivity BLE @0.1% BER		-94		dBm
Output power range BLE		3.0		dBm

(1) Typical value, depend type of modulation.

5.6 Mobile device support

TapNLink 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.

The Tap Manager app manages the radio interfaces on mobile devices running Android v4.0.3 and iOS v10 or later versions.

5.7 Cloud support

TapNLink includes an open source MQTT relay. Designers using TapNLink are free to copy and adapt this to meet their specific requirements for data exchanges with IoT Cloud platforms. Full information about IoTize Cloud support for TapNLink is provided in the IoTize MQTT Relay User Manual.

5.8 Operating temperature range

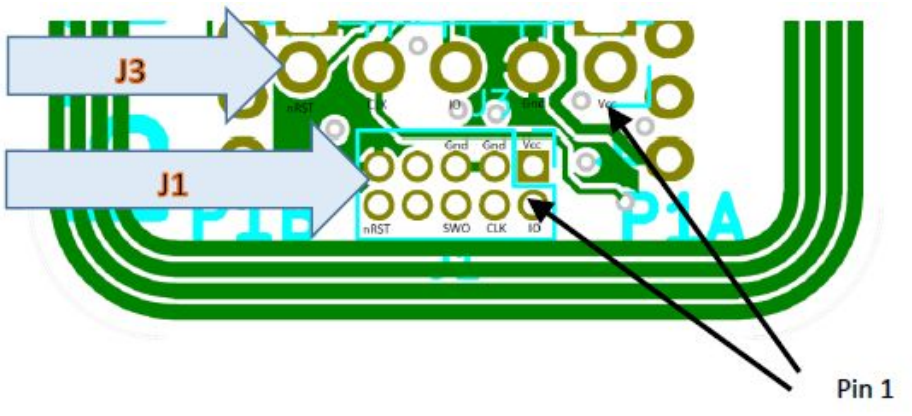
The behavior and the radio characteristics have been tested to guarantee a correct operation in the range [-20°C, +55°C].

6 Pin assignment

The TapNLink Wi-Fi/NFC module has 3 connectors:

- J1 (2x5 in 1.27mm steps) which connects the TapNLink to the debug connector (ARM-SWD standard) of the target board via a flex cable (in 0.635mm steps).
- J3 (1x5 in 2.54mm steps) which connects the TapNLink to the target board using free wires that need not be grouped in a ribbon cable or with a single end connector. Note that J3 is a subset of J1.
- P1 extension connector which is composed of two rows of contacts (P1A and P1B) with 2mm spacing. This connector is mainly reserved for the addition of expansion cards and is only briefly described in this document.

The following figure shows (bottom view) the signals connected to J1 and J3:



6.1 J1 pinout

This connection corresponds to the format specified by ARM for Cortex-M microcontrollers

Vcc	1	●	●	2	S3PIO/SWDIO (TMS)
Gnd	3	●	●	4	S3PCLK/SWDCLK (TCK)
Gnd	5	●	●	6	SWO (TDO)
Not connected	7	●	●	8	-- (TDI)
Gnd	9	●	●	10	nRST

Note:
The names in parentheses correspond to the JTAG protocol. In general, it is advisable to priviledge using SWD over JTAG for Cortex M-based microcontrollers. For any other microcontroller, use the S3P protocol.

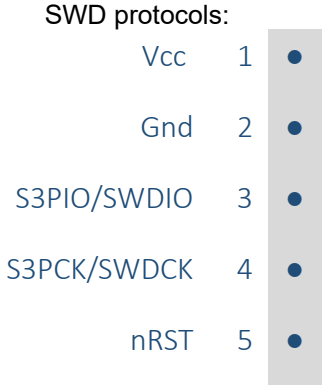
The signals to be connected in SWD or S3P are:

- Gnd
- Vcc (the target must provide the TapNLink power),
- S3PIO/SWDIO, a bi-directional data signal.
- S3PCLK/SWDCLK, the clock signal, bi-directional in S3P.
- NRST: Reset signal of the target processor. Its connection is optional. It should be maintained if you want to use the reset command, or if you want to use TapNLink as a programmer (the reset signal is required in some programming situations).

6.2 J3 pinout

J3 was added for practical reasons. The 2.54 mm step connectors are cheaper and more robust and can connect to a wide range of other connectors. It is easier to use this connector to connect to the 20-point ARM 2.54mm-step standard.

J3 does not correspond to a standard. It contains the main signals necessary for the S3P and SWD protocols:



6.3 P1 extension connector

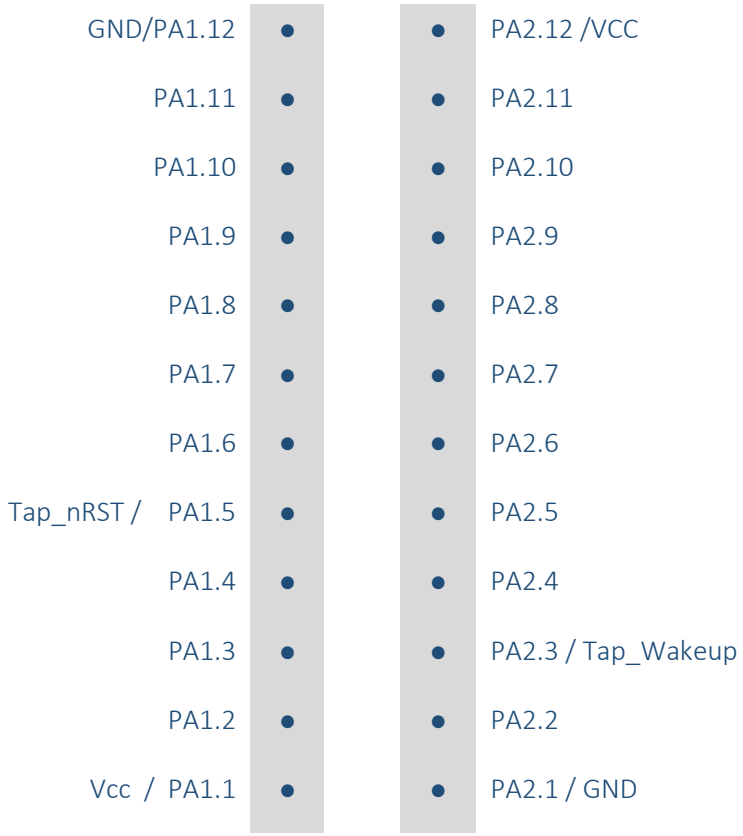
P1 extension connector is composed of two mechanically independent parts:

· PA1 has 12 points

· PA2 has 12 points. The two additional points are used exclusively for initial programming.

Most of the signals on the expansion connector are reserved for extensions proposed by IoTize, so this connector will only be used in exceptional situations, for example, if it is necessary to control the reset of the TAP.

The figure below shows the position of the TapNLink's power, reset and wakeup points.



7 Regulatory compliance

Changes or modifications not expressly approved by IOTIZE S.A.S. could void the user's authority to operate the equipment.

TapNLink TnL-FIW10x is tested and qualified under the following standards:

7.1 CE certification (Europe)

The TapNLink TnL-FIW10x operating range corresponds to:

- Frequency Band: 2402-2480MHz (BLE) / 2412-2472MHz (WIFI)
- Maximum Transmitting Power: Wi-fi 17.4mW and BLE 0.5mW (EIRP)

This device has been tested and certified for use in the European Union and IOTIZE hereby declares that the device "TapNLink TnL-FIW10x" is in conformity with the essential requirements of Directive RED 2014/53/EU. The complete Declaration of Conformity can be found at:

- Appendix 1 of the present notice,
- www.iotize.com for the electronic version.

If this device is used in a product, the OEM is responsible for verifying compliance of the final product with the relevant EU standards. A Declaration of Conformity must be issued and kept on file. The 'CE' mark must be placed on the OEM product per the labeling requirements of the Directive.

7.2 FCC (USA) and IC (Canada)

7.2.1 FCC Part 15 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.
- This module has been approved under FCC part 15C 15.247. This modular transmitter is only FCC authorized for this specific rule part.
- The module is limited to OEM installation ONLY.
- The OEM integrator is responsible for ensuring that the end-user has no manual instruction to remove or install module.
- The host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. (For example, Part 15 Subpart B)
- If testing of the host product with this transmitter installed and operating is necessary (to verify that the host product meets all the applicable FCC rules), a test mode for this specific module is available upon request to IOTIZE.
- Trace antenna design, list of antenna type approved and professional installation is not applicable to this modular certification.

7.2.2 ISED - Industry Canada Licence-Exempt Radio Apparatus

This device contains licence-exempt transmitter(s)/receivers(s) that comply with Innovation, Science and Economic Development Canda's licence-exempt RSS(s). Operation is subject to the following two conditions:

1. This device may not cause interference.
2. This device must accept any interference, including interference that may cause undesired operation of the device.

7.2.3 ISED - Industrie Canada appareil radio exempts de licence

L'émetteur/récepteur 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 :

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

7.2.4 Radio Frequency (RF) Exposure Compliance of Radio communication for mobile Apparatus

To satisfy FCC and IC RF Exposure requirements , a separation distance of 30mm or more should be maintained between the antenna of this device and persons during operation. To ensure compliance, operation at a closer distance than this is not recommended. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

7.2.5 Conformité à l'exposition aux champs RF des équipements radio mobiles

Pour satisfaire aux exigences FCC et IC concernant l'exposition aux champs RF, une distance de séparation de 30mm ou plus doit être maintenu entre l'antenne de ce dispositif et les personnes pendant le fonctionnement. Pour assurer la conformité, il est déconseillé d'utiliser cet équipement à une distance inférieure. Cet émetteur ne doit pas être co-situé ou fonctionner conjointement avec une autre antenne ou un autre émetteur.

7.2.6 End Product Labeling

7.2.6.1 FCC Certification

The final end product must be labeled in a visible area with the following:

"*Contains Transmitter Module FCC ID: 2APCX-TNLFIW10*"
or "*Contains FCC ID: 2APCX-TNLFIW10*"

7.2.6.2 ISED Certification

The final end product must be labeled in a visible area with the following:

L'équipement final doit être étiqueté sur un endroit visible avec le texte suivant :

"Contains IC: 23741-TNLFIW10"

7.2.7 End Product User's Manual:

The user manual for end users must include the following information in a prominent location:

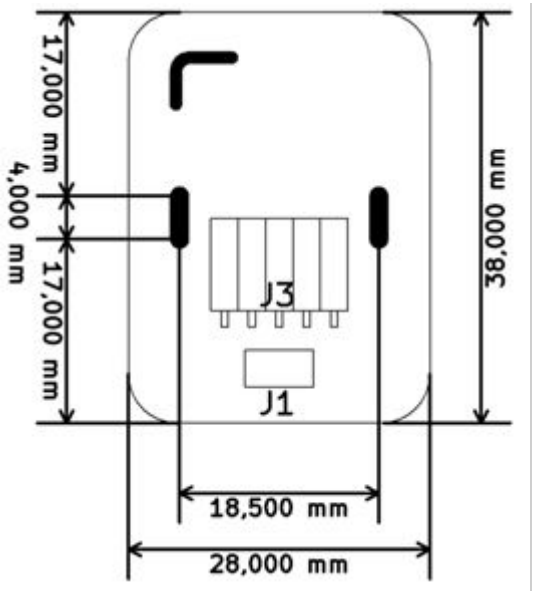
To satisfy FCC and ISED RF Exposure requirements, a separation distance of 30mm or more should be maintained between the antenna of this device and persons during operation. To ensure compliance, operation at a closer distance than this is not recommended. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Pour satisfaire aux exigences FCC et ISDE concernant l'exposition aux champs RF, une distance de séparation de 30mm ou plus doit être maintenu entre l'antenne de ce dispositif et les personnes pendant le fonctionnement. Pour assurer la conformité, il est déconseillé d'utiliser cet équipement à une distance inférieure. Cet émetteur ne doit pas être co-situé ou fonctionner conjointement avec une autre antenne ou un autre émetteur.

8 Mechanical characteristics

8.1 Module dimensions

The main dimensions are noted in the diagram below (bottom view):

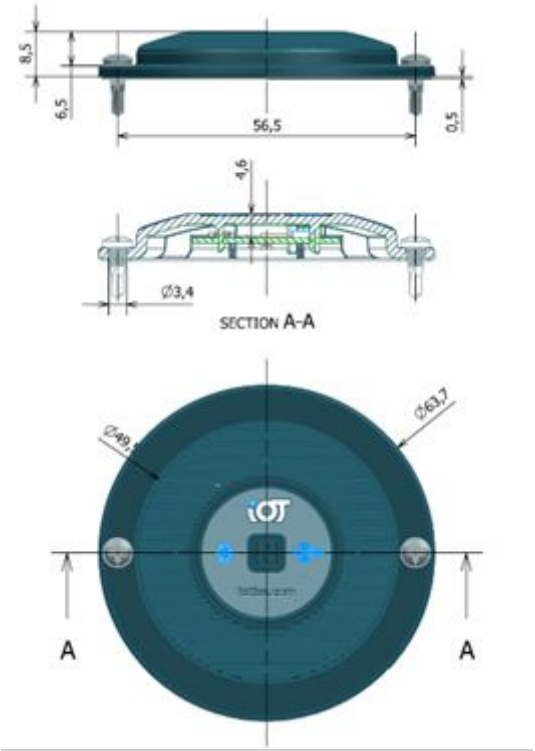


Dimensions[3]: 28 x 38 x 3 mm

Weight: 3 g

8.2 Standard plastic case

An optional plastic casing is available from IoTize (see dimensions below):



8.3 Ordering Codes and Options

Base part number: **TnL-FIW10x**

Available part numbers:

- TnL-FIW103

Product Line	Use Mode	Physical Interface	Radio Interface[1]	Product Prefix	Security	Casing Type	Power Supply
TnL	F	I	W	10	3	-0	-TO

Product Lines:	**TnL = TapNLink[1]**
Use Mode:	**F = Fixed** (powered by target system)
Physical interface:	**I = SWD/S3P**
Radio interface:	**W = Wi-Fi/BLE**, T = NFC Only, R = BLE, B = Bluetooth Classic, L = BLE, LoRa
Security:	1 = Primer, 2 = Low, **3 = software based**, 5 = hardware based with embedded secure element.
Casing Type[2]:	**-0 = No casing option selected**
Power Supply:	**-TO = Powered by target system only**

Notes:

1. The features of the part number shown in the table are indicated in bold.
2. The ABS plastic casing is available as an option with its specific type number.

1 Appendices

EU Declaration of Conformity (DoC)

We, the undersigned:

IoTize S.A.S.
960, Chemin de la Croix Verte
38330 Montbonnot St Martin
France
Email: contact@iotize.com
Phone : +33 4 76 41 87 99

Designated product: **TapNLink Wifi Low Energy module**

Model:	TnL-FIW10x
Frequency band 1:	2412-2484MHz
Max Power:	Wi-fi 32mW and BLE 10mW (e.i.r.p)

Certify and declare: **under our sole responsibility that the designated product is in conformity with the essential requirements and provisions of the following European Directives:**

☒ Directive **2014/53/EU** of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of **radio equipment (RED)**.
The conformity of the designated product(s) with the provisions of this European Directive is given by the compliance with the following European Standard(s):

Essential requirements of article 3.1a) of RED: (Safety, electrical)	- EN 62368-1 (2014)
Essential requirements of article 3.1a) of RED: (Safety, health)	- EN 62311 (2008)
Essential requirements of article 3.1b) of RED: (Electromagnetic Compatibility)	- ETSI 301 489-1 (V2.1.1) - ETSI 301 489-3 (V2.1.1)
Essential requirements of article 3.2) of RED: (Efficient use of radio spectrum)	- ETSI EN 300 328 (V2.1.1)

☒ 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)**.

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TapNLink DoC, page 1 of 2

EU Declaration of Conformity (DoC)

Important Notice:	Red approval is only valid for products in delivery state, including standard hardware and software. The user is responsible for operating the radio equipment and the accessories as intended and in accordance with the provided instructions. It is the responsibility of the OEM manufacturer to demonstrate compliance with all applicable EU directives and standards. The IoTize declaration of conformity serves as a support input for the declaration of conformity for the final equipment.

The technical construction file is available from:

IoTize S.A.S

960 Chemin de la croix verte

38330 Montbonnot Saint Martin

Phone: +33 4 76 41 87 99

Issued on November 8th, 2019.

Name and position of person binding the manufacturer or his authorized representative:

Name: Francis Lamotte
Position: President
Email: francis.lamotte@iotize.com

Signature:

iotize.com

2 History

Date	Version	Author	Modification
May 10th 2019	1.0	AM	First release version.
June 14th 2019	1.1	PF, SG	Text revisions and corrections
June 27th 2019	1.2	SG	Product photo updates
November 8th 2019	1.3	PF	Add BLE features